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Effect of different spatial models of physical properties on water table dynamics and stream discharge

C. Gascuel-Odoux (1,2), M. Weiler (2), J. Molenat (1)

(1) INRA, UMR SAS, Rennes, France, (2) University of British Columbia, Canada

(Chantal.gascuel@rennes.inra.fr / Fax: +33 223485430 / Phone: +33 223485227)

Physical properties are often assumed to be homogeneous over the catchment or hillslope when modeling discharge and water table dynamics. We hypothesize that this assumption often results in poor simulations of water table depth dynamics, particularly in upslope position. This hypothesis is rarely tested due to lack of water table observations in the upslope area. We present a study that tests the effect of different spatial models of the saturated hydraulic conductivity and drainable porosity. The study was located in an experimental watershed underlain by schist crystalline bedrock where shallow and perennial groundwater develops mainly in the weathered layer of the bedrock. Groundwater observation wells were drilled along the hillslope transect to a maximum depth of 15m and continuously monitored. We used the physically-based hillslope model Hill-vi to simulate water fluxes in the unsaturated and saturated zone, the water table dynamics at different slope positions and the discharge. Four different spatial models were considered assuming different landscape controls on saturated hydraulic conductivity and drainable porosity.We used Monte Carlo simulations within a multiobjective framework to compare the different model structures and determine the best overall model based on discharge and the comparison between average water level and range in variations among three wells. The results demonstrate that all models were able to capture the discharge and water table dynamics observed in the downslope wells, but the water table data from the upslope region of the watershed (plateau or ridge) was more difficult to predict. In this upslope region, however, the large annual water table variations of 4-6 m have significant effects on nutrient and contaminant transport and also on residence time variations.