



Discussion

The value of extreme events: What doesn't exterminate your water system makes it more resilient

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ABSTRACT

Problems have a high rank in decision making when they are both *urgent* and *important*. Accordingly, water has not earned the attention it deserves in public policy agenda because under normal circumstances it is not viewed as an *urgent* matter in the eyes of the public and politicians. By creating a sense of urgency, extreme events such as droughts, floods, conflicts, and migrations can create opportunities for implementing some essential policy reforms that would be politically costly otherwise. So, despite their high short-term costs, extreme natural and societal events have the potential to increase the resilience of water systems in the long run. It is argued here that the societal and political sense of urgency about water must be promoted through public outreach and information dissemination. Otherwise, for useful reforms and long-term improvements, we will rely on costly and risky extreme events that sometimes have the potential to fully collapse the human-natural system-of-systems.

1. Addressing water bankruptcy

The global water system is bankrupt with water consumption already exceeding the accessible renewable water, leading to the over-draft of non-renewable water resources and ecosystem damages in many parts of the world. Addressing water bankruptcy requires investment in both mitigation and adaptation. The former normally involves efforts that seek to increase the volume of accessible water or cutting demand through technologic (hard) and sometimes policy (soft) solutions within the boundaries of water systems. The latter, on the other hand, involves efforts that are of soft nature and typically out of the authority of water resource managers. This type of policy and planning efforts appreciate the nexus of water systems with other systems such as food, energy, economy, society, and politics.

Example mitigation measures include water storage and diversion, desalination, wastewater recycling, water conservation technology invention, developing drought-resistant crops, improving irrigation efficiency, raising water prices and removing subsidies, as well as metering and quota enforcement. Most, if not all, of these measures have been already proven to be unsustainable when implemented without considering their long-term impacts and feedbacks (see Bahaddin et al. (2018) and Mirchi et al. (2012) for a review of some common long-term and unintended consequences of shortsighted water management solutions).

Adaptation solutions, however, are supposed to be based on a more comprehensive understanding and appreciation of the complexity of human-natural system-of-systems (Fig. 1). Adaptation measures do consider the problems of water sector as products of the complex inter-related dynamics of a system-of-systems involving human and nature. Example adaptation measures include national and regional development plan reforms to make them less water-dependant, economic diversification and decoupling economic growth or political economy from water, introduction of alternative jobs and livelihoods to farming, increased water allocation to ecosystem, revision of food security policies and changing crop patterns, altering food trade strategies, and land use amendments.

2. Mitigation or adaptation?

Improving the resilience of water systems is realized through boosting their capacity for 1) preparation for, 2) absorption of, 3) recovering from, and 4) adapting to human-natural perturbations. Thus, mitigation and adaptation solutions must be co-employed in a complementary manner based on a portfolio-approach for achieving resilient water systems. Nevertheless, within the existing water and environmental management paradigms, the decision makers are mainly concentrated on selective mitigation efforts for recovery (in reaction to perturbations) and to some extent preparation and absorption

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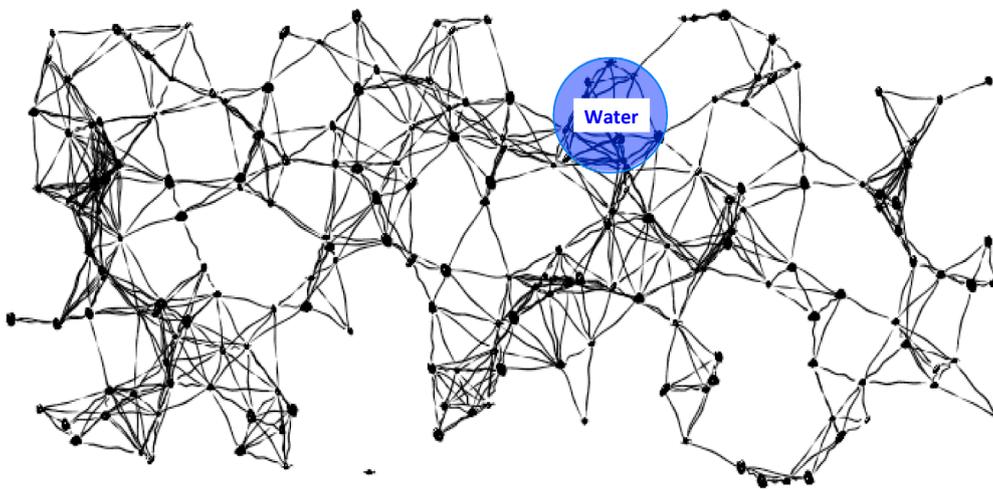


Fig. 1. A conceptual position of the water sector (system) within a complex human-natural system-of-systems. Mitigation solutions are normally implemented by policy makers within the boundaries of water management systems. Adaptation solutions consider the complexity of a larger system-of-systems and the nexus of water system with other components. Implementation of adaptation solutions requires a higher level of authority.

(proactively based on stationary assumptions).

Decision makers dealing with water systems rarely pursue adaptation strategies. This is because they usually suffer from the lack of proper understanding of the complex and non-stationary dynamics (Ristic and Madani, 2019) of human-natural system-of-systems and are often not authorized to implement changes that involve multiple sectors. More importantly, effective adaptation solutions have considerable socio-economic and political costs in the short run. So, they are less appealing to the politicians involved in popularity contests that are mainly concerned with maximizing the short-term monetary gains of the public rather than investing in efforts and reforms that are unpleasant in the short run, but effectively contribute to the long-term sustainability of human-ecological systems.

3. Importance versus urgency

For a problem to be of top priority in the decision-making agenda, it should be both *urgent* and *important* (Fig. 2). No matter how much we care about water as water users and experts, water is currently a non-urgent topic from a public policy standpoint. Even its level of importance to the high-level decision makers under normal circumstances is disputed when compared with other issues such as economy, employment, defence, foreign policy, energy, transportation, food, health, public infrastructure, and citizen satisfaction.

Water is indeed a small component of complex human-natural system-of-systems (Fig. 3). A politician with inadequate resources and the goal of remaining popular for maintaining power or getting re-elected (Bruce and Madani, 2015) is more interested in taking actions in relation to sectors that matter the most to the public during her/his limited tenure. While citizens generally assign some value to the state of the environment, sustainable development, and respecting the rights of future generations, issues such as economy, employment, housing, health, politics, and quality of public services/infrastructure have higher weights in their utility function. Thus, even if considered to be *important*, ‘rational’ policy makers do not naturally dedicate much attention, efforts, and resources to water unless it turns into an *urgent* issue under special circumstances, such as: when water shortage results in job losses, major economic damages to farmers and even migration (e.g. Australia, Iran, and California); when water unavailability has potential to create public anger and health risks (e.g. Flint and Cape Town); and when an upstream country uses water as a potential weapon to threaten downstream national security and limits the flow of a trans-boundary river (e.g., Nile, Mekong, Tigris-Euphrates, Indus, and Jordan river systems.)

4. The value of extremes

Extreme water and societal events such as droughts, floods, water outage, terrorist attacks to water infrastructure, water allocation conflicts, and water-borne disease outbreaks are always expected to occur, but their time, frequency, and magnitude of occurrence are hard to predict accurately. They are always costly (economically and politically) and can sometimes get out of control (e.g., it is believed that droughts functioned as a catalyst to the Syrian internal war). Nevertheless, they have the power to turn water into an *urgent* matter during their time of occurrence and in a limited time window afterwards.

Once the society finds it both *urgent* and *important*, water earns a high priority in the public policy agenda and a window of opportunity for reactive interventions opens up. In this situation, the potential political cost of public dissatisfaction with no action (business as usual) increases while the political cost of policy reforms drops and the economic cost of reactive interventions becomes justifiable. For example, the 2011–2017 California drought provided an invaluable opportunity window to justify and implement some major reforms that were politically costly otherwise, such as the new legislation on regulating and monitoring groundwater in 2014 (mitigation measure) and the Governor’s Executive Order B-29 on a state-wide 25% reduction in potable urban water in 2015 (adaptation measure). As another

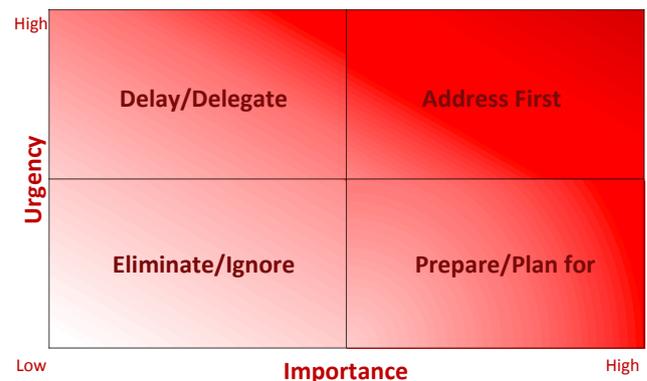


Fig. 2. According to the Urgent-Important Matrix or the Eisenhower Matrix (Box) one must 1) address first (immediately) what is both important and urgent; 2) plan to take action on what is important but not urgent; 3) delay and push back (and when possible delegate) what is urgent but unimportant; and 4) eliminate and ignore what is non-urgent and unimportant. Water is generally (under normal circumstances) perceived by the general public and policy makers as a non-urgent issue and its level of importance varies by regions and countries based on local natural and socio-economic conditions.

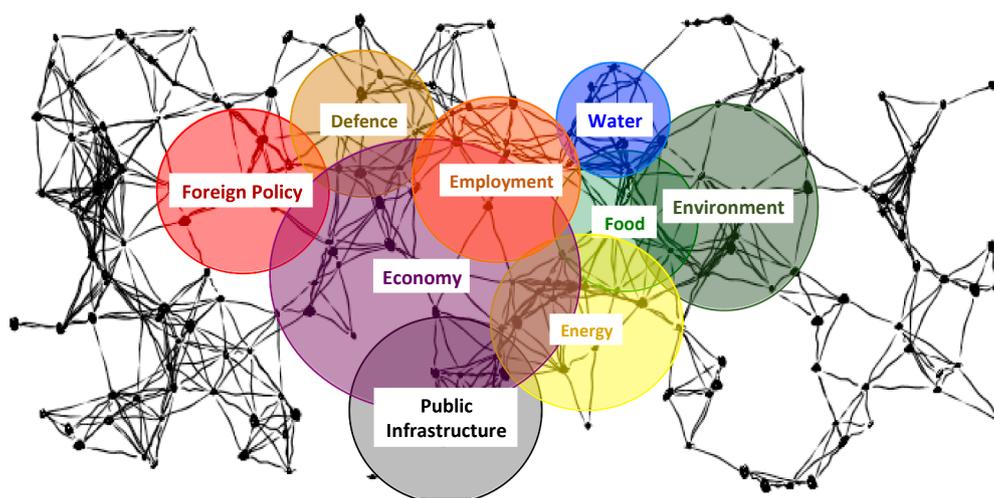


Fig. 3. Conceptual positions of various (example) sectors within a complex human-natural system-of-systems, involving water. Water is, indeed, a relatively small component of a large system-of-systems and is not of top priority in public policy under normal circumstances.

example, the Australia's Millennium drought justified the implementation of a range of costly (both economically and politically) reactive mitigation and adaptation measures. Similarly, the socio-political fear of "Day Zero" and the risk of earning the infamous title of the world's first major city to run out of water justified unprecedented water use restrictions (mainly mitigation strategies) in Cape Town in 2018 with lasting impacts on the city's water consumption pattern.

5. Information and education

Water problems are developed gradually and are mostly invisible to the general public. By the time they are noted by the society and politicians (e.g. under extreme events or after a major ecosystem damage), emotional and populist reactive measures and mitigation solutions are more likely as at that time it is usually too late to implement proactive fundamental reforms and adaptation measures. Once the window of intervention opportunity is closed as a result of public distraction to other important and urgent societal, economic, and political matters, effective interventions lose political attraction. In cases when the intervention opportunity period is long (e.g., during a multi-year drought instead of a major 2-day flood event), the implementation of adaptive measures is likely, but they will still be based on a reactive mode. Frequent extremes also result in the extension of the opportunity window, refreshing of public memory, and persistence of the urgency level, leading to useful interventions (e.g. the frequency of major flood events is recognized as one of the main drivers of advancements in flood management by the Dutch).

Achieving resilience through proactive mitigation and adaptation actions independent of extreme events requires stimulating the societal sense of *importance* and *urgency* of water. This can be done through education, raising awareness, close interactions with the society, public outreach, and citizen engagement (Hjorth and Madani, 2014). A water-informed society has less dependency on reactive reforms and is not in need of extreme events to improve the efficiency of its water management system. Such a society assigns a higher priority to water, questions the past water actions and future water plans of its leaders, and reduces the political cost of interventions in the water sector, in turn, forcing its policy makers to take meaningful water actions.

6. Final remarks

Building resilient human-natural system-of-systems and addressing the water bankruptcy problems around the world requires reactive and proactive implementation of a portfolio of mitigation and adaptation

solutions. Yet, water does not have a high priority in public policy agenda in the absence of societal and political sense of urgency about water. As a result, the existing water management paradigms mainly promote reactive mitigation solutions within the boundaries of water resource systems as opposed to proactive adaptation solutions that have a larger impact domain in complex human-natural system-of-systems.

Whether natural or man-made, a crisis, extreme event, or disaster can create invaluable opportunities to improve the resilience of coupled human-natural system-of-systems as long as the system under control does not completely collapse. Extreme events can create a sense of urgency about water and pave the way for the implementation of solutions that are politically and economically daunting otherwise. Nevertheless, extreme event-dependent interventions are mostly of reactive and mitigation types. In addition, the risk of the complete collapse of the system or socio-natural regime changes (as in the cases of Aral Sea or Lake Urmia desiccation or the drought-relevant security crisis and mass migration in Syria) makes this type of interventions highly unreliable and risky.

Proactive development of resilient human-natural systems can be pursued by promotion and maintenance of the public and political sense of urgency. A water-informed society assigns a high priority to water issues, rewards meaningful water-related interventions, and is harder to manipulate by politics (see a real world experience reported in Madani (2018, 2019) and Stone (2018)). This is of particular importance for academicians, who are institutionally incentivized to and normally take more pride in communicating their findings to the policy makers rather than the general public. This is due to the overlooked power of public opinion and its role in changing the behavior of politicians. Academics and experts need to believe in the fact that the common narrative of the society about the issues that matter the most and the general public's serious expression of concern about the issues that they find *urgent* and *important* can result in interventions and reforms even in autocracies.

Declaration of Competing Interest

The author declares no conflict of interest.

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