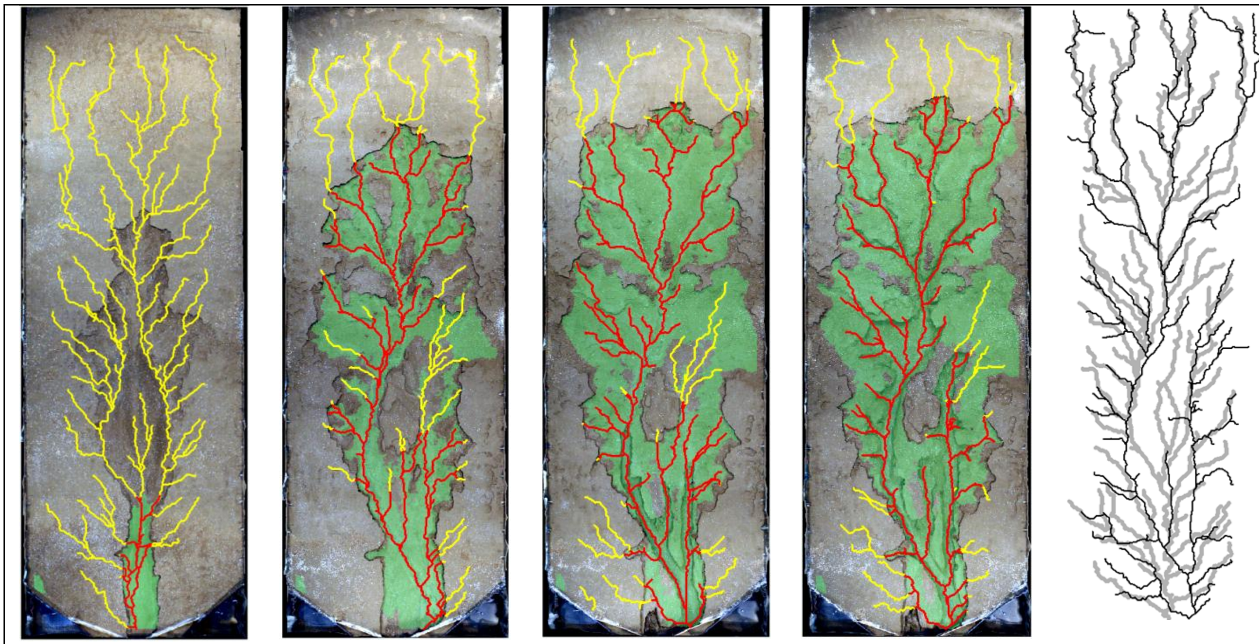
Pattern Emergence and Resilience of Rill Networks and Their Relation to Soil Loss, Landscape Degradation, and Erosion Prediction Technology

Soil erosion remains the principal cause of soil degradation worldwide, soil loss continues to be a critical concern for the sustainable management of agricultural resources, and off-site sedimentation from upland sources severely affects water quality and ecology. Areas of intense, localized erosion, such as rills and gullies, often are the primary cause of soil loss and the dominant source of sediment yield from these landscapes. Yet there remains a serious disconnect between the geomorphic and hydraulic drivers of soil erosion on hillslopes and agricultural fields (rills and gullies), and current field-scale prediction and management technology. This is because most models do not address rill and gully erosion explicitly.

This project proposes to combine laboratory, analytic, and field investigation of the emergence, evolution, and resiliency of rill networks on soil-mantled landscapes at the field-plot scale to address this disconnect. It is hypothesized that rill networks display rapid pattern-emergent characteristics and long-term resiliency on hillslopes, and that the location, organization, and dimensions of these rills can be predicted before any erosion takes place. This project will conduct full-scale soil erosion experiments where terrain analysis will be combined with state-of-the-art physical models and analytical formulations for soil erosion processes. The theoretical framework and terrain analysis tools developed in the experimental landscape then will applied to a field experiment, where erosion plots will be created to replicate the in-house experiments and monitored over time. The ultimate goal of this research is to develop more physically-based soil erosion prediction models that fully exploit the latest digital technologies available, and to mitigate soil and landscape degradation before it actually occurs.



Four orthophotographs (on left) of the time-variation in rill development for the preliminary experiment, showing the surface drainage network (in yellow) and the rill network (in red, with green areas) at times (from left to right): 100, 490, 890, and 1060 minutes since the beginning of the experiment. On right, maps of the surface drainage system prior to any incision (at 87 min; grey lines) and the final rill network at the conclusion of the experiment (at 1060 min; black lines). Flume is 7 m long and 2.4 m wide, and flow is from top to bottom.