

Abstract

Hydrodynamic numerical modelling lays the foundation for modelling studies to investigate sediment transport, water quality, ecological changes, waves, currents, and many more. Simulating the flow of fluid following the governing dynamics is a complicated task. This study explores spatially explicit, depth-dependent, and data-driven roughness calibration of a hydrodynamic numerical model for the Lower Yuba River, located in Marysville, California. The study implements Ferguson's approach for frictional computation and considers the river section's diverse morphological unit and roughness components. A workflow is developed to integrate Ferguson's law by altering the pre-existing subroutines of Telemac-2D software. Spatially explicit friction zones are demarcated to assign independent calibration parameters to different regions of the river section. Two constants of Ferguson's variable-power equation are considered as the calibration parameters for the model. The fully developed hydrodynamic numerical model becomes computationally expensive and manual calibration is inconvenient owing to the time factor. To overcome this challenge, the full complexity model is substituted by a surrogate model. Equivalency between the surrogate model and the full-complexity model is achieved by using Bayesian active learning to train the surrogate model. Based on the information theory score, Bayesian active learning improves the model in the regions of parameter space that are more relevant for Bayesian inference. The calibration results indicate that the surrogate model is able to predict the outcome of the full-complexity model with high precision. Bayesian active learning methodology enhances the predictive capacity of the surrogate model with increasing iterations. The simulated results of the hydrodynamic numerical model are inconsistent with the measurement values for flow velocity and water depth in the regions with higher grain sizes due to the lack of roughness attribute representation and computation of enhanced roughness in these regions. Ferguson's approach computes higher roughness in comparison to Manning's approach. The increased precision of the model in predicting the low-flow velocities is a significant observation from this study in contrast to this usually being a drawback of a hydrodynamic numerical model.