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The Geomorphic Regionalisation of Delhi and its Surrounding

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Abstract: The geomorphological classification of a region into different land systems is a comprehensive study of geology, surface forms, soils, hydrology, vegetation and their interrelationships. These land systems can form a useful framework for environmental and land use planning. This is because on this basis not only can relationships between the immediately observable properties be established but also inferences can be made about terrain properties which are not immediately observable. On a broad basis of homogenous geological structure and morphogenesis, Delhi and its surroundings is divided into two land systems- The Bedrock Area and The Alluvial Area and their subunits. The Bedrock Area is a morpho-structural feature and the Alluvial Area is a morpho-sculptural feature.

Keywords: Geomorphic Regionalisation, Geomorphic unit, Land System, Landsat imagery.

The present study is the description, analysis and interpretation of landforms from the point of view of geomorphic regionalisation. This type of regionalisation involves the delimitation, characterisation and cartographical representation of regional units composed of similar structure and surface forms. It rests in the geomorphological analysis of relief forms and relief forming processes. This promotes the regionalisation of other landscape elements as soil, water, vegetation including natural resources and potentials in the frame of complex geomorphological survey. Regionalisation is an independent form of classification of objects and phenomena which comprise

regular terrain associations, the properties of which depend on their geographic position. In such a classification the regions retain their territorial homogeneity and internal unity due to their common history of development, geographic positon, common geographic processes and spatial association of individual constituents. This type of classification has a very diverse and practical significance as identification of geomorphic region which form different land systems (Area with a recurring pattern of topography soil vegetation and hydrology) has given the needed impetus to tackle some of the environmental problems.

The Delhi Region forms an ideal unit for geomorphological regionalisation as in this region with the passage of time, the geomorphologic features are getting subdued by manmade features. In the heart is the NCT of Delhi, a growing metropolis which has influenced the peripheral region through urbanisation and in many areas inappropriate land use has led to various land problems. Therefore, knowledge of the geology and geomorphology of the region helps in linking physical environment to land use thus leading to judicious utilisation of the available resources.

The Study Area.

The Delhi Region (Figure 1) is situated in the Indo- Gangetic divide between the corridors of foreign invasions and the fertile Ganga Plains and extends between 28°20'-28°54'N latitude and 76°55'-77°27'E longitude. The area comprises of NCT of Delhi, Ghaziabad tehsil in the east, parts of Sonepat, Rohtak and Jhajjar tehsil of Rohtak district in the west and parts of Gurgaon and Ballabgarh tehsil of Gurgaon district in the south. The total area of the region is 3385 sq.kms with NCT of Delhi occupying an area of1485 sq.kms and the surrounding area of about 1900 sq.kms. The name of the area "Delhi Region" is not on the basis of any political boundary. The criteria for grouping this area into one region is because the characteristics of land in this area is controlled by the lithology and structure of two physical units-The Aravalli hills to the southwest and the River Yamuna to the east. The NCT of Delhi is the largest administrative unit within the area, the rest being the

surrounding area, the term "Delhi Region" is appropriate. Geologically the study area comprises of grey to grey brown quartzite and the quaternary alluvial deposits. A general stratigraphic sequence denotes that the oldest rocks are the Delhi Quartzite, which belong to the Algonkian time period while the Alluvial deposits belong to the more recent Pleistocene period. These two geological formations are interspaced by a long interval of time. These different physical features merge gradually into each other resulting in contact zones indicating a change from one landform type to another. The region has a sub-tropical climate which supports a xerophytic vegetation.

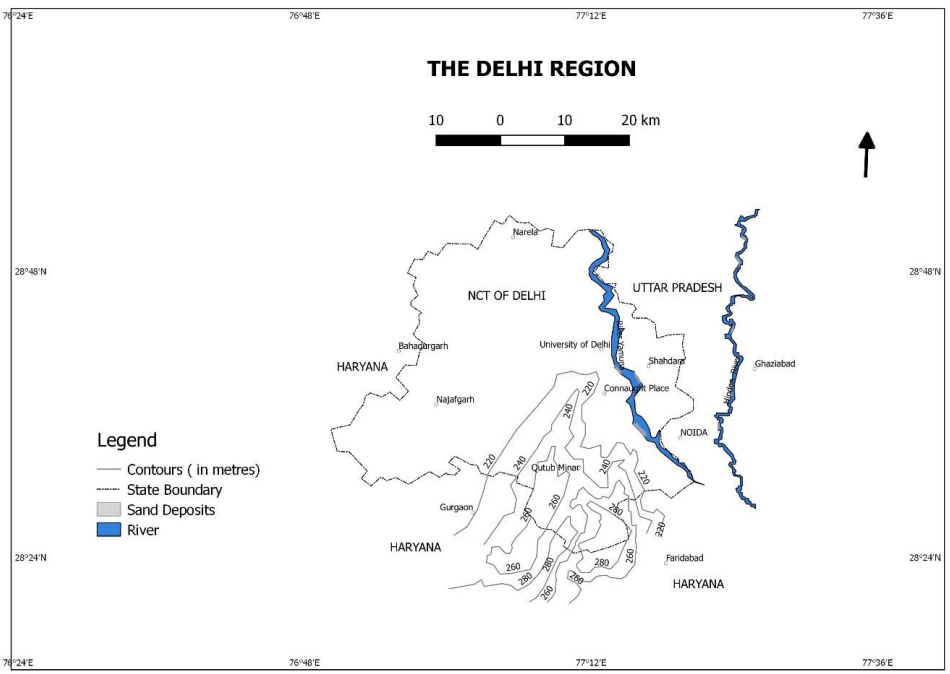

Figure 1. *Source: Map made by author based on Census 2011 map of Delhi and Survey of India, Topographical maps of Delhi and its surrounding.*

Physical Setting of the Region

The significant physiographic features of the region are the hills and plateaus of the Aravalli Ridge, the old and the new floodplain of the Yamuna and the low lying areas. The ridge here represents the northern extremity of the Mewat branch of the Aravalli. The time worn hills and plateaus of the ridge are made up of the Alwar series of rocks that is the Alwar or Delhi Quartzite. The ridge is the north-eastern extension of the Aravalli range of Rajasthan which is one of the oldest mountain ranges of significant size. A branch of these Aravallis enters the Delhi Region from the southwest and extends straight to the Yamuna in a north-easterly direction. Apart from the main branch there are a number of flanking spurs adding to the complexity of the landscape. The ridge is fairly dissected and storm water streams have etched into its rounded contours. These dry channels, the gullies and ravines sculptured by soil erosion, the residual hills, the boulders scattered over gullied plains, the undulating dales and vales give the ridge a fairly high degree of picturesqueness.

The River Yamuna is the chief drainage channel of this region and it flows in the north-south direction following the general slope of the land. The Hindon River is the smaller stream to the east and it flows parallel to the Yamuna. The 220 metres contour is the western boundary of the plains, demarcating it from the ridge. With an average height of 200 metres above mean sea level, the plains are considerably fertile and wider in the north and lose themselves in a maze of rocky undulations to the south.

The Yamuna plains have a deep mantle of Quaternary alluvium. These deposits laid down to the east of the ridge up to western banks of the Yamuna, generally comprise of unconsolidated strata of silt, clay and sand interbedded with nodular calcareous material at places. The region of recent deposits is the new floodplain and it occupies a lower level and is liable to

inundation during floods. The area has clay loam and high water table facilitating irrigation from wells. The old floodplain is a region of Pleistocene deposit and it is on a higher ground as compared to the new floodplain. Besides this old and new floodplain, there is the basin or low lying area to the west of the hills where the drainage from the hills collects and converges.

Methodology and Sources of Data

The geology and geomorphic processes determine the surface configuration of the region. These are a result of interacting phenomena which gives rise to various features over the earth surface, thus resulting in different land systems. On a broad basis of homogenous geological structure and morphogenesis (origin and formation of surface forms) the Delhi Region is divided into two land systems- (A) The Bedrock Area (B) The Alluvial Area The Bedrock Area is a morpho-structural feature resulting from geological structure. These features are a result of endogenous processes and surface ruggedness is the major geologic information. On the other hand, the alluvial area is a morpho-sculptural feature which has resulted from exogenous processes. For the description of these land systems and their sub units the aspects taken into account are the altitude (Table 1), gradient of slope and the surface configuration. The sources of data are the topographical maps and satellite imageries and the census map of NCT of Delhi. The toposheets used are 53H/1, 53H/2, 53H/3, 53H/5, 53H/6, 53H/7, 53D/13, 53B/14, 53D/15 on a scale of 1:50000.

Two Landsat imageries of the region are used to delineate the land use and land cover characteristics. The imageries are a product of Landsat IV (MSS, FCC) on bands 2, 3 and 4. The imagery of the Delhi Region is on a scale of 1:398000 and the imagery of the NCT of Delhi is on a scale of 1:280000.

Table 1. *Altitudinal area of the Delhi Region.*

Height in metres	Area (% age)
Below 180	15
180-220	53
220-240	22
240-270	8
270-300	0.2
300-320	0.1

Source: Area calculated by the author

Geomorphic Units of the Bedrock Area

The bedrock area is the north eastern extension of the old fold mountains of Rajasthan- the Aravalli Ranges. These ranges are the Pre Cambrian group of mountains and are the remnants of one of the oldest mountains on the earth surface. The geology of this area is hard, compact rocks with rectangular joint system and pale grey, pale pinkish or white in colour. Their long existence and the dry climatic conditions of the region, resulting in sparse vegetation, has made these ranges vulnerable to large scale weathering and erosion. Due to this aspect the height of the ranges is not very much and ranges from 240-300 feet in the Delhi Region.

Subunits of the Bedrock Area: On the basis of their elevation, the bedrock area can be classified into three subunits (a) The Aravalli Ridge (b) The Piedmont plains (c) Undulating to level plains of the Aravalli alluvium. The Aravalli Ridge: The Aravalli Ridge is the most significant physiographic feature in this area and includes the area enclosed by the 240 metres contour. The area can be further subdivided into smaller units- The Northern Ridge and the Southern Ridge.

The Northern Ridge occurs in the northern part of the region from the north of Sadar Bazar up to Timarpur with its maximum elevation at 240 metres and a steep gradient of slope from 1°1' to 1°30'. The ridge is not continuous all throughout and has been broken up at several places. This rocky region has a thin soil cover which comes under the world group of grey brown soils of the desert and semi desert region. The soils are coarse in texture and deficient in nitrogen but have a thin layer of organic material. The vegetation here is tropical xerophytic thorn forest with acacia as the dominant permanent vegetation. Other small varieties include Neem, Dhak and Wild Date Palm. The natural depressions support ephemeral vegetation. As compared to the southern ridge, this part supports some vegetation because of the government policy to declare the area under reserve forest. However the area is not completely free from human interference and large areas have been cleared for construction of parks and roads. The surface hydrology shows that the ridge is a dry area and only the depressions tend to hold water during the monsoons. The satellite imageries show that most of the ridge is under 'open forests' but in recent years the vegetation here faces some natural problems like thin and poor soil cover, lack of water due to greater surface runoff . In order to maintain the environment of the region and to lessen the process of weathering and erosion, the vegetation in the area has to be protected. This can be done by promoting afforestation and preventing urban encroachment on forest land. The northern ridge further continues southward and after being intercepted by built up area, it appears in the Delhi Region forming the Southern Ridge.

The Southern Ridge is larger in extent and stands out distinctly from the surrounding alluvial plains. The southern Ridge starts from Rajinder Nagar and proceeds southwards up to Munirka. From Munirka it bifurcates into two parts, one part continues towards Gurgaon and the other towards Faridabad. This aspect helps in further sub dividing the Southern Ridge into two smaller units (i) South Ridge 'A' (from Rajinder Nagar to Munirka) (ii) South Ridge 'B'(from Munirka towards Gurgaon and Faridabad).

The South Ridge ‘A’ occupies the maximum height, width and length, is highly undulating and the elevation varies from 240-255 metres, with maximum elevation at Dhaula Kuan and Buddha Jayanti Park. The major geomorphic processes of weathering and denudation operating here have given rise to features like scattered boulders, bare rocks and ravines. Soil cover is thin and sandy in nature. Soil erosion is a problem in the higher slopes. The satellite imageries show that the area around Shankar road and Buddha Jayanti Park is densely forested. The predominant trees are Acacia and the forest thins out toward Dhaula Kuan. The formation of ravines is a major problem in the region resulting in accelerating the formation of sandy soil and soil erosion.

South Ridge ‘B’ bifurcates into two spurs from Munirka, one moving towards Gurgaon and the other towards Faridabad. The area is rocky with average elevation above 240 metres and there is a steep gradient of slope. The ridge reaches its highest point at Kalkaji. The geomorphic processes operating here are those of physical weathering and erosion, with exfoliation giving rise to numerous rounded boulders called tors. Heaps of tors are observed all throughout the southern ridge. The satellite imageries show that the southern ridge is totally bare of vegetation.

The Piedmont Plains: The piedmont plains occur at the foot of the ridge at an elevation of 240-260 metres. The satellite imageries show that the piedmont plains of the northern ridge are under forests while that of the southern ridge are under residential colonies like Rajinder Nagar, Chanakyapuri, R.K Puram, Govindpuri, Greater Kailash and Mehrauli. A large part of the area is under wastelands because of badland topography.

Undulating to Level Plains of the Aravalli Alluvium: These plains are formed by the eroded materials from the Aravalli Ranges and enclosed by the 220-240 metres contours. The region has a slightly undulating topography and the slope is very gentle. The surface has been mainly formed by granular

disintegration of Quartzite rocks. The 220 metres contour makes a clear distinction between the Bedrock Area and the Alluvial Area.

Geomorphic Units of the Alluvial Area

The Alluvial area is formed by the deposition of sediments by the major rivers flowing here, the River Yamuna and its tributary Hindon. The river Yamuna rises in the Jamnotri glacier in the Himalayas and flows in a south westerly direction towards the Siwalik Hills. It enters Delhi about 1.6 km north of the Palla village at an altitude of 210 metres. Within the Delhi Region it flows for a distance of 62 kms and within the NCT of Delhi for a distance of 51kms. The other river in the region is the Hindon River which flows parallel to the River Yamuna in the Delhi Region. This shows that the floodplain of the River Yamuna towards the east is quite high and the smaller river is not able to cut through it and becomes a 'Yazoo Stream'. The Yamuna being a Himalayan river has eroded and transported large amount of sediments which have been deposited in the plains, forming the floodplain of the river. The deposition kept on occurring all along the river forming the New Floodplain and as the river shifted, the older deposits gained further distance from the main river and formed the Old Floodplain. Another feature of the alluvial area is the low lying area or depression which becomes waterlogged during the rainy season. The Alluvial Area can be subdivided into three subunits- (a) Old floodplain, (b) New Floodplain and (c) Low Lying Area or Basin.

The Old Floodplain: This is the flat plain to the north, northwest and east of Bedrock area. This plain occurs at an elevation of 215-220 metres, it is not an even plain but has up and down topography due to the presence of low mound and depressions. The major morphological features are the old levees, river terraces and meander plains. The largest old levees are to the north of Nazafgarh. The river terraces mark the dividing line between the old and new floodplain. The soil is made up of coarse clay, silt and sand mixed with nodules of calcium carbonate, locally called kankar. The levees and

terraces are characterized by saline soils. The satellite imageries show that the area is mostly under settlements. The area to the north of Bahadurgarh is barren because of the sandy condition of the soil.

The New Floodplain: This is the floodplain along the river and has been formed by continuous deposition of silt along the sides of the channel. During floods this area is prone to inundation. The elevation of this area is 210 metres above mean sea level. Due to regular inundation the area does not have any permanent landform feature. Levees or natural embankments occur all along the river. Most of these levees are 3-4 mts wide and covered by grass or scrub vegetation. Gully erosion can be seen around Chandrawal and Metcalfe house where the river cuts into the Bedrock area. The area between the River Yamuna and River Hindon is mostly under settlements and patches of agricultural land.

The Low Lying Area or Basin: This area is a depression to the west, southwest and east of the Bedrock Area with an elevation of less than 210 metres and occupies 15% of the alluvial area.. The Najafgarh drain diverts the water and saves the area from being heavily inundated especially during the rains. Due to shortage and high price of land in the interior, this area has been brought under settlements.

Conclusion

Geomorphological classification provides an effective summary of characteristics of the area which can form a framework for environmental planners. This is because on this basis not only can relationship between the immediately observable properties be established but also inferences can be drawn about terrain properties which are not directly observable. For the Delhi Region the inferences made by the study of the two major land systems show that the increase in urban landscape sometimes has been at the expense of other land use especially agriculture and forestry. This has resulted in various environmental problems like heat island effect, water logging, increase in barren lands and wastelands and also increasing the risk of

disaster due to environmental hazards like torrential rainfall, floods and earthquake. The land system approach to the study of Delhi Region has scope for practical application in environmental and urban planning.

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