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Understanding barriers to collaborative governance for the food-energy-water nexus: The case of Phoenix, Arizona

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ABSTRACT

Food-energy-water (FEW) nexus governance includes the communication and collaboration among multi-level stakeholders across sectoral boundaries of the resources for decision-making. It can increase resource security and decrease unintended consequences, as compared to single-sector governance approaches. Despite these benefits, in practice, many decisions continue to be made separately from one another without cross-sector collaboration. This research integrates the theory of collaborative governance with the concept of the FEW nexus to identify and understand the barriers to this collaboration and to provide recommendations for increased collaborative FEW nexus governance. Focusing on the Phoenix, Arizona metropolitan area, a water-scarce region with a growing population, we conduct a comprehensive case study with social network analysis, participant observation, and interviews. We present the results of our analysis in three sections. First, we identify the key barriers to collaborative FEW nexus governance within four identified themes: structural asymmetries, process asymmetries, communication and coordination, and external influences. Second, we unpack how stakeholders in our study case experience these barriers. Finally, from our case study, we provide recommendations for overcoming barriers and implementing collaborative FEW nexus governance in practice, such as building trust and finding mutual benefit. We conclude that "sector mismatch," similar to scale mismatch, is the main cause of the identified barriers and that approaches to collaborative FEW nexus governance must address this mismatch for successful engagement.

1. Introduction

The food-energy-water (FEW) nexus refers to the trade-offs, relationships, co-benefits, and interactions between the resource systems and governance sectors (Bazilian et al., 2011). Given the social and environmental interconnections, collaboration can promote policy coherence, sustainability, and resource security (Leck et al., 2015; Lele et al., 2013). Despite the benefits of integrated governance, however, stakeholders from public, private, and nonprofit sectors do not always effectively coordinate across sectoral boundaries. This may lead to incomplete knowledge, fragmented governance, and unintended consequences of policy decisions, which may exacerbate vulnerabilities to risks, uncertainties, and external shocks. While prior research has identified some barriers to collaboration, there is currently limited understanding of how stakeholders experience and navigate these barriers in the context of the food-energy-water nexus (Weitz et al., 2017a). Collaborative governance, the process of engaging multiple actors across scales and sectors to cooperate for joint policy and management, presents an opportunity to understand FEW nexus governance barriers. Our research addresses a gap in the scholarship by integrating the theory of collaborative governance and the concept of FEW nexus governance to provide a more complete explanation of the limitations to collaboration within the food-energy-water nexus and the structures and drivers that reinforce those barriers. We would expect collaborative governance to be practiced within the FEW nexus context as a framework to improve organizational design and decision-making effectiveness. Therefore, directly exploring the nature of collaborative governance within the FEW nexus may provide insights for more effective environmental management and policy.

Phoenix, Arizona, in the southwestern United States, presents a

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unique opportunity to examine the barriers to and opportunities for collaborative governance for the FEW nexus. There are numerous interactions between food, energy, and water resources and governance sectors in the region (White et al., 2017), establishing it as a "resource nexus hotspot" (Daher et al., 2018; Mohtar and Daher, 2016). The Phoenix metro area is in a water scarce, semi-arid region with a large and rapidly growing urban population, with a significant extent of peri-urban agriculture, and with considerable electricity generation from water-intensive approaches such as nuclear and hydropower. The area is experiencing increased water stress and extreme heat, exacerbated by the climate crisis, which is intensifying risks for interdependent infrastructure systems (Clark et al., 2019). Furthermore, the region is characterized by a complex environmental governance regime and interdependent policy structures, which create additional challenges that could benefit from novel collaborative approaches (Larson et al., 2013; Sullivan et al., 2019).

This paper examines the nature of barriers to collaborative governance for the food-energy-water nexus. Examining the case of the Phoenix, Arizona metropolitan area, we address the following research questions:

1. What are the barriers to collaborative governance of the food-energy-water nexus in a water scarce, semi-arid urban context?
2. Why do these barriers exist? How do stakeholders experience barriers to collaborative governance for the food-energy-water nexus?
3. How can concepts of collaborative governance be applied to understand and overcome these barriers?

To answer these questions, we employ a structured case study method (Creswell and Poth, 2017; Yin, 2018), guided by theoretical propositions derived from the literature to inform the data analysis and interpretation (Yin, 2018). Theoretical propositions are hypotheses that guide the case study analysis, and evidence gathered from a study is used show whether the proposition is supported or not (Yin, 2018). We expected that, first, the barriers to collaborative FEW nexus governance would be consistent to those identified in relevant prior literature. Second, we expected that these barriers exist because of misaligned sectoral decision-making processes and organizational structures. Third, we expected that overcoming these barriers will require adaptations to current organizational structures and processes across the three FEW nexus sectors. In the next section, we draw from the literature on the food-energy-water nexus and collaborative governance to expand upon these expected results and develop three formal theoretical propositions. In the methods section, we first describe the case context, focusing on the interactions of the FEW nexus in the Phoenix metropolitan area. We then discuss data collection, which includes participant observation and individual in-depth interviews, and the data analysis process of theoretically driven qualitative coding with pattern matching analysis to synthesize the case. The results section is organized around each of the three theoretical propositions as they correlate to the three research questions, using evidence from our data. Finally, we discuss our findings considering the literature as well as the potential application to similar FEW nexus contexts.

2. Theoretical background and study propositions

2.1. Collaborative governance

Collaborative governance is a process to shape public policy, management, planning, and implementation by engaging multiple actors across sectors and scales (Emerson et al., 2012). We further define collaborative governance as the processes and structures to engage multiple stakeholders across different levels of governance from public, private, and civic domains to intentionally and collectively influence decision making, public policy, management, and governance outcomes (Ansell and Gash, 2008; Emerson et al., 2012; Newig et al., 2017; Sullivan et al., 2019; Yeboah-Assiamah et al., 2016). Collaborative governance has been promoted as a paradigm that addresses the challenges of power asymmetries, enhances accountability of the decision-making entity, increases transparency of the decision-making process, includes stakeholders directly in knowledge generation, and facilitates cross-sector coordination and planning (Ansell and Gash, 2008; Emerson et al., 2012). Collaborative governance of actors from across scales and disciplines can lead towards greater credibility, legitimacy, and salience in the decision-making process, which can result in reduced vulnerabilities in the natural resource system (Cash et al., 2006).

Two key frameworks have been created to understand the factors for successful collaborative governance. The first was created through a literature review by Ansell and Gash (2008). Most central to collaborative governance is the collaborative process itself, which is dependent upon the iterative cycle of face-to-face dialog, trust building, commitment to the process, shared understanding, and intermediate outcomes. It is heavily influenced by factors such as previous history of conflict or cooperation, power imbalances, and incentives for participation (Ansell and Gash, 2008). A subsequent framework was proposed by Emerson et al. (2012), emphasizing the iterative and dynamic nature of collaborative governance in practice. This framework is centered around the Collaborative Governance Regime (CGR), which considers how principled engagement, shared motivation, and capacity for joint action work together toward shared outcomes (Emerson et al., 2012). With these frameworks, along with other empirical studies (e.g., Medema et al., 2017; Sullivan et al., 2019) and theoretical scholarship (e.g., Yeboah-Assiamah et al., 2016; Newig et al., 2017), we use collaborative governance to present a frame for understanding challenges to collaboration within FEW nexus governance. Based on this literature, the first proposition of the case study is as follows:

Proposition 1:. *Specific barriers to collaborative governance of the FEW nexus in practice result from the limited presence of success factors identified in prior theoretical and empirical research.*

2.2. Food-energy-water nexus governance framework

The food-energy-water nexus is defined as an interconnected system of the resources and their related governance sectors, considering trade-offs, interactions, and co-benefits (Bazilian et al., 2011). FEW nexus governance then refers to the structures and processes through which decisions are made, implemented, and enforced by and for stakeholders from across the food, energy, and water sectors for security of the integrated system (Lele et al., 2013). This integrated approach offers promise to improve resource security and reduce unintended consequences to manage uncertainty and improve sustainability outcomes from governance (Kurian et al., 2019; Leck et al., 2015). Despite the known benefits of FEW nexus governance, in practice, decisions are often made within sectoral silos with inadequate coordination (Leck et al., 2015). This can lead to fragmented knowledge and incoherent policy, exposing the linked systems to vulnerabilities, uncertainties, and external shocks.

While the FEW nexus perspective offers several conceptual advantages, there is critique in the literature. First, FEW nexus research has been criticized for focusing narrowly on quantitative and modeling approaches, and scholars have called for greater attention to interpretive and qualitative approaches (Albrecht et al., 2018; Newell and Ramaswami, 2020). Additionally, scholars argue that FEW nexus literature in practice highlights one resource over the others, with water typically being prioritized (Smajgl et al., 2016). Other scholars, however, note that focusing on the implications of one resource on the other two allows for more manageable analysis and more meaningful implementation (Allan et al., 2015; Finley and Seiber, 2014; Pahl-Wostl, 2019; Ringler et al., 2013). Finally, much existing literature focuses on the speculative benefits of FEW nexus governance (Finley and Seiber, 2014; Leck et al.,

2015; Lele et al., 2013; Rasul and Sharma, 2016). With this heavy focus on conceptual understanding, there are calls for more empirical studies, tool creation, and implementation approaches (Liu et al., 2018; Opejin et al., 2020; Ringler et al., 2013). Further, research should employ empirical and qualitative approaches to understand the drivers and structures behind identified barriers to FEW nexus governance, as experienced in practice.

Several empirical studies of FEW nexus governance focus on identifying the barriers to implementation (Howarth and Monasterolo, 2016; Pahl-Wostl, 2019). Howarth and Monasterolo (2016) found in the United Kingdom that lack of communication, differences in the decision-making process within each sector, differences in term definitions, and the presence of uncertainties were barriers to nexus governance. Additionally, power asymmetries (Pahl-Wostl, 2019) and rigid sectoral regulations and planning procedures (Liu et al., 2018) create further challenges. There is, however, limited understanding derived from stakeholders' views about why these barriers are in place and the structures that uphold the barriers to collaborative FEW nexus governance (Weitz et al., 2017a). With differences in the processes and structures between the three sectors, coordination between the three sectors can be challenging, and stakeholders in each sector may experience those barriers differently based on their sector-specific interests, (Weitz et al., 2017a). Previous research on FEW nexus stakeholders in the study region has noted the difficulties in collaborative governance caused by these sector-specific differences in function, institutional processes, and organizational cultures (White et al., 2017). Based on existing literature, the second proposition in the case study is as follows:

Proposition 2a. : *Specific barriers to collaborative governance of the FEW nexus, as experienced by stakeholders, are caused by differences in organizational structures and decision-making processes between food, energy, and water sectors.*

Proposition 2b. : *The differences in organizational structures and decision-making processes result in stakeholders in each FEW nexus sector experiencing collaborative FEW nexus governance differently.*

Interdisciplinary collaborative governance provides opportunities to explore the complexities of resource management for holistic collaborative governance with reduced uncertainty. Though collaboration across all resource sectors may not be effective, certain resources could greatly benefit through collaborative approaches. Collaboration specifically between food, energy, and water resources is important because of the strong interdependencies of the resources (Leck et al., 2015; Lele et al., 2013; Rasul and Sharma, 2016). Applying the developed theory of collaborative governance to the newer concept of the FEW nexus can provide an avenue to better understand and empirically study collaborative FEW nexus governance. For example, Weitz et al. (2017b) applied integrative environmental governance (IEG) to the concept of the FEW nexus, concluding that coordination across the FEW nexus sectors may benefit both from shifts in political and legal structures and from changes in cognitive factors such as trust and willingness to share knowledge. While the IEG literature differs from collaborative governance, it contains similar characteristics which may be useful for collaborative governance in practice and in empirical study. Thus, overcoming barriers to collaborative governance and leading toward implementation in practice may benefit from shifts in attitudes and restructuring of organizational structures and decision-making processes. Based on the literature and expert understanding of the case, we present the third proposition in the case study as follows:

Proposition 3:. *Overcoming these barriers to implement collaborative FEW nexus governance requires adaptations that promote success factors for collaborative governance and that overcome differences in decision-making processes and organizational structures.*

The research reported here addresses the critiques within FEW nexus literature in several ways. First, we complement quantitative and modeling studies through a structured qualitative case study approach, contributing to greater diversity in methods for analyzing FEW nexus systems. Second, our empirical case study elicits perspectives directly from stakeholders and practitioners, including through participant observation of collaboration in naturalistic settings, providing evidence about the opportunities for collaborative governance of the nexus in situ. Third, we address a gap in the literature by focusing on reasons behind barriers. Understanding why identified barriers are in place provides opportunity to create structures and approaches to overcome these challenges and lead towards collaborative governance of the FEW nexus in practice. Finally, in line with recent research (e.g., Mounir et al., 2019; Guan et al., 2020), we focus on the metropolitan scale, complementing existing national, regional, and state scale studies.

3. Methods

We employed a case study approach (Yin, 2018) to understand the barriers to collaborative governance between the FEW nexus sectors. Case study is appropriate when the research examines a complex, contemporary phenomenon within its natural context using multiple sources of evidence (Creswell and Poth, 2017; Yin, 2018). The Phoenix area was selected because it is an exemplar of the interconnected food-energy-water resources, also called a food-energy-water "resource nexus hotspot" (Daher et al., 2018; Mohtar and Daher, 2016).

3.1. Study context: Phoenix, Arizona

The Phoenix, Arizona metropolitan area has a population of about 5 million people as of 2020. This water-scarce region is among the most rapidly growing, urbanizing, and diversifying areas in the country; high agricultural demand, growing municipal demand, land use changes, and aging infrastructure are pressing concerns (Gober, 2018). Since 2000, the Phoenix area has experienced the most extreme drought in a century and among the worst droughts in the last 1200 years (Overpeck and Udall, 2020; Udall and Overpeck, 2017), causing water levels in major reservoirs, such as Lake Mead, to drop to historic lows, triggering a federal declaration of shortage on the river, and depleting groundwater resources. The regional impacts of climate change mean that the region will experience higher temperatures, more frequent and extreme drought, and more variable precipitation, posing major risks for agriculture, energy, and water security, according to the Fourth National Climate Assessment (Gonzalez et al., 2018).

There are strong interlinkages between food, energy, and water in the region (Clark et al., 2019; Guan et al., 2020; White et al., 2017). Agriculture is historically important to the economy, history, and culture in the Phoenix area, and while agricultural acreage in the metropolitan region is declining, irrigation still accounts for much of the water demand. Energy is also intricately tied to the water system. Energy is used for local water distribution, water treatment, groundwater pumping, and surface water conveyance. For example, the Central Arizona Project (CAP) canal transports water from the Colorado River to central and southern Arizona, and CAP is the single largest electricity user in the state (Bartos and Chester, 2014). Additionally, hydroelectric power generation contributes towards the electricity mix.

Food, energy, and water governance in the region is multi-level. Governance of agriculture is largely decentralized, with many actors making decisions at the farm-level or through local collectives such as irrigation districts, farm bureaus, and lobbying associations (e.g., AZ Cattlemen's Association, Cotton Growers Association) (Eakin et al., 2016). State-level policy is developed by the Department of Agriculture and the Arizona Legislature. In contrast, energy governance is largely centralized, with a few actors controlling most of the decision-making authority. These actors include two major electricity utilities in the metro area, Arizona Public Service (APS) and Salt River Project (SRP), along with the Arizona Corporation Commission, which regulates public utilities, as well as the Arizona Legislature. Water governance occurs

across multiple levels. At the state-level, the Arizona Department of Water Resources (ADWR) is a powerful actor. At the regional-level, CAP, SRP, and Arizona Municipal Water Users Association (AMWUA) play a significant role. Local decision-making includes individual cities, such as the City of Phoenix, and private water companies, among others (Larson et al., 2013).

3.2. Data collection

We identified study participants and participant observation opportunities using centrality measures from a social network analysis (Jones and White, 2021). Social network analysis quantifies and visualizes the interactions, relationships, and knowledge flows between actors within a defined system (Borgatti et al., 2009) and is a well-defined approach to stakeholder identification, analysis, and collaborative governance (Baird et al., 2016; Fliervoet et al., 2016). This social network identified 93 stakeholders in the case and evaluated their collaboration (Jones and White, 2021). We calculated degree centrality for each stakeholder, which is the number of other entities to which a particular actor is connected (Freeman, 1978). Using this ranked degree centrality from the social network analysis (Jones and White, 2021) and perspectives from stakeholders in a previous study (White et al., 2017), we then placed stakeholder organizations into an interest-influence diagram. A subset of this sorting of actors can be seen in Fig. 1; for clarity, not all 93 stakeholders are included here. This interest-influence diagram emphasizes the robust approach to and rationale for the sampling selection of participants to include in the data collection. From this diagram, we selected stakeholders from the top-right (high influence-high interest), the top-left (low influence-high interest), and bottom-right (high influence-low interest) quadrants. Actors from the bottom-left quadrant were not selected as they have low influence over and low interest in the collaborative governance of FEW nexus resources.

We collected data during a six-month period, between January and June 2020. From this stakeholder analysis, we conducted 17 interviews with key stakeholders. This included actors from the City of Phoenix, irrigation districts, local farmers, and water and electricity utilities. Interview questions focused on the approaches to and nature of previous collaborative engagements, on their perspective on relevant nexus actors in the region, and on the barriers that they encountered in collaborating with other stakeholders. Each interview was labeled with the letter "P" followed by a number, such as P3. Additionally, we conducted participant observation of six public meetings. The lead author wrote fieldnotes as data for these engagements. While not exhaustive, these public meetings provided additional data of how stakeholders manage and govern food, energy, and water resources to support the interview data. Table 1 provides an overview of the organizations that were included in the participant observations and the interviews.

3.3. Data analysis

The transcribed interviews and the fieldnotes from participant observation were imported into MAXQDA 2020 software for qualitative coding. First, we created a codebook deductively, including codes from a systematic, though not comprehensive, literature review of collaborative governance scholarship. In this literature review, we used a matrix to capture the key components of collaborative governance and compare them across multiple peer-reviewed articles. The most frequent components for collaborative governance were selected to be used in the codebook. This approach to codebook development has been used in similar studies (e.g., Sullivan et al., 2019). Then, we coded the data inductively to denote the barriers to collaborative FEW nexus governance and approaches to overcoming those barriers that emerged in the data. Finally, we applied the deductive codebook to the data. Once all the codes were applied to all the text, we used pattern matching to synthesize the case study analysis. Pattern matching is the process of comparing patterns uncovered in the empirical data to the expected patterns made prior to data collection (Trochim, 1989; Yin, 2018). It is used to determine how well the data align with theory. Pattern matching is a widely used approach to case study analysis and has been used in studies in disciplines ranging from urban planning (e.g., Bradshaw, 1999) to sustainability (e.g., Hörisch, 2018) to public administration (e.g., Cordella and Paletti, 2019). We used it here to synthesize the case to address the research questions.

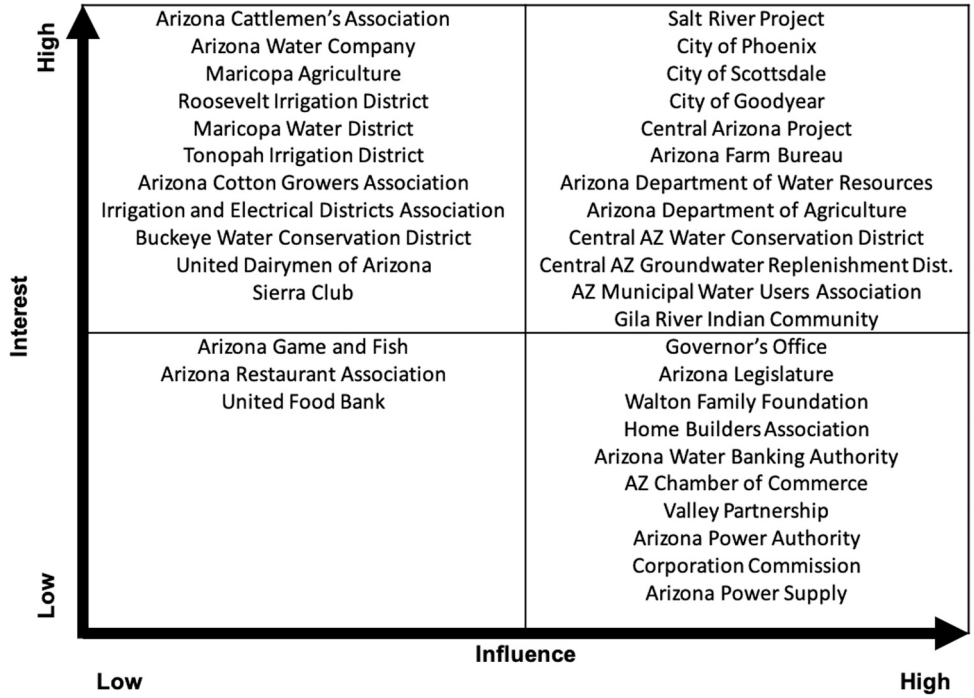

Fig. 1. Subset of the interest-influence diagram for stakeholder analysis of actors identified through social network analysis of the case region.

Table 1
An overview of the stakeholder organizations for participant observation and interviews, in alphabetical order.

Organization	Organization Type	Nexus Sector (s)
Participant Observation		
Arizona Corporation Commission	Utility Regulator	E/W
Arizona House Committee on Natural Resources, Water, and Energy	State Legislative Committee	W/E
Arizona Municipal Water Users Association	Nonprofit Corporation	W
Arizona Power Authority	State Body Corporate and Politic	E
Arizona Senate Committee on Water and Agriculture	State Legislative Committee	W/F
Central Arizona Project	Surface Water Supplier	W
Interviews		
Agribusiness and Water Council	Nonprofit Trade Association	F/W
Arizona Cattlemen's Association/AZ Farm and Ranch Group	Nonprofit Organization/Lobbying Organization	F
Arizona Department of Agriculture	State Agency	F
Arizona Farm Bureau	Nonprofit Corporation	F
Arizona Municipal Water Users Association	Nonprofit Corporation	W
Arizona Power Authority	State Body Corporate and Politic	E
Arizona Water Banking Authority	Groundwater Recharge Authority for the Arizona Department of Water Resources	W
Central Arizona Groundwater Replenishment District	Groundwater Replenishment Authority for CAP	W
Central Arizona Project (CAP)	Surface Water Supplier	W
City of Phoenix – Environment Department	Municipal Government	F
City of Phoenix – Water Department	Municipal Government	W
City of Scottsdale	Municipal Government	W
Family Farm	Farm	F
Roosevelt Irrigation District	Municipal Corporation	W/F
Salt River Project – Water	Utility Cooperative and State Agency	W
Salt River Project – Power	Utility Cooperative and State Agency	E
Sierra Club	Environmental Nonprofit	Cross-cutting

4. Results

The results section is organized around each of the three theoretical propositions, where each proposition supports the accompanying research question. The results then present evidence to support or refute the proposition.

4.1. ***Proposition 1:*** *Specific barriers to collaborative governance of the FEW nexus in practice result from the limited presence of success factors identified in prior theoretical and empirical research*

Our findings supported Proposition 1, as the identified barriers to FEW nexus governance suggest a lack of success factors for successful collaborative governance. This study revealed barriers that can be organized into four categories: (i) structural asymmetries, (ii) process asymmetries, (iii) coordination challenges, and (iv) external influences. Structural asymmetries refer to barriers between the differences in organizational structures across the three FEW nexus governance sectors that inhibit collaborative engagement. This includes factors like inflexible organizational structures and limited resources such as time and personnel. For example, when asked about barriers to collaborative governance, one stakeholder said, "That lack of resources to do the work that's needed is truly a barrier" (P2), while another stakeholder said, "Time and personnel resources are the thing holding it back" (P8). Second, process asymmetries refer to barriers resulting from the differences in decision-making, management, and policy processes between the three FEW nexus sectors. This includes factors such as unequal power distribution, lack of commitment to collaboration, and differences in bureaucratic processes. For example, one stakeholder simply said, "It's a lack of power" (P3) that contributes towards challenges for collaborative governance. Third, coordination challenges refer to interpersonal and cognitive challenges that inhibit collaborative engagement. This includes factors such as lack of trust, arrogance, and lack of communication. For example, a stakeholder reflected on challenges to expanding water storage capacity in the state, noting, "You can't build a storage project because there isn't trust" (P13). Finally, external influences refer to previous histories of conflict or unfavorable context that create a hostile environment for collaboration. For example, a stakeholder said, "It can be a history of past issues [or] it could be unrelated issues in history" (P13) that lead to challenges for collaborative governance. Thus, these barriers juxtapose with the identified factors in the literature (e.g., Ansell and Gash, 2008; Emerson et al., 2012) that contribute towards successful collaborative governance, suggesting that the absence of these success factors in FEW nexus engagements allows barriers to collaborative governance to prevail.

4.2. ***Proposition 2***

4.2.1. ***Proposition 2a:*** *Specific barriers to collaborative governance of the FEW nexus, as experienced by stakeholders, are caused by differences in organizational structures and decision-making processes between food, energy, and water sectors*

Our analysis supported Proposition 2a. The four categories of barriers experienced and expressed by stakeholders in the results for Proposition 1 can help us understand why these barriers exist. First, our results revealed how the different organizational structures between food, energy, and water stakeholders can contribute towards challenges for collaborative FEW nexus governance. This includes differences in the norms and rules between sectors and different stakeholder goals and objectives. For example, a water actor noted, "A lot of water policy has been built on the idea of, 'I'm building my portfolio of needs.' This kind of silo effect. I think that's really been a real barrier and actually continues to be a barrier" (P2). This emphasizes how a focus on accomplishing one's own needs can inhibit the prioritization of collaboration that could benefit multiple sectors' priorities and further emphasizes the structural differences between food, energy, and water organizations.

Second, these differences in structures can lead to differences in processes. Though food, energy, and water organizations all tend to have similar overall purposes—reducing risk and uncertainty and increasing efficiency and affordability—the way in which each sector's organizations do this is different and may not be compatible across sectors. For example, one food stakeholder noted the challenges of working across scales when sectors have different timescales, stating, "The tough part is being able to continue those collaborations and that relationship given our sometimes slow, bureaucratic process" (P11). Additionally, achieving the goals of one actor may inherently counteract achieving the goals of another sector, as noted by other scholars (e.g., Fader et al., 2018). For example, a water stakeholder noted that, "Every community, every area has their own interest. And so, what makes [collaboration] harder is communities' competing interests" (P10). Differences in processes that exist at various governance and temporal scales can exacerbate other differences between organizational structures and uphold barriers to collaborative governance.

Furthermore, these differences in structures and processes can be affected by influences external to the FEW nexus system, further exacerbating challenges to collaborative governance. For example, as noted by one water stakeholder, "Any meeting with the tribal communities is going to start with how 100 years ago you stole our water, and we still haven't forgiven you for it. And I mean, it's very relevant but you say that to an Anglo decision maker, and you know you can't do anything

with that" (P3). Additionally, changes in circumstances can present challenges. In discussing the failed attempt to collaborate to prevent the closure of a large coal power plant, one water actor noted, "The main issue was the fact that natural gas was so inexpensive now, that it couldn't compete with coal" (P7). Historical conflict and changing circumstances are phenomena that can inhibit collaborative governance, but often are outside the control of any specific individual or organization. In summary, barriers exist because of different organizational structures and operational processes between the food, energy, and water sectors, where external influences can exacerbate these differences.

4.2.2. ***Proposition 2b:*** *The differences in organizational structures and decision-making processes result in stakeholders in each FEW nexus sector experiencing collaborative FEW nexus governance differently*

Our findings supported Proposition 2b. While actors in all three FEW nexus sectors do engage in collaborative governance practices, they collaborate in different ways. This is partly due to power imbalances and different perceptions of the level of inclusion present within collaborative FEW nexus decision-making. First, water actors tend to collaborate both within their sector and with food and energy stakeholders. In finding consensus within the water sector, at an Arizona Municipal Water Users Association meeting, one board member stated that a bill was "an opportunity for all of us in the water sector to work together on legislation." Similarly, another water stakeholder said, "Everyone is always involved in stakeholder processes all the time. And what I have found is they've always seemed to bring in people from different organizations…it's not just one group." (P9). Additionally, in the water sector, collaborative governance across sectors is needed to effectively manage limited water resources that span across political and sectoral jurisdictions. For example, a water actor noted that, "The [city] has a really robust portfolio…But we can't rely solely upon that, and just ignore the fact that there are cities around us…that will be impacted…so we've been trying to work with others to increase their sustainability and resiliency" (P2). They emphasized that water extends beyond the political bounds of their city, and that partnering with neighboring cities and organizations is necessary for comprehensive management of water resources.

Food and agriculture actors, however, tend to collaborate mostly within the food sector. For example, one participant from the food sector discussed collaborating mostly with other food sector actors.

> "Our partners, not just all the agriculture organizations that we're connected with, but also Local First Arizona, as an example. And the food banks, we're very connected with them…on the national level, it would be everyone from the American Farm Bureau Federation to the national Cattle Growers Association. And then on the state level, we have the United Dairymen's Association, the Arizona Pork Council, [and] the Arizona Beef Council." (P12).

The participant went on to discuss attempts to collaborate with environmental groups, noting challenges. "We also reach out to the environmental groups that sometimes, I must confess, kind of throw us under the bus every once in a while, but we do reach out to them" (P12). This within-sector collaborative governance of the food sector may occur because the agriculture gains the benefit of the economy of scale when a predominately disaggregated set of actors can come together over a common purpose or shared resources. For example, one food actor discussed how several organizations came together to purchase a unit of a local power plant. "It's been really great because we've been able to get that economy of scale of owning a power plant without actually have to own, construct, build, or operate one. So, we get all the benefits" (P13). Therefore, while the food sector does engage in collaborative governance, it focuses on within-sector governance, which may be due to experiencing challenges in attempts at cross-sector collaborative governance.

In the energy sector, some stakeholders collaborate exclusively with organizations like them, while others make efforts to reach across sectoral boundaries. One energy stakeholder emphasized the similarities they had with their collaborative partners, noting, "We work pretty extensively with [hydropower company]. We seem to be in lockstep there. They are a similar agency with regards to function…We try to work collaboratively with them" (P4). However, a different energy stakeholder noted the extensive stakeholder engagement work they had done with updating the organizations' sustainability goals. "I went and visited with about 20 stakeholders from across the [Phoenix] valley… and we got feedback" (P16). The differences in how these organizations collaborate may be that the former is an energy-only organization while the latter focuses on both energy and water.

In summary, the water sector more readily engages in collaborative FEW nexus governance outside of its resource sector. This may be because water is the fulcrum of natural resource management and the FEW nexus in central Arizona, due to the semi-arid climate of the region (White et al., 2017). This creates a landscape where water actors may have greater power over collaborative processes than food and energy actors. For example, a cross-cutting stakeholder discussed their frustrations with collaboration because a small group of actors held most of the decision-making power. "In Arizona, there's a group of water interests that people refer to as the water buffalos…they're the ones that have been calling the shots on what happens with our water laws and policies for a pretty long time" (P6). These power imbalances between the three sectors can inhibit collaborative FEW nexus governance, as not all stakeholders feel that they have equal influence in decision-making arenas. Furthermore, each sector has a different perspective on how inclusive collaborative FEW nexus governance is. A water stakeholder discussed how a diversity of actors were included in the process of creating the Groundwater Management Act. "Everyone was involved in that binding: agriculture, cities, ag districts, everybody was involved, but not everybody got what they wanted…And I visualize as we go forward, that will continue. That we'll always have full collaboration by all water users and energy users" (P7). However, non-water stakeholders may not agree that FEW nexus governance is as inclusive. While referring to another legislative process, the Drought Contingency Plan, an energy stakeholder noted, "Their drought contingency plan moved so quickly that they limited who could be in the room. Power [energy] was not in the room" (P4). These power asymmetries result in different perceptions of the collaborative FEW nexus governance; while water actors may perceive that there is full collaboration, energy and food actors often express being left-out of the decision-making process. This barrier of power imbalance results in stakeholders across the three sectors experiencing attempts at collaborative FEW nexus governance differently.

4.3. ***Proposition 3:*** *Overcoming these barriers to implement collaborative FEW nexus governance requires adaptations that promote success factors for collaborative governance and that overcome differences in decision-making processes and organizational structures*

Our findings partially supported Proposition 3. While overcoming barriers may require adaptations in organizational structures and decision-making processes, stakeholders must first establish a strong foundation that supports successful collaborative engagement. Participants identified seven factors to establish this foundation, overcome barriers, and lead toward adaptations for collaborative governance: building trust, shifting attitudes, finding common ground, transparency, sharing resources, finding mutual benefit, and responding to times of crisis. (1) Building trust was identified as a foundational element to collaboration and overcoming barriers. One stakeholder said, "I think the way that you would remove all those barriers is for people to operate with complete trust" (P15). (2) Shifting attitudes involve putting aside one's differences, removing selfishness, and eliminating personal biases. An energy stakeholder said that overcoming the barriers to collaboration

"would require the need to be so great that people would put aside their self-serving nature" (P4). (3) Finding common ground through understanding other's perspectives and being open to compromise can move collaboration forward. A food actor said, "You try and come to some understanding of where other people are coming from. And then you try and help everyone find a solution that works for everyone" (P17). (4) Engagement through transparency, openness, and communication can create a pathway to move beyond sectoral differences. In describing the organization's experience with the DCP process, a cross-cutting participant described how the barriers that prevented collaboration could have been overcome. "[It requires] open and transparent communication, collaborating publicly, and not moving important discussions and decisions behind closed doors" (P6). (5) Resources, including time and money, are necessary to engage in collaboration. Increasing access and availability to said resources can help facilitate collaborative engagement. One food actor suggested "identifying resources for those who maybe don't have resources to be at the table" (P6). (6) Finding mutual benefit and win-win solutions between all the parties in collaboration provides an incentive for actors to commit to collaborative processes, despite the challenges. A participant stated, "Once they recognized that there's an opportunity for mutually beneficial partnerships, I think we're going to see more collaboration with them" (P5). (7) Finally, times of crisis or disaster can promote collaboration by forcing different parties to come together to address the immediate challenge. One water actor said, "Sometimes it takes a major disaster, a major event to bring people together" (P1). In summary, establishing a foundation of collaborative success factors can improve the shared motivation for collaborative engagement, while adaptations to organizational arrangements can improve the capacity for joint action. These are two of the collaborative dynamics identified by Emerson et al. (2012) as essential for successful collaborative governance.

5. Discussion and conclusion

In this study, we examined barriers to collaborative governance for the food, energy, and water nexus in the Phoenix metropolitan area in the southwestern U.S., which is an exemplar case of a nexus hotspot city in a water-scarce region (Daher et al., 2018). While the findings and conclusions of this study are based upon a close contextual examination of naturalistic settings for environmental policy and decision making, the insights may be generalizable to other cities with comparable social and environmental contexts. Naturalistic generalization, as compared to traditional statistical generalizability, allows us to generalize from a single case by recognizing similarities between the outcomes of the single case and other contexts (Schwandt and Gates, 2018; Stake, 2000). In this way, the results of this study may be useful to understand collaborative FEW nexus governance in other case cities. We propose three noteworthy contributions to scholarship on collaborative governance and FEW nexus governance.

First, we conceptualize barriers to collaborative governance of the FEW nexus in four categories: structural asymmetries, process asymmetries, coordination challenges, and external influences. The first three categories of barriers are consistent with prior empirical research (e.g., Howarth and Monasterolo, 2016) and theoretical conceptualizations (Liu et al., 2018; Pahl-Wostl, 2019; Weitz et al., 2017b) of barriers to FEW nexus governance. However, the barrier of external influences had not been noted in the literature. These external influences, from the collaborative governance literature (e.g., Ansell and Gash, 2008; Emerson et al., 2012), are crucial to understanding the context of FEW nexus governance, as this context can encourage or hinder collaborative governance between the sectors. Thus, the context in which the FEW nexus governance system is situated may need to change to allow for greater collaboration, such as overcoming conflict from previous engagements. Systems that are unable to overcome this barrier may not be suitable for collaborative governance of FEW nexus sectors.

Second, while the goals for each resource sector may be similar, mismatches in approaches to achieve those goals hinder collaborative governance. For example, there may be differences in the temporal scales in which decision are made between FEW nexus sectors or differences in the geographic jurisdiction of organizations between them. These mismatches become particularly evident when considering the cross-scale and cross-level interactions of collaborative governance that occur within and between sectors (Cash et al., 2006). Similar to the scale mismatch discussed in environmental governance and social-ecological-systems (Cash et al., 2006; Cumming et al., 2006; Gibson et al., 2000; Pahl-Wostl et al., 2020), then, this "sector mismatch" relates to the differences between food, energy, and water governance systems that make them inherently challenging to collaborate with one another. Understanding the mismatch between governance organizations can be key for successful collaborative governance (Plummer et al., 2013). However, the water sector has begun to overcome existing barriers to initiate cross-sector collaboration. This may be because water is the limiting resource within the local FEW nexus and thus connects to both the food and energy sectors. Energy is needed to ensure sufficient water supply in the Phoenix area and water is needed to ensure sufficient cooling in power plants, while water is also needed to maintain food and agriculture production. In this way, many water actors may serve as boundary organizations within the nexus. Boundary organizations sit across the divide between policy and science and are an approach to overcoming mismatches between governance challenges related to scale (Cash and Moser, 2000). Thus, Phoenix water organizations, which conduct research, influence and advise policy teams, and inform decision-making, intersect with both the energy and food sectors, linking the local Phoenix FEW nexus. Therefore, in sum, the barriers between FEW nexus governance sectors in the Phoenix area exist because of "sector mismatch," though existing cross-sector collaborations may be explained by the presence of water boundary organizations, a strategy to overcome scale mismatch. This is consistent with previous scholarship that has noted the need for better consideration of the importance of scale in understanding governance challenges and proposed solutions (Pahl-Wostl et al., 2020).

Third, seven approaches to overcoming these barriers to collaborative governance of the FEW nexus were identified by stakeholders. These include building trust, shifting attitudes, finding common ground, improving transparency, increasing resources for collaboration, establishing win-win solutions between parties, and addressing times of crisis. This suggests three requirements in moving towards implementing these strategies in practice. First, certain conditions, such as trust and common understanding, are essential foundations for adaptation to occur (Nilsson and Eckerberg, 2009; Weitz et al., 2017b); establishing a shared foundation of these conditions across sectors is thus necessary for successful collaborative governance. Second, as suggested by recommendations such as win-win solutions and shared resources, there needs to be a motivation and an incentive to engage in collaboration. These require a common definition of FEW nexus governance and a shared understanding of its goal. In practice, however, the term "nexus" has been critiqued for not having a clear definition (Cairns and Krzywoszynska, 2016) and in practice has experienced challenges from a lack of common understanding of the shared goal of engagement (Weitz et al., 2017b). Thus, a common understanding of FEW nexus governance in practice needs to be established for each collaborative engagement. Finally, while overcoming "sector mismatch" is the key for collaborative governance across the FEW nexus sectors, the focus of the stakeholders on the lack of foundational components for collaborative governance suggest that foundations for collaboration generally need to be established first. This may promote more within-sector collaborative governance as well as cross-sector collaborative governance.

In conclusion, this study explores the barriers to collaborative FEW nexus governance. While much theoretical research has explained the presence of siloed FEW nexus governance (Liu et al., 2018; Pahl-Wostl, 2019), and some empirical studies have identified barriers to integration (e.g., Howarth and Monasterolo, 2016), there is minimal understanding

of why these barriers exist (Weitz et al., 2017a). This in-depth case study begins to address this research gap by exploring the structures and processes behind barriers to collaborative governance within the Phoenix, Arizona metropolitan area. The results of this study identified the key barriers to cross-sector collaborative governance, which exist because of "sector mismatch," where differences in organizational structures and decision-making processes between food, energy, and water organizations do not align in ways that naturally lend themselves to collaborative governance. To move towards true collaborative governance of the FEW nexus, though, these mismatches must be overcome. However, first, as recommended by stakeholders, an essential foundation for collaboration needs to be established, including establishing trust and finding mutual benefit. This research provides an opportunity for greater collaborative FEW nexus governance in practice. Though this case study produces evidence from only one system, this research provides an opportunity to generalize to other urban spaces, as the Phoenix metropolitan area contains many of the same characteristics of other urban FEW nexus hotspots (Daher et al., 2018). We recommend future investigation to consider other cities as case studies to understand the generalizability of the structure of these barriers. To our knowledge, this is one of only a few empirical studies that has examined the barriers to collaboration in FEW nexus governance (see Schreiner and Baleta, 2015; Howarth and Monasterolo, 2016; Bielicki et al., 2019; Melloni et al., 2020). Investigation of additional cities provides an opportunity to synthesize across cases and create triangulation for identifying generalizable barriers to collaborative governance of the FEW nexus.

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Author contributions

DDW received grant funding for the study; JLJ designed the study; JLJ conducted the data collection and analysis; JLJ drafted the manuscript; and DDW revised the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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