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Sensitivity of Hydrologic Projections to PET Assessment Method: Case Study of the Kolubara River Catchment in Serbia

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ABSTRACT

Climate change impact on water resources is evaluated in terms of changes in hydrologic variables (usually characteristic flows) in a future period relative to the baseline one. The variables in a future period are calculated by employing several modelling chains (General Circulation Model - Regional Climate Model – bias-correction method - Hydrological Model), run under assumed emission scenarios. Hydrologic projections depend on each element in the chain, which has been increasingly elaborated in the literature.

In this research, the sensitivity of flow projections to potential evapotranspiration (PET) assessment method is evaluated. Flow projections are obtained for near future (2010-2040), mid 21st century (2040-2070) and distant future (2070-2100) for the Kolubara River catchment in Serbia. This catchment is particularly important, since it was hit by one of the most devastating floods in 2014. Relative changes in the future periods are calculated for following variables: high, median and low flows, calculated as 95th, 59th and 5th percentile of daily flows in the considered period, respectively, annual runoff volume and mean relative soil water content.

Flow projections are obtained by employing a semi-distributed HBV-light hydrological model (Seibert and Vis, 2012), which is calibrated in the baseline period (1961-1990), and evaluated in 1990-2013 period, with meteorological input data observed at the Valjevo meteorological station. A composite objective function used for model calibration to provide balanced model performance in both, high and low-flow domain, and to reproduce overall runoff volume.

To obtain flow projections, the model is forced with precipitation and temperature projections obtained with ECHAM5-EBU-POM climate model, which was run under A1B and A2 emission scenarios and bias-corrected to reproduce precipitation and temperature distributions for location of the Valjevo station in the baseline period. Mean monthly PET rates are calculated by employing (1) three temperature-based methods: Blaney-Criddle, Hamon and Thornthwaite, and (2) four radiation-based methods: Jensen and Haise, McGuinness-Bordne, and the Hargreaves method (Oudin et al., 2005; Seiller and Anctil, 2015), where the Hargreaves exponent is adjusted for the Western Balkans region (Trajkovic, 2007).

The HBV-light model accurately reproduced runoff volume in both calibration and evaluation periods, with relative bias of 0.5% and 6%, respectively. The flow dynamics is simulated reasonably with the Nash-Sutcliffe efficiency NSE amounting to 0.63 and 0.5 in the calibration and evaluation periods, respectively, and amounting to 0.7 and 0.66 for the log-transformed flows. Flow projections vary with the future period and selected PET assessment method. The results indicate significant decrease in low flows, whereas estimated changes in other hydrologic variables vary both, in sign and magnitude, thus indicating significant uncertainty. Projections in all considered hydrologic variables are shown sensitive to PET assessment method, namely different PET assessment methods may yield projections of opposite signs.

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