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Simulated river runoff components using spatially derived response functions of hill slope processes

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Hydrograph analysis of stream flow indicates preferential groupings of flow paths which lead to identifiable components of runoff that have been attributed to hill slope processes. These have been conceptualized in this study as hill slope reservoirs with unique flow characteristics that can be represented by their spatially derived unit hydrographs.

The initial derivation of increased storage (recharge) to each hill slope reservoir is estimated from vertical flow derived from the partitioning of effective rainfall, using basic storm characteristics (rain intensity and duration), as well as soil types and land use. The storage in each reservoir is scaled to conserve mass according to rain storm size.

The discharges from the reservoirs are conceived to follow traditional flow processes down the hill slope involving, respectively, surface, unsaturated and saturated soil conditions. The discharge is a function of travel times from all catchment segments on the hill slopes to the point where it discharges into a channel feature. The distribution of travel distances is derived from the characteristic features of the hill slopes for flow morphologically derived patterns of pathways (called a geomorphic response function). The velocity profile along each pathway is derived from adaptions of traditional flow models (Manning's equation and Darcy's Law) that are based on similar functions of hydraulic slope and resistance/conductance of flow. Integrated travel time distributions are related to catchment flow response functions to rainfall. The component response functions are scaled for catchment size to create an equivalent of an unit hydrograph for each flow component. The recessions of these unit response functions (related to the travel times over individual catchment segments) are calibrated against

observed recession rates derived from analysis of observed hydrographs.

The unit response functions for each flow component are convoluted to form the runoff hydrograph for each storm type. The simulated storm hydrographs are compared to observed flow series in three small headwater catchments, where mixing of different flow components have not been completed. Upscaling of the hillslope model to a larger catchment is presented.