

Abstract

Current numerical landscape evolution models, when forced with steady, uniform uplift and rainfall, evolve from a random initial condition to fully developed drainage basins. In this final state, ridges and valleys cease to evolve, and erosion rate is spatially uniform and everywhere equal to the uplift rate. This thesis project developed a physical experiment to test this proposition.

As a check on published reports of model stability, a stream power erosion law was implemented in a numerical landscape evolution model. Additional terms were added to the erosion law to account for local diffusion, slope aspect driven diffusion, spatial and temporal variation in rainfall, and temporal variation in uplift. Time series of elevation extracted from each run verify that a numerical erosion model based on stream power develop stable, uniformly eroding landforms. The addition of diffusion to the erosion law, and spatial variations in rainfall patterns and temporal variations in uplift did not destabilize the landform.

An erosion facility was constructed to test the proposition that landscape erodes uniformly under steady and uniform forcing conditions. A series of seven runs were conducted where uplift rate and rainfall intensity were varied between runs. While a *statistically* steady form developed for each run, all of the experimental landforms failed to replicate the spatially uniform erosion exhibited by numerical erosion models at long term steady forcing. Intrinsic mass transport processes, such as hillslope failures, deposition, and knickpoint propagation, exhibit nonuniform erosion at both short and intermediate time scales, where the pertinent time scale is that required to erode through a relief of the drainage basin. Experimental landforms experienced migration, extension, and annihilation of drainage divides long after the landform had attained an overall balance between uplift and erosion. Erosional variability coupled with upstream drainage capture drives persistent destabilizing feedback in experimental landscapes, as evidenced by migrating divides. Similar processes operate in natural settings, and suggest that natural drainage basins may behave in a similar fashion.