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A PHYSICALLY-BASED SURFACE-SUBSURFACE HYDROLOGIC MODEL FOR CLEAR CREEK WATERSHED

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Abstract. Devastating flooding caused by heavy rains brought economic, social, and environmental impacts in many watersheds across the state of Iowa, USA. From 2011–2013, Iowa suffered eight Presidential Disaster Declarations, encompassing more than 70% of the state. The Clear Creek Watershed covers about 270 km2 with three headwater streams converging in Iowa Township. The watershed comprises 60% of agriculture in the form of corn-soybean rotations, 23% pasture and other grasslands, 10% forest, and 7% urban areas. In this study, a fully coupled distributed surface-subsurface model, PIHM, was used to predict the hydrologic dynamic response of the Clear Creek Watershed over an annual period. The numerical model takes into account interception, through fall, infiltration, recharge, evapotranspiration, and infiltration, enabling discharge through the surface or subsurface into downstream water bodies or aquifer flows. Evapotranspiration is a function of water content in the soil and vegetation characteristics. The model considers the special distribution of land use and soil type. Overland flow is modeled using the diffusive wave approximation of 2D St. Venant equations. River routing is computed using 1D St. Venant equations. Water content in the soil is modeled using Richard's equation. Water movement in the unsaturated zone is assumed to be vertical and the saturated groundwater region is modeled using the 2D Dupuit approximation. PIHM uses a finite-volume formulation for solving the system of coupled equations. The resulting ordinary differential equation system is solved with the solver SUNDIALS. The model was calibrated and validated with monitoring data. Model details, convergence challenges and model calibration in the Clear Creek Watershed will be presented and discussed.