Bayesian analysis of stage-fall-discharge rating curves and their uncertainties

Valentin Mansanarez (1), Jérôme Le Coz (1), Benjamin Renard (1), Michel Lang (1), Gilles Pierrefeu (2), Raphaël Le Boursicaud (2), and Karine Pobanz (2)

(1) Irstea, HHLY, Villeurbanne, France (valentin.mansanarez@irstea.fr), (2) Compagnie Nationale du Rhône (CNR), Lyon, France

Stage-fall-discharge (SFD) rating curves are traditionally used to compute streamflow records at sites where the energy slope of the flow is variable due to variable backwater effects. Building on existing Bayesian approaches, we introduce an original hydraulics-based method for developing SFD rating curves used at twin gauge stations and estimating their uncertainties. Conventional power functions for channel and section controls are used, and transition to a backwater-affected channel control is computed based on a continuity condition, solved either analytically or numerically. The difference between the reference levels at the two stations is estimated as another uncertain parameter of the SFD model.

The method proposed in this presentation incorporates information from both the hydraulic knowledge (equations of channel or section controls) and the information available in the stage-fall-discharge observations (gauging data). The obtained total uncertainty combines the parametric uncertainty and the remnant uncertainty related to the model of rating curve. This method provides a direct estimation of the physical inputs of the rating curve (roughness, width, slope bed, distance between twin gauges, etc.).

The performance of the new method is tested using an application case affected by the variable backwater of a run-of-the-river dam: the Rhône river at Valence, France. In particular, a sensitivity analysis to the prior information and to the gauging dataset is performed.

At that site, the stage-fall-discharge domain is well documented with gaugings conducted over a range of backwater affected and unaffected conditions. The performance of the new model was deemed to be satisfactory. Notably, transition to uniform flow when the overall range of the auxiliary stage is gauged is correctly simulated. The resulting curves are in good agreement with the observations (gaugings) and their uncertainty envelopes are acceptable for computing streamflow records. Similar conclusions were drawn from the application to other similar sites.