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Abstract

India's urban transition is salient to the growing emphasis on city responses to climate change. While projected to experience the largest global urban transition with significant infrastructure investment in the next few decades, the welfare of Indian cities remains poor, which complicates the implications for climate change mitigation and adaptation. This paper traces, synthesizes and characterizes the emerging literature on Indian urban climate debates. It discusses the arc of urban climate efforts, from an initial emphasis on climate vulnerabilities and risks, broadening over time to include climate mitigation. The paper examines the governance forms and political motivations with which such actions are pursued in cities and finds three overarching characteristics: the use of local development priorities as an entry point to climate mitigation and adaptation; the role of non-state actors in promoting climate-relevant outcomes; and the proclivity for discrete project-based activities. The paper suggests that while a range of Indian cities are beginning to consider climate concerns, a larger strategic understanding of the interaction between climate and development priorities, across policy and governance levels, is yet to be developed. The future trajectory of urban India's responses to climate change will be shaped by how pressing local development and mitigation and adaptation goals will be institutionally linked, integrated and prioritized.

Introduction

Cities are increasingly seen as sites of strategic action on climate change. The 2015 Paris Climate Agreement enables new nationally determined avenues to promote climate outcomes and stresses the importance of cities. The UN-Habitat's 2016 New Urban Agenda emphasizes the role of local urban governments to address climate change. The eleventh Sustainable Development Goal explicitly focuses on cities. As sites of infrastructure provision, and with immediate social and environmental concerns, cities have become central to the economic, environmental and social pillars of sustainability (Acuto, Parnell, & Seto, 2018; Sanchez Rodriguez, Ürge-Vorsatz, & Barau, 2018).

The prominence of urban climate responses is particularly salient to developing countries, where the bulk of urban growth is projected to occur, and which are often the most vulnerable to climate impacts (Nagendra, Bai, Brondizio, & Lwasa, 2018). Indeed, the emissions to upgrade and construct infrastructure to accommodate this growth is projected to be 226 Gt of CO_2 by 2050 (Bai et al., 2018) , nearly 20% more than the G-77's (excluding China's) CO_2 emissions since 1850 (WRI, 2014). At the same time, cities in transitioning economies often have limited local capacities, scarce data and informal governance structures, making their climate responses different from those documented in developed countries (Anguelovski, Chu, & Carmin, 2014; Carmin, Anguelovski, & Roberts, 2012; Bai et al., 2018; E. Chu, Anguelovski, & Roberts, 2017; Nagendra et al., 2018; Parnell & Pieterse, 2014; Romero-Lankao et al., 2018; Satterthwaite, Huq, Pelling, Reid, & Romero Lankao, 2007).

India is central to these discussions as it will undergo the largest global urban transition in the next few decades (UN DESA, 2014). The country already has more than 50 urban agglomerations with a million people and 400 million urban residents, a number that is expected to double by 2050 (Government of India, 2011). How these cities are built and grow will condition consumption and production practices and exposure to climate risks for decades (Ürge-Vorsatz et al., 2018). Given the scale and scope of its urbanization, how are Indian cities enabling growth while mitigating and adapting to climate change? Does decision-making in urban India account for the urgency of current choices, which can lock-in, or lock-out, inclusive, climate resilient and low-carbon urban forms and practices for the long-term (Seto, Davis, Stokes, Unruh, & Urge-Vorsatz, 2016; Ürge-Vorsatz et al., 2018)? Which forms of climate change related interventions have found traction and how can they be scaled? This paper responds to these questions by synthesizing the research on the linkages between India's urban transition and climate change. It describes the arc that urban climate science and action have taken over the past decade, and the characteristics that mark them. In doing so, the

paper lays forth the literature landscape of emerging Indian urban climate debates, with an eye to the long-term mainstreaming of greenhouse gas (GHG) mitigation and adaptation into local development.

Urban India: Transitioning Structures and a Changing Climate

A snapshot of urban India

India's urban population is projected to double to more than 800 million between 2014 and 2050 (UN DESA, 2014). To accommodate this growth, studies suggest that two-thirds of India's buildings in 2030 will be constructed after 2010 and mostly in urban areas (S. Kumar, Kapoor, Rewal, Seth, & Walia, 2010). Already, the built environment is estimated to have increased by 95% between 1990 and 2014, outpacing population growth and city planning efforts (OECD, 2017). These new urban forms will range from mega-cities to many medium sized cities and small urban clusters (Denis & Zérah, 2017). To support quality of life within these urban areas, the demand for basic services such as electrification, mobility, and clean cooking fuels are all projected to rise (IEA, 2015). The resulting pressure on the energy system is predicted to be extraordinary, and there is little doubt that India's urban context will be a central determinant of the country's future energy demand and GHG emissions.

In spite of the scale and productivity projected for urban India, its welfare conditions remain dire. Urban poverty, based on definitions of 1000 and 1407 INR (66 and 93 USD 2011 PPP[1]) expenditure per capita per month, is at 14 and 26%, respectively. (MoUD, 2016; Rangarajan, Mahendra Dev, Sundaram, Vyas, & Datta, 2014; OECD, 2018). The cities are poorly serviced, with uneven and low-quality access to water, toilets and drainage. One in six urban dwellers live in 'slums', accommodations officially defined as "unfit for human habitation." (Government of India, 2011; HPEC, 2011) The health of the local environment, from air to water pollution and management of solid waste, is in serious deterioration, and ranked amongst the worst in the world (WHO, 2016). Implicit in India's urbanization and climate change response are thereby the multiple challenges of access, inclusivity, livelihoods and well-being.

[1] Conversion to USD is made in Purchasing Power Parity (PPP) terms for the year poverty data was reported, using historic conversion rates available from the OECD. As the Indian poverty line data are based on consumption baskets, we assume it is comparable to the PPP basket.

An additional feature of India's wave of urbanization is that it coincides with increasing global concern on climate change, as exemplified by the Paris Agreement, according to which almost every country has pledged a 'nationally determined contribution' (NDC). India's NDC states that it will urbanize while reducing the economy's carbon intensity and fossil-fuel share of electricity (Government of India, 2015) – reflecting the slow inclusion of climate considerations into its domestic development agenda. This shift, in part, is a result of the changing geopolitics and a growing awareness of climate impacts on India (Dubash, Khosla, Kelkar, & Lele, 2018). By this measure, it could be argued that India will embark upon the first, large-scale, climate-conscious urban transition. This places further urgency on the decisions which can lock-in low carbon and resilient urban forms for the long-run (Seto et al., 2016; Ürge-Vorsatz et al., 2018).

The governance of urban climate responses

Institutionally, urban governments in India have no mandate to respond to climate change (Sami, 2017, 2018), unlike the national and state governments which produce 'Action Plans on Climate Change' (Dubash, Khosla, Kelkar, et al., 2018; Jogesh & Dubash, 2015). Nor is climate change a focus in urban master plans and comprehensive development plans, which are the primary documents that cities produce to strategize their spatial growth and service provision. A qualitative analysis of 59 city plans across 24 states found only 30% of the urban masterplans exhibit awareness of climate change and only 10% of the spatial plans have climate-relevant analysis (P. Kumar & Geneletti, 2015, p. 215). At the same time, India's NDC describes a host of urban development actions with climate adaptation and mitigation co-benefits, such as the provision of basic services, access to clean energy, sustainable environments, mass rapid transit and electric mobility (Government of India, 2015). Indeed, a more recent study on city masterplans indicates the prevalence of 'climate relevant' features such as transit-oriented and mixed-used development, in contrast to the earlier literature (Raparthi, 2018). These activities distil to the urban level through a multi-level governance framework, that conditions the types of local climate responses that are possible (Bulkeley, 2005; Jörgensen, Mishra, & Sarangi, 2015).

Governance in Indian cities involves a complex arrangement of laws, involving municipal and non-municipal institutions with "tangled" jurisdictions (Sivaramakrishnan, 2013, p. 89; Gandhi & Pethe, 2017). There are, often, multiple, overlapping and poorly coordinated plans across sectors (Ahluwalia, 2017; Gandhi & Pethe, 2017), and pervasive informal arrangements (C. B. Kumar, 2013; Pathak & Mahadevia, 2018; A. Roy, 2009). India's federal structure places urban services provision at the central and state levels, with limited control for urban local bodies outside of implementation

(Sivaramakrishnan, 2013). States determine the roles and financial capabilities of their urban governments, and manage para-statal bodies such as water supply boards, electricity utilities, pollution control boards, disaster management agencies and development authorities (Ahluwalia, 2017; Praharaj, Han, & Hawken, 2017; Sivaramakrishnan, 2013). Within the city, the democratic arms of government have little executive power which rests solely with the state-appointed bureaucratic officer (Sivaramakrishnan, 2013). Nonetheless, while the bureaucratic, executive arms of city governments have limited strategic planning leeway, as implementers of various state and central schemes, they can co-ordinate and converge local activities and financing (Gandhi & Pethe, 2017) to implement climate actions within the boundaries of the existing policy framework. This scope to converge schemes gives city bureaucracies the potential to formulate and implement locally-specific actions across sectors.

The central government remains the key actor as it provides financing (Sadoway, Gopakumar, Baindur, & Badami, 2018), and of late is taking a target-driven approach to urban governance, with goals of building 12 million affordable housing units by 2022, and providing 100% coverage of sanitation infrastructure by 2019 (Ahluwalia, 2017). However, local governments are underequipped to implement such tasks (Ahluwalia, 2017; Kundu, 2014; Kundu & Samanta, 2011), let alone deliberate their climate adaptation or mitigation implications. In this centralized urban governance framework which affords few opportunities for creative urban action, how are Indian cities engaging with climate change? In the next section, we map the evolution of India's urban climate responses and the scientific literature that these responses are informed by.

Evolution of India's Urban Climate Responses

The initial climate change concerns in urban India were around the vulnerability to multiple climate risks, which resulted in early climate efforts being adaptation focussed. India's urban transition is prone to multiple local stressors including population growth, land use change and industrialisation, which are collectively compounded by climate change (Lele, Srinivasan, Thomas, & Jamwal, 2018). Existing environmental stresses such as air pollution, degradation of greenery and water scarcity also interplay with climate change (Dholakia & Garg, 2018; Gurjar et al., 2018; James, John, & Menon, 2018; Ranjan & Narain, 2012). The science points to a range of impacts: higher incidences of heat waves and drought (Hughes, 2013; Rumbach, 2017; Saini, Aggarwal, & Punhani, 2015); coastal surges, cyclones, cloud bursts (Pandve, 2010; A. K. Roy & Sharma, 2015; Sridhar, 2016); riverine floods, variances in precipitation and water stress (Aartsen et al., 2018; P. Kumar, Geneletti, & Nagendra, 2016; Ranjan & Narain, 2012); temperature increase (Deka, Saikia, Mahanta, & Dutta,

2018; Dholakia, Mishra, & Garg, 2015) and thermal discomfort (Desai & Dhorde, 2018); and higher incidence of disease (Revi, 2008; Sahay, 2017).

These multiple risks that urban India faces are 'interlinked and growing' (Revi, Gajjar, Basu, Jain, & Bazaz, 2016, p. 49) and will impinge on already stressed infrastructure systems to disproportionately affect those without adequate access (Lele et al., 2018; Rumbach, 2017). As a study of intra-city vulnerability shows, deficits in infrastructure, such as water connections and paved roads, are as critical to inducing climate threats as climatological shifts (P. Kumar et al., 2016). Climate change is also predicted to exacerbate existing social gaps of caste and gender (Saini et al., 2015), class and location (Ranjan & Narain, 2012), and the existing vulnerabilities of marginalised groups such as the urban poor, the elderly, children and those whose livelihoods are subject to climatic cycles such as fisherfolk (Lundgren-Kownacki et al., 2018; Pandey et al., 2018; Tran et al., 2013; Wilk, Jonsson, Rydhagen, Rani, & Kumar, 2018; Yenneti, Tripathi, Wei, Chen, & Joshi, 2016). In addition, a variety of indirect impacts are predicted, such as decreased resilience of food supply and increased urban migration due to climate impacts on the hinterlands (Neupane, Rubinyi, Sivappha, & Wang, 2016; Santha et al., 2016). Many of these issues, especially the latter, extend to scales beyond city territories.

This range of studies on the risks from climate change stimulated an early conversation, and subsequent actions, towards climate adaptation in cities. Conceptually, too, it was easier to motivate adaptation actions as their benefits accrue locally, compared with the more complicated politics around the non-local beneficiaries of greenhouse gas (GHG) mitigation (Dubash, 2013; Sharma & Tomar, 2010). The early adaptation efforts in urban India were pioneered by two international networks, the Asian Cities Climate Change Resilience Network (ACCCRN) and ICLEI – Local Governments for Sustainability (Beermann, Damodaran, Jörgensen, & Schreurs, 2016; Fisher, 2014; Hackenbroch & Woiwode, 2016; Hickmann, Fuhr, Höhne, Lederer, & Stehle, 2017; Rajasekar, Bhat, & Karanth, 2012). Actions pursued for adaptation and resilience differed geographically, depending on local vulnerabilities and risks, and related infrastructure deficits (Dhyani, Lahoti, Khare, Pujari, & Verma, 2018; ICLEI-South Asia, 2013; Joerin, Shaw, Takeuchi, & Krishnamurthy, 2014; Sharma, Singh, & Singh, 2014; UNDP, 2014; Yenneti et al., 2016). In Gorakhpur, water logging was the rallying point, while in Indore it was water scarcity (Bahadur & Tanner, 2014a; Rajasekar, Chakraborty, & Bhat, 2018). In Ahmedabad, heat stress motivated the call for action (Knowlton et al., 2014). In Surat and Kochi, the primary issue identified was the risk of sea level rise and flooding (Blok, 2016; E. Chu, 2016; Sowmya, John, & Shrivasthava, 2015). The large variations in climate risks across urban India

are a function of local geographies and climates, indicating the need for adaptation strategies to be locally applicable and deliberated.

Over time, the early emphasis on adaptation broadened to include GHG mitigation. This shift was consistent with the changing international climate discourse and India's 2009 (Copenhagen) and 2015 (Paris) pledges of economy-wide carbon intensity targets. At the same time, the relevance of urban mitigation to national climate outcomes became more pronounced, with studies pointing to accelerating urban energy consumption and emissions to provide basic services to a larger portion of the population, even though starting from a low base, coupled with the increasing affordability of energy efficiency and renewable technologies (Dubash, Khosla, Rao, & Bhardwaj, 2018). Transport, residential and industrial end-use were found to concentrate future urban energy consumption (ICLEI-South Asia, 2009). The future share of private vehicles, and five to six fold increase in household electricity use stemming from increased incomes and government energy-access policies are set to be important drivers of future energy consumption (Ahmad, Baiocchi, & Creutzig, 2015; Khosla & Chunekar, 2017). There remain, however, methodological challenges in data collection and accounting which result in limited data-informed climate planning, especially for informal economies, and little standardization in accurately predicting demand and benchmarking the GHG emissions from cities, though there are initial efforts to bridge this gap (Arora et al., 2016; CERAG, 2009; Chavez, Ramaswami, Nath, Guru, & Kumar, 2012; ICLEI-South Asia, 2009, 2012; Ramaswami, Russell, Culligan, Sharma, & Kumar, 2016).

It is worth noting that the capacities of cities to mitigate and adapt to climate change will also be a function of future urban form, though no city plan, so far, strategically incorporates this perspective. The literature, too, is limited on this issue. One study shows that larger contiguous urban areas tend to be wealthier and better serviced by infrastructure, with higher per capita emissions (Marcotullio, Albrecht, & Sarzynski, 2011). Analogously, dense urban areas have lower emissions (Marcotullio et al., 2011; Sethi & Mohapatra, 2013). Another study, in Bangalore, shows how intra-city variation in CO_2 emissions from domestic energy mirrors the city's economic disparity and levels of service provision (Ramachandra, Bajpai, Kulkarni, Aithal, & Han, 2017). For the most part though, the relationship between urban compactness, transit networks and density with climate change, especially in terms of adaptation, remain understudied (Byahut, 2010; Padukone, 2012; Sethi, 2017; Sethi & Mohapatra, 2013). This is not simply a question of spatial planning, but also one of political economy of land and real-estate (Chakravorty, 2013) and whether the increasingly speculative mode of real-estate growth is compatible with climate objectives or exacerbates risks (Romero-Lankao et

al., 2018). The development practices in mega-cities Kolkata and Mumbai suggest the latter (Weinstein, Rumbach, & Sinha, forthcoming).

In the last few years, the societal and technological transitions taking place in urban areas have begun to include a shift towards low-carbon forms of living (J. Roy et al., 2018). Nation level policies and schemes, informed by the growing studies on urban climate change, are also promoting cities to adopt climate friendly features. For instance, the National Mission on Sustainable Habitat, Smart Cities Mission, Solar City Program and Green Urban Transport Mission collectively enable rooftop solar, energy efficiency, public transport, pavements and bike lanes, and building energy codes (Hackenbroch & Woiwode, 2016; Rajasekar et al., 2018; Taraporevala, 2018). Simultaneously, the development of water and storm drain infrastructure, via the Atal Mission for Rejuvenation and Urban Transformation, is being justified in terms of urban climate resilience (Government of India, 2015). Together, these locally or sectorally specific adaptation and mitigation efforts, and the accompanying literature, signal the growing awareness and move towards climate actions in India's urban areas.

Characteristics of Indian Cities' Climate Responses

The previous section documents the types of responses that central, state and city governments are taking to address climate change in urban India. For city governments, endogenous and contextual motivations such as local climate risks or political arrangements also come into play alongside exogenous factors such as central-level policies, international climate actors and external climate related shocks (Carmin et al., 2012). In order to understand the nature of these city responses, it is important to examine how they relate to, and are integrated into, existing regimes, interests, and local politics, and how particular governance rationalities emerge (Anguelovski et al., 2014; Bulkeley, 2010; Castán Broto, 2017; Hughes, Chu, & Mason, 2018). Focusing on what Indian cities can do in this multi-level governance arrangement with its strong centrally-driven architecture, we examine the governance and political motivations of climate action in Indian cities, and the variety of institutional forms with which such actions are pursued to find three overarching characteristics. These are: the use of local development priorities as an entry point to climate actions; the role of non-state actors in promoting climate-relevant outcomes; and the proclivity for discrete project-based activities. We discuss each in turn.

Local development as an entry point for climate mitigation and adaptation

The global literature demonstrates that cities develop innovative climate approaches which act upon alignments between mitigation and adaptation, environment and development, government functions (Satterthwaite, 2011) and political coalitions (E. Chu et al., 2017; Castán Broto, 2017; Bulkeley, 2010). In India, the *modus operandi* of city climate actions – adaptation or mitigation – has been the linking of climate change with immediate and local development needs (Aggarwal, 2013; Beermann et al., 2016; E. Chu, 2015b; E. K. Chu, 2017; Colenbrander et al., 2016; Cook & Chu, 2018; Sethi & Mohapatra, 2016; Sharma & Tomar, 2010). Such a linking of climate change with local development objectives has a legacy in India's national climate politics with the language of 'co-benefits' formally enshrined in the National Action Plan on Climate Change (Dubash, 2013; Government of India, 2008).

Indian city bureaucrats have little choice but to focus on the pressing and immediate gaps in the provision of housing, transit, sanitation, safety, jobs, water and energy. Using such development concerns as an entry point for climate efforts is also an artefact of the relatively low, though now increasing, political priority of climate change within city governments (Fisher, 2014; Sharma et al., 2014). Also, since city governments have no mandate to submit formal climate change plans (Revi, 2008; Sethi & Mohapatra, 2013), city agencies and private actors with climate-related motivations often link their objectives with development to enable implementation (Bahadur & Tanner, 2014a; Fisher, 2014). Climate planning within this architecture is thereby often a merger of climate objectives with local concerns and national and state priorities, schemes and funding. In an example from Rajkot, the city enhanced the central government's Housing for All program by incorporating locally relevant climate adaptive elements such as rain water harvesting, passive cooling and ventilation (Bhardwaj & Khosla, 2017). In Indore and Gorakhpur, climate projects had to focus on immediate and local challenges such as garbage collection (Bahadur & Tanner, 2014a).

However, studies that investigate the political economy of climate actions also note that local priorities are not always welfare oriented and can be influenced by powerful lobbies. In Surat, entrepreneurial communities directed adaptation activity to an industrial area at risk of sea-level rise (Blok, 2016; E. Chu, 2016). In a high-profile project to develop a greenfield 'eco-city' in Lavasa by private-public partnership, sustainable climate-friendly urbanism was evoked to prioritise technological and economic growth instead of the welfare of local populations and environment (Datta, 2012, 2015). In Bangalore, as in Lavasa, luxury real estate developments are justified in terms encouraging low-carbon living (Bulkeley & Castán Broto, 2014). Whether politically or technically

motivated, finding linkages between climate and development goals has become a key feature of urban climate responses in India.

The role of non-state actors in promoting climate outcomes

City climate actions are a product of collaborations between actors at different levels of governance. As seen in the literature from other countries, city actions can be implemented and championed by political leadership, but in most cases are built by partnerships between state and non-state actors across networks and sectors, reflecting climate change's cross cutting nature (Bulkeley, 2005; Castán Broto, 2017; E. Chu et al., 2017; Hughes et al., 2018; Roberts, 2008). For India, in the absence of central or state urban climate action, there has been a dominance of non-state actors involved in urban climate efforts who play a crucial role in bridging the gaps of state capacity, data and finances (Sethi & Mohapatra, 2013; Sharma et al., 2014; van der Heijden, 2016). Non-state actors range from large international and bi-lateral donors explicitly focussed on climate change, the consultants and research groups they fund, to local industrial lobbies, resident associations and small-scale NGOs focussed on specific issues (Alankar, 2015; Boyd & Ghosh, 2013; Bulkeley & Castán Broto, 2014; Castán Broto, 2017; E. Chu, 2015b; E. K. Chu, 2017; Revi, 2008; Weinstein et al., forthcoming). These actors seek collaborations with city governments and build alliances with sectoral departments, para-statal agencies and state governments. For example, state para-statal agencies in charge of disaster management, pollution control and the environment have been important in formulating urban climate action. In Karnataka, the Environmental Management Policy Research Institute (EMPRI) liased with city governments to formulate climate action plans, though without any funding capability, found it challenging to incentivise local governments (Sami, 2017, 2018). In Odisha, the state's disaster management agency collaborated with the local city government, consultants and international agencies to formulate a vulnerability analysis for the state capital, Bhubaneswar (UNDP, 2014).

For the most part, non-state actors working on urban climate concerns are part of international networks (Bulkeley, 2005) which, responding to lack of national motivation to formulate climate responses, have honed in on cities. International actors also prefer cities as they are headed by bureaucratic officials and offer relative operational ease in implementing programs(Fisher, 2012, 2014). These networks play the role of connecting cities, standardising practices and building knowledge and resources (Castán Broto, 2017). In India, this the role of non-state actor international networks is illustrated by the presence of C40, a global consortium of city mayors; Rockefeller Foundation's ACCCRN and '100 Resilient Cities'; and the UN-sponsored ICLEI. An analysis of the work

of the South Asia chapter of ICLEI highlighted their role in fostering collaboration between the network and Indian cities and seeding or embedding policy ideas through techniques such as generating data or building inventories (Fisher, 2014). Donor agencies also play an active role in these networks, providing funding, selecting partners and often setting agendas.

The resulting climate actions in Indian cities are usually outcomes of negotiations between state actors such as city governments which bring a local development agenda to the table, influential political players (Bahadur & Tanner, 2014a; Blok, 2016; E. Chu, 2016; Datta, 2012; Hughes, 2013), and the spectrum of non-state actors and their varied concerns which range from GHG mitigation, preservation of the local environment, infrastructure services and economic growth. Local city governments in these multi-actor arrangements are found to strategically "bundle" (Aggarwal, 2013) and "steer" (Cook & Chu, 2018) partnering organizations and financing to achieve results (Padigala & Kraleti, 2014). While scholarship has highlighted the limitations faced by Indian cities in formulating climate responses due to highly centralised governance arrangements, (Sami, 2017, 2018; Sharma & Tomar, 2010), the more recent instances discussed reflect findings that cities of the Global South have 'unique but often overlooked capacity' (Nagendra et al., 2018, p. 341) to creatively formulate innovative climate actions with partners (Castán Broto, 2017; Castán Broto & Bulkeley, 2013). At the same time, the emphasis on donor-driven activities has also lead to the critique that the motivations for climate efforts are often global rather than domestic (Khosla, Sagar, & Mathur, 2017).

Depending on the city, the collaborations between state and non-state actors range from the informal, as was the case in Delhi (Hughes & Romero-Lankao, 2014), to the institutionalized, as in Surat (E. Chu, Anguelovski, & Carmin, 2016; E. Chu et al., 2017). In the latter, the city government, local chamber of commerce, education institutions and technical consultants set up the Surat Climate Change Trust to co-ordinate climate change activity, aided by the capacities of the Rockefeller Foundation. As a Trust, the organization could circumvent conventional procedure and acquire funds externally to enable independent action (E. Chu, 2016; Karanth & Archer, 2014). However, studies also find that participation in such collaborative climate planning activities is often limited to those with influence such as entrepreneurial lobbies and consultancies (Blok, 2016; E. Chu, 2016; cf. also Aylett, 2010), rather than those representing vulnerable groups (Hughes, 2013; Wilk et al., 2018). In part, this is also a function of the preferences of actors to work with the bureaucratic rather than the more limited political arms of city governments for operational benefits, though often at the expense of the accountability and representativeness of actions (E. Chu, 2016; Hughes, 2013; Satterthwaite, 2011; Wilk et al., 2018).

A proclivity for project-based activities

A final feature of India's urban climate responses is that mitigation and adaptation actions mostly take the form of projects, which are implementable, manageable, and provide evidence of outcomes and benefits (E. Chu, 2015b). This is partially because cities do not have the resources, nor the institutional spaces to develop programmatic and strategic responses to climate change and are limited to implementing central and state projects. Instead, as climate actions are often funded by international donors, projects take more discrete, time-bound shape, aimed at developing measurable but often narrow outcomes (Khosla et al., 2017). Most projects are ad hoc and experimental in nature (Boyd & Ghosh, 2013; E. Chu, 2015b; Hackenbroch & Woiwode, 2016; van der Heijden, 2016), with a focus on 'win-win' technical solutions with city-level project implementers (Fisher, 2014). This experimental approach mirrors the global experience (Bulkeley & Castán Broto, 2014), where cities trial and innovate responses to climate change as international and national action falters (Bulkeley, 2010). Further, the experiments arise from an uncertainty about what urban climate responses could entail, and which approaches would be effective (Bulkeley & Castán Broto, 2014).

The discrete and short-term (Hughes et al., 2018) activities are also because of broader governance and capacity constraints that stem from the centralized nature of policy making, especially for small to medium cities with inadequate capacities (Ahluwalia, 2017; Birkmann, Welle, Solecki, Lwasa, & Garschagen, 2016). Surat is the anomaly, where climate activities were institutionalized via the creation of the Climate Trust, with the joint formulation of actions by civic, private, international and government actors (E. Chu, 2015a). In the contrasting case of Mumbai, different climate experiments engaged with the waste sector, real estate, transport networks, coastal regulations, and state pollution policies, but with little strategic and cross-sectoral coordination among them (Boyd & Ghosh, 2013).

Collectively, these three characteristics indicate how Indian cities have responded to climate change and what they can, and cannot, do in a centralised governance system and amidst simultaneous and multiple local interests. While innovative responses exist, the involvement of non-state actors and the limitations on cities as mere implementers of schemes, has prioritised short-term projects rather than strategic approaches. In the following section, we build on the backdrop of climate approaches discussed so far and look ahead to the elements of a larger coordinated and structured framing of Indian urban climate policy.

Mainstreaming India's Urban Climate Responses

Responses by Indian cities to climate change are still nascent. Most cities have not adequately addressed, nor even mentioned, climate change in their development plans (P. Kumar & Geneletti, 2015) and have little institutional incentive or mandate to do so. While the previous section shows what cities can creatively do to address climate change within the existing centralised governance of urban India, a larger strategic understanding of the interaction between climate and development priorities, across policy and governance levels, is yet to be developed. Most actions are short-term and discrete and without an understanding of their cumulative impact, and, as a result, often prone being influenced by vested interests. Government, at any level, is yet to formulate a strategy that considers climate change in relation to urbanisation. Given the magnitude of impending change that Indian cities will face, and the centralized nature of urban governance, how can emerging climate actions be better integrated and up-scaled, while paying attention to inclusivity and vulnerability?

The range of urban climate efforts so far have uncovered the complex interdependencies of climate change with different aspects of urban development (Bahadur & Tanner, 2014b; TERI, 2013; WS Atkins, 2014). In Chennai, the focus on flood management made explicit the interdependencies between infrastructure planning, coastal management, and real estate practices (Rajagopalan, 2017). While in Delhi, the climate plan received criticism for not highlighting impacts on vulnerable groups (Hughes, 2013). Further, vulnerable communities that do not yet have access to water, waste, shelter and drainage require infrastructures that both address the current deficits and also alleviate more climate-specific local risks (Lele et al., 2018). These multiple objective needs of India's urbanity were recently reflected in the central government's multi-dimensional Livability Index for Cities (MoUD, 2017).

The literature on the linkages of climate and development actions, or of simultaneously meeting multiple objectives, is also growing. For some cities, the focus on meeting multiple goals (P. Kumar et al., 2016; Parikh, Sandal, & Jindal, 2016) resulted in cross-cutting solutions such as "green spaces" (Govindarajulu, 2014; Imam & Banerjee, 2016), "urban agriculture" (Hackenbroch & Woiwode, 2016) and "lake redevelopment"(Brown, Dayal, & Rumbaitis Del Rio, 2012; Revi et al., 2016). In Delhi and Kolkata, studies proposed both affordable and low-carbon residences by end-use efficiency, rooftop solar and waste-to-energy plants (Colenbrander et al., 2016; Farzaneh, Suwa, Dolla, & Oliveira, 2014). In Surat, a waste-to-energy plant reduced carbon emissions and water pollution, accruing in

local health benefits (Kapshe, Kuriakose, Srivastava, & Surjan, 2013; Puppim de Oliveira & Doll, 2016). Another analysis shows how existing actions on biodiversity, slum development, solid-waste management, water supply, energy, transport, housing and urban development can be further enhanced to achieve multiple benefits (Narender & Sethi, 2018). An India-wide study suggested that an increase in electricity consumption, modern cooking and clean water could lower short-term morbidity for 2.4 million people with only modest increases to GHG emissions (Ahmad, Pachauri, & Creutzig, 2017). A range of studies point out that public and para transport can enhance safety, health and GHG mitigation (Ahmad et al., 2017; Arora et al., 2016; Doll & Balaban, 2013; Guttikunda, 2008; Maitra & Sadhukhan, 2013; Pathak & Shukla, 2016; Puppim de Oliveira & Doll, 2016; Woodcock et al., 2009). However, only few transport studies look at trade-offs between GHG mitigation, land use, inclusivity and the local environment (Arora et al., 2016; Doll, Dreyfus, Ahmad, & Balaban, 2013; Li, 2011).

The complex interconnectedness between development concerns such as air, water, waste, energy, among others, and climate change, requires cities to manage multiple objectives, which often vary in salience for different political actors (Bhardwaj & Khosla, 2017, 2018; Pathak, Shukla, Garg, & Dholakia, 2015). In order to systematically address the synergies and trade-offs across these interacting objectives, methodologies that can be operationalized in urban decisions *ex ante* are needed. One suggestion is the use of a 'multiple objectives framework' which provides a structure to assess simultaneous urban priorities, identify scenarios which can maximize benefits, and make trade-offs explicit (Khosla, Dukkipati, Dubash, Sreenivas, & Cohen, 2015; Sethi, 2018; Sethi & Puppim de Oliveira, 2018). A more comprehensive multiple objectives approach can help cities push beyond piecemeal actions to enable wide-scale strategic integration of adaptation and mitigation agendas with urban development. This can enable cities to address objectives across various interests, in conventionally siloed departments, and at different spatial and time scales. For example, in Coimbatore, the city government has to consider multi-decadal growth patterns and impacts on water sources across jurisdictions, alongside immediate considerations such as transportation, drainage and sewage management, all while balancing industrial, ecological, social and political interests (Bhardwaj & Khosla, 2018). This also tilts the focus on climate change to the wider political and social drivers of urbanisation such as political economy of land and infrastructure (Romero-Lankao et al., 2018; Bhardwaj & Khosla, 2018; Weinstein et al., forthcoming).

Reshaping urban trajectories and decision-making, however, to overcome existing, energy intensive and climate risky infrastructures is not trivial. To do so requires an institutional structure that

focuses on the strategic interactions across sectors, as opposed to compartmentalized projects (E. Chu et al., 2017). Indian cities have limited institutional spaces, capacity or incentive to reap such systemic benefits, or to identify climate synergies and trade-offs (Bhardwaj & Khosla, 2017; Boyd & Ghosh, 2013; E. Chu, 2015b; Doll et al., 2013, p. 20; Revi, 2008; Revi et al., 2016; Sethi & Mohapatra, 2013). For example, Ahmedabad's heat action plan has no institutional influence over mechanisms that govern green cover and water bodies (Pathak & Mahadevia, 2018) and climate action plans in Kolkata and Mumbai have no influence over development practices, leading scholars to describe the documents as 'fantasy plans' (Weinstein et al., forthcoming). In fact, different urban climate actions can even result in conflict (Bhardwaj & Khosla, 2017; P. Kumar & Geneletti, 2015; Sharma & Tomar, 2010), as in the case of Coimbatore, where in the name of climate resilience there were simultaneous ambitions to dedicate the city's lakes to the contradictory functions of water storage and storm drainage (Bhardwaj & Khosla, 2018). In Kolkata, plans for transit-oriented development are not co-ordinated with flood risk diagnoses (Weinstein et al., forthcoming).

The limited coordination between climate-related projects is compounded by the multi-level and informal nature of urban governance (Bahadur & Tanner, 2014a; Hughes & Romero-Lankao, 2014; Pathak & Mahadevia, 2018; Revi et al., 2016; A. Roy, 2009; Sharma & Tomar, 2010). Due to the cities' dependence on central schemes, higher levels of government have a role in framing urban climate action. While recent central government programs such as the Transit Oriented Development Policy, Green Urban Mobility Scheme, Unified Metropolitan Transport Authorities and most notably the Smart Cities Mission aim to encourage coordinated forms of urban governance, their success is yet to be seen.

As studies on the political economy of climate action have emphasized, there also remains a structural lack of inclusion of the concerns of vulnerable groups in urban decision making (Hughes, 2013; Hughes et al., 2018; Satterthwaite, 2011), which makes climate efforts that operate within existing frameworks prone to replicate these biases (CERAG, 2009; Wilk et al., 2018). As a result, studies propose more normative frameworks centered around representation, rights and justice, alongside co-ordinating objectives and bureaucratic incentives (E. Chu, Anguelovski, & Roberts, 2018; Doll et al., 2013; Hughes, 2013; Rumbach & Németh, 2018; Satterthwaite, 2011; Ziervogel et al., 2017).

Finally, while the synthesized literature suggests the need for more local responses to climate change, such territorial approaches do not sufficiently consider the relationship of cities to spaces

beyond their boundaries (Bai et al., 2016; Brenner & Schmid, 2015; Gururani & Dasgupta, 2018; Hughes et al., 2018). For instance, regional effects, such as agricultural policies of neighbouring states are as relevant to a city's air pollution as local transit infrastructure and waste management. Delhi's climate change plan is unique in its proposed co-ordination beyond its borders with upstream states Haryana and Himachal Pradesh to ensure water sharing and security (Aggarwal, 2013). A strategic mainstreaming of climate action in Indian cities would ideally incorporate an understanding of such peri-urban and hinterland dynamics, emphasizing the role of multi-level governance.

Conclusion

India's urbanity, even for its complexity and magnitude, is mostly yet to be built. How urban spaces are constructed over the next decade will condition the consumption practices of most Indians until the end of the century: in the choice of building types; in how they expend energy to cool and heat; in the ways and amount of distance travelled; and the social and environmental vulnerability of communities. These choices will have material consequences for GHG mitigation and adaptation and will likely not be solely motivated by climate change. In light of this larger urbanization trend, this paper reflects on India's urban responses to climate change. It synthesizes the growing research on this topic, and describes the narratives that mark these actions.

If initial experiences are indicative, the future trajectory of urban India's responses to climate change will be shaped by how pressing local development and climate goals will be linked, integrated and prioritized. This is important because cities are not culminations of discrete sites and projects, but entail complex and interacting infrastructures and socio-technical systems (Bai et al., 2016). Decision-making regarding the urban requires contending with a varied set of interactions: social needs; political demands and interests; policy priorities; economic trends; local environment and infrastructure systems. Climate change impacts and solutions are embedded in these linkages, and an increasing set of examples demonstrate how policy initiatives are incorporating climate action into urban planning. These initiatives are primarily driven by the overlaps between development and GHG mitigation and adaptation goals, which state and non-state actors creatively identify. In principle, this reliance on easily identifiable synergies serves as an effective and politically viable entry point for city climate action. Upscaling and systematizing urban climate solutions will however require engaging with the more politically difficult issues of selecting trade-offs and making the decision-making process more democratic.

The current ability of India to invest in urban form and shape energy and resilience practices is a distinctive window of opportunity to choose alternative development pathways that do not compromise on basic needs and also internalize resilience to long-term climate risks. This opportunity, however, will only be as useful as the decisions that cities, central and state governments make within the next decade or two. A strategic and coordinated urban climate approach across levels of government that acknowledges the often sprawling and unbounded nature of India's urban forms, and the chance to lock-in lower consumption and sustainable infrastructures, has the potential to be an important shaper of India's development.

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