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At what cost? Can forecasts allow us to protect to more severe flood events without sacrificing performance on other river basin objectives?

Julianne Quinn (1), Patrick Reed (2), Matteo Giuliani (3), Andrea Castelletti (3), Jared Oyler (4), and Robert Nicholas (4)

(1) Department of Engineering Systems and Environment, University of Virginia, Charlottesville, VA (jdq6nn@virginia.edu), (2) Department of Civil and Environmental Engineering, Cornell University, Ithaca, NY (patrick.reed@cornell.edu), (3) Department of Electronics, Information, and Bioengineering, Politecnico di Milano, Milano, Italy (matteo.giuliani@polimi.it; andrea.castelletti@polimi.it), (4) Earth and Environmental Systems Institute, The Pennsylvania State University, University Park, PA (jared.oyler@psu.edu; rob.nicholas@psu.edu)

Engineering systems are designed to be robust to low-probability, high-consequence hazards. The concept of robustness has been crucial to the safety of our built environment. However, increasing robustness to one hazard must come at the expense of performance on other objectives. An interesting question is: Can we avert these opportunity costs by better conditioning water management decisions on forecasts? This study explores this question in the Red River Basin of Vietnam, where a system of reservoirs must simultaneously produce hydroelectric power, provide water to meet agricultural, municipal and environmental demands and, most importantly, prevent loss of life by protecting the capital city of Hanoi from devastating floods. The Vietnamese government seeks to use these reservoirs to provide protection to the 500-yr flood and has independently designed their own operating guidelines with this goal. However, optimizing operating policies to meet the multiple sectoral demands while providing protection to the 500-yr flood reveals that meeting this requirement with existing infrastructure is non-trivial. Policies exist that meet this goal under stationary hydrologic conditions, but doing so requires major sacrifices in performance on hydropower and water supply objectives. These tradeoffs are exacerbated if stakeholders also desire robust performance across potential hydrologic and socioeconomic futures; compared to optimizing to the 100-yr flood, it is far more difficult to find policies that also meet minimum performance requirements on hydropower and deficit objectives across a broad range of futures. Conditioning operations on a naïve forecast is partly able to close the gap, though, suggesting more sophisticated forecast products may hold promise in reducing the multi-sectoral consequences of robustness to severe flood events. Future work will explore the potential for seasonal climate forecasts to close the remaining gap and allow for robust flood protection at no cost.