University of Colorado Boulder

Water Energy Nexus IRT

2018 Seed Grant Final Report

Title: Tradeoffs of Alternate Water Resources for Thermoelectric Power Plant Cooling

PI Name: Joseph Kasprzyk (Civil, Environmental, and Architectural Engineering, CEAE)

CoPI Name: Kyri Baker (CEAE), Ben Livneh (CEAE), Lisa Dilling (Environmental Studies), Ashlynn Stillwell (University of Illinois at Urbana-Champaign, UIUC)

Research Objective(s): Through building an external collaboration with Prof. Ashlynn Stillwell at UIUC, who is an expert on the water-energy nexus, we seek to create a modeling framework that can calculate downstream effects of new uses of engineered water reuse in a river system.

Background: Traditional water resources planning focused on adding water supply sources such as new reservoirs, or encouraging water conservation, considering water and not its interplay with other resources. However, water shortages are increasingly revealing the complexities of the water-energy nexus, where pursuing new water sources can lead to new conflicts with energy resources. Large funding proposals such as the NSF Innovations at the Nexus of Food, Energy and Water Systems (INFEWS) require an integrated understanding of such energy and water systems, where quantitative models of natural and engineered river systems could be combined with models of power plant water usage as well as other system components. Such coupled modeling helps address hypotheses about system function such as how changes in energy market conditions and socioeconomic factors propagate to scenarios of water availability.

Research Activities/Methodology: This Seed Grant research catalyzed a modeling framework that can link water and energy resources, focusing on engineered water reuse. Specifically, we completed a study that analyzes downstream impacts of engineered water reuse on river systems. The study combined an analysis of the legal implications of water reuse, with data analysis of scenarios of reuse at multiple downstream stations. The work was completed in two contrasting case study basins: 1) the Illinois River downstream from the greater Chicago, Illinois area, and 2) the Middle Rio Grande River downstream from Albuquerque, New Mexico.

Results: The study contributed a methodology for analyzing water reuse scenarios in river basins. We developed statistical tests for changes in streamflow based on the scenarios, as well as a suite of quantitative performance metrics for the scenarios affect relevant stakeholders. In Illinois, impacts to barge transportation are marginal and decrease with distance downstream of effluent consumption. In the Rio Grande, impacts to the Rio Grande silvery minnow worsen downstream such that a proposed consumption would be unlikely to be established under federal regulations.

The Seed Grant funding also partially funded Brendan Purcell and Joseph Kasprzyk to attend the Fall Meeting of the American Geophysical Union in December 2018. There, Purcell presented a poster presentation of this research, and Kasprzyk was the deputy chair of the Water and Society technical committee meeting, where ideas for disseminating water-energy nexus work were discussed. Purcell and Kasprzyk also attended sessions that provided interesting ideas for extending the research.

Accomplishments: (proposals submitted, awarded, papers published, recognition received etc.)

1. Purcell, B, Z Barkjohn, JR Kasprzyk, AS Stillwell. "Linking reclaimed water consumption with quantitative downstream flow impacts" *Journal of Water Resources Planning and Management*. Submitted March 2019.
2. Purcell, B. "Assessing downstream impacts from an additional consumption of reclaimed wastewater effluent" M.S. Thesis, to be defended March 2019 (Spring 2019 graduation).
3. Purcell, B, ZA Barker, JR Kasprzyk, AS Stillwell "Scenario analysis of downstream flow impacts from reclaimed water consumption in two distinct regions" Poster presentation at the Fall Meeting of the American Geophysical Union 2018
4. Kasprzyk, JR, AS Stillwell "Tradeoffs of Alternate Water Resources for Thermoelectric Power Plant Cooling" Oral presentation at the American Society of Civil Engineering Environmental Water Resources Institute meeting, Minneapolis, MN, June 2018.
5. Successful recruitment of incoming PhD student Jacob Kravits, to be co-advised by Kyri Baker and Joseph Kasprzyk starting fall 2019, to work on further water-energy nexus research.

Conclusions/Next Steps:

- As demonstrated in the analysis of the Illinois River and Rio Grande case studies, the methods quantitatively assess the impacts to downstream stakeholders for a proposed consumption of reclaimed water. This quantification, coupled with local legal considerations, can aid decisionmakers in the evaluation of proposed reclaimed water consumption. More broadly, the methods presented are a necessary evolution in sustainable resource management. Water reuse, along with other seemingly sustainable propositions, requires holistic spatial and quantitative analyses that include stakeholder engagement to determine the relative sustainability of different options within socio-hydrology.
- We have held several meetings to discuss potential future research avenues, including with Kyri Baker who summarized her own Seed Grant results to this team. These preliminary results will galvanize this research team to potentially partner with others on larger efforts in the coming year revolving around water and energy systems analysis.
- Ashlynn Stillwell will visit campus on March 29 for Brendan's thesis, and will meet with Baker, Livneh, Purcell, and Kasprzyk with the goal of outlining a proposal to NSF Environmental Sustainability, as well as talk about team-building for larger efforts in the future. Such larger efforts could include research outcomes that would leverage the expertise of team member Lisa Dilling.