THESIS PROPOSAL

Developing a framework for integrating hydraulic analyses of dynamic discharge into watershed modeling

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Abstract

The discharge data used to calibrate hydrologic models are derived from rating curves, which hydrographers conventionally develop based on operational assumptions of stationarity. However, the stage–discharge relationship governing most alluvial rivers varies over time due to scour-and-fill processes or morphogenic floods that can alter the channel geometry. If not explicitly accounted for and quantified, the rating curve uncertainty associated with such geomorphic changes can introduce bias into hydrologic models that might, in turn, lead to spurious analyses. This study generally aims to develop a framework for integrating hydraulic analyses of dynamic discharge into watershed modeling. First, we propose incorporating two extant rating curve uncertainty estimation methods: (i) the sequential segmentation procedure used in the dynamic management of rating curves (GesDyn) (Morlot et al., 2014) to sample the gaugings into sets of chronologically homogeneous hydraulic analogs; and (ii) the hydraulic analysis in the Bayesian Rating Curve (BaRatin) method (Le Coz et al., 2014) to define, using channel geometry measurements, the prior distributions for the rating curve parameters within a formal Bayesian framework. The posterior rating curve for each gauging and its hydraulic analogs will be computed. We will use the discharge time series reconstructed from these dynamic rating curves, including their associated uncertainties, to calibrate a Soil and Water Assessment Tool (SWAT) model of the study watershed. For benchmarking, we will assess the model performance by comparing its goodness-of-fit and predictive uncertainty with that of a model calibrated against the hydrographers' discharge time series. Preliminary work in this study focused on detecting non-stationary flows in the Mindanao River Basin using LOESS-based decomposition of discharge time series for non-linear trend estimation. We characterized the non-stationary behavior of the gauged river draining the selected study area, the Libungan Watershed (524.66 km^2), in terms of changes in the magnitude, frequency, and timing of its flows before and after the suspected rating shift. Overall, this study shall demonstrate the significance of explicitly integrating a physically based understanding of river flow dynamics into computational methods in hydrologic monitoring and modeling, particularly for sparsely gauged watersheds in increasingly non-stationary environments.

KEYWORDS — discharge, rating curve, non-stationarity, uncertainty analysis, Bayesian inference, SWAT