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Slope shape effects on erosion: A laboratory study

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Data on soil erosion at the slope scale is almost entirely limited to experiments on uniform slopes. The objective of this research was to measure the rates and patterns of erosion on complex shaped slope elements under controlled laboratory conditions where surface morphology changes could be carefully quantified. Artificial rainfall was applied for 90 minutes to a silt loam soil in a 4 by 4 m box. Five slope shapes were formed: uniform, concave-linear, convex-linear, nose-, and head-slopes. DEMs of the surface were measured using photogrammetry after 0, 10, 20, 40, 60, and 90 minutes. Slope shape had significant impact on rill patterns, sediment yield, and runoff production. The uniform, nose, and convex-linear slopes yielded more sediment than the concave-linear and head slopes, where sediment deposited on toe-slopes. Soil topography led to flow convergence and divergence, resulting in a non-uniform distribution of rill spacing and efficiency. Distribution of rills was related to slope steepness, and rill success was related to the contribution area of the rill. Drainage density approached a similar value for all networks during the experiments. Development of the drainage system was similar to the development of optimum channel networks, in that during the evolution of the rill network energy expenditure was reduced. This indicated that energy expenditure was a quantifiable measure of network development and self-organization.