Managing policy-making in the local climate governance landscape: The role of network administrative organizations and member cities

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Abstract
Trans-municipal networks (TMNs) have reshaped the landscape around local government action on global climate policy. Past research has focused on why cities join TMNs and the impact that membership has on local action. This study considers a potential reverse effect: namely, that cities’ membership choices position them to influence TMNs’ overall priorities. In considering this, we emphasize the role of network administrative organizations (NAOs) and posit that the multiple climate-related networks, which share members and operate in overlapping geographic and issue spaces, are bound together as part of a meta-network. We utilize social network analysis and data on membership in four climate-related TMNs to examine the factors that shape how cities can influence meta-network priorities. We find that cities with local vulnerabilities tend to be located in network positions that enable them to influence the meta-network’s overall priorities.

1 | INTRODUCTION

As national and international governments struggle on issues of climate and sustainability, the number of trans-municipal networks (TMNs) developed to support local governments in these areas has increased notably. TMNs are networks of local governments that span jurisdictional boundaries and are formed around a shared objective. They are organized around direct city-to-city contact and are distinguished by three features: (1) voluntary and non-
binding membership; (2) non-hierarchical, horizontal and polycentric organizational structures; and (3) member commitments to implement TMN policy decisions (Kern and Bulkeley 2009). This combination of obligation and flexibility makes TMNs attractive to municipalities compelled to act on complex issues in an era when the range of issues local governments are expected to address has widened, even as their access to resources continues to decline. Although membership requires local investment, some cities have opted to join multiple similarly focused TMNs. The resulting overlap creates links across TMNs from which an overarching informal meta-network emerges. This article addresses the question: ‘What factors shape cities’ influence within this climate and sustainability meta-network, particularly as it pertains to their abilities to mould the overall direction of relevant policy that their peers pursue?’ In so doing, it introduces the potential for a bi-directional influence relationship between cities and TMNs' administrative hubs.

TMNs are organized by and around network administrative organizations (NAOs). NAOs are the managerial bodies to which member actors delegate the organizational responsibilities of facilitating the network-wide development of new approaches and strategies for tackling complex policy problems. NAOs operate the organizational infrastructure and broker relationships between actors within the network and between the network and external partners (Provan and Milward 2001). They help set network priorities, steer activities, champion causes, and handle day-to-day tasks. They also make key decisions which impact how financial, informational, technical and political influence are distributed amongst their members.

TMNs, and the NAOs that manage them, are an important part of the modern governance landscape around climate and sustainability. For example, TMNs, including C40 Cities and ICLEI Cities for Sustainability, have raised awareness of local governments’ role in environmental policy-making and provide representation at national and international policy-making forums (Zeppel 2013; Acuto 2016), including the UN Climate Change Conference (Meyer et al. 2018). In what is often a noisy idea-environment, NAOs select particular priorities, approaches and actions to promote amongst their members, for example by providing guidance on how to measure and report emissions (Ewing-Thiel and Manarolla 2011). A key objective is to facilitate knowledge sharing and collaboration between cities (Rashidi and Patt 2017), which in turn stimulates innovation. NAOs work to capacitate local governments to achieve sustainability targets by providing knowledge, resources and incentives conducive to effective policy-making (Betsill and Bulkeley 2007; Krause 2012a; Lee 2013). They provide the social infrastructures which allow TMNs to function as ‘communities of practice’ while also providing the opportunity for branding and reputation building (Acuto et al. 2017).

Scholars have examined TMNs for their impact on cities' policy initiatives (Sharp et al. 2011; Krause 2012a; Rashidi and Patt 2017). However, the reverse—cities' potential influence on overall TMN priorities—has received little attention. This unidirectional focus limits recognition of the impact that cities' efforts can have beyond their jurisdictional boundaries and ignores the important role they play in catalysing policy change among peers and at higher levels of government (Shipean and Volden 2006; Koski 2010). Similarly, research into NAOs explores how these entities impact the efficacy, efficiency, and endurance of policy-making networks (Provan and Milward 2001; Provan and Kenis 2008; Macciò and Cristofoli 2017), but often overlooks the impact that member behaviour may have on these outcomes. Thus, by empirically accounting for the bi-directional quality of NAO relationships with network members, we can explore the extent to which cities may leverage their membership to amplify their preferred policy approach.

There are multiple similarly aimed TMNs active around local climate and sustainability. Although they may emphasize different dimensions of climate change mitigation and adaption, as a group they increasingly recognize and act at the nexus of these objectives (Lee and Jung 2018). Many municipalities have opted to participate in more than one related TMN, suggesting that they perceive benefits from multiple membership that make these investments worthwhile. This trend towards multiple membership establishes a web of relationships between cities that extends both within and across networks, creating a single 'meta-network'. There is evidence of collaboration among climate-oriented TMNs (Lusk and Gunkel 2018); however, the extant literature largely fails to recognize their connectedness. NAOs play a critical role as stewards of the meta-network; they coordinate with shared-member cities as well as directly with each other to shape priorities and governance (Lusk and Gunkel 2018). Moreover, to the
extent that overlapping member duties place a strain on members, failure to coordinate may also shape member performance. By treating the TMNs operating in the climate arena as isolated entities, the extant literature has overlooked a potentially important interactive dynamic. Our meta-network framework seeks to correct this tendency by: (1) explicitly acknowledging that, in this shared space, information and influence often extend beyond the bounds of individual networks; and (2) analytically accounting for NAOs’ crucial role in connecting and guiding interactions among member cities, which shapes the opportunity structures that emerge across overlapping TMNs.

Cities are important stakeholders in global sustainability and climate protection policy-making, and their participation in related TMNs reflects commitment to these issues (Acuto 2016; Kousky and Schneider 2003). Observing how cities’ engagement with TMNs may shape their influence furnishes public administration scholars and practitioners with an opportunity to examine the relational dynamics between administrators and those whom they administer. Insight offered by this exploration is particularly relevant as complex issues are increasingly being tackled collaboratively as part of semi-formal governance networks (e.g., Fleming et al. 2006). We employ social network analysis (SNA) to account for the presence of NAOs and understand how cities’ multiple memberships shape the distribution of relevant resources within the resulting meta-network. SNA is a useful method for examining environmental policy-making (Bodin and Crona 2008; Henry and Vollan 2014) and is increasingly applied to the study of TMNs (Lee and van der Meene 2012). Here, measures of network centrality offer a theoretically grounded means to empirically test hypotheses about how cities are positioned in the policy space constituted by the meta-network (Freeman 1978; Bonacich 1987; Borgatti 2005). By examining cities’ locations within the larger constellation of their engaged peers, this article deepens current theorizing on governance and policy network membership and reveals substantive implications of positioning for policy influence.

2 | MANAGING THE TRANSMUNICIPAL ENVIRONMENTAL META-NETWORK

Environmental TMNs span the globe and enable distant cities to exchange information, ideas and resources with one another via established platforms. However, the examination of purposive peer-to-peer and city-to-NAO influence requires frequent, patterned interactions. Empirical studies tell us that there is a limit to the number of relationships that can be sustained to make meaningful social exchanges (Dunbar and Spoors 1995; Gonçalves et al. 2011). Moreover, there is a tendency for similar actors to cluster together, a dynamic in networks referred to as homophily (McPherson et al. 2001). Among cities, similar geographies, legal infrastructures and institutional norms may be a crucial driver of homophily. Taking this into consideration, we concentrate on TMN members in a single country: the United States.

Four climate and sustainability networks—ICLEI USA, the Urban Sustainability Directors Network (USDN), 100 Resilient Cities, and C40 Cities—and their local members constitute the US meta-network. Although other similarly aimed organizations exist, only these four actively exhibit the TMN characteristics outlined in the introduction. Moreover, although they lack means of enforcement, regular monitoring and the expectation of follow-through on agreed commitments sets them apart from other groupings of cities that have coalesced around similarly aimed pledges, commitments or certifications. Each TMN is discussed in more detail below.

The four TMNs included in this analysis vary considerably in terms of their size, resources and entry requirements. Although worth noting, there is no reason to expect a priori that certain networks are more important than others in the meta-network. After all, while some TMNs, like C40 and 100RC, are able to offer their members more financial support, other larger networks yield benefits from being able to access more peers. The heterogeneity of the TMNs is interesting for both theoretical and practical reasons. Learning, which is often identified as a key benefit

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1We excluded from the meta-network groups that are: (1) largely symbolic lists of cities that have expressed a common commitment (e.g., US Mayors Climate Protection Agreement); (2) focused on certifying or assisting individual governments rather than on facilitating interaction between them (e.g., LEED STAR Communities); and (3) still-affiliated off-shoots of an included network (e.g., Carbon Neutral Cities Alliance).
of TMN membership (Lee and Van de Meene 2012), illustrates the potential ripple effect multiple membership across these forums can have for policy-making. For example, the City of Ashland, Oregon, which is a member of only one network (ICLEI), may benefit from the multiple memberships of nearby cities like Portland (member of C40, USDN and ICLEI) and Beaverton (member of USDN and ICLEI) simply by interacting with them via ICLEI-sponsored events and communications. Through these interactions, Ashland officials may indirectly access new ideas or information offered by these other networks, and use it to lobby ICLEI leadership for particular action. Table 1 provides an overview of key characteristics of meta-network components.

| Table 1 | Overview of TMNs in the meta-network |
|---------|-------------------------------------|
|         | ICLEI USA | USDN | 100 Resilient Cities | C40 cities |
| **Year founded** | 1997 | 2008 | 2013 | 2006 |
| **Geographic scope** | United States | US and Canada | Global | Global |
| **Total members (2017)** | 205 | 180 | 100 | 92 |
| **US member cities** | 160 | 140 | 23 | 12 |
| **Network Organization Administration** | ICLEI USA has 6 paid staff. Globally ICLEI has ~260 staff | USDN has 15 paid staff | 100R has 52 paid staff. Globally 100R has ~100 staff | Globally C40 has ~100+ paid staff |
| **Membership criteria / eligibility requirements** | Complete application; designate employee and elected official as liaisons. Any city that applies and pays dues is accepted | A sustainability director and record of sustainability accomplishments | Competitive membership. Cities selected from three rounds of applications (2013, 2014, 2016) | Membership restricted. Three classes: (1) Megacities; (2) Innovator cities; (3) Observer cities (one-year temporary status) |
| **Membership obligations** | Annual dues between $600 and $8,000 a year, depending on city size | Annual dues determined on a sliding scale based on city size (e.g., $4,150 for city of 1.5 million). Active participation | Develop and implement the resilience strategy; create Chief Resilience Officer in executive office of city | Mandatory participation standards and progress reporting requirements |
| **Membership benefits (exclusive)** | ClearPath software for GHG emissions inventories; members-only reports and webinars; cohort learning groups; technical assistance from ICLEI staff | Annual meeting to convene in person; private intranet for networking, info sharing, and problem solving; ability to apply for USDN funds | Funds to hire a Chief Resilience Officer and pay salary for 2–3 years; inclusion in the 100RC Network for online and in-person info sharing; direct technical assistance | Annual summit and meetings; staff supported networks around specific issues; access to experts and specialized research; ability to apply for C40 funding and city advisers; high visibility |
2.1 | ICLEI USA

ICLEI Local Governments for Sustainability began in 1991, as a United Nations-sponsored initiative and is now an independent transnational organization. It includes over 1,500 members in 124 countries and consists of several regional networks (Roberts 2019). ICLEI USA is the largest ICLEI regional network. ICLEI played a formative role in identifying local governments as relevant actors in climate and sustainability. It focuses on eight programme areas: emissions management, climate preparedness, resource efficiency and renewables, climate finance, leadership campaigns, international collaboration, climate equity, and city–business collaboration. Member-only benefits include in-depth reports, webinars where members can interact around certain topics, customized technical assistance from ICLEI staff, annual conferences, and the use of ClearPath software, which is described as ‘the leading online software platform for completing greenhouse gas inventories, forecasts, climate action plans, and monitoring at the community-wide or government-operations scales’ (Roberts 2019).

2.2 | Urban Sustainability Directors’ Network

The Urban Sustainability Directors’ Network (USDN) is a ‘peer to peer member-driven practitioner network’, which emerged in 2008 from a shared desire by several municipal sustainability officers for a forum to learn from others working in similar roles (USDN 2017). Municipal sustainability officers are themselves USDN members, but they can bring in others from their city governments as participants in the network. USDN leadership has expressed intentionality about not diluting the network by letting it get too big (Plastrik et al. 2014). Its core membership is capped at 70 but it has added a second category of associate members and is promoting regional partner networks (USDN 2017). USDN’s three areas of focus are GHG (greenhouse gas) reduction, climate resilience and social equity. Member benefits include an annual meeting and other opportunities to convene, a private intranet for networking and information sharing, and the ability to apply for project funding from USDN.

2.3 | C40 Cities

Established in 2005, C40 Cities is an international network aimed at addressing climate change through city-based GHG mitigation initiatives. The network has 92 member cities, 12 of which are in the United States. It is described as comprising ‘economically and politically powerful cities’ led by globally influential mayors (Davidson and Gleeson 2015, p. 25). Cities can join C40 as megacities, innovator cities, and observer cities. Megacities must pass a population or GDP threshold. Innovator cities can be smaller—but still must be a metropolitan anchor—and be internationally known as climate innovators. Observers hold a one-year temporary status prior to applying as an innovator or megacity (C40 2012). C40 contains 17 sub-networks organized under six initiative areas: Adaptation; Waste and Water; Energy and Buildings; Transportation; Urban Planning and Development; Business Data and Innovation. Members may attend regional meetings and the C40 annual summit, have access to specialized research and expertise, and can apply for exclusive funding opportunities.

2.4 | 100 Resilient Cities

100 Resilient Cities (100RC) is an international TMN which aims to build the capacity to ‘survive, adapt, and grow, no matter what kinds of chronic stresses and acute shocks [are experienced]’ (100RC 2018). 100RC’s city members, 23 of which are in the US, were selected via three rounds of competitive applications in 2013, 2014 and 2016. Benefits of membership most notably include funds to employ a Chief Resilience Officer (CRO) for two to three years.
FIGURE 1  The two-mode US climate and sustainability meta-network

Key
- The size of each node indicates their role as connecters within the meta-network.
- TMNs are black diamond-shaped nodes
- Member cities are white square nodes
Member cities are obliged to locate the CRO in the executive branch, organizationally near the mayor or city manager. A second key membership benefit is the 100RC Chief Resilience Officer Network and its global and regional summits. At the time of writing, the 100RC programme is transitioning and has suspended its activities.

### 2.5 Network administrative organizations

Typically, in studies of TMNs, cities are considered the only relevant actors (see Lee and Van de Meene 2012; Bansard et al. 2017; Rashidi and Patt 2017). However, in the meta-network two sets of actors are relevant: cities and each TMN’s NAO. The term NAO was coined by Provan and Milward (2001, p. 418) to describe any organization which ‘in its key role as disseminator of funds, administrator, and coordinator of the network ... is both the agent of the community and the principal of the network participants’. NAOs broker relationships between actors within the network and between the network and external partners. The professional full-time staff (see Table 1) employed by the NAOs operate the organizational infrastructure that monitors and coordinates TMNs. They help set TMN priorities, steer activities, champion causes, and handle day-to-day operational tasks. NAOs can determine networks’ policy-making process by imposing conditions on members and shape how financial, informational, technical and political influence are distributed within their networks. Based on interviews with NAO staff, Lusk and Gunkel (2018) find that they often coordinate activities with the NAOs of other similarly aimed TMNs. More specifically, they observe that NAO staff often work to avoid scheduling conflicts, attend each other’s events, and express awareness of the competing pressures that TMN obligations place on members. These efforts ‘keep the peace’ within the meta-network.

Figure 1 presents the meta-network that links USDN, ICLEI, C40 and 100 Resilient Cities. It consists of the four NAOs (black diamond-shaped nodes) and the 239 US cities (white square nodes) that, as of February 2018, were members of at least one of them. The network is organized using graph theoretic distance which reveals a meta-network organized in seven principal clusters. The size of each node represents its degree centrality score, which indicates the breadth of each actor’s connections within the meta-network. ICLEI and USDN NAOs have the highest degree centrality in the meta-network. Certain cities also serve as important hubs. For example, its membership in all four TMNs and its geographic positioning near a large number of other active California cities, results in Los Angeles having a particularly high degree centrality.

### 3 THEORY AND HYPOTHESES OF META-NETWORK POSITIONING

The question why cities participate in multiple similarly focused TMNs has begun to attract attention from scholars. Leffel and Acuto (2108) examine TMN membership using a political economy perspective and conclude that cities with higher positions in the economic hierarchy simultaneously reap the greatest benefits and challenges from urbanization. They thus have both the capacity and motivation to join multiple TMNs and do so as a resource- and reputation-seeking behaviour aimed at fuelling continued economic growth. Rashidi and Patt (2017) find that membership in two TMNs significantly raises the likelihood that a focal municipality will adopt a climate change policy when compared to membership in only one or no TMNs. They conclude that multiple membership raises a city’s commitment to climate policy by widening its access to services and resources. However, the fact that they do not employ a selection model casts some doubt on their findings. Alternatively, Bansard and co-authors (2017) observe that multiple membership rarely translates into either additional monitoring and evaluation or more robust action by cities to reduce emissions. In combination, these findings suggest that cities with greater ability, motivation and resources are more likely to join multiple TMNs. However, in some cases, such as with C40, having a large size and resource base is a prerequisite of membership, indicating that cities’ membership patterns are not completely self-
determined. As Leffel and Acuto (2018) observe, joining TMNs is thus ‘a combination of both structural forces and the agency of city government actors’ (p. 285).

Membership in TMNs is an investment. Cities expend staff time and energy, political will, and often money in the form of annual fees to fulfill their obligations as members. Moreover, many of the cities that participate in multiple TMNs already possess significant capacity to pursue climate and sustainability policies, independent of any membership (Krause 2011; Lee 2013). Therefore, their own policy innovation may not be the primary motivation for TMN membership, much less multiple membership. For example, local leaders may choose to invest in TMNs to ‘amplify their message by uniting around a common cause, to signal to local constituents that they share a particular priority, and to exchange best practices or other information’ (Lusk and Gunkel 2018, p. 6). This desire to shape the aim of mainstream policies may be motivated by a perception of an urgency due to a specific local vulnerability or by leaders’ ambition to accumulate political capital through sustainability leadership (Gustavsson and Elander 2012). It is an open question whether TMN membership raises cities’ capacities to pursue these aims.

Influence is a requisite for affecting policy. But what additional clout can the meta-network offer that, for example, a well-resourced megacity does not have already? To address this question, we employ Bonacich’s (1987) conceptualization of power in networks which is tied to dependency whereby the actors upon which the greatest number of other actors depend have the greatest influence in the network. This contrasts with perspectives that associate influence with access to high-social status actors. To influence peers, focal actors can use coercion (based in formal authority) or suasion, the act of guiding and convincing peers. It is more difficult for focal actors to exercise suasion with well-connected peers who could turn to many others. Indeed, navigating relationships with high-status peers can take up time and drain resources (Valente and Fujimoto 2010). In contrast, poorly connected actors may be easier to mobilize, steer and steward, thus raising our focal actor’s level of influence.

Since sustainability and climate policy-making is situated within a multi-level governance system (Betsill and Bulkeley 2006), local managers understand that their performance is intertwined with the choices of their neighbours in the region and their peers across the country. Thus, bargaining and negotiation around policy shapes influence in the meta-network. The incorporation of local needs into the policy process can be highly contested and may require repeated negotiations to establish legitimacy and persuade other actors to undertake complementary efforts. Just as importantly, network membership is by no means a lifetime commitment. Cities can abstain from renewing their membership in TMNs at any given time (Krause et al. 2016). It stands to reason that decisions on whether to remain in a TMN or to join yet another TMN are also informed by cities’ assessments of the tangible and intangible benefits that they reap by means of their current position in the meta-network and, to some extent, how that compares to focal peers’ positions. These tendencies are also mediated by cities’ position vis-à-vis NAOs which, as stated previously, are gatekeepers to critical resources and social infrastructures that require substantial commitments from members. Recognizing that network membership is at least somewhat structurally influenced, we offer four hypotheses that examine the dynamics that shape cities’ position in the meta-network.

**Vulnerability hypothesis:** Cities that are more vulnerable to the effects of climate change assume positions of power within the meta-network.

Physically vulnerable cities have immediate and material interests in aggressive climate action being taken by as many governments as possible. Physically vulnerable cities, particularly those threatened by sea-level rise, face imminent effects of climate change and their actions alone can do little to stop it. Thus, they have the greatest incentive to push for stringent policy-making within the meta-network and may see membership as an opportunity to lobby peers who may otherwise be satisfied with baseline climate action targets. Locales that are physically vulnerable to climate change have incentive to be at the front lines of climate change policy-making. In many coastal cities, the impacts of climate change are already perceptible and local awareness of their exposure to climate risk is high.

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2We consider as focal those municipalities that cities emulate or compete with (Shipan and Volden 2008), as well as cities that they lead or negotiate with.
Vulnerable cities have been shown to be particularly invested in mitigation activities since they have more at stake (Zahran et al. 2008b). They stand to gain particular benefits from deep carbon mitigation efforts implemented worldwide, and will suffer drastically from inaction. We expect that these cities will join as many TMNs as necessary to secure positions where they can 'evangelize' other cities and put pressure on NAOs, encouraging them to further align with their policy preferences.

**Risk hypothesis:** Cities whose participation in climate protection-related activities may be perceived as creating local economic risk assume positions of greater social influence in the meta-network.

Cities with carbon-intense economies are less likely than otherwise similar cities to join climate-oriented TMNs (Zahran et al. 2008a). Those that do may be wary of pressure to undertake actions that could harm their local economy. The local economic development literature from the 1970s introduced ideas of cities as 'growth machines' and argues that well-organized pro-growth interests, like real estate developers and business groups, are generally successful in encouraging the adoption of policies that align with their preferences (Molotch 1976). These preferences have conventionally been seen as at odds with sustainability, but may be less influential than previously thought (Portney 2013). Hoping to balance economy with sustainability, engaged cities with carbon-intensive economies may emphasize 'efficiency' as a policy priority. Alternatively, from a political economy perspective, cities with a greater industry and manufacturing basis may recognize their challenges and have the tax-base-fuelled capacity to encourage the development of solutions to address their particular long-term risks (Leffel and Acuto 2018), including those that may be felt economically should a carbon tax ever be introduced. As members of the meta-network, these cities can be expected to join as many TMNs as needed to accumulate the influence to promote these ideas in this policy space without accruing too many costs.

**Institutional incentive hypothesis:** The professional incentives present in a council-manager government increase the power associated with cities' positions in the meta-network.

Local political institutions shape incentives, which shape behaviours, and ultimately help shape cities' policy actions (Clingermayer and Feiock 2001). The most basic and heavily examined operationalization of local political institutions is form of government, as specified in each city's charter. In particular, a large amount of research has examined the impact of 'reformed' government structures (i.e., council-manager) relative to other, more political, forms (Carr 2015). In council-manager governments, an appointed professional city manager serves as chief executive officer. Cities with this form of government are thought to be influenced more heavily by professional norms and be somewhat insulated from political forces. They have also been empirically associated with more progressive policies (Ramirez de la Cruz 2009). Sustainability leadership in council-manager cities therefore may have the freedom and professional incentive to assume positions in the meta-network where they are able to act as opinion leaders and shape the substantive decisions of peer municipalities. City managers have an incentive to balance these policy aims against fiscal and workforce considerations, making them unlikely to invest in more TMNs than is necessary to achieve these aims.

**Capacity hypothesis:** Cities with greater internal capacity are less reliant on political support from other TMN members when pushing for policy change. We thus expect them to have lower influence within the meta-network.

Given that local government capacity has emerged from the empirical literature on sustainability as one of the strongest predictors of local action (Swann and Deslatte 2019), this hypothesis may initially seem counter-intuitive. However, in networks, there is a trade-off between degree centrality—achieved by being connected to many high-powered actors—and the ability to influence (Bonacich 1987). We expect that high-capacity cities, which are often key innovators and knowledge producers, will prioritize the former over the latter.
Government capacity is typically operationalized as having both human and financial dimensions (Hawkins et al. 2016). Particularly for issues that are not core local government functions, the availability of adequate resources is essential for information gathering and policy development as well as the implementation of policies once adopted (Hawkins et al. 2016). Because climate protection is a long-term technical effort—often requiring large investments with lengthy payback periods—having professional staff, stable revenue streams and some flexibility with expenditures is important (Hawkins et al. 2016). Large cities generally are higher capacity than smaller ones and, as such, often play the role of entrepreneur and innovator (Walker 1969; Lee 2013). Particularly when addressing public goods issues like climate protection, there is a motivation to share advancements that enable all interested parties to make progress. This may lead high-capacity cities to attain positions that allow them to spread information quickly, via access to other high-status actors, as opposed to positions that maximize direct social influence. What is more, compared to their peers in the meta-network, high-capacity cities are likely to be less reliant on leveraging the rights, responsibilities, and resources controlled by NAOs to increase their social influence.

FIGURE 2  City TMN membership, overlap, and summary statistics

|                  | ICLEI (n=160) | USDN (n=140) | C40 Cities (n=12) | 100RC (n=23) |
|------------------|---------------|--------------|-------------------|--------------|
| Population (mean)| 209,487       | 376,639      | 1,886,668         | 1,073,980    |
| Per-capita income| 33,724        | 31,488       | 31,466            | 29,679       |
| Education (pct BA+) | 42.2         | 41.2         | 38.4              | 37.4         |

*Note: There are four cities that belong to R100 and USDN*
4 | NETWORK ANALYSIS—SAMPLE AND RESULTS

This article utilizes as its sample the 239 US cities that were members of ICLEI USA, USDN, 100 Resilient Cities and/or C40 Cities, per the 2018 membership rosters listed on each organization’s website. The meta-network is analytically considered as a two-mode, or affiliation, network which includes two types of entities—in our case, cities and NAOs—and the relationship which binds them: membership (Faust 1997; Malinick et al. 2013).

Approximately 30 per cent of the cities in the sample are members of multiple networks, with 61 being members of two networks, and four belonging to all four. The networks exhibit some differences from each other in terms of city member characteristics. The most notable variation is in population size, where C40 and 100RC have, on average, much larger cities as members. Figure 2 depicts this overlap and basic network member characteristics.

The few existing applications of network analysis to the question of multiple-TMN membership have counted co-membership as a relationship shared between cities (see Bansard et al. 2017). To more accurately account for the hub and spoke arrangement of the meta-network and the influence of NOAs, we construct a two-mode social network. We apply weights to network ties to reflect findings in the literature that suggest that nearby cities tend to have stronger interactions with each other as a result of (1) administrative decisions by NOAs, such as holding regional conferences; (2) convenience, that is, lowered transaction costs because of distance; and (3) shared concerns (Marsden 2011; Lee and Van de Meene 2012). If two cities in the same TMN are also from the same region then we assume that they will have greater interactions, and apply distance dependent weights on their relationships. Given their important hub position, we use US geographic regions established by USDN as a guide.3

5 | EMPIRICAL MODEL—DATA AND METHODS

Reflecting the existing empirical literature on local climate policy adoption, we model cities’ decisions on participation in multiple TMNs, and their subsequent positioning in the meta-network, by considering variables associated with each city’s political institutions, government capacity, physical vulnerability and economic profile.

5.1 | Dependent variable

Power centrality, a measure generated from the network analysis, serves as the dependent variable in the empirical model. Centrality measures reflect cities’ network positions, which result from decisions made by focal municipalities and their peers. Although multiple centrality measures exist, each associated with a particular tangible outcome and indicating a different dimension of ‘importance’ in the network, we focus on power centrality. It operationalizes the idea that those who wish to influence peer policy-making will try to build a following within the network by reaching out to poorly connected peers while at the same time building and maintaining connections to well-connected actors, like NAOs and well-connected peers. Cities with links to periphery actors may be efficient at influencing and bridging previously unconnected groups (Valente and Fujimoto 2010). Achieving the position as an important ‘connector’ in a network is not dependent on traditional resources associated with city size or wealth, and a combination of vulnerability and dependency on other actors may heighten motivation to take on a bridging role. Network actors with high power centrality can also act as gatekeepers because they are positioned to allow or hinder the transfer of knowledge and other resources from well-connected cities and NAOs to less well-connected cities, and vice versa.

In sum, Bonacich’s (1987) power centrality ($\beta$) measure captures this ‘big fish in a small pond’ phenomenon by measuring how well connected any network actor, A, is (degree centrality) relative to A’s immediate contacts within

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3Networks with and without regional weighting were run and compared. The regional weights increase the power centrality (see Material and Methods) associated with cities that are members of multiple TMNs. This is because the weighting mathematically acknowledges that one TMN city-member can introduce the TMN’s ideas and connections to its regional neighbours via other network memberships.
the network. Two-mode power centrality measures the centrality of both cities and NAOs (Faust 1997, Borgatti 2009), where each city’s power centrality is measured not only in relation to each other city but also in relation to the centrality of each NAO. Power centrality measures in the meta-network range from 5.7 to 11,862.8. On average, nodes have a power centrality score around 2,332.52 ($\sigma^2 = 3,580.79$).

| TABLE 2 | Independent variable description and source |
|---|---|
| Institutional incentive hypothesis |
| Form of government | Dichotomous variable indicating whether a city has a council-manager form of government (1) or some other form (0). Source: International City/County Management Association. | Mean: 0.66 StdDev: 0.48 |
| Capacity hypothesis variables |
| Population | 2010 city population in 1000s. Source: 2010 US Census. | Mean: 249.2 StdDev: 654.5 |
| Own source general revenue | The cities’ dollar amount of own source general revenue per capita. Source: 2012 Census of Governments. | Mean: 1996.2 StdDev: 1654.7 |
| Vulnerability hypothesis variables |
| Vulnerability to sea-level rise | Dichotomous variable indicating whether a city would be flooded with 10 feet of sea-level rise or surge event. Source: Climate Central. | Mean: 0.35 StdDev: 0.48 |
| Risk hypothesis variables |
| GHG producing economic sector | The per cent of the local economy that is in construction, manufacturing, and transportation sector. Source: 2010 US Census. | Mean: 18.1 StdDev: 5.4 |
| Control variables |
| Education | The per cent of adults over 25 in each city that have obtained a bachelor’s degree or higher. Source: 2010 US Census. | Mean: 41.6 StdDev: 16.7 |
| Political leaning | The per cent of the county vote that was cast for the Democratic candidate in the 2012 presidential elections. Source: CQ Voting and Elections Collection. | Mean: 61.4 StdDev: 13.3 |
| Income | The per capita income in a city. Source: 2010 US Census. | Mean: 32,794 StdDev: 13,853 |
| Race | Per cent of city population that is a racial or ethnic minority (i.e., not non-Hispanic White). Source: 2010 US Census. | Mean: 41.2 StdDev: 22.9 |
| Time in meta-network | An ordinal variable indicating the year in which a city first joined any TMN in the meta-network, where 4 = pre-2005, 3 = 2005 to 2009, 2 = 2010 to 2014, and 1 = after 2014. | Mean: 2.34 StdDev: 0.91 |

5.2 Independent variables

Table 2 provides a description and source of all variables in the model. Reflecting the extant literature, the political institutions hypothesis focuses on form of government (Carr 2015), the data for which are gathered from the International City/County Management Association. The variables associated with local government capacity—per capita own source revenue and population—are obtained from the 2012 Census of Governments and 2010 US Census, respectively. Own source general revenue is used to operationalize fiscal capacity because, relative to other sources of revenue, it has fewer strings attached and allows the most flexibility to pursue non-standard objectives (Hawkins et al. 2016). Cities’ population size is used as a proxy for human capacity. Although it is not an ideal variable, larger cities generally have larger and more professional staff (Krause 2011). Other more direct measures of staff capacity are problematic in this analysis. For example, the commonly used dichotomous variable indicating whether a city has a dedicated sustainability staff raises endogeneity concerns because some TMNs require that cities have such positions.
Data on cities’ climate vulnerability are gathered from the non-profit organization Climate Central. Of the various operationalizations of vulnerability utilized across studies—which have included air quality, weather-related disasters and coastal proximity—there is somewhat more consistent evidence suggesting that vulnerability to sea-level rise increases engagement in sustainability-related activities (Zahran et al. 2008a). The specific measure of vulnerability used here is whether a city would be flooded with a ten-foot increase in sea-level rise or surge event. Finally, the 2010 US Census provides data on GHG-producing sectors (a combination of the per cent of each city’s local economy that is in construction, manufacturing and transportation) which captures the perceived economic risk associated with stringent mitigation.

5.3 | Controls

Acknowledging the argument that public demand for sustainability often varies in a manner that can be predicted by a series of demographics (Lubell et al. 2005), we include relevant community characteristics as control variables. Political leaning is consistently found to be a significant predictor of sustainability action, whereby, all else equal, more liberal cities are more likely to engage (Krause 2011, 2012b; Swann and Deslatte 2019). Although they show somewhat more variation, higher educational attainment rates, average income and larger minority populations are also often associated with greater local action on these issues (Homsy 2016). The length of time that a city has been in the meta-network is a final control.

6 | RESULTS

We run an ordinary least square regression on the power centrality measure dependent variable. This method has been used by social scientists to understand if social outcomes are shaped by network position (e.g., Ibarra and Andrews 1993) and vice versa (see Borgatti et al. 2009). When running linear regressions using network data, researchers must exercise caution that their models do not produce biased results due to violating the assumption of independent and identically distributed (iid) observations. Thus, we employ Kolmogorov–Smirnov tests, a set of commonly used techniques to test for iid (Tygert 2010), to establish that our data meet these assumptions.
The regression results, reported in Table 3, provide mixed support for the hypotheses that we laid out earlier. As expected under the vulnerability hypothesis, vulnerability to sea-level rise is both positively and significantly associated with power centrality. Our risk hypothesis is also strongly supported: the per cent of a city’s economy associated with GHG-producing sectors is both positively and significantly associated with power centrality, our measure of social influence. Together, these findings imply that cities with greater material and economic stakes in climate action tend to join one or more TMNs in ways that allow them to be situated in network positions where they can optimize their ability to persuade other cities of the importance of their local policy priorities, such that their ability to influence any city, A, scales negatively with A’s contacts with other cities. The results also indicate a significant relationship between power centrality and form of government. Therefore, the institutional incentive hypothesis which predicts that staff in manager-led cities make gains in their professional capital through engagement in the meta-network receives empirical support. The capacity hypothesis expects that well-resourced cities are less reliant on external political support for goal attainment, and therefore are thought to have less incentive to accumulate influence through network positioning. Our results support the capacity hypothesis, albeit weakly.

Several of our control variables are significant. Namely, having a higher average per capita income, having a greater proportion of racial minorities, and being in the meta-network for a longer length of time are positively and significantly related to power centrality.

7 | DISCUSSION AND CONCLUSION

This article highlights the role of network administrative organizations and introduces the concept of the meta-network as a two-mode network, arguing that it captures the relational dynamics generated when cities join multiple separate networks. The power centrality network measure calculated through this approach is leveraged to statistically test four novel hypotheses about the factors that predict cities’ relative positions of influence in the meta-network.

Three of our four hypotheses are empirically supported. Perhaps most interestingly, we find that cities that are vulnerable to sea-level rise and those with local economies most tied to GHG emissions are more likely to be in positions that enable them to leverage influence across the meta-network. This may reflect membership patterns associated with cities that have particular concerns about how trends in local climate policy might impact their jurisdiction. Whether or not they utilize their positional advantage to do so, our observations suggest that these cities may be able to shape TMN priorities through their role as brokers and subsequent influence on their peers. This in turn has the potential to be substantively impactful: TMNs have already assumed importance in global conversations about climate and sustainability; thus, anything that shapes their priorities may have amplified influence.

We also find support for the theorizing expressed in the institutional influence hypothesis that cities with council-manager forms of government are more likely to achieve positions of influence in the meta-network. The managers and staff of cities for which climate and sustainability issues are important may benefit by positioning themselves to widen their professional objectives through advocacy in the meta-network.

We find some limited support for our expectation that local government capacity—as proxied by population size and own source general revenue—reduces power centrality within the meta-network. When interpreting this it is important to recall that power centrality is based on a city’s ability to link poorly connected cities to the wider meta-network. By emphasizing this bridging function, power centrality is distinct from measures of prestige (degree centrality) or mediation (betweenness centrality). Well-resourced municipalities, with their own expertise and enhanced abilities to innovate, may have less need to follow the policies of the larger meta-network ‘bandwagon’, and thus have little incentive to try and shape it. Beyond this, because of network tendencies towards homophily—often depicted by the adage that ‘birds of a feather fly together’—large well-resourced cities may cluster together interacting, primarily, with each other. In consequence, they may be less likely to be positioned to act as bridges to the
meta-network. The role that capacity plays in shaping whether and how cities interact in a network setting is an area ripe for additional research.

These findings, and specifically the identification of the cities that are positioned for greatest influence in the meta-network, have the potential to inform the spread of future innovations and offer strategies to aid their rapid diffusion. Given the urgency of the climate and sustainability crises, this may have great practical import. Whether or not they have actively used their positions of influence up to this point, these cities may make opportune targets for future interventions. That is, if a new best practice or approach is developed that proponents would like to see widely adopted by climate-engaged cities, those with high power centrality in the meta-network might be a strategic set to initially focus on. Their positions, which are characterized by having a large number of ties which connect otherwise peripheral cities with the larger network, make them an advantageous intervention point. Future work could, by means of surveys and interviews with member cities and NAOs, further examine their experiences of dually influencing and being influenced by the other’s effort to shape the network’s policy priorities.

It is important to note some limitations of this study. The current research is—for the reasons outlined in the Material and Methods section—limited to cities and networks in the United States. Thus, the meta-network does not account for dynamics and influences from international partners. Relatedly, we are not able to explore how climate-relevant knowledge accessed by cities at non-climate-specific venues influences policy-making in the meta-network. A third limitation relates to the fact that, as explained in the description of each TMN, several have membership criteria that favour the inclusion of certain types of cities over others. For example, C40 favours large cities. As such, cities themselves do not exert complete control over the networks they join. This has the potential to introduce some endogeneity into our regression model. The nature of the dependent variable, that is, a social network analysis centrality measure as opposed to a simple count of TMNs each city is a member of, limits the likely impact of this effect; however, it is not fully eliminated.

A key premise of this research is that municipal network members are not just subject to NAO policy-making, but also actively expend political capital in an attempt to shape it. The findings presented here lay the groundwork for future studies that look beyond internal city efforts to improve their own performance and extend it to those that examine municipalities’ efforts to influence peers. Such work not only coheres with previous research that has looked into how and why mega-cities engage in TMNs (Lee 2013; Lusk and Gunkel 2018), it also holds the potential to make contributions to the larger literature on networked governance and urban policy innovation and diffusion (Shipan and Volden 2008; Zahran et al. 2008a). Given the interdependent nature of TMNs, the implications that membership choices have for one NAO may also affect others in the network, both positively and negatively. By introducing and specifying the meta-network concept, this work opens the door to future research on the relational dynamics which underpin coordinated efforts by local governments to tackle pressing environmental issues.

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