

Robust technology and policy pathways to urban water security

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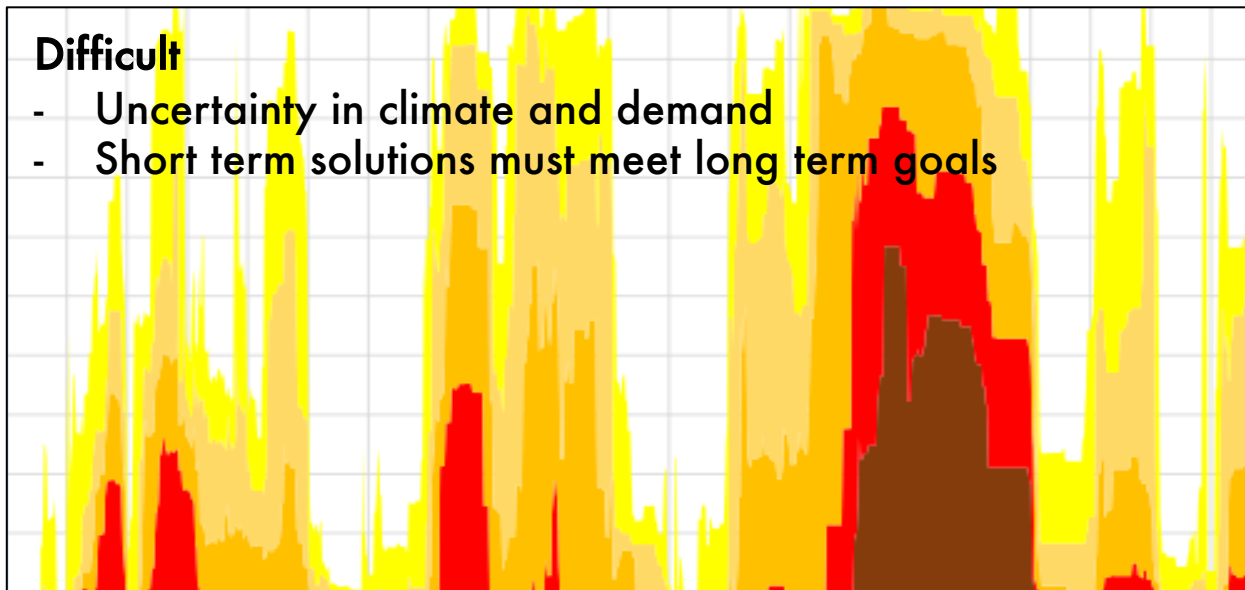
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Picture source: The Guardian

Stanford University

Planning for urban water resilience in California



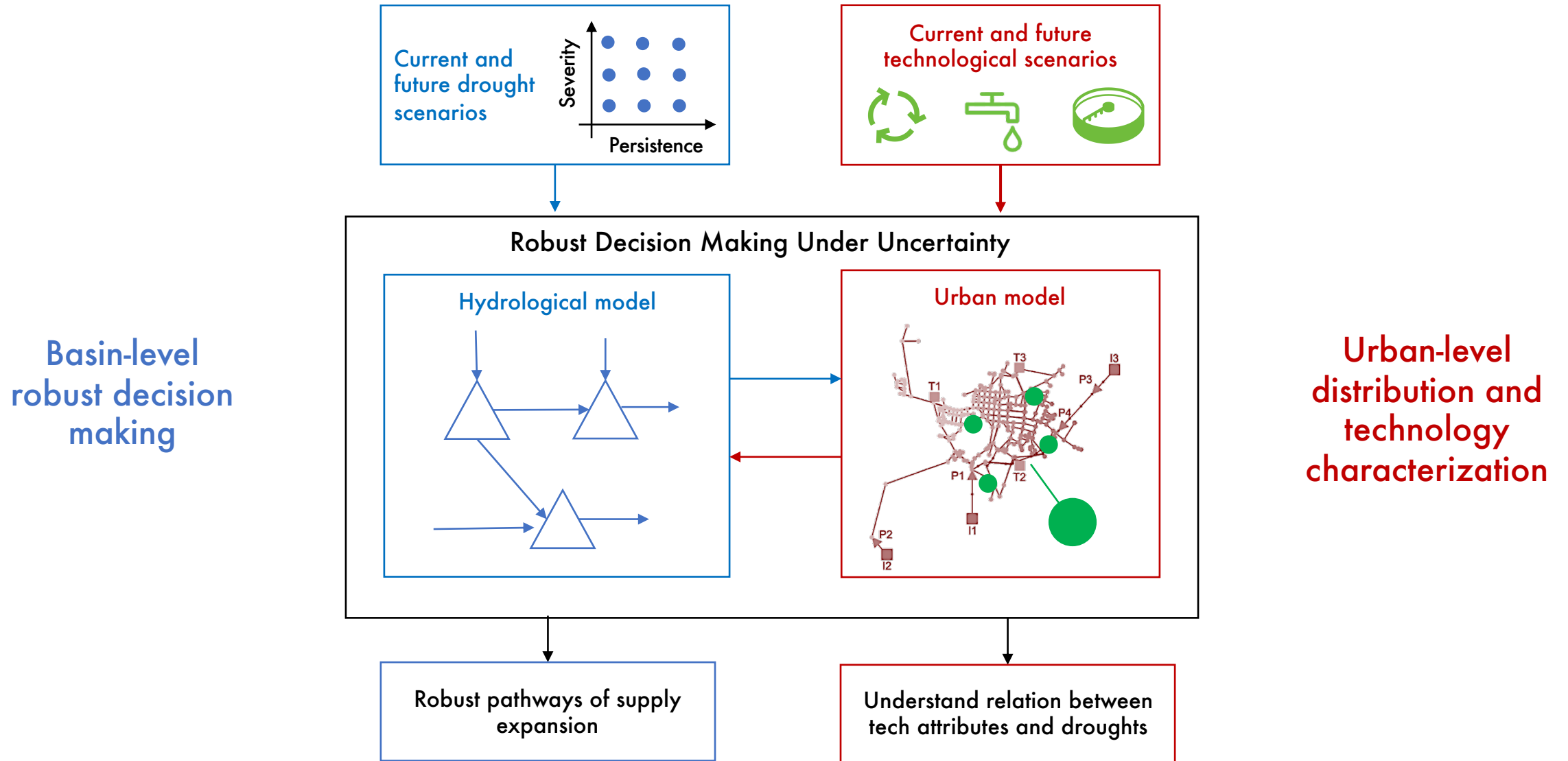
The two scales of water resilience

Literature on basin-level and urban-level water resources planning developed complementary approaches to account for uncertainty and technology

	Strength
	Weakness

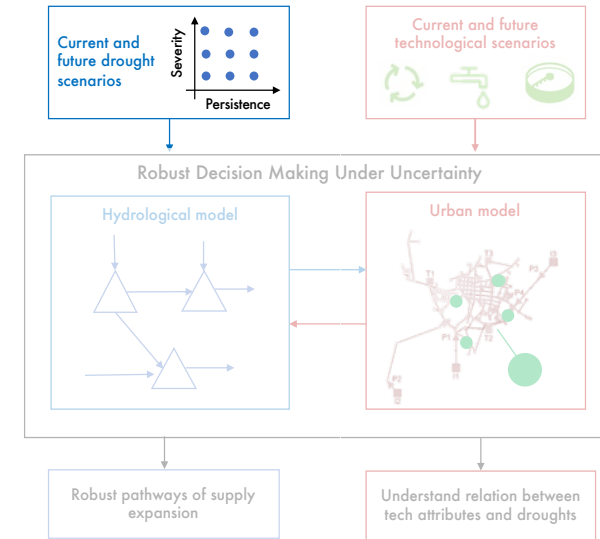
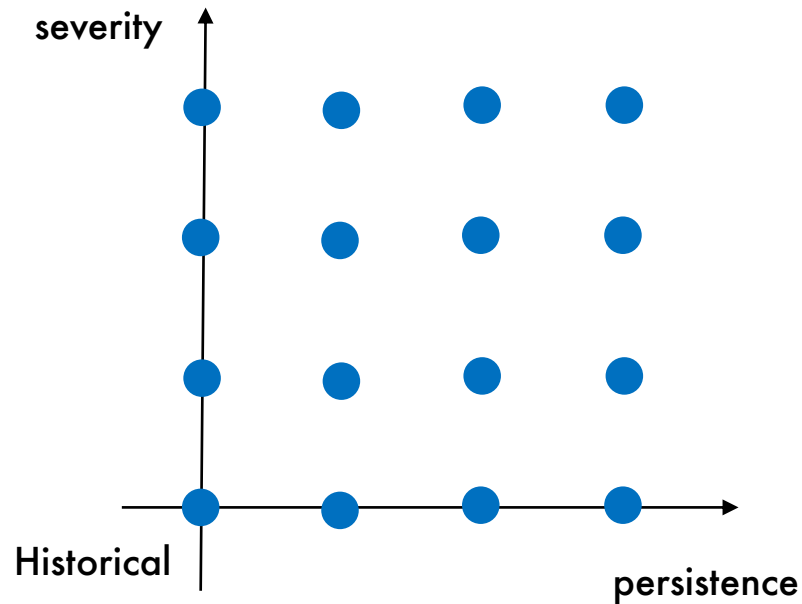
		Supply expansion literature	
		Basin level	Urban level
How does it account for	Climate and demand uncertainty	Robust across many futures	Assumption of static water availability at supply sources
		Adaptive to uncertainty in hydroclimatology in the short and long term	Neglects timing of implementation in response to hydrological signposts
	Technology and water distribution	Large scale only accommodates coarse technological assumptions and one or few options	Considers multiple technologies of different nature and varying capacity
		Neglects distributional aspects by lumping city in single demand point	Allows integration of centralized and decentralized technology to minimize distribution costs

Bridging the gap



Current and future drought scenarios

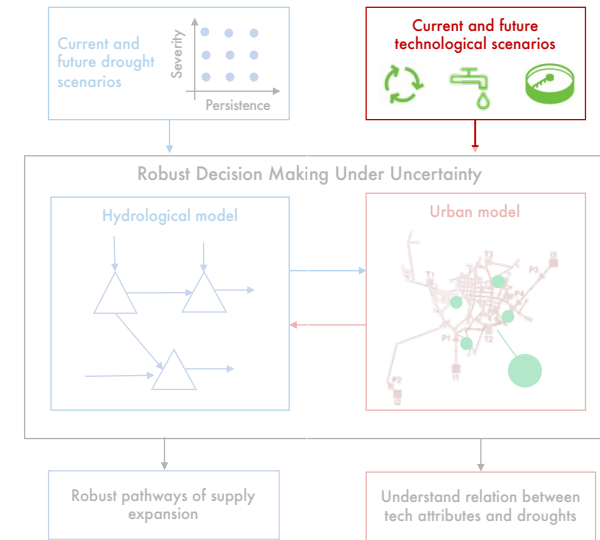
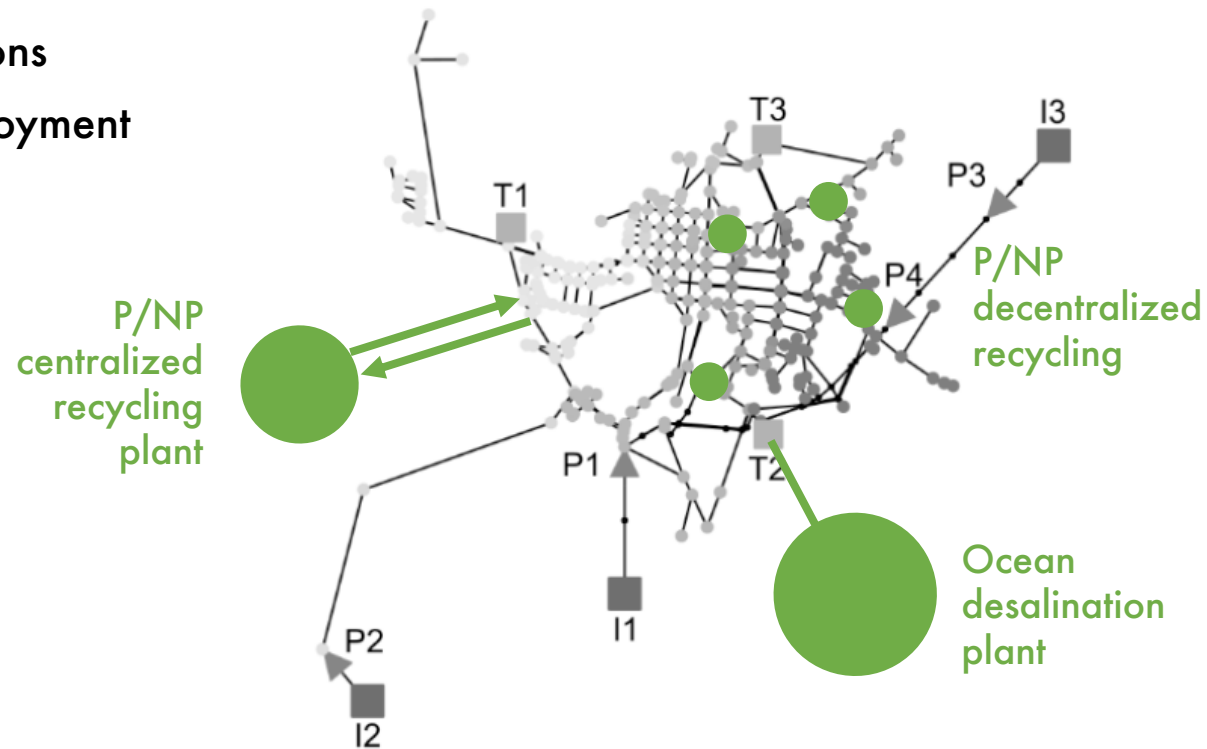
Exposure space of future hydrology generated varying drought severity and persistence.



Current and future technological scenarios

Alternative technologies are characterized by their technological attributes:

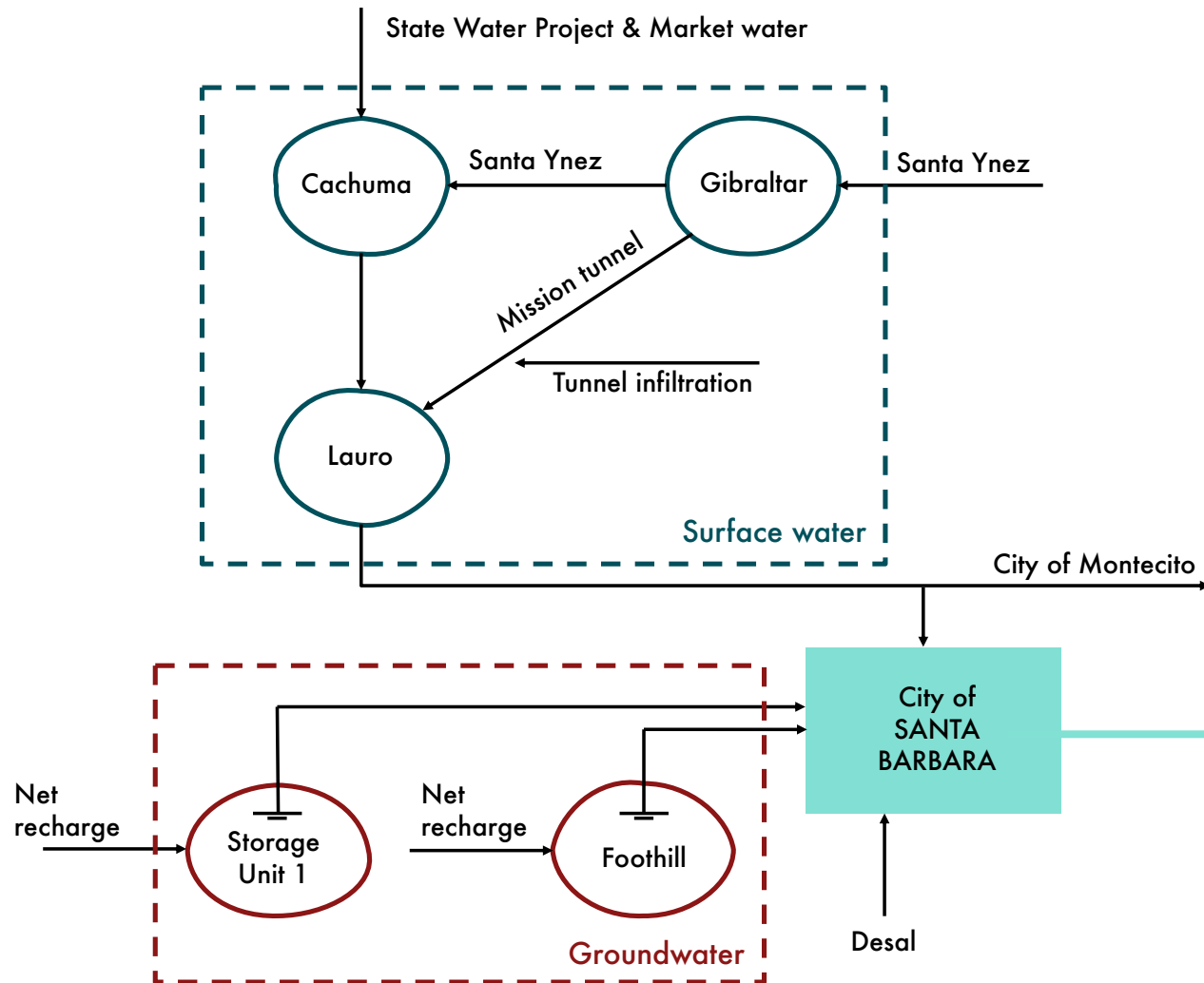
- Capacity
- CAPEX
- OPEX
- GHG emissions
- Time to deployment



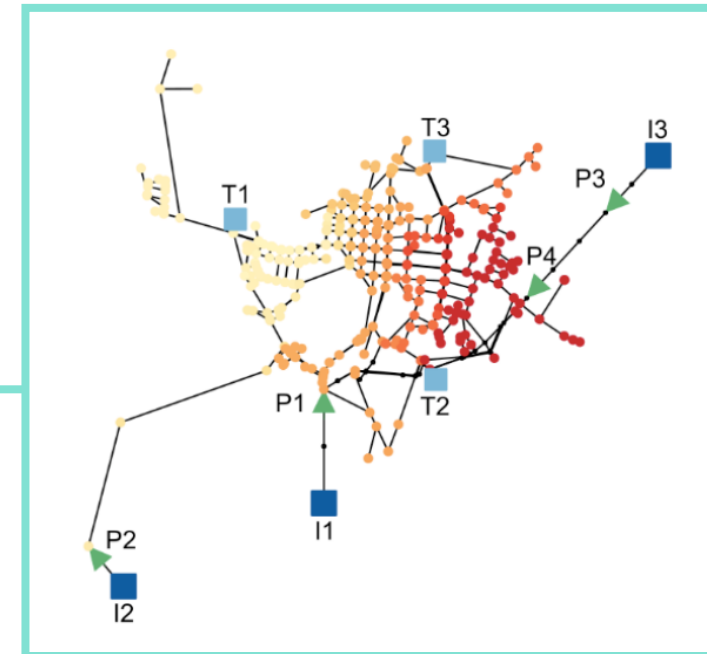
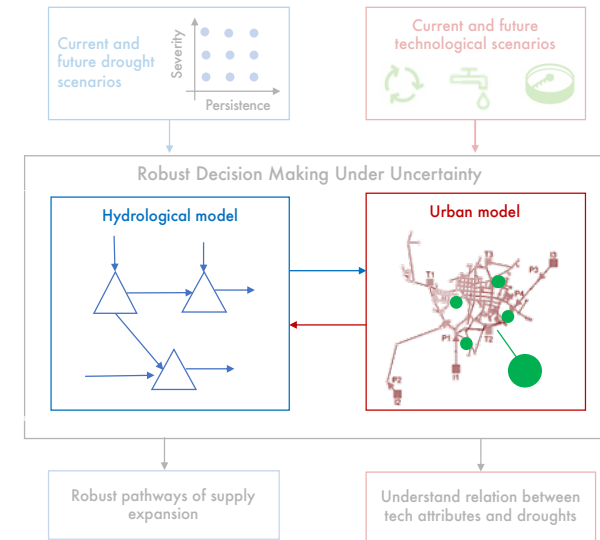
And non-technological solutions:

- Conservation policies
- Water market purchases

Multiscale model



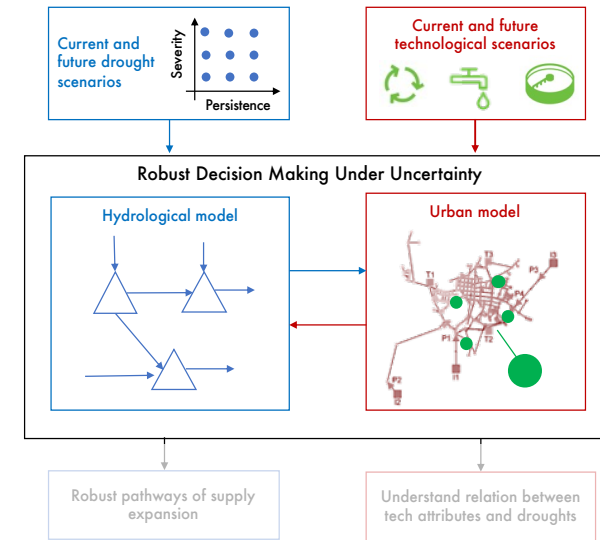
case study



Robust Optimization Framework

For each climate future (stochastically generated x1000 times):

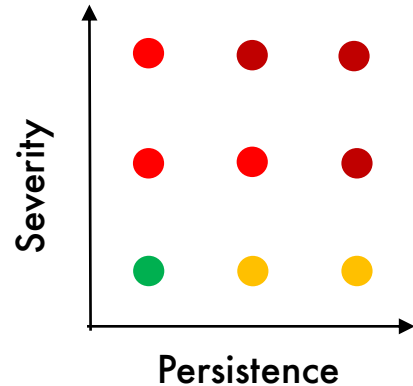
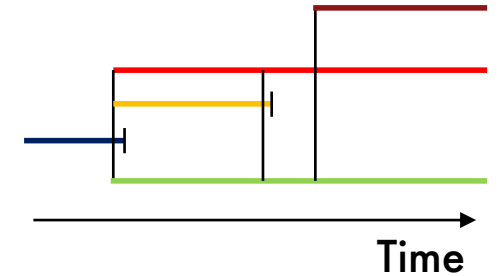
- Calculate supply failure of the core portfolio for a given drought future
- Expand the portfolio via optimization:
 - Portfolio expansion is triggered by threshold defined on low allocation.
 - Decision variables: technology nature, dimension, deployment location
 - Objectives: cost, reliability, GHG emissions
- Recompute objectives with marginally improved technological attributes of costs (capex, opex), energy consumption, modularity potential, time necessary to implement the technology.



Contribution

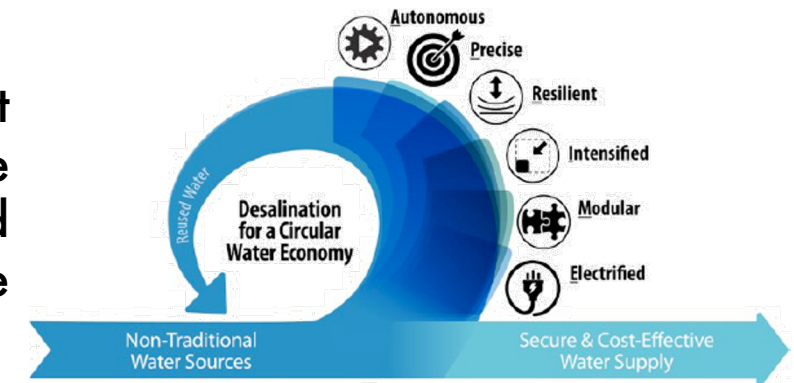
This work is at the conceptual/modeling stage, and I don't have results yet. But I expect to make the following contributions:

Define robust and adaptive pathways of portfolio expansions in many drought futures



Understand the link between technology attributes and drought characteristics (severity, duration).

Make technologically-relevant recommendations by identifying the technological advances that would most contribute to drought resilience



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