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Impact of time-variable vegetation on accuracy of rapid hydrologic predictions

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It is crucial to identify the processes that impact errors of hydrologic forecasts. Since existence of vegetation and its ability to store precipitation is an important element of water distribution in the catchment, especially at the beginning of a rainfall event, it may be considered as one of the processes influencing skills of hydrological forecasts. The main objective of the study is to verify the hypothesis that water level predictions are controlled by vegetation dynamics in the contributing mountainous basins.

The analysis is conducted for the upper Nysa Klodzka catchment with the outlet in Bardo (SW Poland). The basin includes a mid-mountain abasement covered with crops, while surrounding medium-altitude mountain ranges are mainly covered with forests. We focus on the entire year, from autumn 2013 to summer 2014.

Herein, we analyze prediction errors and efficiency measures of hydrologic forecasts provided by two stochastic models – uni- and multivariate autoregressive models as well as their two-model ensemble prediction. In addition, we use the satellite-derived Leaf Area Index (LAI) images from the Moderate Resolution Imaging Spectroradiometer (MODIS). Hydrological prognoses are derived by the HydroProg real-time rapid forecasting system, built at the University of Wroclaw (Poland) in frame of the research project 2011/01/D/ST10/04171 of the National Science Centre of Poland.

Correlation analysis between the plant maximum water storage capacity and prediction error/skill statistics (mean absolute error, root mean square error, Nash-Sutcliffe efficiency , index of agreement) is conducted. To cope with small sample size, the bootstrap simulation is performed.

We conclude that there is a strong negative association between mean or median prediction errors and vegetation state for all meteorological seasons of a year. This result implies that basins with higher interception potential are more vulnerable to forecast inaccuracy than those with sparse natural (forest) vegetation. This phenomenon is explained by the capability of stochastic models to react on approaching high flow and its reliance to slope of the hydrograph at the beginning of the high flow episode.