Developing a Decision Support Tool for Net Zero Urban Water Systems in the US Southwest:

Academic and Utility Collaboration

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WRRC, March 12th 2024

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Acknowledgement

Funding : National Science Foundation Grant # 2206132

Principal Investigator : Prof Courtney Crosson, University of Arizona

Collaborators:

- University of California Los Angeles (UCLA)
- University of New Mexico (UNM)
- Colorado State University (CSU)
- Colorado School of Mines (CSM)
- Tucson Water
- Denver Water
- Los Angeles Dept of Water and Power
- Albuquerque Bernalillo County Water Authority

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Objective of Collaboration: Net Zero Urban Water Future for Southwest

- *"Net Zero Urban Water (NZUW) Systems meets the needs of a given community with a locally available and sustainable water supply, without detriment to interconnected systems".*
- Integrative approach with progressive targets across Natural, Built and Social Systems.
- Reduce dependence on imported Colorado river water and increase urban water security.
  - Rigorous Conservation measures
  - Increased Reuse
  - Increased Use of Local alternative water sources
    - Stormwater and rainwater harvesting

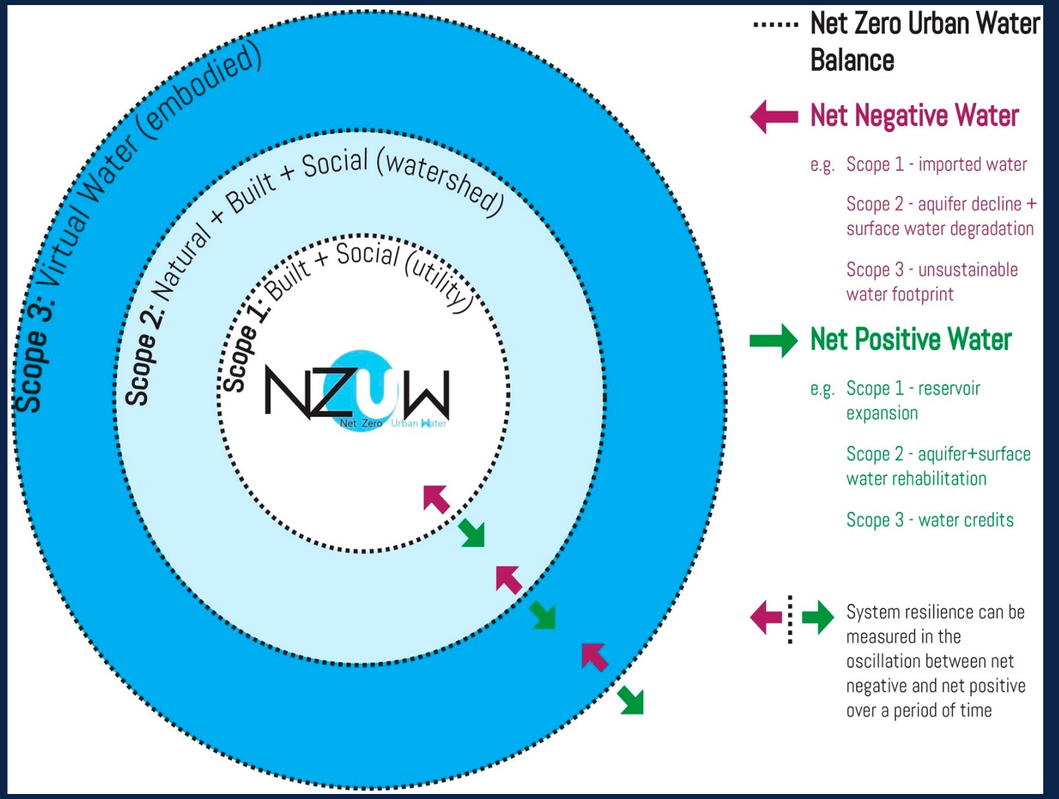

Figure 2. NZUW is a progressive target across three scopes and natural, built and social Systems (Crosson,2020).

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Academic Team

Research Collaboration between Universities in US Southwest

Interdisciplinary team

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Contributions from Academics

- Research Expertise and Vision
- Data Analysis
- Modelling support for NZUW model development
  - Hydrologic modelling
  - Modelling Built Systems
    - Infrastructure capacities, treatment technologies
      - Integrating Alternative water sources
  - Modelling Social Systems
    - Public preference, regulations, water pricing, equity

- Policy and Planning Support
- Education and Training
- Knowledge Transfer and Dissemination
  - Publications, technical reports, newsletters, conference presentations, outreach

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Utilities Team

	Albuquerque	Denver	Los Angeles	Tucson
Population	0.56 millions	0.72 million	3.9 million	0.54 millions
Area	189 sq. miles	154 sq. miles	502 sq. miles	241 sq. miles
Annual Rainfall	8.84 inches	15.84 inches	14.3 inches	10.5 inches
Imported Water Source	**Colorado River** via the San Juan Chama Project	**Colorado River**	LA Aqueduct, State Water Project, **Colorado River**	**Colorado River** via Central Arizona Project
Annual water use	27 billion gallons	30 billion gallons	160 billion gallons	28 billion gallons
% Imported water	**80%**	**46%**	**89%**	**84%**
% Dependence on Colorado river	80%	**46%**	6%	**84%**

Unique Contribution from Utilities

- Operational expertise
  - Practical implementation of academic research findings
  - Implementation of conservation measures
    - Technical aspects, feasibility, practical considerations

- Data access and support for model development
  - Supply: Water sources, quantities, projected availability in future
  - Demand: Water use patterns across sectors
    (Residential, industrial, commercial, environmental)
  - Infrastructure performance, potential for expansion.

- Regulatory Compliance (governing water supply and treatment)

- Community Engagement for Adoption of Conservation Measures
  - Help promote/adopt conservation practices (Rainwater harvesting, greywater reuse, GI) at residential scales
  - Public education, providing rebates

Challenges faced in Collaboration

- Data Sharing and Privacy Concerns
  - Time delays in data procurement for research and modelling efforts
- Specific Data Needs (time intervals or spatial scales)
- Communication Challenges: differences in terminologies used
  (eg Watershed boundary vs Utility service area boundary)
- Multiple Points of contact for Data Access
  - City Depts (e.g., Tucson Water), County agencies (e.g., RFCD), NGOs, CBOs.
  - Coordinating data access and permissions across these diverse stakeholders complex and time-consuming

Approaches Used to Improve Collaboration

- In-person workshops as a part of the NSF project
- Frequent email correspondences and virtual meetings
- Setting a clear timeline and scope of the work
- Collaborative work: Community engagement and joint paper publications with utility partners helped strengthen the bond and include their perspective and feedback into decision making.

Outcome of Collaboration

- 2 In Person Workshops:
  - Tucson 2023: “Policy and Governance Challenges in NZUW transitions”
  - Albuquerque 2024: “Public Preference in NZUW Transitions”
- Online Workshop (Nov 2023): “Alternative Water Sources and Retrofitting”

- Research Publication
  “Governance and Policy Challenges and Future Need for Advancing to a NZUW Future in Southwest US” under review at ES&T.
    - Input from Utilities:
    - Regional water challenges, water laws and regulations, water rights, and Colorado river compact, challenges to reaching NZUW balances.

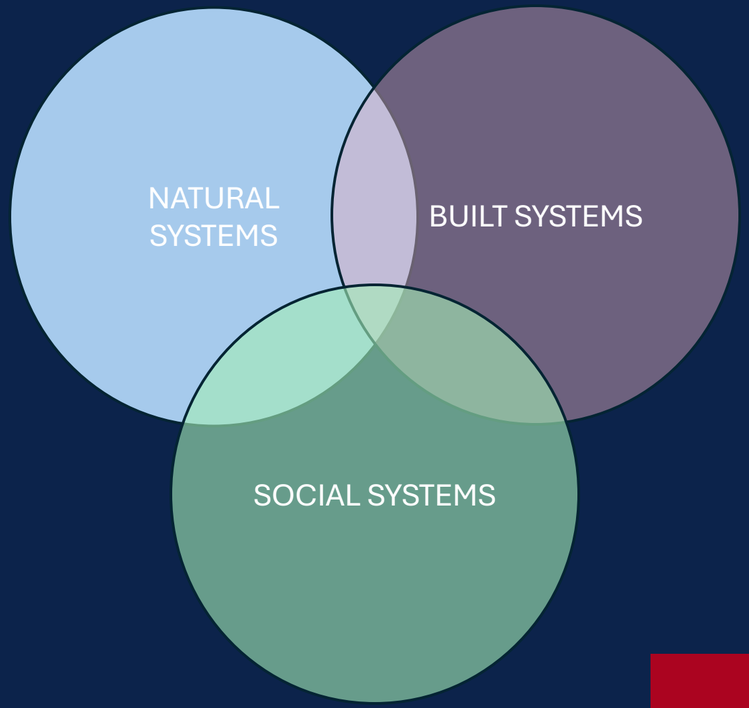
- Newsletters, Conference presentations(SXSW 23, WRRC 2023& 24)

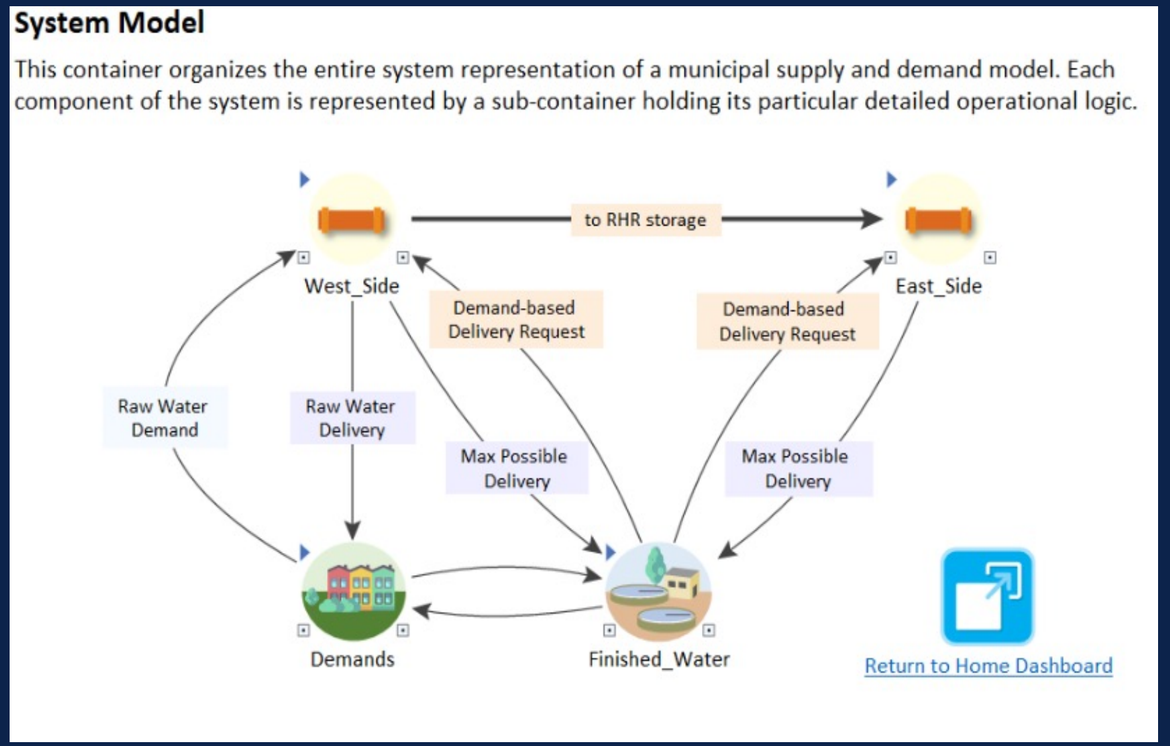
- Ongoing Work: NZUW Model Development through Partnership

Albuquerque Workshop Feb 29, and March 1 2024

Decision Support Tool for NZUW System

- System Dynamics Model
  - Integrated Urban Water System
    - Including Natural, Built and Social System Challenges
  - Expertise and Input from Academics and Utilities





Source: https://www.goldsim.com/Web/Applications/ExampleApplications/EnvironmentalExamples/WaterSupplyModel/

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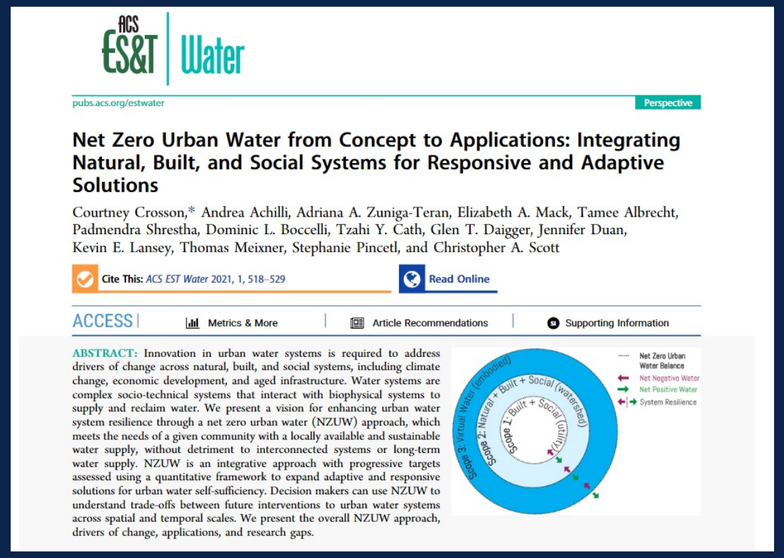
Additional Information



ACS ES&T Water

pubs.acs.org/estwater Perspective

Net Zero Urban Water from Concept to Applications: Integrating Natural, Built, and Social Systems for Responsive and Adaptive Solutions

Courtney Crosson,* Andrea Achilli, Adriana A. Zuniga-Teran, Elizabeth A. Mack, Tamee Albrecht, Padmendra Shrestha, Dominic L. Boccelli, Tzahi Y. Cath, Glen T. Daigger, Jennifer Duan, Kevin E. Lansey, Thomas Meixner, Stephanie Pincetl, and Christopher A. Scott

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ABSTRACT: Innovation in urban water systems is required to address drivers of change across natural, built, and social systems, including climate change, economic development, and aged infrastructure. Water systems are complex socio-technical systems that interact with biophysical systems to supply and reclaim water. We present a vision for enhancing urban water system resilience through a net zero urban water (NZUW) approach, which meets the needs of a given community with a locally available and sustainable water supply, without detriment to interconnected systems or long-term water supply. NZUW is an integrative approach with progressive targets assessed using a quantitative framework to expand adaptive and responsive solutions for urban water self-sufficiency. Decision makers can use NZUW to understand trade-offs between future interventions to urban water systems across spatial and temporal scales. We present the overall NZUW approach, drivers of change, applications, and research gaps.

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Resources, Conservation & Recycling

journal homepage: www.elsevier.com/locate/resconrec

Full length article

Rainwater as a renewable resource to achieve net zero urban water in water stressed cities

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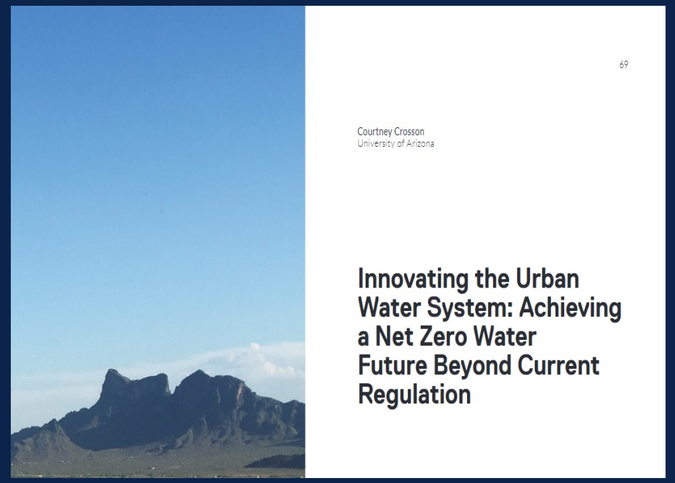
ABSTRACT

Globally, cities are facing increased water stress with an imbalance between available water resources and projected urban water demands. Water experts have pointed to rainwater harvesting (RWH) as one answer; however, the capacity of such a solution to address deficits on an urban scale is largely untested. This study proposes a model to evaluate the necessary network of RWH systems to achieve net zero urban water, meaning a sustainable local supply capable of meeting long-term demand. This approach was applied to a water stressed city, Tucson, Arizona, in the semi-arid Southwestern United States. A daily water balance model optimized for the smallest required storage volumes to reach net zero urban water at a resolution of ten years of consecutive daily rainfall. The potential passive and active RWH network was modelled under four investment scenarios using remote sensing, localized daily rainfall, and municipal water meter data. In the most financially and physically plausible scenario, rainwater replaced imported water and a 30% demand conservation was assumed. The median required storage was 28.2 cubic-meters per 100 square-meters of roof area, or an estimated $10,000 investment. Comparatively, the median RWH household storage installation in Tucson is 5.3 cubic-meters (1395 gallons). In addition to widespread investment in large household storage, this result would require paradigm shifts across built, economic, and social systems to fully integrate the decentralized network across the urban fabric. This study shows that net zero urban water can be achieved with RWH under multiyear drought conditions with large storage volumes.



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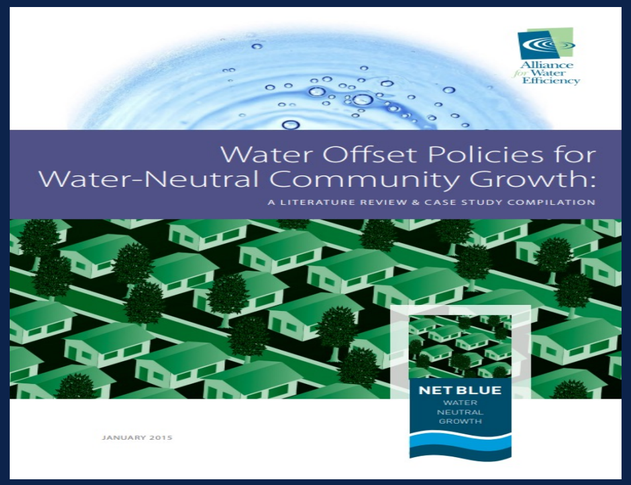
Courtney Crosson
University of Arizona

Innovating the Urban Water System: Achieving a Net Zero Water Future Beyond Current Regulation



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