



## **Reservoir system expansion scheduling under conflicting interests – A Blue Nile application**

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New water resource developments are facing increasing resistance due to their real and perceived potential to affect existing systems' performance negatively. Hence, scheduling new dams in multi-reservoir systems requires considering conflicting performance objectives to minimize impacts, create consensus among wider stakeholder groups and avoid conflict. However, because of the large number of alternative expansion schedules, planning approaches often rely on simplifying assumptions such as the appropriate gap between expansion stages or less flexibility in reservoir release rules than what is possible. In this study, we investigate the extent to which these assumptions could limit our ability to find better performing alternatives. We apply a many-objective sequencing approach to the proposed Blue Nile hydropower reservoir system in Ethiopia to find best investment schedules and operating rules that maximize long-term discounted net benefits, downstream releases and energy generation during reservoir filling periods. The system is optimized using 30 realizations of stochastically generated streamflow data, statistically resembling the historical flow. Results take the form of Pareto-optimal trade-offs where each point on the curve or surface represents a combination of new reservoirs, their implementation dates and operating rules. Results show a significant relationship between detail in operating rule design (i.e. changing operating rules as the multi-reservoir expansion progresses) and the system performance. For the Blue Nile, failure to optimize operating rules in sufficient detail could result in underestimation of the net worth of the proposed investments by up to \$6 billion USD if a development option with low downstream impact (slow filling of the reservoirs) is to be implemented.