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Review

Sustainable cities targeted by combined mitigation–adaptation efforts for future-proofing

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ABSTRACT

This paper examines recent literature on achieving sustainable cities that incorporate a combined mitigation–adaptation approach towards improved urban resilience as a way of future-proofing. A multidisciplinary approach, which integrates scientific as well as ecopolitical frameworks, is found to benefit this sustainability discourse.

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1. Introduction

The concept of 'future-proofing' is not new to sustainability. Richards and Bradbury (2007), for instance, are among several published authors to refer to future-proofing within the context of the built environment. Authors have considered solar irradiation, temperature, humidity, and daylighting in simulations of buildings in order to examine the potential impact of climate change, particularly in terms of overheating in summer months (Jentsch, Bahaj, & James, 2008). Coley, Kershaw, and Eames (2012) examine non-structural adaptations as a way of reducing risk associated with incorrect climate change projections, such as higher temperatures. Georgiadou and Hacking (2010) argue that future-proofing is needed in planning and design to establish more flexible, resilient buildings (urban design) in the longer term. Georgiadou, Hacking, and Guthrie (2012) more recently set forth a conceptual framework for future-proofing that targets the energy efficiency of buildings (future-proofed energy design) within the context of low carbon development (LCD). Again, within a long-term perspective, they refer to future-proofing (of buildings) in terms of design processes (for example, energy efficiency measures and low carbon technologies). Among their considerations is accommodating risks and uncertainties associated with energy consumption.

The chief stance advocated in the current paper is that urban resilience works as a multidisciplinary approach to achieving effective future-proofing of urban climate change. Resilience is considered as a future-proofing tool to assess adaptation to climate change. The concept of resilience has evolved over the years to become a concept that integrates traditional ecological resilience with social resilience, and most recently urban resilience. Moreover, it is posited that a combined mitigation–adaptation perspective is most useful for the realisation of improved urban resilience. This is discussed in the following pages based on current research and findings. First, the authors consider resilience

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as a multidisciplinary concept adopted from ecology. Then, a consideration of the framework for achieving a combined mitigation–adaptation strategy is presented. Finally, recommendations are made for cities experiencing change. Resilience and other considerations are revisited at the end of the paper, when suggestions are made for enhanced adaptation (or enhanced resilience) to climate change in cities in light of what has already been published in the literature.

2. Resilience for future-proofing

It is integral to consider cities as sites where human populations converge and expand, as important sites for social action and development. Holling (1973) develops the concept of resilience by contrasting it with system stability. According to him, *resilience* is a measure of system persistence and the ability to absorb disturbance and change whilst maintaining relationships between system components, such as populations or state variables. Instability in the form of large fluctuations has the ability to introduce resilience (a capacity to persist). When resilience is applied to the management of resources, there is a need (1) to keep options open, (2) to view events at a regional scale (rather than a local context), and (3) to emphasise heterogeneity (p. 21). Such a resilience-based management approach tolerates uncertainty, and does not require a precise prediction of the future, but only some capacity to devise systems able to absorb and accommodate future events.

Rather than simply returning to a preexisting state, this can mean transforming to a new state that is more sustainable in the current environment. Urban resilience is a general quality of the city's social, economic, and natural systems to be sufficiently future-proof. It is noteworthy that reducing reliance on carbon-intensive energy consumption allows urban economies to accommodate better the effects of energy price fluctuations, of the extinction of hydrocarbon resources, and, importantly, of policies and demands increasingly set by international and national governments for low carbon transitions.

Resilience, which has been previously defined by biologists and adopted by sociologists to include society, can be understood from a climate change perspective in terms of the social limits to adaptation (Adger et al., 2009). The word resilience has developed from two paradigms (Pickett, Cadenasso, & Grove, 2004), one of equilibrium (or the extreme equilibrium view of resilience), which is 'the ability of systems to return to their stable equilibrium point after disruption' (p. 373); while the other paradigm (the non-equilibrium view) is more inclusive, dynamic, and evolutionary. It defines resilience as 'the ability of a system to adapt and adjust to changing internal or external processes' with an emphasis on 'staying in the game'. It is imagined that instability in the form of large fluctuations has the ability to introduce resilience (a capacity to persist). Such an approach tolerates uncertainty, and does not require a precise prediction of the future, but only some capacity to devise systems able to absorb and accommodate future events (Holling, 1973). The latter approach to resilience can be adopted to include *social resilience* to refer to 'the ability of a community to respond to a change adaptively' (Satterthwaite, Huq, Reid, Pelling, & Romero Lankao, 2007, p. 11). For instance, where extreme climatic conditions (random events or influences) occur, populations are exposed to fluctuation that can reduce their stability, but enhance their resilience, since they are better able to absorb chance climatic extremes.

Current studies have examined the climate risks associated with sea level rise, water resources, and human health, whilst studies of energy, transport, and the built environment are less investigated (Hunt & Watkiss, 2011). An integrated approach could stimulate dialogue between architects, planners, and insurers in future adaptations to the impacts of climate change in buildings and other sectors in cities (Crichton, 2007). According to the author, particularly buildings need to be rethought from a resilience perspective to withstand natural hazards, which are likely to be more frequent and severe, and should be adaptable to other uses defined by changing social needs. The 2010 World Development Report (World Bank, 2010b) highlights a number of important principles for such strategies:

- 'No-regrets' actions that would provide benefits irrespective of climate change, such as energy and water efficiency.
- Reversible and flexible options to keep the possibility of wrong decisions as low as possible.
- Safety margins or redundancy.
- Long-term planning based on scenario analysis and an assessment of alternative urban development strategies under a range of possible future scenarios.
- Participatory design and implementation based on local knowledge about existing vulnerability and fostering ownership of the strategy by its beneficiaries.

It is important to consider interdisciplinary approaches to low carbon cities, as advocated by Alberti et al. (2003), who argue that the natural and social sciences cannot continue to operate separately for a complete understanding of (or unified approach to) human-dominated ecosystems due to interactions between humans and ecological processes, and propose instead an integrated framework of *consilience* for 'unity of knowledge across fields' (p. 1178), including the unity of sciences and humanities in urban ecology. A recent approach to cultural ecology has been a new ecology (Head, 2010), which should comprise of a theoretical framework that is inclusive of technology (and technical expertise) within the sociopolitical economics of adaptation. Geographical research could be particularly influential in the development of climate policy (Bailey & Compston, 2010).

Whilst the anticipation of the external (natural or economic) shocks is vital for prioritising certain fields or directions and for arranging operational responses, the city's overall vulnerability is ultimately determined by its physical shape and the quality of its socioeconomic infrastructure. A dilapidated and inefficient capital stock; buildings built in the absence or in violation of construction regulations; poorly maintained urban engineering systems; under-developed public services; social inequality; polarisation and deprivation are all factors that leave cities badly exposed. It is not possible to make resilient cities overnight; rather, resilience is purposefully and progressively accumulated by improving the quality of both the social well-being and the physical stock, while incorporating into all capital investment decisions relevant principles and considerations. As Newman, Beatley, and Boyer (2009, p. 7) note, '[i]n a resilient city every step of development and redevelopment of the city will make it more sustainable: it will reduce its ecological footprint (consumption of land; water; materials; and energy, especially the oil so critical to their economies; and the output of waste and emissions) while simultaneously improving the quality of life (environment; health; housing; employment; community) so that it can fit better within the capacities of local, regional, and global ecosystems'.

3. Achieving sustainable cities that incorporate a combined mitigation–adaptation approach towards improved urban resilience

3.1. Increasing urbanisation

Urban communities are vulnerable to the negative impacts of climate change. Urban areas concentrate people and infrastructure, often in hazard-prone areas. They experience some of the largest