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Assessing water reservoir management and development in Northern Vietnam

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In many developing countries water is a key renewable resource to complement carbon-emitting energy production and support food security in the face of demand pressure from fast-growing industrial production and urbanization. To cope with undergoing changes, water resources development and management have to be reconsidered by enlarging their scope across sectors and adopting effective tools to analyze current and projected infrastructure potential and operation strategies.

In this work we use multi-objective deterministic and stochastic optimization to assess the current reservoir operation and planned capacity expansion in the Red River Basin (Northern Vietnam), focusing on the major controllable infrastructure in the basin, the HoaBinh reservoir on the Da River.

We first provide a general and mathematical description of the socio economic and physical system of the Red River Basin, including the three main objectives of hydropower production, flood control, and water supply, and using conceptual and data-driven modeling tools.

Then, we analyze the historical operation of the HoaBinh reservoir and explore re-operation options corresponding to different tradeoffs among the three main objectives, using Multi-Objective Genetic Algorithm.

Results show that there exist several operating policies that prove Pareto-dominant over the historical one, that is, they can improve all three management objectives simultaneously. However, while the improvement is rather significant with respect to hydropower production and water supply, it is much more limited in terms of flood control. To understand whether this is due to structural constraints (insufficient storing capacity) or to the imperfect information system (uncertainty in forecasting future flows and thus anticipate floods), we assessed the infrastructural system potential by application of Deterministic Dynamic Programming.

Results show that the current operation can only be relatively improved by advanced optimization techniques, while investment should be put into enlarging the system storage capacity and exploiting additional information to inform the operation.