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Effect of Land Slopes on Soil Erosion under Simulated Rainfall

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Abstract: *This study was aimed at understanding the effect of land slopes on soil erosion under simulated rainfall characteristics. The experimental set up consisted of three units viz., the runoff plot, the rainfall simulator and the runoff-sediment collection unit. Twelve runoff plots with twelve different slopes of 1.5, 2.0, 2.6, 3.0, 3.2, 4.0, 5.0, 6.0, 9.0, 10, 12 and 13 per cent in different locations, each plot with a size of 2 x 1.5 m were prepared. The results showed that soil loss and runoff was found to increase with increase in land slopes and there were no much variations on runoff and soil loss at 6 to 10 per cent land slopes*

Key words: *Soil erosion, Simulated rainfall*

I. INTRODUCTION

The present study has been taken on a lateritic terrain at Tavanur, Malappuram District of Kerala State. The soils in the area were identified as belonging to the Naduvattom series. A rainfall simulation study was taken on natural soil demarcated in to micro soil erosion study plots of size 2 x1.5 m. Studies were conducted on soil loss and runoff at different land slopes under simulated rainfall conditions. A rainfall simulator was fabricated to study the erosion processes. The fabricated rainfall simulator could produce rainfall intensities varying from 8.16 to 8.80 cm/h. The uniformity of rainfall varied from 89.01 to 92.70 per cent and the average drop size varied from 1.5 to 2.8 mm.

II. MATERIALS AND METHODS

A pressurized nozzle type rainfall simulator using Pop-up sprinkler was designed and fabricated. Erosion plots were established for monitoring runoff and soil loss with the size of 1.5 m wide and 2 m in length. Twelve micro plots with twelve different slopes were prepared. The rainfall simulator was placed over the plot in order to get maximum uniformity over the plot. . A wet run was given until a steady state of runoff generated in the plot. The runoff was collected in collection bucket placed in the pit after 5 minute duration. . The same procedure was repeated for different rainfall intensities and collected the corresponding runoff with eroded soil. The runoff sample was allowed to settle for a period of one week. Then the clear water was removed and the sediment was separated by evaporation technique. The weight of the sediment was recorded.

III. RESULTS AND DISCUSSION

A. Effect of land slopes on runoff

The effect of land slope on runoff was obtained by measuring the runoff under twelve different land slopes on the test plots. The slopes were selected on bare soil surfaces and the slopes ranging from 1.5 per cent to 13 per cent. Simulation studies were conducted at intensities of 8.16, 8.28, 8.44 and 8.8 cm/h at each test plots.

The result found that at 1.5 per cent slope the runoff obtained for an intensity of 8.16 cm/h was 44 m^3/ha/h. On increasing the intensity to 8.28 cm/h, the runoff increased to 52.4 m^3/ha/h and the runoff reached a value of 66 m^3/ha/h at 8.8 cm/h intensity (Table 1). It was observed that as the slope increases the runoff also increases. The maximum runoff was obtained from the plot of 13 per cent at an intensity of 8.8 cm/h and was 230.2 m^3/ha/h.

The graph plotted in between slope and runoff is shown in Fig.1. From the graph also it is clear that the runoff increases with the slope. Furthermore it can be noticed that at 4 to 6 per cent slope there was a greater increase of runoff with increase of intensity and at 6 to 10 per cent slope there was no considerable change in the runoff values and it did not show much variations at all intensities. When the slope increased to 13 per cent, there noticed a further increase of runoff at all intensities simulated rainfall.

B. Effect of land slopes on soil loss

From the experiments it was found that at an intensity of 8.16 cm/h the soil loss from 1.5 per cent slope was 10.8 kg/ha/h, whereas the value increased to 50.3 kg/ha/h for 2 per cent slope. At a higher intensity of 8.8 cm/h, the soil loss from the plot of 1.5 per cent slope was 40.8 kg/ha/h while it was 300 kg/ha/h when slope was increased to 13per cent (Table 1). A general trend of increase in the soil loss with the slope is seen from whole observations.

Higaki et al. (1999) reported the similar results in his study, that surface erosion rate on laterite slopes was increased with increase of slope. Kinnell (2000) noticed that sediment concentration in flow from side slopes increased with slope gradient, particularly if this exceeded 10per cent. However, studying erosion from small plots with slope gradients of 4per cent and 8 per cent in tilled fields, Chaplot and Bissonnais (2003) reported that sediment concentration in runoff was not correlated with slope gradient. In his study, Suhua Fu (2009) found that the total soil loss was increased with slope, and then decreased after a maximum value was reached. He also indicated that the slope gradient has greatest effect on down slope soil erosion and least impact on lateral erosion.

A graph was plotted in between slope and soil loss as shown in Fig. 2. From the graph it can be seen that there was a considerable increase of soil loss at 1.5 to 2 per cent slope at all intensity of simulated rainfall and then the soil loss decreased at 3 to 5 per cent slopes. The soil loss at 6 to 10 per cent slope was found to be without any noticeable differences. This may be due to the fact that the observed runoff at 6 to 10 per cent slope was almost similar. Ben-Hur, (2006) also showed the same results that for the mild slopes of five per cent and nine per cent, the sediment concentration is stable, which could characterize either a transport limited or a detachment limited process. And after that the graph showed that the soil loss again increased to its maximum level at the maximum slope of 13 per cent at each application of intensity of simulated rainfall.

Table 1. Effect of land slope on runoff and soil loss

Intensity(cm/hr)	Slope (%)	Runoff (m^3/ha/h)	Soil loss (kg/ha/h)
8.80	1.5	66.0	40.8
8.44		56.8	21.2
8.28		52.4	14.0
8.16		44.0	10.8
8.80	2.0	70.0	70.8
8.44		68.0	63.1
8.28		60.0	54.8
8.16		46.8	50.3
8.80	2.6	92.6	74.4
8.44		88.0	38.4
8.28		86.8	32.4
8.16		80.4	24.4
8.80	3.0	96.0	80.6
8.44		92.2	78.2
8.28		75.2	56.3
8.16		74.0	48.2
8.80	3.2	102.0	120.0
8.44		92.8	98.0
8.28		88.0	86.0
8.16		84.6	58.0
8.80	4.0	109.6	120.6
8.44		93.2	102.7
8.28		86.0	98.4
8.16		82.0	67.6
8.80	5.0	180.6	120.8
8.44		172.4	101.6
8.28		168.5	99.2
8.16		166.2	62.4
8.80	6.0	192.6	132.2
8.44		188.8	128.9
8.28		178.2	110.4
8.16		170.3	80.2

8.80 8.44 8.28 8.16	9.0	198.2 189.7 179.6 170.3	160.0 80.0 40.0 40.0
8.80 8.44 8.28 8.16	10.0	206.0 176.6 160.0 150.0	180.0 140.0 60.0 40.0
8.80 8.44 8.28 8.16	12.0	206.4 198.3 197.4 166.5	228.0 164.8 123.2 84.8
8.80 8.44 8.28 8.16	13.0	230.2 218.6 207.8 202.5	300.0 160.0 130.0 84.8

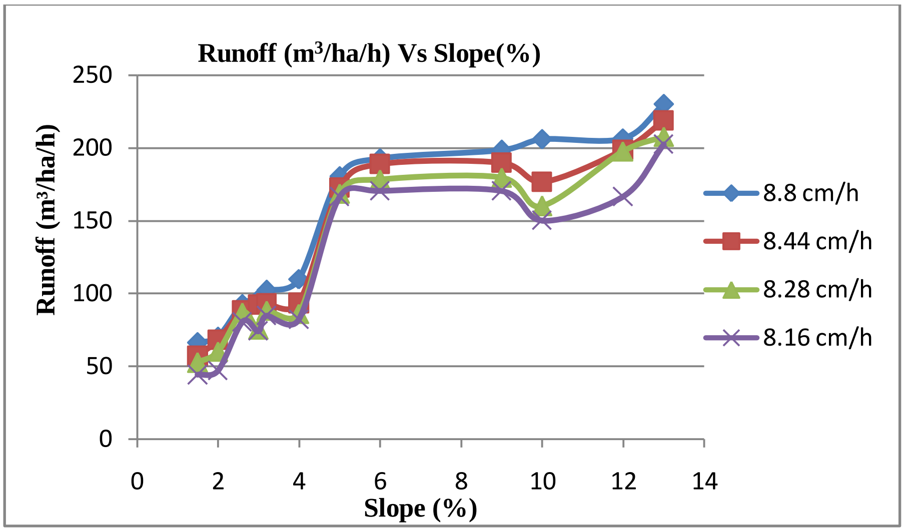

Figure. 1. Effect of landslope on runoff

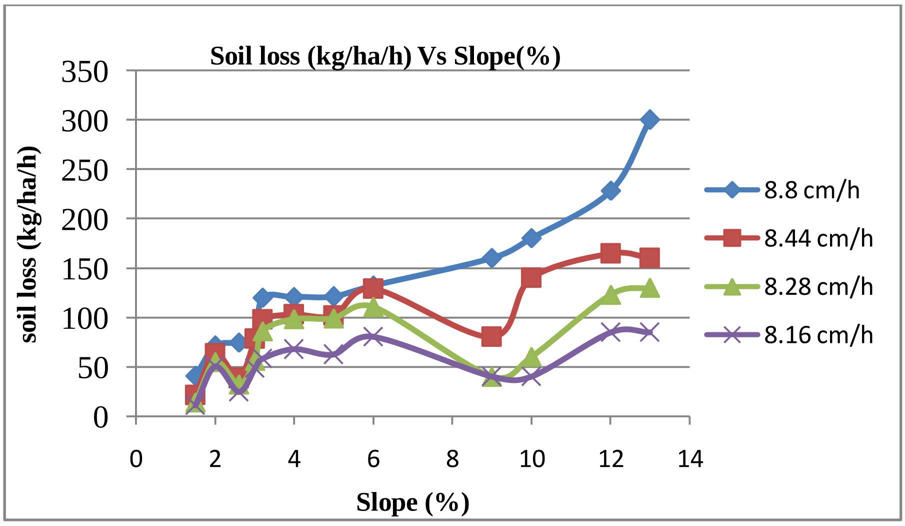

Figure. 2. Effect of landslope on soil loss

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