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Analyzing tradeoffs between hydropower production and hydrological alteration to support water resources planning in large river systems

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In many countries water is a key renewable resource to complement carbon-emitting energy production in the face of demand pressure from fast-growing industrial production and urbanization. In this study, we analyze the case of the Red River Vietnam, a large basin of 169.000 kmq where the storing capacity, mainly targeted at hydropower production, has steadily increased since from the Eighties through the construction of a number of reservoirs (Hoa Binh completed in 1994, Tuyen Quang in 2008, Son La in 2012), which nowadays account for the 15% of the national electric power production. On the other hand, reservoir operation dramatically alters downstream river hydrology, geomorphological processes and riverine ecosystems.

In this work, we focus in particular on the alteration of the hydrological regime downstream of the Hoa Binh reservoir and explore re-operation options to mitigate the hydrological alteration while guaranteeing reasonable hydropower production. To reach this goal we (i) define an index of hydrological alteration starting from the well established set of Indicators of Hydrological Alteration and applying a novel selection and aggregation procedure; (ii) embed such an index into a multi-objective optimization process, to design reservoir operating policies that represent Pareto-optimal solutions between maximization of hydropower production and minimization of hydrological alteration.

This work demonstrates the potential of multi-objective optimization and simulation tools to analyze tradeoffs between conflicting needs and thus support the evaluation and planning of sustainable energy production programs.