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Valley Side Slopes Of Rishi River Basin: Slope Profiles And Their Characteristics

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Abstract: *The valley side slopes are the sloping to very steep surfaces between the valley floor and summits of adjacent uplands. Primarily these are formed by weathered materials, mass movement and country rocks. In this article an attempt has been made towards an in-depth study of the nature and evolution of the valley side slopes in the Rishi River valley located in Reshi, Darjeeling district, West Bengal, India. The surface inclination measured by Abney level at the field has shown interesting features. The valley walls are gradually receding. The slope forms as well as the evolution of the valley-side slopes of this region are largely controlled by the rate and intensity of removal of weathered materials and related erosion .*

Keywords*: Surface Inclination , Recession Of Valley Wall , Daling Group , Slope Decline Theory*

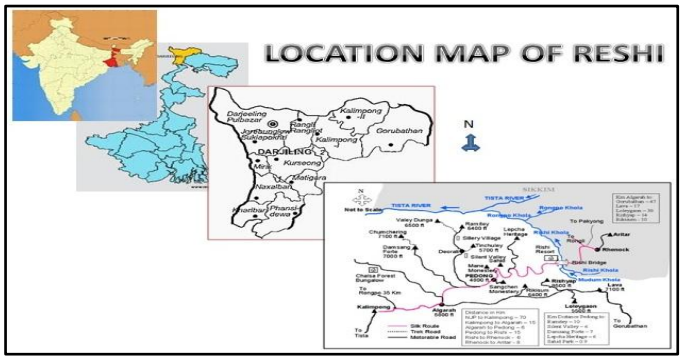
I. Introduction

The term slope is used to denote the angular inclination of terrain between hill top (crests) and valley bottom. Morphological characteristics of a given region are determined by slopes of that region because physical landscapes are the result of combinations of slopes.

The Rishi Khola (the term 'khola' indicates a perennial channel) is a silt free channel with moderate to high velocity during different parts of the year. The channel has curved out its valley which is more or less 300-400m in width and the two valley walls are very steep. This valley includes paired terraces also. The area has a great complexity in its geological structure as number of thrusts has traversed through the area. Such complexities gave rise to a variable nature in the landform characteristics of the basin and fluvial processes as well as mass wasting processes are highly active in the area. All of them are acting together as agents of valley side slope formation and evolution .

II. Study Area

The study area involves the drainage basin of the Rishi Khola which drains into the river Rongli ,a left bank tributary of the river Rongpo .As such ,the drainage basin is located at the north eastern corner of the Kalimpong sub-division of Darjeeling district. The area lies between 27°9'4.40''N to 27°10'55.37'' and 88°37'16.20E to 88°38'42.97''E. The Rishi River is a north flowing stream which has a north-westward bend near Reshi .This basin belongs to the northern face of slope of the Lava-Pankhasari ridge. Here basically thRishi River demarcates the inter-state boundary between WestBengal and Sikkim.



III. Objectives

The main objectives of this study are —

1. To study the nature of evolution of valley side slopes of this area
2. To examine the standard models of slope evolution through real field work.

IV. Methodology

A base map of Rishi basin was prepared from the topographical sheet no 78A/12 on 1:50,000 scale. After demarcating the Rishi river basin an average slope map by Wentworth's method was prepared. Available literatures were studied. During field investigation ground slopes were taken in different parts along the left as well as right bank of the Rishi River by an Abney's level. A GPS was used to obtain the geographical locations of the selected areas and points. Diagrams were prepared from the collected data. In some cases statistical methods were used.

V. Valley Side Slope

A valley's sides are called valley side slopes. According to Alan Wood (1942), the segments of a valley side slope are —

1. An upper convex slope
2. A free face
3. A constant slope
4. A concave slope

According to Penck (1924) valley side slope consists of two parts —

a. The upper part is called Gravity Slope which has relatively steep slope
b. The lower part is called Wash Slope. It is gentle and has a declining gradient.

VI. Field Observation

Characteristics Of Right Bank Slope –

The slopes observed along the right bank, have a variety of underlying materials. Alike the left bank these earth materials are also composed of 3 types of materials viz. rock, rock & soil and soil.

The rocks observed in this area are slates and phyllites. They belong to the Gorubathan formation of the Daling group and have originated during the Pre-Cambrian period. Along the left bank quartzites have been found instead of slates . Slates are hard , compact, sheet-like, fine grained rocks . The exposures of rocks often form rectilinear segments or free faces. The surface inclination varies from 29 ◦to 80 ◦

The slopes, underlain by shallow mass of weathered materials which further underlain by rock beds , are generally rectilinear . The surface inclination varies from 18 ◦ to 20 ◦. These slopes are carrying prominent signs of weathering and erosion. These debris slopes are gradually degrading valley-ward. Flat and slightly concave valley slopes are composed of soils and debris. Here, the rock beds underlie at great depth. In some cases, soils have also developed steep as well as convex slopes. The surface inclination of these slopes varies from 3 ◦to 57 ◦.From the above discussion it can be said that the valley side slopes are gradually extending upward, free faces gradually becoming rectilinear which are basically covered with debris and soils. It indicates that valley side slopes will extend upward due to the work of erosional and weathering processes.

The terrace slopes, observed along the right bank, have experienced some human interference. Though initially these slopes have been developed through the erosional activities but man-made small steps have also been found here. These steps have been created by the local people to serve for the agricultural purpose.The evolution of valley side slopes from free faces to valley floors will take a lot of time. The whole process of recession of valley wall depends on the weathering or erosional activities.

Characteristics Of Left Bank Slopes -

Along the left bank, the slopes have a variety of underlying materials which characterize their surface propagation. As such three types of materials have been found to compose the underlying earth materials. These are rock, rock & soil and soil.

The rocks observed in the area along the valley walls are phyllites and quartzites belonging to the Reyang formation of Daling group. These materials are of Pre-Cambrian origin. The phyllites are soft and foliated when slightly schistose, but in general they have a laminated appearance. These are pelitic rocks of argillaceous composition. On the other hand, quartzites are very hard and they occur as well-jointed bands. However, the exposures of rocks have given rise to steeper slopes which often form free faces . The surface inclination varies from 78 ◦to 82 ◦.

In some small fragments of slope minor exposures have again favoured a steeper character though not like a free face. They however, construct at least rectilinear slopes. Where the slopes are underlain by shallow mass of weathered material which is further underlain by rock beds, the slope is often rectilinear or even nearly flat. The angle of inclination varies from 17◦to 41◦.Valley-ward such slopes have given rise to rectilinear slopes of much longer dimension and a gentler surface. Such slopes are gradually being degraded to valley slopes. These slopes have suffered a lot of weathering and erosion. Soils and Debris have given rise to valley slopes which are flatter and slightly concave. The rock beds underlie such slopes at great depth.

Hence, from the discussion it is clear that greater resistance has given rise to steeper slopes. Moreover, the valley-side slopes are gradually extending upward. Free faces gradually turning into inclined rectilinear slopes which are often covered with debris and soils. This way the valley side slopes extend upward and weathering pari passu erosion favour such upward extension of valley slopes. Finer materials, often categorized as soils have given rise to gentler slopes which truly belong to the valley slope.

The trend of evolution suggests that the concave slope will gradually extend upward and the rectilinear slope will be eaten by that. Further recession of the valley wall will depend on the weathering or erosion of the free faces which will gradually turn into a rectilinear form and then into a concave one with further extension of the concave valley floor. However, that will take a lot of time as the channel incised itself forming terraces along both the banks. This has increased the valley deepening activity and lateral planation will be much delayed under such a situation.

Varying characteristics of slope on different landforms:

1.**SPUR —** In the study area one of the spurs on the right bank of the river has been observed. The surface slope of this spur varies from 3° to 36°. At the base point the ground slope is 10' then the slope becomes steeper. On the whole, the said spur has a convex surface slope along the summits of the longitudinal profile, though the valley side slopes of the spur front form a concave slope. The underlying rock beds assume a southward or upstream direction of dip. Hence, the slopes of the spur are not unstable.

2.**ROCK WALL —** Presence of valley walls are common along theboth banks of the Rishi River. One of them has been studied along the left bank. From the wall a 30m long terrace slope has connected it to the river. The total height of the wall is 11.2m and the surface inclination is 82°. The rocks assume a south-eastward direction of dip in 36° angles.

3.DEBRIS SLOPE — The study area in Rishi valley is a landslide prone zone. Along the right bank one debris slope has been studied. Range of downslope varies between 7° - 40°. Convex and rectilinear forms of slope have been observed.

Relationship Between Slope Angle And Length Of Slope:

In the area under study the relationship between the slope angle and the length of slope has also been noticed.From the scatter diagram and regression line (fig.2 and fig.3) prepared with the obtained data set from the field it is clear that there is a negative co-relation between the slope angle and the slope length. It indicates that length of slope decreases with the increase in slope angle and vice versa. Hence, steeper free face slopes are generally of small length while gentler valley slopes are much elongated.

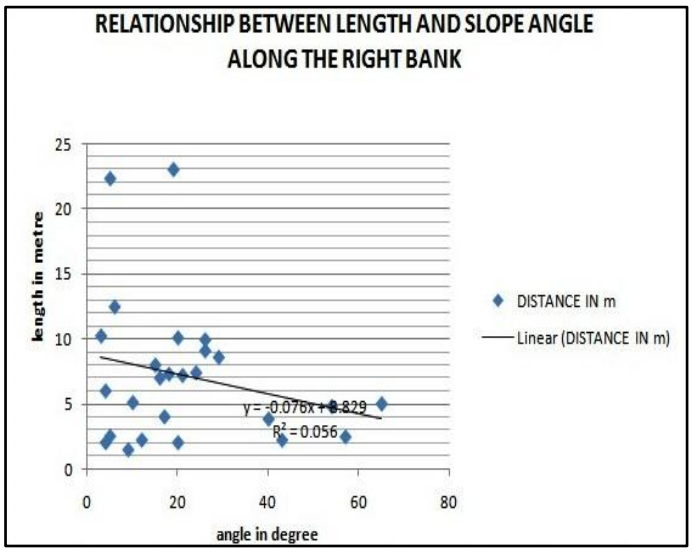


Fig-2 Source: primary data

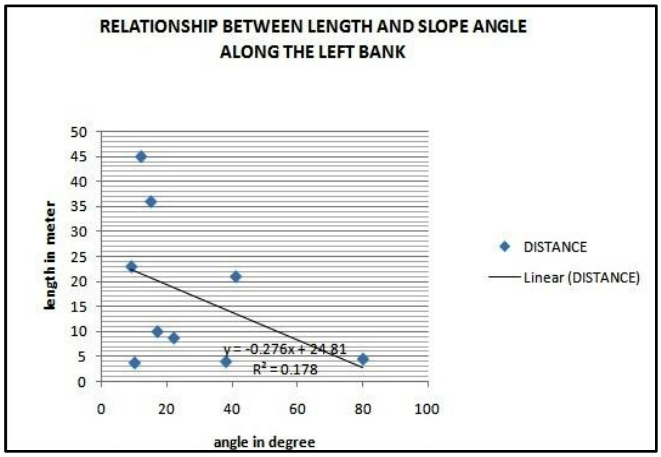


Fig-3 Source: primary data

VII. Conclusion

Major findings of the study are —

- Weathering and erosion processes are greatly influencing the slope profiles.
- Valley side slopes are mainly composed of country rocks, weathered materials and soils. These materials are becoming finer downslope.
- As the valley slopes are extending upward gradual decrease of angle of slope is noticed. Hence, the free faces are transforming into rectilinear slopes into concave one.
- Convexity has only been noticed at the ridge tops.

Therefore, the whole condition will lead to the formation of concavo-convex slope profiles.

These characteristics of the slope profiles have similarity with the concept of W.M.Davis (1892). The nature of the evolution of the slope profiles also matches with the slope model "Slope Decline Theory" of W.M.Davis.

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