Evaluation of Impact of Geospatial and Climatic Input Data Resolution on Hydrological and Sediment Model Performance in a Mining Affected Watershed

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Extended Abstract

Hydrological models are indispensable tools for simulating environmental processes and informing management of water resources and water quality in watersheds and open water bodies (e.g., streams and lakes). Applicability of hydrological models depends on how well they can reproduce similar patterns of observed values of the simulated outputs. This requires adequate input data resolutions and proper model calibration and validation. Geospatial and hydro-climate inputs are chief drivers of hydrological model outputs. Several studies have been conducted to examine the effect of impact of geospatial or climatic input data resolutions (e.g., precipitation, temperature, digital elevation model, and soil maps) on model performance.

These studies have primarily focused on the impact of data resolution categories individually, but often have overlooked the combined effect of geospatial, sub-basin discretization, and climate resolutions on model performance. In this study, we constructed a Soil and Water Assessment Tool (SWAT) model for a watershed known for its legacy mining activities here in the U.S.A., and examined 18 different input data resolution scenarios on the accuracy of the model streamflow and sediment loading predictions. The modelled watershed occupies much of the upper portions of the Spring River Watershed and is located in parts of Midwestern States of Kansas, Missouri, and Oklahoma in the U.S.A.

Mining activities in the watershed were one of the primary sources of metals such as lead and zinc ore in the world for most of the last two centuries. As active mining ended over the past 20 years, most of metals residuals are associated with the sediments within the watershed. The objective of this modeling exercise is to identify optimal input data resolution for best model performance in simulating flow and sediment transport within the Spring River Watershed. Three different DEM resolutions: 10 m, 30 m, and 90 m were used to delineate the channel network. For modeling required soil data, we used STATSGO and SSURGO to extract spatially distributed soil properties. As for climatic input, we compare National Centers for Environmental Protection (NCEP) based daily observations and National Oceanic and Atmospheric Administration (NOAA) based ground data.

We also applied the reanalysis data from Parameter-elevation Regressions on Independent Slopes Model's (PRISM's) data for climatic input. While this study suggests that a combination of 10m DEM for digital elevation model with SSURGO soil data along with climatic input from PRISM provides the best model performance, the use of 30m DEM with PRISM and SSURGO data produced comparable results. For 30m DEM, for example, the pre-calibration Nash and Sutcliffe efficiency (NSE), coefficient of determination (R^2) and Percent Bias (PB) model performance measures were NSE =0.71, R^2=0.74 and PB= +- 12% for the best input data resolution scenario for flow. For sediment loading, NSE =0.41,

R^2=0.44 and PB= +- 19% was observed with this data set. A significant change was observed with the PRISM data comparing all other climatic inputs for flow and sediment loading simulation.

Keywords: Hydrology, Sediment, Watershed, Model, Data Resolution, Spring River, SWAT, NCEP, NOAA, STATSGO, SURRGO, PRISM