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Stochastic Optimization of Large Scale Multi-Reservoir Systems subject to environmental flow demands

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Among the environmental impacts caused by dams, the alteration of flow regimes is one of the most critical to river ecosystems given its influence in long river reaches and its continuous pattern. While the reoperation of reservoir systems to recover some of the natural flow regime is expected to mitigate the impacts, associated costs and losses will be imposed on different power plants depending on flows, power plant and reservoir characteristics, system's topology and other aspects. In a large scale reservoir system this economic impact is not trivial, and it should be properly evaluated to identify coordinated operating solutions that avoid penalizing a single reservoir. This paper combines an efficient stochastic dual dynamic programming method for reservoir optimization subject to environmental flow targets with specific magnitude and return period, which effects on fish recruitment are already known. This allows the evaluation of the economic and power generation impacts in a large scale hydropower system when subject to environmental flow demands. The present paper contributes with methods and results that are useful in (a) quantifying the foregone hydropower and revenues resulting from meeting a specific environmental flow demand, (b) identifying the distribution and reallocation of the foregone hydropower and revenue across a large scale system, and (c) identifying optimal reservoir operating strategies to meet environmental flow demands in a large scale multi-reservoir system.