The Effect of Climate Change on Urban Water Resources: An Interdisciplinary Approach to Modeling Urban Water Supply and Demand

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Renee is a doctoral candidate in Environmental and Ecological Engineering, where she is advised by Dr Roshanak Nateghi. Prior to Purdue, Renee obtained her B.S. in Environmental Engineering from Ohio State University. Her research interests focus on understanding and evaluating the impact of climate change on urban systems, with an emphasis on water systems. More broadly, Renee harnesses methods from data science, climatology, and civil engineering to study the nexus between climate change, people, and urban systems. Throughout her time at Purdue, she has been funded by the Andrews Fellowship as well as grants from NSF and the Purdue Center for the Environment, and she is currently a Bilsland Fellow. Her committee members include Dr. Suresh Rao (Purdue, Civil Engineering), Dr. Zhao Ma (Purdue, Forestry and Natural Resources), and Dr. Rohini Kumar (Helmoholtz Centre for the Environment – UFZ).

ABSTRACT

Urban populations are growing at unprecedented rates around the world, while simultaneously facing increasingly intense impacts of climate change, from sea level rise to extreme weather events. In the face of this concurrent urbanization and climate change, it is imperative that cities improve their resilience to a multitude of stressors. A key aspect of urban resilience to climate change is ensuring that there is enough drinking water available to service the city, especially given the projections of more frequent and intense droughts in some areas. However, the study of climate impacts on urban water resources is fairly nascent and many gaps remain. In this dissertation, I aim to begin to close some of those gaps by adopting an interdisciplinary approach to studying water availability. First, I focus on urban water supply, and in particular, reservoir operations. I employ a variety of methods, ranging from data science techniques to traditional hydrological models, to predict the reservoir levels under a variety of climate conditions. Following the analysis of water supply, I shift focus to urban water demand. Here, I include interconnected systems, such as electricity, to evaluate and characterize the impact of climate on water demand and the benefit of considering system interconnectivities. Additionally, I present an analysis on the projection of water and electricity demand into the future, based on representative concentration pathways of CO_2. Finally, I focus on the human dimension to the demand studies. By studying the social norms surrounding water conservation in urban areas, as well as the demographics, I built a predictive model to estimate monthly water consumption at the census tract-level. Through these interdisciplinary studies, I have made progress in filling knowledge gaps related to the impact of climate change on urban water resources, as well as the impact of people on these water resources.