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Spatial Resolution and Catchment Size Interaction of Soil Hydrological Properties for Hydrological Modeling

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Spatial resolution of soil hydrologic properties is critical for distributed hydrological model streamflow simulations. Soils from US Soil Survey Geographic (SSURGO) Database are mapped at scales varying from 1:12,000 to 65,000. Related to these scales are also soil hydrological properties, which could vary spatially outside of the common SSURGO scale range. The objective of this research was to assess the role of the spatial resolution of soil depth on simulated hydrological response for various watershed sizes using the Distributed Hydrology Soil Vegetation Model (DHSVM). The study site was Hall Creek watershed a 56 km2 in size located in Dubois County in southern Indiana, USA. The watershed size was divided in 55 sub-watersheds varying in size from less than 5 km2 to 56 km2. The grid size spatial resolution of soil hydrological properties varied from 10x10, 30x30 and 90x90m. The simulated streamflow metrics were annual mean, minimum and maximum streamflow, and R-B Flashiness, which measures the variability in streamflow between successive days highlighting the fluctuation of discharge relative to total discharge. The slopes of the regression of simulated stream discharge parameters versus watershed size were used to assess the presence of interaction. In addition, the coefficient of variation was used to assess the variability for the R-B index, annual mean, annual minimum and maximum stream discharge across different model resolutions within each watershed category. The slope for 10x10 and 30x30m spatial resolution for annual mean, and minimum streamflow were not significantly different from zero across all watershed sizes indicating lack of interaction. However, slope for the R-B flashiness was significantly different from zero for the 90x90 m grid size indicating that watershed size change is sensitive at this spatial resolution. The variability of R-B index, annual mean and annual minimum hydrologic metrics decreased with increasing watershed size but increased for annual maximum stream flow except for the 90x90 m grid size. Considering the coefficient of variation as an expression of uncertainty the data suggests that the prediction of flashiness, annual mean, and annual maximum becomes less certain as the watershed size decreases. The 90x90 m grid size shows a greater uncertainty in the predicted stream discharge especially for annual mean and minimum streamflow. The results suggest that the prediction of flashiness, low and high flows are related to both watershed size and the spatial resolution of the soil depth, especially for watersheds less than 10 km2.