Evaluating the Erosion Process from a Single-Stripe Laser-Scanned Topography: A Laboratory Case Study

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Abstract

Topographies during the erosion process obtained from the single-stripe laser-scanning method may provide an accurate, but affordable, soil loss estimation based on high-precision digital elevation model (DEM) data. In this study, we used laboratory erosion experiments with a sloping flume, a rainfall simulator, and a stripe laser apparatus to evaluate topographic changes of soil surface and the erosion process. In the experiments, six slope gradients of the flume (5 to 30 with an increment of 5) were used and the rainfall simulator generated a 30-min rainfall with the kinetic energy equivalent to 80 mm/h on average. The laser-scanned topography and sediment yield were collected every 5 min in each test. The difference between the DEMs from laser scans of different time steps was used to obtain the eroded soil volumes and the corresponding estimates of soil loss in mass. The results suggest that the collected sediment yield and eroded soil volume increased with rainfall duration and slope, and quantified equations are proposed for soil loss prediction using rainfall duration and slope. This study shows the applicability of the stripe laser-scanning method in soil loss prediction and erosion evaluation in a laboratory case study.

Sloping Flume Erosion Experiment- Apparatus

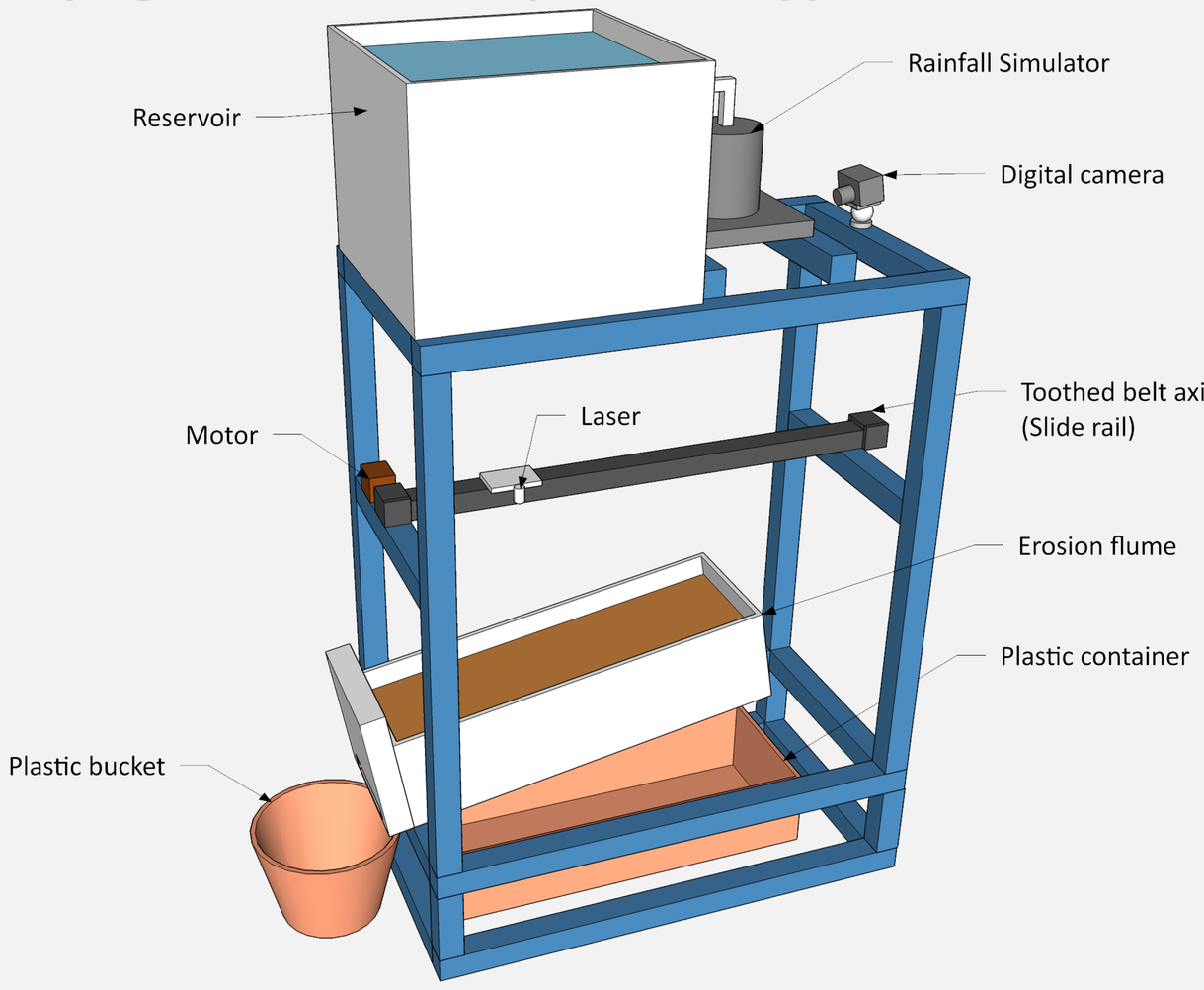

Figure 2. Setup of the sloping flume erosion experiment.

Rainfall duration (min)	Distance from the outlet	45cm-70cm	30cm-45cm	0cm-30cm
5	Soil loss percentage to the total soil loss	23%	28%	49%
10		25%	32%	43%
15		29%	32%	39%
20		32%	31%	37%
25		33%	31%	36%
30		33%	33%	34%

Laser-Scanned Topographies during Erosion

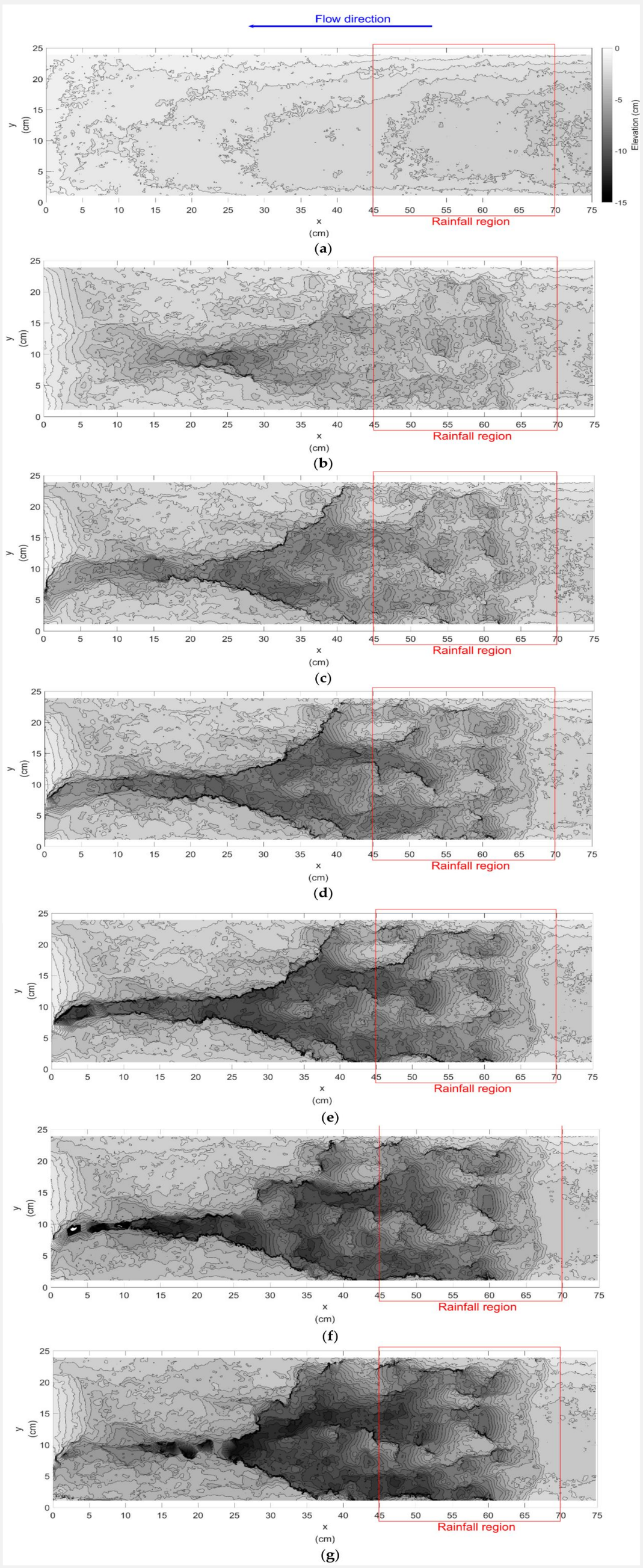

Figure 3. The laser scanned topographies during the simulated rainfall erosion test of a 30° slope: (a) the initial topography before the rainfall started; the erosion topographies after (b) 5 minutes, (c) 10 minutes, (d) 15 minutes, (e) 20 minutes, (f) 25 minutes, and (g) 30 minutes of the rainfall.