Soil surface morphology evolution under spatially non-uniform rainfall

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Abstract

We evaluated the applicability of a large-scale river network evolution model used to simulate morphological changes of a laboratory-scale landscape on which there were no visible rills. Previously, such models were used only at the landscape scale, or in laboratory experiments where rills form in the soils surface. The flume-scale experiment (1-m × 2-m surface area) was designed to allow model calibration. Low-cohesive fine sand was placed in the flume while the slope and relief height were 5% and 25 cm, respectively. Non-uniform rainfall with an average intensity of 85 mmh^{-1} and a standard deviation of 26% was applied to the sediment surface for 16 h. High resolution Digital Elevation Models were captured at intervals during the experiment. Estimates of the overland flow drainage network were derived and, using these, the river network evolution model was numerically solved and calibrated. A noticeable feature of the experiment was a steep transition zone in soil elevation that migrated upstream during the experiment. Physically, this zone indicates where the shear stress is sufficient to cause sediment

erosion. The model was calibrated during the first 4 h of experiment. Afterwards, it predicted the subsequent 12 h of measured surface morphology changes. Therefore, the applicability of the landscape evolution model was extended for non-uniform rainfall and in absence of visible rills.

Keywords:

Numerical simulation, Particle Swarm Optimization, Sediment transport, River network evolution model.