EGU23-8318, updated on 17 Apr 2024
https://doi.org/10.5194/egusphere-egu23-8318
EGU General Assembly 2023

Does prioritizing environmental flows compromise demand satisfaction and hydropower production in the Nagarjuna Sagar reservoir?

Akshay Sunil, Riddhi Singh, and Manvitha Molakala
Indian Institute of Technology, Bombay, Indian Institute of Technology, Bombay, Civil Engineering, India
(akshaysunil172@gmail.com)

The trade-offs between human water needs and environmental considerations have always been challenging for water resources management and governance. Multi-purpose reservoirs present a particularly challenging decision context where multi-sectoral water and energy demands have to be balanced, while also considering the instream water requirements downstream. A systematic framework to evaluate the trade-offs between demand satisfaction, hydropower production, and satisfaction of minimum environmental flows (MEFs) would help reservoir operators better understand the consequences of various operational choices. In this study, we designed two formulations of a multi-purpose reservoir operation problem; one that prioritized MEF (PF_MEF) releases over demand satisfaction and another that did not (PF_nMEF). We identified Pareto approximate strategies to operate the reservoir for each formulation using the Borg multi-objective evolutionary algorithm considering multiple objectives related to water demand satisfaction, hydropower production, prevention of flood exceedance thresholds, and satisfaction of MEF. We applied the framework to the Nagarjuna Sagar (NS) reservoir in southern India. Reservoir operation strategies were modeled using direct policy search (DPS), where piecewise nonlinear Gaussian radial basis functions (RBFs) are used to condition decisions, and reservoir releases for hydropower in this case, on reservoir storage states. Results show that the Pareto approximate strategies resulting from optimizing for PF_MEF and PF_nMEF attain MEF - MEF in ranges 86-98% and 56- 79%, respectively. However, the ensuing compromises in water demand satisfaction and hydropower production are not considerably higher. Mean volumetric demand deficits and mean annual hydropower production ranged from 99.9 -818.1 Mm3 (48.13-818.8 Mm3) and 3252-3900 Gwh (3394- 3910 Gwh) for PF_MEF (PF_nMEF). Notably, we were able to identify strategies from PF_MEF that attained low values of volumetric demand deficits and high values of hydropower production, indicating that prioritizing MEFs may not necessarily yield compromises for human-related objectives in this case.