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161-12 - AN EXPERIMENTAL STUDY OF RIVER NETWORK DEVELOPMENT BY OVERLAND AND SUBSURFACE FLOW IN LOW-GRADIENT LANDSCAPES

Tuesday, 24 September 2019

11:20 AM - 11:35 AM -

Phoenix Convention Center - Room 222BC, North Building

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Abstract

Repeated glaciation in northern latitudes altered or destroyed many pre-glacial river networks. As a result, the landscape contained internally-drained uplands (i.e., non-contributing area, NCA) that rivers had to integrate into broader drainage systems. Our objective is to understand the processes, rates, and controls of integrating the NCA in these low-gradient landscapes. We hypothesize that the degree of hydrologic connection between channels and surface or subsurface water sources dictate the integration processes. Groundwater fluxes to channel heads may drive integration via the subsurface, while channel head cutting and knickpoint migration by overland flow may drive integration via the surface. To study these processes, we modeled river network development using an experimental drainage basin. The apparatus was a 1-meter diameter, cylindrical basin with a single outlet controlled by a motorized gate to adjust base level and a rainfall simulator. The ratio of surface to subsurface flow was controlled by varying the rainfall rate and the infiltration rate into the subsurface. Using a terrestrial lidar scanner, we captured 2-millimeter resolution topography and analyzed using GIS software.

We found that altering the substrate composition and precipitation rate resulted in different processes and rates of channel development. A less permeable substrate or greater precipitation rates generated more overland flow and the formation of dendritic drainage networks. In contrast, a more permeable substrate or lower precipitation rates allowed water to infiltrate into the subsurface and caused groundwater sapping at channel heads or valley walls. Amphitheater-shaped headwalls and wide valleys distinguished the channels that evolved by sapping. Most experiments were not limited to a single process of development for all channels. Instead, one or two dominant channel heads captured most of the basin's contributing area and developed into dendritic channels by overland flow. The channel heads with an insufficient contributing area to achieve overland flow evolved into sapping channels late into experiments. These experiments underscore the sensitivity of channel development processes to landscape characteristics that mediate the partitioning of precipitation between the surface and subsurface.

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