TITLE: Comparative measurement of climate change adaptation policies: A policy instruments approach

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ABSTRACT: Comparative research on climate change adaptation policies is currently limited by difficulties in conceptualizing and measuring adaptation policy as an observable phenomenon. Using a policy instruments approach to this challenge, we propose a theoretically-informed measure of policy instrument mix tendency that characterizes adaptation policy portfolios based on the relative substantiveness or proceduralness of adopted policy instruments. This approach is applied to a study of adaptation policies in 125 local governments, constituting the largest 25 cities in Canada, France, Germany, the Netherlands, and the United Kingdom. Using a systematic data collection protocol, a total of 3,328 adaptation policy instruments were identified from local council archives between the periods of Jan 2010 to May 2017. These instruments are aggregated at the local government level using the measurement of policy instrument mix tendency. Results of this analysis indicate that distinct country clusters are emerging in local adaptation policy styles. We find that local governments in Canada, France, and the United Kingdom tend to adopt instrument mixes that are procedural in nature, while local governments in Germany and the Netherlands have higher rates of substantive instrument adoption.

1.0 Introduction

Climate change adaptation is still an emerging policy domain. There remains, for example, limited consensus within the adaptation community on the purpose or goal(s) of adaptation, its relationship to other policy areas such as sustainable development or disaster risk management, or how we determine what constitutes appropriate or successful adaptation policy implementation. Empirical studies have nonetheless documented a quickly growing number of policies being adopted or adjusted at various levels of government in response to climate change risks, suggesting the emergence of adaptation as an important focus of climate policy (Lesnikowski et al. 2016; Araos et al. 2015; Malcolm Araos et al. 2016; Ford et al. 2015; Biagini et al. 2014; Castán Broto & Bulkeley 2013; Reckien et al. 2014; Shi et al. 2015; Stults & Woodruff 2016; Woodruff & Stults 2016; Hughes 2015). Making sense of the overarching policy approaches to adaptation that are emerging from these activities, however, presents significant measurement challenges that have limited the application of larger comparative research designs (Dupuis & Biesbroek 2013). A focus has now emerged within adaptation policy research on advancing techniques for classifying and making sense of this evolving policy landscape (Ford & Berrang-Ford 2015; Ford et al. 2013).

While debates are on-going within the adaptation community about the role of private sector and third party actors in adaptation, empirical research indicates that adaptation is still happened largely within the public sector (Biesbroek & Lesnikowski 2018; Jordan et al. 2015), with governments from the national to the local level acting as key actors driving the adaptation agenda (Mees 2017; Keskitalo et al. 2016; Massey et al. 2014). Despite this growing research, we still have only a fledging understanding of what adaptation looks like across different contexts. At the root of this gap is the under-specification of adaptation policy as an observable phenomenon; the diversity of approaches taken in the literature to conceptualize and measure adaptation policy has resulted in limited comparability between studies, and a fragmented understanding of how adaptation policy portfolios are emerging and evolving across contexts.

Here we build on recent interest in applying a policy instrument approach to the study of how governments are adapting to climate change (Henstra 2016; Mees et al. 2014; Macintosh et al. 2015; Macintosh et al. 2014), with the aim of developing a stronger conceptual foundation from which to compare how governments are responding to a changing environment across contexts and scales. Policy instruments are understood as "techniques of governance that, one way or another, involve the utilization of state authority or its conscious limitation" (Howlett 2005, p 31). Public policy scholars assume that most policy goals can be achieved using different (and multiple) instruments; the selection of particular types of instruments is therefore significant, and reflects underlying preferences and contextual influences on how governments deal with policy problems (Linder & Peters 1989).

Adaptation presents significant methodological challenges for conducting comparative, quantitative analyses owing to its boundary-spanning, long-term, and intangible nature. Developing a measurement approach that can make sense of the heterogeneous mix of policy instruments be adopted across places and scales would advance comparative research designs and support stronger knowledge accumulation and learning. This study takes local governments as its unit of analysis, as cities are seen in the adaptation governance literature to play a major role in the design and implementation of adaptation policy (Nalau et al. 2015; Revi et al. 2014). We propose a measure of instrument mix tendency as a means of case comparison, and demonstrate its usefulness by comparing the adaptation policy portfolios of 125 local governments across five countries to discern patterns in the emergence of policy instrument mixes. The paper concludes with discussion on the challenges of measuring instrument mixes in policy domains where goals are boundary-spanning and primarily qualitative in nature, and instruments are highly heterogeneous.

The following section provides an overview of the policy instruments concept, and summarizes current approaches to measuring instrument mixes in comparative research. It further describes key methodological challenges to measuring instrument mixes for adaptation specifically, and details the approach adopted here to operationalize the notion of instrument mixes.

2.0 Conceptualizing policy instrument mixes

2.1 Current approaches to measuring instrument mixes

Public policies can be broadly understood as the actions of public actors (generally governments) to address challenges of societal interest. Policies can encompass a wide range of activities; conceptualizing and classifying these activities is a key entry-point for understanding how governments work (Howlett & Cashore 2009; Capano 2009). The early literature on policy instruments aimed to simplify this complexity by categorizing the wide range of tools used by governments to implement their policy goals (Howlett 1991). Various typologies emerged from empirical studies on how policy instruments are used by governments. These typologies tend to focus on different features of policy instruments, such as steering style, design criteria, or how governments deploy resources to influence society (Howlett 1991; Hood 1983; Howlett & Lejano 2012; Jordan, Wurzel, et al. 2013; Howlett & Ramesh 1995). Regardless of typological particulars, however, the underlying logic of policy instruments assumes that the choice of policy tool influences whether and how policy goals are implemented, and how likely governments are to achieve their goals.

While analytically useful, the early focus on identifying individual categories of instruments and the rationales behind policy-makers choices of instruments was critiqued for being overly simplistic in its interpretation of policy instrument selection (Howlett 2004). In contrast to the "one policy, one instrument" lens that characterized this research, policy systems tend to be crowded spaces consisting of multiple instruments that intersect in dynamic ways and become increasingly complex over time (Adam et al. 2018). Later scholarship took note of this overly-simplified treatment of policy instruments and moved towards a focus on understanding how bundles of policy instruments emerge and converge, with the aim of identifying patterns and mechanisms of emergence, stability, and change in policy instrument mixes (Howlett & Rayner 2008; Howlett 2009; Howlett & Rayner 2013).

Environmental policy literature has a well-developed focus on instrument mixes, where it is used as an entry-point for examining patterns of policy adoption and change over time (Jordan, Wurzel, et al. 2013; Jordan et al. 2005; Jordan, Bauer, et al. 2013; Bauer & Knill 2014; Knill et al. 2012). Policy instrument mix studies have adopted a variety of perspectives. *Descriptive* approaches tend to be non-normative in nature, and aim to distill and measure the essential elements of instrument mixes (e.g. Bouwma et al. 2015; Schaffrin et al. 2015; Persson 2006). *Evaluative* approaches tend to be more normative in nature, and aim to improve instrument mix outcomes by informing policy design. These studies assess instrument mixes based on qualities like coherence, consistency, comprehensiveness, effectiveness, or efficiency in policy mixes (e.g. Rogge & Reichardt 2016; Kern & Howlett 2009; Rosenow et al. 2017; Greenwood & Congreve 2015; Weber et al. 2011; Görlach 2014). A discussion on policy instruments has also emerged now within the climate change adaptation policy literature, where instruments are proposed as a way of better specifying the various approaches that governments are taking to respond to climate change risks (Henstra 2016; Vogel & Henstra 2015; Mees et al. 2014; Macintosh et al. 2015; Keskitalo et al. 2016). Using instrument mixes as a measurement approach, however, has not been yet been fully explored in the context of adaptation policy.

A key challenge to operationalizing the instrument mixes concept as a measurement technique in comparative research is the lack of clear metrics that can be used to identify, classify, and aggregate policy instruments across contexts. In general, within the environmental policy literature qualitative approaches to analyzing and interpreting instrument mixes are more common, while quantitative measurements policy instruments have largely tended to focus on single instruments like carbon taxes, avoiding the messiness of measuring entire instrument mixes. More recent studies, however, have attempted to measure mixes more quantitatively. These studies adopt an approach of measuring the "density" and "intensity" of policy instruments separately, and then interpret the results together to characterize whole policy portfolios (Knill et al. 2012; Schaffrin et al. 2015; Schaffrin et al. 2014; Schmidt & Sewerin 2018; Persson 2006; Bauer & Knill 2014).

Density and intensity measurements essentially aim to characterize the size and scope of policy mixes. Density is the relatively simple idea of frequency, namely the number of policy instruments adopted over time. Several recent studies add an additional analytical layer here by measuring the balance of instruments types counted within a policy mix, analogous to policy instrument diversity (Schmidt & Sewerin 2018; Costantini et al. 2017). Intensity measurements,

on the other hand, aim to capture the substance of a policy instrument, and have a more longitudinal and normative aspect to them. Specific metrics for intensity can vary quite significantly between those focused on policy goals, and those that are more processual in nature. Goal-based intensity measurements measure changes in strictness and scope of policies (Bauer & Knill 2014; Knill et al. 2012), for example interest rate fluctuation in monetary policy (Ying & Fan 2014), rates of assistance in agricultural incentive policies (Magrini et al. 2017), energy efficiency targets (Knoop & Lechtenböhmer 2017), and emissions reduction targets (Chen & Gong 2017). Processual measures of intensity capture various descriptive aspects of policy design, such as administrative capacity (Bauer & Knill 2014), budget, implementation, and monitoring (Schaffrin et al. 2015), government transparency and citizen engagement (Takeoka & Reddick 2017), or can track linear hierarchies in policy development such as moving from information gathering to rule changes, procedural policies, and finally substantive policies (Abel & Salazar 2015). Processual intensity measurements can be tracked over time to give a sense of how political commitments to achieving policy goals are changing.

Given their relatively straight-forward application, policy density measurements are already in common use in the comparative adaptation literature, and form the basis, for example, of the Adaptation Initiative Index (Lesnikowski et al. 2016). They have faced criticism, however, for their assumptions that all policy instruments are equivalent, and that a greater number of instruments (or greater diversity of instruments) necessarily correlates with a better developed adaptation policy portfolio or greater likelihood of successful climate risk reduction, a primary goal of adaptation policy. Intensity measurements have been used to measure to change in mitigation policies (Schaffrin et al. 2015; Schaffrin et al. 2014; Schmidt & Sewerin 2018), but have proved difficult to operationalize in a climate adaptation context. To-date, applications of goal-based intensity measurements are limited to policy issues where policy goals tend to be quantitative and measureable, instruments are generally regulatory in nature, and data environments are relatively rich. Adaptation policies, however, are characterized by policy goals that are frequency qualitative in nature (e.g. "increase resilience to change") and focused on capacity-building efforts and knowledge generation and sharing, suggesting a poor fit with measures of strictness and scope (Biagini et al. 2014; Lesnikowski et al. 2013; Conevska et al. 2018; UNEP 2017).

On the other hand, processual measurements are commonly applied in the monitoring and evaluation of adaptation policies and programs (Dinshaw et al. 2014), but their application as intensity measurements raises validity concerns about the systematic use of criteria like budget, implementation, and monitoring across a highly heterogeneous mix of instruments. The following section proposes an alternative measurement for adaptation instrument mixes.

2.2 Measuring instrument mixes for climate change adaptation

Local adaptation policy research tends to be largely qualitative in nature, and the lack of systematic analysis on policy adoption means that little is understood about how local governments are approaching adaptation across contexts (Ford & Berrang-Ford 2016). Given this gap, measuring local adaptation instrument mixes must begin from the systematic classification of individual policy instruments across cases. Existing comparative adaptation studies have focused on classifying and counting policy actions with the aim of identifying whether governments or other agencies are beginning to take steps to respond to climate change risks,

consistent with the density measurement logic in its most basic form (Labbé et al. 2017; Araos et al. 2015; Malcolm Araos et al. 2016; Lesnikowski et al. 2015; Ford et al. 2015; Poutiainen et al. 2013; Biagini et al. 2014; Reckien et al. 2014). The instrument types identified in these studies are somewhat eclectic in nature, and tend to be highly sensitive to the data sources that they utilize (Dupuis & Biesbroek 2013). Consequently, knowledge accumulation and broader theorizing on the nature of policy instruments in the context of adaptation is limited beyond observations about the growing number of policies concerned with climate change adaptation.

The framework applied here begins from the challenge of classifying individual adaptation policy instruments, and then considers the relationship between these instruments. Rather than develop a unique classification of adaptation policy instruments, this study draws on a general taxonomy of policy elements as the starting point for classifying individual adaptation policy instruments, then aggregates these into distinct instrument mixes (Howlett & Cashore 2009). The basic logic of this taxonomy distinguishes between two components of policy: policy goals and policy means (Hall 1993; Howlett & Cashore 2009). Each component can be interpreted on three levels of abstraction, from high level policy ideas (*policy goals)* and norms guiding implementation preferences (*policy means*), to program-level policy objectives (*policy goals*) and instruments (*policy means*), and finally at the level of specific design qualities regarding policy requirements (*policy goals*) and use (*policy means*). Individual policies are thus described along these six elements; instrument mixes result from individual policy instruments over time as governments use a combination of techniques to address policy problems (Howlett & Rayner 2007). Table 1 interprets the six elements of policy in the context of climate change adaptation. With some nuance, these elements are scalable across levels of government.

Table 1: Taxonomy of adaptation policy

	High-level	**Program-level**	**Operational-level**
Policy goals	1. Interpretation of the purpose of adaptation	2. Substantive goal-setting; processual goal-setting	3. Specification of desired (and generally measureable) policy impacts
Policy means	4. Preferred governance approach to achieving policy goals	5. Mechanism(s) for implementation: policy instrument	6. Processual aspects of instrument content

Modified from Howlett and Cashore (2009)

This paper deals primarily with the measurement of policy means, specifically mechanisms for policy implementation (cell 5). Classification of individual policy instruments draws from Howlett's distinction between substantive and procedural governing tools (Howlett 2000). This dichotomy represents two overarching approaches that governments take to achieve their policy goals: either direct provision of services and wielding of authority (substantive instruments- e.g. regulatory reforms, public works projects), or indirect efforts to shift behaviours or actor participation (procedural instruments- e.g. public education and outreach, creation of working groups). Choosing between these different types of policy instruments requires decision-makers to make implicit choices about the resources they will draw on to achieve their goals, and are influenced by preferred governance approaches and how decision-makers frame the problem of adaptation. Implementation of substantive or procedural instruments draws on one of four types of "governing resources" that governments use to implement policies, what is referred to as the

NATO typology (see Table 4 in methods below for details): i) information (*nodality*), ii) regulation (*authority*), iii) financial (*treasure*), and iv) institutional influence (*organization*) (Hood 1983). Specific types of substantive or procedural policy instruments were identified based on the conceptual literature (Howlett 2000; Howlett & Rayner 2013; Howlett & Rayner 2007; Howlett 1991), but refined based on scalar considerations (i.e. the powers and role of local government) and emerging adaptation research that is applying the concept of policy instruments (Henstra 2016; Macintosh et al. 2014; Keskitalo et al. 2016).

A measure of local adaptation instrument mixes is produced by aggregating individual policy instruments for each local government and discerning the ratio of procedural instruments to substantive instruments within that government's overall adaptation policy portfolio. This provides a quantitative representation of the *tendency* of local governments towards substantive or procedural instrument mixes (see 3.3 for further details). Local governments along this tendency spectrum are then grouped into five "adaptor profiles": strongly procedural, moderately procedural, balanced, moderately substantive, and strongly substantive. The tendency measurement approach provides a more nuanced measurement of density that reflects policy instrument preferences within adaptation policy portfolios. It is agnostic about normative preferences for substantive or procedural policy approaches, inductively deriving insight into local implementation styles for adaptation. Patterns in instrument mix tendency are also examined in light of key descriptive features of policy design, and how these relate to general substantiveness or proceduralness in mixes. Here we focus on three aspects of policy design: policy target, geographical scale of implementation, and expected duration of instrument impact (Rogge et al. 2017).

Interpretation of these profiles can provide insight into another dimension of policy means, that of overarching governance approaches to adaptation (cell 4). The high-level features of policy means, namely the preferred governance approaches of governments, are largely implicit in nature. The idea of governance modes suggests that governments tend to develop stable implementation styles over time due to persistent preferences for certain types of instruments (Bressers & O'Toole, Jr. 1998; Freeman 1985; Treib et al. 2007). Theoretical understanding of implementation styles and governance modes is relatively developed at the country level, but underdeveloped in the case of local governments (see Pierre 2005 for one example). As such, there is no robust way of systematically classifying local governments a priori based on overarching governance mode. Identification of patterns in instrument mix adoption across diverse contexts may provide some insight into this dimension by pointing to emerging implementation styles in adaptation policy.

3.0 Methods

3.1 Case selection

The sampling frame for this study consists of 125 local governments (LGs) in five countries (Canada, France, Germany, Netherlands, and the United Kingdom). Here a local government is understood as an administrative and decision-making unit. The diversity of powers allocated to LGs varies across countries, and even within countries (as in the United Kingdom) is a key challenge to comparative cities research (Walton 1975; Pierre 2005). Here this diversity is simplified by taking the level of LG with jurisdiction over all or most local service provision, land use planning, and building permitting as the unit of analysis. When discussed collectively

the term "local government(s)" is used, while references to country clusters specify the appropriate category of local government, i.e. municipality (Canada, Germany, Netherlands), commune (France), or local authority/metropolitan district/London borough (UK).

The case selection process followed a deliberative sampling strategies based on three criteria: i) governance contexts, ii) likelihood of emerging local adaptation policy mixes, and iii) access to textual information on adaptation policy. First, studies about policy instrument selection suggest that the emergence or evolution of instrument mixes are heavily influenced by dominant governance modes, understood as particular styles of governing that manifest in actor's preferences particular policy ideas or instruments (Howlett 2009). Consequently, adaptation instrument mixes should be expected to vary along contextual dimensions like state political structure, relationship of state and society in decision-making, and instrument preferences. With some exceptions (see for example Pierre 2005 and 2011), governance as a comparative concept at the local level is limited (Pierre 2005). Without a broad empirical basis for categorizing LGs based on urban governance mode, however, the concept as limited utility for case selection in large comparative studies. Theorization and empirical study of national governance modes is more developed, so countries were first identified that represent different national modes of governance. Governance mode was identified based on two dynamics: multilevel governance structure, understood as vertical dispersion of authority within a country, and administrative traditions, meaning the institutional and relational features of how national governments administer public policy (Painter & Peters 2010; Biesbroek et al. 2018). Five countries were selected to represent distinctive types of vertical dispersion of authority and administrative tradition (see Table 2).

Table 2: Case selection criteria

	Country				
	Canada	**France**	**Germany**	**Netherlands**	**United Kingdom**
Authority					
State structure	Federal	Unitary	Federal	Unitary	Unitary
*Regional Authority Index score (2010)**	26	20	37	17.5	11.2
Administrative traditions family	Anglo-American	Napoleonic	Germanic	Germanic	Anglo-American

**Higher scores correspond with higher level of regionalization (Hooghe et al. 2016)*

Second, the research is concerned with identifying variation in adaptation instrument mixes; the sampling strategy thus deliberately aim to maximize inclusion of LGs with high likelihood of existing policy instruments of adaptation. Country selection therefore reflects empirical research that identifies relative leaders in adaptation planning; all countries included in the sample selected scored in the top 75th percentile of Annex I Parties to the UNFCCC (Lesnikowski et al. 2016). Furthermore, to maximize the likelihood of identifying adaptation instrument mixes, it was determined that the 25 largest local governments from each country would be included in the sample. This logic follows from previous comparative local adaptation policy research, which suggests that large urban areas possess higher levels of adaptive capacity, and are more likely to be engaged in adaptation policy design (Malcolm Araos et al. 2016; Araos et al. 2015;

Paterson et al. 2017; Campos et al. 2017; Wang 2013; Reckien et al. 2015).[1] Case study and national comparative research also suggests that local governments in these countries are active in adaptation policy planning (Swart et al. 2014; Shi et al. 2015; Reckien et al. 2014).

Third, considerations of feasibility were weighed. Given that a unique dataset of local adaptation instrument mixes needed to be constructed, ease of access to documentation through local government databases and language were critical. Given the unevenness of online document availability for local governments in medium and low-income countries, only LGs in high-income countries were considered for inclusion in the sample. In combination with the previous two criteria, five countries were selected and the largest twenty-five LGs in each were included in the sampling frame, for a total of 125 LGs (Table 3).

Table 3: Dataset coverage

Canada: Municipality (Pop. 2016)	Toronto (2,731,571), Montreal (1,704,694), Calgary (1,239,220), Ottawa (934,243), Edmonton (932,546), Mississauga (721,599), Winnipeg (705,244), Vancouver (631,486), Brampton (593,638), Hamilton (536,917), Quebec City (531,902), Surrey (517,887), Laval (422,993), Halifax (403,131), London (383,822), Markham (328,966), Vaughan (306,233), Gatineau (276,245), Saskatoon (246,376), Longueuil (239,700), Kitchener (233,222), Burnaby (232,755), Windsor (217,188), Regina (215,106), Richmond (198,309)
France: Commun (Pop. 2013)	Paris (2,229,621), Marseille (855,393), Lyon (500,715), Toulouse (458,298), Nice (342,295), Nantes (292,718), Strasbourg (275,718), Montpellier (272,084), Bordeaux (243,626), Lille (231,491), Rennes (211,373), Reims (182,592), Le Havre (172,074), Saint-Etienne (172,023), Toulon (163,760), Grenoble (160,215), Dijon (153,003), Nimes (150,564), Angers (150,125), Villeurbanne (147,192), Le Mans (144,244), Aix-en-Provence (141,545), Clermont-Ferrand (141,463), Brest (139,386), Limoges (135,098)
Germany: Municipality (Pop. 2015)	Berlin (3,520,031), Hamburg (1,787,408), Munich (1,450,381), Cologne (1,060,582), Frankfurt (732,688), Stuttgart (623,738), Düsseldorf (612,178), Dortmund (586,181), Essen (582,624), Leipzig (560,472), Bremen (557,464), Dresden (543,825), Hannover (532,163), Nuremberg (509,975), Duisberg (491,231), Bochum (364,742), Wuppertal (350,046), Bielefeld (333,090), Bonn (318,809), Munster (310,039), Karlsrue (307,755), Mannheim (305,780), Augsburg (286,374), Wiesbaden (276,218), Gelsenkirchen (260,368)
Netherlands: Municipality (Pop. 2017)	Amsterdam (844,947); Rotterdam (634,660); Den Haag (524,882); Utrecht (343,038); Eindhoven (226,868); Tilburg (213,804); Groningen (202,636); Almere (200,914); Breda (182,304); Nijmegen (173,556); Apeldoorn (160,047); Haarlem (159,229); Enschede (158,140); Arnhem (155,699); Amersfoort (154,337); Zaanstad (153,679); Hertogenbosch (152,411); Haarlemmermeer (146,003); Zwolle (125,548); Zoetermeer (124,763); Leiden (123,661); Maastricht (122,753); Dordrecht (118,731); Ede (113,421); Alphen aan den Rijn (108,915)
United Kingdom: Local authority, London borough,	Birmingham (1,124,569), Leeds (781,743), Glasgow (615,070), Sheffield (575,424), Cornwall (553,687), Manchester (541,263), Bradford (534,279), Durham County Council (522,143), Edinburgh (507,170), Wiltshire (488,409),

[1] It is worth noting that nonetheless there is significant variation in population among sampled local governments, from 108,915 (Alphen aan den Rijn, Netherlands) to 3,520,031 (Berlin, Germany) (for full details see Table 3).

metropolitan district (Pop. 2016)[2]	Liverpool (484,578), Bristol (454,213), Kirklees (437,047), Barnet (386,083), Croydon (382,304), Cheshire East (376,695), Fife (370,330), Cardiff (361,468), Coventry (352,911), Leicester (348,343), Ealing (343,196), Newham (340,978), Belfast (339,579), North Lanarkshire (339,390), East Riding of Yorkshire (337,696)

Note: Population in parentheses

3.2 Data collection and policy instrument coding

A key challenge for comparative adaptation policy research, regardless of analytical scale, is the absence of robust existing data sources about policy adoption (Lesnikowski et al. 2016; Lesnikowski et al. 2017). Existing sources for local government action on adaptation (for example the UNFCCC's Nazca database) tend to rely on self-reported information, provide just high-level overviews of policy commitments for governments, and are largely voluntary in nature. As such, they cannot be considered comprehensive in nature. Estimating the measurement gap in these databases between the recorded actions being taken by governments and actual existing instrument mixes is impossible. Therefore, for this study a unique dataset was compiled that systematically measures instrument mixes across local governments.

The documentation for this dataset were collected from local council online archives covering the time period January 2010 to May 2017. Archival searches were conducted for each LG using the keyword "climate change" to identify all available documentation from past council meetings containing references to climate change. In cases of missing years in online archives, requests were sent to the LG's records office for digital copies of the relevant meetings. If no reply was received, then a web search was performed of the LG's general website to identify any pages or files related to climate change. A total of n≈6000 documents were retrieved. Document types identified include meeting agendas, meeting minutes, decision records, staff or consultant reports, records of rezoning and construction applications, and strategic planning documents.

Each document was then checked for content pertaining to climate change adaptation specifically. Climate change references that were unrelated to adaptation (primarily mitigation content and unrelated references to organizational entities with climate change titles) were excluded from further analysis. To be considered sufficiently robust for inclusion in the dataset, the text needed to provide a clear description of what type of policy instrument was being chosen. The motivation for the instrument's adoption needed to be explicit to climate change adaptation, though not exclusively or primarily concerned with adaptation. For example, policy planning tools adopted to manage general risks like flooding or biodiversity were included if there was an explicit mention that current or future climate change impacts were considered in the design or implementation of the tool. If the instrument was not already formally adopted, there needed to be concrete indication of a timeline for its adoption, such as an expected date or

[2] As noted, "local government" is defined here based on jurisdiction over local land use planning and general service delivery. In the case of local governments in the United Kingdom, this corresponds to local authorities, metropolitan districts and London boroughs, which have authority over planning applications, strategic planning, transportation planning, housing, waste management, and revenue collection, among others. These authorities do not always correspond to the boundaries of a city as traditionally understood (as in the case, for example, of the Cornwall Council, Durham County Council, and East Riding of Yorkshire Council).

specified budget. References to potential instruments that could be considered or adopted in future were excluded from the dataset.

The second step was to classify the text retained as adaptation-relevant by policy instrument category, climate impact category, policy target, policy impact, and policy scope (see Table X for further detail). Additional metrics included year of policy instrument adoption, policy framing, and departmental responsibility, but results were considered generally unreliable given the unevenness in level of descriptive detail across texts and so are not reported on here. All text classification was conducted in Atlas.ti, and the data were recorded in an Excel file.

The categories of instruments listed in Table 4 are informed by Howlett's identification of different types of substantive and procedural instrumentation (Howlett 2000), but are adapted to the local government level in light of what we know from the literature about how LGs are adapting to climate change (*dimensions 8 and 9)*. Instruments can only be coded as a single type of substantive or procedural instrument, so there is no double coding of the same instrument. In keeping with Howlett and Cashore's delineation of the six elements of policies, each type of policy instrument is considered based on its fit within an overarching governing logic (*dimension 7*), interpreted based on Hood's work on the governing resources of government (Hood 1983). This fit was determined a priori, and is denoted in Table 4 with brackets.

The goal attached to each instrument is broadly captured in dimension 6 as the nature of the climate change impact(s) the instrument is intended to address. Finally, dimensions 10, 11, and 12 operationalize several key aspects of policy instrument design; these dimensions are intended to consistently capture "on-the-ground" features of both substantive and procedural instruments in such a way that they can be analyzed together. It is worth explicitly noting that this approach to policy mix measurement follows a logic of policy accumulation, and represents an averaging of policy instrument adoption over a seven-year period. It does not measure policy termination, though the measure of policy impact (dimension 10) indicates the time horizons along which instruments are expected to make a difference.

Table 4: Data classification categories

Dimension	**Classifications**
1. Unit	Local government
2. Region	Province, state, region, lander
3. Country	Canada, France, Germany, Netherlands, United Kingdom
4. Instrument	Item name (open)
5. Description	Additional detail from text (open)
6. Nature of adaptation policy goal (climate change impact category)	Sea level rise (including storm surges); floods; storms; water security; drought; wildfires; erosion and landslides; desertification; food security; infectious disease; heat events; cold events; permafrost; air quality; mental health; biodiversity; economic growth; telecommunications; energy supply; heritage conservation; general climate change risk (including extreme events); other
7. Resource type	Nodality; authority; treasure; organization
8. Substantive instrument category	Infrastructure performance standards [authority]; building regulations [authority]; strategic planning [authority]; adaptation planning [authority]; legislation [authority]; inter-governmental mandate [authority]; direct expenditures [treasure]; user charges [treasure]; grants/subsidies [treasure]; loans [treasure]; demonstration projects [organization]; operations [organization]; facilities [organization]; other

9. Procedural instrument category	Exhortation [nodality]; advice [nodality]; training/education [nodality]; reports/assessments [nodality]; monitoring and evaluation [nodality]; knowledge network [nodality]; public outreach [nodality]; conferences/workshops [nodality]; spatial planning [authority]; political agreements [authority]; advisory group creation [authority]; certification/labelling [authority]; research funding [treasure]; interest group funding [treasure]; hearings [organization]; organizational reforms [organization]; other
10. Instrument impact horizon	Short-term; medium-term or episodic; long-term
11. Instrument target	Public-at-large; households; private sector; local government (internal); senior government; other
12. Geographical boundaries of policy instrument	Area-specific; city-wide; metropolitan area; regional; country-level; unclear; other

3.3 Measurement and analysis of instrument mixes

As described in section 2.2, this paper proposes a measure of instrument mixes based on the relative tendency of LGs toward substantive or procedural instrumentation. This tendency measurement is calculated as a ratio of the frequency (or density) of substantive or procedural instruments. Policy portfolios at the LG level are first categorized as being predominantly substantive (n>55%) or procedural (n>55%) in nature, and then further categorized by degree of tendency based on the ratio of substantive to procedural instrumentation (see Table 5). These results are interpreted in sections 4.3 and 4.4 primarily at the level of country clusters, reflecting the sampling strategy described above. Fisher's exact tests for statistical significant were performed on patterns that emerge from the descriptive results between adaptor profiles and country clusters. Finally, instrument mix tendency is examined in relation to descriptive features of policy design: policy target, geographical scale of implementation, and expected time horizon of instrument impact.

Table 5: Policy instrument mix tendency

	Predominant instrument category		
Adaptor Profile	**Substantive Instrumentation**	**Balanced**	**Procedural Instrumentation**
Strong substantive	0.78-1		0-0.22
Moderate substantive	0.56-0.77		0.25-0.44
Balanced		0.45-0.55	
Moderate procedural	0.25-0.44		0.56-0.75
Strong procedural	0-0.25		0.75-1

4.0 Results

4.1 Data description

A total of 3,328 policy instruments were identified across 119 local governments. Of the 125 LGs included in the sample frame, only six units demonstrated no textual evidence of adaptation policy instrument adoption. All six LGs are located in either Germany (Augsburg, Bielefeld, Duisburg, Leipzig, Wiesbaden) or the Netherlands (Alphen aan den Rijn, Zoetermeer). With the exception of Leipzig (population=560,472), all of these LGs have populations under 500,000. Descriptive statistics for the frequency of policy instrument observations are summarized in

Table 6. On average, nearly 28 policy instruments were observed in each LG, with Canadian and UK units demonstrating above average numbers of policy instruments. Canadian municipalities also demonstrated the greatest spread in frequency of observations, with a substantially higher standard deviation compared to the other four countries. This can be attributed to the large number of instruments identified for Toronto (n=211), which has nearly twice the number of instruments as the municipality with the second highest density of instruments (Surrey, n=109). When Canadian municipalities were removed from the dataset, the overall standard deviation in observation frequency reduces to 25.75; the standard deviation of Canadian municipalities reduces to 32.36. Dutch municipalities constitute notable outliers, with far lower average frequency of policy instruments (n=9.6).

Table 6: Descriptive statistics (Frequency of observations)

	All	**Canada**	**France**	**Germany**	**Netherlands**	**United Kingdom**
N	119	25	25	21	23	25
Total Obs.	3328	933	613	569	221	986
Min	1	2	2	1	1	1
Max	211	211	81	116	27	89
Mean	27.97	37.32	25.76	27.10	9.61	39.44
Median	16	16	14	19	7	38
Std. Dev.	31.88*	48.09**	24.20	29.64	8.23	27.27

*Without Canada, std. dev.=25.75

**Without Toronto, std. dev.=32.36

4.2 The governing logics of instruments

The overall distribution of instruments across country clusters suggests some structured variation in the predominant governing logics of instruments (Figure 7). In general, local governments in Canada, France, and the UK tend to adopt instruments that are in line with nodal and authoritative instrument logics, while German municipalities tend to be a bit more balanced in instrument logic. Canadian and French LGs have the most similar distributions in resource logics, with strong adoption of nodal instrumentation. German and UK LGs tend to have a relative equal balance between nodal and authoritative instruments, but municipalities in Germany differ in that they also tend to have higher rates of treasure-based instrument adoption. Local governments in Canada, France, and the UK tend to cluster within a similar range of treasure-based instrumentation. LGs show limited variation across countries with regards to organizational resources, with the exception of the Netherlands, where adoption of organization-based instruments is less than half that of the sample overall (Netherlands=5%, overall=12%).

Table 7: Share of instruments by resource logic

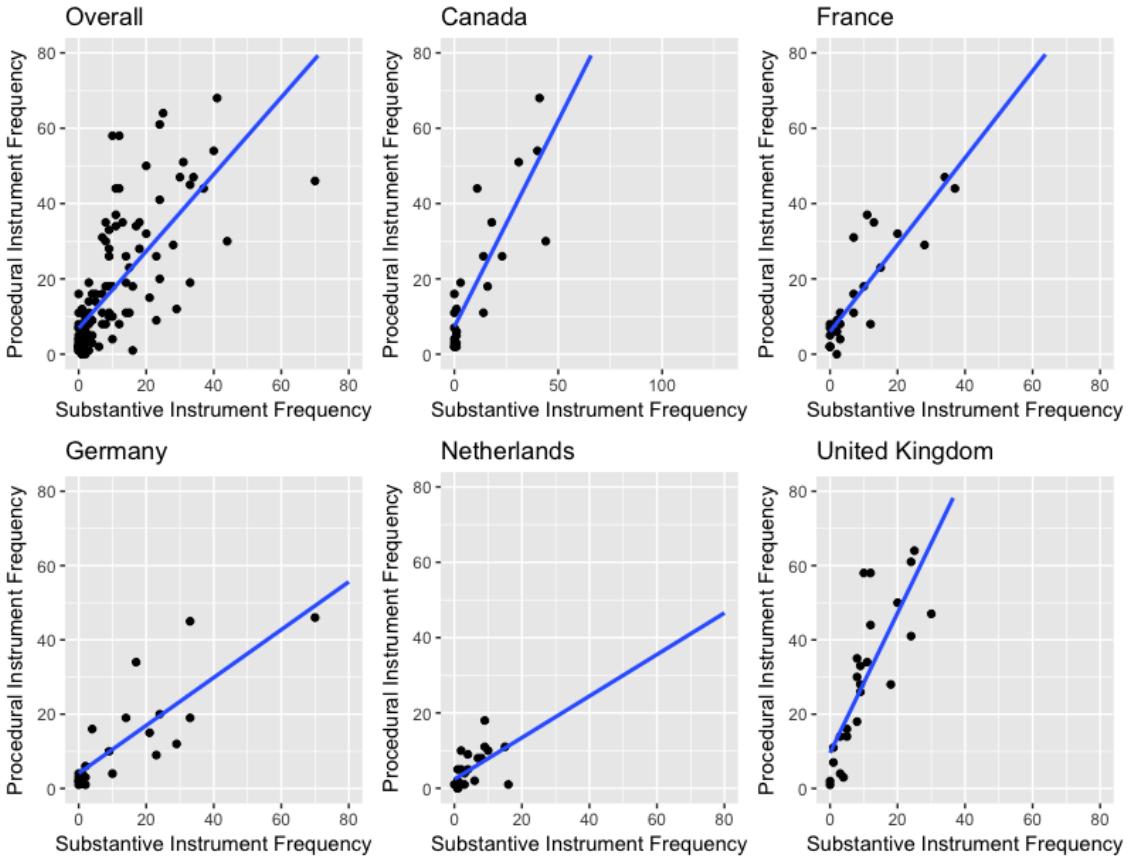
		Country				
Resource	***Overall***	**Canada**	**France**	**Germany**	**Netherlands**	**United Kingdom**
Nodality	*39.48*	44.59	45.56	35.33	28.05	35.80
Authority	*30.47*	25.29	25.73	31.11	37.56	36.41
Treasure	*17.58*	16.51	17.77	21.09	28.96	13.89
Organization	*12.47*	13.61	11.00	12.48	5.43	13.89

Note: All numbers above are percentages

4.3. Country trends in local adaptation policy mixes

Analysis of policy instrument adoption at the level of instrument type provides more nuanced insight into patterns of local policy instrument adoption. A quick glance at the co-occurrence of substantive and procedural policy instrument density in LGs by country cluster initially suggests that instrument choice occurs largely in step, though with some tendency towards procedural instrumentation (see Figure 1). Overall, LGs with higher numbers of substantive instrument also tend to have higher numbers of procedural instruments (p=0.01, Fisher's exact two-sided test). When disaggregated by country, however, we see variation in this pattern. LGs in Canada, France, and the UK tend towards procedural instrumentation, while LGs in Germany and the Netherlands exhibit a greater tendency towards substantive instrumentation.

Figure 1: Co-occurence of Substantive and Procedural Instruments By Country



Instrument mixes are estimated based on the proportion of substantive instruments to procedural instruments within each LG (see Table 8). Each LG is then categorized along a spectrum from strongly substantive instrument adoption to strongly procedural instrument adoption according to the proportion of substantive and procedural instruments identified in each LG's adaptation instrument mix (see section 3.3). These groups are labelled "adaptor profiles." A Fisher's exact two-sided test indicates that adaptor profile and country cluster are significantly related at the 99% confidence level ($p < 0.01$), suggesting that there are distinctive patterns in local instrument mixes emerging among these countries. A Fisher's exact two-sided test between adaptor profile and population quartile are borderline significant at the 95% level (p=0.06), but this relationship appears to emerge specifically from the Canadian cases, where population quartile and adaptor

profile are significantly related (p=0.02); relationships between population quartile and adaptor profile were insignificant when tested for every other country subset.

Table 8: Local adaptation instrument mix profiles

	City Adaptor Profile (N=119)				
Country	**Strong Substantive**	**Moderate Substantive**	**Balanced**	**Moderate Procedural**	**Strong Procedural**
Canada	0	2	2	7	14
France	1	1	2	9	12
Germany	1	6	2	4	8
Netherlands	6	2	6	6	3
United Kingdom	0	1	0	10	14
Total	8	12	12	36	51

Overall, local governments demonstrate tendencies towards procedural instrument mixes (n=86), but as suggested by the correlation test results, these tendencies differ significantly between countries. Local governments in Canada, France, and the UK tend to have instrument mixes that are highly procedural in nature, while mixes in Germany and the Netherlands tend towards more substantive composition. The largest number of procedural LGs are in Canada (n=21) and the UK (n=21), with about half of communes in France also falling into the strongly procedural category (n=12). The range of instrument density between LGs is found to be wider among moderately procedural local governments, with n=3 to 211 and an average number of instruments equal to 46 (average=41 with the exclusion of Toronto, considered an outlier with regards to instrument density). Strongly procedural LGs (n=51) tend to have a much lower density of observations (average=16), but show a sizeable range of instrument density (n=1 to 70).

Far fewer local governments tend towards instrument mixes that are substantive in nature. In these cases, instrument mixes tend to have lower average densities and somewhat narrower ranges. Among the 12 local governments with moderately substantive instrumentation, instrument mixes contain an average of 34 instruments, with a minimum and maximum range of 3-116. Only four moderately substantive LGs are located in Canada, France, and the UK, while six are located in Germany and two are located in the Netherlands. Only eight of the sampled LGs were found to have strongly substantive instrument mixes. Country-level dynamics seem to play a significant role here, with the largest concentration of strong substantive instrument mixes found in the Netherlands (n=6), and only a couple found in France (n=1) and Germany, (n=1). No strongly substantive local instrument mixes were identified in Canada or the UK. Like strongly procedural mixes, strong substantive instrument mixes tend to be smaller in size, with an average density of nine (range=1 to 41).

Finally, 12 LGs were measured as having balanced instrument mixes, meaning they have a roughly equal frequency of substantive and procedural instrumentation. Half of these mixes were identified in Dutch municipalities (n=6). These mixes tend to have a slightly lower average density of instruments (n=30), but a wide range similar to moderate instrument mixes (n=2 to 81).

4.4 Policy instrument composition in instrument mixes

Table 9 summarizes the composition of instruments mixes aggregated by country. Here we see that while certain types of substantive and procedural instruments are commonly found across local governments in all countries, the relative importance of different types of instruments varies across country clusters.

Turning first to substantive policy instruments, instrument adoption patterns mirror trends in adaptor profiles discussed above. Every country demonstrates high usage of direct expenditures, including for example capital spending on public works, flood defense construction, park construction, and tree planting. Nonetheless, adoption rates are notably higher in German and Dutch municipalities (15 percent and 26 percent, respectively). Similarly, adoption of spatial planning instruments is higher in Germany and the Netherlands than in Canada, France, or the UK. Minimal use of infrastructure standards and building regulations is observed across country clusters, likely reflecting the limited jurisdiction that local governments have in this area. Canadian municipalities are distinctive in their higher adoption of operational instruments that modify local government routines and procedures in response of changing environmental risk, though French and German LGs also have slightly higher update of operational instruments. These types of instruments include, for example, road maintenance procedures during winter storms, adjustment of outdoor work schedules during heat waves, and updates to emergency event protocols.

Variation between country clusters is similarly evident in patterns of procedural instrument adoption. Reports and assessments, public outreach, and strategic planning are the most commonly occurring types of procedural instrumentation, with some observable differences among Canadian and UK local governments. Most notably, LGs in Canada and the UK demonstrate an elevated focus on expanding the evidence base for adaptation planning with assessments and reports. This perhaps reflects the influence of the "rational" planning approaches to adaptation advocated by the now-defunct National Indicator 188 in the UK, and the Partnership for Climate Protection program jointly conducted by ICLEI Canada and the Canadian Federation of Municipalities. Exhortations to senior government are also higher in Canada when compared with the other country clusters, suggesting that Canadian municipalities are more engaged in upward pressure for guidance and resources from provincial and federal authorities.

Strategic planning efforts are evident across all country clusters, but are particularly strong in UK local authorities/metropolitan districts. This includes standalone adaptation plan creation, as well as integration of adaptation considerations into planning tools in related fields such as conservation, flood management, and emergency management. LGs in the UK also tend to have higher levels of organizational change, including creation or expansion of staff positions with adaptation responsibilities, formation of new working groups, and creation of climate change portfolios within local councils.

Table 9: Policy instrument mixes by share of instrument type

		Country				
		Canada	**France**	**Germany**	**Netherlands**	**United Kingdom**
Total Obs.: Substantive Instruments		331	218	294	107	259
Total Obs.: Procedural Instruments		602	401	275	114	727
Substantive Instruments (share of total)						
Authority	Spatial planning	4.29	6.79	16.52	14.83	8.42
	Infrastructure standards	2.36	1.62	2.11	0.45	2.13
	Building regulations	2.25	1.62	2.11	0.45	2.13
Treasure	User charges	0.96	---	1.05	---	---
	Subsidies/grants	2.25	4.20	2.99	3.17	1.01
	Direct expenditures	12.86	13.57	17.22	26.24	12.58
Organization	Demonstration projects	0.64	1.62	1.05	1.36	0.61
	Operations	9.43	5.01	5.45	0.45	1.42
	Facilities	0.11	1.45	0.35	---	0.10
Procedural Instruments (share of total)						
Nodality	Exhortation	4.93	---	0.18	0.45	0.91
	Training/Education	0.96	2.75	0.70	0.45	1.01
	Reports/assessments	23.04	14.05	15.47	12.22	20.39
	M&E	3.43	2.91	2.99	0.90	1.12
	Knowledge networks	1.71	4.52	3.51	3.17	3.25
	Public outreach	8.90	14.05	9.14	10.41	7.30
	Conferences/workshops	1.61	5.98	1.76	---	2.23
Authority	Strategic planning	13.29	12.44	7.21	13.57	22.92
	Political agreements	1.93	2.91	0.35	5.88	1.93
	Advisory group creation	0.11	0.97	---	0.45	0.81
	Certification/labelling	0.11	1.13	0.35	---	---
Treasure	Research funding	0.11	---	---	0.45	0.10
Organization	Institutional changes	3.11	3.07	6.33	3.62	11.66
	Hearings	0.32	---	---	---	0.10

Note: In categories with n=0 for all countries, instrument was removed from table for clarity.

4.5 Design features of instrument mixes

Examination of three design features of policy instruments indicates that local adaptation policy instruments are primarily focused on targeting government operations and services, rather than for example the public-at-large or private sector (Table 10). This pattern holds across all countries, although local governments in France and the Netherlands have slightly higher targeting of the public-at-large (e.g. with public education events or campaigns), and LGs in Germany have a higher share of instruments targeting the private sector (this reflects the use of spatial planning instruments like zoning to achieve policy goals). Instrument scope tends to align with jurisdictional boundaries, though the higher use of direct expenditure and spatial planning

instruments in German and Dutch LGs is associated with a slightly higher incidence of area-specific policy instruments. In countries with a greater number of enhanced metropolitan governance structures (France, Germany), we observe a higher share of instruments operating at the metropolitan scale, reflecting increased cooperation between neighbouring local governments.

Finally, adoption of policy instruments with long-term consequences has a higher prevalence in Germany and the Netherlands, where local governments have a stronger tendency towards substantive instrument mixes, namely direct expenditures on public works projects and spatial planning tools. Local governments in countries that tend towards procedural or balanced instrument mixes (Canada, France, United Kingdom) tend to implement instruments with short or medium-term impacts, or that are episodic in nature (e.g. strategic planning initiatives, weather warning systems, assessment and monitoring). Fisher's exact two-sided tests indicate that there is a statistically significant relationship between country cluster and frequency of short-term instruments ($p<0.01$) and long-term instruments ($p=0.02$), while the relationship between country cluster and frequency of medium-term instruments is insignificant ($p=0.48$).

Table 10: Policy instrument design features

	Country				
	Canada	**France**	**Germany**	**Netherlands**	**United Kingdom**
Instrument Impact – Time Horizon					
Short-term	31	24	17	12	21
Medium-term/Episodic	39	43	34	40	52
Long-term	30	34	49	50	26
Instrument Scope – Geographical Scope					
Area-specific	5	5	15	13	9
City-wide	89	84	60	76	83
Metropolitan	2	12	19	0	7
Regional	4	0	6	5	1
Country	0	0	0	6	0
Instrument Target					
Public-at-large	8	15	8	10	5
Households	6	2	5	9	2
Private sector	7	8	27	10	7
Local government	74	73	72	84	83
Senior government	5	0	0	1	2
Other	3	3	0	2	1

Note: All numbers are percentages

5.0 Discussion

5.1 Emerging patterns in local adaptation instrument mixes

In designing policy strategies to achieve particular goals, governments make important decisions about the resources they will expend and the instruments they will adopt as a means to achieving those ends. Evidence from the adaptation governance research at the national level suggests that there is structured variation in how actors are making these decisions (Wellstead & Stedman

2014; Klein 2018; Buuren et al. 2018; Biesbroek et al. 2018); the results from this study contribute to a growing body of research indicating that there are similar variations in how local actors are adapting to climate change (e.g. Macintosh et al. 2014). While LGs in Canada, France, and the UK tend to be more procedural or balanced in their approach, LGs in Germany and the Netherlands have a higher tendency to adopt substantive instrument mixes.

These findings suggest that governing context is integral to how (and to what extent) adaptation is emerging as a distinct policy domain, warranting further in-depth study to specify precisely which elements matter most, where, and how. Nonetheless we can draw some preliminary insights into what these instrument mix patterns suggest about the emergence of different local adaptation governance approaches across these countries. First, the link between a more comprehensive approach to adaptation planning and uptake of procedural instrument mixes is consistent with what would be expected in policy subsystems with a strong emphasis on policy integration (Tosun & Lang 2017; Candel & Biesbroek 2016). The high prevalence of assessments, strategic planning, and organizational development among local governments in the UK emerged from the emphasis on adaptation mainstreaming that characterized early adaptation guidance from the national government. This guidance directed local governments to conduct local climate change impact assessments and develop strategic adaptation plans. The much smaller number of substantive policy instruments that were identified here is also consistent with other research suggesting that in the absence of adequate resources and jurisdiction, local governments in the UK have been largely unable to translate these procedural efforts into more substantive implementation (Porter et al. 2015).

Canadian municipalities like Vancouver and Toronto that were on the leading edge of engagement on adaptation tended to adopt a similar comprehensive approach to adaptation planning, beginning with completion of impact assessments and adaptation research, and then moving to integration of adaptation into community plans or completion of standalone adaptation policies. At the same time, however, Canadian municipalities demonstrated a greater range in instrument density between highly active LGs like Toronto, Vancouver, or Halifax and those less engaged with adaptation. The state structure of Canada and the UK differ significantly, with Canada being a highly devolved federal state and the UK a more centralized unitary state (Henstra 2017). These contextual dynamics may impact on some aspects of how adaptation instrument mixes are emerging at the local level. Specifically, results here indicated that in Canada, urban population is related to adaptation instrument mix adoption, which was not the case for the other country clusters. Other studies have found similar relationships, suggesting that differences in resources and capacity affect the engagement of LGs in adaptation (Araos et al. 2016; Reckien et al. 2014). The relevance of this gap could also account for the greater number of exhortations recorded among Canadian municipalities encouraging leadership on climate change to senior government (see Table 9).

Given the fragmented nature of climate change governance in Canada, in the absence of strong inter-governmental mandates and guidance around adaptation it would seem that local government resources and capacity may play a more significant role in the emergence of instrument mixes. Nonetheless, Canadian and UK local governments share similar characteristics with regards to adaptor profile and instrument mix composition, suggesting that the managerial style of public administration that these countries share influences adaptation instrument

adoption despite differences in state structure. A key trend to watch will be whether we see Canadian municipalities moving closer to the UK model over time, with greater integration of adaptation into strategic planning instruments and a more dedicated organizational capacity for adaptation.

In contrast, German and Dutch municipalities seem to be moving towards a more targeted and substantive model of policy adoption. The strong focus on water management within the Dutch spatial planning tradition seems reflected in the more substantive make-up of local instrument mixes, which emphasizes direct spending on public infrastructure (e.g. sewer systems, storm water systems) and spatial planning instruments rather than development of new organizational structures for comprehensive adaptation policy planning (van den Berg & Coenen 2012; den Exter et al. 2014). This may also explain the relatively low number of policy instruments identified among Dutch municipalities, where the existing institutional structure for water management in the Netherlands means that key climate change risks like flooding are primarily addressed by other levels of government, and other climate change risks such as drought or heat receive far less attention (Kamperman & Biesbroek 2017; Biesbroek et al. 2013; Court of Audit 2012). This distinction between Canada/UK and Germany/Netherlands is also consistent with variations in national administrative traditions, with the Canadian and UK approach to policy-making tending towards greater proceduralism and managerialism, and the Germany and Dutch systems tending towards more formal, legalistic approaches (Verheijen 2010).

The French case would seem to be more ambiguous, aligning more closely to the Canadian and UK instrument mix patterns than to that of Germany and the Netherlands, but it seems that this might reflect the strong regional approach taken by the national government to climate change planning. The government of France's mandate for the creation of regional climate, air and energy plans and regional ecological plans emerged in local strategic planning documents as a key point of reference of priority setting, suggesting that communes are partners to that process, rather than separate loci for adaptation policy development. If so, this suggests that even though patterns in instrument adoption may be similar across countries, the institutional context from which they emerge can be very different. This reinforces the need to understand the role of structural and organizational dynamics in shaping patterns of instrument adoption across contexts (Wellstead et al. 2016).

A key takeaway from these results is that policy instrument density is not necessarily associated with great substantiveness.[3] In the cases of both Canadian and UK local governments, which tend to have a significantly higher density of policy instruments, we observe far stronger patterns of procedural instrument mixes, while the Netherlands with its low instrument density leans much more towards substantive instrument mixes. Adaptation policy studies have tended to, whether explicitly or not, associate higher densities of instrumentation with the notion of greater progress on adaptation (for example see Lesnikowski et al. 2013; Heidrich et al. 2016; Araos et al. 2016). Given the linkages found between proceduralism and substantiveness and the time horizon of policy instruments (section 4.5), this study indicates that great caution is required

[3] When disaggregated at the country level, a significant correlation between total observations and adaptor profile is found only for the Netherlands ($p<0.01$, Fisher's exact two-sided test), suggesting a stronger sensitivity in cities with smaller numbers of instruments.

around this assumption; a higher density of procedural instruments could, in some cases, equate to doing less with regards to tangible changes "on-the-ground" compared to a lower density of substantive instruments. This also echoes our previous observation that rather than measuring the density of instruments as a simple frequency count, adaptation policy studies need to analyze whole instrument mixes with regards to their logic and characteristics. Whether procedural instrument mixes can evolve into more substantive instrument mixes over time (or vice versa) can only be determined with longitudinal analysis.

5.2 Future directions

This paper has focused only on measuring instrument mixes, but a larger issue is how to measure entire policy mixes. This means being able to draw connections between policy goals and policy means, and is key to answering normative questions about the coherence and consistency of adaptation policy mixes, and assessing policy integration across domains (Howlett & del Rio 2015; Rayner et al. 2017; Candel & Biesbroek 2016). Implementing this type of research question with a comparative research design is complicated by the reality that adaptation policy goals are highly diverse and often qualitative. In general, we can identify two categories of policy goals: i) substantive goals, which aim to address particular risks, hazards, or vulnerability sources, and ii) processual goals, which aim to change how government structures its adaptation planning efforts. Systematic measurement of policy goals and instruments requires being able to match groups of instruments to specific goals, a significant empirical challenge given the diversity and volume of documents that need to be analyzed to comprehensively identify boundary-spanning policy mixes. Within current large-n comparative adaptation research the closest proxy measurement for policy goals is essentially issue salience measurements of different categories of climate change impacts (for example, see Lesnikowski et al. 2011; Lesnikowski et al. 2015; Lesnikowski et al. 2016). Advancing beyond this limited measurement is essential for capturing whole adaptation policy mixes, and would have applications in other boundary-spanning policy areas, such as food policy.

Finally, another important challenge is the development of intensity measurements that can provide a roadmap for assessing changes in policy mixes over time, and can shed light on important normative questions like the adequacy of adaptation policy efforts and their likelihood of achieving policy goals. A trade-off would seem to exist between the flexibility of intensity measurements in their applicability across different types of policy instruments, and the depth of information that can be gleaned from them. Further debate around this trade-off is needed to shed light on the relative importance of consistency vs. depth in the context of different research questions, and more empirical work is needed to refine these measurements in heterogeneous instrument mix settings.

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