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A dam-reservoir module for a semi-distributed hydrological model

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Developing modeling tools that help to assess the spatial distribution of water resources is a key issue to achieve better solutions for the optimal management of water availability among users in a river basin. Streamflow dynamics depends on (i) the spatial variability of rainfall, (ii) the heterogeneity of catchment behavior and response, and (iii) local human regulations (e.g., reservoirs) that store and control surface water. These aspects can be successfully handled by distributed or semi-distributed hydrological models.

In this study, we develop a dam-reservoir module within a semi-distributed rainfall-runoff model (de Lavenne et al. 2016). The model runs at the daily time step, and has five parameters for each sub-catchment as well as a streamflow velocity parameter for flow routing. Its structure is based on two stores, one for runoff production and one for routing. The calibration of the model is performed from upstream to downstream sub-catchments, which efficiently uses spatially-distributed streamflow measurements.

In a previous study, Payan et al. (2008) described a strategy to implement a dam module within a lumped rainfall-runoff model. Here we propose to adapt this strategy to a semi-distributed hydrological modelling framework. In this way, the specific location of existing reservoirs inside a river basin is explicitly accounted for. Our goal is to develop a tool that can provide answers to the different issues involved in spatial water management in human-influenced contexts and at large modelling scales.

The approach is tested for the Seine basin in France. Results are shown for model performance with and without the dam module. Also, a comparison with the lumped GR5J model highlights the improvements obtained in model performance by considering human influences more explicitly, and by facilitating parameter identifiability. This work opens up new perspectives for streamflow naturalization analyses and scenario-based spatial assessment of water resources under global change.

References

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