An approach to multi-criteria calibration of hydrologic models and their mixtures

F. Fenicia (1,2), D.P. Solomatine (3), H.H.G. Savenije (2), L. Hoffmann (1)

(1) Public Research Center – Gabriel Lippmann, Luxembourg

(2) Water Resources Section, Faculty of Civil Engineering and Geosciences, Delft University of Technology, The Netherlands

(3) UNESCO-IHE Institute for Water Education, Delft, The Netherlands

Conceptual hydrologic models are useful tools as they provide an interpretable representation of the hydrologic behaviour of a catchment. Their application, however, is conditioned by several sources of uncertainty that affect their accuracy with respect to various aspects of the system behaviour. One of the ways of increasing their accuracy is to combine individual models, each of them representative of a specific aspect of the system behaviour.

To address this issue, we refer to a common hydrological model (the HBV model) and we evaluate its ability of reproducing the rainfall-discharge behaviour of a catchment in Luxembourg, with particular reference to accurate reproduction of the high and low-flows behaviour.

A multi-objective calibration with respect to two defined objectives representing model performances for the selected hydrograph characteristics shows that there are several solutions (the so-called "Pareto optimal" region) that simultaneously optimize the selected criteria. These solutions represent a trade-off between the selected objectives and show that individual optimal models are better at matching different aspects of the observed hydrograph.

To provide a solution to this problem and obtain a model that matches the selected hydrograph characteristics simultaneously, a combination of individual optimal models can be used.

In the present study we use the so-called fuzzy committee approach, where a global

model is composed of multiple local models that are weighted using fuzzy membership functions. Local models are selected choosing the best performing models associated to the selected hydrograph characteristics (in this case high flows or low flows). In operation, each local model is triggered based on the expected discharge of the catchment.

Results show that such an approach to building a composite model allows for a significant improvement of the accuracy of the simulation.