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Assessment of potential climate and land use change impacts on the regional water resources of Lusatia (Germany)

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Being one of the driest regions in Germany, the climatic water balance of Lusatia is already negative under current climate conditions. Due to excessive open-cast lignite mining activities during the last centuries, the water balance of the catchments of the rivers Spree, Schwarze Elster, and Lusatian Neisse is profoundly disturbed. Potential changes of future climate and land use conditions will certainly impact the hydrologic conditions and may tighten already existing water user conflicts. The aim of the study is (1) the determination of the impact of climate and land use change on the natural discharge in the Lusatian river catchments as a prerequisite for the formulation of suitable water related climate change adaptation strategies and (2) the assessment whether climate or land use changes will be the dominant reason for potential future changes of the water resources in the Lusatian river basins.

In a first step, the spatially-distributed, process-based Water Balance Simulation Model (WaSiM-ETH), the semi-distributed, process-oriented Soil and Water Integrated Model (SWIM), and the simple conceptual lumped model HBV-light are calibrated for subcatchments where the influence of lignite mining and water management on discharge is comparably low. The application of three conceptually different models allows for the estimation of the uncertainty related to the hydrological model as well as to verify the applicability of SWIM for the whole study region. SWIM was chosen as hydrological model for the entire river basins because its computational effort is comparably low while allowing through its hydrotope approach spatially distributed analyses.

In a second step, the model parameters of SWIM are regionalized onto the scale of the entire river basin. For the consideration of possible impacts of climate change, SWIM is the driven by the meteorological parameters of two statistical regional climate models: Statistical Analogue Resampling scheme (STAR; 3 scenarios – 100 realisations each) and the Wetterlagen-basierte Regionalisierungsmethode WettReg (3 scenarios – 10 realisations each). Land use change scenarios considered in this study include (1) the decline of the groundwater depression cone caused by lignite mining and (2) the increase of cultivating agricultural energy crops. Both, changes in river discharges at selected gauging stations and temporally and spatially distributed changes of water balance components, are analyzed.

First results based on the subcatchments indicate that SWIM performs equally well compared to the more complex WaSiM-ETH and the simpler HBV-light during calibration and validation. When the hydrological models are driven by the statistical regional climate models, a strong decrease of the available water resources is simulated especially during the vegetation period. The differences between the results based on the STAR and WettReg are negligible, especially when considering the 25th- and 75th percentile of the distribution.

The simulated discharges will later be used as input data for the long term water management model WBalMo in order to assess potential climate and land use change impacts on water users and managed discharges as a prerequisite for a long term integrated river basin management and planning.