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A Gis Based Study on Slope Characteristics of Porandalar Watershed, Amaravathi Sub-Basin, Tamil Nadu

KEYWORDS: Watershed, Slope, GIS, Fishnet, IDW.

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ABSTRACT *A watershed is an area that drains surface water to a common outlet. It is hydrologic unit that is often used for the management and planning of natural resources. The study of slope in a natural unit like watershed has become an important aspect of geomorphology. The present study aims at analyzing the slope characteristics of Porandalar Watershed. A glance over the frequency distribution of slope provides uneven distribution of slope throughout the watershed. About 19.35% of the total area is level land which is found in the northern part of the study area. The very steep slope category can be found in the middle of the watershed as a small patch. Almost 57% of total study area is covered by moderate to steep slope zones.*

1. INTRODUCTION

The term slope in geomorphology denotes the declivity of some small portions of land surface with respect to the horizontal plane. In broader sense, slope means an element of earth's solid surface, including both terrestrial and submarine; it is, therefore, simply an element of the interface between the lithosphere and either hydrosphere or atmosphere (Strahler, 1956). Representation and analysis of slope are of great significance in landform study. The degree of slope controls the amount of run-off, velocity of river as well as the intensity of the processes of erosion, transportation and deposition. Thus, it plays a crucial role in landform development. Its study helps to delineate the character of various landform features as well as to identify the stage of landform development. It is an important element that determines the nature of land uses of the earth's space and is strongly influenced by structure, lithology, climate, soil, vegetation, altitude, relief, tectonic disturbances, etc. The study of slope provides information not only about the variety of topographical features but also makes available the evidences needed for interpretation of complex forms of landscape. In hilly terrain, the pattern of agriculture and distribution of settlements are controlled mostly by slope. Thus, slope is regarded as an important morphological attribute which helps to discern the surface configuration of different areas.

2. OBJECTIVES

The prime aim of the present study is to analyze the slope characteristics of Porandalar Watershed with the following objectives: (1) To ascertain the average slope of Porandalar watershed for each Km^2. (2) To classify different slope zones of the study area.

3. STUDY AREA

The Porandalar watershed extends between 10°11'23.77"N to 10°27'49.37"N latitude and 77°22'2.35"E to 77°30'3.89"E longitude. It covers an area of 284.16 km^2 with a perimeter of 89.80 km (Fig.1). It extends from north to south over a distance of about 29.17 km and from east to west over a distance of about 13.30 km. In general, Porandalar watershed is elongated in North to South direction. It is narrower in the extreme south and wider in the middle.

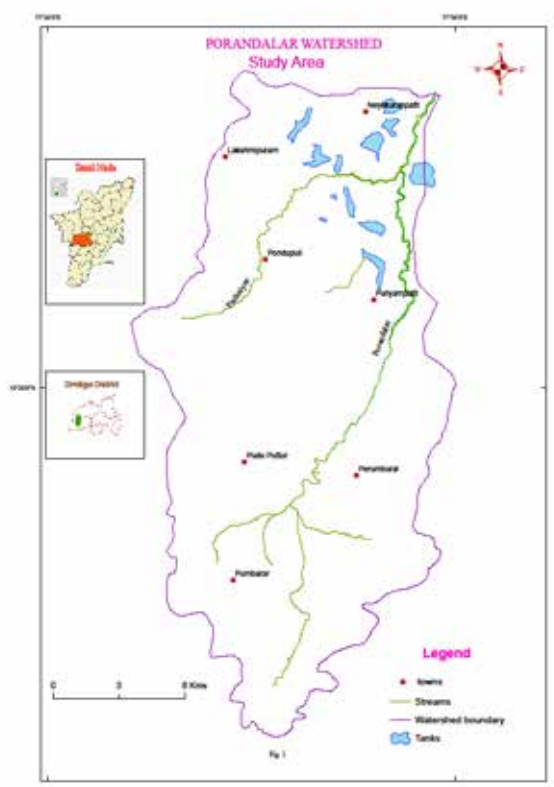

Figure 1: Location Map of the Study Area

4. METHODOLOGY

The study has been carried out based on secondary data generated through the Survey of India (SOI) toposheets numbered 58 F/7 & 58 F/8. These toposheets have been georeferenced using ArcGIS 9.3. The analysis of slope of the study area has been carried out following Wentworth's method. This method is the most convenient for computing average slope and making quantitative generalizations. Calculation of average slope has been based on the analysis of contours represented on Survey of India's topographical sheet numbered 58 F/7 and 58 F/8 on the scale of

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1:50,000. For analysis, the contour map of the study area with an interval of 20m has been divided into grids of 1 km^2 each and then the number of contour crossings has been counted along each side of the grid and divided by 4 to get average contour crossing per km. The number of contour cuttings over the diagonal sides are also counted and divided by 2.8 which gives the average contour crossing diagonally. The average contour crossings of four sides and two diagonals are added and divided by two to get the mean values. In this process, a total of 305 grids measuring about 284.16 km^2 have been analysed. Wentworth gave the following formula for computation of average slope from contour maps, using the British system.

$$Tan\theta = \frac{\text{Number of contour cuttings per mile x Contour Interval (in feet)}}{3361}$$

The tangent value of the average angle of slope is converted into degreesThis formula has been modified for application to the metric system as follows;

$$Tan\theta = \frac{\text{Number of contour cuttings per km x Contour Interval (in m)}}{636.6}$$

Where 636.6 is a constant derived for length in km from the original Wentworth's formula.

The square grids are drawn over the study area using fishnet tool of ArcGIS 9.3 to plot the slope values, derived from the above mentioned formula, in respective grids. The various slope zones have been classified using Inverse Distance Weighted (IDW) method.

5. RESULT AND DISCUSSION

The slope of the study area has been classified into six zones. They are mapped as level (< 2°), gentle (2-5°), moderate (5-10°), moderately steep (10-20°), steep (20-35°) and very steep (> 35°). The various slope classifications are shown in fig.2. The frequency distribution of slope and slope-area distribution are shown in Table 1 & 2.

5.1. Level slope category (S_L)

This category covers 54.98 km^2 (19.35%) of the total area under study. It covers the northern part of the Porandalar watershed. Most of the village settlements namely Lakshmipuram, Neikkarapatti, Chinnappampatti, Curadykuttam, Vadippatti, Kavapatti, Perumalpudur, Ottanpudur, Rajapuram and Thamaraikulam are located in this zone.

5.2. Gentle slope category (S_G)

It covers an area of 9.35 km^2 embracing 3.29% of the total area of the watershed. It is flanked by level slope area in the north and moderate slope category in the south.

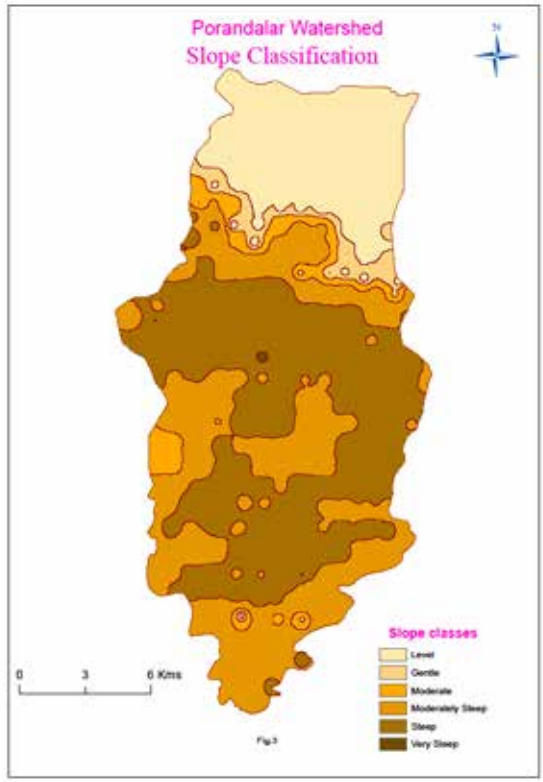

Figure 1 : Slope Classification

5.3. Moderate slope category (S_M)

The moderate slope category occupies an area of 12.60km^2 covering only 4.44 percent of the total area. Pondupuli is a settlement which is located in the category of 5 - 10° slope.

Table 1: Slope Distribution

Class Interval	Frequency	Cumulative Frequency	Frequency (%)	Cumulative Frequency (%)	Slope Classification
< 2	75	75	24.59	24.32	Level
2 - 5	9	84	2.95	27.54	Gentle
5 - 10	13	97	4.26	31.80	Moderate
10 - 20	97	194	31.80	63.61	Moderately Steep
20 - 35	110	304	36.07	99.67	Steep
> 35	1	305	0.33	100.00	Very Steep
Total	305		100.00		

5.4. Moderately steep category (S_{MS})

It constitutes an area of 91.28 km^2 (32.12%). It is found in the central and southern part of the watershed. Most of this forms the catchment area of Porandalar River.

5.5. Steep slope category (S_S)

It covers an area of 115.77 km^2 (40.74%) of the total area. The steep slope is found around the very steep slope area and it extends from west to east in the central part of the watershed. It is also found in the south central part of the watershed.

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5.6. Very steep slope category (S_{VS})

It covers an area of 0.19 km^2 (0.07%) and is found in the middle of the watershed.

Table 2: Slope-Area Distribution

Class Interval	Area (Km^2)	Cumulative Area (Km^2)	Area (%)	Cumulative Area (%)	Slope Classification
< 2	54.98	54.98	19.35	19.35	Level
2 - 5	9.35	64.33	3.29	22.64	Gentle
5 - 10	12.60	76.93	4.44	27.07	Moderate
10 - 20	91.28	168.21	32.12	59.20	Moderately Steep
20 - 35	115.77	283.98	40.74	99.93	Steep
> 35	0.19	284.16	0.07	100.00	Very Steep
Total	284.16		100.00		

6. CONCLUSION

Slope expresses the inclination of the surface of relief from the horizontal or local base level in a unit and is expressed in degrees. Wentworth's method of average slope determination has been applied for the present study area. About 19.35% of the total area lies between the slope categories of 0 to 2°. The highest slope values (above 35°) cover a very small area of about 0.19 km^2 (0.07%). Almost 57% of total study area is covered by three slope zones of 10-15°, 15-20° and 20-25° and these zones respectively cover 30.22 km^2, 61.06km^2 and 73.80 km^2. A slope category of 2-5° covers an area of 19.35 km^2 which is mostly found in the northern part of the watershed. The slope categories of 25-30° and 30-35° cover an area of 36.61 km^2 and 5.36 km^2 respectively. They contribute 14.35% of the total study area. The highest slope category of above 35° is found in the middle of the watershed as a small patch. The slope zone of 30-35° is found scattered in the central and southern part of the watershed. The three slope zones, viz., < 2°, 15-20° and 20-25° occupy the largest area of the watershed. They account for 190.81 km^2 (67.14%) of the study area.The present study aims to unfold the slope aspects of Porandalar watershed from geomorphologic point of view. Several economic issues such as protection of agricultural land, laying of roads and railway lines, land preparation for urban and rural developments can be addressed by this analysis.

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