Build Simul (2023) 16: 1583–1585
https://doi.org/10.1007/s12273-023-1072-7

Healthy and low-carbon communities: Design, optimization, and new technologies

Jianlin Liu[1] (✉), Xing Zheng[2] (✉), Yixing Chen[3]

(Guest Editors)

1. College of Environmental Science and Engineering, Donghua University, China
2. Future Cities Lab Global, Singapore-ETH Centre, Singapore
3. College of Civil Engineering, Hunan University, China

As the world grapples with the challenges of global warming, the urban heat island (UHI) effect, urban air pollution, and the imperative to transition towards low-carbon economies, the role of communities in fostering sustainability and innovation becomes more critical than ever. For example, the frequent occurrences of air pollution and extreme weather conditions have seriously threatened residents' health and property safety. The global warming and urban heat island effect bring challenges to the climate resilience of communities. Urbanization has accelerated the growth of building stock and urban energy consumption. To avoid catastrophic climate change and energy crisis, communities are under the stress of low-carbon transition. In this sense, communities are not only the primary space to create true sustainability but also the starting point for the use of healthy and low-carbon ideas and novel technologies to address climate change and energy efficiency and promote carbon-neutral cities. Given the nature of communities, which encompass occupants, buildings, and energy systems, holistic and innovative approaches are necessary to address their complexities. These include spatial and temporal dynamics, as well as the multifaceted interplay between energy consumption, climate, and human comfort. A comprehensive assessment of their spatial and temporal characteristics is essential to identify suitable solutions that align with the expectations of users, owners, and society. The need to create healthy and low-carbon communities has prompted research efforts to explore novel design approaches, optimization strategies, and emerging technologies to address these pressing issues. The recent advancements in building simulation techniques, belonging to the scope of this journal, bring both opportunities and challenges in improving the complex processes of design, optimization, and implementation of new technologies for creating healthy and low-carbon communities. This special issue of *Building Simulation* is dedicated to advancing our understanding of the complex interplay between urban environments, building performance, and climate change mitigation, with a focus on creating healthy and low-carbon communities.

This special issue of *Building Simulation* includes 12 original research articles that have rigorous peer review. Each article is associated with one of the following research topics, including (a) optimization of communities towards health, comfort, low carbon/zero carbon emissions, and energy-saving, (b) exploring the interaction between urban neighborhood climate and building performance, bridging multiple scales among cities, communities, and buildings, (c) novel design methodology for creating healthy and low-carbon communities, (d) mitigation of heatwave, heat islands, air pollutants, and extreme weather at the community scale, and (e) urban building energy modeling for energy planning at the community scale. Detailed information of the articles are as follows.

For studies associated with optimization of communities towards health, comfort, low carbon/zero carbon emissions, and energy-saving: Hu et al. (2023) assessed the effects of mask wearing duration and relative humidity on thermal perception in the summer outdoors via questionnaire survey, indicated that mask wearing had a crucial impact on outdoor thermal comfort assessment in a warm-biased outdoor thermal environment. Apart from survey, Lavor

E-mail: jianlin.liu@dhu.edu.cn (Jianlin Liu); xing.zheng@sec.ethz.ch (Xing Zheng)

et al. (2023) assessed the possible high COVID-19 airborne infection risk by adopting computational fluid dynamics (CFD) in deep and poorly ventilated 2D street canyons, and reported that urban morphology played a critical role in controlling airborne infectious disease transmission in outdoor environments, especially under calm winds.

For studies associated with exploring the interaction between urban neighborhood climate and building performance, bridging multiple scales among cities, communities, and buildings: Deng et al. (2023) integrated future weather data with an urban building energy modeling (UBEM) approach to assess the impacts of climate change on the energy consumption of residential buildings. Also, the potential of energy conservation measures (ECMs) in mitigating the impact of climate change on the energy consumption of buildings was examined. Singh and Sharston (2023) addressed the temporal variation of UHI by deriving four normalized UHI indicators that could capture the seasonal and diurnal variation of UHI, facilitating more accurate predictions of building energy consumption in various climate conditions.

For studies associated with novel design methodology for creating healthy and low-carbon communities: Romero Rodríguez et al. (2023) developed a user-friendly tool for creating district geometries and performing dynamic hourly simulations to evaluate building energy demands. It was dedicated to improving the accuracy and efficiency of large-scale building energy assessments. Wang et al. (2023) investigated the potential use cases of the heat battery (HB), a recent proposed closed-loop thermal energy storage (TES) system, by adopting the simulation-based approach to analyze its influence on building performance in various use cases within Dutch residential buildings.

For studies associated with mitigation of heatwave, heat islands, air pollutants, and extreme weather at the community scale: Mohammed et al. (2023) delved into the intricacies of desert urban environments, specifically focused on the implementation of green infrastructure (GI) to mitigate urban heat in Dubai. By employing the weather research and forecasting (WRF) model and considering various fractions of GI, the study showed that increased GI could lead to significant reductions in ambient temperatures during heatwaves. Zhao et al. (2023) reported the urban wind environment under typhoon weather conditions via CFD, particularly the wind flow over mountainous terrain was simulated using a one-way nested simulation approach between mesoscale and microscale models. It addressed the challenges of predicting wind profiles during such an extreme weather event and demonstrated the potential of simulation-based strategies to enhance urban resilience. Fu et al. (2023) presented a physio-chemical model assessing the dispersion of reactive air pollutants around an isolated building. This study exemplified how a deeper understanding of pollutant dispersion could guide building design to reduce human exposure to pollutants. Duman and Seckin (2023) focused on combustion process management, a crucial aspect of the operation of cabin heaters for emergency shelters after an earthquake in the freezing weather. More details about the air–fuel ratio in the combustion chamber of the cabin heater were adjusted to be controlled adaptively depending on system dynamics to get lower carbon emissions and fuel consumption.

For studies associated with urban building energy modeling for energy planning at the community scale: Demir Dilsiz et al. (2023) investigated the sensitivity of uncertain input parameters that affected the annual heating and cooling energy demand by employing UBEM, which further determined the relative influence of each set of input parameters and their interactions on heating and cooling loads for various building forms under different climates. Taken residential blocks in central China as an example, Xu et al. (2023) evaluated the influence of urban morphological factors on building energy consumption, and further indicated their photovoltaic (PV) potential. This study concluded that the energy use intensity (EUI) of residential blocks was mainly affected by shape factor, building density and floor area ratio, while EUI-PV and photovoltaic substitution rate (PSR) were mainly affected by height and sky view factor.

The special issue captures the multifaceted nature of the challenges and opportunities in creating sustainable urban environments. The collected papers contribute to diverse topics and pave the way for a future where communities are resilient, healthy, and aligned with the imperatives of sustainability and carbon neutrality. Those who are interested in the aforementioned topics, the special issue has provided one or more articles that match with their interests. If not, the readers might not be disappointed as the articles represent the most leading-edge recently accepted research results for these topics in the journal. The special issue will not be consolidated without the authors' work and the peer reviewers' efforts. Meanwhile, special thanks are given to the Editor-in-Chief: Professor Da Yan, and the other editors for their kind supports and valuable suggestions in preparing this issue.

References

Demir Dilsiz A, Ng K, Kämpf J, et al. (2023). Ranking parameters in urban energy models for various building forms and climates using sensitivity analysis. *Building Simulation*, 16: 1587–1600.

Deng Z, Javanroodi K, Nik VM, et al. (2023). Using urban building energy modeling to quantify the energy performance of

residential buildings under climate change. *Building Simulation*, 16: 1629–1643.

Duman E, Seckin D (2023). Enhancing the efficiency of cabin heaters in emergency shelters after earthquakes through an optimized fuzzy controller. *Building Simulation*, 16: 1759–1776.

Fu Y, Lin X, Zheng X, et al. (2023). Physio-chemical modeling of the NO_x-O_3 photochemical cycle and the air pollutants' reactive dispersion around an isolated building. *Building Simulation*, 16: 1735–1758.

Hu R, Liu J, Xie Y, et al. (2023). Effects of mask wearing duration and relative humidity on thermal perception in the summer outdoor built environment. *Building Simulation*, 16: 1601–1616.

Lavor V, Coceal O, Grimmond S, et al. (2023). Possible high COVID-19 airborne infection risk in deep and poorly ventilated 2D street canyons. *Building Simulation*, 16: 1617–1628.

Mohammed A, Khan A, Santamouris M (2023). Numerical evaluation of enhanced green infrastructures for mitigating urban heat in a desert urban setting. *Building Simulation*, 16: 1691–1712.

Romero Rodríguez L, Sánchez Ramos J, Álvarez Domínguez S (2023). Building geometry data from online maps for accurate thermal simulations of districts. *Building Simulation*, 16: 1659–1674.

Singh M, Sharston R (2023). Normalized urban heat island (UHI) indicators: Classifying the temporal variation of UHI for building energy simulation (BES) applications. *Building Simulation*, 16: 1645–1658.

Wang S, Hoes P-J, Hensen JLM, et al. (2023). Investigating the use cases of a novel heat battery in Dutch residential buildings. *Building Simulation*, 16: 1675–1689.

Xu S, Sang M, Xie M, et al. (2023). Influence of urban morphological factors on building energy consumption combined with photovoltaic potential: A case study of residential blocks in central China. *Building Simulation*, 16: 1777–1792.

Zhao Z, Xiao Y, Li C, et al. (2023). Multiscale simulation of the urban wind environment under typhoon weather conditions. *Building Simulation*, 16: 1713–1734.