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Organizational networks and sustainable urban water practices in US local governments

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ABSTRACT

Organizational networks are regarded as key in policy innovation for sustainable development. They are thought to enhance innovation through access to first-hand experience, enhanced trust within a community, and exposure to role models and competitors. Despite theoretical pertinence, organizational networks have not been studied as much as other drivers of innovation, such as organizational capacity, leadership, and the socio-political environment. This empirical study explores how networks affect the implementation of Sustainable Urban Water Management Practices (SUWM) at the local level. Using data from 110 local governments in five US regions, we examine the relationship between social interaction and the implementation of SUWM, and how this relationship depends on the types of interaction partners. Our findings show that local governments with larger organizational networks implement more SUWM practices. Collaboration with non-governmental organizations, particularly water sector associations, is strongly associated with an increase in use of SUWM practices. Overall, our findings suggest that creating and maintaining a robust organizational network of other government agencies and non-governmental organizations, especially water sector associations, increases the chances that a local government will implement more SUWM practices.

Key words: Diffusion of innovation, Local governments, Organizational networks, Policy innovation, Policy networks, Sustainable Urban Water Management

HIGHLIGHTS

- The use and consideration of sustainable urban water practices are statistically linked to local policy networks.
- Governments with larger policy networks implement more practices.
- Non-governmental organizations are key drivers of the use of sustainable practices.
- Change agents can promote change by involving local water agencies in networking opportunities with NGOs and other agencies.

INTRODUCTION

Water management is a top 10 global sustainability challenge (Forum, 2019) and a leading issue for governments around the globe (McDonald *et al.*, 2011). Current water management challenges are unprecedented in complexity, range, and magnitude. Across the globe, about 2.2 billion people lack safely managed drinking water of which

785 million are without basic drinking water; 4.2 billion people lack safely managed sanitation with 2 billion being without basic sanitation; by 2030, water stress and scarcity could lead to the displacement of an estimated 700 million people; and some countries experience a funding gap of 61% for achieving national water, sanitation, and hygiene targets (United Nations, 2021).

Sustainable Urban Water Management (SUWM) is aimed at addressing these and other water issues (Larsen & Gujer, 1997; Marlow *et al*., 2013; Liu & Jensen, 2018). It is sometimes defined by a list of rather innovative practices, such as potable water reuse, rainwater harvesting, or wastewater heat recovery; but it can also include more common practices, such as leak management (Landis, 2015). The basic purpose of SUWM, and its associated practices, is to promote traditional goals of health, efficiency, safety, and reliability, while also preserving natural capital, reducing energy and material inputs, preventing waste and pollution, fostering co-benefits such as recreation and preservation, and ensuring water justice.

Organizational networks are a kind of social network in which individuals within organizations, such as local governments, collaborate with individuals in other organizations. The term 'collaboration' covers many activities that organizations engage in with one another, including the sharing of resources, joint implementation of programs or policies, and seeking information relevant to organizational missions. Organizational networks can foster the adoption of practices, such as SUWM, that are new to collaborating governments (Henry, 2009, 2018). This process of adopting practices that are new to a government and alter established practices and thinking is commonly referred to as *policy innovation* (Henry, 2009, 2018; Sørensen & Torfing, 2017).

Organizational networks can foster policy innovation in many ways. Interacting with other organizations allows governments to learn novel strategies and access first-hand experience that others may have had with them. For instance, networks that connect regulatory agencies in different regions allow governments to be more aware of practices that have been used in other locations, thereby enabling network participants to learn what might be successful or unsuccessful in their own jurisdiction (Berg & Horrall, 2008). In this way, networks expose communities to role models and competitors, which can motivate policy action and avoid costly investments in policies that do not work. Collaboration with stakeholders is also shown to enhance trust within a community and increase support for novel approaches (Van de Meene *et al*., 2011). Furthermore, networks can also enable collective action among governments jointly implementing programs, such as transboundary infrastructure projects, thereby creating public goods that no single government could deliver on its own (Berg & Phillips, 2018).

While there is a considerable body of literature on factors associated with the adoption of more sustainable water practices in local governments, such as organizational capacity, political support, and policy mandates, the role of networking in creating change tends to be underrepresented (Pivo *et al*. 2020). While some scholars and practitioners might assume networks foster policy learning, we have no national surveys to demonstrate their potential effect including the kind of network partners that might be most important and how much difference networking might make in the amount of innovation it might promote. Given the demonstrated role of organizational networks in other areas of environmental policy, we may expect them to be a powerful tool in fostering progress toward sustainable urban water systems and their study is an important step toward fully exploiting their potential.

In this paper, we explore *how organizational networks affect the implementation of SUWM at the local level*. Using data from 319 water managers working in 110 local governments in five US regions, we examine the relationship between organizational networking and the implementation of SUWM, and how this relationship depends on the types of network partners. While the study is nationally focused, the findings are of global relevance. The United States exhibits a broad range of water-related challenges also observed around the globe including drinking water safety concerns, particularly affecting minority groups (Allaire *et al*., 2018), aging and

under-funded infrastructure and water loss (The American Society of Civil Engineers, 2017), and a considerable proportion of urban settlements being located in high flood risk zones (American Rivers, 2019). The regions studied here were purposefully selected to exhibit variety in hydrologic, climatic, economic, and political settings. Furthermore, it is important to note that the central role of networks is not unique to the United States and indeed is global. The global trend toward decentralization speaks to this (Andersson *et al.*, 2006; Andersson & Gibson, 2007), and even in places with strong central government control, nations still show fragmentation of authority in natural resources (particularly water) across multiple domains, levels of government, and formal organizations (Yi & Cui, 2019). Insights from this study could be applied to foster sustainable water management in diverse regions facing a variety of water challenges.

Our paper consists of five sections. First, we discuss the role of networks in policy innovation and introduce our hypotheses. Then, we proceed to methods, findings, discussion, and conclusions.

BACKGROUND AND HYPOTHESES

The term 'organizational networks' refers to the patterns of relationships among organizations (Gulati *et al.*, 2002). In this paper, we focus on the number and types of organizations with which local government water managers maintain networks in the course of their jobs. These relationships include multiple forms of collaboration such as information exchange and joint action on programs or policies.

The literature provides different explanations for why organizational networking matters to policy innovation (e.g., Wasserman & Faust, 1994; Borgatti *et al.*, 2018). *Learning* is one of the most prominent. Learning refers to the process by which governments develop a better knowledge of complex problems and solutions and employ knowledge to manage issues (Bennett & Howlett, 1992; Shipan & Volden, 2008). Learning encompasses several distinct processes including changing skills and practices, questioning and adjusting worldviews and policies, and updating values and norms (Ilgen *et al.*, 2019). Organizational networks are important drivers of learning because they give organizations access to expertise and experience, shape narratives, and provide venues for the exchange of perspectives, knowledge transfer, and the co-production of knowledge (e.g., Shipan & Volden, 2008; Farrelly & Brown, 2011; Brown, Farrelly & Loorbach, 2013; Henry & Vollan, 2014; Ruzol *et al.*, 2017; Ilgen *et al.*, 2019). Local government networks are a central pillar of policy learning. These networks give their members access to a broader pool of knowledge, thus putting them into a better position to address sustainability challenges (e.g., Ilgen *et al.*, 2019).

Closely related to learning is the concept of *social capital*. Social capital refers to norms of reciprocity, community bonds, mutual sympathy, and trust resulting from repeated interaction (Lubell, 2004; Henry & Vollan, 2014; Aldrich & Meyer, 2015). Social capital enables learning. Organizations are more likely to learn from others they have come to trust through established relationships. The effect of social capital on policy innovation, however, reaches beyond learning. Communities with more social capital are better positioned to collaborate on innovative solutions, address challenges, and resolve disputes (Van de Meene *et al.*, 2011; Henry & Vollan, 2014). Studies show, for example, that communities with more social capital are more resilient and show a better collective response to disasters leading to quicker recovery and more satisfaction with the recovery process (Nakagawa & Shaw, 2004; Chamlee-Wright, 2006; Airriess *et al.*, 2008; Adger, 2010; Waters & Adger, 2017).

Apart from learning and social capital, *social influence* is another explanation for the role of networks in policy innovation. Social influence is an umbrella concept encompassing different ways in which organizations affect each other's actions. Knowledge exchange and learning is one form of social influence; other forms include identification, imitation, authority, and competition (Marsden & Friedkin, 1993). Organizations exert influence through interactions when they are directly exposed to each other's policy approaches. Social influence, however, does not require direct interaction as it is sufficient for organizations to *know about each other* to exert influence

(Marsden & Friedkin, 1993). Competitors, for example, may not be in a direct exchange but still influence each other through shared acquaintances such as collaborators, customers, or suppliers.

Learning, *social capital*, and *social influence* are thus three separate theoretical mechanisms that explain and predict the importance of networks in fostering policy innovation. The three mechanisms are not directly observed by us empirically. Rather, we observe relationships between network characteristics and outcomes, which suggest that at least one of these mechanisms is at play.

One important relationship pertains to the *number of collaborators*. The above mechanisms suggest that more collaborators lead to more policy innovation. Organizations may innovate more because of access to a larger pool of expertise (i.e., learning), more trust and stronger bonds in the community (i.e., social capital), increased opportunities for others to exert influence (i.e., social influence), or a combination of these. Based on this reasoning, we adopted our first hypothesis:

Hypothesis 1: The number of SUWM practices implemented by a local government increases with the total number of unique organizational collaborators in its organizational network.

However, prior theories do not only suggest that *how many* connections an organization has matters, but also *with whom* it is connected. Different theoretical perspectives emphasize the importance of connections between governmental and non-governmental organizations in policy innovation. Concepts of stakeholder partnerships, adaptive risk management, and co-production of knowledge identify these relationships as central to knowledge creation and linking knowledge to action (e.g., Booher & Innes, 2002; Hoverman *et al*., 2011; Bidwell *et al*., 2013; Trencher *et al*., 2013, 2014). Partnerships with universities and so-called knowledge networks, in particular, can foster two-way communications between producers (i.e., scientists) and users (i.e., policy makers) of scientific information (Bidwell *et al*., 2013; Trencher *et al*., 2013, 2014). They provide policy makers access to scientific information while simultaneously fostering awareness of policy needs among the scientific community (Bidwell *et al*., 2013; Trencher *et al*., 2013).

Non-governmental organizations also play an important role in policy change. In particular, meta-organizations, that is, organizations or associations with organizations as their members, can be particularly effective in helping to diffuse new norms and best practices, including sustainability practices, among their members in a process of collective learning (Gadille *et al*., 2013; Berkowitz, 2018; Webb, 2018). Similarly, networks of non-governmental organizations acting as cooperating service providers to governments can be important enablers of public policy implementation (Agranoff & McGuire, 1998; Provan & Milward, 2001).

Finally, non-governmental organizations can enhance legitimacy and support for sustainability initiatives. External support networks consisting of specialized organizations or technical experts can provide neutral assessments of sustainability interventions thus providing political cover, or they can enhance legitimacy through 'joint fact finding' with local stakeholders (Hawkins & Wang, 2012). The engagement of NGOs and neighborhood associations likewise can support the negotiation of broadly supported solutions (Hanna, 2005; Daley *et al*., 2013).

While the importance of collaboration with non-governmental organizations for policy innovation is theoretically salient, empirical evidence is limited and primarily consists of case studies. Most notably, little is known about the relative effects of different types of partnerships. We address this gap through our second hypothesis:

Hypothesis 2: Collaboration with non-governmental organizations is more strongly associated with an increase in the use of SUWM practices compared to other types of collaboration.

METHODS

Our unit of analysis is what we refer to as Local Water Governments (LWGs), that is, local governments that report some level of spending on water functions in the US Census of Governments. Water functions include water supply, water quality, sewage treatment, flood control, groundwater management, water conservation, and watershed management. Different types of local governments spend on water functions, including general-purpose counties, municipalities and townships, and special-purpose districts.

Much of our data comes from an online survey of local water officials conducted in 2018–2019 by the authors. The sample included 612 local governments with water functions in the core-based statistical areas (CBSAs) centered on Baltimore MD, Portland OR, and Fort Collins CO, all those in the CBSAs of southeast Florida, and all those in the entire state of Arizona. The sample was chosen to cover a wide range of hydrologic, climatic, economic, demographic, cultural, and policy settings. This sample selection allows us to capture pervasive effects that are relevant across regions and water management settings.

Survey invitations were emailed to 2,118 senior managers and professionals working in the departments within those local governments that mentioned water responsibilities in their webpages. Responses were received from 316 recipients (15%) working in 18% of the local governments. There were three responses per local government on average, which were then aggregated to the local government level using the average, total, or maximum answers given by the respondents in the agency depending on the nature of the question. This entire process resulted in a final dataset of 110 local governments.

We used several regression models to test our hypotheses. The dependent variable in all cases was the number of SUWM practices implemented by a local government (SUWM PRACTICES). SUWM PRACTICES was estimated by first asking respondents to indicate which of 73 practices were being 'implemented' by their organization, and then pooling the reported practices of all organizational representatives operating within the same local government. We defined 'being implemented' in the survey as active deployment of a practice, as opposed to consideration or experimentation. Appendix A provides an overview of the 73 practices. Our list was developed from the SUWM literature and reviewed by water professionals. The practices are numerous, diverse, and touch all aspects of water management. Examples include full-cost pricing for services, reporting on sustainability metrics, outreach to underserved areas in various languages, sewer pipe heat recovery, graywater programs, watershed protection, and real-time water quality monitoring.

It should be re-emphasized here, as was mentioned in the Introduction, that some SUWM practices, such as rainwater harvesting, are themselves more innovative, in the sense of being uncommon across the country. Meanwhile others, such as leak management, are themselves less innovative, in the sense of being more widely used by local governments nationwide (Landis, 2015). In this study, however, we are not interested in how innovative the tools are that a community has chosen to implement, in the sense of how rare they are at the regional or national scale. Rather, we are focused on whether the community itself appears to have undergone more or less policy learning or innovation, compared to other communities, by adopting more sustainable local water management practices, regardless of how unique or rare the set of SUWM practices are that the community chooses to adopt. A useful extension of our work, however, would examine the nature of communities that are 'early adopters' of rare or groundbreaking practices.

The focus (dependent) variables used to test our hypotheses were metrics characterizing the size of a local government's organizational network and the types of organizations in their network. These aspects of each local government's network were derived from answers to survey questions completed by water managers in the local governments.

In our survey, local water managers were asked to list 'up to 10 organizations that *you interact with* as part of *your* job in water management' (emphasis added). As the survey instructions stated, we were interested in 'interactions with specific organizations, such as federal/state agencies or municipal departments, as well as private and nonprofit organizations.' These could include 'both voluntary and required interactions' as well as 'organizations that do not necessarily share your goals.' This language was intended to capture as broad as possible a set of organizational collaborators, not necessarily constrained to the allies of the organization in question. The survey continued by asking respondents about particular types of collaboration they engage in, ranging from weak forms of collaboration such as shared participation in meetings to strong forms of collaboration such as joint implementation of programs. Each *organization* listed by a respondent as one they 'interact with as part of their job in water management' is referred to here as a 'collaborator.'

The collaborators thus identified by individual respondents in a given local government were then aggregated by summing unique collaborators.[1] The resulting network allowed us to see organizations with which water managers in a local government interact. Organizations included those from the private, public, or non-profit sectors, those with which collaboration is voluntary or required, and those that may or may not share the water management goals of our survey respondents.

The network is unvalued and binary – a link from agency A to organization B exists if at least one survey respondent affiliated with agency A named organization B as a collaborator or if at least one respondent affiliated with agency B named agency A as a collaborator. The network, shown in Figure 1, contains 509 unique organizations, including all the organizations that responded to our survey and their various collaborators. This network was used to compute the *total connections* variable (TOTAL CONTACTS). The technical term for total connections in network studies is 'degree centrality,' meaning in our case the total number of connections a local government has with unique organizations.

To differentiate types of organizational connections, we coded the contact organizations as governmental, academic, or non-governmental. The non-governmental organizations were further divided into sub-types. The sub-types were water sector associations (e.g., American Water Works Association), government associations (e.g., Maryland Municipal League), private companies (e.g., Clean Water Services), certification agencies (e.g., US Green Building Council), consultancies (e.g., AECOM), environmental groups (e.g., The Nature Conservancy), stakeholder partnerships (e.g., Coalition for the Poudre River Watershed), academia (e.g., University of Pennsylvania), and trusts (e.g., Baltimore Tree Trust). Based on this, we computed organizational connection variables for the different organization types. These variables represent the number of connections of a particular type that a local government has to a particular type of organization. For example, the *government connections* variable (GOV CONTACTS) indicates the number of governments with which a given local government interacts.

Forty-two additional variables were examined as possible controls for other factors that could affect our dependent variable. They covered two broad categories including governance (e.g., organizational capacity factors) and environmental factors (natural, built, social, and economic), all appearing in prior empirical or theoretical work on 'essential elements' driving local policy change (Pivo *et al.*, 2020). Some of these data were drawn from survey

[1] Our method for measuring the total number of agency contacts could have positively biased total contacts by agency size if the number of respondents from an agency was correlated with agency size. But our agency contact metrics were very weakly correlated with agency size, as measured by total revenues and expenditures, gathered from the US Census of Governments ($r < 0.04$). Total revenue was also weakly correlated with total practices ($r = 0.25$), as shown in Table 1. Moreover, when we tried either total agency revenues or total agency expenditures in the regression models, both revenues and expenditures were insignificant, the focus variables remained highly significant and their coefficients changed very little, and the overall model statistics changed very little and remained significant. These findings suggest that any bias in the contact metrics did not significantly affect our main results.

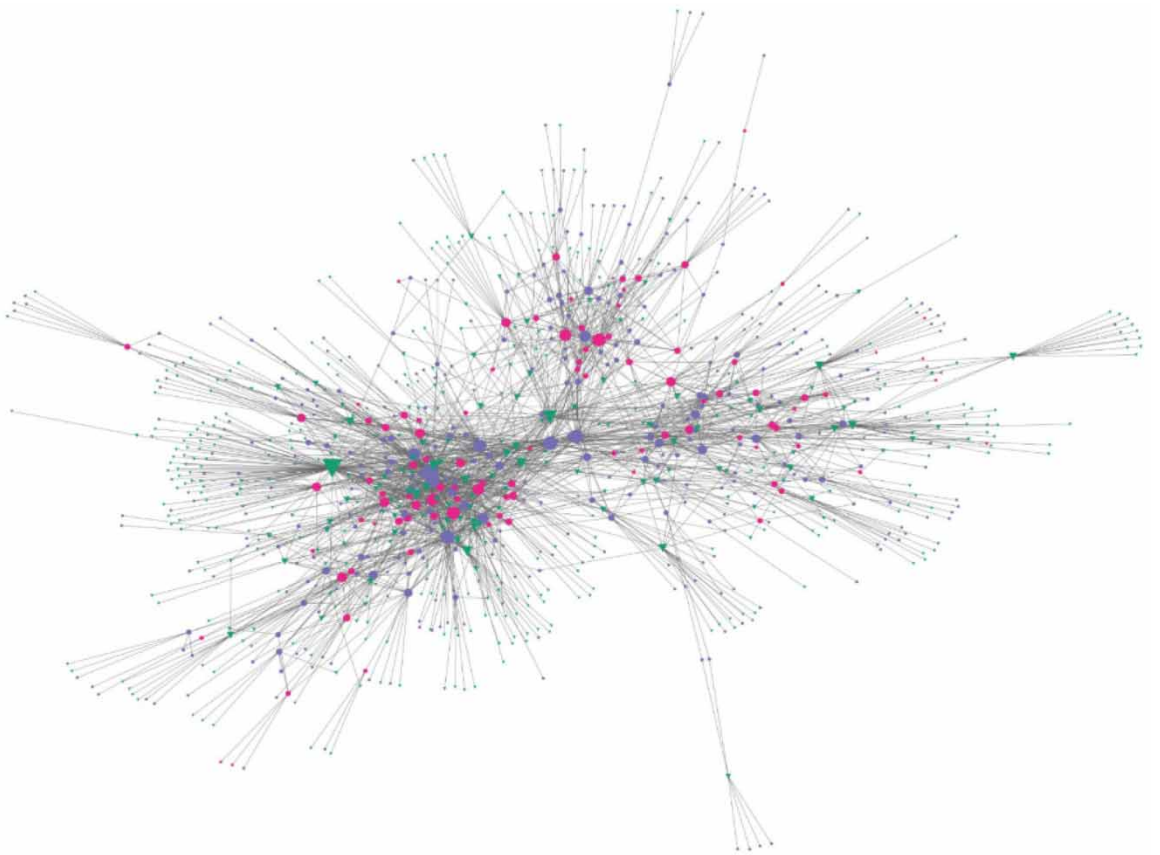

Fig. 1 | Network of governmental and non-governmental organizations. Color and shape correspond to the type of organization. Governmental organizations being shaped as circles with red, indicating that the organization is in our sample while purple indicates it is not. The non-governmental organizations in the governments' networks are shown as green triangles. The size of the nodes corresponds to the number of unique collaborators in the agency's network.

questions on mission (e.g., flood control and water supply), severity of local water problems (e.g., flood risk and unequal access to safe water), and community attitudes and capabilities (e.g., degree of interest in adopting innovative approaches to water management and financial capacity to do so). Other data came from secondary sources covering demographic, political, geographic, climate, and governance context. Table 1 lists all the possible controls we considered.

Many of the possible controls (20) were significantly correlated with our dependent variable. However, all but one (population size) had weak (<.4) or very weak (<.2) correlation coefficients. Many controls covaried with one another, and there were many possible controls relative to the degrees of freedom from our sample size. Still, given that many controls were significant, we needed them to isolate the effects of the focus variables. We did so by using factor analysis to produce linear combinations of the controls, which could then be used successfully in parsimonious models. Three resulting factors were found to significantly improve the models:

SMALL AND RURAL captures a combination of environmental and governmental factors. Higher scores indicate that a local government is smaller and slower growing, more likely to be in Colorado (which historically had legal barriers to certain SUWM innovations, such as rainwater harvesting), concentrates water provision in fewer organizations, and is in a rural county that voted for Donald Trump in the 2016 presidential election.

Table 1 | Correlations of possible controls with SUWM PRACTICE.

Governance		Water quality	0.225*
Power		Water supply	0.349**
TrumpMajority2016	−0.222*	**Agency type**	
LWG actors		Special district	−0.221*
Good understanding of available innovations	0.306**	Municipality	0.170
LWG culture		County	0.041
Interest in innovation	0.258*	**Environment**	
LWG capacity		**Economic**	
Log normal of Population	0.525**	County median household income	0.012
Total agency revenue	0.251*	Pct Pop. Growth 2010–2019	0.223*
Experience_capacity	0.372*	**Social**	
Legal context		NCHS Urban–Rural Classification	−0.358**
Oregon	−0.025	Pct College Grads	0.041
Colorado	−0.223*	**Problem severity**	
Florida	0.072	Riparian area degradation	0.022
Arizona	0.148	Drought risk	0.176
Maryland	−0.078	Water supply cost	−0.019
Government Form/function		Groundwater overuse	0.094
CBSA sewerage Herfindahl Index	−0.233*	Flood risks	0.063
CBSA Water Herfindahl Index	−0.358**	Unequal access to safe water	−0.113
CBSA Nat Res Herfindahl Index	−0.217*	Flood claim payments	0.012
County sewerage Herfindahl Index	0.036	**Built**	
County water Herfindahl Index	−0.062	Population on public surface water supply	0.263**
LWG domains of responsibility		Population on public ground water supply	0.199*
Floods	0.166	**Natural**	
Stormwater	0.275**	Above mean drought conditions	0.279**
Wastewater	0.176	Above mean flood conditions	0.094
Water conservation	0.257**	Average annual precipitation	−0.018
Groundwater	0.154		

*Correlation is significant at the 0.05 level (two-tailed).
**Correlation is significant at the 0.01 level (two-tailed).

FORM AND DOMAINS captures the structure and function of the local governments. Higher scores indicate that a local government is a general-purpose government, as compared to a special-purpose district, with responsibility for multiple water functions including groundwater, wastewater, storm water, and flood control. Local governments with more responsibilities could be expected to use more practices, all else equal.

INNOVATIVE WATER SUPPLIER provides information on a local government's focus, capacity for innovation, and attitude toward innovation. Higher scores indicate that a local government has water supply and conservation in its portfolios, the water professionals in the community have a good understanding of SUWM innovations, and the community is interested in adopting innovative approaches to water management.

All correlational survey research designs, such as the one used in our study, risk mischaracterizing observed correlations as causation. This can occur when correlation between a dependent and focus variable is due to both variables being correlated with some unobserved third causal variable. But many such third variables relevant to our hypotheses were found to be weakly or very weakly correlated with our dependent variable (as shown in Table 1) or were associated with the control variables in the regression models. This, together with our theoretical reasoning reported under the section 'Background and Hypotheses' for expecting networks to foster innovation, reduces the likelihood that there are other valid explanations for our findings. Ultimately, however, quasi-experimental research designs could provide even stronger tests of our hypotheses. But given the inherent cost and difficulty of finding or creating such experiments, and the smaller samples and threats to external validity typically associated with such work, it made sense to us to begin testing our hypotheses with a correlational survey design. We do not reject the possibility of other explanations for the reported results if there are other factors we did not include in our efforts to find and use needed controls. Indeed, we would encourage future efforts to retest our hypotheses using quasi-experimental or experimental research designs, motivated by the strong results reported here.

RESULTS

Our initial analysis considered the simple linear relationships between SUWM PRACTICES and both TOTAL CONTACTS and the variables indicating the number of governmental, non-governmental, and academic organizational contacts. The relations between SUWM PRACTICES and both governmental and non-governmental contacts demonstrated high R^2 as shown in Figure 2. A comparison of both R^2 and the steepness of the fitted lines for GOV CONTACTS and NON GOV CONTACTS also suggested that the number of contacts with non-governmental organizations may be the more important of the two. Of course, these findings lack the control variables used in the regression models.

Turning now to the regressions reported in Table 2, we first see, in model (1), the effect of TOTAL CONTACTS alone on SUWM PRACTICES as a benchmark for the other models. Consistent with Figure 2, the results were highly significant. Given the variables' units, we can easily see that without controls, local governments had a mean of 1.15 more SUWM practices for every additional organizational network contact (i.e., for an increase of 1 in TOTAL CONTACTS).[2]

Next, in model (2), we introduced the three factors from the factor analysis as controls. All were significant along with TOTAL CONTACTS. We also saw an improved R^2 and modest reduction in the coefficient for SUWM PRACTICES. This suggests that TOTAL CONTACTS has an effect on SUWM PRACTICES independent of other forces that could be affecting the number of practices adopted.

We were concerned, however, with the loss of degrees of freedom (df) in model (2), caused by the missing values that occurred when using factors with missing data that are a linear combination of other control variables. To check if that loss of data directly affected the coefficient for TOTAL CONTACTS, we created models (3) and (4) to replicate model (2) but with approaches to controls that avoided losing degrees of freedom. In model (3), we substituted each factor with the control variable used in the factor analysis that had the strongest association with the factor (i.e., the variable with the highest factor loading). In model (4), we replaced the missing values with

[2] All the models reported in Table 2 are also robust to a log–log specification in which the dependent and focus variables are replaced with their log transformations. This produces coefficients for the focus variable coefficients that are elasticities, meaning that the coefficient for the focus variable (e.g., TOTAL CONTACTS) is the percent change in the dependent variable (SUWM PRACTICES) produced by a 1 percent change in the focus variable(s). In Model 2, for example, this specification indicates that a 1 percent change in TOTAL CONTACTS produces a 0.4 percent increase in the number SUWM PRACTICES.

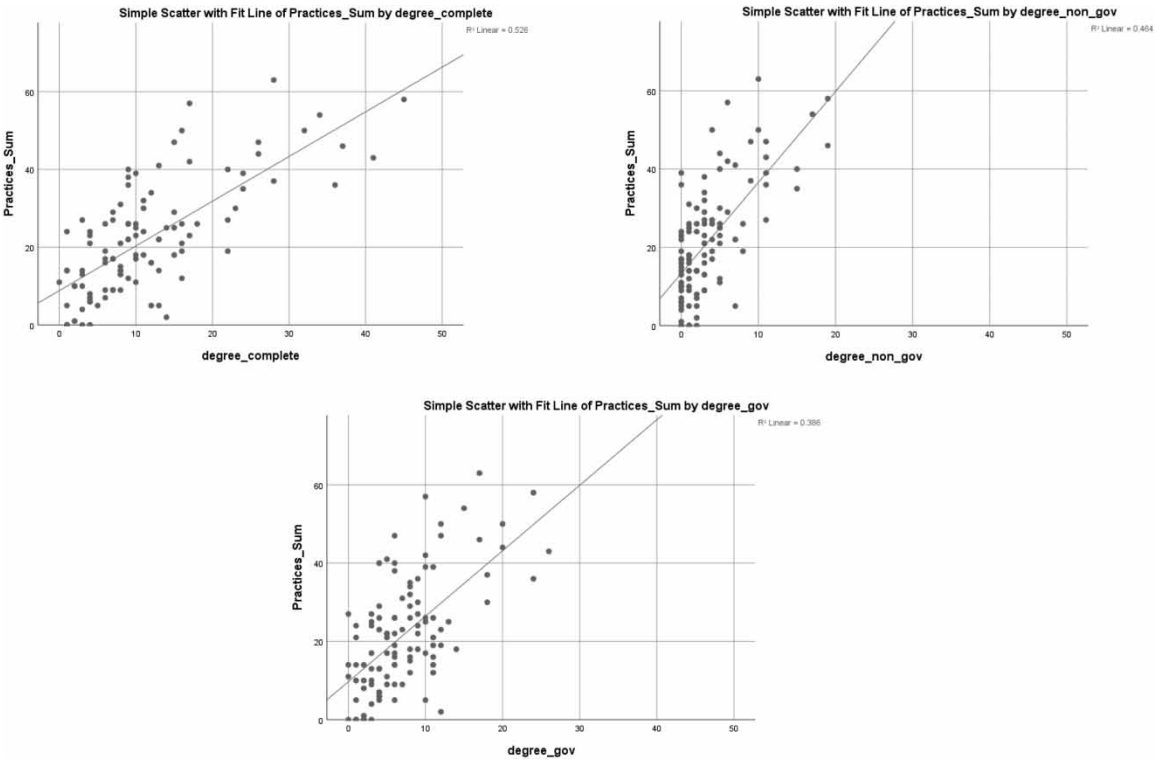

Fig. 2 | Relationships between SUWM PRACTICES (Practices_Sum) and governmental (degree_gov), non-governmental (degree_non_gov), and the combination of both types (degree_complete) of contacts.

means of the variables' distribution. The results for models (3) and (4) demonstrated that the low df in model (2) did not significantly affect the coefficient for TOTAL CONTACTS, increasing our confidence in model (2).

These results supported Hypothesis 1. Local Water Governments with larger organizational networks have implemented more SUWM practices.

We now move to Hypothesis 2 that collaboration with non-governmental organizations is more strongly associated with an increase in the use of SUWM practices compared to other types of collaboration. For our test, we replaced the focus variable TOTAL CONTACTS, which is a single measure of the total number of contacts, with two variables, GOV CONTACTS and NON GOV CONTACTS. That allowed us to differentiate the contacts counted to create TOTAL CONTACTS into two groups, those that were other government agencies and those that were not. The results are given in models (5) and (6), which indicate that both are highly significant. Their R^2 also indicate that both produce a better fit with the data, compared to TOTAL CONTACTS as indicated by model (1).

Note, however, that the coefficient for NON GOV CONTACTS in model (6) is considerably larger than for GOV CONTACTS in model (5). This difference is even more pronounced when GOV CONTACTS and NON GOV CONTACTS are used together in model (7). And given that R^2 was higher in model (7) than in models (1), (5), or (6), we can see that the prediction of SUWM PRACTICES is strengthened by using both GOV CONTACTS and NON GOV CONTACTS in the model. Based on model (7), we can estimate that local governments increase their number of SUWM practices by a mean of about 1.2 for every additional non-governmental organizational network contact and by a mean of about 0.7 for every governmental organizational network contact. In

Table 2 | Regression results.

	(1) SUWM practices	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	**Total contacts**	**Total contacts w/controls**	**Total contacts w/proxy controls**	**Total contacts w/controls and missing values replaced w/ mean**	**Government contacts w/controls**	**Non-government contacts w/controls**	**Government and non-government contacts w/controls**	**Government and non-government sub-types w/controls**
Total contacts	1.150***	0.832***	0.873***	0.953***				
Gov contacts					1.098***		0.680*	0.795**
Non gov contacts						1.493***	1.163***	
Water sector associations								3.580***
Academia								0.692
Consultancies								0.909
Small and rural		−4.099**		−3.752*	−5.256**	−4.136*	−3.877*	−3.927**
LWG domains		3.928**		3.888*	4.412**	3.539*	3.816*	2.825*
Innovative water supplier		3.896*		3.732*	4.188*	4.177**	3.846*	2.765*
Stormwater manager			2.383					
Water supplier			8.335**					
Increasingly rural county			−1.899**					
Df	105	44	94	110	44	44	44	44
R^2	0.526	0.632	0.553	0.553	0.529	0.588	0.638	0.735
Adj. R^2	0.521	0.595	0.533	0.536	0.482	0.547	0.592	0.685
F-stat	115.338***	17.140***	27.837***	32.749***	10.884***	14.264***	13.756***	14.647***

* ≤ 0.05, ** ≤ 0.01, *** ≤ 0.001.

other words, consistent with Hypothesis 2, *collaboration with non-governmental organizations is more strongly associated with an increase in the use of SUWM practices than other types of collaboration*.

To dive deeper into the nature of non-governmental contacts, we decomposed NON GOV CONTACTS into the sub-types listed under Methods and used the total number of each type as variables. Three of the sub-types had moderately significant correlations with SUWM PRACTICES: ACADEMIA (0.529), CONSULTANCIES (0.462), and WATER SECTOR ASSOCIATIONS (0.669). However, when all three were added to the model, only WATER SECTOR ASSOCIATIONS was significant, and multicollinearity problems were not encountered.

Water sector associations (WSA) generally include voluntary associations of governmental, non-governmental and private sector actors, such as the American Water Works Association and the Water Environment Federation at the national level, and the Arizona Municipal Water Users Association, the Colorado Stormwater Council, and the Southeast Florida Utility Council at the local or regional level. As shown by model (8), when the number of water sector associations is modeled with the number of government contacts and the control factors, the R^2 is the highest across all the models and WSA CONTACTS is highly significant. The number of SUWM practices implemented by a local government increases by a mean of about 1.2 for every additional non-governmental organizational network contact (model 7) and by a mean of about 3.6 for every additional organizational network contact that is a water sector association (model 8). *WSA is the type of contact most strongly associated with an increase in the use of SUWM practices.*[3]

DISCUSSION

Our results strongly support both our hypotheses. The number and the quality of organizational network partners are strongly associated with an increase in the use of SUWM practices, all else equal.

We do not have the data to establish which mechanisms are linking the number of contacts to practices; whether it is due to learning, social capital, social influence, risk mitigation, or coalition politics, all of which are theoretically prominent explanations. Nor can we say that the greater importance of non-governmental contacts, especially water sector associations, as compared to governmental contacts, is due to their distinct knowledge or geographic scope. Parsing these varied explanations requires a different research design that probes more deeply into what the contacts bring to the local governments and how the contact relationships shape a local government's capacity and motivation to implement new SUWM practices. While that would certainly be worth pursuing, for practitioners, as compared to theorists, it is certainly still useful to know what this study does show. *Creating and maintaining a robust organizational network of other government agencies and non-governmental organizations, especially water sector associations, increases the chances that a local government will implement more SUWM practices*.

The strength of water sector associations in the models is worth underscoring. Water sector organizations are an example of 'meta-organizations' discussed under the section 'Background and Hypotheses'. They are associations with public, private, and third sector organizations as their members that diffuse norms and best practices, including sustainability practices, among their members to achieve collective learning (Gadille *et al.*, 2013; Berkowitz, 2018; Webb, 2018). Berkowitz & Bor (2018) emphasize the need for more research into how they foster sustainability. Corazza *et al.* (2019) agree with them, but also claim that there is 'general support in the sustainability literature over the suitability of meta-organizations to foster sustainable development.'

[3] As suggested by an anonymous reviewer, it would be useful to know which organizations are most effective in fostering innovation, and what makes those organizations most effective. We agree that this could be an important extension of our present work.

Why might water sector associations, as meta-organizations, make them such influential parts of local government organizational network when it comes to fostering innovation? Berkowitz & Bor (2018) point to their capacity to be a 'multistakeholder and distributed governance device that defines and diffuses sustainable practices.' Corazza *et al.* (2019) emphasize their role in social learning. Berkowitz (2018) sees them as 'a neutral space of dialogue, negotiation and capacity building.' And Webb (2018) suggests that their collective identity allows greater credibility for actions, and supports the creation of shared values, which have 'integrative, directive and generative potentials for innovation activities.'

Certainly, the way water sector associations and other meta-organizations function to propel change deserves closer scrutiny, but for practitioners, knowing that they seem to make a big difference, as this study shows, may be reason enough for a local government that is interested in policy learning to join one or more of them. If more local governments became involved with sector associations, it could well hasten transitions toward more sustainable urban systems. Change agents seeking to foster such change would do well to encourage as much.

CONCLUSION

This paper builds on the growing recognition that organizational networks can be powerful drivers of policy change. While this study has focused on water, we imagine that networks are influential in other policy areas as well. Our prior review of research on water policy change in local governments did indicate, however, that organizational networks have not been studied as much as other drivers, such as organizational capacity, leaderships, and the socio-political environment (Pivo *et al.* 2020). The present study clearly shows that they deserve more attention both in research and practice. Our advice to change agents seeking to foster sustainable urban systems is not to go it alone. Get networked and be a part of a wider movement.

DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

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