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Urban Development and Climate Adaptation: Implications for Policymaking and Governance in Indian Cities

Eric Chu
Department of Urban Studies and Planning, Massachusetts Institute of Technology

ABSTRACT

In recent years, numerous international actors have stepped in to support climate change adaptation efforts in developing country cities. These external interventions provide guidelines and strategies for incentivizing local responses to climate impacts, but their implications for on-the-ground implementation and overall urban governance are unclear. Through a critical comparative analysis of climate adaptation policymaking and planning in the Indian cities of Bhubaneswar, Indore, and Surat, this paper unpacks the various approaches to mainstreaming adaptation into urban development, interrogates the different ways to engage local actors, and identifies mismatches between designing external policy interventions and implementing grounded adaptation projects and programs.

INTRODUCTION

Cities in developing countries are beginning to recognize the importance of adaptation because of their disproportionate exposure to climate impacts and lower capacity to respond. At the same time, an increasing number of international policymakers and funders are advocating toolkits that

integrate and support both climate adaptation and development objectives, arguing that combining these two objectives will help ensure the long-term resilience of cities. As a condition of financial support, these external interventions frequently emphasize which urban sectors are to be considered during adaptation planning, what sorts of participatory approaches are to be pursued, and how projects and programs are to be prioritized based on particular evaluative indicators. What is less documented, however, is how these external incentives and planning prescriptions get translated into new or existing urban programs for supporting local livelihoods, improving public infrastructure and services, and promoting economic development.

In response to these gaps in research and practice, this paper investigates the cities of Bhubaneswar, Indore, and Surat in India to understand how urban local governments plan, implement, and advocate for locally grounded, contextually relevant adaptation priorities given the existence of external mandates and incentives. Through unpacking the implications of these emerging incentives, this paper argues that adaptation planning, as well as how adaptation is integrated into urban development planning, occurs through processes of prioritizing adaptation against development needs and implementing options that are cocreated amongst concerned public and civil society actors. In terms of its relevance to urban policy and planning, this paper informs cities, both within and outside of India, about the variety of approaches to mainstreaming adaptation into urban development, highlights the policy trade-offs associated with different adaptation planning and implementation pathways, sheds light on the most suitable ways to engage civil society actors, and identifies the institutional mismatches between designing external policy interventions and implementing local adaptation projects and programs.

THEORIES OF URBAN CLIMATE ADAPTATION POLICYMAKING AND GOVERNANCE

Climate adaptation is the process of adjusting to actual or expected climate impacts (IPCC 2014). Although mitigation continues to dominate the international discourse on climate change, adaptation is gradually gaining policy importance. Given that many developing countries have contributed minimal greenhouse gas emissions, but have and will feel the severest

climate impacts, adaptation has become closely linked with the development agenda (Ayers and Dodman 2010). The cost of climate proofing development investments in developing countries is estimated to be between US$9 and $109 billion per year (World Bank 2010), so discussions around the practical opportunities for integrating initiatives that support development while also reducing climate vulnerabilities have come to the fore in international negotiations.

Climatic stresses on natural and social systems are global in origin but adaptive responses are often found at the local or national levels, so the process of adaptation necessarily entails the conjoining of actors and stakeholders across all these different scales. The decentralization of climate adaptation policymaking and governance is accompanied by the expansion of non-state actors participating in this arena, such as various nongovernmental and civil society organizations, philanthropic foundations, aid agencies, and different partnership networks (Bulkeley and Betsill 2013). The diversity of actors is a major determinant of the legitimacy and sustainability of adaptation processes, while multiple nodes of governance are necessary to maintain system flexibility and diversity (Finan and Nelson 2009). Although the legitimacy and effectiveness of adaptation depends heavily on local institutional capacity, many scholars have also noted that the presence of global agreements or protocols (Revi et al. 2014), strong legal and regulatory frameworks (Kehew et al. 2013), and finance and capacity transfer mechanisms are strong enabling factors that incentivize local implementation (Klein 2010; Ciplet, Roberts, and Khan 2013; Smith et al. 2011; Gomez-Echeverri 2013; Streck 2010).

For developing country cities, adaptation and development are closely related. The literature notes that mainstreaming adaptation into development planning and implementation can contribute to the livelihoods of people and make improvements in their capacity to deal with changes in climate (Halsnæs and Trærup 2009; Huq and Reid 2004; Mertz et al. 2009; Puppim de Oliveira 2013). For example, adaptation policies and plans often seek to generate co-benefits with sectoral health initiatives (Ebi and Semenza 2008; Lesnikowski et al. 2013; Edwards et al. 2011), natural disaster management (Pelling and Dill 2009; Mercer 2010), socioeconomic development (Mertz et al. 2009; Huq and Reid 2004; Halsnæs and Trærup 2009), or spatial development agendas (Carmin, Anguelovski, and Roberts 2012; Uittenbroek, Janssen-Jansen, and Runhaar 2012). All

of these approaches seek to improve the social and climate resilience of the urban system as a whole (Tyler and Moench 2012; da Silva, Kernaghan, and Luque 2012).

Local governments are often most attuned and responsive to climate risks, vulnerabilities, and impacts (Carmin, Anguelovski, and Roberts 2012; Hunt and Watkiss 2010). Many cities often oversee primary responsibility for managing infrastructure and social services that are essential for promoting good living standards, inclusiveness, and the reduction of vulnerability to many environmental hazards (Dodman and Satterthwaite 2009). Cities that are "early adaptors" seem to be motivated by internal incentives, ideas, and knowledge generated through local projects and networks, and the means to link adaptation to ongoing programs and enlist the support of diverse stakeholders from within the city (Carmin, Dodman, and Chu 2013).

"Early adaptor" cities tend to formalize adaptation planning early on, such as in the form of line departments or laws and legislations, in order to strengthen legitimacy and facilitate implementation and coordination across sectors and departments (Anguelovski and Carmin 2011). Cities in developing countries have historically experienced strict resource limitations when planning and operationalizing adaptation strategies (Dodman and Satterthwaite 2009); to bypass these constraints, cities have pursued numerous experimental and creative strategies for assessing adaptation needs and prioritizing and implementing options (Anguelovski, Chu, and Carmin 2014; Carmin, Dodman, and Chu 2013). For example, cities have pursued different vulnerability and hazard assessments (Patt et al. 2009; Fussel 2007), devised local geographic information system-based climate projections and scenarios (Berkhout et al. 2013; Ebi et al. 2014), developed economic models and similar decision-support tools (Nay et al. 2014), and relied on inclusive and participatory planning approaches to highlight social justice and equity priorities (Hughes 2013; Sherman and Ford 2014; Susskind 2010). As one can see, urban climate adaptation is fundamentally a governance challenge given the diversity of strategies, approaches, and actors interacting in this arena (Friend et al. 2014; Termeer, Dewulf, and Breeman 2013).

Table 1. Key city climate and development indicators

City/Indicator	Bhubaneswar	Indore	Surat
State	Odisha (Orissa)	Madhya Pradesh	Gujarat
Urban Population (2011)	880,000	2,200,000	4,500,000
Key Climate Impacts	Heatwaves, increasing cyclones, flooding, precipitation change	Water scarcity, drought, river flooding, vector-borne diseases	Flooding, vector-borne diseases, public heath and sanitation, sea-level rise
Key Development Pressures	Rapid urbanization, migration, housing, infrastructure	Rapid urbanization, migration, water supply infrastructure	Rapid urbanization, migration, infrastructure pressures
Key Industries	Information technology, telecommunications, tourism, retail and hospitality	Automotives, light engineering, household food production, pharmaceuticals	Textiles, diamond, heavy engineering, petrochemicals, real estate
Key City Institutions	Bhubaneswar Municipal Corporation, Odisha State Disaster Management Authority	Indore Municipal Corporation, Indore Development Authority	Surat Municipal Corporation, Southern Gujarat Chamber of Commerce and Industry
Key External Actors	United Nations Development Programme, US Agency for International Development, ICLEI-Local Governments for Sustainability	Asian Cities Climate Change Resilience Network, UK Department for International Development, TARU-Leading Edge	Asian Cities Climate Change Resilience Network, TARU-Leading Edge
Key Urban Climate Plans/Policies	Bhubaneswar Climate Resilience Strategy (2013)	Indore City Resilience Strategy for Changing Climate Scenarios (2012)	Surat Climate Resilience Strategy (2011)

METHODOLOGY

This paper explores how urban governments in India plan, implement, and advocate for locally grounded, contextually relevant adaptation and development priorities given the existence of external mandates and incentives. To do this, the paper presents a comparative place-based case study method encompassing document analysis and key informant interviews conducted in the cities of Bhubaneswar (Odisha), Indore (Madhya Pradesh), and Surat (Gujarat) between January 2011 and June 2014. Data sources include interviews with experts on the city's adaptation planning process, observations of planning meetings, and analyses of municipal plans and different reports on project implementation, monitoring, and evaluation.

The cities of Surat, Indore, and Bhubaneswar were selected because they have long histories of engagement with and have received support from external programs, including the Rockefeller Foundation's Asian Cities Climate Change Resilience Network (ACCCRN) and the Climate Risk Management technical assistance project through the United Nations Development Program (UNDP) and the United States Agency for International Development (USAID) (see Table 1 for additional descriptive indicators). Furthermore, these cities have actively articulated and advocated for their own development needs while working with these actors.

COMPARATIVE ASSESSMENT OF URBAN ADAPTATION EXPERIENCES

Key climate priorities in India include rising temperatures (Mathison et al. 2013), increasingly erratic rainfall and monsoon patterns (Menon et al. 2013; Chhotray and Few 2012), increasing flooding risks (Chatterjee 2010; Mathew, Trück, and Henderson-Sellers 2012), and rising sea levels (Revi 2008). In Indian cities, climate-induced vulnerabilities are likely to further reduce the resilience of poor and vulnerable communities (Srinivasan 2012; Sharma and Tomar 2010), such as through loss of livelihoods and loss of community social safety nets, with asymmetric impacts based on gender, age, caste, and class (Mukhopadhyay and Revi 2012; Ahmed and Fajber 2009; Archer et al. 2014).

In 2008, the Government of India released the National Action Plan on Climate Change, which outlined explicit goals for mitigating climate

change and addressing key climate vulnerabilities at the national, state, and local levels (Government of India 2008; Dubash et al. 2013). Urban climate adaptation planning is a new phenomenon in India, where many cities are just beginning to think about managing climate vulnerabilities and devising planning methodologies to address adaptation and development (Castán Broto and Bulkeley 2013; Rodima-Taylor, Olwig, and Chhetri 2012). These emerging climate adaptation policy and planning experiments allow stakeholders to flexibly frame adaptation objectives, implement resilient development pilot projects, and monitor and evaluate project outcomes (Cárdenas 2009; Wise et al. 2014). Experiments, such as those described in this paper, are critical practical and analytical tools because they allow local governments and urban actors to test decision-making pathways (Rondinelli 1983), to help prioritize climate adaptation options, and to evaluate overall project benefits in the face of uncertain climate futures and highly decentralized governance arrangements (Anguelovski, Chu, and Carmin 2014; Castán Broto and Bulkeley 2013).

Mainstreaming Adaptation into Disaster Risk Management in Bhubaneswar

Bhubaneswar is situated on the Mahanadi Delta in the eastern coastal plains of Odisha. The city is both the administrative and economic capital of Odisha and, with a population of 880,000, is also one of fastest growing in the country. The city is managed and administered by the Bhubaneswar Municipal Corporation. Prior to economic liberalization in the early 1990s, Bhubaneswar's economy was dominated by small-scale industries, most of which involved the processing and trading of natural resources extracted from interior Odisha. Since then, Bhubaneswar's economy has expanded significantly and the city has become a service, tourism, and information technology hub (Bhubaneswar Development Authority 2012).

According to official figures, there are 377 slums in Bhubaneswar, which account for approximately 50% of the population. The city has been affected by many major climatic hazards in the past, including heat waves, cyclones, and floods (Bhubaneswar Municipal Corporation 2003; Chittibabu et al. 2004). For example, in October 1999, Bhubaneswar experienced a "super cyclone" with winds of nearly 300 kilometers an hour that also inundated the city with torrential rainfall (Thomalla and Schmuck 2004). The cyclone caused more than ten thousand deaths across Odisha; damaged more than

two million hectares of agricultural land; halted basic services such as water, sewage, and solid waste collection in Bhubaneswar; and resulted in more than US$5 billion in damages along the Odisha coast (Chhotray and Few 2012; Mishra and Mishra 2010). This prompted the immediate creation of the Odisha State Disaster Mitigation Authority (OSDMA), the publishing of the *Environmental Management Plan of Bhubaneswar* (Bhubaneswar Municipal Corporation 2003) in 2003, and eventually the *Odisha Climate Change Action Plan* (Government of Odisha 2010) in 2010.

Between 2005 and 2012, the Bhubaneswar Municipal Corporation was part of the United Nations Development Programme's Urban Risk Reduction project, which worked to reduce disaster vulnerabilities across the local government. In 2012, the Bhubaneswar Municipal Corporation, in partnership with ICLEI—Local Governments for Sustainability, initiated the city's vulnerability and risk assessment and adaptation planning process. The assessment highlighted issues of precipitation change, temperature change, and extreme events as key climate impacts. Major risks to the urban system include ensuring adequate water supply, maintaining housing and energy infrastructures, and protecting ecosystems. Since 2013, Bhubaneswar has been a pilot city for the Climate Risk Management project supported by United Nations Development Programme and the United States Agency for International Development. The project aims to promote the city's overall resilience through focusing on institutionalizing programs, building community-level awareness, and policy-level changes.

Throughout Bhubaneswar's engagement with these different external actors, the focus has always been on disaster risk reduction and community engagement and awareness. So, in addition to facilitating cross-departmental coordination within local government and identifying nodal champions, these recent projects have also focused on implementing school safety programs, community disaster response workshops, and, most importantly, facilitating community-based hazard risk and vulnerability assessments. These assessments then catalyzed ward-level disaster management plans, incentivized the creation of a volunteer civil defense corps, and initiated various community workshops to help generate awareness of search and rescue procedures, debris management, and other training programs.

For Bhubaneswar, the overall urban development agenda has framed adaptation and climate resilience in terms of immediate capacities for responding to and managing the impacts of extreme events, rather than dedicating

significant investments towards addressing slow-onset climate impacts. For example, when Cyclone Phailin struck the coast of Odisha in October 2013, government authorities were able to evacuate more than ten thousand people from slums across the city within hours of notice. Moreover, due to extensive response training programs, there were no causalities in Bhubaneswar that were directly attributable to Cyclone Phailin, compared to the thousands who perished during the 1999 "super cyclone." There were clear directives for each city department for both disaster preparation and for restoring services to roads, buildings, public health, and water supply systems immediately afterwards. From the 198 disaster response centers spread across the city, the Bhubaneswar Municipal Corporation was able to reinstate water supply through public and private tankers and restore electricity supply to critical services and residential areas within three days.

Adaptive water management and infrastructure upgrading in Indore

Indore is the largest city and the commercial capital of Madhya Pradesh. The city, which is managed by the Indore Municipal Corporation, lies at the confluence of the Rivers Saraswati and Khan, though both are non-perennial rivers that experience low to no flow during the dry winter months. Indore has a population of approximately 2.2 million and has experienced nearly 50% population growth and approximately 6.5% annual economic growth for the past decade (Indore Municipal Corporation 2006; Agarwal et al. 2008; Gupta et al. 2006). Many of the city's 540 slum settlements are located along creeks and, thus, are prone to flooding, waterlogging, and vector-borne diseases (*Indore City Resilience Strategy* 2012). Rapid urbanization has also accelerated the loss of green space and has contributed to pollution of water bodies, high rates of solid waste generation, and general inadequacy of urban public services (Gupta et al. 2006).

Water accessibility and distribution are Indore's most critical environmental stressors (Dipak and Arti 2011). Currently, portions of the city's water are supplied through groundwater, which has declined by up to four meters in parts of the city (Gupta et al. 2006), existing rainwater collection tanks, and the Yashwant Sagar Dam located to the south of the city. The bulk of Indore's water (nearly 80%) comes from the Narmada River, which is located 70 kilometers away and is 550 meters lower in elevation compared to the city (UN-Habitat 2006). Although climate projections

have showed that the quantity of water supply from the Narmada River will not be an issue in the near term, transportation will become more expensive as operational and maintenance costs for the entire pipeline system gradually increase. Under the Narmada Water Supply Scheme, Narmada water is supplied to Indore only for several hours every other day (Indore Municipal Corporation 2006). Furthermore, 90% of water connections in Indore are unmetered, and are being assessed only flat charges according to the number of connections rather than according to the quantity of water consumed. Even with these minimal fees, the collection rate is only 70%. Various assessments indicate that the demand for water in the city is increasing at the rate of nearly 5% per year (Gupta et al. 2006).

With support from the Rockefeller Foundation's Asian Cities Climate Change Resilience Network (ACCCRN), adaptation planning in Indore began in 2009, which culminated in the release of the *Indore City Resilience Strategy* in 2012. This document identified water, public health, and human settlements as most vulnerable to climate change and, therefore, catalyzed pilot projects around experimenting with new water harvesting and conservation technologies and devising new decentralized wastewater management and treatment models.

For example, in one urban slum settlement, Rahul Gandhi Nagar, a reverse osmosis plant was built with direct financial support from ACCCRN and indirect institutional support, through permits and subsidies, from the Indore Municipal Corporation. The reverse osmosis plant was inaugurated in March 2013 and has a capacity to treat 7,000 liters of groundwater and gray-water per day. The financial replacement rate for the plant is to sell 250 twenty-liter bottles per day, at 5 rupees (approximately US$0.08) each. The profits would then be funneled back for cleaning and maintaining the plant. In another slum, Nawal Kankab, ACCCRN partners built and disseminated water storage tanks. Because the primary source of potable water for this community is located far from the village itself, these tanks, costing 500 rupees (approximately US$8) each, provide additional household water storage capacity. Lastly, a community water-harvesting program was launched in the third site, Ganeshnagar, which involved designing a community-wide system of collecting and storing rainwater; purifying this water through drum filters consisting of coal, sand, and brick fragments; and, finally, collecting water through common-access outflow taps.

These projects facilitated a renewed local focus on water conservation and protection as critical urban development priorities and have catalyzed some institutional change in the local government itself. In particular, the Indore Municipal Corporation recently banned the drilling of new bore wells within the city limits. Also, since 2006, the Municipal Corporation has mandated that water harvesting be integrated into the development of master plans for new commercial buildings and home construction. Currently, in addition to subsidies that cover initial purchase and installation costs, private residences that install rainwater-harvesting technologies receive a 6% rebate on their annual property tax bill.

Urban public health and climate resilience in Surat

Surat, in the western state of Gujarat, has an urban population of more than 4.5 million and is bureaucratically managed by the Surat Municipal Corporation. Since the 1960s, Surat has experienced about 80% decadal population growth, which makes it one of the fastest growing cities in the world. Much of this urban growth can be attributed to migrants in search of jobs in Surat's well-developed textile, diamond, and petrochemical industries. In the most recent census, around 55% of the population lived across 400 slums scattered across the city, mainly along riverbanks and tidal creeks (ACCCRN 2011).

Surat is a coastal city and is vulnerable to sea level rise, river flooding, and urban heat. Notably, in 1994, Surat experienced a plague epidemic that led to one of India's first large-scale urban sanitation and public health programs. In 2006, unusually high rainfall produced high discharges from Ukai Dam, which is situated upstream from Surat on the Tapi River. During this episode, 75% of the city's built-up area was flooded, leading to an explosion of gastrointestinal and vector-borne diseases especially within low-income and slum neighborhoods. Due to the experience of these major disasters, Surat's climate adaptation initiative is heavily focused on addressing public health, flooding, water supply, and resilient economic development needs (ACCCRN 2011; Bhat et al. 2013).

Surat, like Indore, has been a part of Asian Cities Climate Change Resilience Network (ACCCRN) since 2008. Between 2009 and 2010, ACCCRN partners assisted the city in designing pilot projects and drafting a city resilience strategy. This methodology placed particular attention on stakeholder engagement and vulnerability assessment processes to

identify indicators for potential short- and medium-term adaptation interventions (Kernaghan and da Silva 2014; Brown, Dayal, and Rumbaitis Del Rio 2012; Karanth and Archer 2014). Between 2010 and 2011, one of these recommended projects, the Urban Services Monitoring System, was piloted across the city. This project established a robust electronic platform to improve the city's urban health monitoring system, particularly around incidences of malaria, dengue fever, and leptospirosis. The system included designing a mobile application for health data collection, a web-based mapping and data visualization tool, and an electronic server to store and manage data. This system resulted in the real-time collection, visualization, and analysis of urban health data, which has further assisted different Municipal Corporation departments with predicting disease outbreak and enabling swift response.

Soon after the *Surat City Resilience Strategy* (ACCCRN 2011) was published in late 2010, the various stakeholders decided to form the Surat Climate Change Trust to institutionalize the process that ACCCRN had initiated. Located outside of formal local government decision making, the trust is a platform upon which different actors can contribute to prioritizing adaptation options, soliciting external financial support, and defining the city's overall resilient development agenda. One of the initial projects pursued by the trust is the Urban Health and Climate Resilience Center, which, like the Urban Services Monitoring System, targeted the nexus of public health and climate resilience. In order to meet the increased demands brought on by climate change, the Urban Health and Climate Resilience Center was designed to build on the knowledge and operating procedures of the city's existing public health facilities. This center would then go on to provide auxiliary support to state and national level urban health professionals while also incorporating climate resilience issues across all levels of decision making. Since the center was launched in 2013, the facility has worked to install an improved vector-borne disease surveillance system, has hired an interdisciplinary research team to steer and advise the city's actions towards managing the existing public health system in light of climate change, and has inaugurated a city-wide outreach program that promotes preventative health practices.

Finally, many urban actors beyond the Surat Climate Change Trust are recognizing the importance of climate resilience as a key component of the city's overall socioeconomic wellbeing. In early 2013, the Surat Municipal

Corporation adopted the issue of climate change as one of the line items included in its annual municipal budget. The line item earmarked 20 million rupees (approximately US$300,000) per year to complement and build upon existing urban infrastructure upgrading and service enhancement efforts. These include programs around slum relocation and rehabilitation, road and public transportation infrastructure improvement, flood and storm water control, water distribution system improvement, and wastewater management.

IMPLICATIONS FOR URBAN ADAPTATION POLICY AND GOVERNANCE

As the case studies show, there are a number of planning methodologies and implementation approaches that Indian cities have pursued in order to further climate adaptation and resilient urban development objectives. The remainder of the paper is devoted to a critical comparative analysis of these various approaches. A summary of these patterns is presented in Table 2.

Enabling Climate Adaptation in Cities

The projects and experiments described in this paper all note that the ability of cities to implement climate adaptation requires innovative planning and decision-making methodologies that take into account local socioeconomic and environmental conditions, even when transnational and intergovernmental actors are involved in the initial and enabling stages. For the Indian context, in particular, the local agenda has been disproportionately focused on industrialization and economic development, where sustainability and climate protection has come to mean safeguarding and increasing the resilience of economic systems and associated infrastructures (Atteridge et al. 2012; Fisher 2012), rather than on equitable development, poverty reduction, and social justice and human rights.

This dichotomy can be clearly seen in the "early adapter" cities of Bhubaneswar, Indore, and Surat. In Bhubaneswar, the majority of projects focused on disaster risk reduction, urban risk management, and natural hazard mitigation. This is a sensible strategy given the city's historic vulnerability to extreme weather events, including cyclones and urban heat. Projects framed around improving climate resilience, therefore, are motivated by an overall interest in protecting infrastructure and physical investments against damages from extreme weather and providing response and

Table 2. Summary of Patterns of Climate Adaptation Planning and Implementation

	Bhubaneswar	Indore	Surat
Initial Framing			
Motivations	Disaster risk reduction, urban risk management, and natural hazard mitigation.	Ensure access and availability of water resources and upgrading urban infrastructures.	Improve public health, reduce the city's risk profile, and protect urban infrastructures.
Co-Benefits	Protection of infrastructure and physical investments against weather damage. Response and rehabilitation services after extreme events.	Water supply protection and development for urban consumption. Solid waste and sewage management improvements.	Public health research and investments in urban socioeconomic data management and visualization techniques.
Implementation Pathway			
Strategy	Integrating urban adaptation objectives into city and community disaster risk management plans.	Relying mostly on community-level water management and conservation programs.	Institutionalizing adaptation projects into formal public-private decision-making and fundraising bodies.
Participation	Community-based strategies involving community members, service delivery professionals, and external agents.	Community support, local government incentives, and planners and engineers with knowledge of the local water infrastructure.	Constant engagement from international actors and capacity and resource support from local and regional research institutions
Barriers	Project-focus only catalyzed incremental changes to disaster and climate planning. Also, there is an over-reliance on external financial and capacity support.	Difficulty in sustaining local government leadership and the inability to coordinate cross-jurisdictional water planning.	Focused on promoting sector-specific adaption. Lack of broadly inclusive planning processes to promote social equity and justice.

rehabilitation services after particular disaster events. In Indore, the developmental challenge has always been safeguarding water resources and upgrading urban infrastructures. Climate adaptation and resilience, therefore, came to mean ensuring water supplies for urban consumption and improving existing solid waste and sewage management systems. Lastly, for Surat, the main motivator for adaptation was the need to improve public health, reduce the city's overall risk profile, and protect urban infrastructures in the event of flooding or drought. This, then, led to projects around improving public health research and targeting investments at associating data management, geospatial mapping, and visualization techniques.

In Bhubaneswar, Indore, and Surat, development objectives around economic resilience and infrastructure protection have overshadowed livelihoods security, poverty reduction, and social justice agendas. This reflects local governments' interest in articulating adaptation options that yield tangible and visible local benefits. As a result, the overriding motivations found in these three cities are the ability to further immediate growth-oriented development projects, facilitate private and public-private capital investment, address existing urban infrastructure and service deficits, and, in the meantime, to creatively reframe emerging adaptation priorities initiated by external support programs. The trade-offs here, therefore, are not necessarily between climate and development agendas, but between near-term economic benefits and long-term equitable development objectives.

Implementation pathways, institutions, and governance

The cases of urban adaptation also point to the variety of institutional and participatory pathways through which projects and experiments are eventually implemented. The diversity of actors involved in planning not only brings particular institutional and socioeconomic interests to the fore, but it also legitimizes the process by ensuring procedural justice (Moser and Ekstrom 2011; Paavola and Adger 2006). Although many local stakeholders lack access to specific climate projections and, therefore, may not be able to make adequately informed decisions around potential adaptation options (Few, Brown, and Tompkins 2007; Carmin and Dodman 2013), local actors are often cognizant of livelihoods, infrastructural, and economic development needs.

One common enabling factor across the three cities is the presence of an international actor, particularly in the form of the Rockefeller Foundation's

Asian Cities Climate Change Resilience Network and the United Nations Development Programme (Sharma and Tomar 2010). Through increased public exposure and awareness provided by these actors and networks, cities are increasingly realizing that actions towards mitigating climate risks and adapting to climate impacts cannot be addressed independently of interrelating economic development and livelihoods security priorities. Local governments are indeed profiting from the support provided by these external actors, especially since cities tend to be financially constrained in general. But since external interventions are not enough to ensure the sustainability of climate adaptation projects across time or to enact broad-ranging programmatic change within local government itself, Bhubaneswar, Indore, and Surat have all enlisted support from local civil society and private actors to further legitimize and facilitate the implementation of adaptation experiments.

For Bhubaneswar, adaptation experiments relied on community-based strategies that involved concerned urban slum dwellers, service delivery professionals, and additional support from external agents. The success of the many disaster management projects relied on the ability of these actors to raise awareness of impacts across slum settlements and schools. In Indore, water conservation and management projects relied on a combination of community support, local government incentives, and planners and engineers with knowledge of the local water infrastructure. Finally, in Surat, public health experiments succeeded because of constant engagement from international actors and capacity and resource support from research institutions. In all three cities, the local government played a pivotal role in providing an institutional home for emerging climate adaptation priorities, but the different strategies for implementing these experiments relied on extensive networks of public, private, and civil society actors whose constant engagement with each other revealed opportunities for integrating climate and development objectives. Since experiments tend to be time-bound and location specific, the experimental approach helps control costs, ensures effective and accountable implementation, and helps monitor and evaluate specific project benefits.

These interactive and iterative engagement processes between different urban actors and institutions have incentivized policy and planning framings around maximizing complementarities based on a city's overall developmental agenda, such as disaster management in Bhubaneswar, water availability and protection in Indore, and improvement of public health in

Surat. These examples show that in order to achieve such common framings that produce synergistic projects, there exists a discursive process of uncovering and framing co-benefits between climate resilience and urban socioeconomic development priorities. This discursive process often includes assembling expert advisory committees, task forces, and other consultative groups that mostly exist outside of local government decision making and, as highlighted in the case studies themselves, is driven strongly by private and civil society interventions.

Barriers to institutionalization

Finally, the cases described in this paper have shown that experiments are critical for testing ideas, quantifying co-benefits, and navigating through different participatory governance arrangements. Still, there is little evidence to show that these projects and experiments are being institutionalized into overall urban planning and management to affect sustained programmatic change. For example, disaster management projects in Bhubaneswar have only catalyzed incremental changes in how the city plans for extreme events across all sectors and communities. Similarly, public health interventions in Surat have only resulted in sector-specific climate adaptive behaviors, rather than showcasing cross-sectoral adaptation pathways. As a result, without institutionalization, adaptive capacities will be built only within discrete sectors, actors, and locations, rather than towards improving climate resilience throughout the urban socioeconomic system as a whole.

There are also different institutional barriers that need to be overcome if climate adaptation experiments are to be institutionalized into wider urban development planning approaches. First, even with additional financial support from external agents, local governments find it challenging to sustain adaptation experiments over time, particularly because cities often also lack knowledge, expertise, and staffing capacity (Carmin, Dodman, and Chu 2013). For Bhubaneswar, Indore, and Surat, seed money for projects was pieced together by creatively navigating external and intergovernmental sources, but these cities will likely assume future maintenance and upkeep costs alone. This daunting cost trajectory has incentivized local governments to select low-cost, co-beneficial projects that integrate sustainability, climate, and development objectives. However, in cities with high governance capacity and fiscal autonomy, such as the case of Surat, larger capital-intensive adaptation projects, including hard flood management

infrastructures, have been built. These were done because industries critical to the long-term development of the city were located in some of the most vulnerable areas.

Second, and most important, despite the general success of most adaptation experiments, issues of equity and social justice have not been adequately addressed. Even though local governments have solicited public and private participation throughout the planning process, this has mostly been limited to expert stakeholders. Moreover, while focusing specifically on ensuring the city's overall infrastructure resilience and developmental sustainability, many projects have neglected to tackle issues of poverty reduction and livelihoods security. For example, focusing only on public health interventions in Surat, though critical for the overall resilience of the city, may result in the diversion of local government attention away from other critical adaptation needs such as addressing chronic poverty among the migrant community and improving delivery of water, electricity, and sanitation services to slum settlements. These indirect institutional costs threaten the long-term trajectory of experimentation and prevent proper institutionalization of adaptation projects into overall urban planning, decision making, and governance processes.

CONCLUSION

Through critically assessing climate adaptation experiences in the cities of Bhubaneswar, Indore, and Surat, this paper contributes to understanding the political and governance dimensions of how cities frame and implement interventions that balance adaptation and resilient development objectives. Experiments are critical to this process because they provide a platform upon which cities can test out adaptation options against their existing development priorities, knowledge of climate impacts, and levels of external support (Castán Broto and Bulkeley 2013; Anguelovski, Chu, and Carmin 2014). Through discursively articulating adaptation options against different urban institutional and sectoral interests, cities are able to synchronize and contextualize tangible near-term adaptation benefits with immediate economic development needs.

This paper also notes that a project-oriented approach to adaptation that negates the need for wider institutionalization cannot yield sustained

engagement around furthering climate resilience and urban development objectives. Adaptation does not entail development as usual, but instead speaks to the need to incorporate long-term climate concerns into current planning. So, in terms of its wider policy contribution, this paper argues that external agents should approach urban adaptation and urban development as mutually reinforcing objectives, rather than dedicating adaptation funds that are operationally distinct from "traditional" development assistance. Finally, in terms of the ability to implement effective, legitimate, and inclusive climate adaptation experiments, external actors and local governments alike must design more collaborative and participatory approaches that incorporate climate adaptation and the development needs of the most environmentally and socioeconomically vulnerable sectors of society.

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