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Adaptive Capacity in Urban Areas of Developing Countries

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Abstract

Urban areas of developing countries face increasing risks due to climate change. This paper systematically identifies and examines research published between 2000 and 2017 that assesses urban adaptive capacity to climate change in developing countries. To critically examine this literature, we developed a conceptual framework of urban adaptive capacity. The framework focuses on key components of urban adaptive capacity in three dimensions: the characterization of adaptive capacity, the external factors mediating adaptive capacity, and the dynamics of adaptive capacity. The study sheds light on the spatial and scalar interactions of individuals, communities, and authorities' adaptive capacities within urban areas and highlights the importance of governance and social institutions in shaping urban adaptive capacity. The work also finds shortcomings in the current assessment of urban adaptive capacity, with key gaps including a narrow focus on the range and types of adaptive capacity; limited assessment of the multilevel determinants, place-based processes, and urban determinants that shape adaptive capacity; and a lack of consideration of adaptive capacity interactions between social entities and with regard to climate sensitivity and exposure of a given area, including the potential for maladaptation. Addressing these research gaps would contribute to generate knowledge that can adequately support adaptation planning of urban areas in developing countries.

Keywords: climate change, adaptation, adaptive capacity, urban, developing countries

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1. Introduction

The saliency of the risks posed by climate change to urban areas of the developing world and their populations has increased considerably since the turn of the century. This has been matched by increasing scholarly interest in the opportunities and constraints for adaptation (Revi et al. 2014). The last two decades witnessed a steady rise in the number of empirical studies on these issues that now cover a large part of what is sometimes called the Global South (Rosenzweig et al. 2018). These studies, however, tend to focus on different dimensions of adaptation, rendering comparisons, let alone generalizations, of findings across urban contexts and scales difficult.

This paper tackles this challenge through a synthesis and evaluation of recent scientific publications on adaptive capacity (hereafter "AC") in urban areas of developing countries. At the most general level, we define AC as the ability of a system, region, community, household, or an individual to perceive, cope with, prepare for, and adapt to disturbances and uncertain social-ecological conditions (Hinkel 2011; Plummer and Armitage 2010; Smit and Wandel 2006). Since the turn of the century, this notion has acquired a pivotal position in the urban adaptation literature. It is now mobilized by research on disaster risk, vulnerability, and resilience—the three areas of investigation at the core of this scholarship (O'Brien and Selboe 2015; Romero-Lankao and Qin 2011). All three bodies of work use the concept of AC, making it a useful entry point to critically examine how urban adaptation is currently conceptualized, defined, and operationalized across disciplines and regions (Engle 2011).

Urban areas display specific characteristics which, according to the literature, not only shape but adversely sharpen climate change impacts on these areas. These specificities include: the spatial concentration of population and infrastructure; urban cores' dependency on their hinterlands and related center-periphery governance mismatches; the role cities play within larger socio-economic systems as hubs of political and economic power; the distinct urban livelihoods that condition population dynamics; and the propensity for social fragmentation (Birkmann et al. 2010; Lehmann et al. 2015; Revi et al. 2014; Rosenzweig et al. 2018). The situation is even more critical in developing countries, where economic, social, and institutional challenges exacerbate local sensitivities and decrease urban populations' capacities to adapt (Anguelovski et al. 2014; De Coninck et al. 2018; Hunt and Watkiss 2011; Satterthwaite et al. 2007). The need to better understand AC, including ways to facilitate AC in these challenging urban contexts, is pressing. Most importantly, while existing research concurs to connect weak AC with increased vulnerability, we still have a limited and fragmented understanding of what fosters AC across urban contexts of developing countries. This situation may be related to a narrow conceptualization of AC in the larger (non-specifically urban) literature.

As Mortreux and Barnett (2017) explain, conceptualizations of AC to climate change can be organized according to two generations. The first generation, rooted in Sens's capabilities theory,

apprehends AC as a broad set of resources or capitals (e.g., financial assets) and the determinants to access them (e.g. education). While this conceptualization provides a straightforward way to measure and compare AC (Brooks et al. 2005; Eakin et al. 2014), it has been criticized for its failure to capture how adaptive practices emerge from the sum of resources. In other words, it leaves unanswered the critical question of how capacity becomes action (Adger and Vincent 2005; Mortreux and Barnett 2017; Toole et al. 2016). The second generation of AC conceptualization, on which this study builds, seeks to fill this gap by focusing on the process of adaptation and by examining the attributes that enable social entities to adapt, thus extending the analysis to include psycho-social and institutional dimensions (e.g., place attachment) (Grothmann and Patt 2005; Nelson et al. 2007). This latter conceptualization gives rise to two key questions that underpin this critical literature review: What do we know about the ways in which socio-cultural and urban processes shape urban AC in developing world contexts? and, how do internal dynamics of AC evolve in these urban settings?

This study uses these two questions to examine how urban AC to climate change in developing countries has been characterized and assessed in studies published between 2000 and 2017. While adaptation literature has a long history (Smit and Wandel 2006), it was not until 2000 that adaptation re-emerged as central component of climate policy. As the climate change adaptation literature boomed in the 2000s (Bassett and Fogelman 2013; Ribot 2011), it interfaced with calls for greater conceptual and methodological consolidation of the climate vulnerability scholarship (Crane et al. 2017; Ford et al. 2018). By focusing on the 2000–2017 period, this systematic literature review of empirical research on urban AC contributes to take stock of scholarly responses to this call. It does so by examining recent empirical research in light of the theoretical advances in adaptation that stemmed from the important conjuncture in the research outlined above.

To this end, this study formulates a novel conceptual framework which seeks to capture how studies published since the early 2000s assess key dimensions of AC in urban settings, shedding light on the characteristics, external factors, and dynamics of AC. This framework supports the identification and discussion of four emergent research patterns within empirical studies of urban AC in developing countries: 1) AC's variability across and within scales, 2) the relevancy of objective and subjective approaches to AC, 3) the importance of both governance and social institutions for AC; and 4) the limited attention paid to urban determinants in explanations of AC. Finally, we call for a better integration of theoretical debates about adaptation in empirical assessments of urban AC. More specifically, studies need to move beyond treatments of AC as static in time and space and to address the relationships between coping, adaptation, and transformation.

2. Conceptual framework

The construction of the conceptual framework presented in this section was the first step in this study (see Methodology section). In the absence of a pre-existing framework, we adopted Jabareen

(2009) qualitative method, which although not specifically tailored for systematic literature review, supports the building of conceptual frameworks to study phenomena linked to multiple scholarships (such as urban AC in the developing world). This involved a broad survey of the adaptation literature, from its foundation to now, and selective forays into the resilience and disaster risk scholarship. In a first phase, this survey involved mapping the most cited scientific papers on climate change adaptation and served to identify contributions discussing the state and frontiers of the adaptation literature. In a second phase, we identified and categorized what we called the "theorized determinants of AC" for diverse settings and scales, and contextualized them to urban settings taking into consideration the characteristics of socio-urban systems. In doing so, and in contradistinction to some conceptualizations of AC, we integrated linked concepts from the scholarships to depict different stages in the adaptation thinking (e.g., coping, adapting, and transforming). Finally, we grouped these determinants under three broad theoretical dimensions that we call: *adaptive capacity characterization*, *external factors*, and *adaptive capacity dynamics*. The dimensions, their determinants, and the ways they relate to each other are schematized in Figure 1. The resulting conceptual framework is described in more details below.

2.1 Adaptive capacity characterization

The first dimension is at the core of our conceptual framework as it delineates researchers' conception of the nature and extent of the AC of the urban social entity studied.[1] It translates into the first general question that we asked when examining each paper included in this systematic literature review: *What does this study understand adaptive capacity to be?* The determinants of AC grouped under this dimension allow us to systematize answers to this first question by examining what each study considers to be: the attributes composing AC; the agents putting it into action; the type of ability that these agents have; and the range of the capacity to adapt.

Urban AC attributes concerns the definition of adaptive capacity to climate change used in different studies. These definitions vary depending on the scholarship and object of study. They may be framed solely in response to climate change threats or to multiple threats with a special focus on climate change. Overall, these definitions refer either to: 1) a broad set of resources (e.g., financial resources) accessible to an individual or social entity to be employed when adapting (Engle 2011; Heinrichs et al. 2013); 2) a series of determinants and processes that enable the ability of an area, community, or individual to adapt (e.g., social learning) (Adger et al. 2004; Smit and Wandel 2006); or 3) the ability to perceive and avoid or lessen the negative consequences of climate hazards (e.g., risk perception) (Grothmann and Patt 2005). Looking at the definitions of urban AC and the attributed relation to key concepts in the studies' contexts reveals the literature understandings of AC as: the ways in which individuals and groups mobilize the resources available to them; the factors that enable human responses in urban areas; and the ability of urban actors to perceive and avoid climate change impacts.

[1] Some authors refer to AC characterization determinants as endogenous variables of AC.

Adaptive capacity cannot exist in a vacuum or be separated from the actor(s) that has the ability and resources to deal with climate change. As such, a second determinant that characterized how AC is mobilized in the literature concerns the agents to whom studies ascribe the capacity to act in the adaptation process. We call this determinant *adaptive capacity agency* and divide it into individual, social, and institutional agency (Grothmann et al. 2013; Moser and Satterthwaite 2008). Individual agency refers to urban dwellers' ability to manage threats at the individual or household level. Social agency denotes the ability of groups of people or households and of civil society organizations to deal with threats at the community level. And institutional agency refers to the ability of urban political authorities to address vulnerabilities and facilitate resilience by guiding decision-making and providing incentives for actors to act in certain ways in an urban system (Dodman and Satterthwaite 2008; Hughes and Sarzynski 2015).

The way AC is used in the literature is further characterized by whether the concept is conceived of as an objective or as a subjective ability to deal with climate change. We refer to this determinant as the *adaptive capacity type*. Objective AC refers to the ability of an individual or social group to deal with climate change, employing the resources available within the given factors that enhance or diminish their AC (Grothmann and Patt 2005). In this view, AC can be accounted for and measured towards the understanding of vulnerability and resilience. Alternatively, AC can be conceived of as a subjective ability concerned with the perceived ability of actors to deal with climate change given the resources available and prevailing social norms. The distinction is important because actors are not always aware of their objective ability scope, which they may under- or overestimate (Gifford et al. 2011; Grothmann and Patt 2005). Subjective AC may be influenced by cognitive mechanisms (e.g., illusion of control), perceptions of risk, previous experience, and social norms (Clayton et al. 2015; Grothmann et al. 2013). This suggests that AC depends partially on each actor's perspective and can differ among actors evolving in the same urban milieu (Fuchs et al. 2017).

We call the last determinant of AC characterization *adaptive capacity range*. It concerns the way in which studies understand agents' ability to deal with extremes and manage the sensitivities of the system at stake. We organize studies' *AC range* in three levels: coping, adapting, and transforming. Coping refers to the ability to deal directly with in-the-moment and short-term climate threats with concrete actions and using existing resources (Few 2003; Yohe and Tol 2002). Adapting describes longer-term efforts to adjust to and prepare for potential climate change opportunities and risks, including actions to facilitate learning processes (Qin et al. 2015; Smit and Wandel 2006). Transforming refers to the ability to change structural conditions that are no longer desirable as they sustain the vulnerability of the system and change these conditions with the aim of increasing resilience (O'Brien 2012; Revi et al. 2014). Transformations, such as the formulation of alternative urban development paths (Revi et al. 2014), opens a range of novel policy options through non-linear changes (Fazey et al. 2018; Pelling et al. 2015). All three levels of AC can coexist. The same urban household may, for instance, adopt a mix of coping, adapting, or

transforming strategies to deal the different risks it faces or with regard to different sector paths (e.g., water infrastructure or market choices).

2.2 External factors shaping adaptive capacity

The second dimension in our conceptual framework concerns the factors, external to agents' character and internal logics, which directly shape the circumstances in which the process of adapting takes place and, incidentally, agents' broader decision structures.[2] As with the first dimension, this translates into a general question: *What factors do studies of urban AC identify as the structural shapers of adaptive capacity?* To systematize answers to this question, we differentiate between processes and institutions (though recognizing that they are interconnected). In the case of processes, we further distinguish between multi-level and place-based processes.

Processes occurring at the global, national, regional, and local levels shape actors' ability to deal with climate change. We refer to this determinant as *multilevel processes.* Studies may identify processes such as globalization, urbanization, decentralization, trade agreements, and international conflicts (Leichenko and O'Brien 2008; Sanchez-Rodriguez 2015). These processes often occur at multiple scales concomitantly and have a particular dynamic in a given urban area, which together condition the AC of urban dwellers and their authorities.

In contrast, and although they are rarely entirely disconnected from processes occurring at different scales, *place-based processes* mainly occur due to specific place traits of the urban system under analysis. These more localized social, economic, political, or ecological processes influence the vulnerability of people in that particular place (Cutter et al. 2008) and shape how actors respond to hazards and thus influence urban AC (Krellenberg et al. 2014; Romero-Lankao et al. 2014). Studies may analyze place-based processes such as urban sprawl, gentrification, mobility patterns, place identity, socio-environmental fragmentation, and socio-spatial inequalities.

Finally, the determinant concerning the formal and informal norms that evolve from social interactions and guide actors' behavior and collective action is called *institutions* (Ostrom 2014). Institutions can either facilitate or constrain adaptive actions (Bisaro et al. 2018). To schematize the studies' assessment of institution we build on Ostrom's (2005) classification of institutions relevant to socio-environmental contexts, including position, boundary, choice, aggregation, information, scope, and payoff rules.

2.3 Adaptive capacity dynamics

The last dimension in our conceptual framework concerns the constant time-space interactions between social entities and their socio-natural context which mediates how AC is practiced in a given moment and its effects over time. It leads to a third general question: *How do studies observe changes in AC change over time and space?*

[2] Some authors refer to this as the exogenous variables of AC.

A first determinant of the *AC dynamics* dimension relates to how studies consider certain vulnerable populations in relation to the broader social setting in which they are situated and how they see this setting as affecting their AC. Specific population groups, such as the elderly, children, women, marginalized communities, and indigenous populations may be more negatively affected by external shocks given their inherent vulnerabilities and have been recognized as being particularly vulnerable to the effects of climate change (Bunce and Ford 2015; Gencer 2013; Romero-Lankao et al. 2014). These groups tend to have higher levels of sensitivity and lower levels of AC to climate change. The assessment of *vulnerable urban populations* groups involves examining the conditions that drive their vulnerability in a given urban setting, and how these conditions mediate their AC.

Climate change research findings also show that the impacts of disasters are experienced differently according to individuals and social contexts which are rarely homogenous across or within urban communities (Leichenko 2011; Shi et al. 2016). Further, the AC of a given area is relative in terms of the spatial distribution of people and their capacities (Lemos et al. 2013). We call this determinant *differentiated urban AC.* Studies' assessment of urban dweller groups may be disaggregated according to demographic and spatial determinants such as income, profession, age, gender, social group, geographic area, and length of settlement.

As discussed earlier, adaptation can further take place at different scales, and different agents have the capacity to implement adaptation measures. As such, the *AC interaction* determinant regards the examination of the dynamic relation between the AC of different entities, considering that the AC of an individual or group can mediate the AC of another individual or group (Romero-Lankao et al. 2014; Wilhelmi and Hayden 2010). Also, we also look into studies' consideration of tradeoffs between specific capacities (e.g., climate risk insurance) and generic capacities (e.g., income diversification) (Eakin et al. 2014).

Scholars have also underlined that one of the main challenges with climate change is that it is a continuous change process (Chelleri et al. 2015). Adapting to climate change means dealing with changing conditions that require continuous societal adjustments (from habits to laws) over time. The *AC time frame* determinant involves the examination of AC attributes that can transform over time because changing social or individual conditions may affect the extent to which individuals or groups can withstand and adapt to shocks (Ford et al. 2013; Leichenko and O'brien 2002). Further, AC put in practice (as adaptation) can lock in risks and the future capacity of cities to respond to climatic events (Ürge-Vorsatz et al. 2018).

Finally, analyzing the relationship of *AC, exposure and sensitivity* is important to better understand the interactions between society and the environment and thus for meeting the needs of both systems along sustainable trajectories (Kates et al. 2001; Turner et al. 2003). Hence, exposure and sensitivities can shape urban AC and, conversely, the AC of urban social entities can shape future

exposure and sensitivities of the urban area. At the same time, these interactions are mediated by the type of hazard and correspondingly how the hazard is shaped by the given urban setting and development.

3. Methodology

Developing the conceptual framework presented above was the first of six steps in the procedure outlined by Berrang-Ford et al. (2015) and which we followed to develop the present systematic literature review (Online Resource 1). Secondly, we selected the keywords to identify papers dealing with urban AC, these were: ("climat* change" OR "global warming") AND TOPIC: ("adaptive capacity" OR "coping strategies" OR "coping capacity" OR "adaptation capacity") AND TOPIC: (urban OR cities OR city OR metropolitan). Thirdly, we used these keywords in the Web of Science platform to systematically collect all relevant scientific articles in English and Spanish[3] published between 2000 and 2017, which resulted in 341 publications. After retaining only original research articles, the citation information of 289 articles was downloaded into a bibliography manager software (EndNote). Fourthly, we reviewed each article with a finer set of inclusion criteria, so as to retain only those articles presenting empirical research relevant to urban AC in developing countries (Table 1). We began applying these finer inclusion criteria by reading the articles' abstracts, which resulted in the exclusion of 185 articles. The remaining 104 articles were assessed in their entirety against the inclusion criteria listed above and also in terms of their quality. In this regard, we excluded those papers that failed to explicitly present conceptual and methodological approaches. This left us with 38 articles that underwent a thorough full text review (Online Resource 2). Most articles excluded either did not focus on a developing country or on urban areas, or did not have AC to climate change as their primary focus. Only a handful of articles were excluded due to quality issues (Online Resource 3). Fifthly, data was extracted to a table by reviewing each article with a conceptual framework rubric (Online Resource 4). The rubric contained 20 questions (both open- and closed-ended) organized around the three dimensions of AC presented in the conceptual framework. Finally, we analyzed the questionnaire results based on the three dimensions of AC and by looking for trends according to year of publication and region studied.

4. Results

4.1 General research trends

All 38 articles retained for full review were published in English[4] from 2009 on, with the majority published between 2013 and 2017 (Online Resource 5). This trend mirrors a broadening of vulnerability research that has evolved from mainly looking at climate impacts and possible adaptation options towards assessing barriers to adaptation and examining social capacities to deal with changes and uncertainty (Ford et al. 2018).

[3] The two languages spoken by the lead author.

[4] None of the articles in Spanish originally identified were retained for review.

In total, this review covers studies looking at 32 urban areas in 21 countries, two regions with 85 cities, and one global study on urban areas (Online Resource 6). The studies are situated in Africa (n=9), Latin America and the Caribbean (LAC) (n=11), and Asia (n=17). Approximately half of this corpus focuses on only five countries (i.e., Chile, Ghana, India, Philippines, and South Africa). Further, the majority of urban areas studied (82%) are located in middle-income countries,[5] including both upper-middle income (one-third) and lower-middle income (two-thirds) countries. Only one urban area is located in a low-income country (Dakar, Senegal) and the few remaining urban areas studied are located in high-income countries. The urban areas studied include small cities of 200,000 or less people (n=5), medium cities of 200,000 to 1 million (n=6), large cities of 1-10 million (n=16), and mega cities of 10 million or more (n=5). A third of the articles analyze AC at the city scale (n=13) and most of the remaining articles are framed at the district or sub-district (or neighborhood) scale (n=10). A lower frequency of articles narrow the research at the community (n=5), household (n=6), or individual levels (n=3) as their primary scale of analysis.

The studies reviewed rely on a mix of qualitative, quantitative, and spatial methods. More than half use only one of these three methods: qualitative (n=13), quantitative (n=8), or spatial (n=3) methods. Nevertheless, the distribution of study designs shows an increase in the use of mixed methods (n=14) over time, especially with regard to mixed qualitative and quantitative methods (n=11). Studies using spatial analysis are the least common (n=6), and this holds whether this method is used alone or as part of a mixed method strategy.

The studies reviewed include single case studies (n=29), comparative case studies (n=6) including four south–south and two north–south[6] urban areas comparisons, territorial studies (n=2), and one global study (n=1). Comparative case studies examine in-depth two or more urban areas within one country or region (e.g., comparing two cities in LAC), and territorial studies assess many cities within one country area (e.g., 65 cities in southern China).

The majority of studies frame the analysis of AC in responding to climatic stressors or hazards (e.g., urban heat), focusing less on the possible impacts of those stressors (e.g., health impacts). More than half of the studies (n=22) consider multiple climatic stressors, while fewer articles focus on only one climatic stressor (n=11) or otherwise define their analysis as motivated by the threat of climate change generally (n=5). Researchers design their studies to focus mostly on floods, droughts, urban heat, sea-level rise, and water scarcity.

Most of the articles reviewed were published in journals within the environmental sciences and studies disciplines (n=27). A smaller number of studies were published by journals at the interface of urban and environmental studies, and/or planning and development (n=5), by geography-focused journals (n=3) or other disciplines (n=3) such as women studies.

[5] Country income levels were drawn from the UN World Economic Situation and Prospects 2017, based on the per capita Gross National Income (GNI) in September 2016.

[6] We assessed only the approach on the developing country information of the north–south studies.

4.2 Adaptive capacity characteristics

The literature characterizes urban AC in multiple ways. The methodological approach discussions in over two-fifth of the studies reviewed (n=16) do not provide an explicit explanation of what constitutes AC, limiting comparison possibilities. In these studies, adaptation practices are generally understood to be determined by AC levels (low/high) and these tend to be assessed using key determinants. Conversely, studies featuring explicit AC definitions (n=22) tend to apprehend urban AC as the result of resources and determinants that structure agents' ability to respond to climate variability and climate change. A less common understanding of urban AC apprehends it as processes leading to adaptation actions.

The resources and determinants most often used to describe AC are financial (income and assets), informational, technological, access to basic services, and social capital. Other determinants utilized by studies are knowledge, education, experience with previous hazards, awareness, risk perception, infrastructure, social networks, warning systems, and to a lesser extent innovation, governance, political participation, legal structure, self-efficacy, and leadership. For instance, in a study of AC in San Salvador, El Salvador, Wamsler et al. (2012) found a significant correlation between past disaster impacts and the use of coping strategies, showing that previous experiences can determine AC. Some studies further highlight determinants of AC significant to developing contexts, such as poverty and deprivation. A study in Accra, Ghana, for instance reported that while 97% of the urban traders it surveyed reported that climate change negatively impacted their livelihoods, a majority of respondents were unable to meet their basic needs, let alone adopt coping strategies to respond to climate change (Arku et al. 2017).

In the majority of studies (n=29), scholars did not refer to specific urban attributes when characterizing urban AC. Instead, they used standard AC attributes such as income and knowledge. Urban attributes call attention to the settlement's characteristics (e.g., density, size), the systems that facilitate social urban life (e.g., urban governance settings, flux of resources from the hinterlands), and social-urban dynamics (e.g., social fragmentation). In the few cases (n=9) where studies did refer to urban attributes, these included infrastructure (e.g., urban water supply), household location, property characteristics (e.g., ownership, insurance), land use regulation processes (e.g., informal settlements, urban governance), and stability and security of the urban areas. These cases illustrated the importance of considering urban attributes, for instance city size as demonstrated by a comparative study of three Indonesian cities (Handayani et al. 2017).

The studies reviewed analyze AC agency from a mix of individual, social, and institutional stances. Half of them focus on only one type of agency (individual or governmental) while the other half takes a broader perspective and include two or more types. Individual agency is the type most often considered (n=26), closely followed by institutional (n=22) and, somewhat later, by communities' social agency (n=11). Studies looking at all three types of agency tend to frame AC as an objective ability to deal with climate change. Overall, less than a third of studies (n=11) discuss the

subjective AC of an actor or social group. Studies that do consider the subjectivities of AC mostly do so as a supplement to the analysis of objective AC. The combination of objective and subjective AC is typically done by combining resources and determinants that compose AC with climate change awareness and risk perceptions, and to a lesser extent with self-efficacy perceptions. These studies' findings show that subjective factors influence adaptation decisions. For example, in Taichung, Taiwan, the community members' risk perceptions and appraisals of their abilities to access resources and perform adaptation successfully have been shown to be key determinants of residents' willingness to take adaptive actions (Hung et al. 2016).

Regarding the range of AC, more than a third of the studies reviewed focus only on the ability to deal with short-term climate threats through concrete actions (e.g., moving furniture one floor up during floods), which corresponds to the coping level (n=15). Around half of the studies reviewed analyze AC in a medium time frame by considering the ability to adjust and prepare in advance for climate impacts; this includes studies that exclusively assess the adapting level, and studies that combined the coping and adapting levels (n=17). Few studies examine longer-term strategies that aim to change structural conditions in urban areas, the transformability level (n=6), and when they do, they do so at a primarily theoretical level. An exception to this trend is Schaer (2015), whose study in Dakar explores the effect of past maladaptation as a determinant of present coping and adaptation levels of AC and discusses the timing of coping and adaptation strategies and whether they support permanent transformations.

4.3 External factors shaping urban adaptive capacity

The majority of articles reviewed consider external factors that mediate urban AC (n=30). This consideration ranges from the description of processes that contextualize AC to analyses of how these processes empower (or undermine) the AC of urban actors. Several of the articles reviewed include urban vulnerability assessments that explicitly consider AC (n=17), along with exposure and sensitivity (as is common practice in the scholarship). In these cases, the external factors that shape AC are analyzed as factors shaping vulnerability and therefore AC.

Research concerned with multi-level processes tends to identify global and national processes that affect local urban circumstances. A third of the studies reviewed take into account multilevel processes (n=12). This literature frequently highlights decentralization, urban growth, and economic growth and transformation as factors directly influencing AC. For example, in Nadi, decentralization of early warning systems was shown to enhance AC, but at the same time national political instability eroded international finance, which decreased AC (Chandra and Gaganis 2016). In a global-level study, Garschagen and Romero-Lankao (2015) demonstrate that countries with rapid urbanization and economic transformation face significant challenges with respect to the lack of capacities and sensitivities, while urbanization can also be a main driver for enhancing AC. Other multilevel processes identified include migration, national political instability,

institutional national fragmentation, historical processes following post-colonialism, and neoliberal reforms.

More than half of the peer-reviewed articles (n=22) describe place-based processes that influence how actors respond to climate hazards. These processes include the informality of settlements, employment, poverty, forced evictions, social segregation and marginalization, provision of city services, increased mobility, and population density. The most common place-based process, addressed in 39% of the articles reviewed (n=15), is urban spatial expansion through informal settlements. Studies concerned with this process are looking at an informal settlement or at the way informality influences the local capacities to adapt to climate change. As exemplified in Lagos, Nigeria, communities living on informal settlements are marginalized by being classified as "outside" of the city and hence excluded from the city's regulatory and planning systems for dealing with climate hazards (Ajibade and McBean 2014). Likewise in relation to informal settlements, in San Salvador researchers found that the increasing ease of mobility leads households to default on their obligations to relatives and neighbors, as the different income levels foster individualistic behavior that result in opting out of mutual and hierarchical arrangements that could support adaptation (Wamsler and Lawson 2012).

The documentation of institutions (i.e., rules and social norms) affecting urban AC is elaborated in much more detail than the multilevel and place-based processes. The institutions identified as shaping urban AC correspond to position, boundary, choice, aggregation, and information rule types, following Ostrom's classification (Table 2). Regarding the influence of governance institutions on institutional capacity (e.g., governmental), the literature reviewed highlights the roles and responsibilities of policymakers and stakeholders, the flexibility or rigidity of institutional procedures, leadership, elitism, turnover, and flow of information. Frick-Trzebitzky (2017) demonstrated the importance of informal institutions for adaptation in Accra, where the role of the chief contributed to or impeded adaptation to urban flooding, depending on the chief's own rationalities and institutional context.

Considering the influence of institutions on social and individual AC, several studies (n=9) found that tenure security mediates households' AC. In Korail, for example, a large informal settlement in Dhaka, Bangladesh, Jabeen et al. (2010) found inhabitants unwilling to invest in improving their living conditions because of tenure insecurity, despite the fact that some have lived there for as long as 20 years. Similarly, in urban communities in Lagos, while the authorities enforce evictions and demolitions on account of flood prevention and urban development, the inhabitants expressed a reluctance to invest in quality housing because they feared these forced actions from the authorities (Ajibade and McBean 2014).

Further, several studies mention that urban dwellers distrust local authorities (n=8), which can impact the capacity to respond and adjust the urban system to climate change. For example, in

Ekurhuleni, South Africa, the relationship between local governments and residents has historically been distrustful, thus shaping the risk perceptions of the latter and prompting them to pool ideas as well as financial resources to combat floods on their own rather than to rely on the government (Fatti and Patel 2013), which shows the importance of local political interactions in shaping AC.

4.4. Adaptive capacity dynamics

The literature often disaggregates the AC of different urban dwellers groups (n=12). This is mainly done by contrasting low-income to high-income groups, low-risk to high-risk groups (measured by their exposure and/or sensitivities), and geographic areas. For example, Wamsler et al. (2012) showed a relationship between households' level of education and risk level in San Salvador and Rio de Janeiro. Their study explained the lower risks faced by people with higher levels of education because they are more likely to be responsive to disaster warnings and alerts, to accept and use institutional support, and to move to a more secure area. Further, the study shows that formal education seems to be of special importance for determining women's risk level. The urban dwellers differences in AC have also been assessed in relation to the capacity of other actors to foster adaptation (i.e., authorities).

Where only the most vulnerable populations are identified (n=16), the literature focuses mostly on one vulnerable group (e.g., urban poor) or alternatively disaggregates results and identifies particular phenomena related to a vulnerable group (e.g., women). For example, in Dakar, the most vulnerable population groups are excluded from taking part in local decision-making and thus are negatively affected by the undesirable impact of adaptation initiatives (Schaer 2015). Moreover, while a majority of studies (n=34) did not include gender considerations to characterize AC, those that did had noteworthy results. For example, studies in Delhi, India, shed light on the decision-making process of households in which social gender relations undermine women's adaptation decisions (Saini et al. 2015).

Six articles engage with the dynamics of AC, from considering the interaction of a person's own capacities to the individuals' capacities within the social groups. For example, in Mexico City there are tradeoffs between specific and generic capacities at the household level. Households' efforts to adapt in conditions of marginality can come at the expense of households' investment in other aspects of human welfare, reinforcing poverty traps and leading to inequity in the burden of risk management (Eakin et al. 2016). Also, a study in Malolos, Philippines, shows that some children, especially those from poor families, experience helplessness and exasperation in performing individual-level adaptations in the absence of corresponding long-term action from their community (Berse 2017). The literature also highlights the importance of studying the internal dynamics of AC at multiple scales. For example, in Paramaribo, Suriname, and Georgetown, Guyana, households perform most of the preventative actions, and during floods

households often act collectively within their localities without contacting the authorities (Linnekamp et al. 2011).

Only four articles examine time when studying urban AC. Regarding changes of AC over time, in Concepción, Chile, researchers concluded that all the municipalities in the area increased their level of AC between 1992 and 2002. In most municipalities, knowledge was the most important determinant of this increase. However, the relative differences in AC between rich and poor municipalities did not change significantly over the studied period, which is explained by economic conditions, location, and inequalities rising from urban sprawl (Araya-Munoz et al. 2016).

Some researchers reflected on the relationship between AC and exposure and sensitivity to climate change, showing the strong connections to the broader vulnerability research. For example, in Nadi, it was suggested that the presence of multiple exposures, of physical, social, economic, and political factors reinforced, transformed, or weakened the existing patterns of local people's AC, highlighting the importance of contextual vulnerability (Chandra and Gaganis 2016). From a metalevel perspective, scholars propose that understanding the content of AC and how it interacts with exposure and sensitivity during different periods will be an important basis for responding to unexpected climatic events (Berse 2017; Hung et al. 2016; Sales 2009).

5. Discussion

This paper systematically examined how urban adaptive capacity (AC) to climate change in developing countries is being framed and assessed in the peer-reviewed literature. In doing so, we responded to calls for more research across urban contexts in a globalized world facing climate change (Huyssen 2008), while remaining cognizant of ongoing debates about comparability stemming from differences in methodological and theoretical approach (see Robinson 2011). The 38 studies on AC to climate change in urban settings of the developing world analyzed in this paper are but a small fraction of the broader urban adaptation literature, with 1,957 articles on this theme published during the 2000–2017 period.[7] The articles retained in this study were all published from 2009 on, signaling the relatively recent—yet significant—rise of scholarly interest in the question of urban AC in the developing world. Moreover, research on urban AC in this context tends to focus on a rather limited number of countries and their urban areas. This uneven geographic distribution means many countries of the Global South are "off the map" in existing urban AC research, and this despite the fact that they are expected to be significantly impacted by future climate change. There is need to research urban areas in all developing regions, including Sub-Saharan Africa, Arab states, South and East Asia, Central and South America, the Caribbean and the Pacific states. The conceptual framework presented in this paper can assist further research to characterize and examine urban AC in developing countries, especially those "off the map."

[7] According to a Web of Science query for the 2000–2017 period using the following keywords: TOPIC: (urban OR cities OR metropolitan) AND TOPIC: (adaptation) AND TOPIC: ("climat* change" OR "global warming").

This review also identified four emergent patterns within urban AC research and sheds light on the mismatch between theoretical debates on AC dynamics and empirical assessments. Firstly, the results support previous claims that AC varies across urban scales (Moser and Satterthwaite 2008; Romero-Lankao et al. 2014), including individuals, households, communities, districts, and city levels. Moreover, urban AC consistently varies within scales, such as between urban sub-groups and geographic locations within urban areas. Hence, it is important to contextualize and map AC as suggested by broader vulnerability researchers (Dunford et al. 2015; Lemos et al. 2013; Waters and Adger 2017). Secondly, the review showed that objective resources and processes mediate AC in urban areas and that subjective AC can directly influence the resulting adaptive practices. Articles that use an integrated framing of both objective and subjective AC in urban settings provide more nuanced results than those focusing only on one type of AC. Thirdly, the role of governance and social institutions is key to understanding the agency of actors in their path to adaptive actions. As such, our review supports previous studies concluding that governance institutions shape institutional and individual urban AC (as a two-fold capacity) (Hughes and Sarzynski 2015; Wamsler and Brink 2014), also illustrating that social institutions are critical in shaping individual, social, and institutional urban AC in developing countries. Fourthly, most articles fail to include specific urban determinants in their analysis and questions remain as to how and why these determinants can have different impacts in urban areas globally. In addition, it would be appropriate to explore possible interdependencies between the urban determinants and multilevel and place-based processes, which together affect urban AC.

The treatment of AC dynamics in the scholarship is found to be marginal with regard to the interactions of AC over time, between and within urban groups' capacities, and with urban exposure and sensitivities. These gaps point to a rather narrow understanding of AC as static in time and space, and non-reciprocal between social entities. Although some studies did consider differentiated AC in a given urban area, analyses of how these reinforce or diminish one another is weak. While it has been largely agreed that adaptation actions will unavoidably produce winners and losers (even with no-regret options) (Eriksen et al. 2011; O'Brien and Leichenko 2003; Sovacool et al. 2015), there is limited consideration on the effects of how AC in a given moment by a specific social group or in response to certain exposure can affect AC elsewhere. Research needs to more strongly emphasize the dynamics of urban AC, including potential for maladaptation, as has been addressed in the context of land-use measures and adaption planning (Anguelovski et al. 2016). Further, considering that one third of the studies reviewed only focus on the coping level of AC, there is need to promote analysis that links coping, adapting, and transforming levels of AC. This is particularly important when considering that coping responses of individuals and social entities can generate undesirable outcomes for communities in the long-term, as has been studied in rural and national settings (Fazey et al. 2010; Fazey et al. 2016). The treatment of urban AC in research as a short-term ability to deal with shocks can translate into an equivocal analysis of vulnerability to climate change and support maladaptation of urban areas and

their communities. Altogether, we can observe a mismatch between theoretical papers addressing the adaptability and transformability of urban areas (Hordijk et al. 2014; Pelling et al. 2015; Rosenzweig et al. 2018; Solecki et al. 2017; Ziervogel et al. 2016) and the limited empirical papers that sought to study these processes on the ground. Studying the dynamics of urban AC has methodological challenges such as designing approaches that account for multiple AC paths within urban milieus in changing socio-natural contexts. Likewise, taking longer study time-frames (i.e., 10 years and longer) is a challenge but then again it would allow to see the effects of AC in other entities and places. Despite these challenges, there is need to strengthen and link empirical work to the current theoretical debates on climate change adaptation in and beyond urban areas, especially the growing body of research dealing with the political nature of adaptation (Chu 2016; Chu et al. 2017; Eriksen et al. 2015; Meerow and Mitchell 2017), historical processes framing adaptation (Adamson et al. 2018), and the role of values in defining adaptation practices (O'Brien and Wolf 2010).

Ultimately, this review of urban AC literature raises a key question: *How should we explain the process of adaptation?* Using the concept of AC is useful to address the ability of urban social systems to deal with climate change. However, using this concept should not restrict the analysis to a sum of characteristics that may or may not indicate possible adaptations. As Mortreux and Barnett (2017) warned, the first generation of AC research (what they define as the sum of capitals) has been unable to explain how adaptation is practiced across diverse contexts and scales. Thus, there is need for research that focuses on understanding existing adaptation processes (Mortreux and Barnett 2017). Embracing the second generation of AC by adopting an understanding of urban AC as the adaptation process that leads to adaptive practices and outcomes in specific socio-urban settings would be valuable. In this paper, such an understanding allowed us to better integrate the socio-cultural and urban processes that shape urban AC in the analysis and to inquire how the dynamics of AC evolve. At the same time, the understanding of urban AC as a process requires engaging with broader literatures concerned with urban space, such as urban planning, urban sociology, geography, and history. All of these disciplines can contribute to equip scholarship on urban AC with a better and more in-depth understanding of the psychological, cultural, and political processes it seeks to explain.

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Adaptive Capacity in Urban Areas of Developing Countries

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Systematic Literature Review Steps

1. Development of an urban AC conceptual framework.
2. Identification of keywords (and their combination) to use in the search.
3. A systematic review of ISI Web of Science using the selected keywords.
4. A review for inclusion of the articles using review parameters.
5. A formal revision of the selected articles using a questionnaire for data extraction and synthesis of the results.
6. Analysis of the results using the three dimensions of the conceptual framework of urban AC.

Adaptive Capacity in Urban Areas of Developing Countries

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A. Urban Area Cases included in the Review

	Urban Area	Country
1	Dhaka	Bangladesh
2	Rio de Janeiro	Brazil
3	Santos	Brazil
4	San Salvador**	El Salvador
5	Concepcion	Chile
6	Santiago de Chile****	Chile
7	Bogota	Colombia
8	Nadi	Fiji Islands
9	Accra***	Ghana
10	Georgetown	Guyana
11	Ahmedabad	India
12	Bangalore	India
13	Delhi**	India
14	Semarang	Indonesia
15	Tegal	Indonesia
16	Lasem	Indonesia
17	Busan	Korea
18	Daegu Metropolitan City	Korea
19	Mexico City**	Mexico
20	Lagos	Nigeria
21	Ibadan	Nigeria
22	Cavite City	Philippines
23	Malolos	Philippines
24	Metro Manila	Philippines
25	Dakar	Senegal
26	Bergriver	South Africa
27	Cape Town	South Africa
28	Ekurhuleni	South Africa
29	Paramaribo	Suriname
30	Taichung metropolis	Taiwan
31	Da Nang	Vietnam
32	Quy Nhon	Vietnam

**This urban area is part of two studies.
*** This urban area is part of the three studies.
**** This urban area is part of the four studies.

B. Urban Areas within Territorial Studies Included in the Review

	Urban Area	Country
1	65 cities in Anhui, Henan, Jiangsu and Shandong provinces	China
2	20 cities in Pearl River Delta area in Southern China	China

Adaptive Capacity in Urban Areas of Developing Countries

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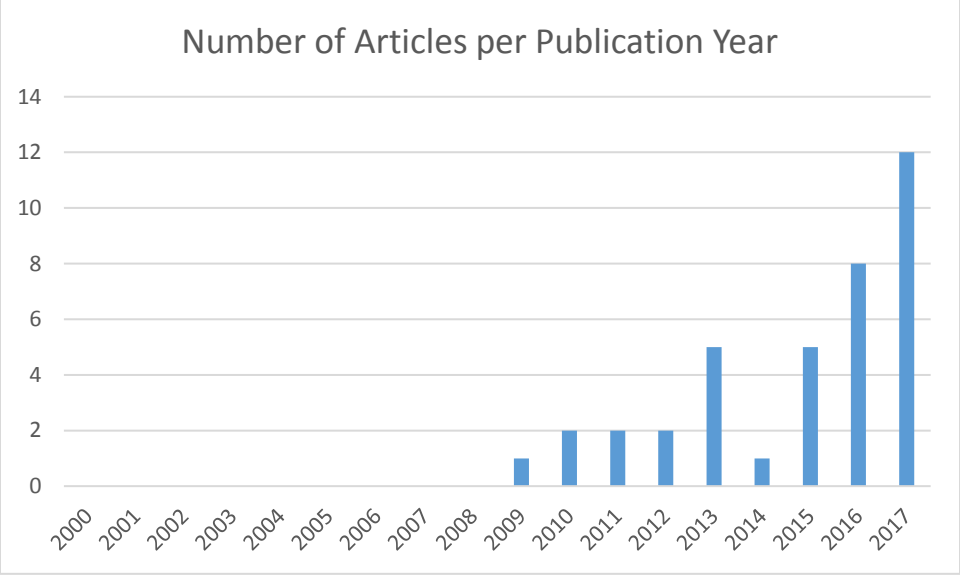
Articles by Publication Year



Source: Own elaboration.

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The conceptual framework for Examining how research assesses urban adaptive capacity to climate change.

Features	Questions	Response options
1. Basic Case Study Information		
Year of the article	When was the article published?	2000 to 2017
Region	In which geographic region is the research?	Africa; Asia; Latin America
Country Income level[1]	Which is the country income level of the urban location?	High income country; upper-middle income country; lower-middle income country; low-income country
Study Scale	Which is the scale of the research?	City, district, community, household or individual
Urban Population Size	What is the urban population size?	< 500,000; <1 million; >1 million
Stressors	Does the research focus on one or more than one stressor?	1; > 1
Scholarship	Under which scientific scholarship is AC framed?	Natural hazards; vulnerability science; resilience science
Research Design	What is the type of research design?	Quantitative; qualitative; spatial analysis; mixed method (qualitative & quantitative); mixed method (all)
2. Adaptive Capacity Characteristics		
AC attributes	What attributes constitute urban AC?	Open-ended answer
AC agency	Who has the capacity to reduce vulnerability and/or increase resilience?	Individuals; communities; governments
AC type	Does the research consider objective and/or subjective AC?	Objective; subjective; both
AC range	Does the research focus on coping, adaptive or transforming capacities?	Coping; adapting; transforming; all
3. Multilevel factors shaping Adaptive Capacity		

[1] Country income levels come from the United Nations World Economic Situation and Prospects 2017, based on the per capita Gross National Income (GNI) in September 2016. Countries with less than $1,025 GNI per capita are classified as low-income countries, those with between $1,026 and $4,035 as lower-middle income countries, those with between $4,036 and $12,475 as upper-middle income countries, and those with incomes of more than $12, 475 as high-income countries.

Multi-level processes	Does the research consider multi-level processes that shape AC? Which ones?	Open-ended, e.g. globalization; decentralization; urbanization
Place-based processes	Does the research consider urban place-based processes that shape AC? Which ones?	Open-ended, e.g. informality; household ownership
Institutions (formal and informal norms)	What institutions that shape AC does the research consider?	Open-ended
4. Adaptive Capacity Dynamics		
Urban vulnerable population	Does the research considers specific vulnerable urban populations? / Which ones?	Yes; no / open-ended, e.g. elders, women, indigenous communities
Differentiated urban AC	Does the research differentiate AC of urban dwellers?	Yes; no
AC interaction	Does the research consider how the adaptive capacities of different urban actors interact?	Yes; no
AC temporal interaction	Does the research consider how AC evolves over time?	Yes; no
AC, sensitivity, and exposure	Does the research consider how the changes in AC interact with the system's sensitivity and/or exposure?	Yes; no

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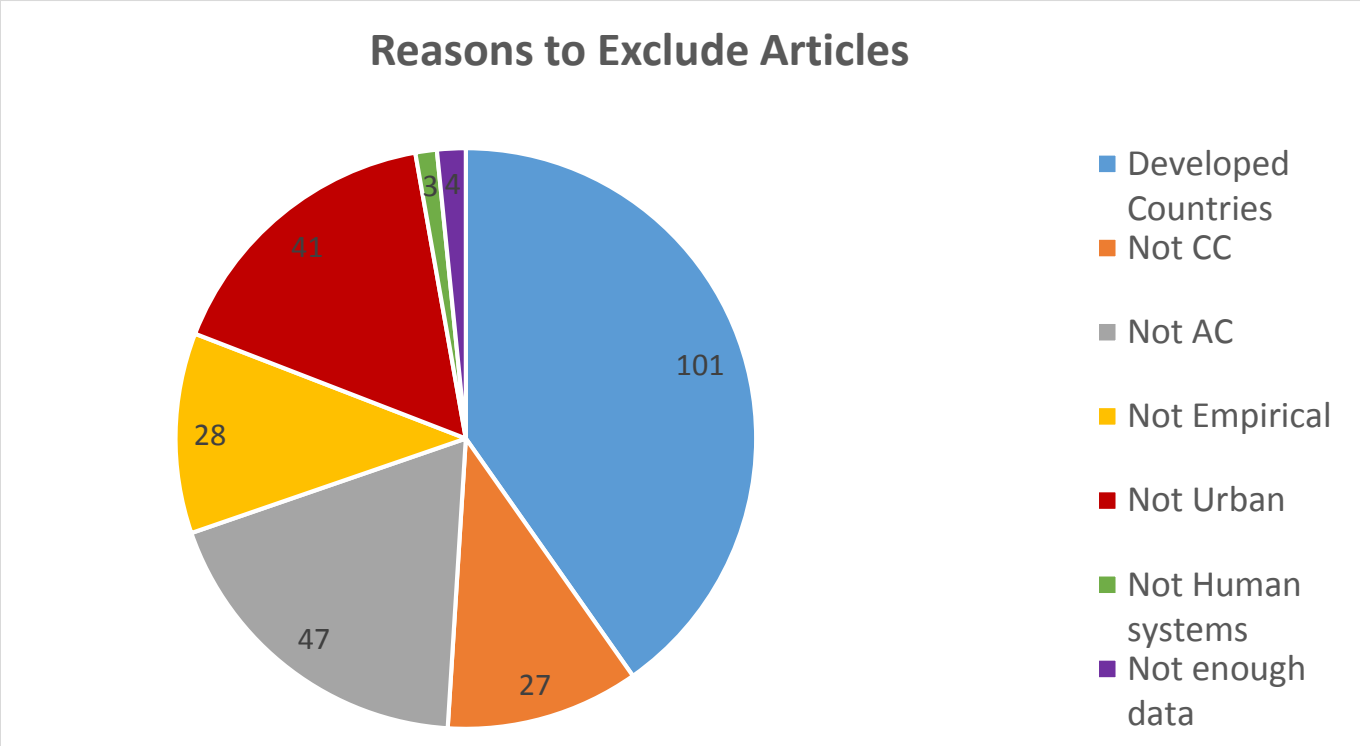
Articles by Exclusion Criteria



Adaptive Capacity in Urban Areas of Developing Countries

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