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Integrating and combining semi-distributed conceptual and data-driven models in flow forecasting: application to the Meuse river basin

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In flood forecasting and in assessing flood-induced risks hydraulic and hydrologic (process, or physically-based) models proved their usefulness. In recent years it has been shown that the so-called data-driven models (including various statistical approaches, neural networks, machine learning, fuzzy systems and chaos theory) successfully complement the physically-based ones and allow for quantification of predictions uncertainty.

Combination of physically-based simulation models and data-driven methods (hybrid modelling) leads to additional possibilities. Various types of models could be used in conjunction, being combined or cross-checking each other. This approach is of the main interest in this research. The problem of evaluating combined models in terms of error and risk is developed. These models are compared in operational data and offline information, their applicability for flood warning systems is tested, and recommendations are provided.

The results are assessed measuring the influence of using hybrid models for online and offline process (e.g. design and operation). For both types of situations modularization of the process in space (various sub-catchments being modelled by models of different types) and time (different models are built for different time intervals) is considered. This process involves the use of hydrological methodologies (baseflow separation methods) and computational intelligence algorithm (clustering techniques). For design purpose this approach was tested on three different river basins – Bagmati (Nepal), Sieve (Italy) and Brue (England). For operational analysis the hybrid models are explored on the Meuse river basin using the Delft-FEWS. The results show that there is a reduction in the error on the use of multiple seasonal and flow driven models. The use of hydrological information in the separation of the flow and its combination in a spatial distributed system leads to identification of important flow regimes and improvement in the modelling process, especially visible for 2 days ahead forecasts. Further analysis need to be made to test the models performance on hourly basis.