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Revisiting the storage-reliability-yield concept in hydroelectricity

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The storage-reliability-yield (SRY) relationship is a well-established tool for preliminary design of reservoirs fulfilling consumptive water uses, yet rarely employed within hydropower planning studies. Here, we discuss the theoretical basis for representing the trade-offs between reservoir size and expected revenues from hydropower production, under uncertain inflows, by taking advantage of the stochastic simulation-optimization approach. We also demonstrate that under some assumptions, the complex and site-specific problem, mainly induced by the nonlinearity of storage-head-energy conversion, can be significantly simplified and generalized as well. The methodology is tested across varying runoff regimes and under a wide range of potential reservoir geometries, expressed in terms of a generic shape parameter of the head-storage relationship. Based on the outcomes of these analyses we derive empirical expressions that link reliable energy with summary inflow statistics, reservoir capacity and geometry.