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Editorial

Advancing Climate Change Adaptation and Mitigation Strategies in the Tropics

Tropical environments cover a large part of the Earth: almost all the portion of the planetary surface included between latitudes 23.43 North (Tropic of Cancer) and 23.43 South (Tropic of Capricorn) [1]. Tropical climates can be divided in three subclimates: rainforest, monsoon, and savannah [2]. All these climates imply high humidity values and average temperatures of the coldest month greater to 18 °C [3]. In such environments, buildings and cities must face overheating for large periods of the year. Moreover, almost the 40% of humanity is living in these environments [4], and the number is expected to grow to the 50% by the 2050 [5]. Many megalopolises with more than 10.000.000 of inhabitants are placed there: Calcutta (India), Lagos (Nigeria), Rio de Janeiro (Brazil), Canton (China), and Manila (Philippines) are just a few examples.

Energy use in the built environment is a critical aspect of sustainability. In tropical environments, where population is growing fast, energy intensity is expected to rise at a rate of 100–200% in the next years [6] basically due to the need to assure livability of urban and built environments.

Global warming and urban heat island phenomenon are worsening the scenario: tropical cities experienced record temperatures during the last decades in most tropical countries: India 2016 (51.0 °C), Brazil 2020 (44.8 °C), China 2017 (50.5 °C), Nigeria 2010 (46.4 °C), and Ghana 2017 (43.8 °C). Urban heat island phenomenon has been recently addressed and studied [7] for tropical environments, showing intensities in the range of 2–10 °C, during the whole year, and prevalence during the night.

The use of energy, and the nexus of energy with other aspects of urban environment, like water and food supply, will be a key factor in the development of human settlements in areas where the density of population will be very high [8].

Advanced energy systems are needed to manage and control indoor and outdoor environmental parameters [9]. Among the general systems, we should account at least for dehumidification, ventilation, air-conditioning, refrigeration, and solar protection devices. Complex systems are also needed to manage urban heat, so among advanced energy systems, we could include nature-based solutions (NBS) such as green urban areas, blue infrastructure, urban ventilation systems, district cooling, and geothermal systems at urban scale [10].

At building level, new energy systems should combine efficiency improvement, loads reduction, and transition to renewable sources to substantially contribute to global warming mitigation and adaptation to extreme heat [11].

At urban scale, vulnerability to heat is often extreme in neighborhoods where adaptation capacity is poor [12]. That means, that adaptive planning should be intensified and focused on more exposed population. Advanced energy systems for the tropics should also be equally distributed, including basic energy access for all, as prescribed by the sustainable development goals [13].

While considering the relevance of the aforementioned topics, the building-climate interaction can be studied in three main dimensions, each one of them presenting significant opportunities for research contributions:

(a) New building designed as contributors for a decarbonized economy. As energy used in buildings accounts for over 17% of greenhouse gases (GHG) emissions [14], the need for enhanced use of passive measures for comfort conditions in the built environment demands cost-effective and massively adopted technologies, practices, and policies, especially in tropical cities. Additionally, buildings as carbon sinks require new materials and integration of NBS that go beyond the traditional design target of efficient energy consumption. In times when the world braces for high fuels and electricity costs and low availability of key fuels for heating, such as natural gas, the importance of passive measures for comfort becomes more relevant, and part of the energy security equation.

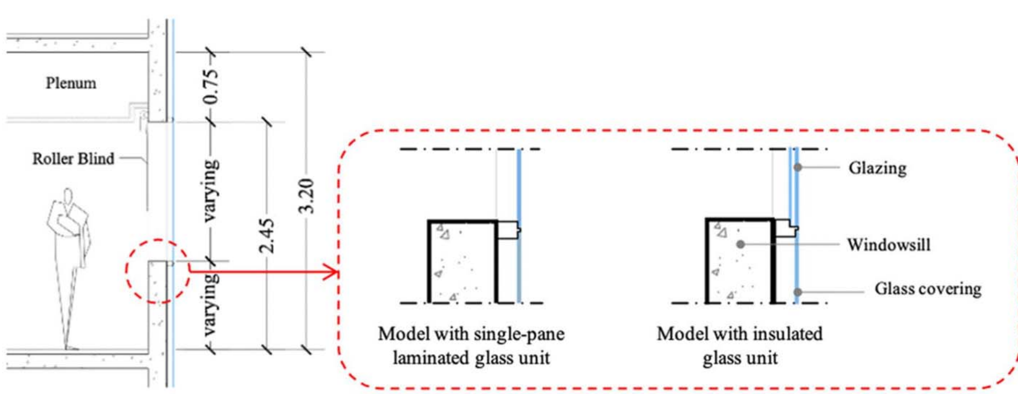

Fig. 1 Glazing analysis for office buildings in Brazil (from Pinto and Westphal [15])

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(b) Buildings resiliency to climate change effects. Although the increase in the average global temperature has an immediate and quantifiable effect on energy consumption in buildings, resiliency to climate change should consider how houses and buildings remain functional and safe spaces under extreme cold or hot waves (especially in areas not traditionally affected by such phenomena), severe storms, floods, and long droughts. This type of challenge requires adaptability, modularity, and new design principles and components for heating, ventilation and air conditioning (HVAC) and hydronics systems, as well as forms of electrical and thermal energy storage at residential scale embedded in the building. Considering that many tropical regions are located in areas with high exposure to climate change effects and are populated with low- and mid-income economies, how to achieve these targets with affordable solutions requires contributions from many disciplines.

(c) Buildings as active players in the energy grid. As distributed energy systems outpace the grow of large, central power plants, and charging stations for electrical vehicles become more popular, the role of buildings in the design, expansion, and operation of the electricity grid is being revisited. As a distributed active contributor to energy supply and energy quality, buildings may not only contribute to a sustainable built environment but also to sustainable cities where efficiencies are achieved at a system scale.

As there is no shortage of technical, scientific, and policy challenges, the field for contributions in sustainable buildings and cities is as wide open, relevant, and current, as it has ever been.

This Special Issue (SI) on Advanced Energy Systems for Buildings and Cities in the Tropics aims to advance this emerging topic by original contributions. This Issue of May 2022 includes two contributions that explore the use of window systems (Fig. 1) for the tropics [15] and sky radiation systems for hot/humid climates [16]. We anticipate additional contributions to the SI in the August 2022 issue, and beyond.

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