Modelling landscape evolution at the flume scale

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Abstract

The ability of a large-scale Landscape Evolution Model (LEM) to simulate the soil surface morphological evolution as observed in a laboratory flume (1-m × 2-m surface area) was investigated. The soil surface was initially smooth, and was subjected to heterogeneous rainfall in an experiment designed to avoid rill formation. Low-cohesive fine sand was placed in the flume while the slope and relief height were 5 % and 20 cm, respectively. Non-uniform rainfall with an average intensity of 85 mm h^{-1} and a standard deviation of 26 % was applied to the sediment surface for 16 h. We

hypothesized that the complex overland water flow can be represented by a drainage discharge network, which was calculated via the micro-morphology and the rainfall distribution. Measurements included high resolution Digital Elevation Models that were captured at intervals during the experiment. The calibrated LEM captured the migration of the main flow path from the low precipitation area into the high precipitation area. Furthermore, both model and experiment showed a steep transition zone in soil elevation that moved upstream during the experiment. We conclude that the LEM is applicable under non-uniform rainfall and in the absence of surface incisions, thereby extending its applicability beyond that shown in previous applications.

Keywords:

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