Master thesis: Stochastic Calibration of Sediment Transport Models Using Surrogate-Assisted Bayesian Inversion

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Abstract:

This work uses the surrogate-assisted Bayesian inversion technique proposed by Oladyshkin et al. (2020) to perform a stochastic calibration of a hydro-morphodynamic model for the Banja reservoir, located in Albania. Four parameters were considered during the calibration process: critical shear stress for erosion, critical shear stress for deposition, dry-bulk density and a sediment size multiplier. To compensate for the lack of field measurements for the first three parameters, the stochastic calibration approach assumes prior distributions through a literature review, and are then updated in a Bayesian inference process to get a more informative posterior. To overcome the challenge of performing a Bayesian inference analysis in a computationally expensive model (~5h per run), the full complexity hydro-morphodynamic model was replaced by a surrogate model computed through Gaussian Process Regression. A good equivalence between the hydro-morphodynamic and the surrogate model was accomplished by training the latter with a Bayesian active learning technique based on information theory scores. This technique *"adaptively improves the surrogate model in those regions of the parameter space that are most important for Bayesian inference, while including relevant information in an iterative manner"* (Oladyshkin et al., 2020). After the calibration process, a Nash-Sutcliffe efficiency of 0.92 was obtained between the hydro-morphodynamic and surrogate models, and of 0.7 between the surrogate model and the measurement data. These scores demonstrate a high capacity of the surrogate-assisted Bayesian inversion method to calibrate computationally expensive models.

Keywords: Stochastic calibration, Bayesian Inference, Surrogate model, Relative entropy, Bayesian Active Learning.