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Climate Science Integration and Urban Planning: A Climate Change Adaptation Exegesis

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Abstract. It is increasingly acknowledged in the adaptation to climate change literature that factors such as climate science play a large role when adaptation strategies are either chosen or rejected at a local scale. Regrettably, the discussion of climate science integration has tended to focus on mitigation decisions taken at international and national levels. This has limited our own thinking and understanding of the hurdles and promises that climate science integration presents at the local scale. This analysis distills existing literature on the subject. Based on such a review, it identifies the optimal level at which adaptation decisions should be taken and deciphers some of the most important factors that would cement the integration of climate science with urban planning under climate change scenario. The analysis argues that the selection of proactive, planned adaptation measures in response to climate change would certainly require a city based strategy that taps on *glocalized* climate science transcending on all levels of planning including settlement, neighbourhood and building scales. Achieving this, would require a much more elevated role of urban planning and the removal of all obstacles to effective adaptation that currently characterize most climate change initiatives.

Key words: Adaptation, climate science, urban planning

1. Introduction

Decisions relating to global environmental change are plagued by a myriad of uncertainties (Dessai and Hulme, 2007). Such uncertainties can be linked to complexities associated with three major drivers of global environmental change. There is a general consensus among development practitioners and academics that complexities brought about by climate change and the twin processes of globalization and urbanization have in recent times led to a renewed interest in the way cities are planned, designed and lived in (de Groot et al., 2002; UNEP, 2007). More specifically, the social, economic and environmental consequences thereof have led to a reevaluation of the factors that contribute to sustainable urban environments (Li et al., 2003; Lyytimaki and Sipila, 2009). At the helm of a climate change scenario has been the recognition of the role that climate science can play in winnowing some of the intricate complexities that obtain at the local scale. This alone has ignited a renewed interest in the way cities are planned and designed (figure 1).

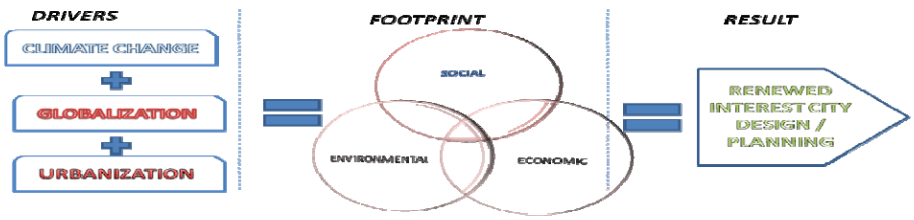

Fig. 1: Drivers of global environmental change and their consequences.

Uncertainties that characterize local conditions at the urban scale have however not given enough practical insights as to how climate change science can best be integrated in urban planning at the city scale. This alone presents difficulties for planners taking decisions on adaptation measures in urban ecosystems (Dessai and Hulme, 2007). Such uncertainties form the hall mark of 'information gap theory' espoused by Regan et al, (2005). Environmental uncertainties under such a school of thought can be conceptualized in three major ways. First there are uncertainties relating to the past state of the environment. Second are uncertainties associated with the current state of the environment. Third are uncertainties related to the future state of the environment.

Current literature does not seem to accumulate and converge in a number of areas. First there is appears to be no consensus as to which is the most appropriate entry point for adaptation decisions at the city scale. In the absence of compelling evidence on the application of climatic science in urban ecosystems, identifying what and how to adapt has remained far from clear than otherwise implied in literature (OECD, 2010). This analysis contributes to the ensuing debate of how best climate science can be transplanted from a much more global level to the local contexts of cities.

2. Climate change adaptation, urban planning and climate science

This analysis adopts the definition by the Intergovernmental Panel on Climate Change (IPCC, 2001) that defines adaptation as an "adjustment in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects or impacts". A review of current literature on urban planning reveals that most policy makers recognize the role that climate science integration plays in planning decisions. The discussion of climate science integration however has tended to focus on mitigation and adaptation decisions taken at international and national levels. Statistical models that seek to predict future climate are still confined to global and national figures. Within the context of urban areas climatic simulations regrettably only focus the total amount of urban space to be affected (table1). A much more locally focused adaptation dimension to climate science integration has largely remained unexplored by academics and policy makers (OECD, 2010).

Evidently there is a more localized dimension to climate change impacts that require greater application of climate science. There are two major reasons to this argument. First, scenario uncertainties are believed to be highest at the local scale (Næss et al, 2005). The second argument holds that past climate induced natural disasters (Blaikie et al., 1994; Morrow, 1999), as well as climate variability and long-term climate change (Liverman and Merideth, 2002; O'Brien et al., 2004) show that vulnerability and its causes are location-specific. It is also believed that the bulk of decisions regarding climate-induced hazards are local (Cutter, 2003). This last quality alone makes urban planning an optimal level of climate science integration and adaptation. This is so because urban landscapes are largely viewed human ecosystems where adaptation decisions are either taken or rejected (Dessai and Hulme, 2007).

Empirical evidence from elsewhere reveals that such a focus on city level planning is not misguided given that cities are (undoubtedly) centers of economic growth and population (Young, 2010). It is (arguably) this dominant feature that has seen cities becoming a focal point of both climate change related risks and disasters and the solutions thereof. The OECD, (2009) for instance has advanced three main reasons why climate change policy should be redirected to municipal level planning. First, it is believed that climate

Table 1: Sea level rise and its projected impact on populations and urban land area around the world.

Sea level rise	**Parameter**	***Measurement***	**Latin America & Caribbean**	**Middle East & North America**	**Sub-Saharan Africa**	**East Asia**	**South Asia**	**World**
	Population directly Affected	Millions	4.7	10.9	3.7	60.2	10.2	89.6
		% of total	0.9	4.2	0.8	3.2	0.8	2.0

2 meters	*Urban Area Inundated*	Km^2	5212	5037	742	11127	1379	23497
		% of total	1.0	2.7	0.7	2.9	0.6	1.6
5 meters	*Population directly Affected*	Millions	13.5	19.4	11.0	162.4	39.5	245.9
		%	2.7	7.5	2.4	8.6	3.0	5.6
	Urban Area Inundated	Km^2	15294	9384	2449	34896	5117	67140
		%	3.0	4.9	2.2	9.0	2.1	4.7

NB: Based on statistics obtained from Susmita Dasgupta et al., The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis (Washington, DC: World Bank, February 2007).

change impacts are manifested locally, affecting city-wide systems (including, economic systems, livelihoods, infrastructure, water and so on). The second argument holds that vulnerability and adaptive capacities are determined by local conditions. The third and final argument holds that those adaptation activities are often observed at the local level and it is therefore easy to tailor actions to the specifics of a particular city (OECD, 2009).

Given the intricate nature of uncertainties that characterize the urban scale, it is therefore clear that the future design of urban settlements and infrastructure in response to climate change will require approaches that integrate science and urban planning (Norman, 2009). The application of climate knowledge to deal with cumulative impacts and risks is however not spontaneous. There is overwhelming empirical evidence to suggest that the bulk of planning efforts are constrained by the non application of climate knowledge (Dessai and van der Sluijs, 2007). An Obvious challenge has been difficulties associated with climate change projection at city scale given substantial amount of uncertainty that surrounds prediction of local area impacts (Dessai and van der Sluijs, 2007). Difficulties that decision makers face in interpreting and using climate scenarios and uncertainty information, as well as how to appraise the policy implications of uncertainties are also well documented (Mathijssen et al, 2008; Waridekker et al, 2008). Such drawbacks have had major implications for climate science application at various scales within urban areas. Mills, (2010) observes that responsive urban designs characteristically incorporate climate based planning approaches at various scales including (1) building, (2) neighbourhood and (3) settlement scales. Specific planning interventions under climate change scenarios are depicted on figure 2.

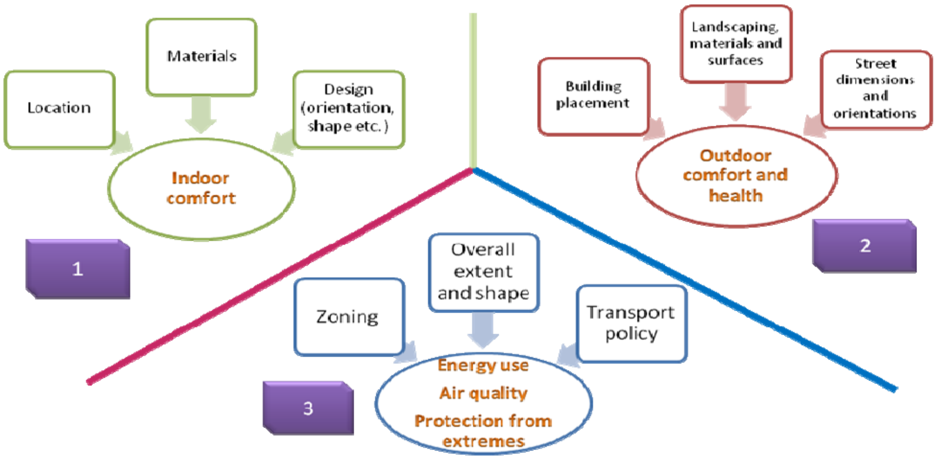

Fig. 2: Climate based planning interventions at three levels (of planning).

Various approaches to overcoming uncertainty exist – including the risk approach, anticipating design, resilience, adaptive management, and robust decision making among others (Dessai and Hulme, 2007; Hallegate, 2009). Central to all such interventions is the role played by climate science. Evidence associated with its application and is widespread and has a long history at least in the developed world. The first studies on applied urban climatology and challenges thereof were conducted in Germany in the 1960s and 1970s.

Similar projects have also been carried out in Switzerland (Thommes et al., 2001), in Portugal and Lisbon among others (Alcoforado and Andrade, 2006). Such limited application of climate science in urban planning has tended to stifle any meaningful climate change adaptation measures by city authorities.

2.1. Understanding limitations to climate change adaptations at the urban scale

Identifying what and how to adapt has remained far from clear owing to a multitude of challenges related to the application and / or non application of climate science in urban planning endeavours (OECD, 2010). Current literature is pregnant with what are viewed as major constraints to climate change . This analysis will however focus on limiting factors that are obtaining at the urban planning scale and will ignore the many social, cultural and psychological factors that affect adaptation practices at an individual level. Most studies concur that effective adaptive decisions in urban ecosystems are constrained by factors ranging from scientific uncertainty, through to current state of technology, availability of financial resources, and short time horizons (Lorenzoni et al., 2000a, b; Smit and Pilifosova, 2001; EEA, 2005; EU, 2007). Other scholars have noted that the policy context also plays a crucial role. This is upon realization that some policy contexts are supportive while others are inhibitive to effective adaptation (see Burton et al., 2002; Lim et al., 2005; EU, 2007). This limitation alone has been singled out by the United Nations Development Programme (UNDP) under its 'Adaptation Policy Framework' that underscored the need to integrate climate change into all strands of policies that may transcend different sectors (Lim et al., 2005; Niang-Diop and Bosch, 2005, p. 190). To this end, removing policy conflicts and legislative barriers to adaptation has been considered as a major research priority – at least in European Union countries (DEFRA, 2005).

The absence of a credible climate change response planning mechanism has also been identified as another limiting factor. The framing of National Adaptation Programmes of Action (NAPAs) under the United Nations Framework Convention on Climate Change (UNFCCC) has applauded the crucial role played by explicit adaptation plans in climate change mitigation efforts (Ford, 2008). Similarly, other scholars have underscored the presents of practical guidelines for implementation of sustainable urban solutions (Ford, 2008). Other researchers have also noted that fostering strong partnerships between all actors is critical in planning and decision-making, especially in building the resources and capacities of the municipal government to address climate change (Bulkeley et al, 2009).

3. Concluding remarks

The analysis has revealed that climate science integration has been confined to climate change mitigation efforts at a much more global scale that at local. Evidently, there is also a more local adaptation dimension that has still not been adequately explored. Drawing on a review of existing literature on climate change adaptation, the analysis has argued that a city based planning strategy provides an optimal entry point for adaptation decisions that seek to harness the value of climate science in dealing with actual and potential climate change related risks. Such integration can be effected at three levels of planning activity – including the building, neighbourhood and settlement scales. The analysis has also revealed that the transition from climate science to practice is not automatic. It needs to be created and nurtured through. This alone would require that urban planners step up to the challenge by eliminating a host of problems that constrain the application of climate science to adaptation decisions.

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