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Effect of spatial forcing data and landscape heterogeneity on performance and consistency of model structures

Tanja Euser (1), Hessel Winsemius (2), Markus Hrachowitz (1), and Hubert Savenije (1)

(1) Water Resources Section, Faculty of Civil Engineering and Geosciences, Delft University of Technology, P.O. Box 5048, 2600 GA Delft, The Netherlands, (2) Deltares, P.O. Box 177, 2600 MH Delft, The Netherlands

One of the main questions in hydrological modelling is how to design conceptual rainfall-runoff models with a higher degree of realism. It is expected that if models have a higher degree of realism, their predictive power will increase. One frequently discussed option is the use of more spatial information, which is increasingly available. Information with spatial variability can be found for example for forcing data, elevation, land use, etc. The abundance of spatially variable data requires the modeller to carefully select which data add realism to the model and which data only add complexity. An additional complication is further that the spatial detail required is a function of the time scales of the forcing data and the required output. The amount of spatially variable data available can guide the choice of an adequate distribution level of a model. As it is often difficult to determine the most suitable level of distribution for a certain catchment, this study systematically evaluates the value of incorporating distributed forcing data and distributed model structures in a stepwise approach for the Ourthe catchment (Belgium). The distribution of the model structures is based on landscape heterogeneity, using both elevation data and land use data. Eight different model configurations are tested: a lumped and a distributed model structure, each with lumped and stepwise distributed fluxes and stocks. To stepwise distribute the fluxes and stocks, the distributed forcing data is sequentially kept distributed for each reservoir of the model. To compare the degree of realism of the different configurations, both model performance and consistency are compared. Performance describes the ability of a model configuration to mimic a specific part of the hydrological behaviour in a specific catchment. Consistency describes the ability of a model configuration to adequately reproduce several hydrological signatures simultaneously. FARM (Framework to Assess the Realism of Model structures; Euser et al., 2013) can be used to evaluate this performance and consistency, using different hydrological signatures. In this way it can be determined whether the use of spatially variable data adds realism or only complexity to a model structure and which level of distribution is most suitable for a certain catchment.

References:
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