Impact of Slope on Agricultural Land Use: A Case Study of Gangapur Tehsil in Sawai Madhopur District, Rajasthan

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Abstract

This study investigates the relationship between slope appropriateness and agricultural land use in the eastern plains of Rajasthan, which comprise an area of around 645.45 sq. km and include 117 village habitats. The study area spans from 26° 31'N to 26° 41'N latitude and 76° 31'E to 76° 59'E longitude. The report is based on field research that has been done throughout the region. Slope analysis made use of 1:50,000 Survey of India toposheets, with the average slope being determined using Wentworth's approach. It was shown that higher slope angles were associated with higher levels of slope instability.

Four generalized slope types are used to describe the study area: gentle slopes, hillsides with moderate inclines, hilltops with relatively steep inclines, and level slopes of low-lying plains. These groups are associated with different land use techniques in agriculture.

Introduction

Interactions between historical, socioeconomic, and geomorphic factors lead to patterns of agricultural land usage. In particular, geomorphology is very important in determining how land is used in any given area. There are two ways that slope affects how agricultural land is used: directly and indirectly. Steep slopes can have direct affects on farming, but pedological and climatic factors including water table levels, soil growth and development, and drainage features can have indirect consequences. Natural forests are usually found in areas with slopes higher than 6º, and slope instability increases with increasing slope angles. Thus, it is crucial to comprehend how land use and slope are related.

The purpose of this study is to determine how the study area's agricultural land use is impacted by geomorphic features. Despite its significance, not much research has been done on how land is used in semi-arid regions. This field has evolved greatly due to the efforts of Cook et al. (1974, 1976) and the Landuse Research division of CSIRO, Australia. Researchers who have studied land use in relation to landforms in India include Sen (1964), Vaidyanadhan (1964), Ghosh and Singh (1965), Iyer and Srinivasan (1977), Singh (1977), Sharma and Padmaja (1977), Subramanyam (1978), Sharma (1979), Sen and Painuli (1984), and Hironi (1991). Their work has shed important light on this subject.

Study Area

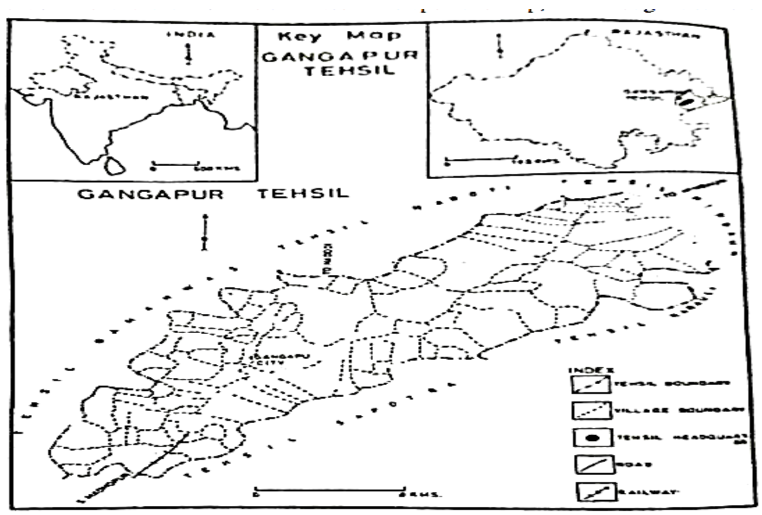
The Gangapur tehsil is located in the heart of Rajasthan, India's Sawai Madhopur district. Geographically, it extends from latitude 26° 31' N to latitude 26° 41' N and longitude 76° 31' E to longitude 76° 59' E. It shares borders with the Karauli district's Hindaun and Nadauti tehsils to the north, Sapotara tehsil and a portion of Baunli tehsil to the south, and Karauli tehsil to the east. The tehsil has 117 inhabited villages spread across an area of around 645.50 sq. km (see Figure 1).

Plains make up a large component of the tehsil physiologically. Geologically speaking, the tehsil is a component of the Indian Tableland, which has mostly escaped the effects of biological tectonic processes with the exception of a few unintentional consequences from different stages of the Himalayan orogeny. With the exception of the southeast, the Pre-Aravalli System's schists, gneissose stone, and magnetite make up the entire tehsil. Shale and sandstone from the Vindhyan Supergroup (Rewa Group) are located in the far southeast.

The research region is located in India's semi-arid climate zone. It receives 685.8 mm of rain on average per year, and in June, the highest recorded temperature is 47°C.

Techniques

The current research is based on fieldwork that has been done throughout the region. The Survey of India's 1:50,000 topographical maps provided the first information on many landforms. The Soil Research Institute in Durgapura, Jaipur, Rajasthan, conducted soil analysis. The Indian Meteorological Department in Jaipur and the Department of Hydrology of the Government of Rajasthan in Jaipur provided the climatic data.



(Fig-1)

Field observations were added to 1:50,000 Survey of India topographical maps for the purpose of conducting slope analysis. The slope zone map was created using Wentworth's average slope determination approach, notwithstanding its shortcomings in precisely minimizing real slope values. Using the formula developed by Wentworth (1930), the slopes of grid cells are calculated using this technique.

The Wentworth's formula is as follow:

$Tan\theta = N/L \times (Vi)/(3361 or 637)$

Where,

$Tan\theta$ = Slope angle in tangent values,

N = Number of contour crossing in a grid,

L =Length of a grid in miles, and

Vi = Vertical contour interval,

3361/637 = Constant value of $\sin\theta$

Result and Discussions

Slopes in the studied region vary from 0.00° at minimum to 14.2° at maximum. Table 1 shows the four generic classes into which these slope measurements have been divided. The mean slope map (Fig. 2) and the areal distribution analysis demonstrate that the slope is distributed unevenly throughout the region. Only 0.37% of the total surface is covered by slopes higher than 9°.

Within the research area, the average slope falls from south to north. In the southern region, more precisely in the Narayanpura Tatwara hills, the steepest slope measured is 14.2°.

TABLE- Generalized Slope Categories

S. No	Slope in Degrees	Slope Category	Percentage of area under slope categories
1.	Below 3°	Level Slope of Low Land Plains	94.35
2.	3° -6°	Gentle Slope Zone	3.20
3.	6° -9°	Foot Hills of Moderate Inclination	2.05
4.	Above 9°	Hill Tops of Moderate Steep Inclination	0.37

The following are thorough explanations of the generalized slope categories:

1. Low Land Plains' Level Slope (Below 3°)

This slope category, which covers the majority of the tehsil, is the lowest in the research region. It is linked to incredibly level areas in the region, mostly found on alluvial plains that are recent or quite recent. This class is distributed throughout its north, middle, and southwest regions of the tehsil, making up a substantial amount of the overall area—roughly 94.35%. Barley and wheat, that are plowed on two occasions annually for seasonal harvests, are among the crops that are grown on the majority of these plains because they are resistant to water erosion.

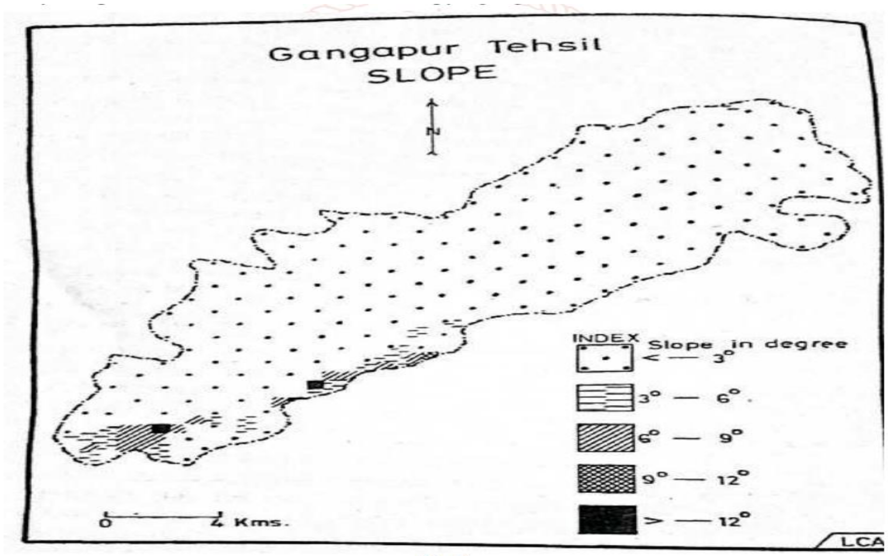


Fig-2

2. Zone of Gentle Slope (3° - 6°)

This zone includes the southeastern and southern border sections of the tehsil (3.20% area). It includes portions of the villages of Chooli, Bucholai, Barh Milakpur, and Barh Gauri in addition to Barh Chhawa, Chak Chhawa, Khera Barh Ram Garh, and Barh Guwari. Due to the ample water supply in the gently sloping valley bottoms, the gentle slope zone is quite profitable from a farming standpoint. Nonetheless, there are issues in this category due to waste land regions' propensity for undulation and certain patches' salinity and alkalinity.

3. Moderately Inclinated Foot Hills (6° - 9°)

This zone, which has a total area of 3.37 sq kilometers (2.14%), includes portions of the villages of Barh Tatwara, Kholai, Totalsi, and Miliskpur in addition to the tehsil's extreme southeast. In field research, scattered cultivation was noted on the lower parts of ridges, where cultivation strips are frequently three to four times longer than they are wide. Strip width and slope gradient are directly correlated, with higher slope being indicated by lower relative relief. These regions have a lot of potential for agriculture.

4. Hills with an inclination that is somewhat steep (above 9°)

Only 0.37% of the tehsil land is covered by the sharpest slope, 14.2°, which is located in the north of Barh Tatwara and the south of Umri villages. Because of the adverse soil and climate conditions in these places, terracing for agricultural development is practically impossible. In spite of this, there is some cultivation—mainly in the form of tree plantations—in valleys and protected regions.

Conclusion

The relationship between agricultural patterns and slope suitability has been investigated in this study. Slope instability was found to increase with increasing slope angle. Lowland plains are the penultimate stage of the erosion cycle, created by river erosion. Crops that withstand erosion, such as wheat and barley, are the main crops grown on these plains. The zone with a mild slope yields a lot of crop because there is enough water available. Lower relative relief in the moderately inclined foothills is correlated with greater agricultural potential. Hills with a moderately steep slope fall into this group. Because of the unsuitability of the climate and soil, terracing is not feasible for agricultural cultivation; instead, tree plantations may be the best use for these hills.

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