

The role of boundary organizations in climate change adaptation from the perspective of municipal practitioners

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Abstract City planners have an opportunity to act as agents of change to build resilience within their cities to respond to climate change. This article builds on urban climate governance research and organizational change theory to focus on how city planners' partnerships with boundary organizations influence adaptation planning. At the root of effective urban climate governance is the integration of science and policy. Boundary organizations offer a governance approach that disseminates knowledge, builds capacity, and engages more participants in the adaptation planning process. However, little is known about how these partnerships foster adaptation at the local scale. Using a case study in Metro Vancouver, this study investigated how boundary organizations can better influence municipal adaptation action. The results of this study demonstrated that boundary organizations were perceived as more influential when they were *credible*, *legitimate*, and *salient* as well as when they provided *action-oriented support*. Ultimately, this paper contributes to the literature by illustrating how boundary organizations operate at the sub-regional scale to foster adaptation and proposing tangible practices to improve the effectiveness of partnerships.

1 Introduction

As the world continues to urbanize and greenhouse gases increase, cities are becoming more vulnerable to both gradual and more frequent, intense climate change impacts. Adaptation, once described as “the poor cousin of mitigation,” is now unavoidable (Berrang-Ford et al. 2011: 25). Local adaptation action is a result of a consortium of public, private, and

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civic actors operating across scales and geographic regions. Within this complex governance system, some municipal actors are emerging as leaders due to the local impacts of climate change and a lack of national direction (Rosenzweig et al. 2010). However, many cities have not yet started planning for adaptation and there are still significant barriers to implementation for cities that have initiated the planning process (Burch 2010; Hanna et al. 2014; Moser and Ekstrom 2010).

The objective of this study is to understand how boundary organizations can better support municipal adaptation from the municipal practitioners' perspective. Boundary organizations connect science to practice (Cash et al. 2003; Corfee-Morlot et al. 2011; Guston et al. 2000; Lemos et al. 2012; Tribbia and Moser 2008). Partnerships with boundary organizations offer a governance approach that disseminates knowledge, builds capacity, and engages more participants in the adaptation planning process (Bauer and Steurer 2014). However, little is known about specific management strategies that create successful boundary organizations (Parker and Crona 2012). To investigate how sub-regional or municipal actors incorporate new climate science and adaptation planning methods we draw upon organizational theory to examine specific change management strategies. Building on previous research that investigated adaptation trends internationally (Aylett 2014; Biagini et al. 2014) and within Canada (Hanna et al. 2014), we conducted a case study in Metro Vancouver, British Columbia to determine how boundary organizations operate at a sub-regional scale to influence municipalities' work on adaptation. This research is timely, as there are few empirical cases that describe how local partnerships improve adaptation planning at the local level in practice (Harman et al. 2014).

1.1 Multi-level governance and climate change adaptation

The study of new approaches to urban governance is a prominent research topic in climate change literature (Archer et al. 2014). Urban climate governance is defined as “ways in which public, private, and civil society actors and institutions articulate climate goals, exercise influence and authority, and manage urban climate planning and implementation processes” (Anguelovski and Carmin 2011). While there are several conceptual models of governance, the multi-level governance model is applicable to climate action because it outlines the multi-scalar, interconnected actors and partnerships involved in adaptation (Bauer and Steurer 2014; Carter et al. 2015).

Type I multi-level governance describes a hierarchical authority (for example a federal ministry of climate change) with a limited number of discrete jurisdictions below (such as provincial and local climate change ministries) (Hooghe and Marks 2003). Type II multi-level governance illustrates how many state and non-state actors act across all scales, overlapping in jurisdiction, and partnering on initiatives (Hooghe and Marks 2003). Type II multi-level governance and polycentric management provide a better categorization of adaptation actors who operate at different scales, overlap in jurisdictions, and form partnerships with public, private, and civil society players. Adaptation actors in Metro Vancouver include government, research institutions, not-for-profit organizations, community-based organizations, Indigenous groups, and private industry.

Within a complex governance system, some municipal governments are leading the way on climate adaptation efforts (Cashmore and Wejs 2014; Hallegatte and Corfee-Morlot 2011; Rosenzweig et al. 2010). Municipal planners and practitioners can support adaptation because they can foster negotiation among stakeholders, coordinate capacity, facilitate implementation, and serve as a point of consistency in the adaptation planning process (Hanna et al. 2014).

Urban planning is a tool to manage land, resources, and services used by municipal practitioners who operate within a wider urban governance space.

1.2 Boundary organizations and organizational change theory

While cities have incentive to adapt, many cities have not yet started adapting to climate change. The science-policy disconnect is a critical barrier to many environmental planning decisions, whereby policy decisions are made without incorporating recent, robust scientific information (Tribbia and Moser 2008). Environmental planning decisions require adequate scientific resources to improve evidence-based decision making (Parker and Crona 2012; Rose 2014). However, while scientific information is critical, “better information” and “more information” does not necessarily result in better decision making (Tribbia and Moser 2008: 317).

Science needs to be usable and relevant to the needs of municipal decision makers to influence policy makers (Dilling and Lemos 2011; Parker and Crona 2012; Sarewitz and Pielke 2007; Tribbia and Moser 2008). Research has been conducted to investigate how science can be more usable for policy makers (Dilling and Lemos 2011) and effective in influencing social responses to public issues (Cash et al. 2003). Many tools have been proposed and studied to address the science-policy disconnect, including analytical deliberation (Stern 2005), community-based adaptation (Reid and Huq 2014), community-based participatory research, and participatory action research (Chevalier and Buckles 2013). Boundary organizations have been proposed specifically by climate change adaptation scholars (Tribbia and Moser 2008; Corfee-Morlot et al. 2011; Bauer and Steurer 2014; Hoppe and Wesselink 2014), as a critical tool to connect science with practice and support municipal climate change adaptation.

Boundary organizations are actors that can connect academics to policy by (1) creating boundary objects (i.e. conceptual models, research), (2) mediating between policymakers and scientists, and (3) operating at the forefront of both research and policy (Guston 2001). Boundary organizations can be non-profit groups, private consultants, or embedded within research institutions or governments. Boundary organization theory emerged out of characterizations of knowledge and originally focused on policy assessments (Guston 2000). However, in recent years, researchers have applied the concepts of boundary work beyond assessments to improve the flow of information to end-users – specifically to end-users that work in municipal climate change adaptation (Corfee-Morlot et al. 2011; Tribbia and Moser 2008). Cash et al. (2003) stated that in order for science to influence policy making, stakeholders must perceive the science to be *credible*, *salient*, and *legitimate*. For the purpose of this paper, a boundary organization is considered to be influential if it supports the “evolution of social responses to public issues” (Cash et al. 2003).

Corfee-Morlot et al. (2011) considered boundary organizations to be a valuable intermediary organization that could address the science-policy disconnect inherent in municipal adaptation planning. Building on the work of Cash et al. (2003), Corfee-Morlot et al. reaffirmed that successful boundary organizations produce boundary objects (i.e. assessments or policy advice) that are perceived as *credible*, *legitimate*, and *salient*. Boundary organizations need to produce scientific assessments that are *credible* to the scientific community, yet also accountable to policy standards. However, it is not sufficient to just produce policy-driven science. The research process must also be perceived as *legitimate*. This requires boundary organizations to involve key stakeholders and decision-makers throughout the process (Groot et al. 2014; Jasanoff 2004;

Ostrom et al. 2002) and to co-produce knowledge (Hegger and Dieperink 2014). The benefits of co-produced climate science have been expressed extensively in climate and environmental literature (Guston 2001; Lemos and Morehouse 2005; Hegger and Dieperink 2014; Jasanoff 2004). Lemos and Morehouse (2005) define successful co-production of knowledge as a process of interdisciplinary, stakeholder participation, and production of usable knowledge. Finally, the *salience* of the research produced is increased if the science is framed in a relevant and accessible format for users (Lemos et al. 2012). Boundary organizations can operate at multiple scales within multi-level governance systems. Hoppe et al. (2013) presented the multi-level conceptual framework for boundary work to demonstrate how actors at different scales influence policy (Fig. 1).

Research on the role of boundary organizations and climate change adaptation has been growing in recent years (Corfee-Morlot et al. 2011; Bauer and Steurer 2014; Hoppe and Wesselink 2014; Lemos et al. 2014; Parker and Crona 2012; Tribbia and Moser 2008). However, while boundary organizations have been proposed as an effective partnership to help cities plan for adaptation (Tribbia and Moser 2008), Harman et al.’s (2014) systemic review indicated that many partnerships are struggling to influence urban planning at the city scale. They stated that an obvious empirical gap in the literature is knowledge on how partnerships at sub-regional scales can more effectively foster adaptation action. Similarly, Parker and Crona (2012: 263) stated that “little is known about how to create successful boundary organizations, how they relate to their constituents, and the most effective boundary management approaches and on-the-ground administrative strategies.” This case study in Metro Vancouver aims to add to the literature by providing empirical evidence for how boundary organizations operate at a sub-regional scale to influence municipal planners’ adaptation work and provide tangible strategies to improve boundary management approaches.

To investigate how sub-regional or municipal actors incorporate new climate science and adaptation planning methods, it is critical to understand organizational change theory. Organizational change theory is the systematic study of factors that increase the probability of successful

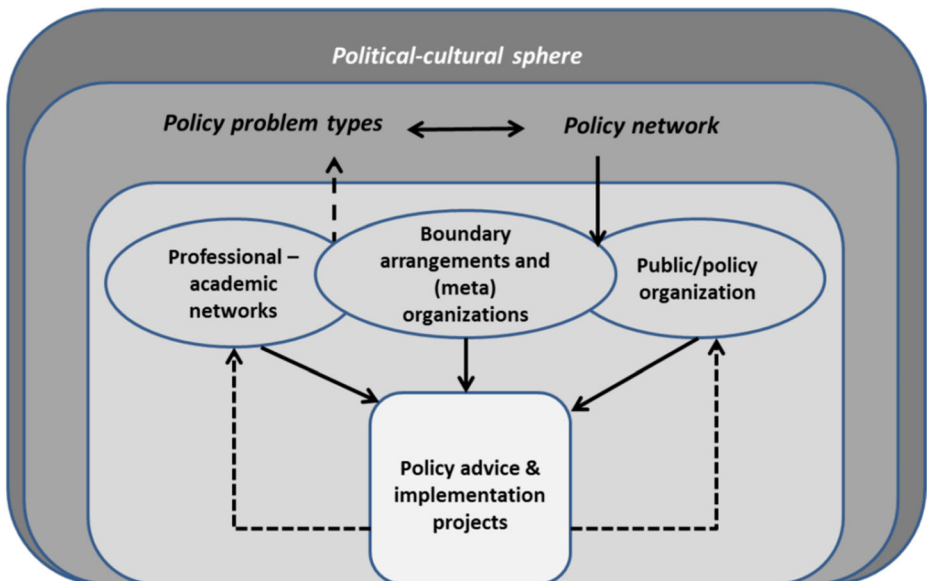


Fig. 1 Multi-level conceptual framework for boundary work (Hoppe et al. 2013)

organizational change (Al-Haddad and Kotnour 2015). This paper investigates organizational change at the municipal urban planning scale because these practitioners are well positioned to plan for a long time scales and engage key stakeholders (Hanna et al. 2014); however, organizational change is relevant to many multi-level governance actors who need to shift internal culture and processes to incorporate adaptation planning.

Boundary organizations looking to support municipal change can learn from recent findings in organizational change management literature. Al-Haddad and Kotnour's (2015) describe *change methods* as the actions carried out by managers to manage change and are grouped into two categories: systematic change methods and change management methods. Systematic change methods involve understanding the *processes and tools* used to facilitate change, whereas change management methods tackle change on a larger scale and can often include a range of intervention strategies that help assist in integrating change into the *organizational culture*. Burch (2010) notes that responses to climate change at the municipal scale must be both process and culture based: change methods must incorporate both an organizational culture that promotes innovation and collaboration, as well as a process that 'institutionalizes' climate action within current operations.

1.3 Metro Vancouver case study

Metro Vancouver was chosen as a case study to better understand how municipal practitioners are working with boundary organizations to prepare for climate change in practice. The region of Metro Vancouver is situated on the west coast of Canada in the province of British Columbia and is a partnership of 21 municipalities, one Treaty First Nation, and one Electoral Area. Metro Vancouver has a population of 2,400,000 (Statistics Canada 2012). The City of Vancouver accounts for 600,000 of those local residents, making the City of Vancouver one of the most densely populated municipalities in Canada (Statistics Canada 2014).

Climate change is projected to impact Metro Vancouver in both gradual and abrupt ways. Gradual impacts include increased annual precipitation, higher annual temperatures, and rising sea levels (Pacific Climate Impacts Consortium 2012). The long-term impacts of these gradual changes are particularly concerning. For example, a one-meter sea-level rise is projected to inundate 15,000 ha of residential and industrial urban areas (Yin 2001). Infrastructure at risk to flooding and extreme rain includes over USD \$55 billion of port assets (Nicholls et al. 2008), including Vancouver's International Airport, sewer systems, waste treatment facilities, and highways. In May 2011, British Columbia's Ministry of Environment released recommendations that Metro Vancouver should plan for a sea level one-meter higher by 2100 based on the most recent projections; dike improvements are projected to cost \$9.5 billion (Ministry of Forests, Lands, and Natural Resource Operations 2012). Going forward, the Pacific Climate Institute Consortium (2012) projected that the expected increases in rain volume, storm intensity, and sea level rise under climate change will make the region more vulnerable to street flooding, sewer backups and overflows, transportation malfunctions, and shoreline damage. With Metro Vancouver's recent climate hazards and projected changes, multiple actors are collaborating to plan for adaptation.

1.4 Multi-level adaptation actors in Metro Vancouver

A polycentric consortium of actors at the national, regional, and local level influence adaptation in Metro Vancouver. Adaptation resources provided by both the Canadian government

and the provincial government call for cities to be the main implementers of adaptation initiatives (Richardson 2010; Richardson and Otero 2012).

At the national level, the Climate Change Impacts and Adaptation Division operates under Natural Resources Canada. In 2009, they launched the Regional Adaptation Collaborative (RAC) program to build regional collaboratives focused on transferring adaptation knowledge to action. The British Columbia RAC is run by British Columbia's Ministry of Environment and the boundary organization Fraser Basin Council. In 2012, Natural Resources Canada also launched the "Adaptation Platform" to create working groups around specific industry sectors and themes.

The Province of British Columbia is taking a more proactive approach to climate change adaptation than the federal government. In 2010, British Columbia published a provincial adaptation strategy to guide local adaptation action. The province has developed several resources to help communities plan for sea level rise and storm surges (Ministry of Environment, n.d.) and actively works to mainstream adaptation across other departments. Similar to the federal government, the provincial government supports projects that foster local action, positioning local communities as adaptation executors.

Local adaptation actors in Metro Vancouver include municipal governments, academic institutions, civil society groups, Indigenous groups, private industry, and boundary organizations. The municipalities within Metro Vancouver vary in the responses to climate change. Only five municipalities have adaptation strategies or resources published online: The Corporation of Delta, The City of North Vancouver, The District of North Vancouver, The City of Surrey, and The City of Vancouver.

2 Methodology

We conducted qualitative interviews to elicit the views and opinions of municipal adaptation planners and practitioners. This method provided practitioners with an opportunity to share their insight and validate historical information. City participants were purposefully selected (Creswell 2014) based on two criteria: (1) employment, or previous employment, at a municipality within Metro Vancouver and (2) involvement in the adaptation planning or implementation process. While multiple stakeholders are critical to urban climate adaptation, we specifically interviewed municipal staff to critically investigate one key relationship that exists to support municipal adaptation planning: the relationship between city staff and boundary organizations.

Twenty-two municipal practitioners that fit these criteria were identified through consultation with local academics and boundary groups, government websites, and a 'snowballing' technique. Of those identified, thirteen municipal practitioners participated in the study, which is when ideas became saturated (Charmaz 2006). Interviewees were from Bowen Island, the City of Vancouver, the City of North Vancouver, the Corporation of Delta, the District of North Vancouver, the City of Port Coquitlam, the City of Surrey, the Township of Langley, as well as the regional government Metro Vancouver. Practitioners were municipal staff that had a key role in adaptation planning within their municipality, and held positions in planning, engineering, environment, and/or sustainability.

Interviewees participated in a 30–60 min semi-structured interview. The two main research questions were (1) how do boundary organizations operate at the local level to support municipal adaptation planning, and (2) what practical strategies should boundary organizations

incorporate to better support municipal adaptation planning. The term boundary organization was defined for participants as intermediary organizations that connect climate science to municipal practice, and several local examples were provided. Interview questions focused on how staff currently incorporated climate change science and adaptation information, the benefits and challenges of working with boundary organizations, and recommendations for how boundary organizations could better support municipal actors plan for climate change adaptation. The qualitative analysis software NVivo was used to code and group trends.

3 Results and discussion

The results of this study build on literature on boundary organizations, organizational change, and action-oriented support by providing practical strategies specifically for boundary organizations from the municipal practitioners’ perspective. As a way of structuring our results, we have grouped recommendations based on conditions outlined by Cash et al. (2003) and Corfee-Morlot et al. (2011) for boundary organization to be influential – *salience*, *legitimacy*, and *credibility*. Moreover, our findings suggest an additional condition is necessary, namely *action-oriented support*. All four conditions are detailed in Fig. 2.

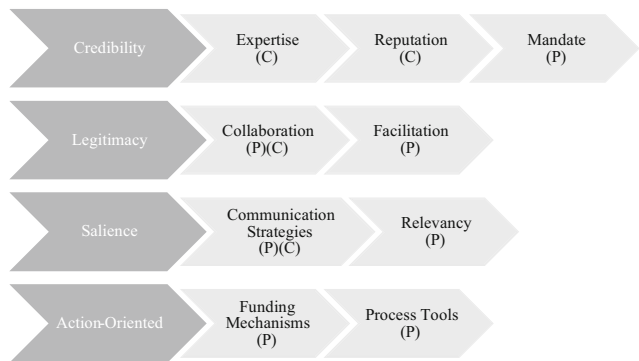
Overall, these results operationalize core conditions of boundary organizations and provide process-based and culture-based strategies from organizational theory to support municipal adaptation action. Additionally, the results reveal inherent tensions between criteria and demonstrate why boundary organizations should be viewed as a supplementary, but not a singularly sufficient, tool to support local adaptation.

3.1 Credibility: reputation and clear mandate

Corfee-Morlot et al. (2011) described *credibility* as “whether the science assessment has met acceptable quality standards as judged by other scientists or the peer expert community” (p. 181). While this is critical, municipal practitioners in Metro Vancouver stated boundary objects – and the organizations themselves – must have credible reputations and mandates.

When municipal practitioners were asked why they work with specific boundary groups, most explained it was because of their reputation. They are looking for reputable information

Fig. 2 Strategies for Effective Boundary Organizations



(P) – Indicates process-based strategies
(C) – Indicates culture-based strategies

to defend to their respective city councils. A reputation was built from a group's affiliation with a university institution, provincial funding, word of mouth, or a long-term relationship. One individual explained that a boundary group had "been here for 20 years so people understand that they have a very good sense of the community...I think that's where they get that trust from." Several municipal practitioners showed how new boundary organizations were establishing their reputation by starting with small projects and proving their impact, or offering tools and services for free.

Having a clear mandate is also critical to better support municipal climate change adaptation. One of the biggest frustrations regarding boundary organizations was the sheer number of them and their tendencies towards mission drift. One practitioner started the interview by stating, "First we have to stop having so many boundary organizations." Another interviewee stated, "You see [boundary organizations] that have a certain mandate and then they try to expand their mandate into someone else's who is already doing a pretty good job. Don't waste your time." They stated that boundary organizations end up "adding to the noise" when they should instead "be clear about what they do and why it's different." Additionally, participants stated that boundary organizations must be aware of what other boundary groups do and show respect to fellow researchers. Two participants recognized that the power of these groups is in their ability to join forces and provide a larger voice for adaptation.

3.2 Legitimacy: collaborative research practices and facilitation

Boundary organizations' credibility might help establish an initial relationship, but the next critical stage of influence relates to the creation of adaptation knowledge. Knowledge creation was mentioned in all interviews a total of 32 times. This reaffirmed Busch's (2011) first enabling criteria for organizational change surrounding climate change: climate knowledge absorption. Climate knowledge absorption is a product of knowledge creation and utilization (Busch 2011). Legitimacy is a requirement for culture change that enables knowledge creation and utilization. Adaptation practitioners mentioned two main strategies for boundary organizations to produce adaptation knowledge: (1) collaboration, or co-production of knowledge, with municipalities, and (2) facilitation.

3.2.1 Collaborative and co-produced research practices

Collaboration and co-production of knowledge were mentioned in seven out of the 13 interviews with practitioners. Practitioners explained that collaborative research practices were critical to help understand a municipality's needs, frame research findings, and provide support after the research project.

Practitioners criticized boundary organizations that failed to adequately understand a municipality's needs. Two practitioners mentioned that when municipalities are not engaged early on, results tend to be too high level to be of any use. Other practitioners complained that some boundary organizations would disappear for a long time only to come back with too much information to sort through, a concept Hanger et al. (2013) describes as a 'loading dock' of information.

However, practitioners also had success stories to share regarding effective collaboration throughout the process. One interviewee was asked to be a project advisor in a study being organized by the Credit Valley Conservation (CVC), which was acting a boundary organization between researchers and a municipality. CVC had students and professors present findings

throughout the study to project advisors, who were practitioners, via webinars and phone meetings. Here practitioners had the opportunity to guide them to more accurate information or correct misleading statements before they published their results.

Co-production of climate adaptation information is also critical to ensure results are effectively framed depending on target audiences. For example, one municipality was acutely aware that the farming community in their region would be more receptive to discussing weather, crop loss, and resilience but less open to discussing anthropogenic climate change. It is critical that boundary organizations work closely with municipalities to understand how their project results should be framed to have the greatest influence. Additionally, university-embedded boundary organizations were criticized for not remaining project ‘owners’ after researchers had graduated or moved on to new research.

3.2.2 Facilitating networking

Eleven out of 13 municipal practitioners stated facilitation as a unique asset of boundary organizations. Facilitation and stakeholder engagement is a critical ingredient to improve collective decision making regarding environmental resources (Ostrom 1990, 2000). Battilana and Casciaro’s (2012) theory of organizational change highlighted that organizations that have more “structural holes” are more likely to generate novel ideas. In other words, the more open an organization’s network is, the less likely they are to suffer from normative pressures (Krackhardt 1999) and redundancy of information (Ruef 2002). Boundary organizations create opportunities for municipal practitioners to gain outside perspectives and share them internally with more confidence.

Boundary organization can support several types of facilitation. First, boundary organizations can connect neighbouring municipalities to facilitate a regional approach to climate change impacts. The Fraser Basin Council was praised in the interviews for their ability to facilitate municipal discussion on regional flood management in Metro Vancouver. One participant stated, “When it comes to flood management everyone is going to take a different approach. [Municipalities] have different priorities, approaches, resources, so having someone bring everyone together and talk about ideas keeps pushing the [work] forward.” Second, boundary groups influence adaptation via facilitation by providing an opportunity for cities to learn from each other. Tools listed included conferences, working groups, webinars, and e-newsletters. Third, interviewees stated that boundary organization use facilitation to create a neutral space for public and private interest groups to create adaptation strategies together. Their neutrality allows them to be viewed as professional and scientific and not politically biased. Many boundary organizations are affiliated with university or research institutions that aim to produce ‘neutral’ and ‘objective’ science. However, can a boundary organization be truly neutral if they exist to support, and therefore influence, adaptation planning? More research is required to understand how boundary organizations can serve as facilitators and collaborators in the absence of neutrality.

Municipal practitioners also provided input into how boundary organizations could better use facilitation to influence adaptation. First and foremost, municipal staff stated that boundary organizations needed to spend money on *good* facilitation: “Facilitators are worth the money.... They need to hire someone else because scientists and engineers are *not* good at communication. We all know this.”

Municipal practitioners also complained that boundary organizations should make an effort to encourage facilitation *within* a municipality. There is usually one point-person for adaptation

at a municipality. However, one of the challenges for that individual is spreading adaptation messages to other departments. Boundary organizations should reach out to staff in engineering, planning, environment, and/or finance to create adaptation champions. This finding highlights the role of communication in facilitation. Cash et al. (2003) state that communication is a core strategy to ensure knowledge is perceived as legitimate, as well as credible and salient. Effective communication is more than articulating the problem and communicating the needs of stakeholders; it also requires generating interest within city hall. Communication must be active, iterative, and inclusive (Cash et al. 2003).

This recommendation speaks to the culture-based aspects of change management. As stated earlier, organizational change requires process strategies and culture-based strategies. While boundary organizations promote a culture of innovation by expanding staff networks outside their city, this effort proves futile if their local municipality is not receptive to a culture of climate innovation. This is consistent with research by Battilana and Casciaro (2012), who stated that open networks are more likely to *generate* novel ideas. However, more cohesive networks were more likely to *adopt* innovative ideas (Fleming et al. 2007; Obstfeld 2005). Therefore, it is not surprising that municipal staff acknowledge the positive benefit of networking to generate novel ideas, but are also quick to point out the associated implementation challenges. Therefore, facilitating adaptation discussions within a municipality is a critical step to help cities adopt innovative adaptation ideas.

3.3 Salience: acquiring and translating science

Boundary organizations must provide resources that make science *salient* and accessible to municipal practitioners. Boundary organization's ability to translate relevant science for practitioners was mentioned 32 times by 10 interviewees. Boundary organizations were seen as supportive when they acquired new and localized science, provided resources that translated the science, such as webinars and visualizations, and completed research quickly.

Boundary organizations exist to protect the politicization of science (Guston 1999; 2001) and to improve the flow of information to end-users (Tribbia and Moser 2008). All interviewed municipalities in Metro Vancouver were involved with boundary organizations to access climate change information and adaptation strategies. While many municipalities had scientists on staff, no municipality had climate scientists, and therefore they all relied on external expertise to help project climate impacts in their municipality. The Pacific Climate Impacts Consortium (PCIC) was mentioned in 12 of the 13 interviews because they provided local, downscaled climate modelling for Metro Vancouver. While some municipalities in Metro Vancouver have hired PCIC as a consultant, others take advantage of their free online tool: Plan2Adapt. Plan2Adapt has an intuitive interface that provides future projections for climate changes, including temperature, precipitation, and snowfall. Their work was praised for its simplicity and policy applicability.

One significant barrier for climate adaptation at the municipal scale can be city councils' approval of adaptation plans or budgets for adaptation work (Aylett 2014; Burch 2010). Three people interviewed mentioned the Collaborative for Landscape Planning (CALP) because of their ability to translate science through visualization. For example, CALP launched a website to help individuals visualize projected climate impacts and potential adaptation scenarios. One interviewee stated that this "information proved quite powerful when presenting to elected officials the outcomes and trade offs between different alternatives." Visualizations are a soft tool based on motivating action by changing a municipality's culture.

Municipal practitioners had numerous recommendations for boundary organizations pertaining to translating science and connecting it with policy. Firstly, several organizations mentioned that boundary organizations need a better understanding of municipal tools and resources. One individual stated that boundary organizations need a better understanding of urban planning, or an “understanding of what development permits are, an understanding what by-laws are, an understanding of the building code, and how they can implement actions at the municipal level. So when there’s messaging that comes out of the science, you’re specifically targeting an opportunity within municipal systems.” Another noted, “They don’t understand the local government world. Yes, we would love to make scientifically informed policy decisions, and we do our best to do that, but we also have to integrate it with the political issues at hand.” They need to be aware of the limited time and budgets many municipalities are working with. Practitioners recommended that, after relationships are established, boundary organizations should take advantage of disseminating information online and only hold strategic meetings. However, this could hinder their ability to co-create resources.

Parker and Crona (2012) highlight that boundary organizations can struggle to connect science to policy because of the incentives that exists within the systems they operate. They determined that university-based boundary organizations were expected to be “all things to all people all of the time” (p. 285). Municipalities expected them to act as consultants and provide real time, interdisciplinary, applied research; however, academic institutions rewarded boundary staff based on their contribution to long-term, basic, disciplinary knowledge through peer-reviewed publications. Boundary organizations that exist outside academic institutions face similar conflicts of accountability with funders, internal strategic plans, and staff.

3.4 Action-oriented: tools for action and funding mechanisms

In addition to credibility, legitimacy, and salience, boundary organizations need an additional quality to influence municipal adaptation; they need to be *action-oriented*. Action-oriented support relates directly to the process-nature of change management. While substantial literature exists that describes action-based decision making processes – such as tactical urbanism, community-based participatory research, and participatory action research – our research explicitly highlights its relevance to boundary organizations’ management practices. This finding is where our research deviates and builds on boundary organization theory (Corfee-Morlot et al. 2011). Six out of the 13 practitioners stressed the need for boundary organizations to explicitly support action and implementation. Two main strategies emerged: funding mechanisms and/or action-oriented processes.

3.4.1 Funding mechanisms

Many practitioners have cited budget constraints as a barrier for climate adaptation research and action. Even though other researchers, such as Burch (2010), have suggested that the lack of prioritization is the root cause of perceived budget barriers, practitioners still believed they were limited by financial constraints. Three practitioners recognized that a significant benefit of working with boundary organizations is that they build capacity for research and are often able to bring funding to cities. This was particularly true for smaller municipalities. Interviewees recognized that boundary organizations often represent broader groups that fund their work and can bring federal money to local municipalities. One stated, “That makes it much easier to work with them obviously. If they say ‘I want to do a big research project’ and it’s

going cost a \$100,000 and they pay for that, then it is going to happen.” Two practitioners working in adaptation stated that boundary organizations actually funded their first few months with a municipality to get the adaptation plans off the ground. Both continued working at the organizations afterward.

Lemos et al. (2014) demonstrate how boundary organizations can innovate and expand their impact through creative funding mechanisms, while minimizing transaction costs. Through a *key chain approach*, a boundary organization can partner with end-users to fund separate projects. In a *linked chain approach*, a boundary organization can partner with other boundary organizations to customize information for end-users. In a *network chain approach*, a boundary organization can play a facilitation role in connecting boundary groups and end-users to maximize knowledge translation. Ultimately, boundary organizations that are able to provide funds, provide free resources, and direct municipalities to funding mechanisms are going to be more influential.

3.4.2 Tools for action

Several interviewees mentioned the need for tools that generate action. Boundary organizations cannot simply rely on “hucksterism,” as one practitioner called it. Hucksterism describes an individual who is excited and preaching information. While passion is important, one practitioner urged boundary organizations to recognize that “this is their own personal journey around learning and it might not be the journey of the audience.” Two practitioners were concerned that some information translated by boundary organization was designed to “shock and awe” or “be alarmist in nature.” While those types of messages have their place, they are looking to boundary organizations to support actual implementation. Several interviewees praised ICLEI Canada for their Building Adaptive and Resilient Communities (BARC) program. ICLEI Canada’s new BARC program now has 19 members including six from Metro Vancouver. The BARC program provides a comprehensive framework and online tool to help communities develop and implement an adaptation plan. This framework has been cited as helpful to conduct vulnerability assessments, identify risks, create climate change adaptation plans, and move work forward. Practitioners are looking to ICLEI Canada to “continue to encourage us...Now we need a fire under our butts to get to the implementation and the monitoring and reviewing. We all know those are the two hardest steps.”

It is not enough for boundary organizations to be credible, legitimate, and salient. Our research results demonstrate that if boundary organizations want to influence cities they also need to provide practitioners with action-oriented support. Ultimately, boundary organizations play a critical role in urban climate governance and should be considered an effective stakeholder to support adaptation action at the municipal scale. If national and regional governments are looking to cities to become leaders in climate change adaptation, boundary organizations need to ensure that they are connected with the best, most relevant science, financial resources, and planning tools. While boundary organizations are only one actor within multi-level climate governance, the practical strategies revealed through this research aim to improve the impact of this key relationship.

4 Conclusion

The aim of this study was to provide insight on how boundary organizations function at the municipal scale and propose concrete management strategies for boundary organizations that

foster climate change adaptation. The results of this study validated themes in the boundary organization literature on credibility, legitimacy, and salience (Cash et al. 2003; Corfee-Morlot et al. 2011), action-oriented decision making (Chevalier and Buckles 2013), as well as change management theories (Al-Haddad and Kotnour 2015; Busch 2009). Our findings built on these themes to operationalize these terms with ‘on-the-ground’ administrative strategies, which were identified as a gap in the literature (Parker and Crona 2012). Credibility was seen as a function of trusted relationships and proven experience. Legitimacy related to co-constructivist views of knowledge creation and facilitation. Salience was possible through communication targeted to municipal planners and councilors and by providing relevant science in a timely manner. In addition to credibility, legitimacy, and salience, boundary organizations must also provide action-oriented support to foster municipal adaptation. The two main functions of action-oriented support related to providing funding and process-based tools.

Polycentric and multi-scale governance reveals there are many actors involved in supporting local adaptation; our results demonstrate that boundary organizations can be more effective in supporting local, municipal action. The results also suggest that boundary organizations are not a silver-bullet solution to municipal adaptation action. Moreover, while the science-policy disconnect in and of itself might not represent a top adaptation barrier (Aylett 2014), it is highly interconnected with resource allocation, prioritization, and leadership. Having access to credible, legitimate, salient, and action-oriented adaptation information would help municipal practitioners better advocate for adaptation funding and resources. While this research focused primarily on the views of municipal practitioners, more research is required to understand the perspective of other adaptation actors operating at various scales – including boundary organizations, higher levels of government, civil society, Indigenous groups, and the private sector. Additionally, further research should investigate the role of neutrality in climate change research, knowledge dissemination, and boundary work.

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