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Robust River Basin planning under extreme climate events and socio-economic changes: the Red River Basin in China-Vietnam

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Climate and socio-economic changes bring multiple challenges to river basin development worldwide. The large uncertainty characterizing future conditions requires robust and adaptive planning and management solutions capable of handling uncertain future changes. This is particularly true in monsoonal Southeast Asian catchments, where large multipurpose reservoir systems play a crucial role in flood protection and providing water, energy, and food to a rapidly changing society. In such river basins, high intra-annual and inter-annual hydroclimatic variability, as well as increasing frequency of extreme events, further challenge the management of multi-sector water demands across multiple time scales.

In this context, we develop a robust decision-analytic framework for supporting the strategic planning of river basins in monsoonal areas with respect to future changes in water availability and demands. The framework integrates future climate scenarios, including a catalogue of extreme climate events, future water demand scenarios, a high-resolution infrastructure-accounting hydrological model, Topkapi-ETH, and a strategic, operational model to design multiobjective optimal water management policies. We first build climate change driven projections of water availability; second, we apply the optimization engine to select a subset of operation policies optimized based on key selected indicators; and third, we use the spatially distributed hydrological model to evaluate the impact of the chosen policies on a broader set of indicators capturing the spatially distributed impact of dam operations.

We focus here on the Red River Basin, a large transboundary river basin in China and Vietnam. In the basin, conflicts among different water uses, such as flood control, hydropower production, agriculture and aquaculture, are expected to increase under the combined pressure of increasing water and energy demands and climate change. A specific focus is given to extreme rainfall events, expected to increase their frequency and magnitude. The framework proposed will allow us to assess the vulnerability of the basin under future scenarios as well as the sustainability and robustness of future river basin development plans in the context of the water-energy-food-

environment nexus.