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Downslope travel distance and hydrological connectivity: On the role of interflow in different landscapes

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Understanding and modeling the hydrological and solute transport of hillslopes and headwater catchments requires an estimate of the relative importance of different runoff generation processes as affected by pedology, lithology, topography, climate, and floral and faunal influences. However, identifying and understanding these processes is limited by current observational protocols that quantify time series of hillslope states, such as piezometric or moisture levels, rather than flow directions, magnitudes, or processes. Consequently, our ability to infer processes depends partly on the types and spatial frequencies of sensors and partly on the spatial scale of the investigation, so that the identification of undelaying hydrological processes is still limited. Here we analyze published data from twelve hillslope studies conducted in a range of landscapes to better understand the relative role of interflow, i.e. shallow lateral subsurface flow moving over a layer impeding percolation, in hillslope flow processes and stream-flow generation. For each of these studies, we calculate downslope interflow travel distances, i.e. the potential travel distance of a water parcel until it percolates through the impeding layer, as a measure of hydrological connectivity in the landscape. Downslope travel distances from the twelve studies ranged from around one meter to 900 meters. With two exceptions, slope lengths were much longer than downslope travel distances. Thus, we can conclude that interflow contributes directly to the stream flow only from the lower portions of the hillslopes in most landscapes. Furthermore our analysis reveals that a continuously perched saturated zone with downslope flow does not imply continuous connectivity to the valley.