

Planning and design for sustainable cities in the MENA region

Recent research indicates that many densely populated areas of the world will be uninhabitable in the coming century due to the depletion of resources, climate change and increasing urbanization. Climate change impacts, including rising temperatures, rising sea levels, increasing frequency of heat waves and extreme weather are already evident. Along with the challenges of climate change, the percentage of populations residing in urban areas is steadily increasing. In 2014, 54 percent of the world's population lived in urban areas, and this is expected to rise to 66 percent by 2050, with the most rapid urbanization in Asia and Africa (United Nations Department of Economic and Social Affairs Population Division, 2014). Climate change impacts on cities are yet to be fully understood, though a recognition that the interaction of social, infrastructure and ecosystems features can amplify impacts is consistent (Ramaswami *et al.*, 2016).

With the high-profile withdrawal of the USA from the Paris climate agreement, cities are emerging as the political unit that will continue with the bulk of climate change governance initiatives in the USA. Bulkeley *et al.* (2012) note that the scale and nature of response at the municipal level have increased since the early 1990s. However, Bulkeley and Betsill (2003, p. i) argue that “the formation and implementation of local climate change policy has been limited by the resources and powers of local government, and by conflicts between economic and environmental objectives” (p. i). This particular combination of climate change impacts and urbanization pose serious planning and design challenges that need new insights, designs and approaches in order to improve the chances for survival of shelter, infrastructure, human and ecosystem health, biodiversity, etc. With human populations concentrated in urbanized areas, the chances for a single event or a single impact of climate change (e.g. an extreme weather event or rising sea levels) to affect greater populations are evident.

A recent study of future temperatures in Southwest Asia found that many cities in the region of the Arabian Gulf will become uninhabitable by 2,100 under current climate change projections (Pal and Eltahir, 2016), while a Lancet article detailed the population–environment–development dynamics that require an urgent focus on survivability for the Arab world (El-Zein *et al.*, 2014). In the Middle East North Africa region, for example, many cities already experience temperature and humidity maximums that make it difficult to find acceptable levels of comfort outdoors during most of the day in Summer, and during midday in temperate seasons, such as spring and autumn. As an example of one country in the MENA region, Qatar is predicted to have 65 days of heat wave conditions per year by 2020 under the Relative Concentration Pathway 8.5 (business-as-usual) modeling scenario, with this number expected to increase to 88 by 2050 (ESRI, 2017). Exposure to hot days may result in heat stroke while indirect impacts have been studied, including the increased risk of cardiovascular disease, worsening of respiratory conditions, risk of decreased kidney function, risk of adverse birth outcomes and the changes in distribution of vector-borne disease (Watts *et al.*, 2018). Also, reduced labor productivity is already being seen in Gulf countries and elsewhere, which has a direct impact on both economic and well-being outcomes.

Cities in the MENA region are as diverse in character as any outside the region (Elsheshtawy, 2015): some have great wealth due to oil and gas reserves or a well-planned and diversified economy and some have serious economic challenges; some are gleaming examples of modernity, while others are informal and unplanned; some are



engaged; some are rising international business centers, while others face high unemployment and lack of investment. Yet overall, many of these cities stand poised to take advantage of rich cultural and commercial histories, politically active populations (as in Cairo during the Arab Spring) and cultures of tolerance that could lead to successful/sustainable outcomes for the future.

Many recent studies emphasize the role of the alteration of the built environment as a strategy for heat mitigation, combating sea level rise and water scarcity (Göll, 2017), improvements to ecosystem and human health (Wilby and Perry, 2006; Tzoulas *et al.*, 2007; Southon *et al.*, 2018; Vieira *et al.*, 2018) and energy conservation (Huang *et al.*, 1987; McPherson, 1994; Akbari *et al.*, 2001; McPherson *et al.*, 2003). Commonly proposed interventions include both planning and architectural solutions – tree planting and increases in green or blue spaces (Oliveira *et al.*, 2011; Qiu *et al.*, 2017; Upreti *et al.*, 2017), green roofs, window treatments and window placement, architectural materials which are thermally responsive (Santamouris *et al.*, 2011), and lightening roads, roofs, and buildings to increase albedo (Radhi *et al.*, 2017; Kyriakodis and Santamouris, 2018). However, no single strategy or group of strategies is suited for all locations, cultures and socio-economic circumstances. The combined pressures of climate change and rapid urbanization create an acute need for place-specific and human-centric planning and design practices.

With these challenges in mind, this Special Issue was proposed to gather some insights on current approaches to sustainable planning and design in the MENA region. This Special Issue comprises four papers that present several tools and planning approaches that add to the literature on sustainable planning in the region. They cover a range of infrastructure design, residential design and planning concepts with two papers focused on modeling approaches (Bensalah and Hammad) and two human-centric planning approaches (Randeree and Smits).

Certainly rail infrastructure has played an important role in economic development globally, and while the development of building information modeling has been widely adopted in the fields of building engineering and architecture, it is only recently being applied to infrastructure projects (Bradley *et al.*, 2016). The paper by Bensalah *et al.* reviews the importance of the rail sector and its assets in economic, social and ecological terms and then focuses on benefits, risks and limitations of BIM in railway projects. The paper incorporates practical case studies of projects that have chosen the BIM approach and develops a summary of benefits and limitations of its use in relation to railway, as one type of infrastructure project. They note that BIM would not only optimize project costs and schedules leading to efficiency in the design and construction stages but may also optimize maintenance. It notes that the approach is limited by a lack of standards for its application to the rail sector, lack of a BIM charter, and that projects that apply it are not always well-documented in order to assess the effectiveness of the inclusion of BIM.

A second paper by Hammad also focuses on technical aspects of design by exploring optimal solutions to window design in the MENA region. It notes that the region is known for its extremely hot weather during Summer. The paper explores the problem of designing and locating windows on building facades based on relevant criteria to the region including solar heat gain, privacy, daylighting and cost of installation.

With a focus on residential dwellings in the MENA region, conflicting objectives are optimized using a lexicographic approach. Depending on the preference of criteria adopted in lexicographic optimization, the location of the windows on the building façade tends to change. The bi-objective analysis attempts to balance the daylight factor against each of privacy, solar heat gain and installation cost criteria. Using examples in three major cities in the MENA region, the research highlights the change in design alternatives depending on the local climatic condition. The proposed model provides designers with guidance through

an automated support tool that yields optimized window designs and layout to ensure the sustainability of their designed buildings.

The remaining two papers focus on the social aspects of sustainable design in planning and architecture. Randeree, in “The social imperative in sustainable urban development: the case of Masdar City in the United Arab Emirates,” examines the social sustainability effectiveness of eco-cities through the case of Masdar City’s strategy for urban sustainability in Abu Dhabi, United Arab Emirates. The paper investigates the social, environmental and economic performance of Masdar City, a purported carbon-neutral, zero-waste urban development. The paper asserts that although Masdar City substantively contributes to innovation in sustainable urban development within environmental and economic contexts and has been effective in capital circulation in green technology markets, the impetus as a commercially driven enterprise is most evident and successful sustainable urban development requires greater consideration for the social imperative.

The final paper by Smits designs and evaluates a design approach for professionals that has the potential to increase residents’ self-reliance in constructing their built environment. The approach intends to enable professionals to advise impoverished rural communities on the methods of building and improving residential dwellings through their own labor and resources. Building on previous publications, the author devises a quasi-experiment to test the design approach within a DRM framework. The experiment and measurement of impact are described. The paper concludes with how the formulated quasi-experiment design will provide researchers working in comparable empirical research with a suitable framework. The framework and the experiment design are unique in their design and application in a vulnerable context, and offer an applicable framework for the increasing demand from humanitarian organizations.

While the total impacts of climate change and urbanization remain to be seen in the MENA region and globally, the challenges of innovative and effective planning and design are being taken up by municipal planners, architects and engineers. The papers in this SI are a contribution to the developing knowledge for the region.

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