EGU21-8884
https://doi.org/10.5194/egusphere-egu21-8884
EGU General Assembly 2021

Optimized planning and operation of interconnected multi-purpose reservoir systems using integrated modeling for climate change adaptation

Patrick Nistahl, Tim Müller, Gerhard Riedel, Hannes Müller-Thomy, and Günter Meon
Leichtweiss Institute for Hydraulic Engineering and Water Resources Department Hydrology, Water Management and Water Protection, TU Braunschweig, Braunschweig, Germany (p.nistahl@tu-braunschweig.de)

Climate change impact studies performed for Northern Germany indicate a growing demand for water storage capacity to account for flood protection, low flow augmentation, drinking and agricultural water supply. At the same time, larger storage volumes for hydropower plants can be used to cope with the demands of changing energy supply from fossil to renewable energies. To tackle these challenges for the next decades, a novel reservoir system planning instrument is developed, which consists of combined numerical models and evaluation components. It allows to model simultaneously the current interconnected infrastructure of reservoirs as well as additional planning variants (structural and operational) as preparation for climate change. This planning instrument consists of a hydrological model and a detailed reservoir operation model.

As hydrological model, the conceptual, semi-distributed version of PANTA RHEI is applied. Bias-corrected regional climate models (based on the RCP 8.5 scenario) are used as meteorological input. The hydrological model is coupled with a detailed reservoir operation model that replicates the complex rules of various interconnected reservoirs based on an hourly time step including pumped storage plants, which may have a subsurface reservoir as a lower basin. Downstream of the reservoirs, the hydrological model is used for routing the reservoir outflows and simulating natural side inflows. In areas of particular interest for flood protection, the hydrological routing is substituted with 2D hydraulic models to calculate the flood risk in terms of expected annual flood damage based on resulting inundation areas.

For the performance analysis, the simulation runs for all integrated modeling variants are evaluated for a reference period (1971-2000) and for future periods (2041-2070). Performance criteria involve flood protection, drinking water supply, low flow augmentation and energy production. These performance criteria will be used as stake holder information as well as a base for further optimization and ranking of the planning variants.

The combination of the hydrological model and the reservoir operation model shows a good performance of the existing complex hydraulic infrastructure using observed meteorological forcing as input. The usage of regional climate models as input shows a wide dispersion of several performance criteria, confirming the expected need for an innovative optimization scheme and

the communication of the underlying uncertainties.