Human-Water Systems Monthly

February Theme:
Managing uncertainty in human-water systems

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Abstract: Water resources systems abound with uncertainties that challenge our ability to productively develop and efficiently manage them. These include structural uncertainties in the governing relationships that define how humans and ecosystems interact with one another, parametric uncertainties in the strength of those structural relationships, and stochastic uncertainty in climatic forcing. Designing robust human-water systems requires methodological advances in systems-based approaches to handle these uncertainties. This talk will focus on how best to address hydrologic model parameter uncertainty in designing infrastructure investments to balance socio-ecological tradeoffs of urbanization and reforestation. Multi-Objective Robust Optimization (MORO) has been proposed to handle parametric model uncertainty in the literature, but it has not actually been shown that this results in better decisions than optimizing to a single, most likely parameter set given a fixed computational budget. In this work, we define and optimize reforestation portfolios to a synthetic true set of hydrologic model parameters so that the utility of MORO can be assessed. We find MORO solutions optimized to minimize flooding and low flow exacerbation at the lowest cost are closer to the synthetic true solutions, confirming the value of considering parametric uncertainty in designing robust water systems. However they still underestimate the levels of investment needed to meet minimum performance thresholds, opening new questions about alternative approaches to handling these uncertainties better and more efficiently.

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Abstract: There are significant knowledge gaps associated with the bidirectional interaction between the human and natural systems (aka. the co-evolution process). For example, how can we address the resources management issue in different spatial and temporal scales? How can we quantify different sources of uncertainties like climate variability and human's imperfect rational behavior? This talk will discuss the attempt to address these gaps by applying the agent-based modeling (ABM) method to decipher the dynamics of the co-evolution process in the complex adaptive water system. I will demonstrate the application of different ABM tools to quantify human behaviors at different temporal and spatial scales and their impacts on the natural system. Case study results will be used to show the improvement of ABM application in water resources system analysis in the past decade from ideal and optimized agents to learning and adaptive agents.