LANDSCAPE EVOLUTION AND RE-ORGANIZATION UNDER STEADY AND TRANSIENT STATES: RESULTS FROM AN EXPERIMENTAL INVESTIGATION

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Key words Landscape evolution; Drainage network dynamics; Extreme events; Transport regimes

Understanding and quantifying landscapes dynamics under steady and transient states in terms of their geomorphic and topologic re-organization across a range of scales is an issue of timely interest in view of recent climatic trends in many regions of the world. Although several studies have addressed the large-scale response, studies that focus on the smaller-scale drainage pattern re-organization and quantification of landscape vulnerability to the timing, magnitude, and frequency of the changing forcing are lacking. The reason is the absence of data for such an analysis. To that goal, a series of controlled laboratory experiments were conducted at the St. Anthony Falls laboratory of the University of Minnesota to study the effect of space-time variable and changing precipitation patterns on landscape evolution at the short and long-time scales. High resolution digital elevation (DEM) both in space and time were measured for a range of rainfall patterns and uplift rates. These experiments were designed to create an evolving and self-organized drainage network by growth and propagation of erosional instabilities in response to external forcing, such as, tectonic uplift and rainfall dynamics. Results from our study show distinct signatures of extreme climatic fluctuations on the statistics and geometry of topographical features which are evident in widening and deepening of channels and valleys, change in drainage patterns within a basin and change in the probabilistic structure of “hot-spots” of change contributing to mass-wasting events, such as, landslides and debris flows. These results suggest a regime shift, during the onset of the transient state, in the transport processes on the fluvial regime of the landscape, i.e., from supply-limited to transport-limited. We also analyze landscape features, extracted via an innovative curvelet-based decomposition approach, to understand and quantify landscape reorganization in terms of the evolution in the energy distribution across scales and directions.