Spatial – Temporal Urban Water Consumption Prediction

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Motivation

Estimating current and future urban water demand is complicated as it is influenced by a number of complex variables such as human behavior, climate, weather and appliances life-cycles. Understanding drivers of municipal water demand is of great importance when assessing water infrastructure efficiency and redevelopment strategies.

Technological Challenges

Methods for predicting existing and future water consumption and wastewater production at high spatial-resolutions are limited, as is the understanding of how different water consumption determinants affect the urban water demand [1]. Even utilities face challenges predicting water demand to appropriately plan for their future strategies. Water footprints have been developed using factors like occupancy behavior patterns, appliance water efficiency, and evapotranspiration, but a framework for mapping changes in these footprints is lacking. Furthermore, water footprints do not translate into the data needed to develop process models and techno-economic analysis (TEA) of water supply, distribution, reuse and treatment.

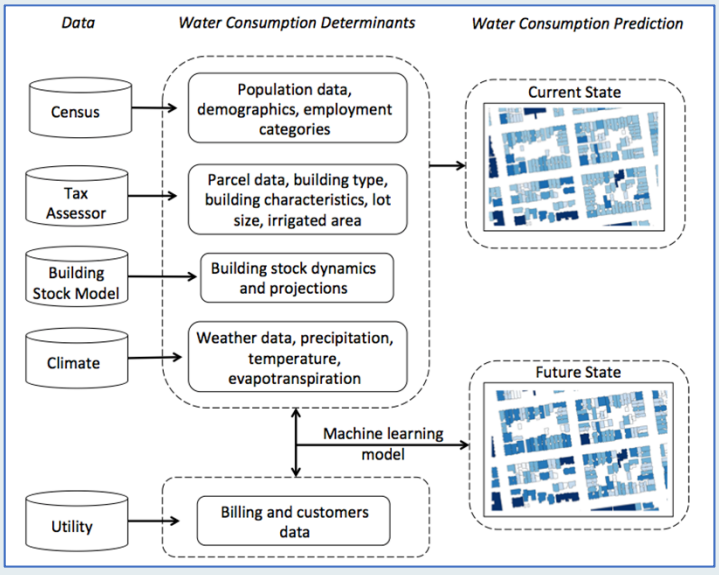

Figure 1: Urban Water Prediction Modeling Approach

Research

This research project aims to develop a spatially resolved water demand forecast model, that can quantify the impacts of urban development decisions on the spatial distribution of water demand and wastewater production (Figure 1). Developing high resolution maps of water demand and wastewater production would support policy-makers in setting effective water-energy efficiency targets, and allow municipalities and utilities to identify cost-saving measures for correcting water treatment and networks that are or will become under or oversized.

Combining building stock dynamics and prediction models [2] with utility data is crucial for conducting a robust statistical analysis of water use and wastewater production and quality at local scales. Provided utility data is available, this project will apply machine learning modeling techniques to identify relationships between various water consumption determinants, and location with urban water usage. Machine learning models can be incredibly powerful tools to make predictions based on identifying patterns in large amounts of data. This approach can be useful in water demand prediction where building characteristics and human behavior are hard to model using analytical approaches alone. This connection between building characteristics and water consumption projections can enable the scenario planning for optimal development pathways to minimize water stress.

References

1. House-Peters et al. (2011) Urban water demand modeling: Review of concepts, methods and organizing principles. Water Resources Research, 47(5)

2. Breunig et al. (2018) Dynamic Geospatial Modeling of the Building Stock to Project Urban Energy Demand. Environmental Science and Technology. Under Review

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