



When and how to activate large new hydropower reservoirs

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Water resources system planners are increasingly required to address multiple long and short-term management objectives and the trade-offs these imply. Expansion planning in hydropower reservoir systems, where assets either temporarily or permanently reduce each other's performance, is a complex and potentially conflictual task requiring attention to multiple impacts. This paper proposes a multi-criteria scheduling approach considering many objectives and their associated uncertainties. The method considers the coordination and flexibility of reservoir operation in different expansion stages. The impact of abstraction (i.e. during filling of new reservoirs) and regulation of inflows by upstream reservoirs, is represented by simultaneously optimizing the storage size of reservoirs. Sensitivity analysis of performance given financial uncertainty and hydrological variability reveals which expansion schedules are robust to a wide range of future conditions. This informs how alternative designs compare in multiple performance dimensions and can serve stakeholders with differing attitudes towards risk and opportunity. The method is applied to proposed Blue Nile hydropower reservoirs to find efficient new dam activation schedules considering energy revenues, downstream release requirements, and energy generation during reservoir filling periods. Results take the form of Pareto-optimal trade-offs where each point on the curve or surface represents asset choices, size, activation date, and filling period reservoir operating rules. The results help explore the complex planning and management issues involved in the Blue Nile and demonstrate a possible approach to negotiate the design, filling and coordinated use of hydropower reservoirs.