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The Effects of Evaporation and Intensity Smoothing by Canopy Interception on Flood Generation: A Virtual Land Use Change Experiment

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Land use change often involves alteration of the vegetation canopy: from forest to agriculture; from agriculture to residential lawns and parks; etc. Nevertheless, the effects of canopy evaporation and intensity smoothing on flood generation and, in particular, hillslope subsurface stormflow generation during rain events, are poorly understood. While watershed manipulation experiments have suggested that these processes are important at long timescales, these processes may also be important at the storm-timescale. Notwithstanding, there are few hillslopes in which both internal subsurface stormflow generation processes and canopy processes are understood, so canopy interception effects on subsurface stormflow have not been tested mechanistically. We present a series of virtual experiments (numerical experiments driven by field intelligence) using HYDRUS-2D to model flow in a well-studied and characterized research hillslope. Our virtual experiments compared modeled hillslope response to (1) measured rainfall; (2) measured throughfall from three sites within a forest; and (3) synthetic, simplified throughfall signals containing either evaporation alone or intensity smoothing alone. As expected, results from our virtual experiments showed that evaporative loss delayed the onset of subsurface stormflow, lowered and delayed peak stormflow, and decreased total subsurface flow and the runoff ratio. Canopy evaporation was responsible for most of these effects, while intensity smoothing showed measurable differences only in peak subsurface stormflow rate. This work has implications for the calibration of watershed models. Ignoring interception in the model structure would miss a major effect of vegetation on subsurface stormflow generation. Our work also shows that simply applying some fractional reduction as a scaled input

signal (as is customary in watershed modeling studies) may mask important canopy interception effects on peak subsurface stormflow response in some situations.