Climate Policy

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tcpo20

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To cite this article: Nina J. L. Rogers, Vanessa M. Adams & Jason A. Byrne (2023): Factors affecting the mainstreaming of climate change adaptation in municipal policy and practice: a systematic review, Climate Policy, DOI: 10.1080/14693062.2023.2208098

To link to this article: https://doi.org/10.1080/14693062.2023.2208098

CLIMATE POLICY
https://doi.org/10.1080/14693062.2023.2208098

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SYNTHESIS ARTICLE

Factors affecting the mainstreaming of climate change adaptation in municipal policy and practice: a systematic review

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ABSTRACT

Local governments have a vital climate change adaptation role. However, major breakdowns in the ability of local governments to mainstream adaptation responses have been widely observed. Using a Systematic Quantitative Literature Review method, we assessed 131 original research articles published 2005–2020 to answer three key questions: *What trends are evident in the global literature that explain adaptation mainstreaming efforts in municipal policy and practice? What factors are conceptualized as shaping adaptation mainstreaming in local government? Which elements can be considered key to advancing adaptation mainstreaming in municipal policy and practice?*

We find two overarching factors affect outcomes – *authority to adapt* and *capacity to adapt*. *Authority to adapt* refers to the authorizing environment – or mandate – from national or sub-national government, or from local government leaders, for adaptation action by a municipal administration. *Capacity to adapt* refers to access to resources, professional networks, and supportive organizational systems and culture, that enable local government adaptation. We find lack of support from local government elected leaders is the most frequently identified barrier to municipal adaptation. Yet, few empirical studies offer deep insight into the factors that inform and influence leadership support for municipal adaptation. Further, we find local government capacity to adapt is largely treated as a singular capacity, held constant throughout the policy cycle. We find limited exploration of the capacities vital to each stage of the policy cycle and the configuration of factors that support adaptation outcomes. We devise a conceptual framework explaining how issues of *authority* and *capacity* can interact and influence each other and what they encompass. Such a framework has broader utility for policy development and importantly for implementation at the local level.

Key policy insights

- Municipal adaptation can be strengthened through expanded understanding of, and attention to, the factors that inform local leaders' decisions on adaptation, notably clustered around authority and capacity to adapt.
- Policymakers are encouraged to actively consider the differing capacities needed to progress adaptation through each stage of the policy cycle.
- Using an implementation lens to evaluate adaptation practice could support documentation of planning-to-implementation gaps and ways of bridging these gaps for enhanced municipal adaptation outcomes.

ARTICLE HISTORY
Received 29 July 2022
Accepted 24 April 2023

KEYWORDS
Systematic review; local government; adaptation; mainstreaming; climate policy; implementation gap

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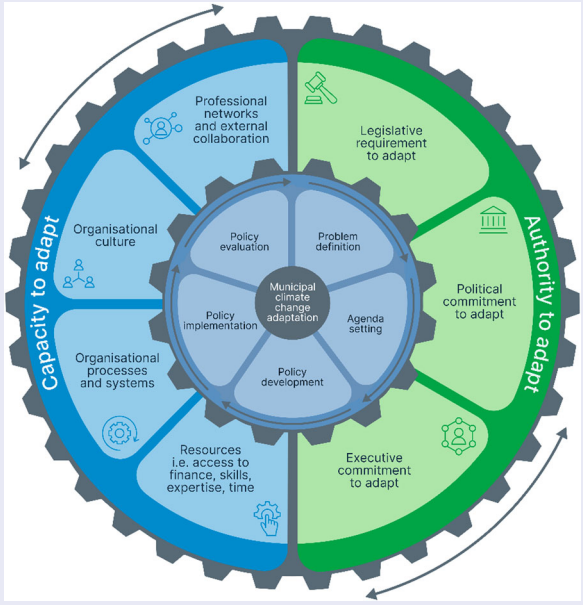
Supplemental data for this article can be accessed online at https://doi.org/10.1080/14693062.2023.2208098.



1. Introduction

Climate change is producing severe and compounding environmental, social, and economic impacts across the globe (IPCC, 2021; Klein et al., 2014). The Intergovernmental Panel on Climate Change (IPCC)'s sobering Sixth Assessment Report (IPCC, 2021) offers irrefutable scientific evidence that climate change will put billions of people at risk, affecting livelihoods and critical infrastructure. The global community urgently needs to respond to predicted changes. How best to do this has become a question of paramount importance. Local government (e.g. municipal councils), as the level of government closest to the community, arguably has a critical role to play (Anguelovski et al., 2014; Aylett, 2015; Bakker, 2021; Birchall et al., 2022; Bulkeley & Kern, 2006; Burch, 2010b; Hjerpe et al., 2015; Measham et al., 2011; Nalau et al., 2015; OECD, 2010; Picketts, 2018; Scott & Moloney, 2021). An important problem, however, is that the task of adaptation may be beyond the capacity of local governments, potentially due to limitations in knowledge, skills, and resources – and, some suggest, due to political impasses (Hjerpe et al., 2015; Leck & Roberts, 2015; Picketts, 2018).

Many local governments support their constituents to plan for and respond to locally experienced impacts of climate change (Aylett, 2015; Bulkeley et al., 2009; Castán Broto & Bulkeley, 2013; Pasquini et al., 2015). Local governments must also ensure their own operations and service delivery are robust to climate change (Tonmoy et al., 2018). Internationally, local governments in urban, rural, and regional locales, are undertaking climate change risk and vulnerability assessments and developing adaptation plans (Araos et al., 2016; Aylett, 2015). Some of these efforts respond to national climate policies or frameworks that prescribe a role for councils, or national funding that seeks to facilitate adaptation (Lundqvist & Von Borgstede, 2008; Salon et al., 2014). But there are many examples where councils assume a delegated authority to adapt and go beyond, or even against, state policies (Bakker, 2021; Bulkeley, 2021). In these instances, municipal adaptation is a voluntary task undertaken in the absence of extant (or adequate) national mandates (Bulkeley, 2010; Simon Rosenthal et al., 2015). Importantly, the scholarly literature documents major breakdowns in local governments moving from planning to implementation of climate change responses (Bulkeley, 2010; Corfee-Morlot et al., 2009; Lawrence et al., 2015; Measham et al., 2011). A key question is *why* does this planning-to-implementation gap arise?

While an implementation gap phenomenon is not unique to climate change responses by local governments, and has been studied in other environmental spheres (Adams et al., 2019), effective implementation of climate change adaptation at the local level is particularly urgent. To accelerate and sustain adaptation

responses, it is essential to better understand the key factors underpinning the inclusion of climate change in municipal decision-making. We need to know more about the barriers and enablers to local governments mainstreaming climate change responses across their operations.

To inform future adaptation research, policy, and practice at the local government level, this article systematically assesses and critiques the global literature on influencing factors, using a Systematic Quantitative Literature Review (SQLR) method (Pickering & Byrne, 2014).

The review seeks to answer three critical questions:

(1) What trends are evident in the global literature that explain adaptation mainstreaming efforts in municipal policy and practice?
(2) What factors are conceptualized as shaping (positively, negatively) adaptation mainstreaming in local government?
(3) Which elements can be considered key to advancing the mainstreaming of adaptation in municipal policy and practice?

We seek to reveal barriers and enablers to successful adaptation mainstreaming, and to identify any gaps in the literature. We discuss core findings and their implications for future municipal adaptation research, policy, and practice – why these findings matter, how local governments might learn from them, and what this means for protecting lives and livelihoods from climate change.

2. Methods: undertaking a systematic quantitative literature review

To assess the relevant scholarly literature on the mainstreaming of adaptation in municipal policy and practice, we employed Pickering and Byrne (2014)'s 15-step Systematic Quantitative Literature Review method. This highly structured approach is robust and reproducible, supporting transparency in the review process and reporting of key findings. We follow the protocols of the *Preferred Reporting Items for Systematic Review Recommendations* (PRISMA) (Moher et al., 2009).

2.1. Search terms, database searches and article selection

Three broad foci are reflected in key words used to search the scholarly databases Web of Science and Scopus – ('local government' OR 'local authority' OR 'municipal') *AND* ('climate change' OR 'climate resilience' OR 'adapt') *AND* ('mainstreaming' OR 'governance' OR 'action' OR 'policy' OR 'decision-making'). Determining the preferred search terms involved a degree of trial and error. For example, the terms ('urban' OR 'city' OR 'council') were introduced in addition to ('local government' OR 'local authority' OR 'municipal') but yielded a large and unwieldy literature beyond our focus on local government.

Through this review it became apparent that definitions of key terms, when offered, varied considerably across research disciplines. Key terms as used in this review are defined in Table 1.

A total of 2,678 articles were identified as potentially relevant (Figure 1). Preliminary screening removed 626 duplicates and 2,052 articles were assessed against rigorous and reproducible inclusion/exclusion criteria (Appendix 1 in Supplementary Materials). To summarize these criteria, peer-reviewed English-language journal articles reporting original empirical research, published online prior to May 2020, were screened for inclusion. Books, book chapters, reports, reviews were not included as we could not be confident they were original source literature; their inclusion could lead to 'double counting' under the quantitative review method. Additionally, criteria required local government and their adaptation responses to be the focus of each article, explicitly, what occurs *within* a municipal entity to affect adaptation. We acknowledge the extensive and valuable literature on topics such as multi-level climate governance, trans-national municipal climate networks, and climate change mitigation, but these have a wider scope than our focus. We note that insights to our research questions might be found in some of the literature that has been excluded.

Results were restricted to the Web of Science and Scopus databases, as Google Scholar yielded > 100,000 records and a high proportion of 'grey literature'. A preliminary database search identified articles in languages

Table 1. Definition of key terms.

	Definitions adopted in this review
Adaptation	Implementation of measures to reduce current and future vulnerabilities of communities, infrastructure, and the environment to the impacts of climate change such that expected harmful impacts are minimized and opportunities maximized (adapted from Bulkeley, 2010; IPCC, 2014).
Adaptation Mainstreaming (Within local government)	The process of integrating climate change adaptation considerations into the established functions, policy, and practice of local government (adapted from Aylett, 2015; Pasquini et al., 2015). This includes a municipal council's vision statements, institutional budget and policy planning processes, project management and reporting tools, working structures, and human resource allocations (IPCC, 2022a; Wamsler et al., 2022).
Governance (Within government)	Purposeful means of intra-organizational coordination, cooperation, and collective decision-making to achieve stated policy goals (adapted from Chhotray & Stoker, 2009; Knill & Tosun, 2020). Comprises three core dimensions: power/authority, decision-making, and accountability (Bland et al., 2021).
Local Government	Within the literature local government is interchangeably referred to as council, city council, shire council, local council, municipal council, local governments, local government authority, local governing body. May be created by the central state, or constitutionally/legally recognized as a legitimate level of government (Bulkeley & Kern, 2006). May be located in urban, rural, regional, and remote locales. Typically comprised of a body of elected officials that provide directives to appointed professional staff (e.g. city managers) for policy and service delivery (Bland et al., 2021).
Planning-to-Implementation Gap	The difference between a set of policy goals and what is actually implemented (adapted from IPCC, 2022b).

other than English (e.g. Spanish, Portuguese, German, French, Chinese); these comprised less than 3% of the total and were excluded from the review. We recognize the benefits of multilingual systematic literature reviews, but note they are rare due to the challenge of including scholars fluent in those languages on a research team (e.g. Rupprecht and Byrne (2014)).

At the conclusion of screening, a total of 131 articles were determined as 'on topic' and included in this review (Appendix 2). Articles were analysed by journal discipline; year of publication; geographic location of the research; research methods and participants; theoretical framing; municipal characteristics; barriers and enablers to municipal climate adaptation; policy 'planning-to-implementation' gap (Appendix 3). Key results are presented in Section 3. All articles have been treated equally and no weightings assigned (e.g. for sample size, year of publication, methods).

Our review, while extensive, is not exhaustive. It excludes non-English language articles, and articles outside Web of Science and Scopus databases. Nonetheless, our review presents the 'state of the research' on this topic at a point in time (Ordonez-Barona et al., 2021).

3. Results

3.1. Characteristics of the global literature

3.1.1. Spatial and temporal characteristics

The 131 articles analysed in this review considered local government/municipal climate change adaptation across 31 countries (Appendix 4). Most studies were undertaken in the United States (21), followed by Australia (18), South Africa (17), and Sweden (12) (Figure 2). Nearly a third of all studies were conducted in Europe (32%), followed by North America (22%), Africa (18%), Oceania (14%), Asia (7%), and South America (7%). A single global study examined every continent (except Antarctica).

Consistent with earlier findings (e.g. Pasquini et al., 2013), a significant imbalance is observed for research in developed and developing economies (i.e. the Global North and Global South). Seventy percent of reviewed studies were undertaken in countries with developed economies as classified by the United Nations. This may have implications for the 'generalizability (within a positivist paradigm) or transferability (within a constructivist paradigm) of research findings' (Taylor, 2017) to the developing world; noting this spatial bias in research output appears to be lessening over time.

The earliest included article was published in 2005 (Naess et al., 2005), with highly variable year-on-year publication output since then (Figure 3). It is unclear what leads to this stochasticity but global or regional events

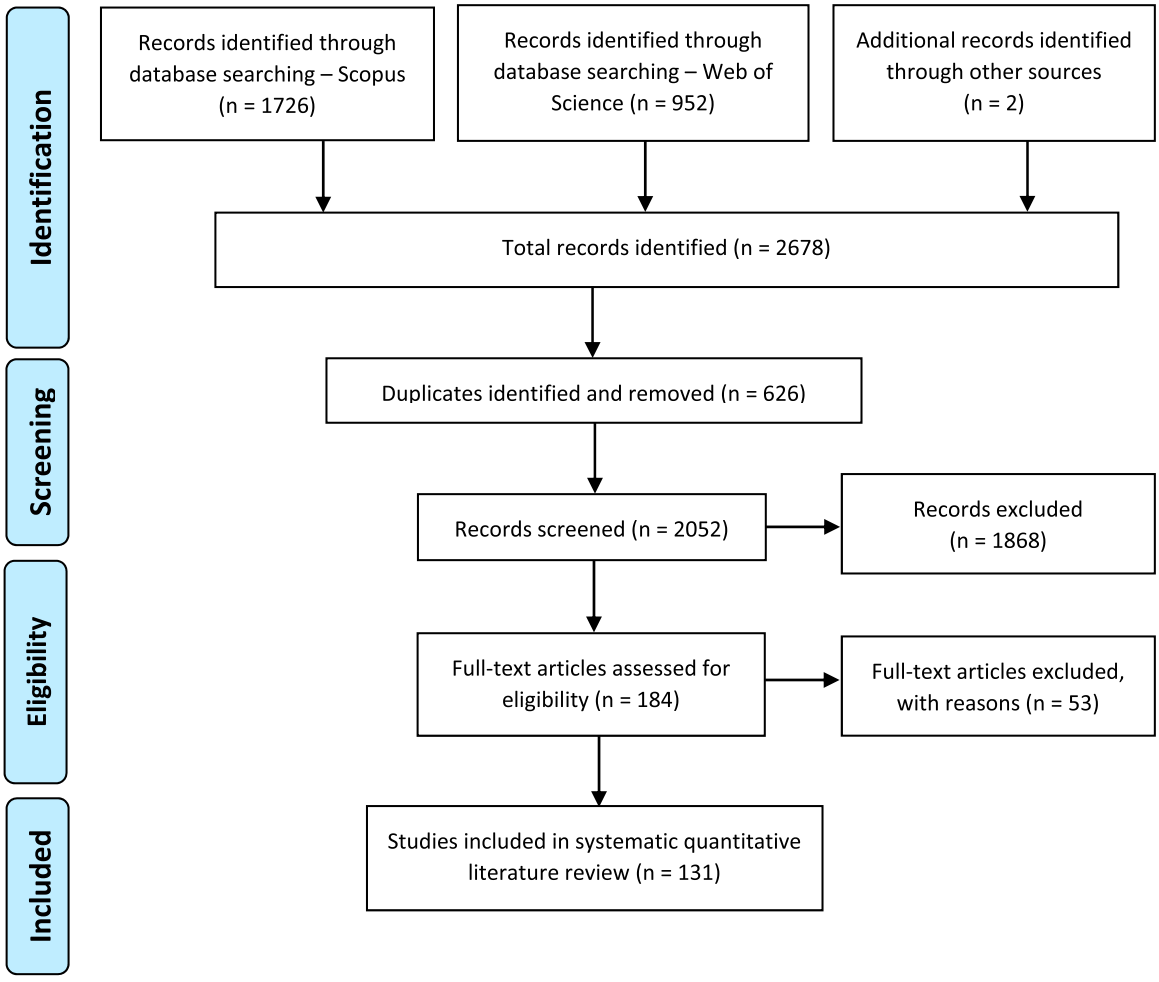


Figure 1. PRISMA statement documenting the process of article selection.

that trigger heightened research interest are possible drivers, for example geopolitics, environmental catastrophe, release of key reports and data, new research funding; whilst also recognizing academic and publication lag time.

We tested for temporal differences in geographies but with no discernible trends. A wider reading of the global climate change literature pre-2005 suggests a local government focus on greenhouse gas emissions reduction (mitigation) activities, as well as a broader agenda of environmental sustainability and Local Agenda 21 (Betsill & Bulkeley, 2004).

3.1.2. Theoretical foundations

Over 40% of reviewed articles (56 of 131 articles) explicitly used a theoretical approach to inform or explain research findings. In 57% of articles, theory was not apparent. More commonly, authors offer a conceptual framework to underpin their research. The most frequently used theories were systems theory, learning theory, and institutional theory in six studies each. A 'long tail' of theories informed the remainder (Appendix 5). Public policy theories guided the bulk of research in which a theoretical underpinning is evident, including institutional and new institutional theories, governance theories, rational choice theory, public choice theory, and policy and political theories.

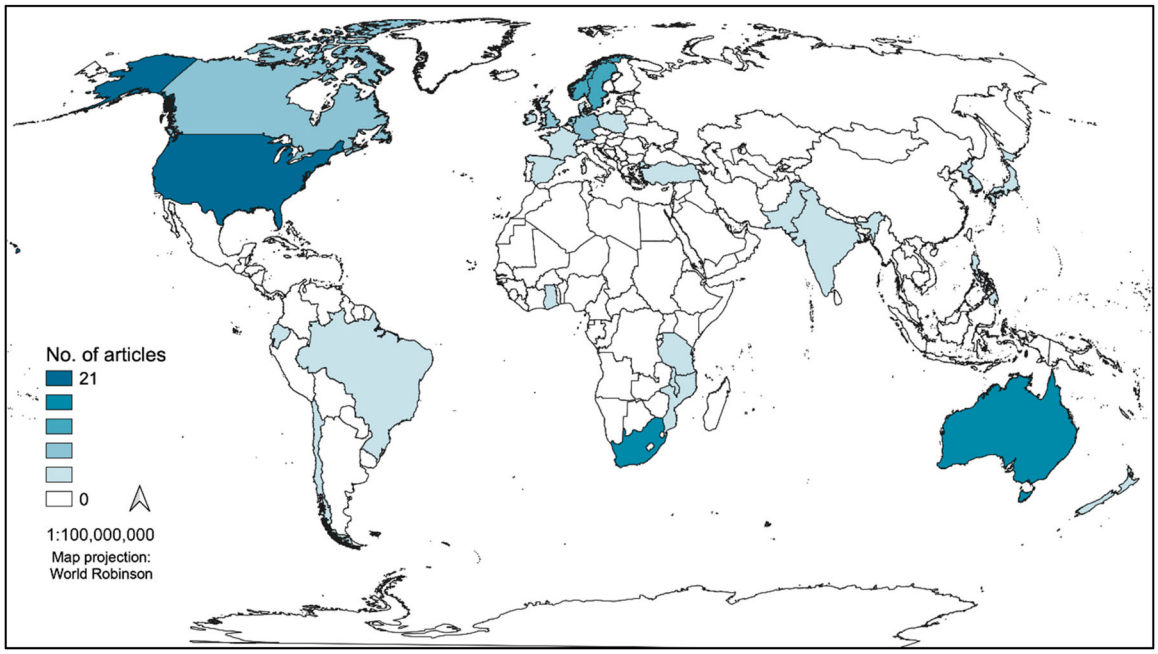


Figure 2. Global distribution of municipal climate change adaptation research included in this review.

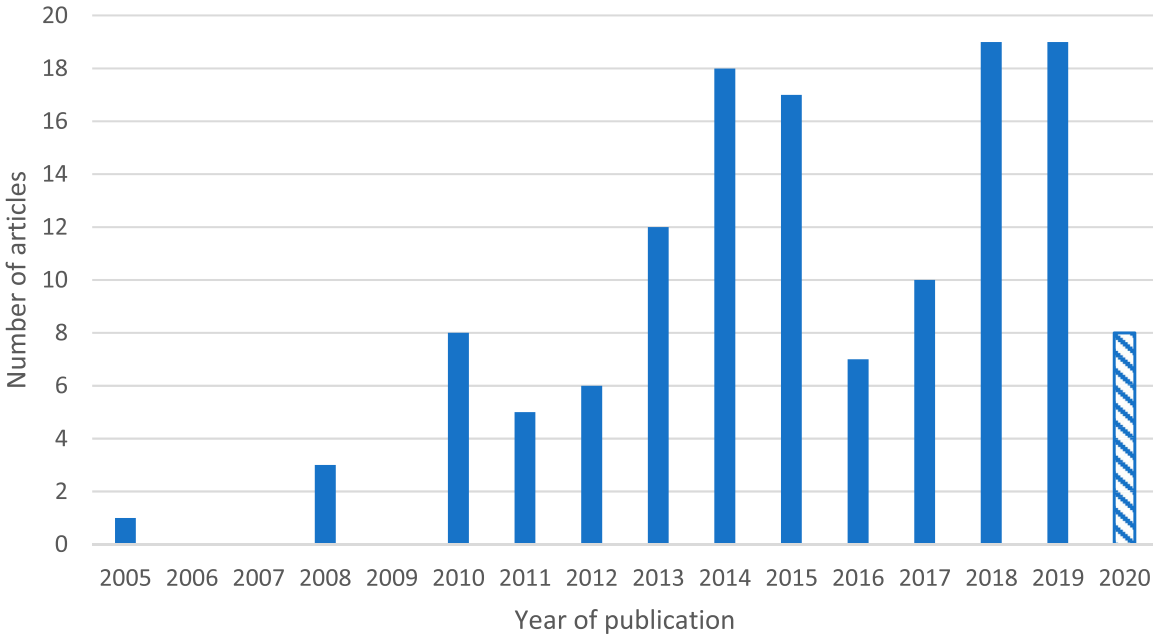


Figure 3. Number of articles published per year (screening for articles to include in this review ceased in May 2020, so we do not offer a full year article count for 2020; see cross-hatched column).

3.1.3. Research methods and design

Seventy per cent of studies (92 of 131 articles) applied qualitative research methods, with semi-structured interviews supported by document analysis most widely employed. Twenty-five articles used mixed methods

studies and a further 11 used quantitative research methods (the balance of three articles did not articulate their research methods). The apparent preferencing of qualitative research methods over quantitative methods suggests many researchers may be seeking to access deep insights from selected case examples, as afforded through interviews, focus groups, and ethnography (Birchall, 2020; Cashmore & Wejs, 2014; Hetz, 2016; Salon et al., 2014). Conversely, where quantitative methods were used, researchers have engaged large samples (arguably preferencing breadth of insight over depth). For example, Orderud and Kelman (2011) engaged 178 mayors in a national survey across Norway of climate change awareness and attitudes; Aylett (2015) documented the results of an international survey of 350 municipalities across five continents on institutional governance for adaptation.

Two-thirds of studies (87 articles) were presented as case studies of one or more municipal councils. A further five articles offered a longitudinal study, and two studies were meta-perspectives drawing upon a number of studies including the researchers' own empirical work (Flyen et al., 2018; Wamsler & Brink, 2014). The longitudinal studies by Porter et al. (2015), Jost et al. (2019), Dale et al. (2019), Göpfert et al. (2019), and Rocher (2017) illuminate the nature and degree of change over time in municipal adaptation. The comparative rarity of these studies suggests researcher time and scholarly funding cycles may present barriers to their wider use.

3.1.4. Location of local governments studied

Studies exhibited location biases (i.e. urban and coastal municipal councils). Thirty percent of the studies assessed local governments located in cities. 'City' here includes mega-cities, large cities, small to medium size cities, capital cities (of a State or Province) and other urban locales identified as a city by study authors. We note the absence of a universally agreed definition of 'city' (Dreyfus, 2015; Kendal et al., 2020) (see for example work of European Commission, 2020). Twenty-eight percent of studies examined coastal municipal councils. We identified studies as 'coastal' where the intent of the article was to explore the adaptation challenges of coastal municipalities, for example, the challenges of sea level rise or coastal inundation. Limited research was found to engage regional, rural, and remote municipalities (12%). The focus on cities and coastal locations suggests a desire to support adaptation in locations with high population and high-value infrastructure and assets.

3.1.5. Research participants

Over two-thirds of research participants were from municipal councils, with the remaining informants sourced from outside of councils. Both 'insiders' and 'outsiders' perspectives, experiences, and observations of adaptation challenges and opportunities are considered. From within local government, most (71%) informants were non-executive staff, that is, managers and below in the organizational hierarchy who might be expected to have day-to-day carriage of a municipal council's adaptation actions. Less than a third of all key informants comprised municipal elected leaders (16%) and executive leaders (13%). We use the term executive leaders to refer to a municipal council's most senior administrative staff (e.g. Chief Executive Officer and functional directors). We distinguish these leaders from a council's political (elected) leaders. Few examples were found within the literature where the views and experiences of municipal leaders were explicitly reported; just six studies solely engaged municipal elected and/or executive leaders as informants, presenting a critical knowledge gap (see Hjerpe et al., 2015; Nursey-Bray et al., 2016; Orderud & Kelman, 2011; Pasquini et al., 2015; Romsdahl et al., 2019; Williams et al., 2017). Those who set the policy direction for a council, and who have budgetary, governance, and process oversight of the municipal organization, appear to be under-represented.

3.2. Factors affecting adaptation mainstreaming in municipal policy and practice

3.2.1. Reported barriers

Of the 131 articles reviewed, 112 (85%) explicitly identified and/or explored a range of barriers to municipal adaptation. Fifty-six different barriers were identified (Appendix 6). Only those barriers identified in at least five articles are captured in this review. These can be broadly clustered into five categories, consistent with

the wider global literature (e.g. Burch, 2010a; Di Giulio et al., 2019; Hamin et al., 2014; Lawrence et al., 2015; Pasquini et al., 2013; Simonet & Leseur, 2019):

- **Inadequate authority to adapt** – e.g. lack of political support (will & commitment) for municipal adaptation, lack of community support, adaptation not a local government statutory requirement – *Identified as a barrier to municipal adaptation in 98 of 112 articles (88%)*
- **Organizational (cultural & structural) barriers** – e.g. not an immediate priority for a municipal administration, siloed thinking across a municipal administration, divergent priorities between municipal administrative units – *Identified in 94 of 112 articles (84%)*
- **Resourcing constraints** – e.g. limited access to funding, insufficient municipal staff time or staff numbers to dedicate to adaptation – *Identified in 76 of 112 articles (68%)*
- **Information & knowledge barriers** – e.g. insufficient municipal staff expertise, limited data available to a municipal council, lack of specific guidance on 'how to' adapt – *Identified in 62 of 112 articles (55%)*
- **Other** – e.g. absence of a trigger event, perceived as an environment issue, difficult economic times.

The single most frequently identified barrier to municipal adaptation was a lack of political support (identified in 86 of the 112 articles examining barriers to adaptation, Table 2). This refers to an absence of will and/or commitment from municipal elected leaders for adaptation. Studies attribute lack of political support to a range of factors, including that some municipal elected leaders:

- consider municipal adaptation action to be inconsistent with the views or policy position of key influencers e.g. property developers, industry groups (identified in 25 studies);
- engage in short-term thinking, attentive to only the current political term and a need for quick and visible results, at the expense of long-term thinking (identified in 20 articles);
- are climate change deniers or sceptics and maintain an ideological opposition to a climate change response (identified in 20 articles); and
- consider an adaptation response by council to be politically risky, for example if there was a need to raise municipal rates or levies to fund adaptation action (identified in 15 articles).

Thirty-four articles identified a lack of broad and visible community support (a social license) for municipal adaptation as a barrier to action. A direct causal relationship between community support and political commitment to adaptation was not necessarily established but often implied. A lack of community support likely influences political decision-making and may also affect decision-making and resource allocation by council's executive leaders or senior staff. We treat 'lack of community support' and 'lack

Table 2. Top 10 most frequently identified barriers to municipal climate change adaptation.

Position	Top 10 most frequently identified barriers	Count*	Type of barrier
1	Lack of political support (will & commitment)	86	Inadequate authority to adapt
2	Limited access to funding	72	Resourcing constraints
3	Not an immediate priority for a municipal administration	50	Organizational (cultural & structural) barriers
4	Data availability	45	Information & knowledge barriers
5	Siloed thinking and planning in a municipal administration	44	Organizational (cultural & structural) barriers
6	Municipal staff expertise *(equal 6th position)*	36	Information & knowledge barriers
6	Divergent priorities between municipal administrative units *(equal 6th position)*	36	Organizational (cultural & structural) barriers
7	A lack of community support for municipal adaptation	34	Inadequate authority to adapt
8	Unclear roles and responsibilities for local government concerning adaptation	33	Inadequate authority to adapt
9	Not knowing how to work with uncertainty in the climate science	31	Information & knowledge barriers
10	Absence of Federal/State leadership in adaptation	27	Other

*'Count' refers to the number of articles that identified this barrier.

of political support' as separate barriers but recognize both inform the authorizing environment for municipal adaptation.

We also found competing priorities to be a barrier to municipal adaptation, often informed by community desires and expectations (amongst other factors), influencing political commitment to adaptation. Fifty articles identified that adaptation is not a high enough priority for municipal councils to commit limited time and resource. The literature describes many challenges to reconciling priorities, for example, where municipal councils are only attentive to 'core priorities' potentially perceived as more urgent (i.e. daily visible concerns and essential service provision mandates), at the expense of adaptation (Hjerpe et al., 2015).

3.2.2. Identified enablers of enhanced municipal adaptation (implemented or potential)

Of the 131 articles reviewed, 112 (85%) explicitly identified and/or explored a range of enablers to, or drivers of, municipal adaptation. This is the same number of articles that empirically identified the barriers to municipal adaptation, suggesting that scholars recognize a need for the two to be discussed in tandem. Articles revealed 43 different enablers or drivers to municipal adaptation (Appendix 7). We assigned these across seven categories:

- **Information, knowledge, and communications** – e.g. emphasizing adaptation co-benefits and synergies for enhanced salience, active communication and scenario planning (or similar) with community, using substitute frames for climate change – *Identified as an enabler of municipal adaptation in 89 of 112 articles (79%)*
- **Authority to adapt** – e.g. political support (will & commitment), presence of an 'adaptation champion', a statutory requirement for municipal adaptation, community expectation to act – *Identified in 85 of 112 articles (76%)*
- **Active professional networks and external collaboration** – e.g. active regional collaboration, support from research/academic institutes, dense professional networks – *Identified in 77 of 112 articles (69%)*
- **Supportive organizational culture** – e.g. collaborative (non-siloed) culture in a municipal administration, a staff position to lead adaptation mainstreaming across the administration, proactive and reflective planning culture – *Identified in 60 of 112 articles (54%)*
- **Enabling organizational processes** – e.g. adaptation embedded in municipal processes, portfolio proximity to decision makers, builds on existing policy and plans – *Identified in 51 of 112 articles (46%)*
- **Enhanced access to funding** – e.g. funding from other levels of government or donors – *Identified in 47 of 112 articles (42%)*
- **Other enablers or motivators** – e.g. presence of a trigger event or experience with climate impacts, effective use of financial arguments in decision-making, recognition – to be seen as a climate leader.

Each of these high-level categories is explored further in Table 3.

Within the reviewed literature, the most frequently identified enabler of municipal adaptation is proactive emphasis of adaptation co-benefits (identified in 54 of 112 articles, Table 3). Salient key messages that draw attention to the synergies between adaptation and wider municipal priorities can be considered critical to overcoming the core barrier 'lack of political support (will & commitment)' for municipal adaptation. Similarly, reframing or substituting the term climate change with other local concerns (e.g. water security or urban heat) was an identified enabler (recognized in 32 articles); particularly where the term climate change was politically contested. Researchers found the use of substitute frames necessary where a disdain for adaptation is apparent among municipal decision makers or the community, or where climate denial presents a barrier to action.

An important enabler of adaptation is a collaborative (non-siloed) culture in a municipal administration (identified in 52 of 112, and number 2 in the Top 10 list of enablers). Other enabling factors that reflect organizational culture include open communication across a municipal administration; a proactive and reflective planning culture; and an innovative culture. The latter described 'a culture open to experimentation' and where there is 'permission to try'.

Support for adaptation from municipal elected leaders was identified as an enabler in 49 articles, and the presence of a 'champion' to drive municipal adaptation efforts was a recognized enabler in 47 articles

Table 3. Top 10 most frequently identified enablers of municipal climate change adaptation.

Position	Top 10 most frequently identified enablers	Count*	Type of enabler
1	Emphasizing co-benefits and synergies for enhanced salience	54	Information, knowledge, and communications
2	Collaborative (non-siloed) culture in a municipal administration	52	Organizational culture
3	Support of municipal elected leaders	49	Authority to adapt
4	Presence of an 'adaptation champion'	47	Authority to adapt
5	External funding	46	Enhanced access to funding
6	Active adaptation communication and scenario planning (or similar) with community	39	Information, knowledge, and communications
7	Presence of a triggering event(s)	38	Other enablers or motivators
8	External support and collaboration (broadly – articles did not elaborate)	32	Professional networks and external collaboration
8	Using substitute frames for climate change *(equal 8th position)*	32	Information, knowledge, and communications
9	Access to external expertise	30	Information, knowledge, and communications
9	Statutory requirement to adapt *(equal 9th position)*	30	Authority to adapt
9	Regional collaboration *(equal 9th position)*	30	Professional networks and external collaboration
10	Community expectation to act	29	Authority to adapt

*'Count' refers to the number of articles that identified this enabler.

(ranked 3 and 4 respectively in the Top 10 enablers). The concept of a champion was variously described as the 'committed individual' or 'policy entrepreneur'.

3.2.3. Municipal climate change adaptation planning and implementation

Of the 131 articles included in this review, 30 (23%) explicitly spoke to the concept of a policy *planning-to-implementation gap* (P-I gap), and in doing so broadly highlighted the different stages of the policy cycle through which a municipal council progresses on its adaptation journey. Only five of these 30 articles addressed local government in developing economies. We define a P-I gap as the difference between a set of policy goals and what is actually implemented (adapted from IPCC, 2022b). The literature suggests six key factors frustrate local government efforts to progress from adaptation planning to implementation (Table 4).

Considering the top three factors identified, foremost was an absence of accountability for implementation in municipal processes and systems (noted in 17 of the 30 studies reporting on a P-I gap, Table 4). The reviewed studies variously described this as implementation not being built into municipal policies, processes, and long-term plans; no one in a municipal administration 'owns' the actions to be implemented; implementation is marginalized; and there is limited external pressure applied on a municipal council to ensure adaptation policy commitments are implemented.

Implementation was also found to be hampered by the simplistic language of municipal adaptation policies (noted in 11 of the 30 studies). For example, studies reported that municipal councils often develop adaptation policies comprising generalized statements or symbolic resolutions that do not articulate clear, implementable actions (Simon Rosenthal et al., 2015). Perhaps contributing to this situation, nine studies identified that municipal councils hold insufficient understanding of adaptation pathways and the specific nature of climate impacts

Table 4. Key factors found to impede implementation of municipal adaptation policies and plans*.

Position	Factor	Count**
1	No accountability for implementation	17
2	Simplistic language of municipal adaptation policies or plans	11
3	Insufficient understanding in a municipal council of adaptation (implementation) pathways	9
4	No resources allocated beyond adaptation planning	8
5	Competing priorities and competing policy agendas within a municipal council	7
6	Insufficient focus on the relational aspects of adaptation	5

* Only those factors identified in at least five articles are captured in this table. Five articles identified a P-I gap but did not explore or explain it.
**'Count' refers to the number of articles that identified this factor.

for which they need to prepare. Studies report a lack of access to scientific information at a scale relevant to inform local adaptation planning (Baker et al., 2012; Fu, 2020). Further, municipal staff report an inability to understand and readily use scientific information, even when available (Porter et al., 2015). Consequently, many municipal councils appear ill-equipped to go beyond the development of generalized statements of policy intent to specific actions costed into annual budgets; a challenge also observed in other areas of municipal administration (see for example Boulton et al., 2018 on council greenspace management). In sum, these findings present valuable insights into the adaptation implementation challenge for local government. Improving the geographic extent and depth of scholarship could usefully guide research, policy, and practice, a consideration to which we now turn our attention.

4. Discussion and priorities for future research

Our review of the global literature suggests that the process of municipal adaptation is complex, unique to local contexts, and can be highly specific to place and time. Despite the inherently context-specific enablers and barriers to successful implementation of adaption measures, the review highlights commonalities across a diverse set of regions and case studies. An array of factors affect how a municipal council can undertake adaptation planning and the implementation of adaptation plans. We offer a conceptual framework explaining how these factors can interact and influence each other (Figure 4). The literature reveals that municipal adaptation appears to be a function of two overarching factors – *authority to adapt* and *capacity to adapt*. These interact with one another and at various stages of the policy cycle to influence successful adaptation. Such a framework has broader utility for policy development and importantly for implementation at the local level.

4.1. Authority to adapt

Two types of authority appear to affect decisions about whether – and the extent to which – a municipal council engages with climate change adaptation: a requirement to act and a commitment to act (Figure 4). A requirement to act can be imposed upon local government by higher levels of government through legislation or regulation (*Legislative requirement to adapt*). Alternatively, and seemingly more frequently, *authority to adapt* reflects the willingness of a municipal council's leadership to engage in adaptation. Authority may be vested in municipal political (elected) leaders or executive (chief administrative) leaders or shared through the agreed (or implicit) governance processes and practices of a council (*Political commitment to adap*t and *Executive commitment to adapt,* Figure 4).

Globally, a range of local government leadership models operate, however, elected leaders often hold executive powers over a municipal administration. Recognizing a lack of support from municipal elected leaders is the most frequently cited barrier to municipal adaptation mainstreaming, this suggests that municipal elected leaders play a central role in determining which issues are advanced to the policy development stage, and how an issue progresses through the policy cycle. The literature points to a constellation of factors influencing municipal elected leaders. Recognition by leaders of a problem is an essential precondition to a decision to adapt. The literature identifies that problem recognition (the first step in the policy cycle at the centre of Figure 4) is informed by the narrative frames used to describe the problem; prevailing attitudes, norms, values, and beliefs; personal or proximate experience of climate impacts; and the availability and understanding of climate data. Additional influencing factors include the public 'mood' and the presence or absence of community support for an issue; the policy positions of advocacy groups, professional associations, and influential or respected voices; competing priorities across the municipal policy agenda; the political implications of action; and the aspirations of individual politicians and political parties. The interplay and weight assigned to these factors will likely be unique to each elected leader.

While the literature widely references the importance of political support as both a barrier and enabler to municipal adaptation, in-depth and systematic consideration of the effects of politics on the mainstreaming of adaptation in municipal policy and practice is uncommon (Hjerpe et al., 2015; Pasquini et al., 2015; Pasquini & Shearing, 2014). The insights offered by Hjerpe et al. (2015), Orderud and Kelman (2011), Pasquini et al. (2015), Williams et al. (2017), Nursey-Bray et al. (2016), Romsdahl et al. (2019) are particularly instructive as they

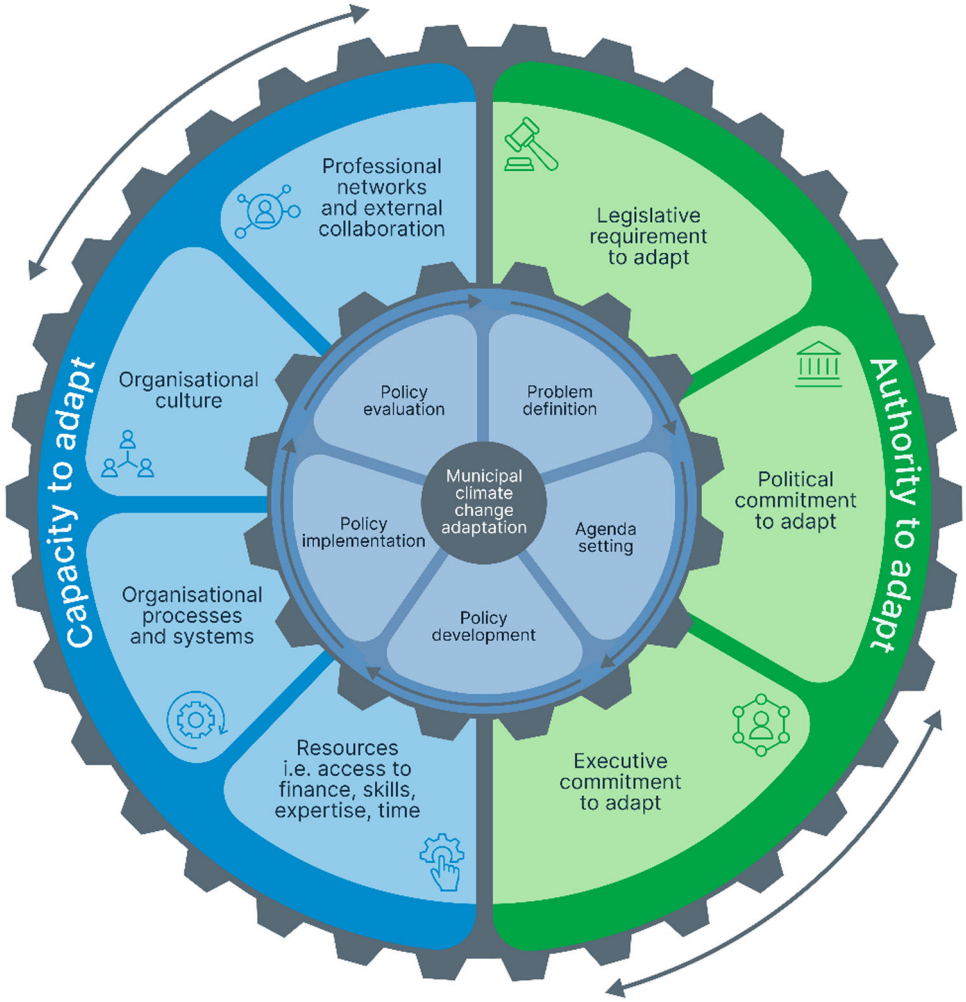


Figure 4. Conceptual framework of the factors that shape municipal climate change adaptation mainstreaming. The analogy of mechanical cogs turning and interacting represents the configuration of factors that inform municipal climate change adaptation mainstreaming. The outer cog indicates that municipal climate change adaptation is a function of two overarching factors – *authority to adapt* and *capacity to adapt* – with their constituent parts (the wedges of the outer cog). The presence or absence of these factors at the different stages of the municipal policy cycle (the inner cog) will positively or negatively influence adaptation outcomes. Conceptually, the two cogs move in dynamic rotation, clockwise, anti-clockwise, rapidly, slowly, or even 'stuck'. Our framework is conceptual and simplifies the messy reality of municipal governance. The wedges are not exclusive to either of the two overarching factors, but for the purposes of this framework reflect common associations revealed through the literature (see Appendices 6 and 7 in Supplementary Materials). The wedges of the outer cog may influence either (or both) *authority to adapt* or *capacity to adapt*. How to optimize the configuration of factors at each stage of the policy cycle to enable successful adaptation planning and implementation is a challenge, likely to be unique to each municipal council in time and place.

exclusively document the perspectives and experiences of municipal leaders. Of the 131 articles reviewed, only they do so. More commonly, the 'voice' of leaders is diluted in the aggregation of research findings.

4.2. Capacity to adapt

Local government's *capacity to adapt* depends upon access to resources, professional networks, and supportive organizational systems and culture (Figure 4). Although the literature gives considerable attention to describing these factors (as summarized in Results), few studies explore the capacities vital to each stage of the policy cycle

and the configuration of factors that support municipal adaptation outcomes. This presents something of a blind spot in current understanding. Attention must be given to the requisite capacities for municipal adaptation at each stage of the policy cycle (at centre of Figure 4). These include capacities: to anticipate climate risk as foundational to the problem definition and agenda setting stage of the policy cycle; to plan for that risk and undertake policy development; to implement identified risk and adaptation responses; and to evaluate the outputs and outcomes of municipal adaptation efforts.

Additionally, we find opportunity for policymakers and practitioners to seek to identify the particular configurations of factors or conditions that support or hinder municipal adaptation mainstreaming. Eisenack and Roggero (2022) suggest the broader climate change literature has yet to theorize the configurations of conditions for effective climate planning. We suggest this holds true for municipal adaptation mainstreaming. Our conceptual framework employs the idea of mechanical cogs turning and interacting; the teeth on the wheels interlocking with other teeth. How might these factors, as affect municipal adaptation, best work together? And at what point in time should they connect to create desired adaptation outcomes? Exploring these questions, particularly with decision makers and in the broader context of multi-level climate governance, could offer deeper insights to strategically inform future adaptation capacity-building efforts, communications, and resource allocations within and to municipal councils, to accelerate and sustain adaptation efforts at the local government level.

4.3. The municipal adaptation policy planning-to-implementation gap and determining policy success

Policy progress is dependent on implementation, yet the gap between stated policy intent and actual outcomes may be sizeable (Davis et al., 2018; Hudson et al., 2019). Acknowledgement of this gap challenges the seemingly still popular view that policy implementation naturally and systematically follows policy planning and adoption (Stewart, 1996). Our review finds that the concept of a municipal policy *planning-to-implementation gap* is widely recognized, but only a fifth of studies explicitly examine the presence of, and factors contributing to, a municipal adaptation planning-to-implementation gap.

To build understanding of, and help overcome, implementation challenges we urge the climate research community to actively partner with local government in adaptation policy and programme (co)design and throughout the implementation journey. This may include facilitated access to and interpretation of local climate data; guidance on feasible adaptation pathways responsive to each municipal council's unique circumstances, priorities, and capacities as they differ over place and time; and expert support to identify and communicate co-benefits of adaptation, thus stimulating alignment with a council's wider strategic priorities and resource allocations.

There is also significant opportunity for local government representative bodies and professional associations (such as for land use planning and engineering) to support the professional development of municipal staff and leaders (elected and executive) to build adaptation literacy, and to facilitate the delivery of local government tailored 'how to adapt' guidance and training, with a focus on implementation. The literature suggests that in many jurisdictions adaptation planning support is available to local government, but geographic gaps exist, especially for municipal councils in developing economies. Whilst building municipal capacity, the participation of representative and professional associations in adaptation can also help legitimize adaptation as a cross-cutting policy concern for local government, contributing to the authority to adapt (Corfee-Morlot et al., 2009).

Lastly, few studies that we examined considered the importance of policy evaluation. This includes whether, and how, municipal councils are embarking on adaptation policy evaluation and the metrics by which councils claim adaptation policy success. Important evaluation questions arise, yet their application appears underdeveloped (Reckien et al., 2019). Scott and Moloney (2021) find *scant empirical evidence* of the evaluation of municipal adaptation outcomes. And within the wider adaptation community, it has been stated that there is of a *dearth of tangible objectives and evaluation metrics by which to measure progress* (Howlett et al., 2019). Key gaps in the literature include how to measure, identify, and attribute adaptation success, and how best to ensure that evaluation findings are embedded in adaptive policy cycles. Addressing these gaps will

provide missing guidance about which adaptation actions succeed (or fail), for whom, under what circumstances, and why (Scott & Moloney, 2021).

4.4. Priorities for future research

Our review points to three key priorities for future research on the mainstreaming of adaptation in local government policy and practice. First, in considering *authority to adapt*, it is critically important that future research deeply engages local government leaders, particularly elected leaders, to understand engagement with and decision-making on adaptation. For example, how do local government leaders perceive the risks of climate change generally and for their municipality? Do local government leaders recognize a mandate, or express a desire, to manage these risks? Is adaptation a priority for them amongst the many policy concerns of local government? And how do decisions made at the local level relate to climate governance decisions made within a broader multi-level governance framework? Answering these questions can better equip policymakers and practitioners to strategically engage local government leaders in municipal adaptation.

Second, rather than treating *capacity to adapt* as a singular capacity held constant throughout the policy cycle, we encourage scholars to examine and make explicit the differing capacity needs of municipal councils at each policy stage, and to identify who or what determines the capacities available to councils throughout the policy cycle. Critically, the relationship between *authority to adapt* and *capacity to adapt* in the process of municipal adaptation mainstreaming could usefully be the subject of future inquiry, as well as the configuration of factors (Figure 4) that give rise to enhanced adaptation outcomes.

Third, our analysis points to a need for research to engage more extensively with the concept of a municipal adaptation *planning-to-implementation gap*; to test the degree to which a planning-to-implementation gap is present, the circumstances that give rise to such a gap, and potential opportunities to close the gap. Our conceptual framework (Figure 4) can be used to guide dialogue with municipal councils on how issues of authority and capacity interact and influence policy implementation at the local level. Scholars could also seek to engage councils in productive conversations about the metrics that could demonstrate and attribute adaptation policy success, and how best to ensure that evaluation findings inform future policy work.

For each of these three areas of inquiry, future research should be alert to potential regional differences for councils in developed and developing economies that may magnify implementation challenges and inequitable adaptation outcomes.

5. Conclusions

Employing a Systematic Quantitative Literature Review method (Pickering & Byrne, 2014) we undertook a critical analysis of 131 peer-reviewed articles, published between 2005 and 2020, to answer three key questions:

(1) What trends are evident in the global literature that explain adaptation mainstreaming efforts in municipal policy and practice?
(2) What factors are conceptualized as shaping (positively, negatively) adaptation mainstreaming in local government?
(3) Which elements can be considered key to advancing the mainstreaming of adaptation in municipal policy and practice?

In considering the first research question, we find a significant skew in research location. Studies focused on local governments in Europe and North America, and in cities (rather than rural or semi-urban communities) and coastal locations. Most research informants were municipal non-executive staff, with less than a third of all key informants in the literature comprised of municipal elected and executive leaders. And we identify an extensive list of barriers and enablers affecting the mainstreaming of adaptation in municipal policy and practice. The single most frequently identified barrier to municipal adaptation is a lack of support from municipal elected leaders. And the most frequently identified enabler of municipal adaptation is the proactive emphasis

of adaptation co-benefits and salient key messages that draw attention to the synergies between adaptation and wider municipal priorities.

In response to the second research question, we find the literature reveals municipal adaptation mainstreaming is a function of two overarching factors – *authority to adapt* and *capacity to adapt*. We have synthesized a conceptual framework explaining how these factors can interact and influence each other, and what they encompass. Within our conceptual framework we identify that *authority* for municipal adaptation may be delegated by national or state (sub-national) government, or a responsibility assumed and directed by local government leaders and enacted by municipal administrations. We find *capacity* to adapt reflects municipal access to resources, professional networks, and supportive organizational systems and culture, that enable local governments to introduce adaptation measures.

And in response to the third research question, we find a critical need to build understanding of the particular (and perhaps optimal) configuration of factors – clustered around authority and capacity to adapt – that support municipal adaptation at each stage of the policy cycle. Increased focus on, and deep engagement with, municipal leaders will assist. Municipal leaders are central as to whether an issue is taken forward onto the municipal policy agenda, and how an issue travels through the policy cycle. Indeed, the priorities, decisions, and ambitions of municipal leaders may ultimately determine whether climate change adaptation, and the management of climate-related risk, comes to be recognized as a mainstream policy consideration for local government, worthy of sustained and substantial attention and investment.

Credit authorship contribution statement

- **Nina Rogers (PhD candidate):** Conceptualization, methodology and methods (inc. generated SQLR data set and data curation), visualization, writing (original and subsequent drafts), review, and editing.
- **Associate Professor Vanessa Adams:** Conceptualization, data curation, visualization, writing, review, and editing.
- **Professor Jason Byrne:** Conceptualization, co-designed SQLR methodology (with Pickering C.), visualization, writing, review, and editing.

Acknowledgements

The authors wish to thank Dr. Stacey McCormack, Scientific Graphic Designer/Director of Visual Knowledge for assistance with the layout of the conceptual model developed for this article, and Dr. Sebastian Rossi University of Tasmania/CONICET Argentina for producing the map seen as Figure 2. The research is supported by an Australian Government Research Training Program Scholarship for Rogers' PhD.

Funding

This work was supported by an Australian Government Research Training Program Scholarship.

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