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Climate change adaptation planning in large cities: A systematic global assessment

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ABSTRACT

Cities globally face significant risks from climate change, and are taking an increasingly active role in formulating and implementing climate change adaptation policy. However, there are few, if any, global assessments of adaptation taking place across cities. This study develops and applies a framework to track urban climate change adaptation policy using municipal adaptation reporting. From 401 local governments globally in urban areas with >1 m people, we find that only 61 cities (15%) report any adaptation initiatives, and 73 cities (18%) report on planning towards adaptation policy. We classified cities based on their adaptation reporting as *extensive adaptors, moderate adaptors, early stage adaptors,* and *non-reporting.* With few exceptions, *extensive adaptors* are large cities located in high-income countries in North America, Europe, and Oceania, and are adapting to a variety of expected impacts. *Moderate adaptors* usually address general disaster risk reduction rather than specific impacts, and are located in a mix of developed and developing countries. *Early stage adaptors* exhibit evidence of planning for adaptation, but do not report any initiatives. Our findings suggest that urban adaptation is in the early stages, but there are still substantive examples of governments taking leadership regardless of wealth levels and institutional barriers.

1. Introduction

Cities globally face significant risks from climate change (Revi et al., 2014). Urban areas are home to >50% of the world's population, are growing rapidly, and often concentrate economic activity, population, and infrastructure in high-risk locations. Many of the largest cities are located in coastal areas, for instance, and are thus exposed to projected increases in sea level, storm activity, and associated flooding (Hallegatte et al., 2013; Hanson et al., 2011). Given these threats, cities are taking an increasingly active role in climate policy action, with mitigation experiences well-documented (Castán Broto and Bulkeley, 2013; Bulkeley, 2010). There are also widely referenced examples of city leadership and action on adaptation (e.g. New York, London) (Rosenzweig and Solecki, 2014; Wilbanks, 2011). Yet there have been few, if any, global-scale analyses of what cities are doing to adapt: is adaptation taking place, where, by whom, and in what ways? (Berrang-Ford et al., 2011) The purpose of this article is to shed light on the emerging adaptation practices of cities globally.

Identifying, monitoring and evaluating adaptation at a large-scale presents significant conceptual and methodological challenges (Dupuis and Biesbroek 2013; Ford et al., 2013). Unlike mitigation, where greenhouse gas emissions can be measured to examine the effectiveness of policy initiatives, there are no similar 'off-the-shelf' metrics available for adaptation (Ford and Berrang-Ford, 2015). In the follow-up from a new international climate agreement in Paris, where cities are identified as important actors for mitigation and adaptation, it is thus of paramount importance to develop standards, methodologies, indicators and baselines for assessing progress towards adaptation goals (Ford et al., 2015; UNFCCC, 2015). We refer to such work as 'adaptation tracking', a subcomponent of monitoring and evaluation that seeks to systematically identify, characterize and compare adaptation across nations or cities and over time.

Adaptation tracking research has highlighted the need for comparative, systematic analysis of adaptation action and reporting across nations and cities. The major obstacle to such efforts remains the absence of appropriate data sources that fulfill the 4Cs

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of adaptation tracking: a *consistent* and operational conceptualization of adaptation, *comparable* units of analysis, *comprehensive* datasets on adaptation action, and *coherence* with our understanding of what constitutes adaptation (Ford and Berrang-Ford, 2015). Data and knowledge on adaptation are difficult to find, and we have to date relied on the reporting of adaptation as the only option currently available for systematic analysis (Berrang-Ford et al., 2014; Gagnon-Lebrun and Agrawala, 2007, Lesnikowski et al., 2015; Reckien et al., 2014). Though an imperfect proxy sample of adaptation on the ground, adaptation reporting is used to identify trends in adaptation action and planning (Berrang-Ford et al., 2014; Ford et al., 2013; Gagnon-Lebrun and Agrawala, 2007; Lesnikowski et al., 2015; Reckien et al., 2014). Reporting of adaptation in itself is an important proxy providing insight into how governments recognize and prioritize adaptation options (Austin et al., 2015). Limited reporting of adaptation programmes and actions may hinder sharing of experiences and best practices, transparency, and effective monitoring and evaluation.

Despite the importance of cities as administrative units where adaptation will be implemented, adaptation tracking studies have been undertaken predominantly at the national level (Lesnikowski et al., 2015). There is negligible comparative and systematic research available on the extent to which global cities are responding to, and reporting on, climate change adaptation. In response to this gap in baseline characterization of global urban adaptation, we develop a framework to characterize reporting on adaptation planning in urban areas globally over 1 million people, creating a descriptive classification of the types, extent, and nature of adaptations in diverse urban contexts.

2. Tracking urban adaptation to climate change

A number of studies have examined adaptation progress, compared different government systems, and proposed "best practices" for adaptation planning in urban areas (Revi et al., 2014). International climate policy has set an adaptation financing goal of $100b per year and so a key challenge will be to track adaptation to ensure accountability and transparency in governance processes (Adger 2003; Ford et al., 2015; Preston et al., 2011). Reporting on progress toward planning adaptation helps the public keep track of whether investments in adaptation are consistent with the outputs (Preston et al., 2011).

While many specific examples of adaptation are being documented, systematic global assessments of urban adaptation are scarce. Most comparative policy studies on urban adaptation have focused on districts within one city, comparing cities within one country or on a particular continent, but not globally (Austin et al., 2015; EEA, 2012; Heidrich et al., 2013; Reckien et al., 2014, 2015). City-specific and regional studies have analyzed barriers and enablers of adaptation progress. Other country-level and regional analyses meanwhile have used publically available municipal planning documents to assess the state of adaptation in multiple cities, mostly in developed contexts (Austin et al., 2015; Reckien et al., 2014). While these in-depth case studies and small-n comparative analyses provide important baseline information on whether adaptation is being considered in specific urban contexts, inference to the global scale requires research with larger sample sizes and seeking breadth to complement depth (Araos et al., 2015; Ford and Berrang-Ford, 2015).

Surveys have also been used to produce large scale assessments of adaptation (Aylett, 2015; Carmin et al., 2012b; CDP, 2014). These surveys assess the content of adaptation policies and the priorities of cities regarding different climate impacts (Aylett, 2015; Carmin et al., 2012b; CDP, 2014). Carmin et al. (2012b), for instance, offer a snapshot of adaptation policy-making in ICLEI member cities by quantifying reported progress on planning and challenges, such as the creation of vulnerability assessments and financing of adaptation projects. Aylett (2015) found that while a number of cities report integrating adaptation planning into their agendas, many sectoral agencies remain uninvolved in climate change planning (Aylett 2015). Surveys can be a powerful method to assess adaptation as researchers can ask focused questions to identify progress or pinpoint factors for adaptation success, and survey-based studies have so far been important contributions to the study of urban adaptation.

In this study we draw on publically available information on urban adaptation policy, with the presupposition that adaptation tracking initiatives and data sources should be guided by: 1) data sources that transparent and open-access datasets for open-source analysis; 2) consistent data collection strategies that facilitate longitudinal analysis of adaptation progress over time, and; 3) are consistent with the 4Cs of adaptation tracking. The goal is to build on existing studies that use expert knowledge and opinion with systematically collected publically available data from climate change planning documents.

3. Framework for tracking urban adaptation across cities globally

We developed a conceptualisation of urban adaptation that allows for comparative analysis, building on previous efforts described in Section 2 (see supplementary materials for detailed figures and further description of the framework components). We characterized urban adaptation along two axes, policy content and policy process, building on the literature evaluating urban adaptation and proposed frameworks for comparing local adaptation (Vogel and Henstra, 2015). In doing so, we are guided by best-practice approaches for systematic review in adaptation research (Berrang-Ford et al., 2015) and the 4Cs of adaptation tracking as proposed by Ford et al. (2015).

3.1. Defining adaptation for systematic review

One of the reported challenges to engage in comparative policy studies is to overcome the challenge of identifying what is being compared. Here we use the IPCC AR4 definition of planned adaptation as "Adaptation that is the result of a deliberate policy decision, based on awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state" (IPCC, 2007). Thus we gathered and analyzed government documents that reported on purposeful adaptation designed to reduce vulnerability to climate change, as per the literature on comparatives studies of adaptation (Dupuis and Biesbroek 2013; Heidrich et al., 2013; Reckien et al., 2014). In this study we focus on government-led adaptation, as municipalities have an important role in adaptation due to managing services and utilities, as well as having authority over important levers of adaptation such as land use regulation and building codes (Bulkeley et al., 2011). Nonetheless, we recognize that adaptation is frequently conceptualized as adjustments by individuals, communities, the private sector, and NGOs, among others. (Carmin et al., 2012a; Romero-Lankao and Dodman, 2011).

3.2. Policy content

Policy content refers to the thematic content of policy and the government's methods for implementing policy (Henstra, 2015; Howlett and Rayner, 2007). In this study we assessed policy content through a thematic and typological classification of adaptation initiatives in urban areas. An adaptation initiative is defined here as any individual adaptation program, action, or project reported by the municipality. We characterize these

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