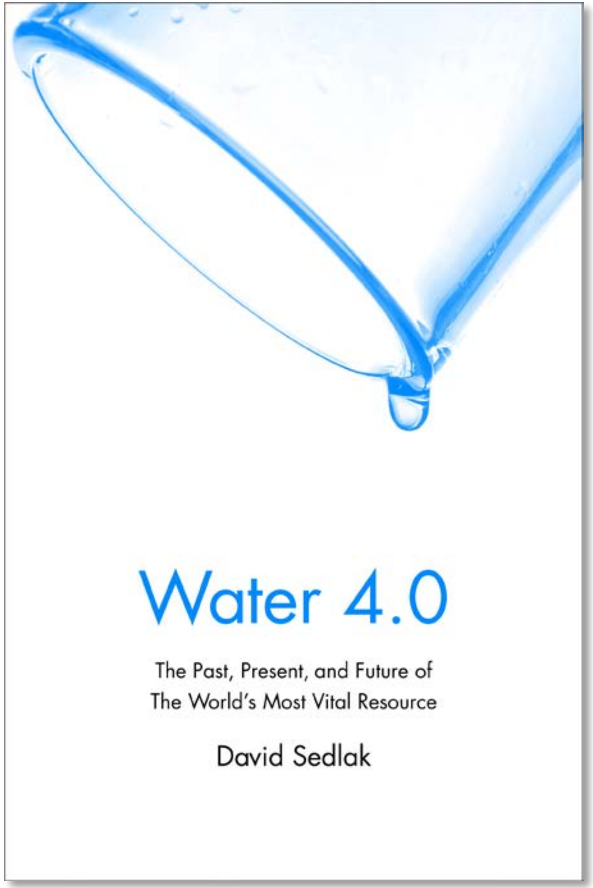
The Next Phase of Our Urban Water Journey

David Sedlak
Department of Civil & Environmental Engineering
University of California, Berkeley

2022 Clean Water Symposium
Stony Brook University
June 17, 2022



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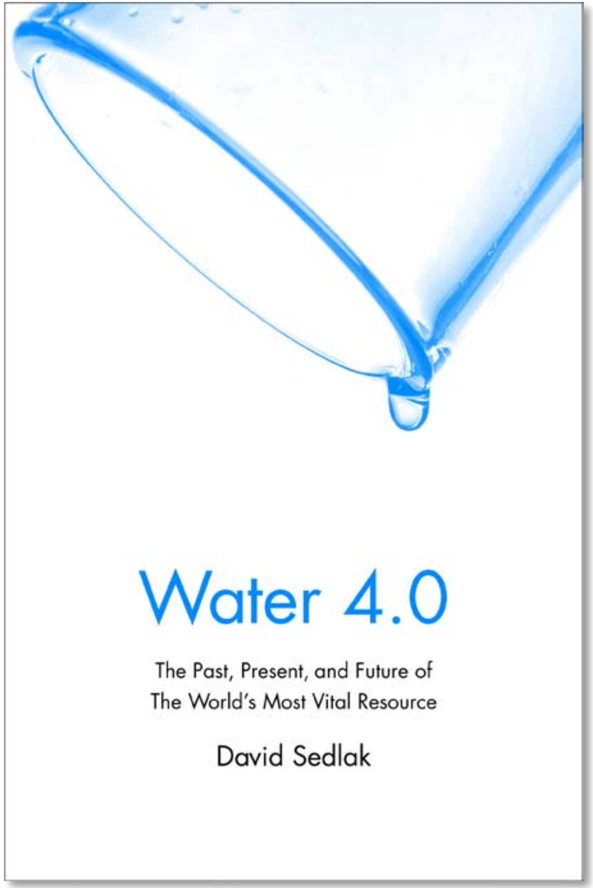
Water 1.0: Centralized Supply



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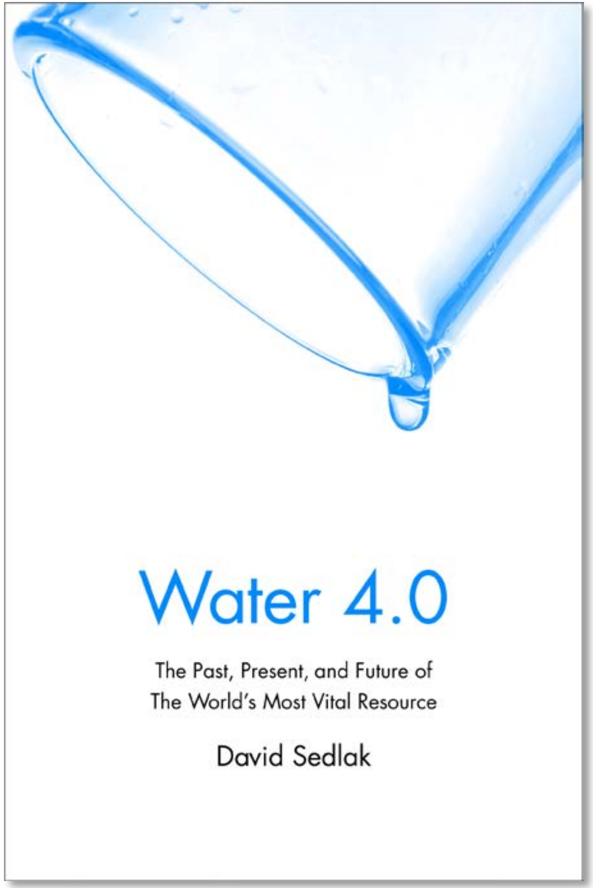
Water 1.0: Centralized Supply
Water 2.0: Drinking Water Treatment



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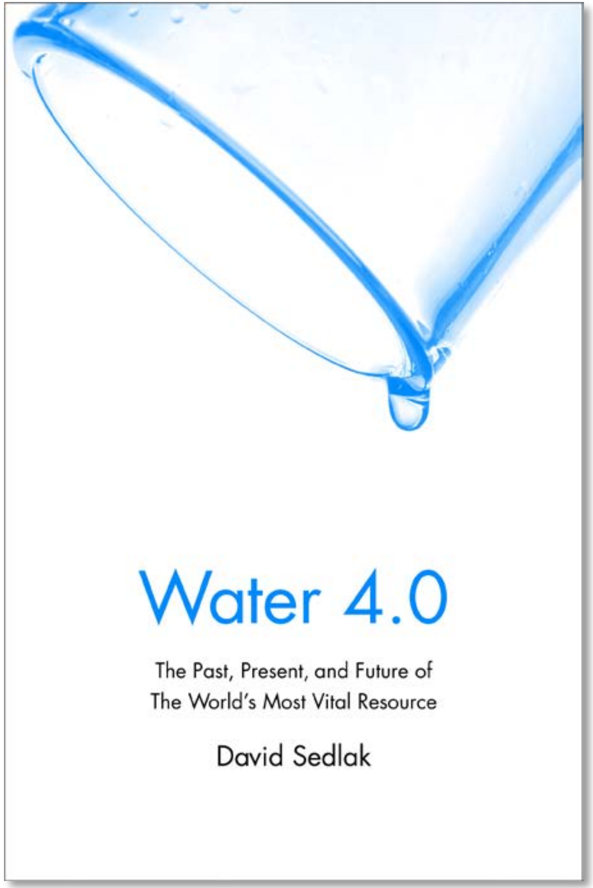

Water 1.0: Centralized Supply
Water 2.0: Drinking Water Treatment
Water 3.0: Wastewater Treatment

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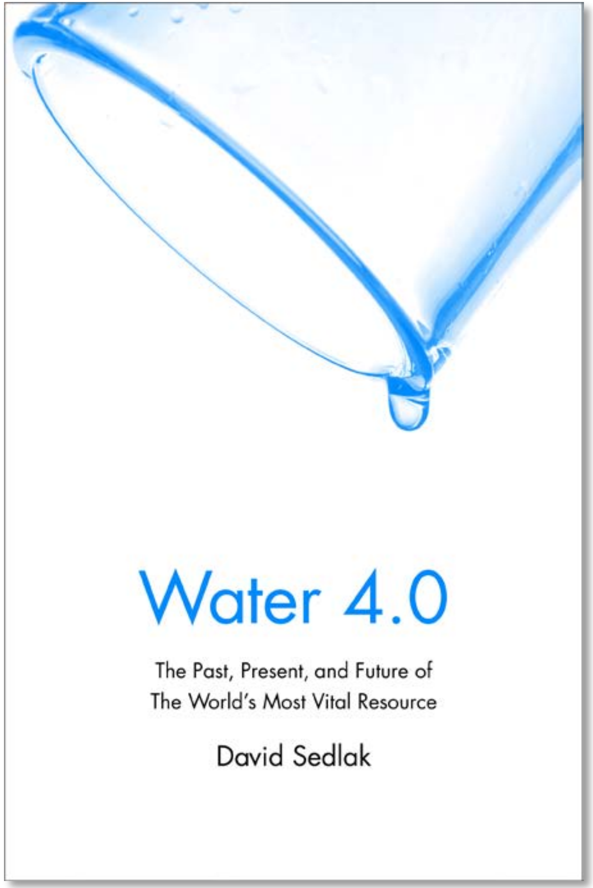
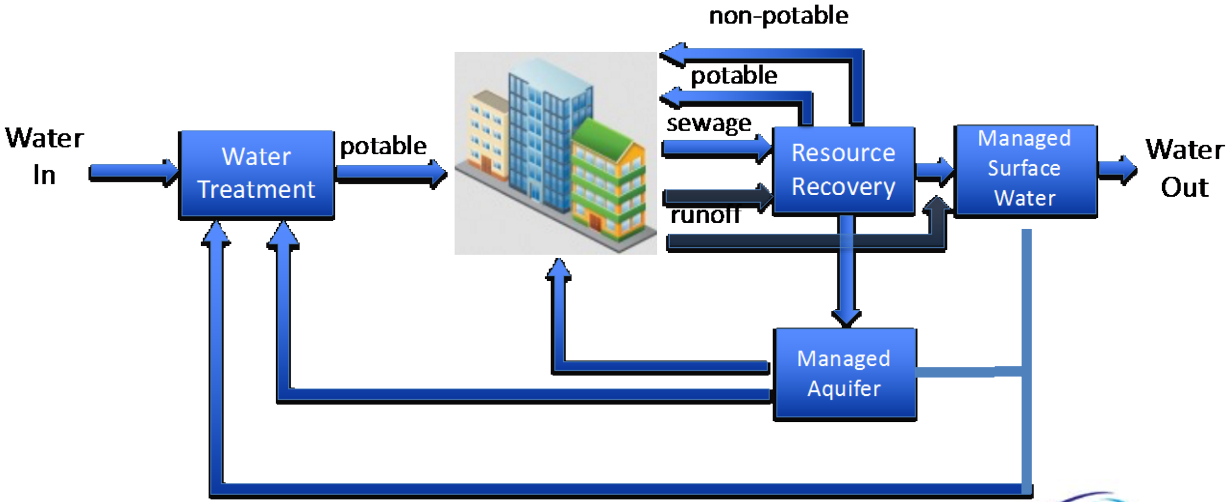


Water 1.0: Centralized Supply

Water 2.0: Drinking Water Treatment

Water 3.0: Wastewater Treatment

Water 4.0: Reuse, Stormwater, Desalination



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Water for the Wealthy
Water for the Many
Water for the Poor
NY Times
Water for All
Water for Health
Wikipedia
Water for Food
2000
Water for Ecosystems
2013
NASA

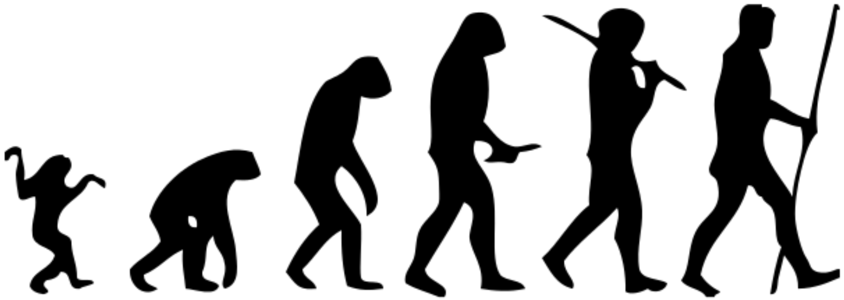

Image: M. Garde

Water Evolution...

…gradually improves system performance.

...is enabled by existing technologies.

...does not disrupt existing institutions.

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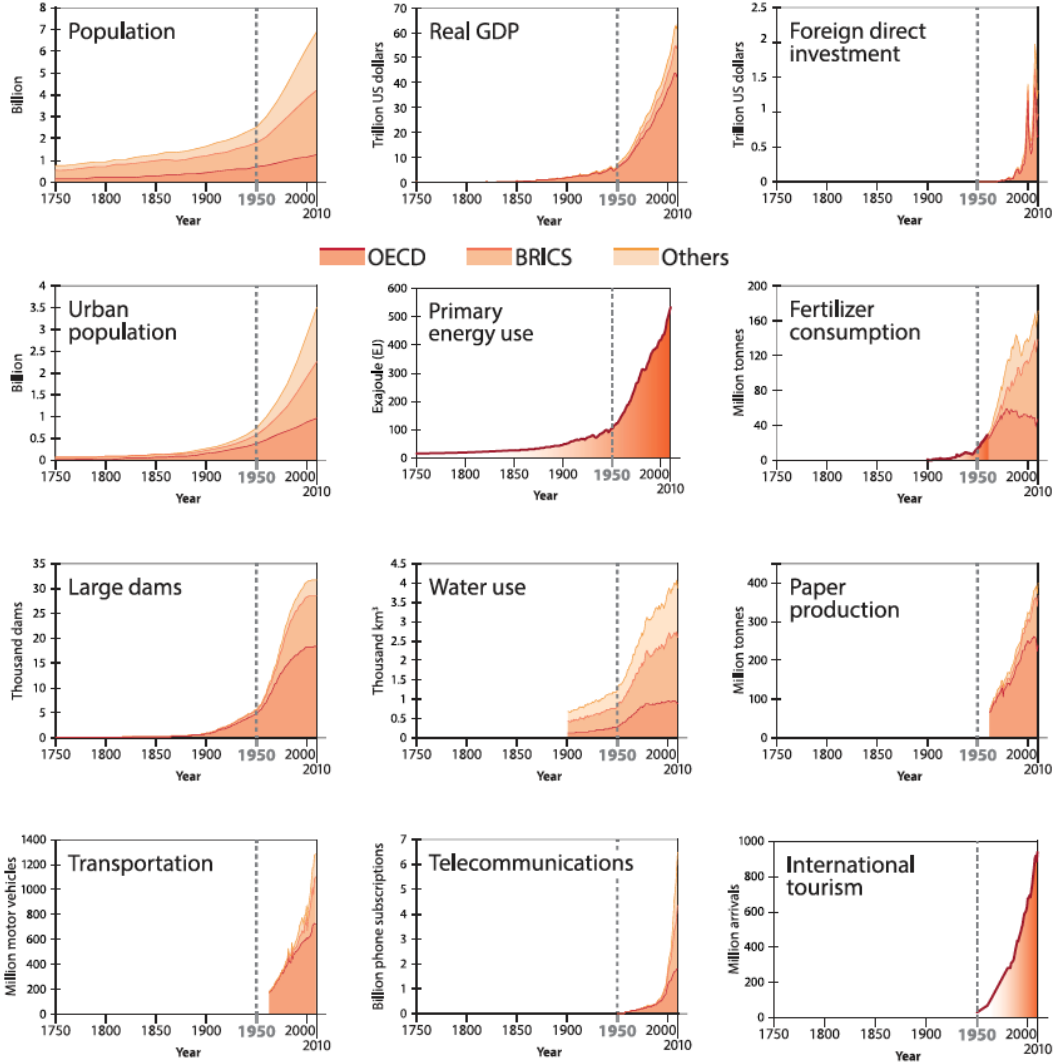

Steffen *et al. (2015)*


Photo: The Atlantic

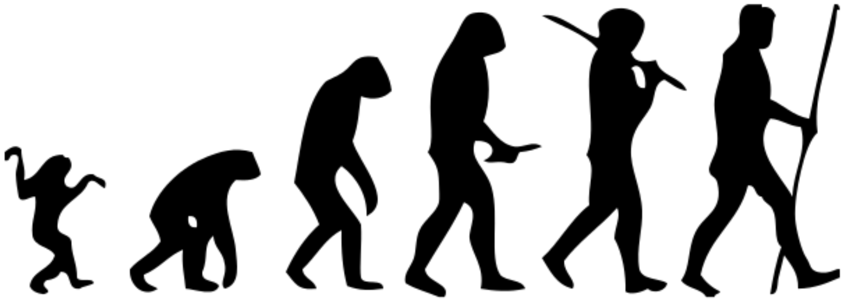

Image: M. Garde

Water Evolution...

...gradually improves system performance.

...is enabled by existing technologies.

...does not disrupt existing institutions.

A Water Revolution is...

...a transformative response to a crisis.

...requires new, reliable technologies.

...permanently changes institutions.

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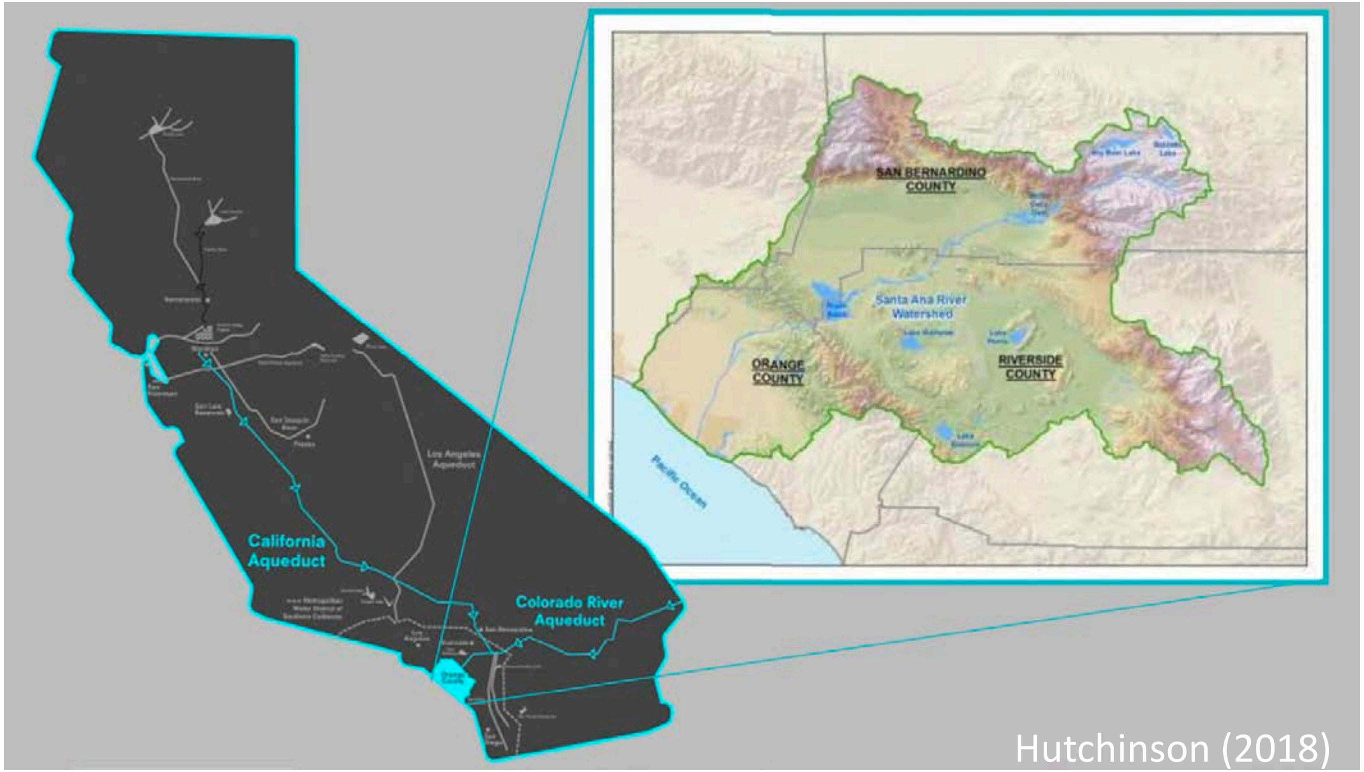
Stillsuit for a City

Santa Ana River Watershed



Hutchinson (2018)

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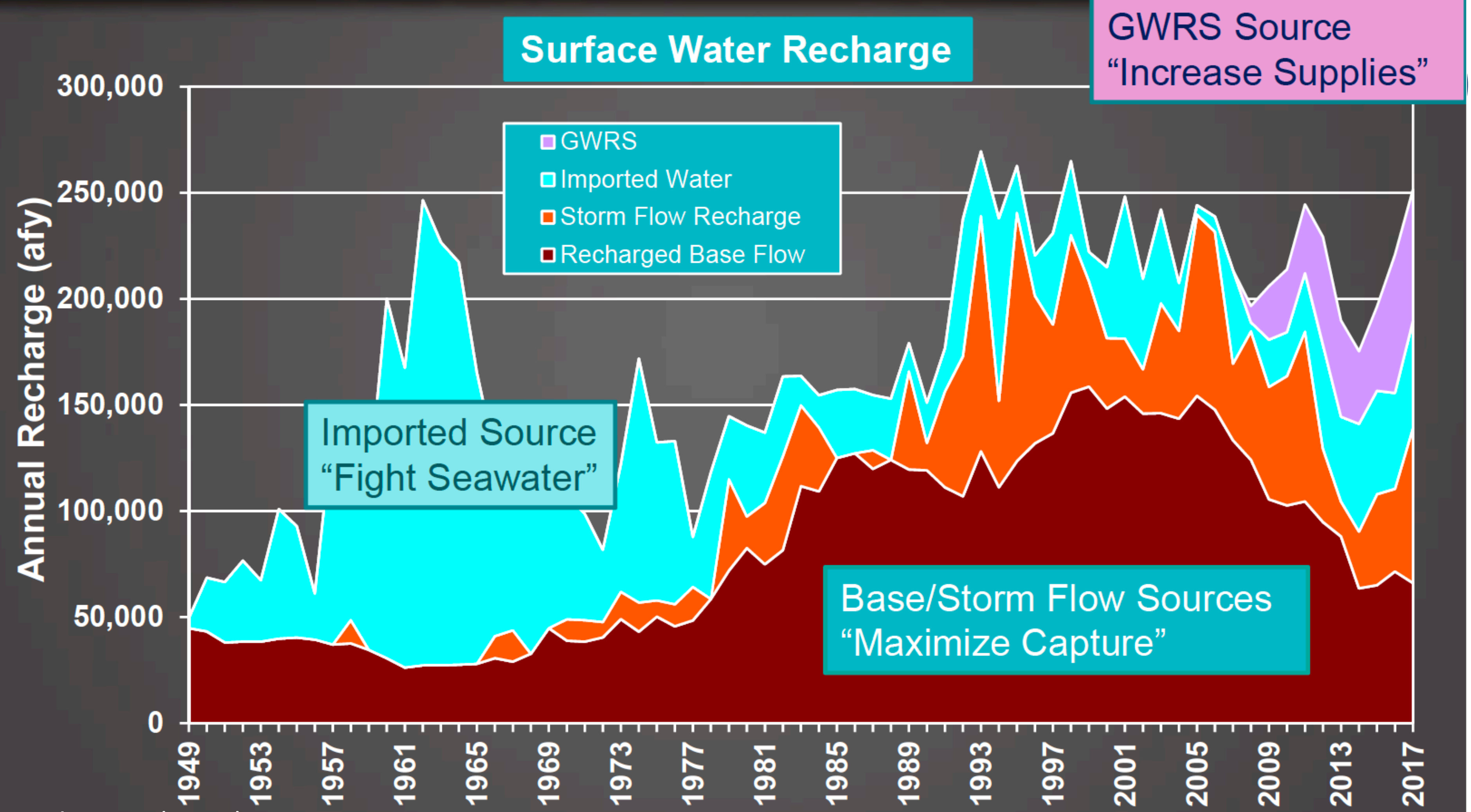

Hutchinson (2018)


Prado Constructed Wetlands

Re-Engineering Treatment Wetlands

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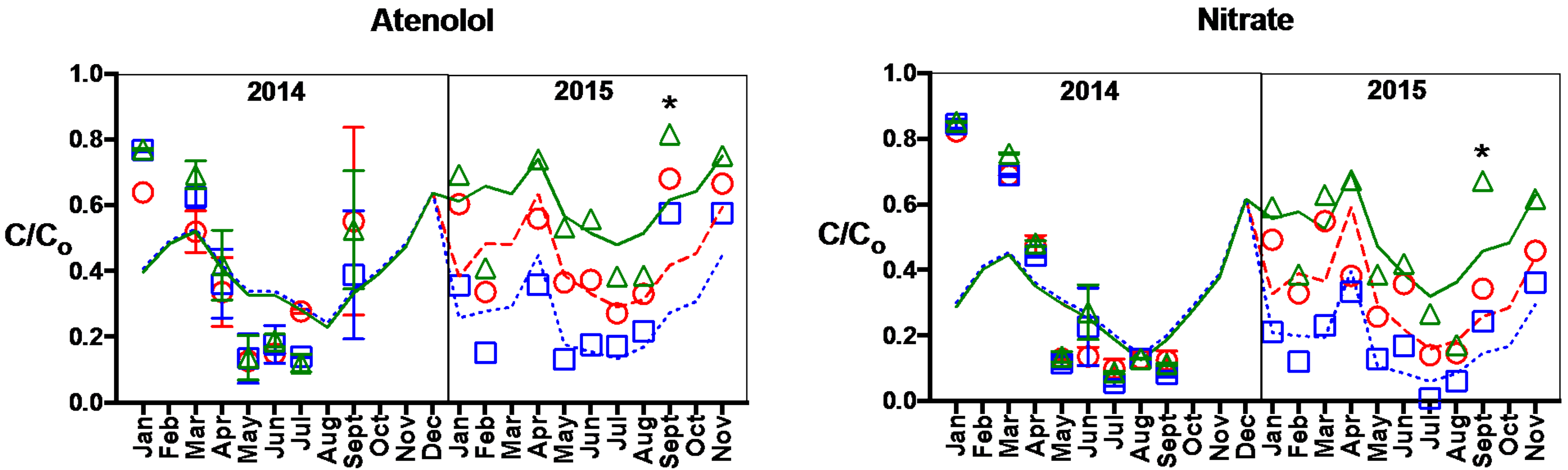
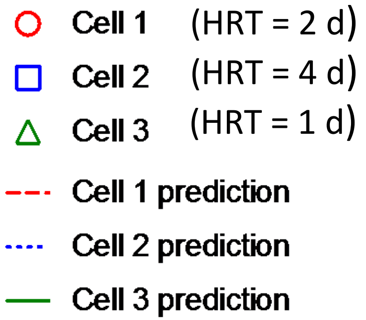
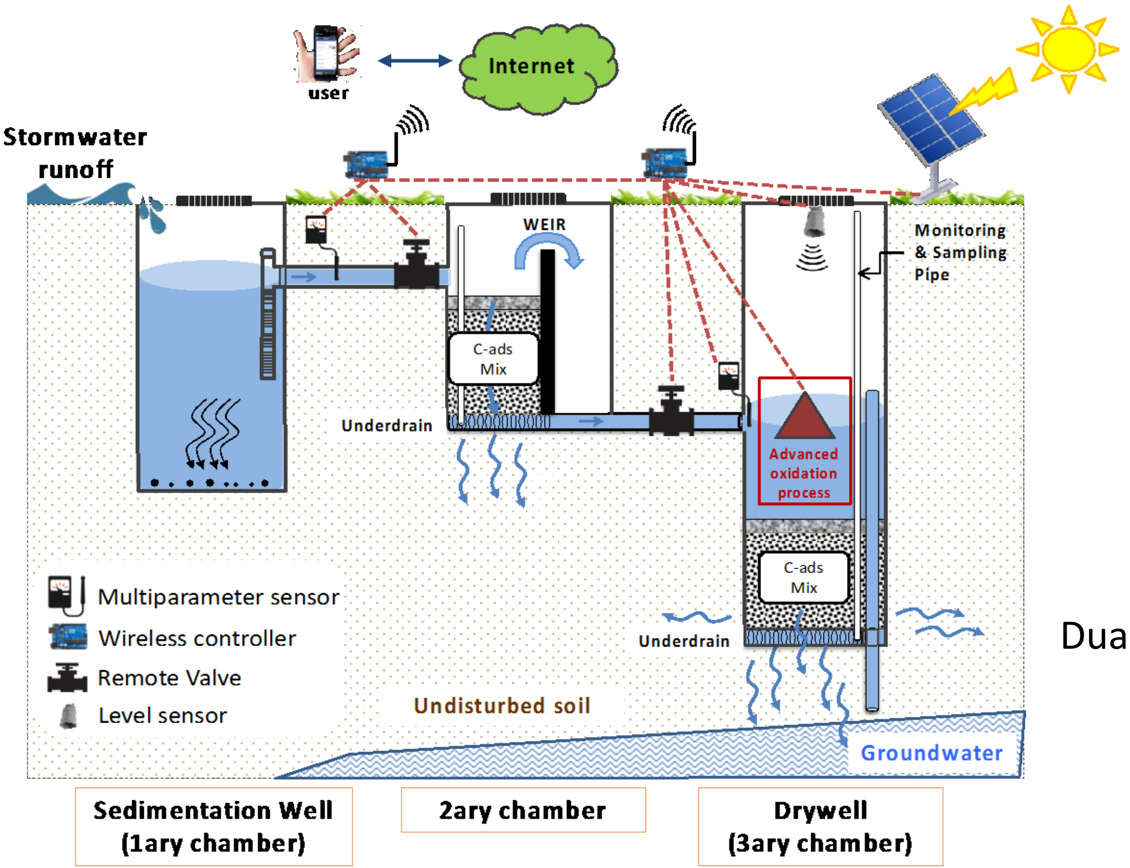
Open Water Wetland Performance





Bear et al. (2017)

Distributed Stormwater Treatment



Duan and Sedlak (2021)

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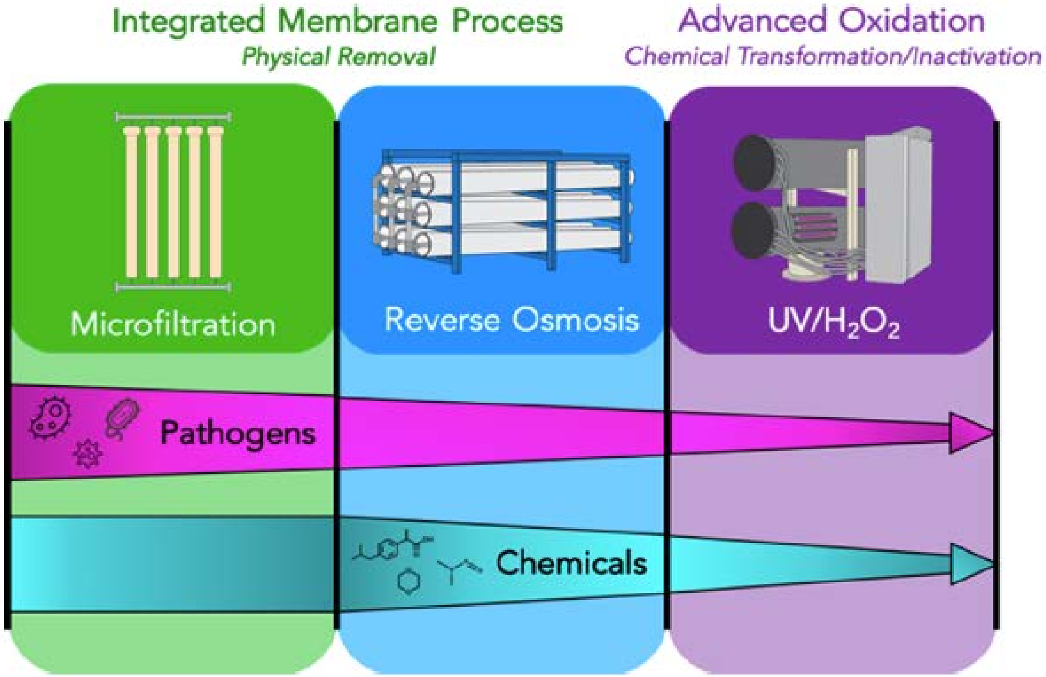
Multibarrier Approach to Safety



Marron et al. (2019)

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(A Leaky) Stillsuit for a City

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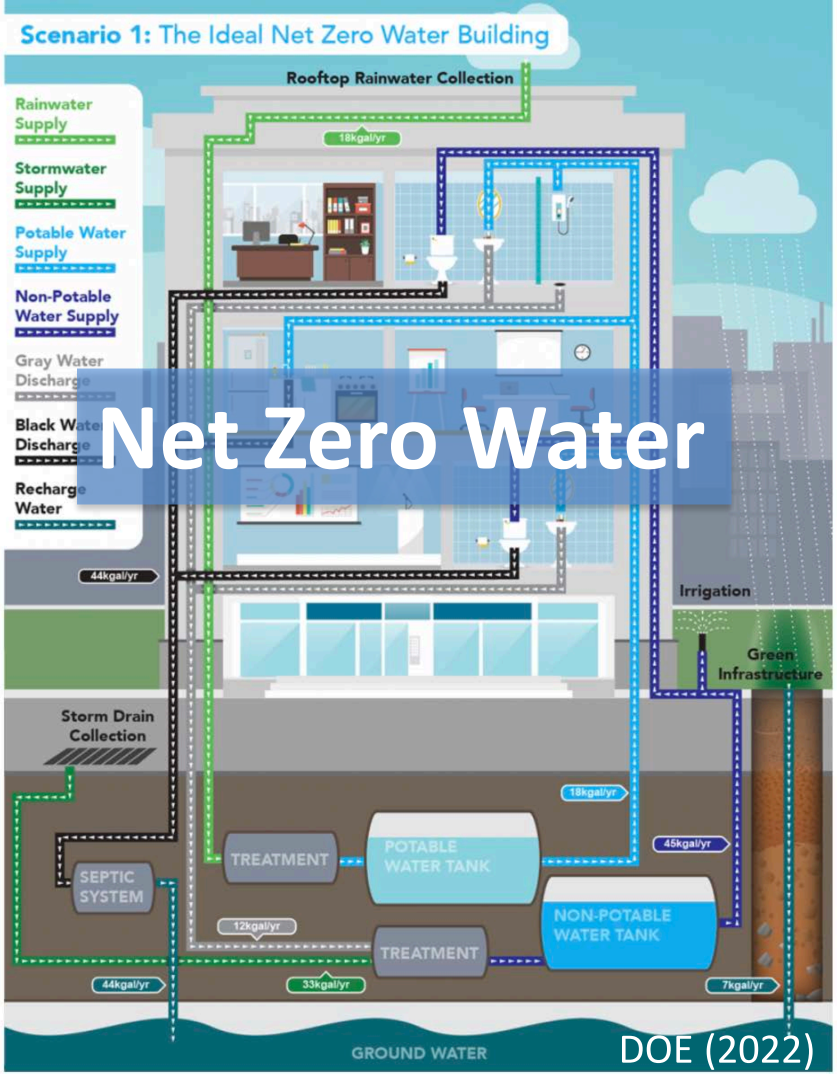
Net Zero Water



DOE (2022)

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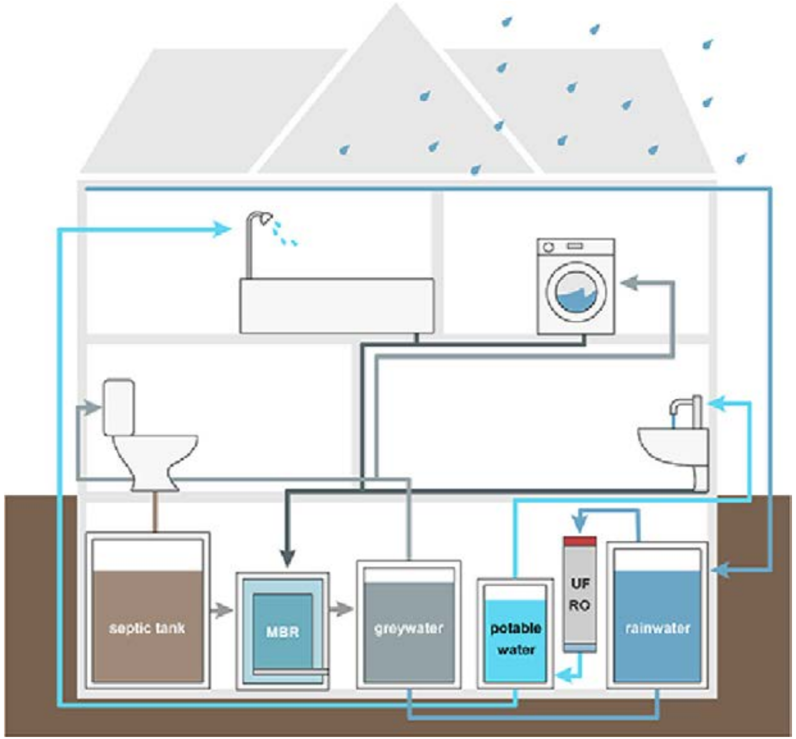
Personalized Water Systems



Rabaey et al. (2020)

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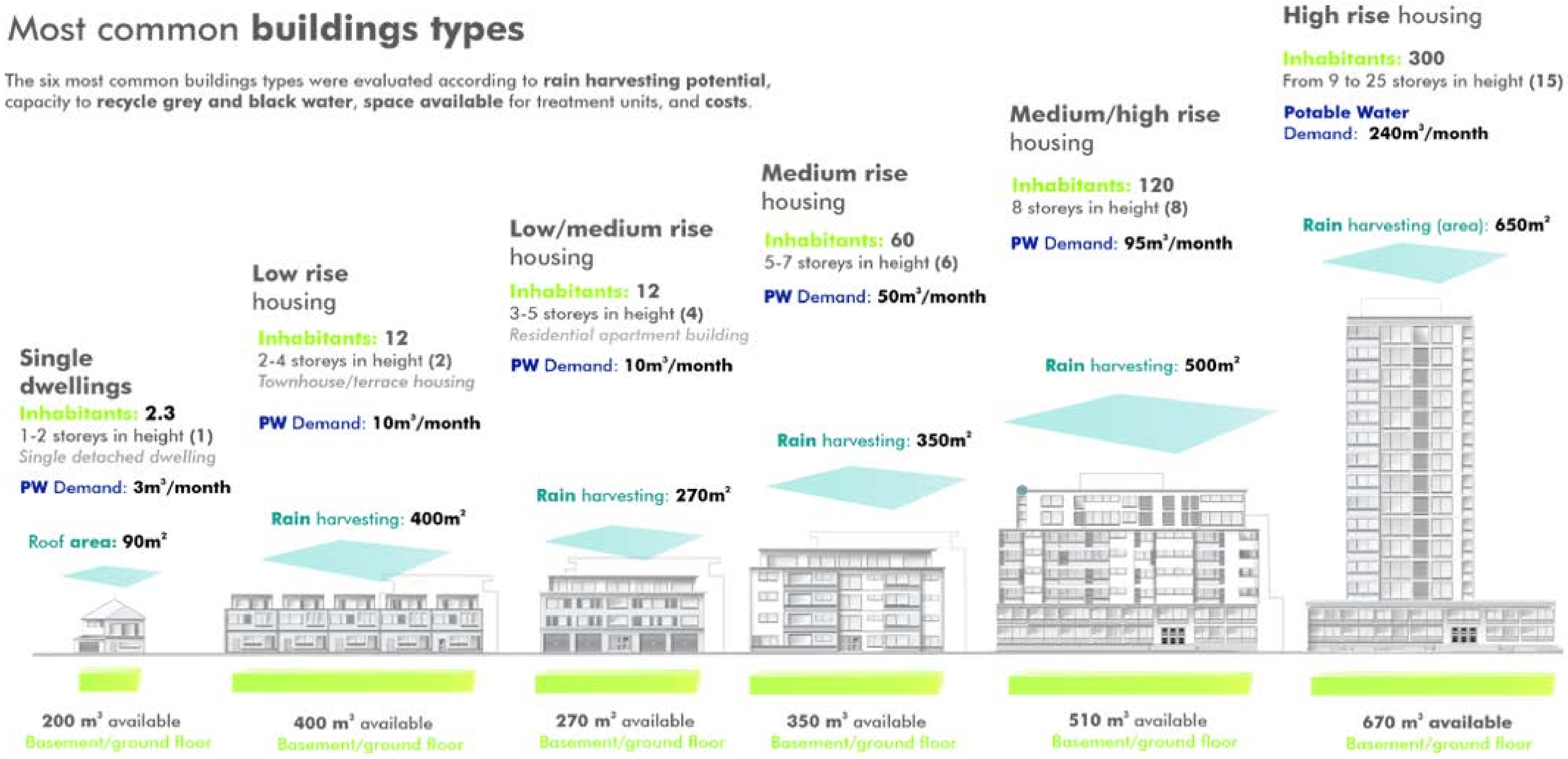
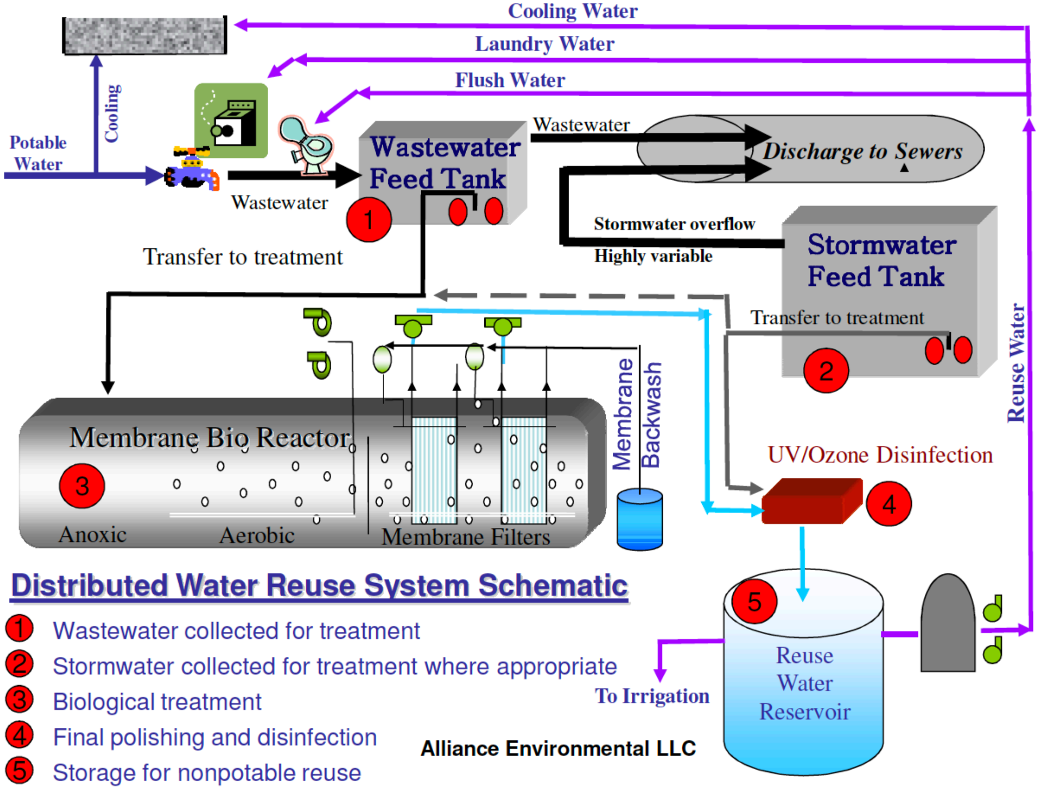
Techno-Economic Analysis



Garrido-Basbera et al. (2022)

Half Way to Net Zero

Battery Park City (New York)



WERF (2008)

e 4: Breakdown of Water Use in the Home in liters per person per day (lppd) [13] [1] [14]

50L HOME

A Circular Water Future: White Paper on How Cities Can Integrate Water Reuse has been possible as a result of the support provided by 50L Home Coalition member organizations Electrolux, ENGIE, Kohler, Procter & Gamble, and Suez. It has benefited from the input from our Partners and advisors Arcadis, the Netherlands Water Partnership, and WateReuse Association, as well as our technical consultants Arup.

Our thanks also go to the numerous colleagues and experts from other organizations in China, India, Mexico and the USA who provided input and feedback on various workshops and consultations.

This document takes into account the particular instructions and requirements of 50L Home Coalition and its member organizations.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Arup team: Sachin Bhoite, Chihurumanya Felly-Njoku, Martin Findlay, Sophie Fisher, Karina Haggerty, Ayisha Paw, Anokhee Shah, Martin Shouler, Phillipa Stanley, and Siraj Tahir.

50L Home Coalition Working Group: Frantz Beznik (P&G), Anne Cateaux (Engie), Colin Clarke (P&G), Namrata Dentan (WBCSD), Jon Freedman (Suez), Rochi Khemka (2030 WRG), Karin Maria Krchnak (2030 WRG), Charlotte Lampre (Suez), Salvatore Milluzzo (Electrolux), Braulio Eduardo Morera (WBCSD), Jirko Müller (Electrolux), Alex Mung (WEF), Ratish Namboothiry (Kohler), Cecilia Nord (Electrolux), Anusha Shah (Arcadis), and Tom Williams (WBCSD).

50L Home Coalition is convened by the World Business Council for Sustainable Development, World Economic Forum, and 2030 Water Resources Group.

A Better Salt Machine


Voutchkov & Kaiser (2020)

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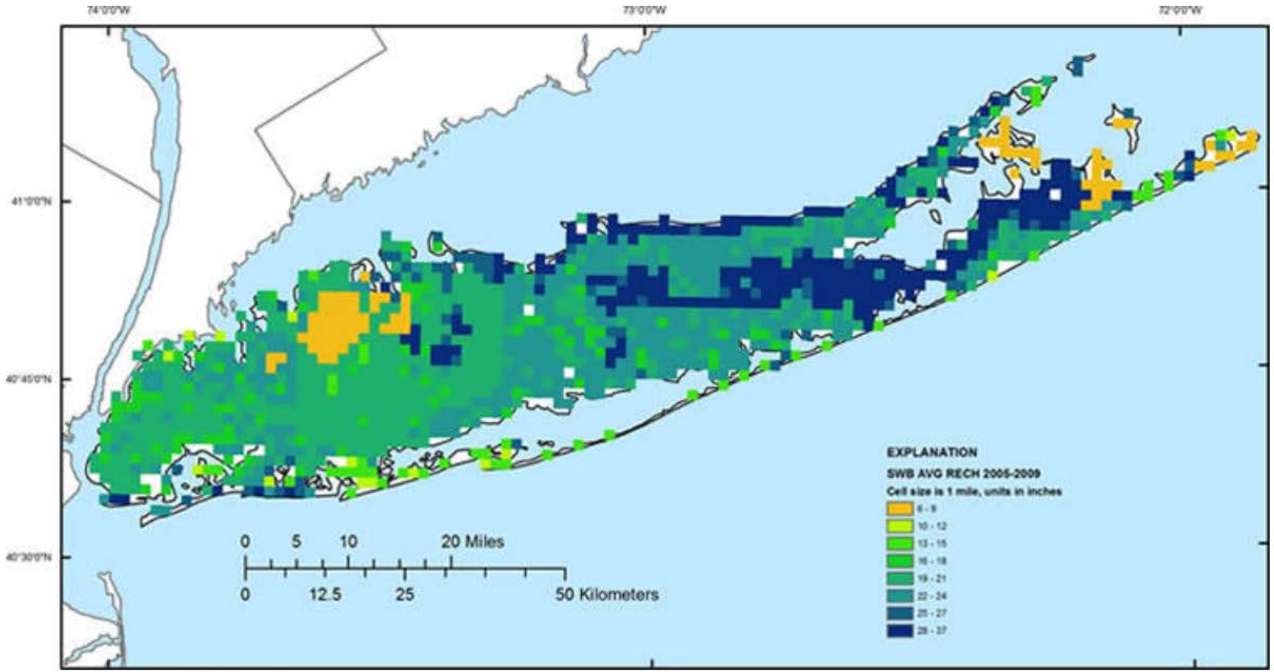
Running the Rivers

Bringing the Solutions Back to the Island



Sources/Usage: Public Domain.

Figure 26. Simulated output of Soil-Water-Balance Code (SWB) of recharge across Long Island, N.Y. from 2005-2009.(Public domain.)

Source: Masterson and others, 2013

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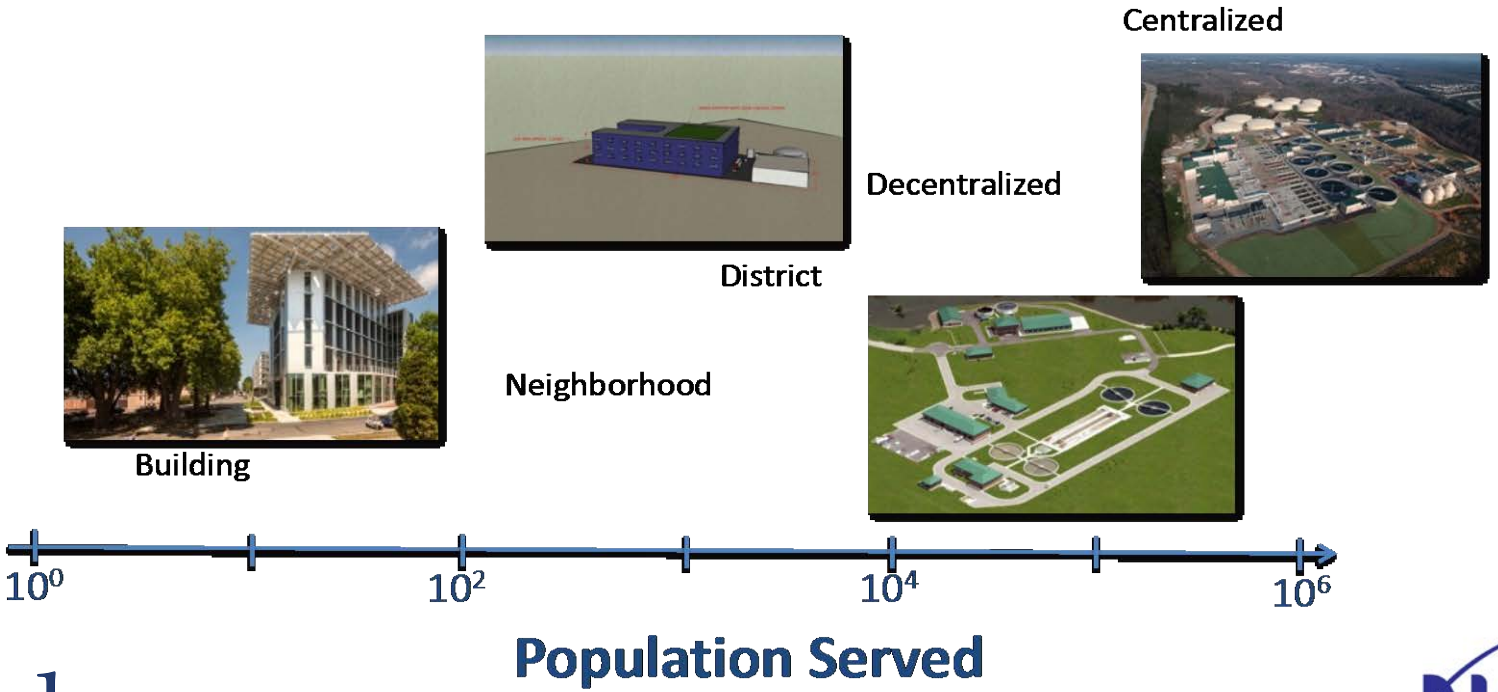
Long Island Challenges

Challenge 1: Contamination of Groundwater by Septic Systems



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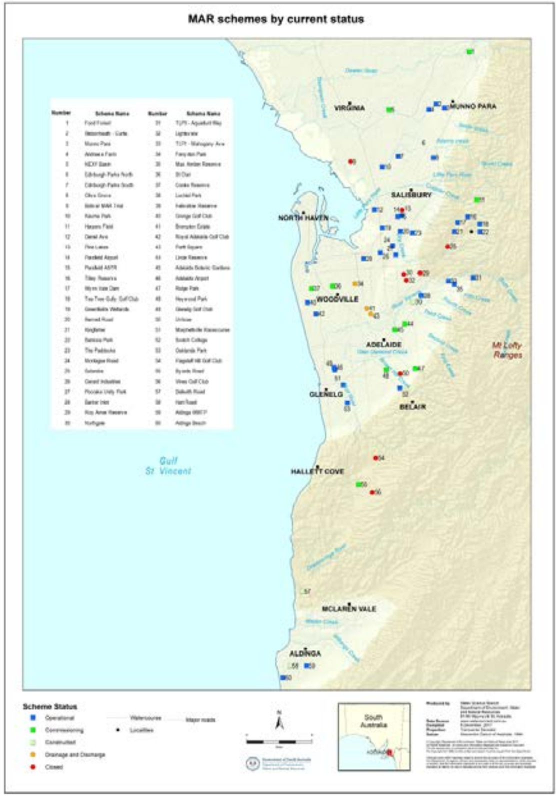
Long Island Challenges

Challenge 2: Contamination of Groundwater by Infiltrated Stormwater



Adelaide: Stormwater Wetlands
2020: 3% of drinking water supply
Future: 10% of supply

Figure 3-3. Ridge Park vertical biofiltration bed: Water is pumped from the creek and is filtered as it percolates through the wetland bed. An injection well is contained in the grey-domed box.

Figure 3-5. Lochiel Park MAR wetland is integrated into the development's water-sensitive urban design

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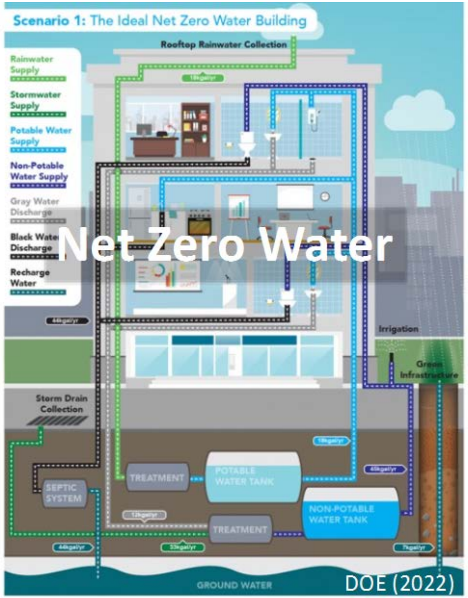
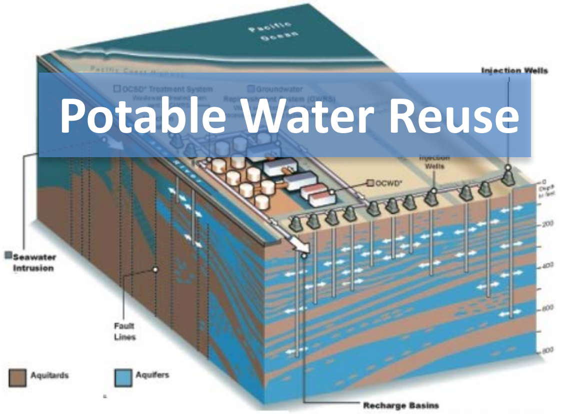
Long Island Challenges

Challenge 3: Water Shortages (i.e., Droughts)





Final Thoughts: Unlocking a Revolution

- Technology lock-in is difficult to avoid

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Final Thoughts: Unlocking a Revolution

- Technology lock-in is difficult to avoid
- Transformative technologies initially merit subsidies or niche markets

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Final Thoughts: Unlocking a Revolution

- Technology lock-in is difficult to avoid
- Transformative technologies initially merit subsidies or niche markets
- Fixing water is the right thing to do
  - -human right to water
  - -rights of the environment
  - -rights of future generations

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Others
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Urs von Gunten (Eawag)

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ReNUWIt Re-inventing the Nation's URBAN WATER INFRASTRUCTURE

Valley Water

ESA

SAN FRANCISCO ESTUARY PARTNERSHIP

ORO LOMA SANITARY DISTRICT

Since 1961 SAVE THE BAY

SINCE 1933 ORANGE COUNTY WATER DISTRICT A TRADITION OF INNOVATION

LA DWP

TOWN OF DISCOVERY BAY CALIFORNIA est. 1998

NSF

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References

Bear S.E., Nguyen M.T., Jasper J.T., Nygren S., Nelson K.L. and Sedlak D.L. (2017) Removal of nutrients, trace organisms in a demonstration-scale unit process open-water treatment wetland *Ecological Engineering* 109: 76-83. doi: 10.1016/j.ecoleng.2017.09.017

Duan Y. and Sedlak D.L. (2021) An electrochemical advanced oxidation process for the treatment of urban stormwater. *Water Research X* Volume 13, article 100127 doi: 10.1016/j.wroa.2021.100127

Finnerty C., Zhang L., Sedlak D.L., Nelson K.L. and Mi, B.X. (2017) Synthetic Graphene Oxide Leaf for Solar Desalination with Zero Liquid Discharge. *Environ. Sci. Technol.* 51: 11701-11709.

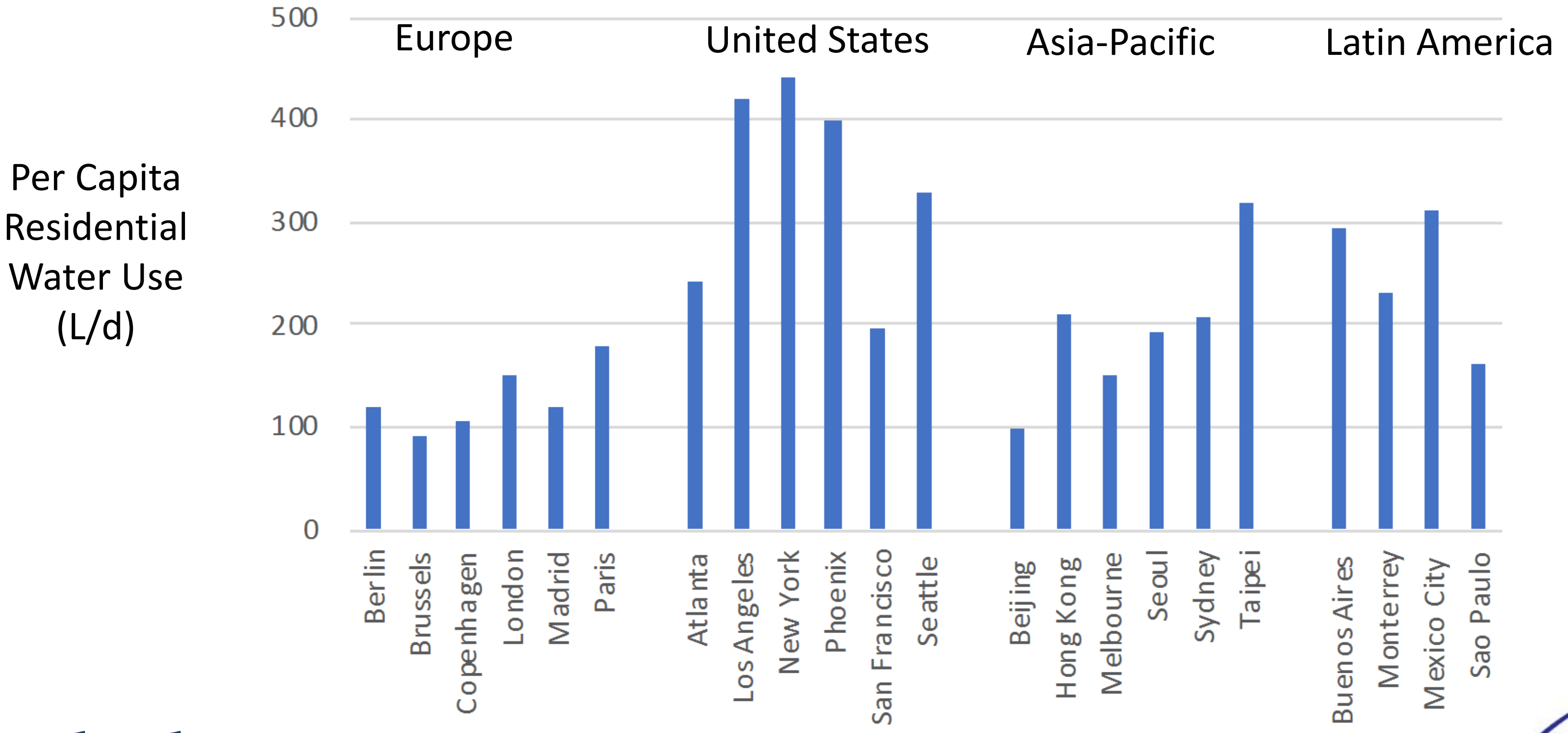
Garrido-Baserba,M., Barnosell I., Molinos-Serat M., Sedlak D.L., Rabaey K., Schraa O., Verdaguear M., Rosso D. and Poch M. (2022) The third route: A techno-economic evaluation of extreme water and wastewater decentralization *Water Research*, 218: 118408. https://doi.org/10.1016/j.watres.2022.118408

Marron E.L., Mitch W.A., von Gunten U. and Sedlak D.L. (2019) A tale of two treatments: the multiple barrier approach to removing chemical contaminants during potable water reuse. *Acc. Chem. Res.* 52(3): 615-622. doi: 10.1021/acs.accounts.8b00612

Rabaey K., Vandekerckhove T., Van de Walle A. and Sedlak D.L. (2020) The third route: using extreme decentralization to create resilient urban water systems. *Water Research*, 185: 116276. doi: 10.1016/j.watres.2020.116276

Extra slides

Urban Water Efficiency



Data from IWA (2014-2017) and other sources

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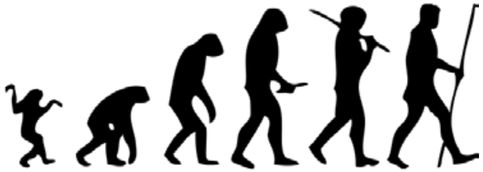
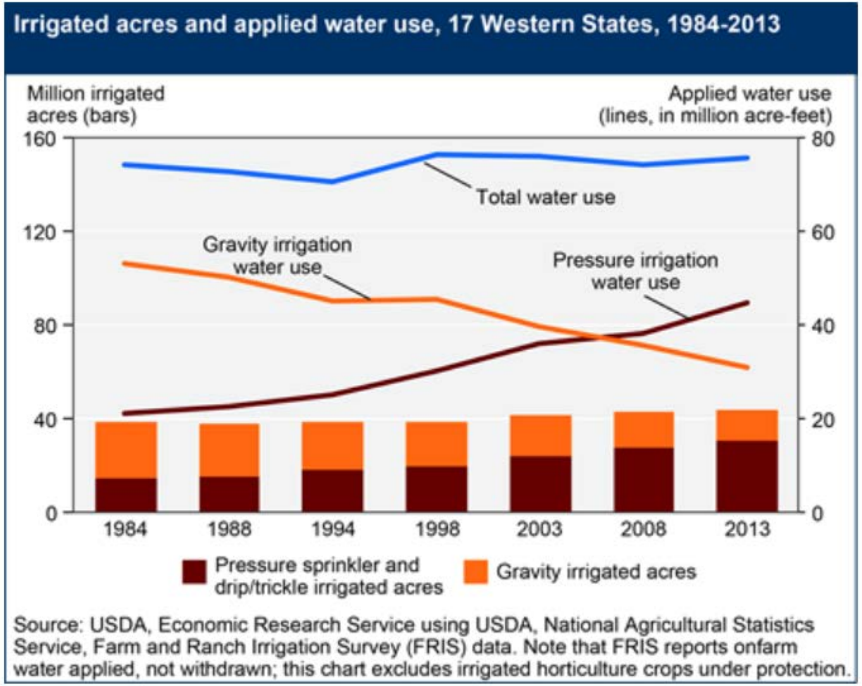
Agricultural Irrigation in US West





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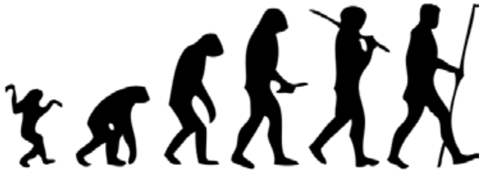
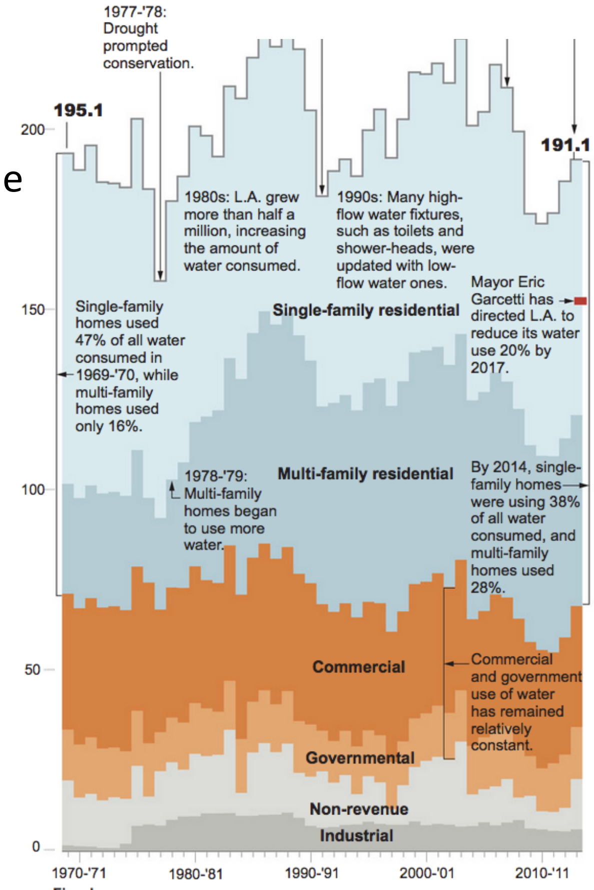
Water Use in Los Angeles

190 g/c d

2.8 million people





137 g/c d

3.8 million people

LA Times

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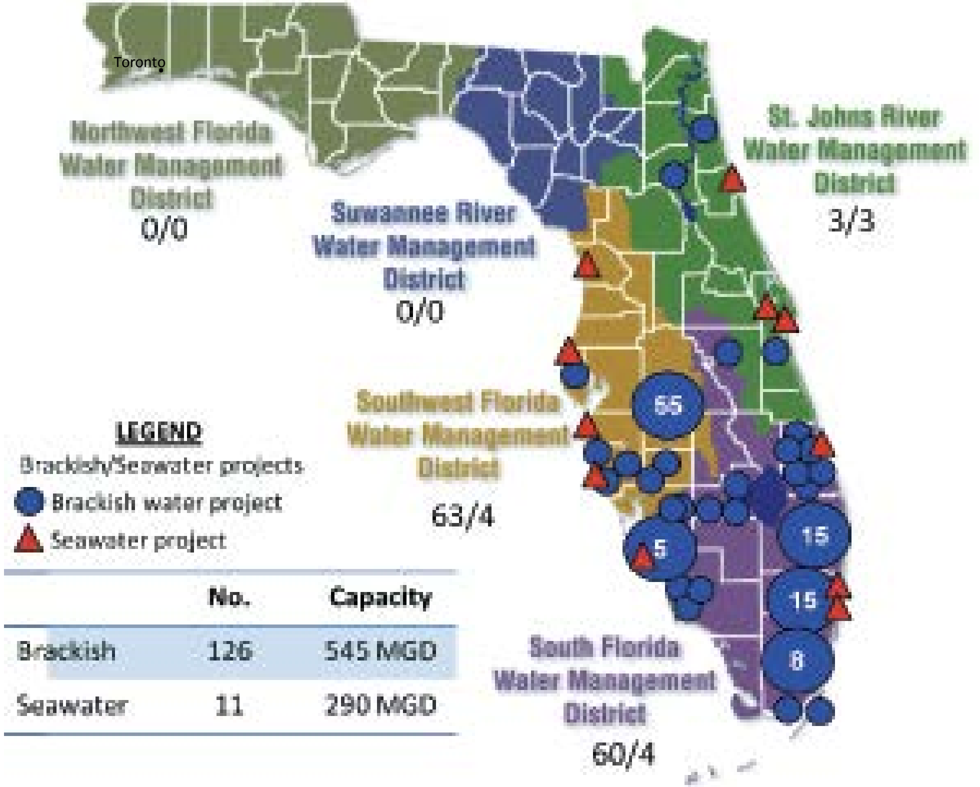
The Promise of Brackish Desalination



Hill (2012)

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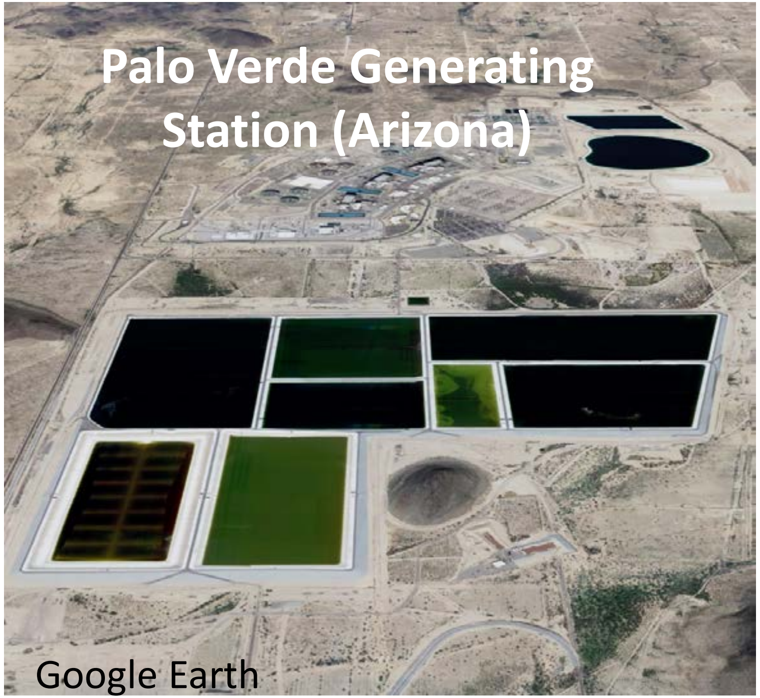

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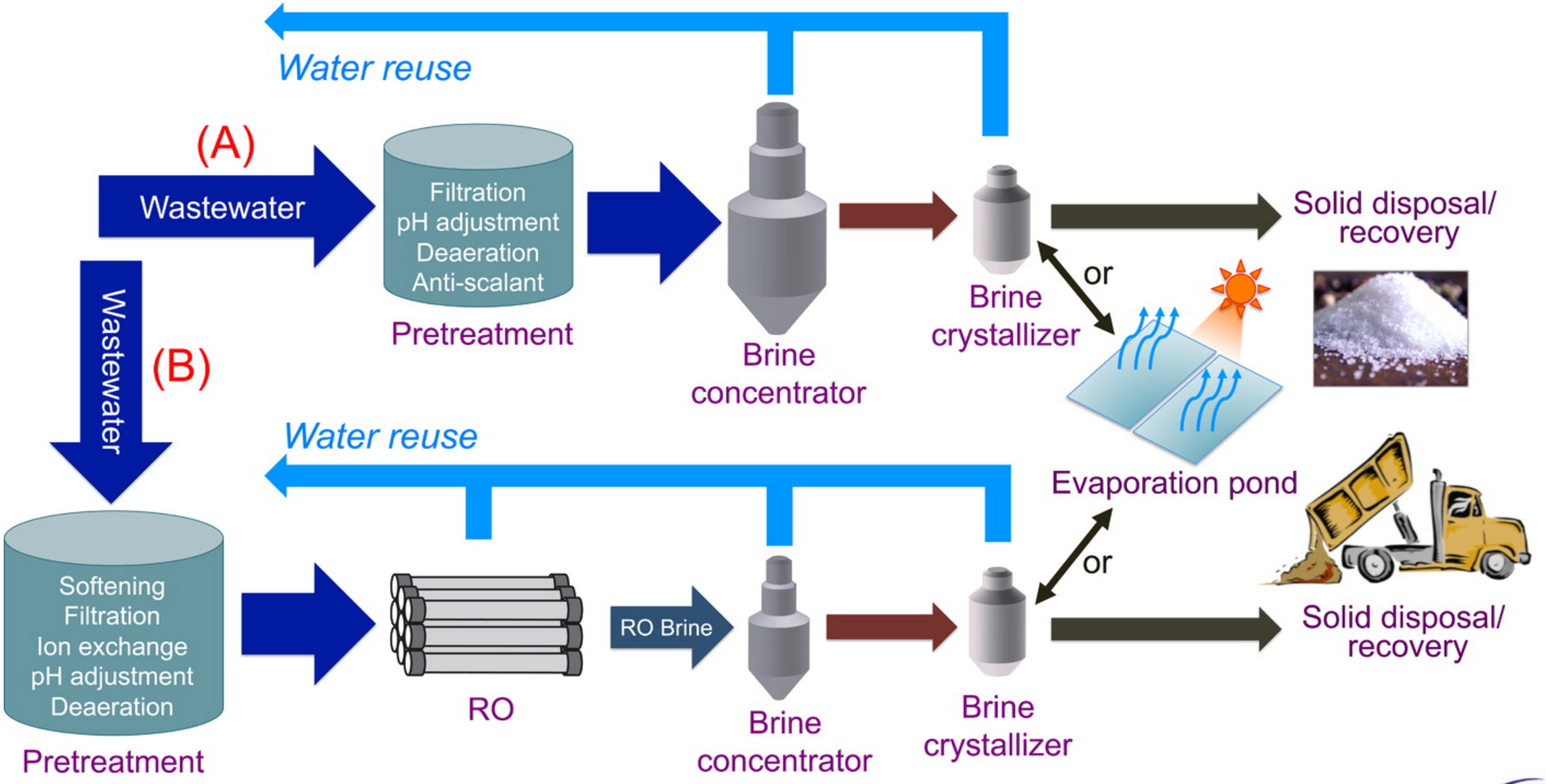
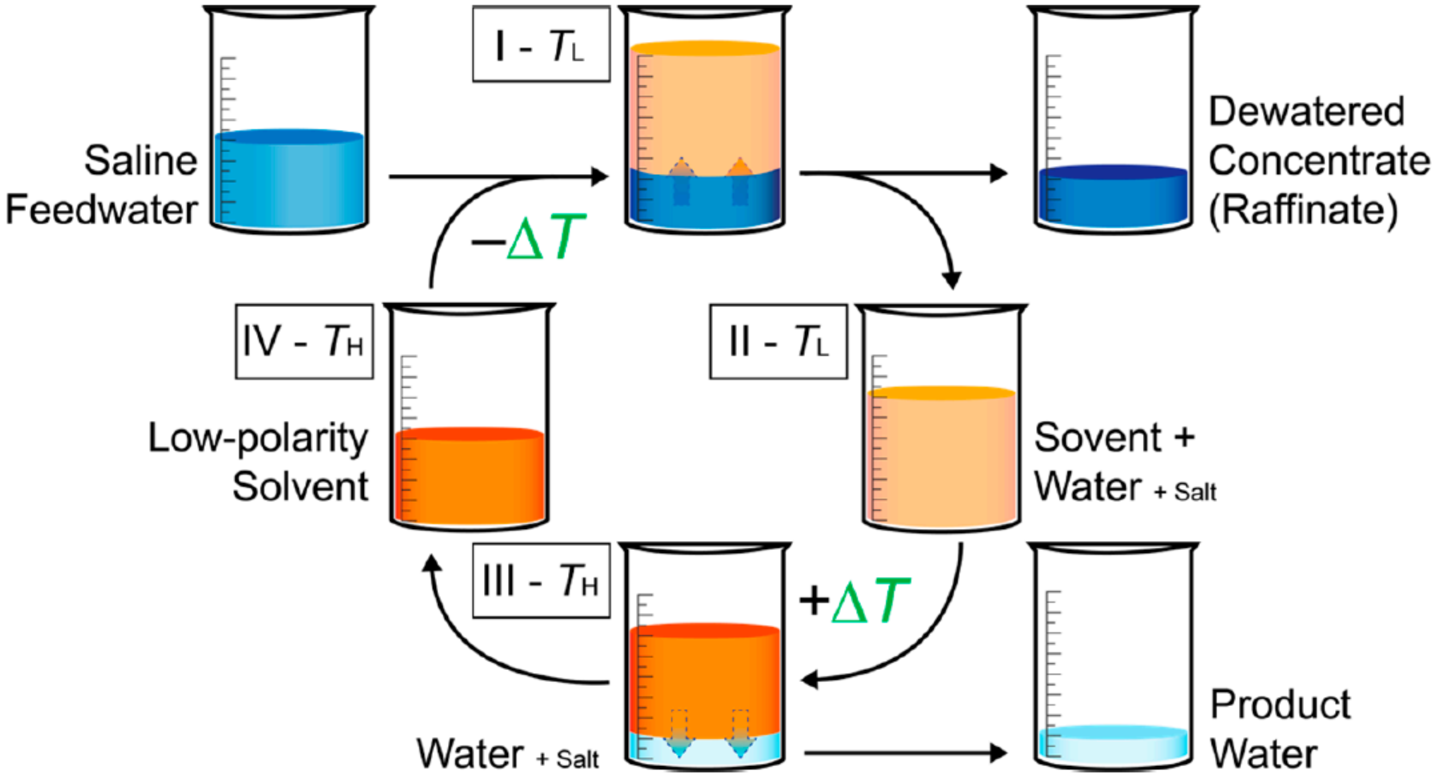
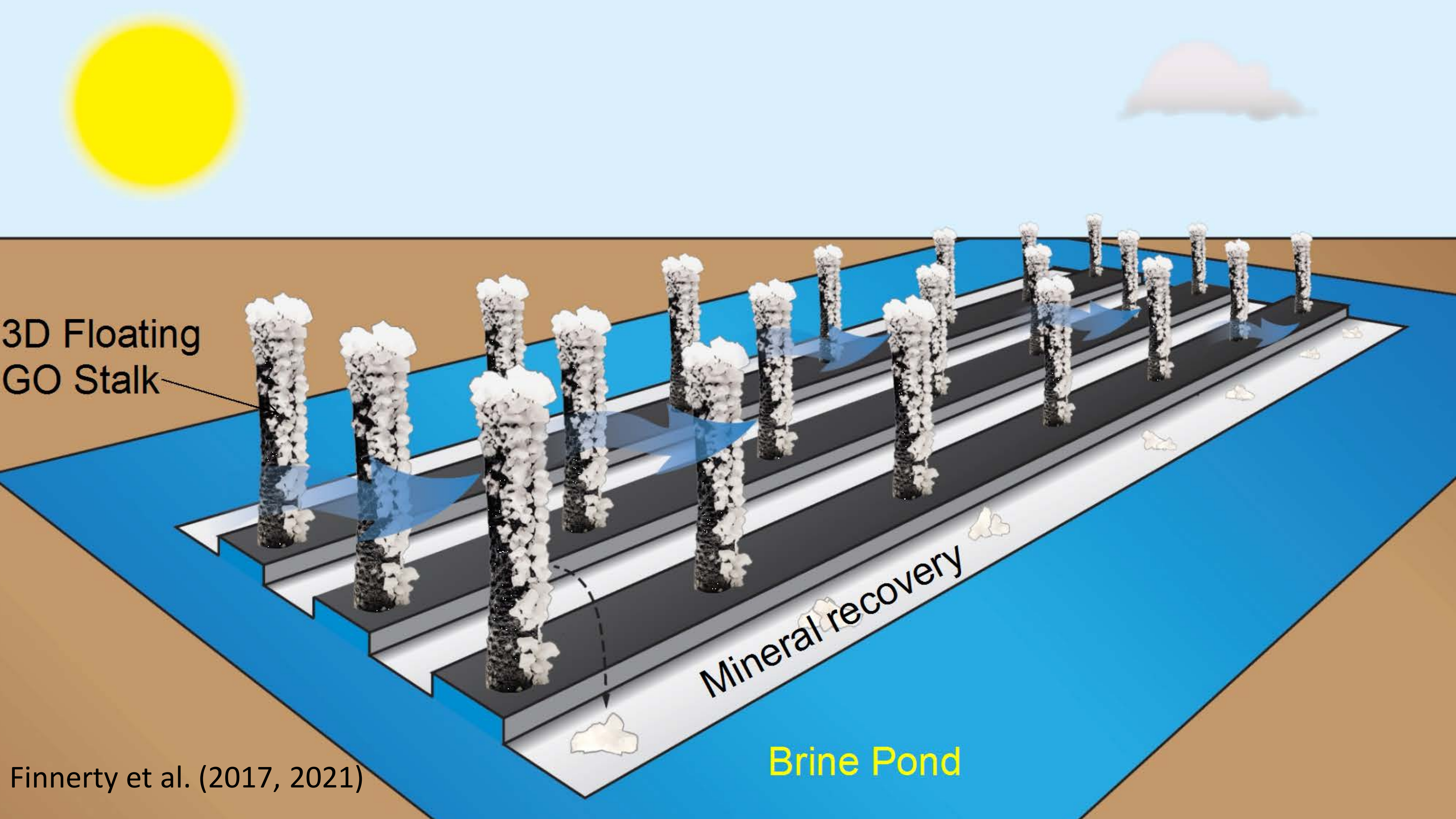


Tong & Elimelech (2016)

Temperature Swing Solvent Extraction




3D Floating
GO Stalk
Mineral recovery
Brine Pond
Finnerty et al. (2017, 2021)

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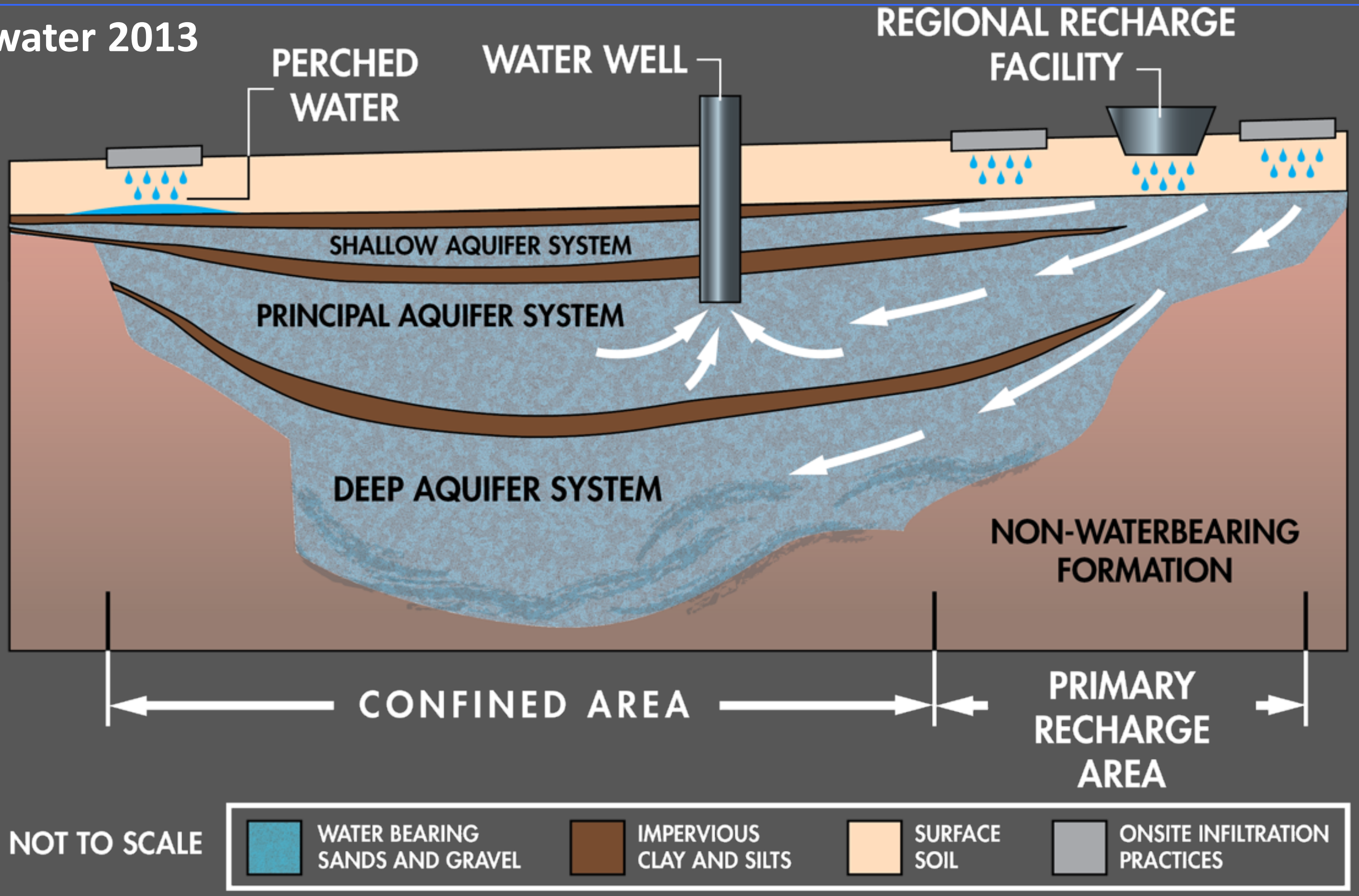
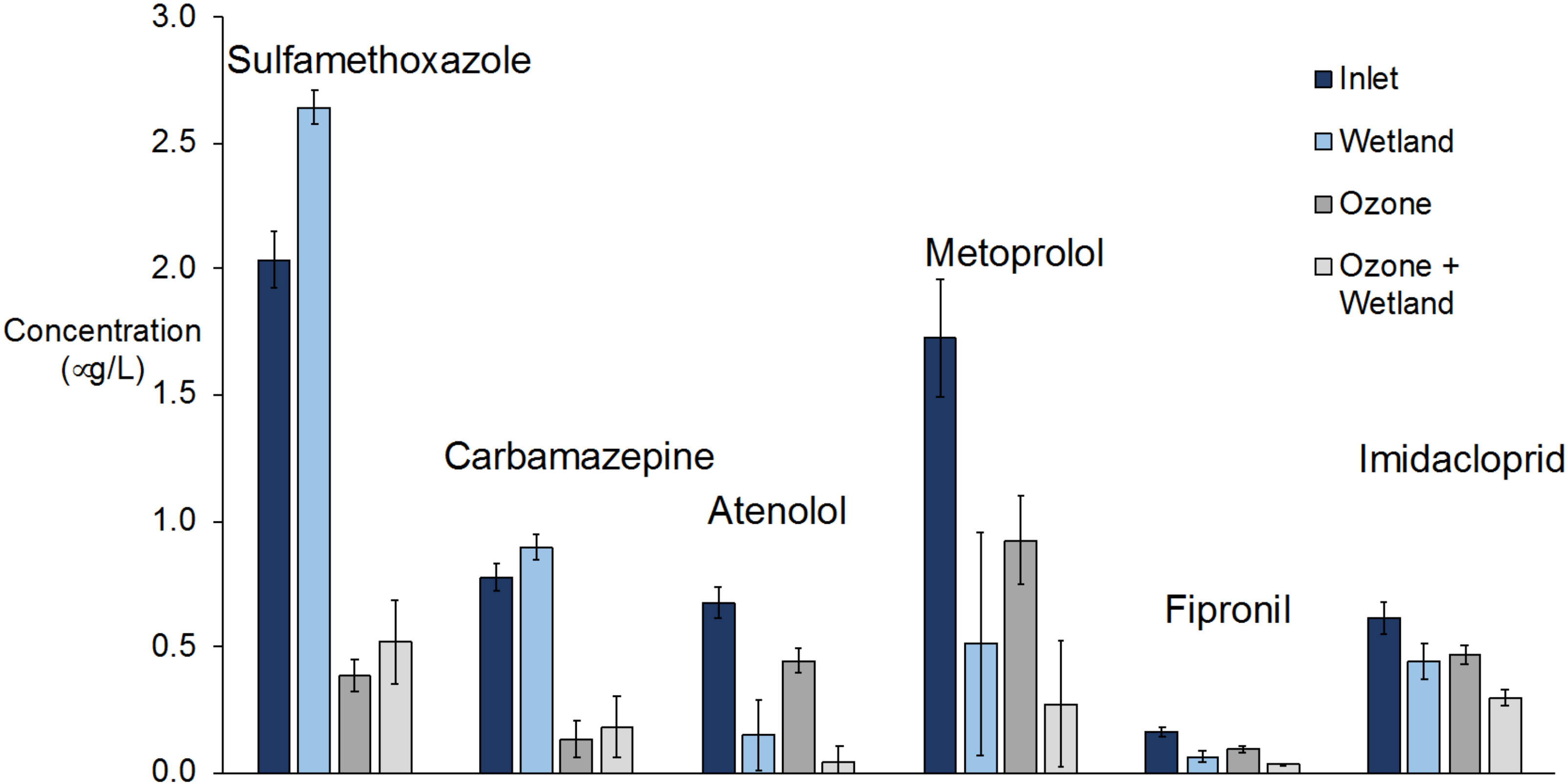
Atwater 2013



Pilot-Scale RO Concentrate Treatment



Scholes et al. (2020)

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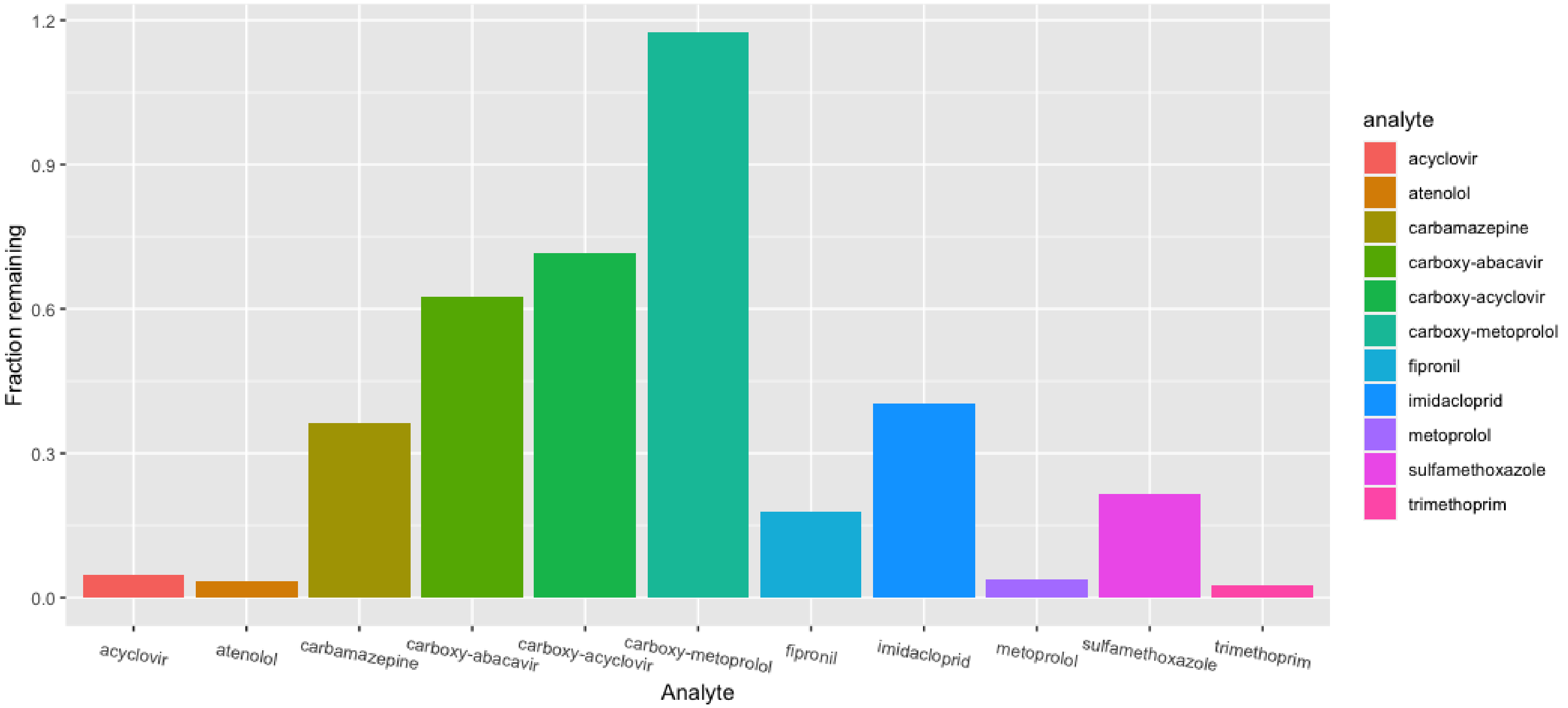
RO Concentrate Treatment



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Perantoni et al. (2022)

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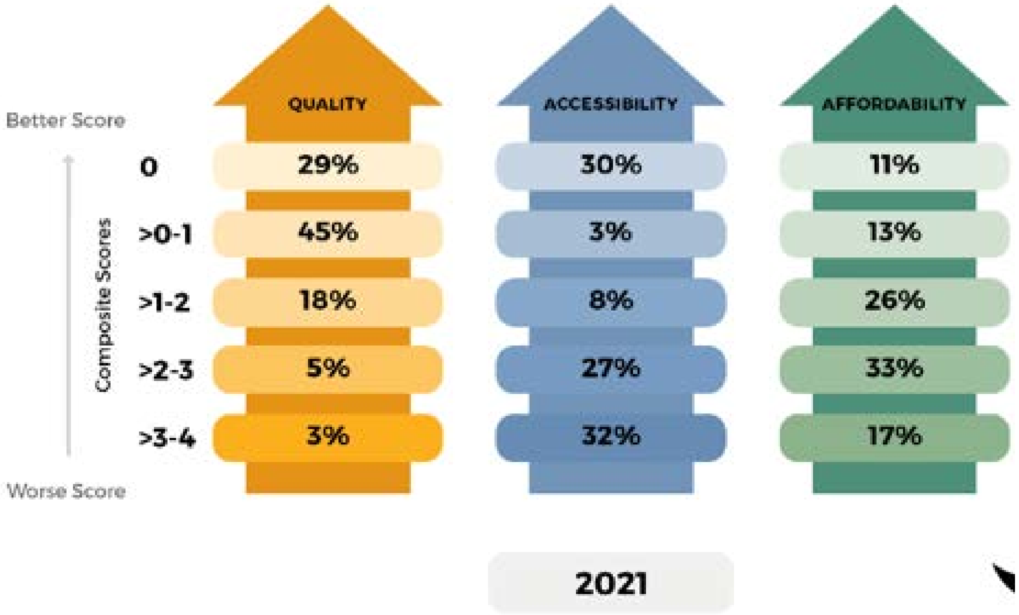
The Underserved



Achieving the Human Right to Water in California, OEHHA 2021

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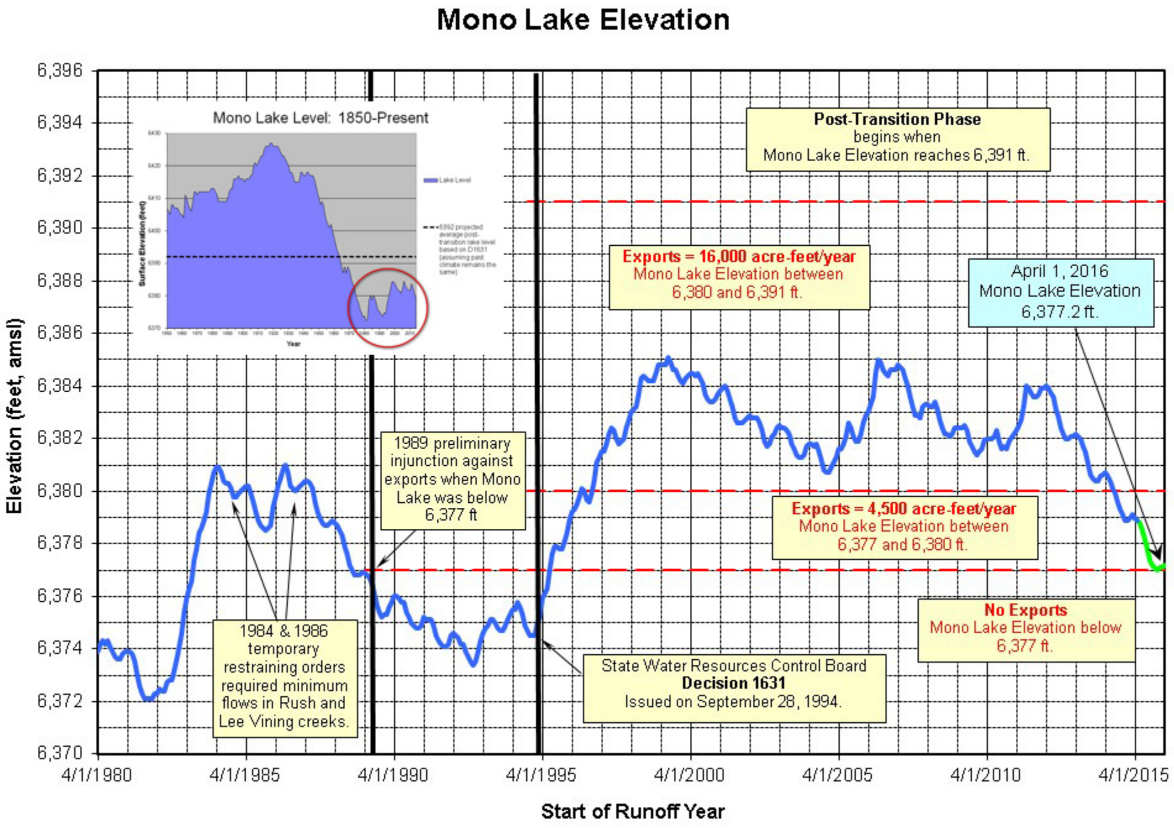
The Environment



Source: Monolake.org

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