Quantifying the Joint Value of Technology and Policy Innovation in Water Resources Planning

Marta Zaniolo, Sarah Fletcher, Meagan S. Mauter
Stanford University, Civil and Environmental Engineering
mzaniolo@Stanford.edu

We propose a suite of tools that explicitly relate hydrologic change, technology innovation, and policy interventions to system-level water costs. These tools serve the water resources planning and technology development communities by prioritizing high-impact innovation goals and setting quantitative research targets.

How innovation in volume, cost, and time impact system costs

Infrastructure systems require planning for long time horizons over which hydrology, technology, and policy are continuously evolving. Current planning models ignore the effects of these innovations.

We introduce a framework to design cost-optimal strategies for water supply expansion across a multi-attribute innovation space including hydrology, policy, and technology levers (Fig 1).

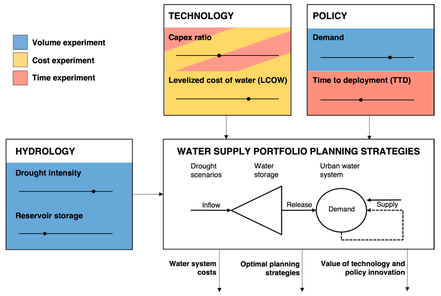

Fig 1. In the central block, optimal planning strategies are created for a water system under the hydrology, technology, and policy innovation specified in the surrounding building blocks.

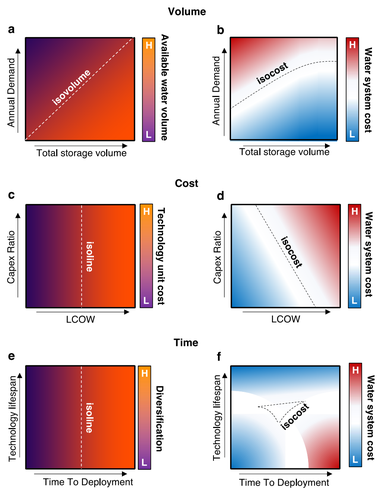

Fig 2. Stylized representation of how innovation in volume, cost, and time can affect water utility planning costs.

In complex systems, component innovation translates non-linearly to system costs (Fig 2).

1. *Volume:* innovation in water-efficient appliances and demand management practices increases available volume and reduces water system costs, but savings level off for large storage volumes.
2. *Cost:* innovation in Capex ratio (fraction of LCOW attributed to capex) has no effect on technology unit costs but can impact system level costs.
3. *Time:* technology time to deployment and expected lifespan interact non-linearly to determine water system costs. Short-lifespan technology deployed as short-term drought measures are only effective when their time to deployment is low.

Target-based innovation planning

Dashboard displays the full set of innovation pathways that realize a specified water system cost reduction for the city of Santa Barbara, California.

- *Single component innovation space that achieves the target system cost reduction (left):* magnitude of innovation from a single component required to meet the system-level cost reduction target.
- *Two component innovation space that achieves the target system cost reduction (right):* magnitude of innovation across two components required to meet the system-level cost reduction target. The suite of viable options grows significantly in this 2-dimensional space.

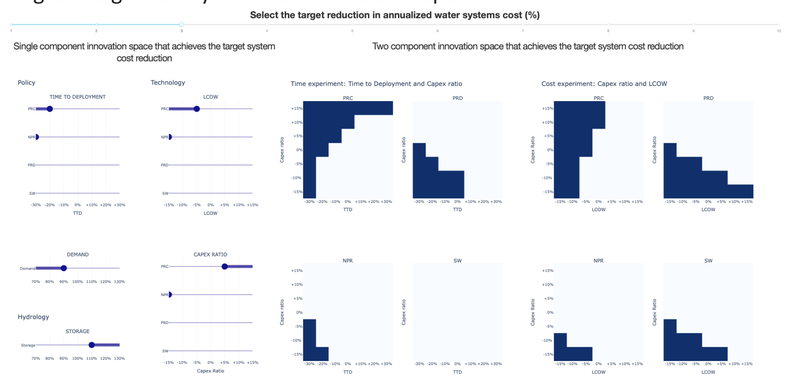

Fig 3. Interact with this dashboard at http://mzaniolo.pythonanywhere.com. Layout optimized for desktop view.

1. Supports technology innovation hubs in identifying high-impact innovation trajectories that maximize cost reduction benefits at the system level.
2. Aids urban water planners in selecting cost optimal technology portfolios and in anticipating cost implications of technology and policy innovation.
3. Supports state and federal water planners in quantifying the costs and benefits of water policy interventions.

NAWI CONNECTIONS

Period of Performance: Sept 2021-Sept 2023

Challenge Area/Topic Area: Data Modelling and Analysis
This project provides an analytical platform to evaluate pipe parity of technologies in a place specific analysis.

NAWI Leverage
This project utilizes NAWI's crosscutting tool WaterTAP for the estimation of capex and opex costs of 5 different treatment trains and a range of design flows. This project also benefits from DoE's computing system, EAGLE.

KEY FINDINGS AND CONCLUSIONS

Key Findings: We identify single- and multi-component pathways of innovation that achieve a target system cost reduction.

Conclusions: This work is a first example of a water planning tool that explores the effects of technology and policy innovation in water systems under climate change. It is demonstrated on the case study of the city of Santa Barbara, CA. While the numerical results presented here are not universally generalizable, they are regionally relevant in guiding drought resilience innovation along the central coast of California.

REFERENCES

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Check out the dashboard and send me your thoughts at mzaniolo@stanford.edu. Layout optimized for desktop view.

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