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Physical modeling of hillslope runoff generation: A scaled lab experiment of the Panola hillslope

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The trenched experimental hillslope at the Panola Mountain Research Watershed (Georgia, USA) has been the site of many investigations of subsurface stormflow, lateral pipeflow, solute flushing and hillslope modeling. While the site has been useful for revealing new controls on hillslope runoff production (bedrock topography, thresholds, etc), it is limited, like any natural field site, to static topography and the natural rainfall conditions of the region. We constructed a scale model of this hillslope to test a number of hypotheses stemming from our field work at the natural site. Specifically, our initial tests were to see if we could replicate the threshold subsurface stormflow response to rainfall and its related hillslope patterns of transient groundwater. A 2x4 m tilting table (fixed at 14 degrees) represented a 1:10 version of the hillslope where we reconstructed the exact surface and bedrock topography of the field site. The soil layer was simulated with 4-5 mm ACCUSAND-brand coarse uniform sand. Rainfall was applied at 10 mm/hr using two spray nozzles positioned 5 m above the slope. Outflow at the base of the slope was captured at 6 different sections each connected to a continuous recording tipping bucket. We observed the spatial pattern of the water table development on grid with 14 recording capacitance rods. Like the natural slope, our experiments showed that the storm flow at the laboratory hillslope was a threshold-function of precipitation and that the spatial variation of the flow at the trench could be better estimated with the bedrock then the surface topography. Measurements are also reported that test hypotheses about slope angle and precipitation intensity effects on threshold responses to rainfall.