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Spatial and temporal evolution of laboratory-generated drainage networks

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In geomorphology first significant experimental studies (Parker, 1977; Schumm et al., 1987) were carried out to qualitatively understand the landform evolution. At present, laboratory experiments conducted under controlled initial and boundary conditions give the advantage to monitor the evolution of generated drainage networks in short time and with high accuracy. The main drawbacks, however, would stay the scale effects that unavoidably occur.

This study would like to present an analysis of physical experiments simulating the evolution and the development of drainage networks inducted by an initial knickpoint. To this purpose, some experiments were carried out at University of Basilicata by using a 1.5 m by 1.5 m box-basin-simulator filled with an erodible material of known textures and properties, mainly constituted by clay and silt. Three surface slopes were tested, namely 10%, 5%, and 0.6%, employing the same treatment, flat surface with negligible roughness, and the same no-cohesive material.

A system of microsprinklers generated an almost uniform artificial precipitation. Simulations were performed at a constant rainfall rate with intensity of 100 mm/h, keeping constant also the base level. Raindrop sizes were significantly smaller than those observed in the field and rainsplash processes were thus practically inhibited.

The landscape evolution was monitored with a laser pointer and/or a laser scanner gaining thus detailed soil surveys. By using the laser pointer, the achieved DEMs had a resolution of 2 mm, obtained interpolating points-grid with a resolution of 10 mm, as a sufficient compromise between accuracy and rainfall time-stop. Whereas, by using the laser scanner the achieved DEMs had a resolution of 1 mm without interpolation. The drainage networks were extracted from the digital elevation models by using the D8 algorithm (O'Callaghan and Mark, 1984).

Based on the data collected, the scaling properties of the simulated networks are analysed and compared with those of natural basins. Findings are provided mainly in terms of Hortonian laws, fractal dimensions and informational entropy. Scaling properties and space filling tendencies are discussed and peculiar differences between quasi-equilibrium and transient states are also highlighted.