Adapting buildings to climate change

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Abstract

The interdependence and feedback between climate impacts mitigation and adaptation to the inevitable changes in climate are the key challenges for the built environment in the coming decades. These challenges are more pronounced in the interface between science and society, in which scientific knowledge and evidence are transformed into policy actions. This editorial looks at current and growing evidence base on the impacts of climate change and the means to adapt buildings, as well as the interface between policies and evidence base while summarising the contributions to this special issue.

Introduction

In light of compelling evidence on anthropogenic climate change (Solomon et al. 2007), there is an urgent need to mitigate the impacts of climate change by reducing the concentrations of greenhouse gases (GHGs) in the atmosphere (Stern 2007). Buildings play an important role in climate impacts mitigation, as they are responsible for 40% of global energy use and over one-third of global GHG emissions (UNEP 2009). Efforts on climate impacts mitigation are also closely linked with adaptation of buildings to the inevitable climate change, as mitigation and adaption are often interdependent and there exists a positive feedback loop between the two (Mourshed 2011). The approaches for the reduction of GHGs in the present-day climate may affect a building's potential for adaptation, from floods (Wilby and Keenan 2012) to increasing temperature (De Wilde and Coley 2012), in a future climate.

Increased emphasis on mitigation without much consideration of the dynamics between buildings and future climates may even exacerbate the cause of climate change by requiring energy intensive adaptation to ensure occupant comfort and wellbeing. Exposure to climate risk varies widely, between regions and groups of people (Solomon et al. 2007). Regions with a prevalence of high temperatures such as overpopulated and sprawling cities in the temperate latitudes may experience higher than the projected temperatures because of disproportionate warming and the urban heat island effect (Patz et al. 2005). The urban poor, in particular the vulnerable groups such as children and the elderly, living in congested communities and with poor access to energy and infrastructure, can be disproportionately affected by increased temperatures (Bartlett 2008) than their well-off neighbours in the same region. The ability to adapt to the projected changes in climate is thus greatly affected by a number of socio-technical factors, a fuller understanding of which is required to tackle the challenges of adaptation. Moreover, the factors affecting adaptation potential of a building or a community are interdependent. Assessment for adaptation, therefore, requires an integrated and multidisciplinary approach (Taseska et al. 2012).

The need for integrated and multidisciplinary processes for environmentally sustainable buildings, cities and communities has been highlighted in the past, even before the mainstreaming of climate change mitigation and adaptation. A wide spectrum of research discussed various aspects of integrated, collaborative and multidisciplinary design, from design platforms and environments (Hartkopf et al. 1997; Mourshed 2006; Rosenman et al. 2007) to design process and methods (Flager et al. 2009; Mlecnik 2010; Mourshed et al. 2003a, 2003b), as well as metrics and tools for integrated assessments (Helgeson and Lippiatt 2009). However, there exist several barriers to the adoption of integrated tools and approaches. Khandokar et al. (2009) explored the barriers in the domain of strategic decision making for sustainability assessments using concepts from information sciences and demonstrated that the adoption of tools is often constrained by the chain effects of interconnected barriers relating to technology, people and resources. The adaptation of buildings and cities to climate change does not necessarily change the underlying process of how decisions are made but adds another dimension to the already complex decision landscape. Contemporary issues of and developments in multi-dimensional decision-making (Mourshed et al. 2011) will, therefore, play a significant role.

Akin to the need for integrated assessments and tools for built environment sustainability (Alavarado et al. 2012; Paranagamage et al. 2010) that dominated both the research and professional circles in the last two decades, the success in adapting buildings and cities to climate change will largely depend on assessment tools and decision making processes. On the one hand, our understanding of the climate and its relationship with the built environment (Mavrogianni et al. 2010; Mourshed et al. 2005), and impacts of climate change will shape the context and directions for adaptation. On the other hand, the interconnected nature of mitigation, adaptation and human health will influence the identification of optimal pathways for adaptation (Mills 2007). As the projected changes in climate will increase the occurrence and severity of disasters (O’Brien et al. 2006), it is also important to consider past lessons in disaster risk management (Wamsler 2010) while identifying and implementing adaptation strategies.

Contributions

This themed issue on *adapting buildings to climate change* contains seven articles on wide ranging topics related to climate change adaptation and green buildings. These range from the investigation into adaptation strategies to the analysis of the development of environmental codes and standards that can enhance the adaptation potential of the built environment.

Marsh (2012) explores the paradox between climate change mitigation and adaptation in the Danish context. The author discusses how the overarching drive to reduce energy consumption from homes has resulted in poor indoor environmental conditions, which may be made worse by climate change. The discussion suggests that there exists an extensive overheating problem in recently completed new-build houses. Analysis carried out by the author also suggests an exacerbation of the overheating problem in future climates. The research further investigates the interplay between climate change adaptation and mitigation, with a cross-disciplinary focus on users, passive design and active technologies. Findings demonstrate that the cumulative use of these strategies has the potential to create an adaptation buffer, thus eliminating problems with overheating while reducing energy consumption.

Bennetts et al. (2012) start their investigation into design strategies for houses subject to heatwaves with a discussion on the Australian context, which has seen a significant increase in the average floor area of new houses, as well as greater expectations of thermal comfort in homes. The rise in the use of air-conditioning for comfort cooling is discussed against the projected increases in temperature in the region, which sets the context for their investigation into design strategies for adaptation. Their research suggests that occupant behaviour and thermal comfort expectations change during heatwaves, which result in increased energy consumption and may have a strong influence on adaptation decision making. The authors investigate the suitability of incorporating cool refuges in the existing dwelling stock and reports that the results are promising.

Translating our understanding of the energy and environmental impacts of buildings into policy actions is an important aspect of adapting buildings and cities to the inevitable climate change. Building environmental codes and standards, most of which are voluntary, have been developed and implemented in various parts of the globe in the past decades. The article by Abdul-Aziz and Ofori (2012) charts the development of one such environmental code, the Green Building Index (GBI), developed for and specifically suited to the Malaysian context. Through interviews with stakeholders and reviews of secondary sources, the paper makes the case for a strong cooperation between the private sector and the government for the development of a green building code. Private sector leadership features strongly in their study and is complemented by a collaborative spirit and the proactive nature of the Government, aimed at greening the economy. The lesson learnt in this case can prove to be a vital resource for developing codes and standards related to adaptation, as well as the development of green building codes in other countries.

The article by Shikder et al. (2012) is aimed at investigating the performance of new-build multi-occupancy dwellings for human thermal comfort in the present-day and projected future climates in four main British cities: Birmingham, Edinburgh, London and Manchester. The investigated cities are geographically distributed to account for variations in climatic condition. They carried out evaluations by a series of dynamic thermal simulations using widely adopted threshold temperature for overheating as suggested by the Chartered Institution of Building Services Engineers (CIBSE) and adaptive thermal comfort standards. The study offered a perspective on regional variations of performance and a snapshot of the use of appropriate adaptive comfort standards in the evaluations. One of the unique features of this article is the use of more appropriate comfort metrics for evaluating the performance of existing buildings in the projected climates. The authors discuss possible personal and building adaptation measures to alleviate overheating risks in dwellings. The authors also shed light on the generation of weather data for the assessment of building energy and environmental performance in projected future climates, in particular how implementing recently developed techniques (e.g. Mourshed 2012) for weather data generation can reduce uncertainties in performance assessment.

Housing accounts for a significant share of global greenhouse gas emissions. It is responsible for 27% of UK's carbon emissions (Hamilton-MacLaren et al. 2013). Dwelling characteristics, construction, age and the type of tenure are some of the important considerations for dwellings' adaptation to climate change. A significant share of European dwelling stock is owned and maintained by large stockowners such as the social housing sector. Roders et al. (2012) look at the level of awareness of climate change adaptation among Dutch housing associations through a content analysis on the policy plans and annual reports of the 25 largest housing associations in the country. Results show a distinct lack of awareness of climate change adaptation in the sector and highlight the need to develop appropriate governance strategies and government policies. The authors opined that the integration of adaptation measures with design and maintenance activities could be a cheaper option to cope with the projected changes in climate, as opposed to inaction.

Adebamowo and Ilesanmi (2012) focus on the structural and behavioural strategies of adaptive measures for buildings in warm humid climate in Nigeria through a case study of a students' accommodation building. Investigated structural strategies include flexible and adaptive structural systems while the behavioural strategies cover the spatial, personal and psychological control measures which may influence the design and operation of buildings. The effectiveness of these strategies are viewed and discussed in the context of adaptive thermal comfort of occupants during the rainy and dry seasons in Abeokuta, Ogun. The analysis of responses from the occupants suggests the need for a greater synergy between the techno-structural and socio-behavioural dimensions of building adaptation. The article attempts at filling a gap in literature on the interrelationships between socio-behavioural, technical and environmental aspects of climate change adaptation in warm humid climates.

Rasmussen (2012) suggests a strategic approach for existing Danish buildings to withstand climate change. The four-stage approach is based on a review of likely impacts of projected increases in temperature in Denmark and set against a background of national and international agreements and targets of greenhouse gas emissions reductions. The article also evaluates the assumptions that form the basis for the projected scenarios, as well as discusses the uncertainties in the projections. The approach developed in this article calls for a risk-based framework for adaptation to climate change in which the consideration of risk is based on a vulnerability analysis. The author stresses the importance of the strategic approach and discusses the risks to continuing investments in the built environment, if one is not developed and adopted.

Conclusion

This themed issue presented seven recent research on adaptation of buildings to climate change. An overwhelming majority of the papers called for an integrated approach, considering social, technological, political and economic aspects of adaptation. The issue also highlights that the built environment community is currently focused on climate impacts mitigation; i.e. the reduction of energy consumption and greenhouse gas emissions from buildings, and that adaptation of buildings to inevitable climate change needs to be urgently incorporated alongside mitigation efforts.

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