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A policy mixes approach to conceptualizing and measuring climate change adaptation policy

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Abstract

Comparative research on climate change adaptation policy struggles with robust conceptualization and measurement of adaptation policy. Using a policy mixes approach to address this challenge, we characterize adaptation policy based on a general model of how governments govern issues of societal interest. We argue that this approach allows for context-sensitive measurement of adaptation policy, while being both comparable and parsimonious. This approach is tested in a study of adaptation policies adopted by 125 local governments located in Canada, France, Germany, the Netherlands, and the UK. Using a systematic data collection protocol, a total of 3328 adaptation policies were identified from local council archives between the periods of January 2010 and May 2017. Results of this analysis suggest that there is structured variation emerging in how local governments govern climate change adaptation, which justifies calls for comparative adaptation research to use measurements that capture the totality of adaptation policies being adopted by governments rather than focusing on specific types of adaptation policy. We conclude with a discussion of key issues for further developing of this approach.

1 Introduction

Over the last decade, adaptation to impacts of climate change has emerged as a core component of the climate change policy agenda (Magnan and Ribera 2016; Aylett 2015). Growing concern with reducing vulnerability to climate change impacts and building adaptive capacity is encouraging a rapid increase of adaptation adoption by national and subnational governments (Reckien et al. 2018; Ford et al. 2015; Lesnikowski et al. 2016). With the emergence of these new policy initiatives, a basic empirical question has arisen of how to make sense of this evolving governance landscape (Jordan and Huitema 2014). How we ascribe meaning to policy as an empirical phenomenon poses a fundamental conceptual issue for adaptation scholarship, with some authors arguing that unclear conceptualization of adaptation policy in the literature is a key barrier to theory building in adaptation policy research (Dupuis and Biesbroek 2013). How we conceptualize climate change adaptation is critical for both the theory of adaptation governance and for developing useful advice to decision-makers on improving adaptation efforts and assessing progress on policy goals. Different conceptualizations of adaptation lead to different explanations of adaptation policy change that can be difficult to reconcile and evaluate, and present significant obstacles to knowledge accumulation.

Here we address this ambiguity by proposing a conceptual approach rooted in the policy sciences, specifically policy mixes. We examine what should be measured from a policy mixes perspective on adaptation, and how this approach can be operationalized using systematic coding protocols for analyzing policy texts. Our conceptual approach begins from an understanding of public policies as the actions of public actors (generally governments) to address challenges of societal interest. Policy approaches to addressing boundary-spanning challenges like climate change adaptation can encompass a wide range of policy goals and policy instruments, which are defined as the various techniques available to governments to achieve their policy goals, such as regulations, market interventions, or behavioral nudges (Howlett 1991). The policy instruments

scholarship recognizes that governments rarely address policy goals through a single policy instrument; instead, policy mixes consisting of multiple goals and instruments tend to develop over time, especially where jurisdiction over policy issues is shared among agencies or levels of government (del Rio and Howlett 2013). Here we argue that the concept of policy mixes offers a robust path forward in conceptualizing adaptation policy, and demonstrate its usefulness by conducting a comparative analysis of adaptation policy mixes among local governments in five countries.

Local governments provide an interesting “test case” for the study of adaptation policy mixes because they are highly diverse in institutional and environmental context, and approach adaptation from different perspectives about how local governments should respond to growing climate change risks. Consequently, the local adaptation policy landscape is highly diverse and poses challenges for comparison across contexts (Vogel and Henstra 2015). We examine emerging policy mixes in 125 local governments located in Canada, France, Germany, Netherlands, and the UK through systematic content analysis of local policy documents published between January 2010 and May 2017. The following section situates the study of policy mixes within current comparative approaches in adaptation policy research, and presents the logic and assumptions underlying a policy mixes perspective on adaptation policy. We then describe the research design that guided data collection and present results on emerging policy mixes among the local governments sampled. The paper concludes with a discussion on the potential contributions of adopting a policy mixes approach to the comparative adaptation policy literature.

2 Conceptualizing and measuring adaptation policy mixes

While early studies that track the emergence of adaptation as a policy issue have made valuable empirical contributions to our understanding of where and how adaptation policy is emerging on government agendas, progress towards a broader theoretical understanding of adaptation policy change is still limited. Adaptation policy tracking has largely been debated as a methodological challenge (Ford and Berrang-Ford 2016), but linking advances in systematic research design with theoretical debates about governance approaches to adaptation is critical for refining comparative research approaches (Bednar and Henstra 2018). Here we argue that recent methodological progress on understanding adaptation policy change requires more advanced conceptual foundations.

2.1 Measurement issues in systematically classifying and comparing adaptation policy

As a complex and boundary-spanning policy issue, adaptation presents several challenges for systematic policy measurement and comparison that the adaptation literature has attempted to resolve in various ways. First, the impacts of climate change are wide-ranging with implications for how governments manage the built environment, public health and safety, livelihoods, economic stability, culture and heritage, and ecosystem health, among other areas. Adaptation policies therefore encompasses diverse goals, and are characterized by a heterogeneous policy environment with actors from multiple policy sectors working both separately and across organizational boundaries to design and implement policies (Dąbrowski 2018; Runhaar et al. 2018). While some areas of environmental policy like air pollution reduction or greenhouse gas

mitigation rely heavily on regulatory or incentive-based policy instruments such as energy efficiency standards or carbon taxes, governments tend to employ a wide range of tools for adaptation, from “soft” tools such as public education campaigns or knowledge-building programs, to “hard” tools such as regulatory reforms and financial incentives (Mees et al. 2014; Henstra 2016). Furthermore, many of the goals that adaptation policies aim to achieve are expressed qualitatively and resist comparison based on quantification. The global goal on adaptation set out in Article 7 of the Paris Agreement, for example, states “Parties hereby establish the global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2” (UNFCCC 2015).

Two primary approaches to simplifying this complexity are proposed in the adaptation policy literature: (i) classifying policies based on functional typologies, and (ii) characterizing adaptation based on specific policy adoption events. Both of these approaches have their advantages, but neither has proposed a fully satisfactory answer to the question of how we conceptualize and measure adaptation. The categorization of policies based on functional typologies reflects an inductive approach to classification that is characteristic of early adaptation policy research (Lesnikowski et al. 2011; Pearce et al. 2018; Ford and King 2015; Biagini et al. 2014; Eisenack and Stecker 2012; Araos et al. 2016) This work contributed important empirical insights into emerging efforts to respond to climate change impacts, but has tended to lead to typologies that are highly sensitive to the priorities, roles, and responsibilities of the organizations that author the texts used to compile policy data (Eisenack and Stecker 2012; Biagini et al. 2014). Early work sought to nuance this approach by integrating a distinction between “groundwork” and “adaptation” that is analogous to two distinct stages in adaptation policy processes, preparation for policy action and the implementation of actual adaptations (Lesnikowski et al. 2011). The assumption that the one stage would always precede the other proved to be problematic, however, when confronted with the messiness of “real-world” policy-making and the nature of adaptation as process of managing climate change impacts and vulnerability rather than an end-point (Levin et al. 2012).

Limitations also arise around how to translate these typologies into measurements for large- n research designs. Given that large-scale comparison requires some degree of quantification to represent similarities and differences either cross-sectionally or longitudinally, typological studies have relied on measurements of policy density to synthesize patterns in policy adoption across places, policy sectors, and levels of government. These measurements represent the number of policies adopted by a government entity. Several recent studies in the climate change policy literature have proposed an additional analytical layer to policy density that accounts for the balance of different instrument types within a policy mix, similar to the idea of policy diversity (Schmidt and Sewerin 2018; Costantini et al. 2017; Lesnikowski et al. 2015). The validity of this approach, however, suffers from the underlying assumption that a greater number of policy instruments (or greater diversity of instruments) implies a “better” adaptation policy mix or greater likelihood of successful climate risk reduction. In reality, the extent to which adaptation requires only a few policy instruments or many policy instruments reflects how narrowly decision-makers define adaptation as a policy problem, and is likely to vary across places, policy sectors, and levels of government (Massey and Huitema 2013). Further- more,

reliance on density measurements neglects a fundamental purpose of policy research, which is to understand the relationship between the content of public policies and the political and institutional environments that they emerge from (Howlett and Mukherjee 2018).

The second branch of adaptation policy research has tended to rely on specific moments of policy adoption that are interpreted as signaling commitment on adaptation policy development. Often these moments are the adoption of a strategic adaptation policy or the decision to join a climate change policy network (Reckien et al. 2018; Reckien et al. 2014; Olazabal et al. 2019; Heidrich et al. 2013; Heidrich et al. 2016; Kamperman and Biesbroek 2017; Fünfgeld 2015). While this approach has facilitated larger-scale comparisons than is typically done using typology-based approaches, scalability has come at the expense of more nuanced measurements of adaptation policy (Biesbroek et al. 2018). Consequently, much of the explanatory research emerging in the adaptation policy literature produces only a vague understanding of emerging adaptation efforts that does not say much about what governments actually do in response to climate change impacts. This approach limits our ability to make observations about a range of key questions for both theory development and developing more refined policy advice, for example what explains variations in emerging policy approaches to adaptation or whether some governing approaches are more effective in addressing climate change impacts than others (Javeline et al. 2014).

The proliferation of different approaches to characterizing adaptation policies has resulted in a relatively idiosyncratic empirical literature that limits accumulation of evidence around even simple ideas such as policy “leaders” or “laggards” (Dupuis and Biesbroek 2013). Adaptation policy research has struggled with how to conceptualize adaptation in such a way that the diversity of policy approaches that are emerging under the broad banner of climate change adaptation is accounted for, while also maintaining comparability of measurements across contexts. The following section examines the conceptual foundations of this debate and argues that the idea of policy mixes provides a promising pathway forward in addressing these measurement challenges. In doing so, we build on several recent papers that propose a policy instruments perspective on adaptation policy formulation (Henstra 2016; Mees et al. 2014; Macintosh et al. 2015; Macintosh et al. 2014; Keskitalo et al. 2016; Thistlethwaite and Henstra 2017).

2.2 A policy mixes approach to measuring and comparing adaptation policy

Policy mixes are defined as combinations of policy goals and policy instruments that emerge over time around a specific policy issue (Howlett and Rayner 2007). The concept builds on a taxonomy of public policies elaborated by Howlett and Cashore that distinguishes between two dimensions of policies, policy goals and policy means, which exist at three levels of abstraction (Table 1). Policy mixes exist at the second, programmatic level of this taxonomy. Goals constitute the strategic policy objectives explicitly stated by decision-makers, while instruments constitute the means by which these goals will be implemented (Howlett and Cashore 2009).

The policy mixes literature observes that governments address only the simplest policy problems through single goals and instruments, and more often policy approaches involve multiple goals and policy instruments that can exist across policy sectors and even administrative levels of

government (Rogge and Reichardt 2016; Rosenow et al. 2017; Mees et al. 2014; Rayner et al. 2017). Mixes reflect temporal dynamics, as individual policies tend to accumulate over time and result in a complex policy landscapes wherein governments address policy problems through multiple pathways (Adam et al. 2018). The co-existence of multiple goals and instruments points to complexities inherent within policy mixes that present significant challenges for effective policy implementation. A large literature has emerged around how “optimal” policy mix can limit contradictory or redundant goals and instruments, and optimize of complementarity and synergy (Cejudo and Michel 2017; Howlett and Rayner 2007, 2007). The tendency for policy mixes to emerge incrementally over time through processes of layering, drift, conversion, and replacement, as opposed to through rational and technical decision-making processes, presents challenges for optimizing the design of policy mixes, and points to the importance of historical policy legacies in decision-making, particularly the potential for institutional “lock-in” that constrains future decision-making (Howlett and Rayner 2008; Eckersley 2017). As such, thinking on the emergence and evolution of policy mixes draws from the literature on historical institutionalism (Pierson 2000).

Del Rio and Howlett propose a typology of policy mixes that theorizes their structure based on possible combinations of policy goals, policy instruments, and whether policy efforts are occurring across multilevel levels of government (del Rio and Howlett 2013). They propose eight types of policy mixes, which we simplify here given our focus on only local government policy mixes (Table 2). These types include complex policy mixes (multiple goals, multiple instruments), simple policy mixes (multiple goals, single instrument), complex instrument mixes (single goal, multiple instruments), and simple instrument mixes (single instrument, single goal).

Table 1 Taxonomy of adaptation policy

	Abstract	Program-level	Operational
Policy goals	Beliefs about the nature of climate change risk and purpose of adaptation	Strategic policy objectives	Specific policy targets (i.e. desired policy impacts)
Policy means	Preferred policy approaches to adaptation	Policy instruments	Processual aspects of instrument design

Modified from Howlett and Cashore (2009)

To operationalize our study of local adaptation policy mixes, we draw on both the adaptation literature and the policy instruments literature (Berrang-Ford et al. 2015; Howlett 1991).

As noted above, adaptation policy goals tend to be highly qualitative and diffused across diverse policy sectors, which creates a challenge for systematic identification of policy goals. Here we take the diversity of climate change impacts addressed in adaptation policy mixes as a proxy measurement for adaptation policy goals. We interpret this as reflecting prioritization of risks within policy mixes. To identify and classify adaptation policy instruments, we draw from Howlett and Rayner (2007), who define policy instruments based on two attributes: the

governing resource that state actors rely on to implement policy, and the governing logic that governments use to achieve a desired change. The governing resource dimension utilizes a well-known typology identified by Christopher Hood that identifies four types of resources available to government: (i) information (nodality), (ii) regulation (authority), (iii) finance (treasure), and (iv) institutional influence (organization) (Hood 1983). The dimension of governing logic specifies two distinct approaches that governments can take to implement policy: direct provision of services and services (substantive policy instruments), or indirect efforts to change the beliefs and behavior of actors (procedural policy instruments).

The advantage of the policy mix approach is that a vast number of very specific types of instruments can be parsimoniously identified, classified, and compared based on these underlying dimensions, irrespective of policy sector or level of government. This provides operational flexibility in research designs, while preserving consistency, comprehensiveness, comparability, and coherence in measurement (Ford and Berrang-Ford 2016). Furthermore, a policy mixes approach avoids comparing policies strictly on the basis of material indicators such as budget allocations or staffing resource allocations, which introduce a bias towards resource-intensive policies at the expense of soft tools such as public awareness campaigns.

We demonstrate the scalability of the policy mix approach in a study of adaptation policy mixes among local governments. Specific climate change impacts and policy instruments identified through this analysis are drawn from the adaptation literature (Lesnikowski et al. 2015; Henstra 2016) and public policy theory (Howlett and Rayner 2007, 2007; del Rio and Howlett 2013; Howlett 2000). Specification of policy instruments was then refined to reflect empirical research on local government engagement with adaptation (Macintosh et al. 2014; Keskitalo et al. 2016; Araos et al. 2016). Table 3 provides an overview of these policy instruments and their classification based underlying governing resources and governing logics.

Table 2 Policy mixes at one level of government

		Policy goals	
		<i>Multiple goals</i>	<i>Single goal</i>
Policy means	<i>Multiple instruments</i>	Complex policy mix	Complex instrument mix
	<i>Single instrument</i>	Simple policy mix	Simple instrument mix

Adapted from del Rei and Howlett 2013

We argue that a policy mixes approach to conceptualizing and measuring adaptation policy addresses both limitations in the comparative adaptation policy literature: the challenges of systematically comparing across diverse adaptation policy approaches, and the need for more nuanced approaches to measuring the content of policy mixes. Rather than attempting to identify comprehensive lists of adaptation policies, our policy mixes approach directs analytical attention to the constitutive parts that define all policies, and can be scaled across levels of government or across different policy sectors. Importantly, our results point to the level of complexity contained in emerging adaptation policy mixes that is lost if research designs only focus on particular types of policy instruments.

3 Methods

3.1 Case selection

The sample for this study consists of 125 local governments in five countries (Canada, France, Germany, Netherlands, and the UK). “Local government” is defined as the lowest level of government with administrative responsibility over all or most local service provision (e.g., waste and water management), land use planning, and building permitting. In the case of this study, these units are municipalities (Canada, Germany, Netherlands), communes (France), and local authorities/metropolitan districts/London boroughs (UK). Two main reasons exist for selecting local governments in these five countries. First, accessibility of data collection was an important consideration in selecting local governments for analysis. Given that a unique dataset of policy instruments needed to be constructed, ease of online access to primary policy documents and the language abilities of the research team were critical. Reliance on online availability of documents can be problematic in medium- and low-income countries, and so only local governments in high-income countries were considered for inclusion in the sample.

Second, we aimed to identify local governments that already have emerging adaptation policy mixes to demonstrate the value of our approach; this purposeful selection strategy thus maximized inclusion of local governments with a high likelihood of having existing adaptation policy mixes. Current research suggests that large urban areas are more likely to be engaged in adaptation policy design, and that the countries identified are among the forerunners on taking adaptation action (Paterson et al. 2017; Campos et al. 2017; Shi et al. 2016; Reckien et al. 2014; Lesnikowski et al. 2015). Given this trend, the largest 25 local governments from each country were included in the sample, for a total sample of 125 local governments (for a complete list, see Supplemental Materials Table 1).¹

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 Supplemental Materials).

Table 3 Taxonomy of local adaptation policy instruments

	Principal governing resource				
	<i>Nodality</i>	<i>Authority</i>	<i>Treasure</i>	<i>Organization</i>	
Governing logic	<i>Substantive</i>	Advice; education and training; reports and assessments; monitoring and evaluation	Land use planning regulations; infrastructure performance standards; building regulations; strategic planning tools; intergovernmental mandates	User charges; grants; subsidies; loans; direct expenditures (e.g. infrastructure spending); demonstration projects	Procurement / local government operations; local government facilities management
	<i>Procedural</i>	Exhortation; public outreach; sustainable practices labelling	Agreements between governments and/or non-governmental actors; advisory group creation; public hearings; joining urban climate networks	Research funding; interest group funding	Conferences and workshops; organizational reforms

Adapted from Howlett and Rayner, 2007

3.2 Data collection

The documentation for this dataset was collected from local council online archives covering the period January 2010 to May 2017. This time horizon reflects the establishment of adaptation as equal in priority with mitigation in international climate policy (UNFCCC 2011), and coincides with when many local governments began to make council meeting documents more fully accessible online. Archival searches were conducted for each local government using the keyword “climate change” to identify all available documentation from past council meetings containing references to climate change. In cases where there were missing years in online archives, requests were sent to the local government’s records office for digital copies of the relevant meetings. If no reply was received, then a web search was performed of the local government’s general website to identify any pages or files related to climate change from missing years. A total of ≈ 6000 documents were retrieved for coding. Documents include meeting agendas, meeting minutes, decision records, staff or consultant reports, records of rezoning and construction applications, and strategic planning documents.

Each document was examined for content explicitly pertaining to climate change adaptation. For example, policy instruments adopted to manage general risks like flooding or biodiversity

were included if there was a mention of current or future climate change impacts. Climate change references that were unrelated to adaptation (namely mitigation content) 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. If the instrument was not already formally adopted, a concrete indication of a timeline for its adoption was required for inclusion, such as an expected date or specified budget. References to potential instruments that could be considered or adopted in the future were excluded from the dataset.

3.3 Policy instrument coding

The text retained as adaptation-relevant was then coded using a unique coding manual containing indicators for year of instrument adoption, policy framing, policy instrument category, climate impact category, policy target, policy impact, departmental responsibility, and policy scope (see Appendix). All text classification was conducted in Atlas.ti, and the data were extracted in an Excel file. Under the indicator “policy instrument category,” instruments were coded as either substantive or procedural, allowing no double coding of instruments. Where policy instruments described other policy instruments (e.g., strategic adaptation plans that summarize current or future adaptation policies), then the embedded policy instruments were also coded individually. Identification of the underlying governing resource for each instrument was determined based on the NATO typology (Hood 1983; Howlett and Rayner 2007, 2007). This fit was determined a priori (see Table 2 for details).

3.4 Analytical approach

To analyze these data, we use a combination of descriptive and inferential statistics. We first summarize the general structure of policy mixes found in our dataset based on the typology of policy mixes described in Table 2. We operationalize a simplified analysis of policy goals based on the climate change impacts that are addressed by individual policy instruments. Specifically, we examine the degree of policy goal complexity in local policy mixes using a Simpson’s Diversity Index calculation, which accounts for the number of climate change risks present in each policy mix and their relative abundance. Following this, we describe policy instrument mixes along the two dimensions of policy instruments described in Table 3, governing resources and governing logics. We examine the relative frequency of governing resources and logics both between country clusters and within country clusters, which demonstrates the diversity of policy approaches represented in complex policy mixes. Finally, we examine the relationship between policy goals and policy instruments within these policy mixes based on a non-parametric (Spearman’s) correlation matrix.

4 Results

4.1 Data description

A total of 3328 policy instruments were identified in 119 local governments (Table 4). Of the 125 local government units included in the sample frame, only six demonstrated no textual evidence of adaptation policy instrument adoption. All six are located in either Germany (Augsburg, Bielefeld, Leipzig, Wiesbaden) or the Netherlands (Alphen aan den Rijn, Zoeter-

meer). With the exception of Leipzig (population = 560,472), all of these non-adaptors have populations under 500,000. Overall, local governments in the UK tend to adopt the largest number of policy instruments and local governments in the Netherlands tend to adopt the fewest. Within-country variation in the number of policy instruments adopted is lowest in the Netherlands and highest in Canada, though the standard deviation reported in Table 4 is strongly influenced by Toronto (without Toronto the standard deviation of Canadian local governments is still high at 32.36).

4.2 Emerging policy mixes

We find an extremely high prevalence of complex policy instruments among the local governments in our dataset (multiple policy goals and multiple policy instruments), reflecting conventional thinking in the policy mixes literature that policy mixes tend to grow over time with incremental (and often ad hoc) additions of new goals and instruments (Howlett and Rayner 2013) (Fig. 1). On average, we find that local governments address five climate change impacts in their policy mixes and adopt 28 policy instruments.

Only three local governments each were identified as having simple policy mixes (multiple policy goals and one policy instrument) and simple instrument mixes (one policy goal and one policy instrument). All simple policy mixes were identified among local governments located in the Netherlands, where three local governments were found to have only one policy instrument that addresses multiple climate change impacts. In two cases, this instrument is a spatial planning tool (a Waterplan addressing flooding and heat risk—Almere, Netherlands; a Municipal Sewerage Plan addressing flooding and heat risk—Maastricht, Netherlands), while in the remaining case the instrument is a political agreement under the Deltaprogramme to address risks of sea level rise, flooding, drought, and heat (Dordrecht, Netherlands). These simple policy mixes thus all signify efforts to target intersections between different climate risks (e.g., flooding and heat) and mainstream responses through existing policy instruments.

The three local governments with simple instrument mixes were identified in Germany, the Netherlands, and the UK. These mixes are more procedural in nature, with two simple instrument mixes constituting organizational development (creation of a working group on climate change—North Lanarkshire, UK) and an assessment report (on heat risk in a changing climate—Dresden, Germany), and the third simple instrument mix constituting spatial planning (a Waterplan addressing water management in a changing climate—Ede, Netherlands).

Finally, eight complex instrument mixes (one policy goal and multiple policy instruments) were found among local governments located primarily in Canada ($n = 5$), but also in France ($n = 1$) and Germany ($n = 2$). Seven of these complex instruments mixes had policy goals that only addressed climate change impacts generally without specifying individual impacts such as flooding or extreme heat, suggesting that these local governments are only loosely mainstreaming adaptation into existing policies rather than developing clear policy goals that reflect key risks.

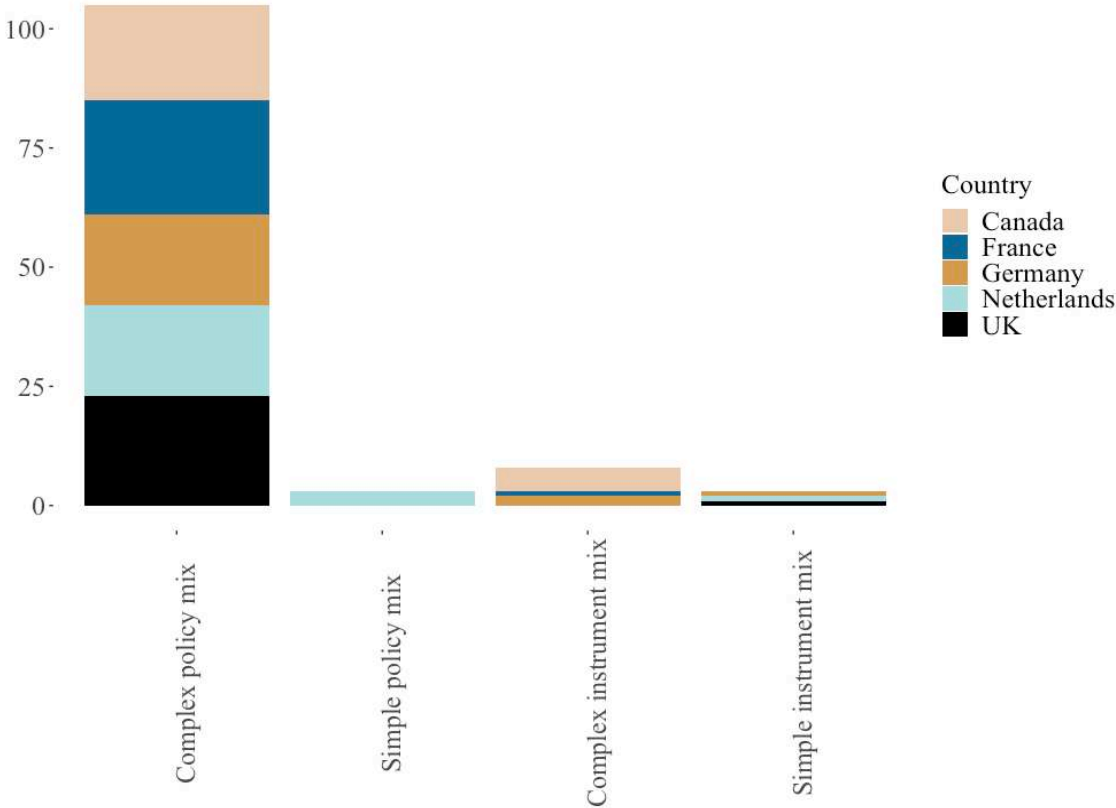
4.3 Policy goals and instruments

If we examine policy goals and policy instruments as separate components of policy mixes, we observe variations in both geography and the relationship between goals and instruments. This suggests that (i) there are differences across country context in the types of policy instruments that local governments tend to adopt, and (ii) there is variation in the types of policy instruments that are commonly adopted to address particular types of climate change impacts.

Table 4 Descriptive statistics (Frequency of observations/instruments by local government)

	All	Canada	France	Germany	Netherlands	United Kingdom
N. LGs	119	25	25	21	23	25
Total	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

Figure 1 Policy mix composition

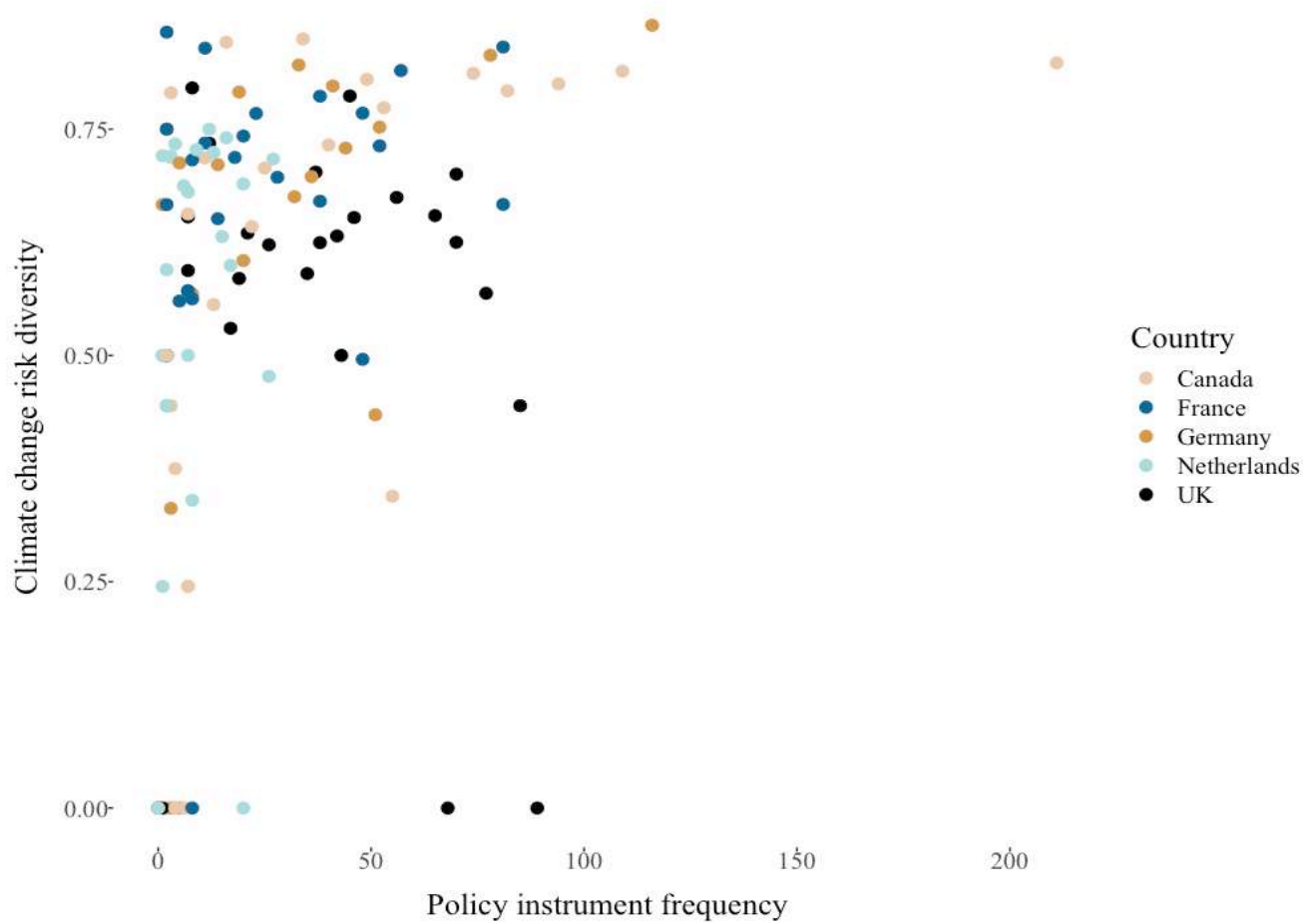


The diversity of self-reported climate change risks addressed in policy mixes appears to be moderately associated with the number of instruments contained in a mix, which may suggest some level of “matching” between the number of policy instruments in a mix and the number of policy goals (Fig. 2). Nonetheless, a number of local governments are also found to have high policy goal diversity and small numbers of policy instruments, so it appears that this is not necessarily the case across all local governments.

Geographic patterns in policy instrument mixes point to differentiated configurations emerging in policy instrument choice among local governments. Figure 3 captures this distribution by country cluster of the governing resources being directed at adaptation according to the NATO typology described in Section 2.2. Overall, we find a high reliance on nodal (i.e., informational) and authoritative governing resources within the dataset, with nearly an equal number of instruments identified within these groups (nodality: $n = 1125$; authority: $n = 1117$). Together nodal and authoritative instruments constitute 67% of the total instruments found, while 18% of the remaining instruments were treasure-based and 13% of instruments were organizational. While the median levels of each government resource tend to be relatively even across resources, variability within country clusters differs quite significantly, with generally lower levels of variation found among Dutch local governments and higher levels found among Canadian, German, and UK local governments. French local governments have relative low levels of variation in all categories except that of organizational policy instruments, where they exhibit quite high variation. This suggests that there are differences both between countries in the types of governing resources that local governments rely on for adaptation, and within countries in the degree of similarity of governing resources used by local governments.

We observe similar differences among country clusters if we consider the general governing logic that local governments take on adaptation (Fig. 4). We find that overall local governments tend to adopt more substantive approaches to adaptation, with high reliance on instruments such as reports and assessments, direct expenditures on public works, strategic planning initiatives, spatial planning, and adjustments to municipal operations. This implies that local governments overall are focusing on directly delivering adaptation-relevant services or goods to communities. In the Canadian context, however, we find high variability in the numbers of substantive instruments being adopted and low variability in the adoption of procedural policy instruments, suggesting that there is a larger variability in substantive policy adoption among Canadian local governments. This contrasts with local governments in the other four countries, where we observe smaller variability in substantive policy adoption relative to procedural policy adoption. This likely reflects the highly devolved institutional context of local decision-making in Canada, where the responsibilities and competencies of local governments are derived from subnational (provincial) government. This devolution of authority has particularly significant implications for climate change adaptation as the federal government has shared jurisdiction with provinces around environmental agenda-setting, and chooses to exercise minimal influence on local-level policy decisions.

Figure 2 Policy goal diversity

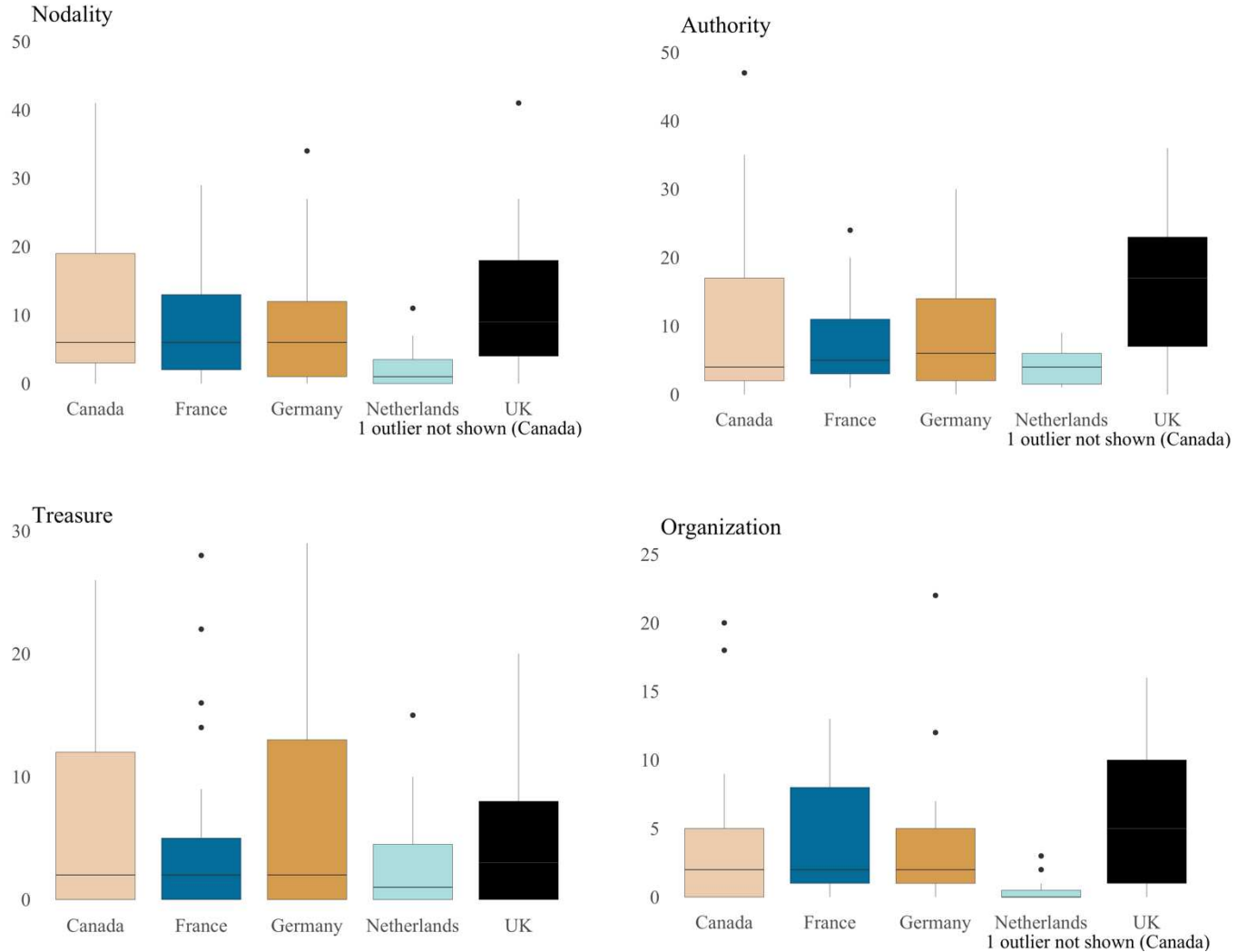


We also examine policy instrument adoption by type of substantive or procedural instrument to further elucidate differences in policy instrument adoption across country clusters (Table 5). While certain categories of policy instruments are more common across all local governments, we observe variations between countries in the relative frequency of policy instrument categories. If we take commonly adopted substantive policy instruments in Germany and the Netherlands as an example, we find a strong emphasis on direct expenditures in the Dutch context, while German local governments demonstrate an even mix of reports and assessments, land use regulations, and direct expenditures. As another example, local governments in the UK demonstrate much higher adoption of institutional changes such as the creation of new staff positions, departments, or working groups than local governments in any other country context.

These patterns suggest that there are some structured differences between countries in how local governments approach adaptation policy design. If we consider the relationship between policy goals and policy instruments within these policy mixes, it appears that the adaptation governing approaches emerging among local governments are also influenced by prioritization of particular impacts. Table 6 summarizes correlation coefficients between each climate change impact and policy instrument. Most notably, strong positive correlations (≥ 0.70) are observed between flood risk and certain types of substantive policy instruments (e.g., direct expenditures, spatial planning, strategic planning). This indicates that where flood risk is prioritized within local

adaptation policy agendas, the adaptation governing approaches of local governments are likely to be more substantive in nature.

Figure 3 Governing resources

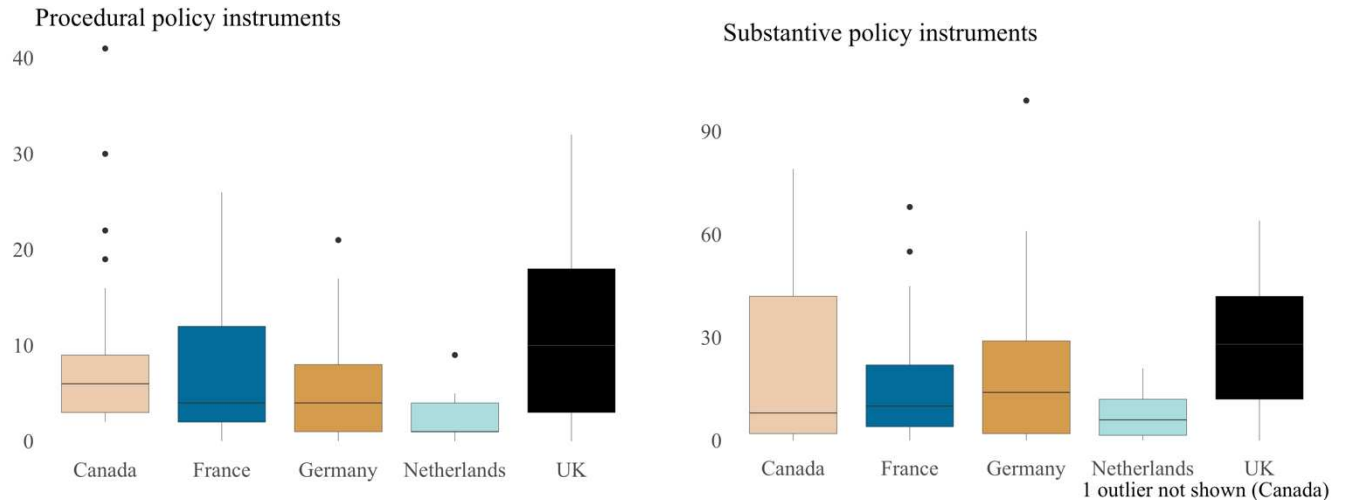


5 Discussion

Here we build on recent efforts in the adaptation policy literature to examine emerging policy efforts through the lens of policy instruments. We propose that the concept of policy mixes offers a promising path forward in addressing the pernicious challenge of how to conceptualize and measure adaptation, and has particular potential for improving the robustness of comparative adaptation research. In this article we operationalize policy mixes based on two components of public policies—goals and instruments—and design a systematic protocol for identifying and comparing adaptation policy mixes across diverse country contexts. We demonstrate the value of

our approach by examining the composition of policy mixes adopted by 125 local governments located in five countries.

Figure 4 Governing logic: substantive and procedural instruments per country



Our results indicate that the adaptation policy approaches of local governments are characterized by complex policy mixes that contain multiple policy goals and policy instruments. Local governments are adopting policy goals that address a multitude of climate change risks, and many, indeed sometimes hundreds, of individual policy instruments to implement their policy goals. Furthermore, our analysis suggests that within this complex policy environment there is structured variation emerging across jurisdictions around how adaptation is being governed by local governments, for example with a stronger emphasis on strategic planning and organizational development among local governments in the UK and on direct expenditures in the Netherlands. We believe this sheds new light on old debates in the policy literature about the tendency for governments to develop distinct approaches to governing policy problems that become institutionalized over time and influence how policy goals are articulated and policy instruments are chosen (Freeman 1985). If similar patterns are emerging in the adaptation sphere, then attention to the rich theoretical literature on policy choice and processes of policy change is key to understanding how different approaches to adaptation governance emerge and evolve across contexts (Howlett 2019).

Table 5 Policy instrument mixes by share of instrument type

	Country				
	Canada	France	Germany	Netherlands	United Kingdom
Total obs.: Substantive instruments	711 (76%)	417 (67%)	446 (78%)	167 (76%)	707 (72%)
Total obs.: Procedural instruments	222 (24%)	202 (33%)	123 (22%)	54 (24%)	279 (28%)
Substantive Instruments (% share of total)					
<i>Nodality</i>			0.35		
<i>Advice</i>					

	Education and training	0.96	2.75	0.70	0.45	1.01
	Reports/assessments	23.04	14.05	15.47	12.22	20.39
	Monitoring/evaluation	3.43	2.91	2.99	0.90	1.12
<i>Authority</i>	Land use planning regulations	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
	Strategic planning ¹	13.29	12.44	7.21	13.57	22.92
<i>Treasure</i>	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
	Demonstration projects	0.64	1.62	1.05	1.36	0.61
<i>Organization</i>	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)

<i>Nodality</i>	Exhortation	4.93	---	0.18	0.45	0.91
	Public outreach	8.90	14.05	9.14	10.41	7.30
	Certification/labelling	0.11	1.13	0.35	---	---
	Knowledge networks	1.71	4.52	3.51	3.17	3.25
<i>Authority</i>	Public hearings	0.32	---	---	---	0.10
	Political agreements	1.93	2.91	0.35	5.88	1.93
	Advisory group creation	0.11	0.97	---	0.45	0.81
<i>Treasure</i>	Research funding	0.11	---	---	0.45	0.10
<i>Organization</i>	Institutional changes	3.11	3.07	6.33	3.62	11.66
	Conferences/workshops	1.61	5.98	1.76	---	2.23

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

¹ Including strategic adaptation planning

Table 7 Correlation matrix for policy goals and policy instruments (Spearman’s correlation)

	Climate change impact																
	Biodiversity	Cold	Drought	Economy	Energy	Erosion	Flooding	Heat	Storms	Disease	Air qual.	Water	General	SLR	Wildfires	Food	Desertification
Substantive policy instruments																	
Nodality																	
Advice	0.148	0.132	0.048	0.182	-0.064	-0.05	0.104	0.173	-0.086	-0.048	0.308	0.186	0.102	-0.073	0.238	-0.065	-0.012
Education / training	0.408	0.148	0.079	0.247	0.425	0.195	0.309	0.216	0.349	0.24	0.02	0.218	0.438	0.171	0.062	0.295	-0.046
Reports / assessments	0.619	0.344	0.171	0.303	0.491	0.412	0.698	0.431	0.511	0.18	0.253	0.35	0.745	0.265	0.195	0.461	0.072
Monitoring / evaluation	0.508	0.287	0.079	0.284	0.389	0.329	0.481	0.423	0.368	0.282	0.208	0.346	0.428	0.147	0.273	0.415	-0.058
Authority																	
Spatial planning	0.545	0.298	0.166	0.165	0.348	0.326	0.708	0.424	0.367	0.11	0.29	0.404	0.488	0.322	0.233	0.322	0.026
Infrastructure standards	0.424	0.476	0.143	0.115	0.367	0.313	0.492	0.413	0.464	0.235	0.292	0.272	0.491	0.157	0.188	0.293	-0.054
Building regulations	0.302	0.271	0.044	0.3	0.262	0.13	0.323	0.585	0.314	0.496	0.363	0.525	0.15	0.051	0.332	0.28	0.189
Strategic planning	0.595	0.412	0.221	0.179	0.473	0.384	0.706	0.266	0.427	0.068	0.147	0.344	0.71	0.233	0.108	0.314	-0.108
Adaptation planning	0.548	0.247	0.074	0.179	0.311	0.212	0.394	0.47	0.35	0.186	0.326	0.259	0.544	0.079	0.191	0.252	0.054
Treasure																	
User charges	0.379	0.215	0.038	0.533	0.342	0.211	0.366	0.134	0.279	0.315	0.16	0.366	0.198	0.046	0.029	0.267	0.267
Subsidies / grants	0.484	0.361	0.022	0.305	0.45	0.209	0.459	0.353	0.346	0.202	0.164	0.49	0.377	0.134	0.102	0.457	-0.063
Loans	0.148	0.274	0.122	-0.031	0.23	0.256	0.156	0.153	0.193	0.283	0.22	0.173	0.159	-0.052	-0.023	0.214	-0.008
Direct expenditures	0.683	0.438	0.326	0.306	0.443	0.378	0.793	0.571	0.465	0.187	0.318	0.602	0.535	0.233	0.219	0.444	0.132
Demonstration project	0.36	0.22	0.047	0.27	0.278	0.287	0.292	0.397	0.127	0.31	0.323	0.431	0.281	-0.004	-0.03	0.29	0.184
Organization																	
Operations	0.567	0.337	0.062	0.262	0.46	0.363	0.456	0.465	0.469	0.331	0.297	0.502	0.53	0.093	0.226	0.41	0.092
Facilities	0.33	0.212	0.064	0.26	0.218	0.096	0.043	0.244	0.125	0.11	0.346	0.344	0.194	0.031	0.078	0.196	-0.025
Procedural policy instruments																	

Nodality																	
Exhortation	0.152	0.166	-0.094	-0.004	0.084	0.249	0.165	-0.086	0.265	0.056	-0.087	0.037	0.199	0.074	-0.009	0.229	-0.042
Public outreach	0.642	0.276	0.13	0.298	0.453	0.293	0.585	0.494	0.415	0.253	0.359	0.444	0.522	0.199	0.249	0.465	0.107
Labelling	0.33	0.018	0.025	0.044	0.1	-0.087	0.033	0.283	0.029	0.164	0.009	0.273	0.204	-0.129	-0.058	0.186	-0.021
Authority																	
Political agreements	0.155	0.094	0.228	0.109	0.148	0.228	0.236	0.09	0.143	0.057	-0.094	0.142	0.36	0.375	0.074	0.09	-0.075
Advisory group creation	0.118	-0.121	-0.003	-0.107	0.061	-0.036	0.151	-0.015	0.029	0.06	-0.143	0.031	0.181	0.146	0.165	0.135	-0.029
Public hearings	-0.053	0.067	-0.022	-0.062	0.024	0.058	-0.118	-0.167	-0.002	-0.068	0.041	-0.154	0.082	-0.105	-0.047	-0.093	-0.017
Urban networks	0.405	0.127	0.027	0.166	0.419	0.205	0.355	0.211	0.395	0.087	0.056	0.177	0.509	0.295	0.223	0.334	-0.071
Treasure																	
Research funding	0.03	-0.061	0.007	-0.054	-0.078	-0.061	0.045	-0.082	-0.106	-0.059	0.055	-0.058	0.114	0.022	-0.04	-0.08	-0.015
Organization																	
Conference / workshops	0.356	0.062	-0.077	0.127	0.277	0.21	0.218	0.171	0.184	0.095	0.026	0.18	0.468	0.111	0.129	0.334	0.082
Institutional reform	0.352	0.256	0.08	0.135	0.346	0.306	0.529	0.19	0.375	0.087	0.129	0.119	0.622	0.131	0.067	0.177	-0.012

NOTE: Climate change impact categories with fewer than two observations are removed from table for clarity.

These findings are significant because they support our argument that adaptation policy research needs to move towards more nuanced measurements of adaptation policy that capture the diversity of policy instruments being adopted to meet adaptation policy goals. By adopting a policy mixes approach, we are able to do this in such a way that avoids eclectic typologizing and situates adaptation policy formulation within general theories about how governments govern. Rather than develop a unique typology of adaptation policy instruments, we propose to measure adaptation policy mixes based on the climate change impacts addressed under adaptation policy goals and the governing resources and logic of policy instruments. Our approach allows for flexibility in categorization of specific policy instruments across contexts, while maintaining comparability based on two fundamental dimensions of policy instruments. Perhaps most critically, interpreting adaptation policies based on policy mixes situates adaptation responses within the broader literature on modes of governance that theorizes different government responses to climate change impacts (Bednar and Henstra 2018). This approach encompasses the whole range of activities that governments can undertake to achieve policy goals, and so provides an entry-point for developing a robust comparative study of adaptation policy change.

The study of adaptation policy mixes also has the potential to make tangible contributions beyond the scientific study of adaptation. The introduction of new mandates through the 2015 Paris Agreement to report progress towards the Global Goal on Adaptation has brought the issue of how we define and measure adaptation policy progress to the forefront of international negotiations on adaptation governance (Lesnikowski et al. 2017). With new requirements in place for national reporting of adaptation progress to the Secretariat of the UN Framework Convention on Climate Change, the question of how we scale up local, regional, and national assessments of adaptation policy action to the global level is front and center in climate change negotiations (Craft and Fisher 2018). Analysis of policy goals and instruments through a policy mixes lens would contribute to increased reporting transparency by clarifying the definition of adaptation policy without needing to specify universal criteria for what this looks like across contexts (Berrang-Ford et al. 2019). This also supports research around critical policy evaluation questions such as how we determine that policy goals are being met and adaptation efforts are meaningful across sectors and jurisdictions, how similar adaptation interventions perform under different contextual conditions, whether certain places adapt better than others based on particular aspects of institutional or political environments, and how the institutionalization of particular policy instruments creates different “winners and losers” from adaptation, the effects of which can become increasingly difficult to change over time.

Notwithstanding the conceptual robustness of this approach, it faces similar challenges with regard to implementation as existing adaptation studies. Coding entire policy landscapes around an issue as wide-ranging as climate change adaptation requires more resource-intensive research designs than those that focus on single moments of policy adoption, often requiring the use of systematic data collection protocols that aim to identify all instances of policy adoption within given parameters. The literature on systematic approaches to studying adaptation policy adoption offers methodological insights how to scale up policy studies beyond a focus on single policy instruments (Berrang-Ford et al. 2015), and should be more widely integrated into explanatory research about local adaptation policy choice. This approach nonetheless has room to evolve with the exploration of techniques for increasing the efficiency of this approach, for example by integrating web scraping to identify policy documents containing climate change references or

even experimenting with automated policy coding (Burscher et al. 2015). The larger challenge is how to scale up this methodological approach, which relies heavily on textual data, to places that are data scarce, particularly local governments in least-developed country contexts. Grey literature and reports from development agencies or non-governmental organizations are important sources of data in these contexts, but more explicit validation of the comparability between these texts and those authored by governments themselves is needed in the literature.

A further area of development for a policy mixes perspective on adaptation is elaborating the longitudinal dimensions of this approach. The study that we conduct here focuses only on changes in the structure of policy mixes and not adjustments to the design of individual policy instruments themselves. Additionally, it follows a logic of policy accumulation and does not account for the reversal or termination of policies (Jordan et al. 2013). Fully capturing the stringency of adaptation policy goals and likelihood of policy instruments to deliver on these goals requires analysis of what are termed policy settings and calibrations, meaning the specific requirements of policies—often expressed as targets—and the strictness with which they will be implemented (Howlett and Cashore 2009).

Analytical attention to the temporal dimensions of policy mixes is better developed in the climate change mitigation literature, where comparative research on instruments like energy efficient regulations has analyzed settings and calibrations using metrics such as the scope of emissions targets and their relative ambition, budgetary allocations to instruments, and specificity of implementation requirements (Schaffrin et al. 2015; Schaffrin et al. 2014; Schmidt and Sewerin 2018). Direct adoption of these types of metrics in the context of adaptation policy is challenging, however, given that adaptation policies are characterized by policy goals that are frequency qualitative in nature (e.g., “increase resilience to change”) and involve highly heterogeneous policy instruments that raise validity concerns about the appropriateness of applying universal criteria like budget allocations to assess the adequacy of policy interventions. Experimentation with measuring longitudinal aspects of adaptation policies is still largely unaddressed in the literature (Lesnikowski et al. 2016), but is urgently needed to build a stronger scientific foundation for the assessment of adaptation policy progress and implementation effectiveness.

6 Conclusion

In this article we argue that defining and measuring adaptation policy based on the underlying dimensions of policy mixes can help overcome current challenges to knowledge accumulation and theory building in adaptation policy research. The findings of this study demonstrate the value of our approach, particularly its ability to capture differences in how governments are responding to climate change impacts and its scalability across levels of government and policy sectors. Integration of the policy mixes concept with systematic approaches to analyzing adaptation policy change can support more comprehensive research on adaptation policy based on how governments actually govern, without privileging one governing style over another. As interest grows in developing instruments-based approaches to studying adaptation policy, we believe that an explicit focus on policy mixes will contribute to a more theoretically robust literature and support the design, implementation, and evaluation of adaptation policy.

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Compliance with ethical standards

Conflict of interest

The authors declare no conflict of interest.

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