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Unraveling effects of reservoirs and their parameterization on streamflow simulation: case study of the Yom-Nan Basins in Thailand

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Most large river basins worldwide have been interfered by man-made reservoirs and dams for flood control, agricultural irrigation, and hydropower generation. The release and storage of reservoir water alter the magnitude, timing, and duration of downstream streamflow, which significantly affect flood and drought occurrence. Previous research has demonstrated considerable impacts of reservoirs on long-term streamflow simulations at regional and global scales. However, the understanding of reservoir impacts on real-time streamflow simulations at the basin scale remains limited due to lack of information on reservoir characteristics and complex reservoir regulations. Moreover, most hydrological models do not represent components related to effects of reservoirs and their water management activities.

Since spatial-temporal quantification of reservoir impacts is essential for water-related hazard assessment, the goal of this study is to gain a deeper insight into effects of reservoirs and their parameterization on real-time (daily) streamflow simulations at the basin scale. Our case study is the Yom-Nan Basins (58,729 km2) in Northern Thailand, which contain two multipurpose reservoirs.

We use the novel fully-distributed hydrological model, wflow_sbm, to simulate rainfall-runoff processes and streamflow in the study area. To investigate reservoir components, we added a reservoir scheme based on the LISFLOOD model into wflow_sbm, with additional model parameters representing reservoir capacity, filling-level thresholds, and streamflow release thresholds. At a spatial resolution of 1 km2, the selected basins were divided into 25 sub-basins. We derived the digital elevation model, soil map, and land cover map from open data sources. Reservoir bodies and their historical inflow/outflow data were obtained from Thai national records. As the basins contain few meteorological stations, we utilized the MSWEP precipitation as forcing data.

Our focus lies in explicitly indicating the most dominant and sensitive parameters related to reservoirs, specifying the best values and ranges of these parameters, and quantifying the uncertainty of these parameters on model performance. We will calibrate and validate the wflow_sbm model, including the reservoir scheme, against observations at active river gauges throughout the study area. With unravelled quantitative effects of reservoirs on streamflow simulations, we hope to further improve the model performance at the basin scale.