



Ability of One-Dimensional Hairsine-Rose Erosion Model to Predict Sediment Transport over a Soil with Significant Surface Stones

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Surface stones affect erosion rates by reducing raindrop-driven detachment and protecting the original soil against overland flow induced-hydraulic stress. Numerous studies have shown that the effect of surface stones on erosion depends on both the stone characteristics (e.g., size, distribution) and the soil properties. The aim of this study was (i) to quantify how the stone characteristics can affect the total sediment concentration and the concentrations of the individual size classes, (ii) to test if stones affect preferentially a particular size class within the eroded sediment and (iii) to determine whether the 1D Hairsine-Rose (H-R) erosion model can represent the experimental data.

A series of laboratory experiments were conducted using the 2 m × 6 m EPFL erosion flume for a high rainfall intensity (60 mm/h) event on a gentle slope (2.2%). The flume was divided into two identical 1-m wide flumes. This separation was done to allow simultaneous replicate experiments. Experiments were conducted with different configurations and scenarios (stone coverage, size and emplacement). Three coverage proportions (20%, 40%, and 70%), two stone diameters (3-4 and 6-7 cm) and two emplacement types (topsoil and partially embedded) were tested.

For each experiment, the total sediment concentration, the concentration for the individual size classes, and the flume discharge were measured. Infiltration rates were measured at different depths and locations. A high resolution laser scanner provided details of the surface change due to erosion during the experiments. This technique allowed us to quantify the spatial distribution of eroded soil and to understand better if sediment transport is 1D or rather 2D over the flumes.

The one-dimensional Hairsine-Rose (H-R) erosion model was used to fit the integrated data and to provide estimates of the parameters. The ability of the 1D H-R model to predict the measured sediment concentrations in the presence of stones in the soil matrix with different configurations was tested, with reasonable results.