Meeting a global challenge cooperatively – facing the future of freshwater via California & Israel

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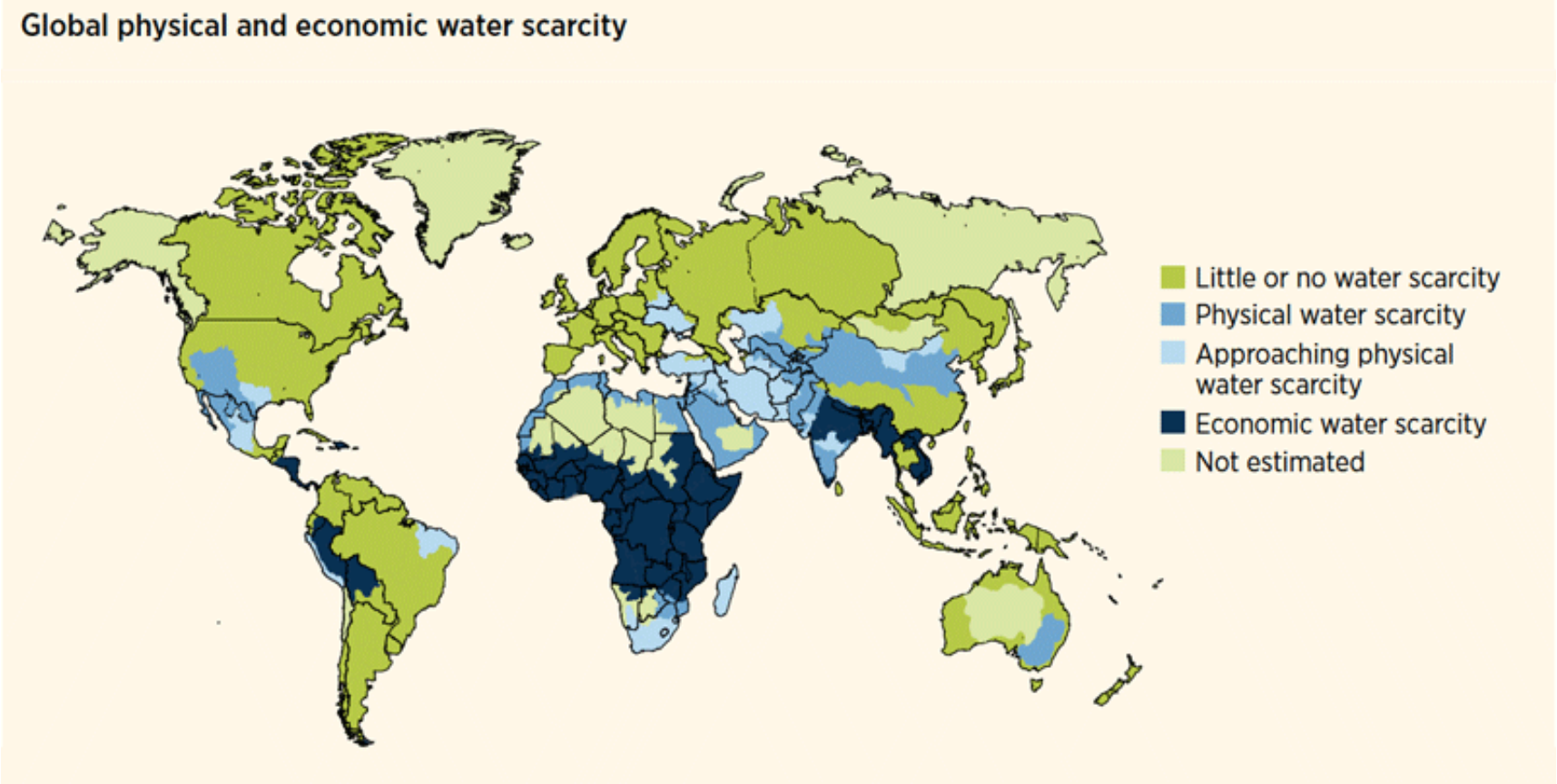
Freshwater as global challenge

- **Growing populations, budgetary constraints, aging infrastructure are straining the capacity of most nations to provide potable water and manage water systems.**
- **Climate change will exacerbate these problems: increased temperatures, changing precipitation patterns, increased concentrations of pollutants, & shifts in disease vectors will significantly impact water quality and quantity.**
- **By 2025, half of the world's population will be living in water-stressed areas (WHO, 2017), with *low-income countries* facing the greatest risk of increased water security stress (Vorosmarty *et al.,* 2010).**
- **Mitigating stressors requires flexible management practices (e.g., diversification of water provision, groundwater recharge, wastewater reuse) and *system-level consideration of feedbacks and interdependencies in the provision of resources*.**

Water stress



Water stress versus water scarcity

Water stress is when annual water supplies drop below 1,700 m^3 per person. When annual water supplies drop below 1,000 m^3 per person, the population faces water scarcity, and below 500 m^3 is termed absolute scarcity. (UN Water 2015)

A partnership – TAU and UCI

- **To better understand these challenges, and aid decision-making, TAU & UCI scholars participated in an interdisciplinary workshop on 2.2018 in California.**
- ***Grand Challenges Facing the Future of Freshwater* featured engineers, economists, biologists, earth systems scientists, political scientists. Objectives?**
  - ***Develop cross-disciplinary understanding of challenges facing California and Israel, and technical, socio-economic, and political factors influencing current management strategies.***
  - ***Assess efficacy, perceived benefits, drawbacks, and associated practices of current and contemplated future technologies and water management strategies/policies.***
  - ***Identify local, national & global lessons regarding effective technologies, management practices, institutions.***
  - ***Identify avenues for future research and educational collaboration.***

Summary of major findings

1. **Despite experiencing similar climatic drivers of water stress, the two polities have adapted different levels of conservation, recycling, and re-use due to differences in public trust, funding constraints, and management inertia.**

   - ***In Israel, decision-makers declared water provision a question of national security, incentivizing efforts to pursue wastewater reuse, desalination, high-efficiency irrigation.***

   - ***In response to its recent drought, California cut urban water usage by 24.5%, however agricultural water rights and urban water district funding schemes impede conservation.***

2. **Globally, given the low profitability of the water sector, there is low incentive to adopt water management strategies that account for shifting climate. Water is diverted, rather than re-used, and infrastructure improvements delayed (e.g., Cape Town, South Africa).**

3. **Water decision-making in the face of large-scale anthropogenic stressors requires a new paradigm of equity and flexibility. Priority should be accorded those most deeply affected by water stressors and account for long-term health and environmental impacts.**

What our partnership can achieve – bottom lines

- **Cross-disciplinary research and management approaches can address these challenges by:**
  - **Providing a deeper understanding of the multi-faceted issues facing the water sector.**
  - **Aiding understanding of factors that inhibit implementation of particular strategies.**
  - **Assisting decision-makers in pursuing sustainable pathways for water management.**

- **For example, Professors Nathaniel Mueller (UCI) and Ram Fishman (TAU) examined the relationship between adoption of modern crop varieties and health indicators in developing countries.**
  - **Their collaboration yielded additional variables for further investigation (e.g., institutional capacity, land tenure systems, local and global market pricing of crop types, and overall water quality and quantity data).**

Potential collaborative projects (1)

- ***The decline and disappearance of inland seas*** **– inland saline seas are highly productive water bodies that support local economies and serve as important cultural and recreational amenities.**
  - **Decisions to divert water from salt seas to agricultural plots has increased salinity, decreased agricultural yields, reduced biodiversity, and impacted human health – these are not isolated incidents, but a global phenomenon.**
  - **The decline of inland salt seas is also an environmental justice issue: large-scale agricultural production is promoted at the expense of the environment and human health, particularly of those in low-income communities.**
  - **The cultural, economic, and ecological importance of these salt seas is not recognized until severe degradation occurs. Following degradation, governments are unable to restore them to prior conditions.**
- **This social ecological challenge requires a multi-disciplinary understanding of water and soil quality, economic impact, land-use management, and decision-making processes and frameworks. Workshop participants developed three avenues for future collaboration:**
  - ***Comparative case analysis*** **– (e.g., Salton Sea (California), Dead Sea (Israel), Aral Sea (Kazakhstan), Lake Urmia (Iran), that details the 1) early productivity and socioeconomic dependence on these bodies of water, 2) policies that led to declining water volume and quality, and 3) the ecological and human health impacts.**
  - ***Global mapping of inland seas*** **– Satellite data can be used to map changes in productivity and size of salt seas at a global scale and combined with other data to associate decline in seas with irrigation upstream of them.**

Dead Sea

Salton Sea

Potential collaborative projects (2)

- ***Living within planetary boundaries: nitrates and water*** **- Humans have doubled the amount of fixed nitrogen through point and non-point fertilizer pollution resulting in high levels of eutrophication. Global biogeochemical flows have crossed a "tipping point" (Steffen *et al.* 2015).**
  - **The process of removing nitrate from water is expensive, energy intensive, and complex, requiring multiple levels of treatment technologies.**
  - **The contamination is seasonal, reducing the incentive of underfunded, low-population water systems to implement treatment technologies and strategies.**
  - **In rural and low-income areas, widespread fertilizer use, thus, poses as a threat to fisheries, crop production, ecological resources, and water supply.**
- **To broaden understanding of nitrogen uptake and examining sources of high pollution, participants developed two possible avenues for future collaborative work:**
  - ***Modeling nitrogen uptake and concentrations*** **– calculations of nitrogen uptake in streams can be overlaid with data on fertilizer usage to predict where nitrogen will be concentrated at the watershed level.**
  - ***Cost-benefit analysis of treatment*****– Drip surface irrigation farming practices in Israel may be an effective way of limiting run-off. Calculating costs and benefits of the treatment component can demonstrate financial feasibility elsewhere.**

Conclusions – adaptability as acceptability

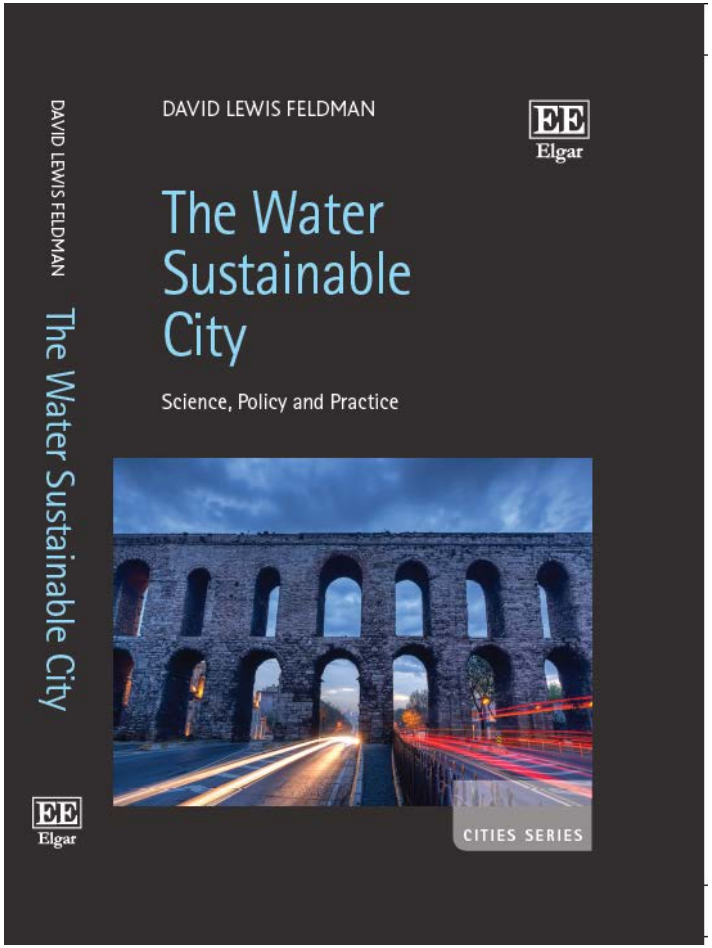
- **The future of freshwater management is tied to energy, food, and ecological well-being – the *water-energy-food-nexus*.**
- **There may be no "best" options from which to choose – instead we should seek the most *adaptive* solutions. Those that:**
  - **Have a *low probability of failure* – rely on flexible, multi-pronged solutions.**
  - **Generate fewer *negative consequences* that are costly to mitigate.**
  - ***Conserve resources* for renewal and innovation – a "no regrets" approach.**
  - ***Incorporate lessons* from previous experiences and failures.**

***"Prediction is difficult, especially when dealing with the future"* – Danish Proverb**

TAU-UCI grand challenges in freshwater workshop participants

Dr. Dave Feldman **UCI, Urban Planning & Public Policy**
Dr. Tim Bradley **UCI, Biological Sciences**
Dr. Stanley Grant **UCI, Engineering**
Dr. Nathaniel Mueller **UCI, Earth System Science**
Dr. Ram Fishman **Tel Aviv University, Social Sciences**
Dr. Maura Allaire **UCI, Urban Planning & Public Policy**
Dr. Hadas Mamane **Tel Aviv University, Engineering**
Dr. Dror Avisar **Tel Aviv University, Engineering**

Thank you



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