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Slope aspects and scenic evaluation of nayaseri-catchment, Himachal Pradesh

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Abstract
Slope analysis is of great importance in assessing the area with regard to its functional utility. In the present study, relationship between slope aspects and land use has been analyzed to evaluate the catchment with regard to its broad land-use. This task can help in making the planning regarding the development, conservation and protection of attractive countryside. The slope in itself is a vector quantity, expressed both in terms of magnitude and direction. The direction of slope is expressed in terms of orientation from the north, measured in various proportions of 0°-360°. The magnitude of slope has been calculated by adopting Wentworth's method of average slope. Land-use and slope has been calculated grid-wise. Investigation reveals that slope aspects have a great impact on cultural land-use. While making the planning of area regarding the development of cultural landscape, slope aspects should be taken into account.

Keywords: nayaseri, Wentworth, sunny slopes, magnitude of slope, slope direction

Introduction
In the research paper, the area under the study is the catchment of the river Nayaseri. The catchment lies in Shimla district of Himachal Pradesh. It is bounded by 76° 6´15´´E to 76° 14´30´´E longitude and 31° 5´ 45´´N to 31° 13´ 45´´N of latitude. The area falls in topographical sheet No. 55E/4; covering an area of 108.81 sq. kms
The study area falls in the lower part of the middle Himalayas. Its average relief is moderate i.e. 1400m. The height of the basin ranges from 943 to 2400 meters. The basin has four mountain ranges namely: Durgapur-Mashobra, Dumi-Barmu, Bhaili-Fantenchi and Shimla (Jutogh- Dhalli) range. Durgapur-Mashobra range extends in northwest to southeast direction and exists in the eastern portion of the basin. The range is covered by agricultural land. Dumi-Barmu range in the central part of the basin extends in NW to SE direction. It is covered by dense pine forests. Bhaili-Fatenchi range which is covered with barren land; extending in North – South direction is located in western part of the basin. Shimla range joins the above stated three ranges in the southern portion of the basin. This is the range on which Shimla is situated.
The average slope of the basin ranges between 9° to 51°. The river has a steep side slope. It forms the George. The catchment has rocks of tertiary age, with bed belonging to the carbonaceous system (Krol and Blaini).
Almost whole the region has a scattered settlement pattern, except along the southern periphery. Settlements are permanent and these are of helmeted type. The density of settlements is high in the eastern portion and along with the southern boundary of the study area. Out of the total area of the catchment, forests cover 28% Area. Agriculture land and uncultivated land respectively constitute 33.8% and 38.2% areas of the basin.

Methodology
The analysis of catchment was carried out using topographical map no. 53 E/4 on the 1:50,000 scale. Went worth's method of average slope has been adopted to calculate the slope of area. To calculate the generalized slope on the map of slope directions, the map has been divided into facts characterized by equally spaced contour lines. The direction of slope is expressed in terms of orientation from north measured in various proportions of 0° to 360°. Various maps, like-average slope, slope directions, land use settlements have been superimposed for the analysis of facts. Field visits have also been carried out to confirm some facts. The steps involved in present study are:

- To study the slope aspects of the area.
- To study the relationship between slope aspects and settlement.
- To study the relationship between slope aspects and land use.
- To study the limits of slope aspects in respects to settlements and land use.

Analysis and interpretation
Slope analysis is of great value in assessing the natural resources of the area; Regional slope analysis has a dominant role in planning agriculture, engineering works, roods and settlements. The agriculture practices and settlements are especially very much influenced by the slope changes. Therefore, the study of regional slopes is of immense use for practical purposes. The slope in itself is a vector quantity expressed both in terms of magnitude and direction.

Magnitude of slope
Slope may be defined as property of the inclination from horizontal. It is result of various exogenetic and endogenetic forces. Various methods of slope analysis have been suggested by different scholars, like- S. Finsterwalder (1890), C.K. Wentworth (1930) [11], G.H. Smith (1935), E. Raize and Henry (1937), A H. Robinson (1981). A.N. Strahler (1952,56) and others for regional slope analysis. In
The present study, average slope map has been calculated by Wentworth's formula which has got wide application and mathematical validity.
The formula is changed into metric system. The formula employed is

$$\text{Tan } \theta = \frac{\text{(No. of counters cutting per km) x 1.6 (CI. In meters 3.3)}}{3361}$$

Where; Cl. Denotes the contour interval and 3361 is the constant value.

In the present analysis, magnitude of slope has been categorized in 5 classes viz. gentle (<10°), moderate (10°-20°), moderately steep (20°-30°), steep (30°-40°) and very steep (>40°). Steep to very steep slope (>30°) which occupies more than 56% area, extends on the eastern part of Shimla ranges, north fringe and in the central part of Bhaili-Fatenchi range. Gentle (0°-10°) to moderate (10°-20°) slopes fall in western part of Shimla range, central part of Durgapur-Masobra range and in the lake region of the basin. This category constitutes 16% area of the catchment. The central and southern part of the basin surrounded by patches of gentle and steep slopes exhibit moderately steep slopes. After studying the geographical behavior of the study area, it may be concluded that the basin in general is governed by moderately steep (20°-30°) and steep (30°-40°) slopes. These two categories constitute 25.7% and 49.4% area of the basin respectively.

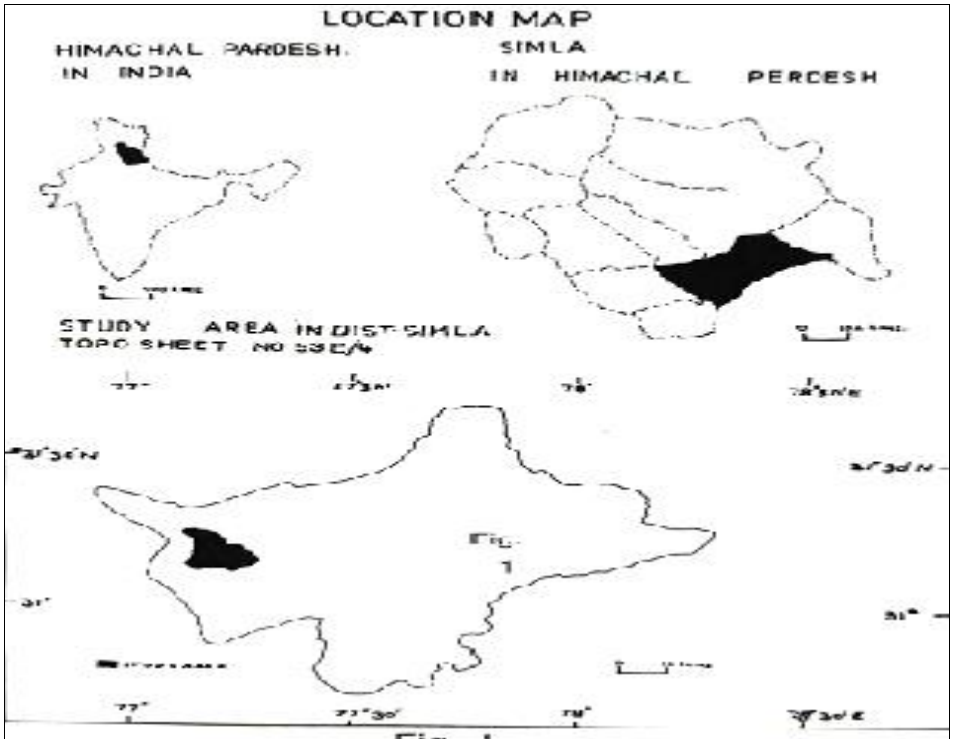

Fig – I

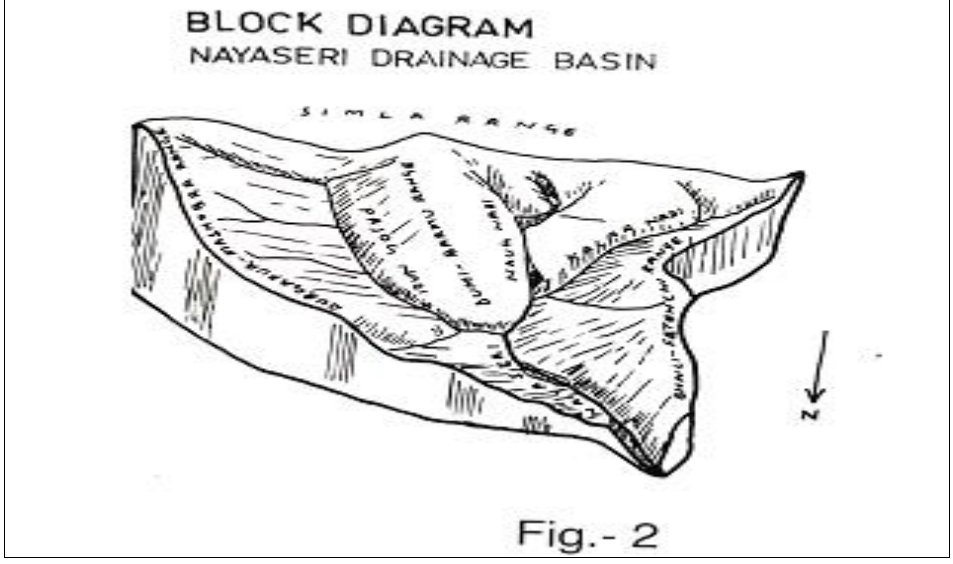

Fig.- 2

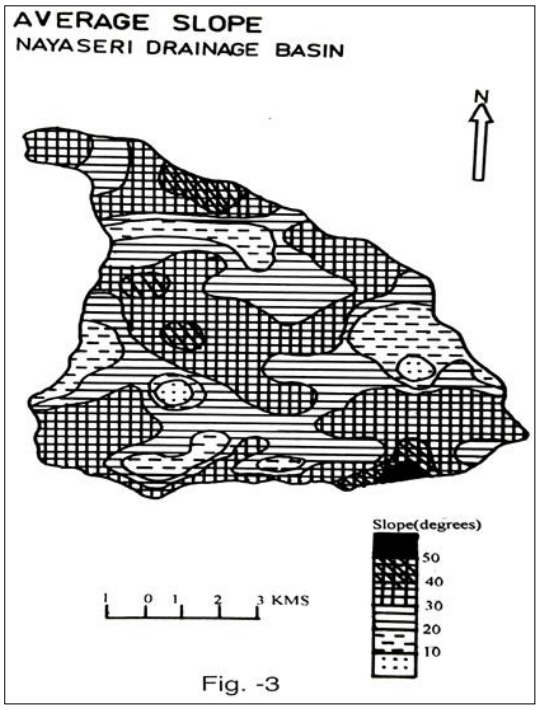

Fig. -3

Slope direction

Slope direction is an important characteristic that should be considered in the analysis of terrain, particularly in the mountainous region. In the present analysis, the term slope direction has been used to show the distribution of shady and sunny aspects of slopes. The study of these aspects of slope has great functional utility. Sunny and Shady aspects of slopes have their own significance. Shady slopes are not easily eroded, hence stable. Shady slopes are generally covered with forests, while sun facing slopes are covered with crops and settlements. These slopes are also easily erodible, hence, less stable and susceptible to landslides. The direction of slope is expressed in terms of orientation from north measured in various proportions of 0°to 360°.

The area under study has been divided into shady (315°-45°), easterly shady (45°-90°) easterly sunny (90°-135°), sunny (135°-225°) westerly sunny (225°-270°) and westerly shady (270°-360°) slopes.

Table 1: Area coverage under different slope facts

Slope facts	Sunny	Eastern Sunny	Western Sunny	Eastern Shady	Western Shady	Shady
Area (%) of catchment	9.6	10.2	27.5	19.5	15.3	17.8

Table 1

Reveals that a large part (27.5%) of study areas has western sunny slopes followed by eastern shady slopes. Sunny slopes cover only 9.6% of the total area under study. A glance at the fig (4) shows that the sunny slopes in the area are predominantly distributed in the north- eastern flank and in the central Durgapur-Mashobra range. Shady slopes are primarily distributed in the Shimla range, separated by some patches of eastern sunny and western shady slopes. Eastern sunny slope covers most of Durgapur-Mashobra range and western part of Naug River. Eastern shady slopes are mainly distributed in the north Western flank of the region.

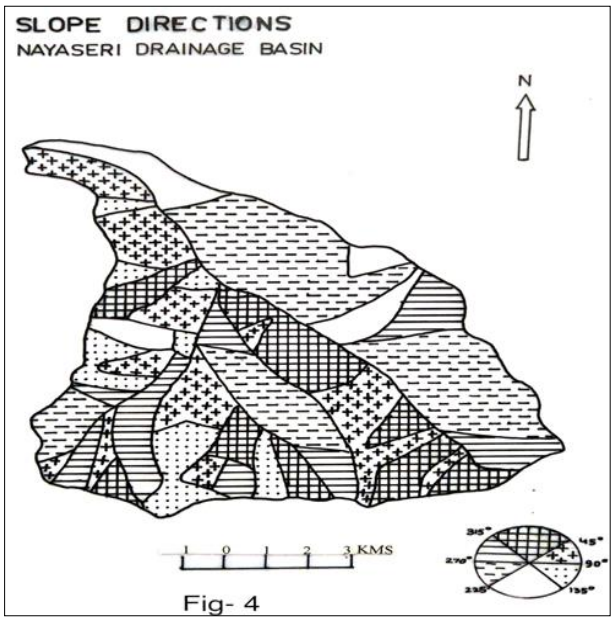

Fig- 4

Density of settlements

It may be defined as the number of settlements per unit area. The area has been divided into three broad categories of density of settlements viz. sparsely settled, moderately settled and densely settled. The areas having density <16 settlements per sq. Km. are classified as sparsely settled areas. More than 81% area of the catchment is covered under this category. There are two distinct patterns of distribution in the category. Areas in the east of Pajog river have density of settlements, ranging from 8-16 settlements/ Sq.Km. The areas in the east of Naug river exhibit a density less than 8 settlements/Sq. km. This pattern may be due to the fact that former areas have western sunny slopes, while the latter has mostly shady slopes, except few segments of sunny slopes. Moderately settled areas (16-24), covering about 11.5% area of the basin is primarily distributed in the southern portion of the catchment in form of narrow belts- one along the Shimal range and the other one along the south western sun facing slopes of Dumi-Barmu range. Densily settled area (>32 settlements/ Sq KM) which is 2.8% of the study area is distributed along with the southern periphery of the basin.

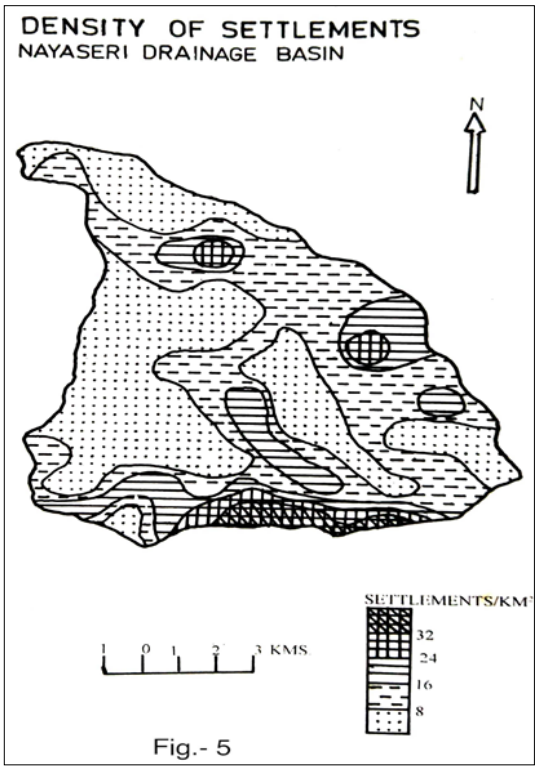

Fig.- 5

Land use

The land use has been divided into three broad categories viz. cultivated (C) uncultivated (U) and forested (F) lands. All the three types of landuses are consolidated in fig. (6). The area has been divided into grids of one square km. The letters F or C or U are placed on those grids where more than 60% area of the grid is covered under particular land use. Two letters – F U or CU or FC are placed on those grids where more than 40% area of each type of landuse does exist in the grid. Three letters- CFU stand that more than 30% area in each box is under each type of land use.

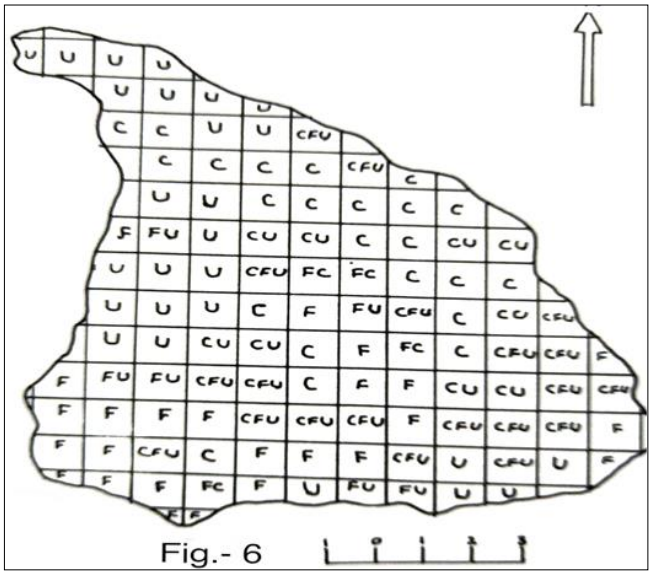
Fig.- 6

Fig 6: illustrates that the area in the east of Pajog river and South western slopes of Dumi-Barmu range is primarily used as agricultural land. Uncultivated land is dominant in the northernmost half of Bhaili- Fatenchi range. North eastern slopes of Dumi- Barmu range and the Upper catchment ar of Kalar and Naug Nadi is primarily covered with forests. In the south eastern flank of basin all the three variables are equally important. This type of land use is also distributed in the central and western part of the catchment in the form of certain patches.

Relationship of slope with settlements and land use

Table 2: Relationship of slope with settlement and land use.

Slope Class	Area (%)	Density of settlement	Land use as % of total area		
			Cultivated	Uncultivated	Forested
<10	2.2	8.0	48	29	23
10-20	13.8	17.2	44	31	25
20-30	27.5	10.4	39	35	26
30-40	49.4	10.0	22	43	34
40-50	5.6	6.4	06	66	28
>50	1.5	2.8	0	70	30

Slope exhibits a strong relationship with settlements and land use. It can be generalized from the Table 2 that settlements are concentrated mainly in those areas where slope is less than 35° and cultivated land is mainly concentrated in those areas where slope is less than 25°; because agriculture activities are restricted by steep slopes. Maximum concentration of uncultivated land is found in those areas where slopes are more than 35°; because at these slopes, it is very difficult to develop settlement and agriculture.

Relationship of slope facets with settlement & land use

It is clear from the table (3) that the highest concentration of settlement and agricultural land is found in sunny slopes. Density of settlements is 18.8 settlements per Sq. kms and 68 % of total areas are under agricultural activities in this category of slope while uncultivated and forested area is merely 14% and 10% respectively in the category. In the shady slopes, the density of settlements is 4.2 per Sq.

kilometer as compared to 18.8 settlements per Sq. kms in the segments of sunny slopes. In shady slopes, cultivated land is only 10% as compared to 68% on sunny slopes. Shady slopes are mainly covered with the forests. Sixty percent of the total area under the shady slopes is covered with forests as compared to 19% at sunny slopes. These coincidences confirm the dictum that sunny slopes are favoured slopes for agriculture and settlements.

Composite Picture of Slope Aspects and Land Use

Generalized slope of each slope segment (directional) has also been found to study the composite picture of slope segments (directional), magnitude of slope and land use. While calculating the generalized slope, major areas within each slope segment have been taken. Minor details such as valley side slope and waterfalls, escarpments have been left out.

Table 3: The composite picture of relationship of slope facets and magnitude of slope with settlements and land use.

Slope Segment	Generalized Slope (degree)	Density of settlement	Land use as % of total area		
			Cultivated	Uncultivated	Forested
Sunny	33	18.8	68	14	18
Eastern	26	10.2	24	48	28
Western Sunny	25	12.3	61	22	17
Eastern Shady	28	7.5	27	50	23
Western Shady	27	9.5	19	49	32
Shady	31	4.2	10	30	60

It can be concluded from the table (4) that high concentrations of settlement are at sunny and western sunny slopes where the generalized slopes are 33° and 25° respectively. Highest concentration of agricultural land also occurs at these facets. It is 68 and 61% respectively at sunny and western sunny facets. Shady and western shady facets having the slopes 31°and 27°respectively have low percentage of agricultural land and low density of settlement. Agricultural lands on these facets are respectively 10% and 19%. These two facets are mainly covered either by forests or uncultivated lands.

Conclusion

The present study reveals that sunny and western sunny slope facts are favoured facets for the development of settlements and agriculture. In spite of the steeper slopes on the sunny facets in comparison with the other slope facets, the density of settlements and concentration of agricultural land is highest among all the slope facets. Shady slope facets are primarily, barren or covered with forests. Thus it can be concluded that slope aspects have a great impact on the cultural landscape. While making the planning regarding development of cultural landscape slope aspects should be taken into account.

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