Geophysical Research Abstracts
Vol. 19, EGU2017-17823-2, 2017
EGU General Assembly 2017

Designing adaptive operating rules for a large multi-purpose reservoir

Robel Geressu (1), Charles Rougé (2), and Julien Harou (2)

(1) University College London, Engineering Faculty, Civil Environmental and Geomatic Engineering, London, United Kingdom, (2) The University of Manchester,School of Mechanical, Aerospace and Civil Engineering,Manchester,United Kingdom

Reservoirs whose live storage capacity is large compared with annual inflow have “memory”, i.e. their storage levels contain information about past inflows and reservoir operations. Such “long-memory” reservoirs can be found in basins in dry regions such as the Nile River Basin in Africa, the Colorado River Basin in the US, or river basins in Western and Central Asia. There the effects of a dry year have the potential to impact reservoir levels and downstream releases for several subsequent years, prompting tensions in transboundary basins. Yet, current reservoir operation rules in those reservoirs do not reflect this by integrating past climate history and release decisions among the factors that influence operating decisions.

This work proposes and demonstrates an adaptive reservoir operating rule that explicitly accounts for the recent history of release decisions, and not only current storage level and near-term inflow forecasts. This implies adding long-term (e.g., multiyear) objectives to the existing short-term (e.g., annual) ones. We apply these operating rules to the Grand Ethiopian Renaissance Dam, a large reservoir under construction on the Blue Nile River. Energy generation has to be balanced with the imperative of releasing enough water in low flow years (e.g., the minimum 1, 2 or 3 year cumulative flow) to avoid tensions with downstream countries, Sudan and Egypt. Maximizing the minimum multi-year releases could be of interest for the Nile problem to minimize the impact on performance of the large High Aswan Dam in Egypt. Objectives include maximizing the average and minimum annual energy generation and maximizing the minimum annual, two year and three year cumulative releases. The system model is tested using 30 stochastically generated streamflow series. One can then derive adaptive release rules depending on the value of one- and two-year total releases with respect to thresholds. Then, there are 3 sets of release rules for the reservoir depending on whether one or both thresholds are not met, vs. only one with a non-adaptive rule. Multi-objective evolutionary algorithms (MOEAs) are used to obtain the Pareto front, i.e. non-dominated adaptive and non-adaptive operating rule sets. Implementing adaptive rules is found to improve the trade-offs between energy generation criteria and minimum release targets. Compared with non-adaptive operations, an adaptive operating policy shows an increase of around 3 and 10 Billion cubic meters in the minimum 1 and 3-year cumulative releases for a given value of the same average annual energy generation.