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Key Points:
- The Urban Water Innovation Network sets the context for national scale case studies of stakeholder-scientist interactions across 5 U.S. regions
- Stakeholders consider climate change impacts, water quality impairments, and aging infrastructure to be the greatest challenges to sustainability
- Innovative solutions addressing limited public awareness/support for water management and communication with decision makers are most desired across sites

Supporting Information:
- Supporting Information S1
- Data Set S1
- Data Set S2

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A Stakeholder-Science Based Approach Using the National Urban Water Innovation Network as a Test Bed for Understanding Urban Water Sustainability Challenges in the U.S.

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Abstract Urban water systems across the United States are struggling to adapt to an evolving set of threats. Understanding specific pressures and the regional responses to those pressures requires input from practitioners with knowledge of sociotechnological aspects of urban water systems. The Urban Water Innovation Network (UWIN), a consortium of academic institutions and partners supported by the National Science Foundation Sustainability Research Network program, provides a unique opportunity to engage stakeholder and research communities across the U.S. Interactions between UWIN researchers and water stakeholders from five regions (Southeast Florida, Sun Corridor, Mid-Atlantic, Pacific Northwest, and Front Range) form the basis for case studies on transitions toward sustainability. Analysis of qualitative data on pressures, states, and responses collected during interactions provides insight into the challenging context of urban water management. Top pressures identified include climate change, aging infrastructure, water quality impairments, and funding limitations. Additionally, stakeholders described resistance to change and short-term perspectives among elected officials, limited understanding/awareness of water systems among decision makers, and lack of leadership on water issues as contributing to pressures. More than technological solutions, practitioners call for improved coordination in water management, strengthened communication with elected officials, and behavioral change among citizens. Regarding stakeholder-scientist interactions, participants sought practical outcomes, such as the organization of seemingly abundant scientific products into usable products. The utility of the pressure-state-response model as a framework for data collection and analysis in the context of understanding transitions toward urban water sustainability is discussed and recommendations for future studies are presented.

1. Introduction

1.1. Key Urban Water Challenges

More than 80% of the population of the United States resides in urban areas (U.S. Census Bureau, 2012). The continued growth and prosperity of the country's cities, the health and well-being of urban populations, and the healthy functioning of ecosystems within and surrounding urban areas are dependent upon reliable and clean water resources. However, urban water management systems are struggling to adapt to evolving threats, which, in addition to population growth, include climate change impacts, emerging contaminants, increasing competition in demands for resources, and declining water infrastructure (Loucks, 2005; McDonald et al., 2011; Niemczynowicz, 1999; ASCE, 2017). Dynamic regulatory environments and resource constraints further contribute to the challenges facing water managers across the country. With the trend toward more urbanization, adapting to pressures by incorporating advances in science and technology along with new approaches in water governance and policy will be critical (U.S. Census Bureau, 2012). These types of transitions require new ways of thinking about and using water (Pahl-Wostl, 2009; Postel, 2003).

In the U.S., urban water management systems have been described as fragmented, overly technical, wasteful, and highly dependent upon linear approaches (Brown & Farrelly, 2009a, 2009b; Farrelly & Brown, 2011;

Rauch et al., 2005). Stove piping (i.e., separate management of drinking water, storm water, and wastewater) within the urban water management sector extends to broader urban planning processes where water resources and urban growth management have been traditionally approached as distinct spheres despite the obvious connections. In fact, the 2017 American Society of Civil Engineers Infrastructure Report Card rated the country's drinking water infrastructure as a D and the wastewater infrastructure as a D+ (ASCE, 2017). Within this context, water managers are confronting degradation of water quality, chronic water shortages, loss of ecosystem services, damage to natural resources, and declining quality of life in many urban areas. Though most urban water systems serve their original intended purposes of keeping our cities healthy, safe, and livable, the socioecological impact has been significant.

Until recently, traditional centralized engineered approaches were acceptable, affordable, even best practice. However, pressures to protect ecosystems, green cities, improve equity, lower costs, and mitigate hazards have inspired new ways of managing water that follow a more integrated and regenerative "make-use-return" paradigm as opposed to the linear "take-make-waste" paradigm common to modern cities (Gleick, 2003). The goal of this integrated approach, which has sometimes been referred to as One Water, and what we generally refer to as integrated urban water management, is to deliver high levels of water services at lower cost to the triple bottom line (social, environmental, economic), while providing cobenefits to linked human and natural systems (Paulson et al., 2017). One Water approaches are based on thinking that all water has value and should be managed sustainably, inclusively, and in an integrated way, from the start of the watershed through to the various end uses (U.S. Water Alliance, 2016). Proponents of One Water apply a holistic view, which brings in other sectors, such as transportation, health, and energy, to the planning and management of wastewater, drinking water, and storm water resources (International Water Association, 2017; Mukheibir et al., 2014).

The desire to integrate related social, ecological, and infrastructural domains, in some cases, may signal the need to move away from prior siloed management approaches toward decentralized, high-performance treatment technologies and distributed storm water management systems. However, despite increasing interest in improving the productivity of water, examples of implementation of more holistic approaches remain limited and progress toward sustainable integrated urban water management has been slow (Brown et al., 2009; Farrelly & Brown, 2011; U.S. Water Alliance, 2016). Past studies have shown both the adoption of new technologies and transitions to new and different paradigms of governance to be complex undertakings for water systems historically resistant to change (Brown, 2008; De Graaf, 2009; van de Meene et al., 2011; Hornberger et al., 2015). The research presented draws on existing studies of sociotechnical transitions to better understand ongoing transitions to sustainable integrated urban water management approaches across five UWIN case-study regions.

1.2. Background

The sociotechnical transition studies literature provides useful perspective on specific social, institutional, and political mechanisms behind how societies undergo transitions to sustainability (Chini et al., 2017; Geels, 2002; Geels & Schot, 2007; Lawhon & Murphy, 2011). Many researchers apply the multilevel perspective (MLP) to describe sociotechnical transitions, which ranges across scales from niche, to regime, to landscape, and includes multiple actors (Geels, 2002; Geels & Schot, 2007; Lawhon & Murphy, 2011). In this perspective, technological niches represent the microlevel where innovations form and diffuse, landscapes are the broader social and institutional framework where potential changes occur, and regimes are the "existing sociotechnical pattern throughout society" providing the setting where research and policy exchanges occur (Chini et al., 2017; Geels & Schot, 2007, p. 105). Transitions occur through interactions between processes across the three levels: "(a) niche-innovations build up internal momentum, through learning processes, price/performance improvements, and support from powerful groups, (b) changes at the landscape level create pressure on the regime, and (c) destabilization of the regime creates windows of opportunity for niche-innovations," (Geels & Schot, 2007, p. 400). According to the MLP, regime stability is maintained as long as actors are in agreement or until there is a shift in pressure on the regime. However, when pressures from internal or external forces or tensions among actors increase, the system stability can falter making it open to technological innovations (van de Poel, 2000). Processes of change usually occur slowly, over extended periods, and can either emerge organically or can be managed more purposively through transition management approaches (Loorbach, 2007; Rotmans et al., 2001). A number of common pathways that transitions have historically taken have been identified, however transitions to new socio-technical regimes are not prescriptive nor guaranteed (Geels & Schot, 2007).

Much of the existing research on transitions to urban water sustainability, specifically, has focused on water systems outside of the U.S. (Bettini et al., 2015; Bos et al., 2015; Brown & Farrelly, 2009a, 2009b; Geels, 2002; Mees et al., 2013; Mukheibir & Currie, 2016; Ottens et al., 2006). These works have identified barriers to transitions, which include the absence of strong models for sustainability governance, absence of communication about technologies, and limited understanding of links between specific context and technology (Kemp et al., 2005; Mees et al., 2013). For example, Mees et al. (2013) point out that few studies investigate relationships between specific technology and site, despite recognition of the role of case specific context to the adoption of technology in society. Others describe characteristics of technologies that might dictate whether or not they are adopted in society, including the degree of harmony with the existing system and the ability to demonstrate clear benefits of the technology (Skambraks et al., 2017). In the U.S., researchers have only more recently been looking at how to facilitate transitions toward the implementation of One Water approaches (Chini et al., 2017; Grigg et al., 2018; Kiparsky et al., 2013). For example, Chini et al. (2017) proposed a framework for analysis of policy, implementation, and evaluation of green storm water management strategies and applied it across 27 U.S. cities through investigation of public documents. Their findings suggest that well-defined system boundaries, effective communication with community members, and strategies for system maintenance and evaluation are critical to learning about the technology (Chini et al., 2017). In order to further our understanding of the mechanisms influencing transitions, more research linking social, environmental, and technological aspects of transitions to integrated One Water approaches among U.S. water systems is needed. Specifically, research that integrates perspectives of water stakeholders and expert practitioners might be particularly useful in this endeavor.

1.3. Case Studies

The purpose of this paper is to share observations and insights from five case studies conducted within the context of the Urban Water Innovations Network (UWIN), Southeast Florida (SEFL), the Sun Corridor in Arizona, Baltimore Mid-Atlantic, the Pacific Northwest, and the Front Range in Colorado (Figure 1). The case studies presented further our understanding of the landscape within which efforts toward transitions in urban water management, like those toward One Water concepts or integrated urban water management, are occurring (U.S. Water Alliance, 2016).

The UWIN, a consortium of 14 academic institutions and key partners, was formed in 2015 with support through a cooperative agreement from the National Science Foundation. As a Sustainability Research Network, the UWIN is focused on forging the collaborations among researchers, resource managers, and policymakers that are essential to addressing the core challenges inherent to complex urban water systems. The UWIN mission is to advance fundamental knowledge and build capacity for technological and behavioral solutions that promote sustainable urban water systems. Stakeholder engagement, a central component of the UWIN mission, is achieved through collaborative participatory research, focus-group workshops, and participation in interviews and surveys (Bernard & Gravlee, 2014; Kahan, 2001).

Figure 1. Map of UWIN case-study sites, study regions and institutions (in this figure, Los Angeles is also included as a case-study region, however it was not included in the first year of stakeholder research).

The UWIN stakeholder engagement strategy has two main aims, to foster the development of a researcher-practitioner network for knowledge exchange, and to ensure that the research conducted through UWIN is relevant to practitioners and researchers alike. These aims fit within the greater science policy context connecting research and practitioner communities (Cash et al., 2003; Gibbons et al., 2008; Rayner, 2006; Reed, 2008; Reed et al., 2009). As a result of both the recognition of the complexity of socioenvironmental challenges and expanded science policy mandates to create useable science, stakeholders, and scientists are increasingly interacting. Water stakeholders engage in research endeavors to learn, to build networks, and to push for the development of research products that are salient and relevant to their needs (Cash et al., 2003; Sarewitz, 2007). Researchers engage to identify and unpack drivers of socioenvironmental problems and to build research programs that are based on stakeholders' needs, broadening the impacts of their research (Pennell et al., 2013). The partnerships that result from scientist-stakeholder engagements can provide avenues for exchange of services between the different communities, and support stakeholders who are eager for mechanisms to address challenges, but lacking the resources to devote to their identification. When conducted thoughtfully, even the process of engaging itself has been shown to be a useful product of science-stakeholder interactions (Reed, 2008; Ziervogel & Downing, 2004). The relationships and networks that result from interactions have the potential to serve as conduits for technology and knowledge exchange and innovation diffusion, and provide opportunities for interdisciplinary participatory research (Bernard & Gravlee, 2014).

Though interactions between stakeholder and research communities are occurring more frequently, most studies report on results from individual case studies, missing opportunities to contribute to theoretical developments. Multisite interactions, or case studies, using uniform design and systematic collection/analysis of data, are needed to move theory on transitions to urban water sustainability forward (Eisenhardt, 1989; Hine, 2007). To help fill this gap, our stakeholder-science engagement strategy for 2016, the first year of UWIN efforts, centered around multisite workshops across five case-study regions. The meetings focused on building a network between Stakeholder Advisory Committee (SAC) members and UWIN researchers, collecting data on urban water systems issues and concerns, and obtaining feedback to align UWIN research with stakeholder interests and needs. The participatory case-study approach was selected to collect empirical descriptions of different water-related phenomenon that emphasize the complex, real-world context in which they occur (Bernard & Gravlee, 2014; Eisenhardt, 1989). The design of scientist-stakeholder interactions in each site was informed by prior research showing the importance of inclusion of multiple varied stakeholder views/values, early project involvement, and insurance of influence on project design in the coproduction of knowledge (Dilling & Lemos, 2011; Hage et al., 2010; Reed et al., 2009). Where the participatory research conducted in each case study can serve as a distinct sort of experiment, selecting multiple cases provided opportunity for replication, comparison, and extension of theoretical construct (Yin, 2009).

2. Methods

2.1. Research Framework

An inductive participatory research approach based on collection of qualitative data from expert water practitioners was applied to understand grand challenges to sustainability of urban water systems (Blaikie, 2000). Applied across case studies, research questions were designed to gather information from practitioners on seven areas: strengths of system, threats to system, problems posed by urban water system, successes, solutions not yet implemented, impediments to those solutions, and needs for research. These questions were intended to improve researchers' understanding of the context where regional water decisions are being made and to help UWIN efforts to develop usable science, an intended product of interactions. Usable or actionable science provides the best available science to meet the needs of decision makers. The critical nature of context to the development of usable science has been described by many researchers and stakeholder engagement in participatory research is suggested as a path toward building an understanding of context (Dilling & Lemos, 2011; Feldman et al., 2008; Glantz, 1994; Hage et al., 2010; Kirchhoff et al., 2013).

Data collection and analysis, were guided by the pressure-state-response (P-S-R) framework, a conceptual model that is useful for studying human-environment interactions (Figure 2) (Gentile et al., 2001). In its original conception, the P-S-R framework was designed to develop indicators to assess anthropogenic pressures on the environment, systems' states, and societal responses to pressures, including feedbacks (OECD, 1993). The P-S-R model was selected as a framework for the research presented for a number of reasons. First, the utility of the model to help decision makers think about causes and effects of environmental stressors and effective responses has been demonstrated (Sikdar et al., 2004). Second, the P-S-R framework provided a simplified model for qualitative data collection/analysis that could inform this and other areas of UWIN research, including a project focused on the development of a broad set of indicators for progress toward One Water solutions. Finally, the P-S-R framework is useful for guiding discussions around and thinking about transitions because its components, pressures on urban water systems, the states of the systems, and

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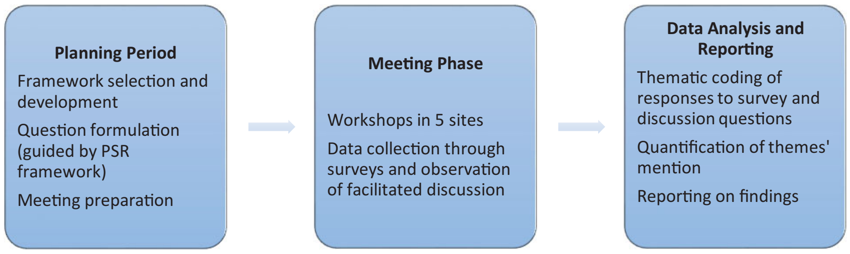

Figure 2. UWIN Stakeholder-based participatory research approach.

responses underway, offer direct insights into notions of regime condition, social and technological factors characterizing the landscape of urban water systems, and the technological responses being considered. Thus, using the P-S-R framework helped us to structure discussions and analysis of qualitative data, providing the depth and breadth we were seeking and informing our analysis of ongoing transitions.

2.2. Stakeholder Engagement Processes

The UWIN research team, referred to as the stakeholder engagement team (SET), consisted of the stakeholder engagement director lead principal investigator (PI), stakeholder engagement co-PI, UWIN lead PI, UWIN co-PI, and meeting facilitator. This core team planned and attended all regional meetings along with the respective research teams from each of the host urban areas. The traveling SET planned and facilitated all meetings to ensure uniform meeting structure and data collection for comparative purposes across regions.

During the planning phase, the SET worked with regional engagement leaders in each region to identify 6–10 water thought leaders from their region to serve as the Stakeholder Advisory Committee (SAC). Thought leaders can be described as intellectual leaders who have tapped into societal trends and who work to address society's concerns by developing novel points of view that may break with or challenge conventional thinking (van Halderen & Kettler-Paddock, 2011). Balanced representation was sought across the following water-related sectors: water supply/watershed, drinking water, wastewater, storm water, streams, linked systems, and institutions/equity, with primary representation from city, county, and state governments (Table 1). Members of the SACs were contacted by phone and email and invited to participate in one full day meeting in their regions.

Table 1
Sectors and Categories of Stakeholder Representation on Stakeholder Advisory Committees

Sector	Categories
Water Supply/Watershed	Water Scarcity
	Water Supply Self Sufficiency
	Nonrenewable Groundwater Degradation
	Drought Hazard
Drinking Water	Drinking Water Quality
	Drinking Water Treatment Facilities
	Drinking Water Pipeline/Delivery Infrastructure
Wastewater	Wastewater Treatment/Sanitation/Sewer Quality
	Wastewater Treatment/Sanitation/Sewer Plants
	Wastewater Collection Systems
	WWTP Nutrient Recovery Capacity
	Combined/Sanitary Sewer Overflows
	Industrial Waste
Storm water	Flood Hazard
	Water Quality
	Anthropogenic Hydrologic/Hydraulic Alteration
	Ecosystem Services
Reclaimed Water	Water Scarcity
	Water Supply Self Sufficiency
	Aquifer storage and Recovery
Streams	Surface Water Quality
	Stability and natural conditions
	Environmental Flows
Linked Systems	Heat Island Effects
	Heat Related Illness
	Heat Related Deaths
	Greenhouse Gas (GHG) Emissions
	Energy Use
Institutions/Equity	Social Environmental Equity
	Management Capacity
	Financial Capacity
	Adaptation Capacity
	Urban Water Sustainability Programs

2.3. Regional Workshops

Each of the five workshops convened regional water stakeholders, SAC members, SET members, and local scientists for a full day meeting in a neutral location. The workshop agenda allowed the UWIN project to be introduced, included a facilitated brainstorming activity, and provided time to collectively think about how UWIN research could assist the region. The facilitated brainstorming activity was designed to maximize opportunities for thought-provoking discussion among participants and the collection of qualitative data. The question framing the activity was composed of six parts: What are the most serious threats to those systems? What are the key strengths of the region's water, wastewater, and storm water systems? What major economic, social, or ecological problems, are caused by those systems? What approaches have already been successful in addressing threats and impacts? What possible solutions not being widely tried deserve a closer look? What are the major impediments to implementing solutions? The foci of these questions are conceptualized in the

P-S-R framework in that threats are represented by pressures, strengths and problems are represented by state of the system, efforts and solutions by responses, and impediments by barriers.

2.4. Data Collection and Analysis

Preworkshop and postworkshop surveys, participant observation, and detailed note keeping during the workshops provided the primary means of data collection. Preworkshop and postworkshop surveys were administered at each site. There were 10 questions on the preworkshop survey, seven open-ended and three multiple-choice. The purpose of the preworkshop survey was to assess baseline views on water challenges in each city/region, to assess perceived barriers to addressing these challenges, and to determine goals and expectations from participation in the UWIN network. We also asked about area of employment and length of time in profession to gain an understanding of participants' professional backgrounds. The postworkshop survey had seven questions total, six open-ended and one multipart multiple-choice question focused on the identification of indicators of urban water sustainability. The goals of the postworkshop survey were to evaluate workshop effectiveness and to gather input to steer the future direction of UWIN.

In addition to surveys, all materials created during the meeting (including sticky notes, flip-charts, and note cards) were collected and included as part of our data set. Each idea that was described during the meeting was recorded, and served as an individual data point that was organized into a spreadsheet by question for each case-study region. Throughout the workshop, ethnographic research methods including participant observation and detailed note keeping by SET team members provided additional means of data collection (Bernard, 2012).

Using the information collected during the stakeholder meetings and preworkshop surveys, a directed, qualitative content-analysis approach was used to analyze the data (Hseih & Shannon, 2005). The categories and themes that were selected to code the data were initially informed by the conceptual P-S-R framework for analysis. For example, the challenges to water systems that stakeholders discussed, were coded by themes of pressures on the system (migration, resource limits, climate, disease, pollution, etc.) and pressures by the system (land development, architecture, and urban form, property management, water, energy, waste management, consumer behavior, etc.). The present state of urban water systems is represented by the strengths and problems described by stakeholders, and the responses, by the efforts underway and solutions desired. Additional or different themes for coding subsequently evolved as new topics emerged from the data. Table 2 shows the organization of our data sources in relation to the coding scheme used in data analysis and the P-S-R framework. The analytical framework was then modified to match stakeholder feedback and a regionally specific version of the framework was developed for each region.

After qualitatively identifying and refining the themes used for coding, we quantified the number of mentions each theme received as well as the percentage of total responses for each theme per question in each region. These quantitative measures provide an idea of the amount of time/focus each theme received in each region. The most often discussed/described issues are reported on.

3. Results

3.1. Participants

We invited stakeholder participants with the intent of balancing representation across the sectors and categories listed in Table 1. The resulting composition of the stakeholder groups by region and sector is shown in Table 3. Most stakeholders represented the public sector and could broadly be characterized as midlevel to senior-level utility and resilience managers. Nonprofit organization representatives were usually the next most frequent participants. Between 7 and 12 stakeholders participated in each region and, in total, the project interacted with 50 stakeholders in its first year. The academic community was also well represented in our workshops, as UWIN research teams from each region were requested to participate, however they were not included as survey participants. In the workshops, academics observed, listened, asked for clarification, and helped broaden and deepen discussions.

Nearly 60% of the 50 stakeholder participants had more than 10 years of experience in their professions (Figure 3). We expect that this is positive for the project as it indicates that most of the stakeholders have extensive experience and the knowledge and wisdom that accompany it. The participation of knowledgeable practitioners is critical to UWIN engagement goals of increasing researchers' understanding of context

Table 2
Analysis Scheme Based on P-S-R Framework

Data source/description Facilitated brainstorming activity question topic *PreWorkshop survey question*	PSR framework heading	Themes used in coding
Threats and challenges to system	**Pressures** *on the city: Reliance Challenges*	Migration, resource limits, disease, pollution, natural hazards, climate change, corruption/ mismanagement, state/federal policy, power, politics, profit & capital
"In your opinion, what are the most important challenges or threats to urban water systems in your region?" and "What drivers and pressures (natural, physical, social, behavioral, and/or economic) contribute to these challenges?"	*By the City: Impact Issues*	Population growth/change, land development, architecture & urban form, property management, water, energy, waste management, transportation, industry, consumer behavior
Problems caused by the system *"In your opinion, what are the most important problems (social, economic or environmental) that are caused by how water is managed in your region?"*	**State of System**	Social equity, governance, transitions, intelligence, sustainability, water quality, ecosystem health, public health, awareness, water demand, drainage, water supply, waste water
Key efforts underway/Solutions desired	**Response**	Centralized, decentralized, natural capital, social/ human capital, man-made capital, financial capital, piped, surface, one water/integrated urban water management (IUWM)
"What are the most important solutions (technological, management, behavioral, institutional, and/or informational) that are currently being considered to address these urban water challenges in your region?"		
Impediments to solutions *"In your opinion, what are the most significant barriers (political, environmental, economic, technologic, and/or information) to implementing these solutions in your city?"*	*Barriers to Responses*	Funding/water rates, politics, coordination, knowledge limitations, resource availability, technological solutions, existing infrastructure, institutional constraints, uncertainty, lack of public support

for water decision making and the development of relevant research products. Conversely, we welcomed the participation of a significant number of individuals with relatively short (<2 years) experience as well; we anticipate that they are open to novel approaches and are more likely to represent future leaders of engaged organizations.

3.2. Pressures-Sustainability Challenges

3.2.1. Synthesis Across Regions

Of the pressures on urban water systems described in preworkshop survey responses, climate change, or climate change related impacts were the most frequently described challenge for three of our five case-study regions: SEFL, the Sun Corridor, and the Pacific NW (Figure 4). In SEFL, climate concerns included sea level rise impacts, such as flooding, saltwater intrusion into aquifers, storm water management, and management of adaptation to these impacts. The Sun Corridor stakeholders' climate-related concerns focus on drought, extreme events, and future water availability. For Pacific NW stakeholders, climate change concerns include impacts on water supply, specifically regarding changes in timing of availability and sustained capacity to meet periods of high demand. In regions where climate was not the top challenge described on surveys, the Front Range and the Mid-Atlantic, it was still mentioned. For example, the most commonly described sustainability challenges for the Front Range include water quality impacts and population growth, followed by climate change. In the Front Range, where water demand is expected to exceed supply in the near future, challenges to water resource planning are exacerbated by growing regional populations and land use change. Climate impacts upon the supply side of this relationship are described as a major concern for

Table 3
Workshop Participants by Region and Sector

Sector	Southeast Florida	Sun corridor	Mid-Atlantic	Pacific Northwest	Front range	Total
Public	6	6	6	5	8	31
Private	1	0	0	1	0	2
Nonprofit	0	3	4	1	3	11
Academic	2	3	0	0	1	6
Total	9	12	10	7	12	50

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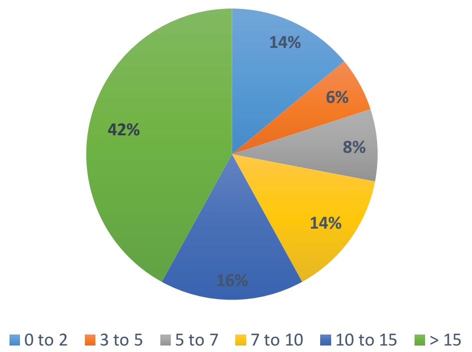

Figure 3. Number of years in profession of UWIN 2016 stakeholder workshop participants ($n = 50$).

the region as they are reliant upon snow melt for water supply. In the Mid-Atlantic, where water quality concerns, particularly relating to Chesapeake Bay and the ability to meet total maximum daily load regulations (TMDL), were greatest, followed by aging infrastructure and storm water management, explicit mention of climate change concerns was the lowest across regions.

Results from workshop discussions regarding pressures on/by urban systems reflect somewhat different themes from preworkshop survey responses. During workshop discussions, pressures that were categorized as economic-related and governance-related challenges were discussed most frequently across all regions. Regarding economic challenges, stakeholders across UWIN case-study regions described mounting pressures created by the high costs of providing water services coupled with unanswered questions about who pays for those costs and political hesitance to increase rates. Exacerbating concerns was the sense that the cost of providing safe and reliable water supply would likely increase in the future as traditional supply sources become more stressed.

Also embedded in discussions of economics, were the difficulties practitioners experience quantifying, and communicating returns on investment (ROI) for various projects underway or of interest to SAC members. Along these lines, stakeholders across regions described needs for support quantifying the costs and benefits of different water programs and reported goals of identifying the “biggest bang for the buck” for projects. A lack of sufficient funding and the need for innovative financing mechanisms for the longer term solutions critical to progress toward sustainable urban water management systems was also described by stakeholders across sites. While the nature and the framing of the discussions on costs/benefits and financing challenges were similar across regions, specific programs of interest differed by site. For example, in the Mid-Atlantic, stakeholders described challenges quantifying impacts of distributed green infrastructure and storm water management systems on Chesapeake Bay Total Maximum Daily Load (TMDL) requirements, while in Southeast Florida, stakeholders desired information about ROI for sea level rise adaptation programs. In the Pacific NW, the cost-benefit relationship for green infrastructure was of interest, and in the Sun Corridor the discussion centered around potential benefits of various reuse technologies. Beyond

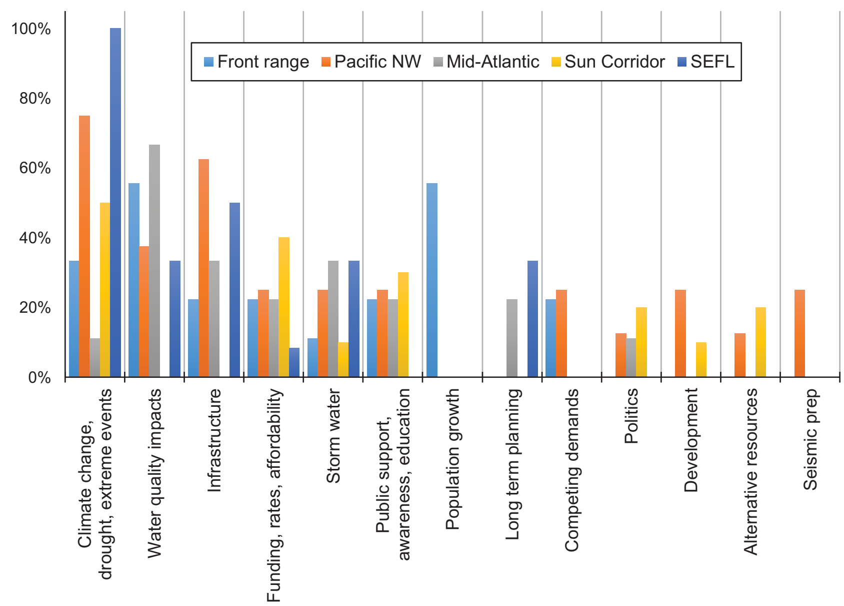

Figure 4. Responses to the presurvey question, “In your opinion, what are the most important challenges or threats to urban water systems in your region?” categorized thematically, and shown as percentage of responses in each region ($n = 50$).

simply having this information, practitioners expressed views that the quantification of ROIs would aid in efforts to communicate with decision makers and clients about the need for different programs.

With regard to the governance challenges discussed in workshops, stakeholders across regions described political norms including resistance to change and short-term perspectives among elected officials, limited understanding/awareness of water systems among decision makers, and lack of leadership on water issues as contributing to the pressures on urban water systems. These factors were described as limitations to progress on sustainability initiatives and reason for maintaining the status quo in water management. Tensions between long-term and short-term planning needs and how best to conduct long-term planning under conditions of uncertainty also emerged as a major challenge in UWIN regions. Furthermore, institutional constraints, including rigid and sometimes outdated regulatory/policy environments, siloed management agencies, and lack of uniformity across jurisdictional boundaries were also described as limits to transitions to sustainability, such as the implementation of green infrastructure programs at a broad scale.

Similar cross-regional responses emerged from workshop discussions in categories of social readiness and consumer behavior as well. Specifically, participants described challenges including limited public support for projects, lack of public awareness regarding water systems, water management, and water systems' complexity, difficulties communicating with diverse audiences, limited willingness to pay, affordability issues, and the need to motivate behavioral change among diverse communities.

3.2.2. Specific Challenges Unique to Each Region

Unique to each of the case-study regions were the specific characterization of pressures that are distinct to each geographic location, population, and culture. For example, there were specific hazards dominating concerns in each region that were expressed. In the Pacific NW, the threat of the "Big One," the massive seismic event that is anticipated to occur sometime within the next 50 years, was a topic of lively workshop discussion. Specifically, Pacific NW participants expressed concerns about regional emergency preparedness, particularly related to the ability to provide water services in the event of this occurrence. In the Sun Corridor, the principal hazard of concern is drought in the Colorado River basin and its potential impacts on water delivery reductions to Arizona as a lower basin state as specified by the Colorado River Compact interim guidelines. Sun Corridor stakeholders also described the absence of a back-up plan to manage potential energy disruptions, which could be terrorism related, and how this would cripple water service provision. In Southeast Florida, both survey responses and the workshop discussion focused on sea level rise, the impacts expected upon water resources, the challenge of planning under uncertainty, and the absence of feasible technological solutions. While in the Front Range, unique pressures result from reliance on a declining snowpack due to increasing temperatures and early runoff and the resulting impacts upon water supply and water quality.

Similarly, the specific nature and cause of wastewater treatment concerns differed across regions. For example, the Mid-Atlantic region faces numerous challenges related to aging infrastructure and flooding, resulting, at times, in sewage backups in residents' basements. In the Sun Corridor, unintended consequences of successful water conservation programs were related to diminishing ability to move sewage through the system. Additional specifics on pressures are described in Table 4.

3.3. State of the System, Problems Created by Systems of Water Management

Through preworkshop surveys, respondents across regions described a range of problems caused by existing water systems, with the majority categorized as problems in ecosystem health, water quality, public awareness, and governance. In the Pacific NW, ecosystem health problems include habitat loss, water quality degradation affecting native species and endangered fish, nutrients in waters, toxic contaminants, thermal pollution, and issues with flow management and how it impacts ecosystems, especially during the summer season. As anticipated, in Baltimore, responses focused on degradation of the Chesapeake Bay and the significant economic impacts on fisheries and recreation caused by limited runoff and pollutant management. In the Sun Corridor, problems including stress on riparian systems, increasing salinity, and loss of natural infrastructure were described. Diminished quality of watersheds, reduced snowpack, and reduced in-stream flows were mentioned by Front Range participants. In Southeast Florida, responses detailed water quality impacts to and development pressures on the Everglades. Specific to individual regions were problems related to vulnerability to climate impacts, limited storage capacity, and health impacts. For example,

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Table 4
Specific Pressures Discussed During Workshops in UWIN Case-Study Regions

Pressures (Themes)	Southeast Florida	Sun corridor	Mid-Atlantic	Pacific NW	Front range
Climate impacts	Sea level rise	Extreme rainfall event	Sea level rise	Immigration to region	Diminished snowpack
	Storm surge	Drought frequency	Changes in precipitation	Drought frequency severity	Early runoff
	Competition for water	Colorado River impacts	Climate variability impacts	Changes in timing of rainfall/hot dry summers	Decreased water supply
	Uncertainty	Uncertainty		Storm water	
	Aquifer contamination	Flooding/inequity and death from flash floods			
Population	Uncertainty about size of future customer base	Population growth	Population growth	Population growth	Population growth
		Out migration from urban areas			
Water quality concerns	Water quality maintenance	Nonpoint source pollution	Emerging contaminants	Hazardous material spills from transport	Water quality, contamination (runoff, Superfund sites, brownfields, industry, emerging contaminants (lead, dust, fracking, drilling, acid mine drainage))
	Aquifer contamination	Aquifer contamination	Stream and bay water quality impairments/pollution of downstream waters	Toxicity of waste stream (endocrine disruptors, pharmaceuticals, emerging contaminants)	
Institutional challenges	Lack of uniform standards across counties	Misalignment between aquifer recharge and stress areas	Limited political support for water programs	Lack of cross-agency coordination in funding	Colorado River Compact based on wet years/usable supplies are limited
	Misalignment between jurisdictions and water boundaries	Emergency planning limitations		Lack of cross-agency coordination in planning	Planning for past
	Decision makers not following staff recommendations	Use of "19th century policies for 21st century problems"			Buy-and-dry of agricultural lands for urban water supply
		Homeowner Association landscaping requirements			
		State focus on short-term profits over long-term			
		Weakening of the Ground Water Management Act to favor development/political influence on land development			
		Resistance to rate increases and conservation spending			
Knowledge limitations	How to maintain public support and quality of life during transitions	How to increase and manage public awareness of water systems	Lack of community awareness	Lack of urgency/water not particularly urgent issue	Lack of awareness of upstream pollution
	Disconnect between politicians and scientists	How to promote support/change perceptions about use of reclaimed water	Lack of strategy to address risks		
	Lack of public awareness about water systems		Lack of internal skill sets to analyze data		
	How to effect behavioral change				

Table 4. (continued)

Pressures (Themes)	Southeast Florida	Sun corridor	Mid-Atlantic	Pacific NW	Front range
Economics	Increasing costs of water services	Capital costs of utilities' not recovered by rates	Vulnerability and inequity	Competing demands for funds	Financing strategies for infrastructure
	Tradeoffs between promoting economic development & protecting natural resources	Underfunded state water management association	Increasing land development	Land development along rivers	
		Conservation can reduce utility budgets		Development outpacing natural systems' conservation	
		High costs of broad scale implementation of reuse			
		Inequitable distribution of resources across state			
Water supply reliability	Aquifer contamination	Groundwater withdrawals/ reliance on fossil groundwater		Timing of water availability (for salmon and people) and for new use types	Water supply availability limits
		Demand exceeding supply/ declining water supply at Lake Mead		Limit to availability of new permits	Wildfires
		Leakage			
Infrastructure		Aging infrastructure		Aging infrastructure	Aging infrastructure
		Water-energy nexus challenges		Maintenance of infrastructure	
Natural systems	Everglades services undervalued	Loss of desert creeks	Chesapeake Bay water quality impacting fish, oysters and recreation	Warm water impact on communities	Wildfire and insect damage
				Pollution footprint	
				Loss of ecological functioning	
Technological solutions	Solutions to sea level rise not readily available	Technology for direct potable reuse needed		Limited space for solutions	
Hazards	Storm surge	Terrorism	Flooding	Cascadia Quake, location of facilities	Headwater location
		Drought			

in Baltimore, health impacts resulting from infrastructure decay and contaminants of concern were mentioned, while in the Front Range, *Escherichia coli* levels in urban rivers are increasing concerns of infection.

In terms of problems created by current systems of governance, surveys reflect limited funding for specific water programs, lack of integration across different water management agencies, political norms, and limited flexibility in regulatory and legal institutions as problems across multiple regions. In four regions, practitioners described the lack of funding specifically for storm water management programs as a shortcoming. In Southeast Florida, participants described the lack of dedicated funds for cities to address ocean outfalls, alternative water supply development, and septic systems, in addition to storm water. In the Sun Corridor, the lack of funding specifically for the integration of water, wastewater, and storm water systems and to further One Water approaches was also recognized. In both the Pacific NW and the Sun Corridor, participants mentioned independent water systems and lacking mechanisms to work across boundaries. Participants in all five regions describe lacking political will to address rate increases and to engage in long-term planning/visioning with water professionals as a problem.

In workshop discussions, responses about the state of urban water systems were closely aligned with survey results, providing the opportunity to understand the nature of responses more deeply. In general, expert practitioners expressed views that the state of US urban water systems are in decline and that current governance regimes have led to unsustainable resource management. The most often mentioned problems in workshops included impacts on and degradation of natural ecosystems, limited public awareness about the costs/state of water systems, aging and degraded infrastructure, siloed management approaches in independent agencies, inequitable distribution of resources across regions, and lack of storage options. Across sites, stakeholders described a lack of long-term vision in the design of current systems and the tradeoffs inherent to decisions about economic development and long-term sustainability strategies.

Some complex relationships between regional economics, environmental impacts, human behaviors, and technology were also revealed. For example, in the Sun Corridor, we learned about the relationship between pricing of water and impacts on the regional urban environment, wherein increasing prices are tied to decreased watering of green spaces resulting in greater potential urban heat island impacts. Sun Corridor stakeholders also described the relationship between energy and water use and shared perspectives on how this relationship might change in the future as energy and water costs change.

3.4. Responses

3.4.1. Solutions Existing and Desired

The types of solutions described by workshop participants were largely those that could be categorized as increases to social or human capital (Figure 5). For example, in Southeast Florida, though we learned about desires for multiple types of solutions, the foci of both discussion and survey responses were largely on policies, behavioral changes, political processes, and management approaches that need to be adapted (Table 5). These findings were consistent across regions in that social and behavioral solutions are most needed to support the various technical solutions, such as decentralized and/or integrated water management approaches, that have been developed. Stakeholders across regions describe the complexity inherent to measuring impacts of decentralized approaches, like green infrastructure, and the lack of understanding of benefits and who receives those benefits.

Although to a lesser extent, there were also workshop discussions about the different technical solutions needed. For example, in the Sun Corridor, we heard an emphasis on expansion of alternative water supply technologies like the desire for more widespread implementation of reuse and reclaimed water and the need to improve efficiency. However, the technical solutions that were described seemed to be within reach for our group of water stakeholders, with the exception of sea level rise solutions in SEFL and solutions to manage potential seismic activity in the Pacific NW. Across our regions, stakeholders seemed to have confidence that the appropriate technical solutions exist and can be identified. However, the institutional, formal and informal, solutions that were desired were linked to the greatest impediments in implementation. For example, Western water law, with its interstate agreements, prior-appropriation doctrine, senior and junior water rights, water project law, treaty rights, varying treatment of surface and groundwater, and the myriad and complex environmental regulations they operate under, were viewed as a major barrier to implementation of known solutions.

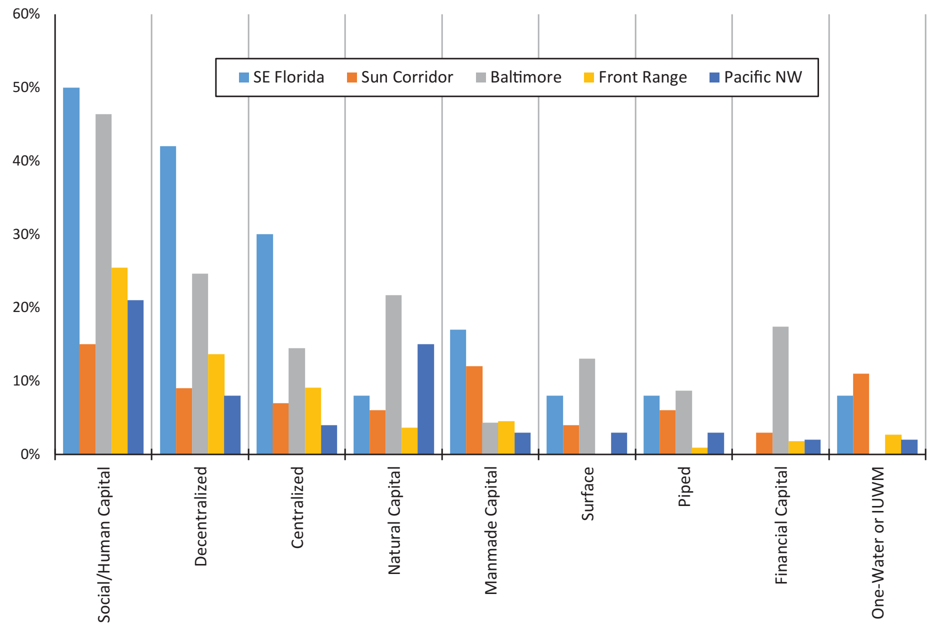

Figure 5. Stakeholder responses during Facilitated Brainstorming workshop activity, categorized thematically, and shown as percentage of responses in each region ($n = 50$).

3.4.2. Barriers to Solutions

Several barriers to implementation of integrated water solutions emerged from workshop discussions. The most commonly discussed barriers were related to funding limitations in all regions except for the Pacific NW (Figure 6). In addition to funding constraints, issues of limited public support and/or awareness of water resource issues also emerged as a top mentioned barrier. For example, in the Mid-Atlantic region, stakeholders described needs for improved public education and greater public awareness in order to achieve success for recommended Chesapeake Bay solutions, such as decentralized green infrastructure

Table 5
Southeast Florida Responses to the Presurvey Question, "What Are the Most Important Solutions (Technological, Management, Behavioral, Institutional, and/or Informational) That Are Currently Being Considered to Address These Urban Water Challenges in Your Region?" (n = 9)

Themes	Solutions desired for Southeast Florida (shared by participants)
Data/Research	Refined/downscaled climate models
	Research on climate change/sea level rise
Policy/Planning	Adaptation planning, sea level rise planning
	Planning for long-term water supply and flood control
	Holistic approaches to resiliency and sustainability planning
Behavioral	Urban design to adapt to future conditions
	Strong water conservation/reduction goals in cities
	Coordination among local governments
	Increased collaboration between academic research and local management
	Institutional and behavioral transitions
	Marketing, informational, educational campaigns regarding climate change to bring public awareness
Politics	Political will to make the necessary economic investments
	Stop passing the buck to the scientists to come up with the technical solutions/Take action!
	Regional political consensus
Infrastructure	Raised streets, storm water pumps
	Additional drainage capacity (pumping)
	Aging infrastructure
Natural resource management	Everglades restoration
	Utilizing green infrastructure like living shorelines and sea walls

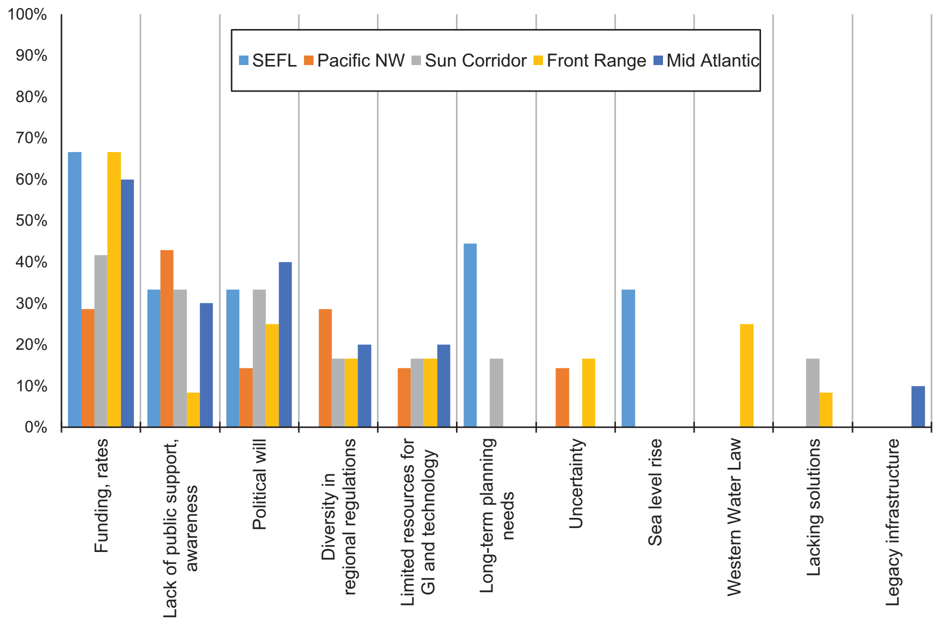

Figure 6. Responses to the preworkshop survey question, “In your opinion, what are the most significant barriers (political, environmental, economic, technologic, and/or information) to implementing these solutions in your region?” categorized thematically, and shown as percentage of responses in each region ($n = 50$).

approaches. In the Pacific NW, stakeholders described the need to promote social readiness to accompany the wide-scale adoption of integrated technological approaches and more sustainable behaviors. Sun Corridor stakeholders described the limited understanding of the water system and a lacking conservation ethic among citizens as barriers to sustainability.

Across regions, limited political will to make changes to status quo or to follow recommendations of technical staff were topics of discussion and survey response. The disconnect between technical experts in water management positions and elected officials emerged as a critical barrier to moving innovative solutions forward in all regions. The challenges of long-term planning within institutional constraints including long standing water laws, jurisdictional diversity, and limiting state-scale policies and ineffective leaders, were also common across regions. These economic and policy concerns provide the backdrop against which challenges—including climate impacts, water quality impacts, increasing competition for resources (which are all increasing, but to different extents and of different nature across our regions), and feasibility of technical solutions—are considered.

3.5. Needs for Research and Themes Identified

Across sites, social, behavioral, and economic research products were most needed by stakeholders with a focus on strategies for communication of complex information and for motivating behavioral change. Instead of additional data or technical models, stakeholders describe a need for strategies to communicate economic and management information to customers and politicians to increase awareness, willingness to pay for, and support different approaches. Information in terms of ROI and financing strategies for both short-term and long-term investments would improve capacity to manage resources and to communicate with public and decision makers. Further, there is a need for strategies for decision making under uncertainty and guidance on implementation.

We also learned about general perspectives on the science-stakeholder interactions. Stakeholders in all regions described a wariness about the role of the UWIN project and were seeking information on how to connect action in meetings to practice. On this topic, there were frustrations with the seeming abundance of data/models and the associated need to organize products into usable, actionable systems. The possibility of the UWIN project providing this type of data organization and guidance was of great interest, especially to stakeholders in the Mid-Atlantic region.

4. Discussion

4.1. Themes Emerging

The results from stakeholder-scientist interactions and surveys across UWIN case-study regions tell a consistent story of existing and growing pressures on the urban water management regime in the U.S. Although the pressures described by stakeholders are caused by nuanced and complex sociopolitical and geographic conditions in each region, overall it seems that the recognition of changes in stationarity of the climate system, declining states of infrastructure, declining water quality, population growth, and current systems of water economics and governance are representative of increasing pressures. Recognition of emerging themes in pressures from perspectives of UWIN stakeholders bolster prior findings regarding challenges to urban water systems (Gleick, 2003; McDonald et al., 2011; Milly et al., 2008).

Feedback from stakeholders indicates agreement that innovative solutions to problems in water management, many of which already exist, need to be implemented and that current paradigms of water management do not support broad scale implementation of One Water approaches. These findings are consistent with studies from other nations regarding limits to institutional readiness for integrated water management approaches (Brown & Farrelly, 2009a, 2009b; Bettini et al., 2015; Mukheibir et al., 2014). Our findings extend the current literature to add that evolution in social readiness, in the form of increasing awareness and behavioral and attitudinal shifts, is also necessary for transitions to more integrated approaches.

Results from UWIN interactions provide insights into ongoing transitions. Across the regions, water systems seem to be in various states of transition, but in general, available integrated urban water management technologies are not being readily adopted into the systems. Our findings suggest a number of barriers and support prior research pointing toward the need to build connections between contextual landscape level factors with technologies (Bettini et al., 2015; Chini et al., 2017). Factors including financial and regulatory aspects of water management which are still dominated by siloed approaches, create critical barriers to the implementation of many of the desired solutions, such as expansion of green infrastructure and long-term planning efforts. Further, the path toward sustainable and integrated urban water management is burdened by complex formal and informal institutions across multiple scales, interactions between individuals with diverse motivations, and by competing regional goals, such as for economic development and water sustainability. While similar pressures characterize the state of water systems across sites, multifaceted and site specific societal barriers present challenges to the implementation of technological solutions that are being promoted. Unpacking these barriers further might allow for more tailoring of technological solutions, including associated communication strategies, to better fit the context, potentially improving efforts to increase adoption.

Our understanding of sociotechnical research shows that the artifact, the technology, the agency, and the landscape or context are all critical to understanding transitions (Bettini et al., 2015; Chini et al., 2017; Geels, 2002; Geels & Schot, 2007; Mees et al., 2013). These concepts were exemplified through our case studies in a number of ways, for example, the existing infrastructure for water/storm water management represents the artifact, green infrastructure is one example of a desired technological pathway, the actors who participated and who were described during discussions represent the agency, and the existing institutional arrangements, both formal and informal make up the landscape. By studying the transition to One Water approaches across diverse regions with expert practitioners, our findings illustrate the central role of context or landscape in ongoing transitions and reinforce the need to understand the nuanced interactions between existing institutions and technology. Analysis of stakeholders' discussions has provided insight into the complexities inherent to the coevolution of technology and society. For example, in western UWIN regions, including the Sun Corridor and the Front Range, results indicate that the adoption of storm water management approaches is constrained by long standing water laws and institutions establishing legal water rights. Discussions with UWIN stakeholders revealed specific details about why these institutions constrain options, including perceptions of Arizona decision makers that integrated storm water management strategies might increase risks of litigation over water rights. Understanding the nature of regional institutional barriers and how they affect the implementation of different water management strategies is critical to understanding adoption.

In addition to institutional barriers, characteristics of technological approaches also signal why transitions may be slow moving in UWIN regions. We heard numerous examples of niche-innovations occurring across sectors of technology, policy, and economics whose benefits have not been clearly understood, illustrated, or communicated. Across cases we see that practitioners are struggling to communicate the (potential) impacts of and need for projects that they believe in. For example, we learned of struggles with communication and dissemination of results from green infrastructure projects in Baltimore. In South Florida we heard the same message regarding adaptation efforts, where practitioners have had trouble estimating and describing the benefits from implementation of adaptation measures enough to justify expenditures and to maintain public support. Through our interactions, it has become apparent that in order for innovative solutions to be accepted by both executive level agency management and by the public, and therefore more likely to be adopted, the communication of benefits and rationale for projects needs to be very clearly expressed in terms that matter to the audiences making decisions and living with the consequences of those decisions. These findings are consistent with prior sociotechnical transition studies that show the importance of demonstration projects that can exemplify the benefit of technologies and promote awareness and communication (Skambraks et al., 2017).

4.2. Utility of Framework for Understanding Transitions

The P-S-R was useful for guiding data collection during this exploratory phase of research and it proved to be illustrative for demonstrating the nature of ongoing transitions. Although simplistic, the P-S-R framework provides a way to think about the multitude of challenges faced in each region from a holistic perspective and serves as a tool to focus discussion among diverse groups of stakeholders who do not usually work together around bigger picture issues, but whose input is central to understanding issues. Additional iterations of the conceptual model are needed to develop a tool for self-assessment and collaborative agenda setting. However, the utility of the P-S-R for structuring discussions that provide insights into transitions has been recognized.

The participatory research approach offered a number of broadly relevant insights into the contextual factors influencing decisions and behaviors of water practitioners and decision makers. Convening stakeholders in multisite workshops provided the ability to study themes that emerge from discussions between diverse actors in water systems, many of whom do not routinely interact around topics of water sustainability. The topics that emerge during discussions differ somewhat from survey results, suggesting value to both approaches. The inclusion of multiple stakeholder perspectives provided a nuanced understanding of the progress toward, and obstacles in the way of, transitioning to sustainable integrated urban water management practices.

While the data collected seem appropriate to each region, there is some risk that concerns identified reflect the particular small stakeholder groups convened and that results might have differed with a different or larger group. It can be argued that the dominance of public sector water utility and resilience managers in our stakeholder cohort is appropriate for our project's core focus on urban water integration. On the other hand, the case can be made that, because a more broadly based group might better foster transitions, we should be interacting with a much broader swath of society ranging from underrepresented communities to urban real estate developers and elected officials. UWIN has deployed a Social Equity/Environmental Justice (SEEJ) subproject that endeavors to reach underrepresented communities, but its activities are just beginning and there are no results to report. We also made some effort to include private sector representatives in two regions. We found however that the dominance of the public sector utility employees, and the SET team's comfort level with that group contributed to some perhaps undesirable uniformity of thought processes. This was brought to light by one of the few private sector stakeholders, who felt maligned as a representative of a sector that the dominant group viewed as "short termers and profiteers who seem to be perceived as unaware, uneducated or uncaring." Our lesson is that careful balancing of stakeholder groups to meet project objectives is important. But achieving broad balance across society is not easy or even possible in small stakeholder groups. The existence of a dominant group is likely to lead to near-consensus perspectives that are incomplete and possible alienation of nondominant stakeholder group members. For some project objectives, more narrowly focused stakeholder groups may be most appropriate, but the corresponding narrowing of the range of perspectives needs to be appreciated.

Another insight gained pertains to the way science is conducted. The nature of obtaining federal funding to conduct research like that supported by the UWIN can limit flexibility to incorporate expressed interests of stakeholders into research design. While some of the desired research products can be incorporated into existing UWIN projects, others are well beyond the scope of proposed efforts, challenging our ability to maintain stakeholder interest in participation. In order to develop and maintain trust and interest in research, flexibility in research design should be built into research proposal design.

5. Conclusion

Interactions with stakeholders across UWIN case-study regions have allowed us to document increasing pressures on urban water systems from both external and internal forces and a perceived need for change among actors. Multisite case-study approach has shown that there are significant pressures on urban water systems, that similar pressures exist across the U.S., and that similar types of solutions or responses are desired. Furthermore, similar problems created by current systems of governance, including limited funding for specific water programs, lack of integration across different water management agencies, political norms and limited flexibility in regulatory and legal institutions were described across multiple regions. Results from UWIN case studies suggest that outside of communities of technical experts and researchers, understanding of innovative solutions to these challenges, typically described as One Water approaches, remains low. Citizens and elected officials are largely unaware of the potential benefits these approaches may offer. These knowledge gaps are the result of a number of factors including communication obstacles, limited awareness, and specific characteristics of the technologies themselves. Each of these areas requires more research and provides an opportunity for the improved alignment of research and practitioner needs.

Critically, our analyses have shown that desired solutions are not limited to more obvious technical solutions, rather they include profound institutional and behavioral shifts away from the status quo. These desired transitions call for further unpacking of the barriers to solutions accompanied by discussions of potential bridges to overcoming those barriers. Moving forward, an adapted framework that provides for analysis of barriers and bridges is suggested.

The interactions described represent the first year of a 5 year stakeholder engagement strategy. As the project matures, we intend to dive more deeply into many of the questions that emerged during this initial year and will use these outcomes to form the research agenda of subsequent years. For example, an integrative framework, which can be used to guide self-assessment and productive action in a collaborative setting, adapted from the P-S-R model is being developed as a result of the interactions described. During our second year of interactions, we will pursue multiple goals: (1) to vet and refine the framework developed in the first year, (2) to share relevant UWIN research with stakeholders, (3) to build our understanding of decision making and the institutional pathways to sustainable integrated urban water management, and (4) to continue to grow our network to encourage innovation and learning among diverse stakeholders. The UWIN stakeholder engagement strategy has shown the importance of including multiple perspectives in discussions of transitions to integrated water management and why these transitions may or may not be occurring. We envision maintaining continued stakeholder engagement to illustrate potential pathways forward that hold promise of success in practice.

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