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Editorial: Urban environments and climate change: relationships and impacts

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Editorial on the Research Topic
Urban environments and climate change: relationships and impacts

The significant changes occur in land use and land cover (LULC) due to population and urbanization growth, affecting the environment and climate of the region (Sadiq Khan et al., 2020). Consequently, biophysical weather patterns, Earth's energy balance, and surface energy budgets are influenced within metropolitan areas. The Research Topic "*Urban Environments and Climate Change: Relationships and Impacts*" provides useful insights into the interaction between atmospheric dynamics, urban structure, and climate change mitigation strategies. The research articles published within this topic develop our understanding of urban growth and its relationship to climate change, greenhouse gases (GHGs) emissions, and, conversely, how urban settings are affected by changing climatic conditions. Urban environments are significantly experiencing the climate change discourse. The amplification of the urban heat island (UHI) effect, land use changes, and rapid urbanization are shaping the sustainability of cities globally (Shahfahad et al., 2022). This editorial highlights the urgent necessity for policy interventions on sustainable urban planning by critically engaging with these findings.

The urban boundary layer model in Jakarta has provided a deep understanding of how LULC changes have significantly influenced Jakarta's urban temperatures (Maheng et al.). This study used UrbClim model and employed LULC data from 1995 to 2014 from the European Centre for Medium-Range Weather Forecasting (ECMWF). The tree-covered areas were dramatically reduced by 58 percent, the urban areas increased by 44 percent, and the corresponding increase in impervious surfaces has escalated the UHI effect over the 20-year study period. The UHI effect has been amplified due to these transformations, highlighting the need for preserving green spaces to maintain thermal comfort and mitigate rising temperatures in urban areas. Similarly, a study in Sri Lanka explains the association between urban surface temperature and landscape structure changes over 26 years (Wijesinghe et al.). This study reveals a 42.3 percent increase in impervious surfaces, 22.5 percent decrease in green spaces, and a 2.74°C rise in mean surface temperature over this period. The UHI effect has intensified due to rapid urban expansion and reduced green cover, amplifying the need to integrate green infrastructure in urban planning to counter heat accrual.

The urban climate variations are significantly affected by local land use changes and broader atmospheric conditions. A study presents the role of large-scale atmospheric forcing and local boundary layer effect in Lausanne, Switzerland (Hamze-Ziabari et al.). The study demonstrates how local climate responses to large-scale forcing can be modified by urban ventilation and wind patterns. The temperature anomalies were found correlating with moderate wind patterns by using microscale computational fluid dynamics (CFD) model, a feature usually ignored by other traditional mesoscale models. Therefore, this research emphasizes the significance of terrain complexity and urban morphology in climate assessments, highlighting the importance of mitigation strategies that should be modified according to the unique atmospheric dynamics of each city.

Urban sustainability is closely linked to emission mapping and carbon suitability in addition to ventilation and temperature. A study presents an Urban Living Space Carbon Suitability Index (ULS-CSI) in Tianjin, China, showing considerable differences in carbon suitability among various municipalities (Yin et al.). Climate resilience can be promoted by addressing carbon inequality and integrating this index into urban planning strategies. Another study was conducted in Berlin (Anjos and Meier) by using an innovative approach of machine learning-based high-resolution traffic modeling to track street-scale carbon dioxide emissions. The emission hotspots were identified providing the foundation for data-driven policies to reduce carbon footprints and regulate traffic flows in urban regions. The CO_2 values reaching 1.639 $kgCO_2\ m^{-2}\ day^{-1}$ on major highways, indicating them as major sources of emissions. This research highlights the importance of urban greenhouse inventories in taking effective climate action in urban areas.

Collectively, these studies comprehensively depict the opportunities and challenges urban environments are facing in the time of climate change. These studies highlight the need for using multidisciplinary approaches blending machine-learning, atmospheric science, and spatial analysis for effectively managing urban climates. These research studies may strengthen the decision-making for implementing green infrastructure projects, regulating land use transformations, and integrating carbon suitability frameworks. To ensure urban resilience measures are scientifically robust and spatially relevant, local adaptation strategies should be in accordance with large-scale atmospheric dynamics. Understanding carbon suitability, atmospheric dynamics, land use, and their intricate relationships have become more crucial as cities grow. The results of these studies are paving the way for enhancing sustainability, reducing emissions, addressing the climate crisis, offering actionable insights, and creating better environments for the future.

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References

Shahfahad, Naikoo, M. W., Islam, A. R. M. T., Mallick, J., and Rahman, A. (2022). Land use/land cover change and its impact on surface urban heat island and urban thermal comfort in a metropolitan city. *Urban Clim.* 41, 101052. doi:10.1016/j.uclim.2021.101052

Sadiq Khan, M., Ullah, S., Sun, T., Rehman, A. U., and Chen, L. (2020). Land-use/land-cover changes and its contribution to urban heat island: a case study of iIslamabad, Pakistan. *Sustainability* 12 (9), 3861. doi:10.3390/su12093861