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Using catchment similarity for model parameter regionalization in highly anthropogenically impacted catchments in Lusatia

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Due to large-scale interventions on the hydrological system by excessive open-cast lignite mining activities and water management measures for decades, there is no natural relationship between rainfall and runoff in the catchments of the rivers Spree, Schwarze Elster, and Lusatian Neisse. Impacts on the hydrological system of Lusatia include: (1) Ground water resources have been reduced by dewatering during the lignite excavation, (2) River discharges have been increased by mine discharges and annual variations have been evened out. Potential changes in future climate and land use conditions will certainly impact the natural hydrologic conditions of the region.

The objective of this study is to set up hydrological models for the catchments of the rivers Spree, Schwarze Elster, and Lusatian Neisse as a prerequisite for climate and land use change impact studies. Due to the strong anthropogenic impact on the discharge, the traditional approach of calibrating hydrological models based on time series of observed discharges is constrained. Thus, the ecohydrological model Soil and Water Integrated Model (SWIM) was first calibrated and validated for representative subcatchments without influence of water management and mining activities. Different sets of optimum parameters could be identified. In order to decrease the risk of equifinality and to overcome overparameterization of the model each of the subcatchments was used as a donor for the parameter set of the others. Because this did not yield satisfactory results, parameters were recalibrated to identify the most sensitive model parameters in the region. Recalibration of three model parameters: (1) a factor for correcting potential evaporation calculated using a modified Turc-Ivanov approach, (2) a factor for correcting the coefficient of saturated hydraulic conductivity and (3) a factor for recession rates for two ground water layers resulted in a satisfactory model fit for those catchments. Calibrating these parameters also yielded good results for further subcatchments without influence of water management and mining activities. Catchment similarities enabled to set up the model also for highly impacted subcatchments and the whole catchments of Spree, Schwarze Elster, and Lusatian Neisse. The approach was successfully validated considering model results of further studies in the region as well as maps of long term annual undisturbed discharges.