SPoRT Seminar Series Presents:

Application of a Non-Steady Runoff Method in Landlab: Implications for Modeling Landscape Change

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Date: Wednesday, April 13, 2016
Time: 10:00 A.M.

Location: SPoRT VCL (NSSTC 3027)

Abstract:

Computational methods are often utilized in the Earth sciences to model processes across a wide range of temporal and spatial scales. Geomorphologists use landscape evolution models to evolve topography over centennial to geological timescales in response to any combination of geomorphic and hydrologic processes: precipitation, hillslope diffusion and bedrock channel erosion are some examples, all to understand landform change through time. While many rainfall-runoff models incorporate physically realistic, non-steady flow routing methods used over small time scales, many of these long-term landscape evolution models generalize hydrology by assuming steady-state discharge, and use this steady-state rate to calculate incision into the landscape. Previous work has demonstrated that in large watersheds or locations dominated by short-duration and high-intensity precipitation events characteristic of semi-arid climates, steady-state hydrology is not achieved, and the impacts of a hydrograph across the landscape may not be captured by the steady-state model. To quantify the impact of non-steady flow on long-term morphology, a 2-D hydrodynamic model has been incorporated into the Landlab surface dynamics modeling framework. In two synthetic study basins, storms of varying intensity and duration are modeled, calculating discharge and incision rate through the hydrograph. Peak discharge and total incision depth are compared to the values predicted by the steady-state model, to evaluate the impact of the two hydrologic methods. Finally, the new non-steady flow model is used to route two precipitation events across a watershed in central Colorado that has been affected by several wildfire and flood events over the last few decades. The first storm is the `average' or base case, while the second storm modeled is based on field measurements from the 100- to 1000-year precipitation event that initiated severe flooding following the 1996 Buffalo Creek fire. In both cases, the storm hydrograph characteristics of peak discharge and total incision are compared to the steady-state cases. Additionally, the impact of the flood-inducing storm is compared to the average storm event, to quantify the erosive difference between the two storms. We hypothesize that in the modeled non-steady storms, total incision will exceed that predicted by the steady-state model, due to the length of the hydrograph. This work demonstrates that when modeling landscapes dominated by short-duration, high-intensity precipitation events, the choice of hydrologic method can significantly impact the resulting morphology.