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Semi-distributed flood forecasting system for the Middle Vistula reach

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The aim of this study is the development of an integrated forecasting system for the middle reach of the River Vistula. The system consists of combined in series lumped parameter Stochastic Transfer Function models. In order to prolong the forecast lead-time, the system was extended to include gauging stations situated upstream of Zawichost. There is a number of tributaries located along the studied reach. The largest are Kamienna, Pilica and Wieprz. Therefore apart from Single- Input –Single-Output models (SISO), multiple input models were also developed (MISO). The system is based on water levels instead of flows, in order to avoid errors related to rating curve transformation. The problem of the nonlinear transformation of system inputs in order to separate the nonlinearity of the flow process to obtain the linear model dynamics is equally important for the accuracy of forecasts. The possibility of linearizing the flow routing process was investigated using a State Dependent Parameter approach. The nonparametric relationship was parameterised using a power function. This procedure allowed the application of a model with a nonlinear transformation of input in the forecasting mode. It is important to note that the applied methods are stochastic in nature and the structure of the models and their parameters are estimated from available observations, taking into account inherent observation and model approximation errors. As a result, forecasts are estimated together with uncertainty bands. We apply a Kalman filter updating of model predictions as a data assimilation procedure. The procedure involves formulating the forecasting problem in a state space form. Validation of the developed forecasting system shows that the quality of forecasts obtained using a semi-distributed lumped parameter model is comparable with the forecasts obtained using a distributed model with the advantage of obtaining forecast uncertainty by the former.

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