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Field Scale Monitoring and Modelling of Water and Chemical Transfer in the Vadose Zone

G. Heathman (1,,), E. Pappas (,,), D. Smith (,,), C. Huang (,,)

(1) (gheathman@purdue.edu), () USDA National Soil Erosion Research Laboratory, West Lafayette, IN, USA

Natural resource systems involve highly complex interactions of soil-plant-atmosphere-management components that are extremely difficult to quantitatively describe. Computer simulations for prediction and management of watersheds, water supply areas, and agricultural fields and farms have become increasingly complex in an effort to more accurately describe natural resource processes. However, often times the development and application of natural system models do not include careful testing against high quality field measured data and variables. This study reports on the assimilation of state-of-the-art monitored hydrologic states and fluxes into a vadose zone model. The specific study objectives were: 1) to calibrate and validate the Root Zone Water Quality Model (RZWQM) for water and chemical transfer in two, 2.5 ha tile-drained agricultural fields in the Upper Cedar Creek Watershed of northeastern Indiana, USA; 2) to assess the space-time evolution of soil hydraulic functions in response to no-till (NT) and rotational tillage (RT) practices in each field; and 3) to evaluate model performance in simulating chemical transfer to surface and subsurface flows. Model parameterization and performance were tested in each field based on data collected from state-of-the-art water quality samplers, weather stations, and soil moisture/temperature sensors, as well as detailed field and laboratory measurements of soil physical and hydraulic properties. Model performance was assessed using the Nash-Sutcliffe Efficiency coefficient (NSE), coefficient of determination (R2), Root Mean Square Error (RMSE), and percent bias (PBIAS). The results show that the RZWQM was able to simulate water and chemical transport in runoff and subsurface flow with sufficient quality. In addition, the use of pedotransfer functions in RZWQM were adequate in characterizing effective field-scale soil hydraulic behavior. Thus, the model should serve as a suitable tool in quantifying the impact of different management practices on water quantity and quality at the field or small watershed scale.