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Spatial and temporal evolution of near-stream saturated areas

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In humid, well-vegetated areas, runoff is most commonly generated from relatively small portions of the landscape becoming completely saturated; however, little is known about the spatial and temporal behavior of these saturated regions. This study looks at the formation of these regions for the near-stream region of a 2 km^2 catchment using 46 distributed sampling locations monitored on 5-minute intervals from the wet (March, 2004) through the dry (August, 2004) season. The short sampling time interval makes it possible to observe changes in spatial structure of saturated areas during rainfall events. Also, variations among the events as the area goes from the wet to dry period are captured. Expansion of converging areas produces saturated regions showing higher spatial structure occurring earlier in events when the pre-event water table is high. Due to quick lateral redistribution in the near-surface soil layer, more sampling locations show rises in water table during high regional water table conditions. In contrast, as the regional water table falls, rainfall events only produce rises in water table for concentrated flow paths occurring at smaller scales. This change in the hydrologic response of the hillslope (i.e., saturated areas caused through direct rainfall and those caused through exfiltration) is evaluated through time lags between peak water table elevations compared to peak stream flows and rainfall. Thus, a critical regional water table elevation is defined above which saturated areas occur at scales capable of being described with topographic controls for the catchment. By understanding the spatial and temporal evolution of saturated regions, better conceptual models can be developed to predict where and when rainfall runs off.