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Towards robust optimization of cascade operation of reservoirs considering streamflow uncertainty

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Abstract: Modern water resource management requires a more robust flood control operation of cascade reservoirs to cope with a more dynamic external environment, whose ultimate goal is to ensure the robust optimization for multiple purposes. To this end, a number of studies with the theme of flood control operation have developed various methods for robust optimization in the presence of uncertainties and in some cases, they may work well. However, these approaches usually incorporate uncertainty into the flood control objectives or constraints and consequently lack explicit robustness indicators that can assist the decision-makers to fully assess the impact of the uncertainty. In order to construct a mature framework of explicit robust optimization of flood control operation, this study uses the Robust Optimization and Probabilistic Analysis of Robustness (ROPAR) technique to identify the robust flood limited water levels of cascade reservoirs for satisfactory compromise hydropower production and flood control risk taking into account the streamflow variability during the flood season: (1) The Monte Carlo method is employed to sample the input set according to the historical streamflow records; (2) The effective non-dominated sorting genetic algorithm II algorithm (NSGA-II) generates a series of Pareto fronts for each hydrograph sample; (3) the ROPAR technique helps building the empirical distribution of the values of hydropower production corresponding to the chosen levels of flood control risk and carry out probabilistic analysis of the Pareto fronts; (4) the ROPAR technique identifies the final robust solutions according to certain criteria. A reservoirs cascade in the Yangtze River basin, China, is considered as a case study. The presented approach allows for studying propagation of uncertainty from the uncertain inflow to the candidate optimal solutions, and selecting the most robust solution, thus better informing decisions related to reservoir operation.

Key words – multi-objective reservoir system, robust optimization, uncertainty, flood control operation, Yangtze River basin

Reference:

Marquez-Calvo, O.O., Solomatine, D.P., 2019. Approach to robust multi-objective optimization and probabilistic analysis: the ROPAR algorithm. *J Hydroinform*, 21(3): 427-440. DOI:10.2166/hydro.2019.095

