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Performance standard for tropical outdoors: A critique of current impasse and a proposal for way forward

Rohinton Emmanuel

Glasgow Caledonian University, Glasgow, UK

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ABSTRACT

Climate change will bring more heat extremes to the already warm tropical areas in Asia, Africa and Latin America. The resulting surge in cooling demand will only make the thermal discomfort in tropical cities even worse. This paper presents evidence to the approaching air conditioned cooling load deluge and shows why the air conditioned management of cooling load is particularly problematic in the tropics. It then presents the technical, institutional and cultural challenges to passive climate-sensitive design in the tropics and posits three ideas as part of the way forward: reformulation of thermal pleasure in the tropics, linking the 'in' and the 'out' at neighbourhood scale and provision of adaptive opportunities varied by activity patterns. Research approaches to advance these ideas are also discussed.

1. Introduction

Unusual (>3 standard deviations [SD] above the base climate of 1951–1980) and unprecedented (>5 SD) heat extremes are expected to be the norm in much of Asia and Africa in the near term even as these regions undergo transformational social and economic change (IPCC, 2013). In Sub-Saharan Africa, unprecedented heat extremes are projected over an increasing percentage of land area as global warming intensifies from 2 to 4 °C, resulting in significant changes in vegetative cover and drought events (Lott et al., 2013). In Southeast Asia, heat extremes that are virtually absent at present will cover nearly 60–70% of total land area in summer, even under a 2 °C global warming scenario; with 4 °C global warming, summer months that in today's climate would be termed unprecedented would be the new normal, affecting nearly 90% of the land area (Sillmann et al., 2013). In South Asia, the situation is even more extreme, irrespective of the global emission paths (Sillmann et al., 2013; Kumar et al., 2010). Reduction in cold days (Yan et al., 2002), increase in both cold and warm tails (Klein Tank et al., 2006), significant increases in the annual number of hot days and

E-mail address: Rohinton.Emmanuel@gcu.ac.uk.

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warm nights, decreases in cold days and cold nights (Manton et al., 2001; Griffiths et al., 2005) and increases in warm extremes are all likely in much of Asia and Africa.

The most populous parts of these continents are within the Tropical belt (from approximately 23°N to 23°S of the equator). Consequently, tropical cooling load – much of which is currently latent due to relatively low (albeit rapidly rising) levels of economic development – is likely to be the dominant category of global energy demand (Isaac and van Vuuren, 2009). In the current paradigm, such increases in cooling load could only be met by air conditioning more and more buildings (Davis and Gertler, 2015), exacerbating the warming problem. At the same time, deep technological development and efficiency improvements in cooling systems are yet to be achieved.

To make matters worse, contemporary cultural practices and attitudes limit adaptive possibilities to warmer temperatures as the improving socioeconomic conditions lead to 'thermal indulgence' (Hitchings and Lee, 2008; Han et al., 2009; Indraganti, 2010a; Karyono et al., 2015). There is evidence that long-term exposure to air conditioned environment may even hamper people's physiological acclimatization and weaken thermal adaptability (Yu et al., 2012). Greater use of air conditioning leads to a cycle of cultural dependency, and breaking it appears enormously difficult (Chang and Winter, 2015). One likely outcome of these developments is an unrealistic thermal comfort expectation in the tropics that is in direct conflict with the 'global good' of low/zero carbon economy. A compromise has to be reached between societal priorities and personal desires to ensure lowest energy expenditure without confining tropical dwellers to an 'inferior' thermal comfort.

This paper presents evidence to the approaching air conditioned cooling load deluge in light of the changing climate made worse by urbanization, critiques the current inability to effectively deal with the problem and proposes a new way of managing the cooling load deluge by 'climate-sensitive commons.' The Background section presents six reasons why the cooling load problem in the tropics is unique and in need of new thinking. In light of these, three ideas are put forward for future urban climate-sensitive design in the topics. Finally, five research and knowledge transfer needs are posited as necessary to realise these design ideas.

2. Background

Much of the climate change risks in the tropics are concentrated in urban areas. These include rising sea levels and storm surges, heat stress, extreme precipitation, inland and coastal flooding, landslides, drought, increased aridity, water scarcity and air pollution (Revi et al., 2014). Given the current level of urban growth and the concentration of populations involved, climate change will interact with the urban risks in a variety of ways, some of which will exacerbate the level of climate risk (IPCC, 2013). Furthermore, there are health inequalities, especially in developing cities that are further exacerbated by urban warming (cf. Campbell-Lendrum and Corvalán, 2007).

However, research on the augmentation of climate change effects by local urban warming (characterised by urban heat islands) remains weak. Initially, even the Intergovernmental Panel on Climate Change (IPCC) overlooked the role of cities both as a forcing factor as well as a key stakeholder in managing climate change (Hebbert and Jankovic, 2013). Additionally, translating future climate change projections at finer spatial scales relevant to cities typically use statistical downscaling techniques to global climate models without modelling the urban areas themselves (Lemonsu et al., 2013). Furthermore, the practical implementation of the limited urban warming knowledge is rare.

But things are changing: urban heat island mitigation is explicitly mentioned in IPCC AR5 Working Group 3 Chapter 9 (Lucon et al., 2014). Explicit connections between climate change and action in cities is increasingly being made (for example, Rosenzweig et al., 2015). Tools and strategies to evaluate the effectiveness of heat island mitigation measures, such as the Comprehensive Assessment System for Building Environmental Efficiency – Heat Island Tool (CASBEE-HI - http://www.ibec.or.jp/CASBEE/english/overviewE.htm) have been proposed. However, the amelioration of the heat island effect in the urban *tropics* is particularly weak. On the one hand, knowledge of tropical heat islands remains patchy and numerically weak (cf. Hung et al., 2006; Roth, 2007). On the other, the proliferation of strategies focusing on heating-only climates (or the dual-mode heating-and-cooling load climates) does not readily translate to cooling-only regions.

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