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Editorial: Intelligence and big data for sustainable urban built environment

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Editorial on the Research Topic
Intelligence and big data for sustainable urban built environment

As the global population is increasingly concentrated in urban areas, cities have become the centers of economic growth and cultural development, resulting in a series of complex and unexpected challenges. For instance, climate change is leading to more frequent and intense events, such as urban flooding and heatwaves, and high-density living generates more pollution and puts greater pressure on public health systems. Moreover, balancing development with environmental quality and cultural preservation is becoming more difficult. To address these challenges, a paradigm shift in urban management is emerging, from traditional, passive practices to active, data-driven strategies. This Research Topic compiles a series of studies that are leading this transformation and demonstrates how advanced digital technologies can help create more sustainable, resilient, and livable cities.

This Research Topic of articles explores the application of digital technologies in various areas and scales of urban environment management. A key focus is on the utilization of high-resolution spatial technologies to monitor, assess, and manage environmental risks more efficiently and accurately. For example, Woo et al. developed a methodology using Unmanned Aerial Vehicles (UAVs) and Geographic Information Systems (GIS) to rapidly estimate flood areas and volumes in urban environment. By creating detailed 3D terrain models from aerial images, the proposed approach provides decision-makers with a valuable tool for urban disaster management by enabling them to access accurate and actionable data much faster than with traditional surveys or satellite images.

Similarly, with the focus on advanced spatial data for sustainable urban management, Ezz et al. demonstrated the feasibility of using 3D GIS to preserve UNESCO World Heritage Sites in Saudi Arabia. By integrating historical records, building designs, and structural details into a single digital system, a comprehensive platform was built for planning conservation work, assessing risks, and supporting informed decision-making. This work underscores that urban resilience relies not only on

environmental protection but also on the preservation of cultural heritage for future generations. In this mission, digital twin technologies have proven to be essential tools.

In addition to environment monitoring and assessment, computational modeling and simulation are also key tools for designing healthier urban spaces. Wang et al. investigated the effect of urban ventilation on mitigating the urban heat island and improving public health. To this end, a new hybrid grid method was developed for Computational Fluid Dynamics (CFD) simulations that effectively balances computational cost and accuracy. By using fewer grids, this method makes large-scale, detailed studies of urban airflow more practical. This advancement assists architects and planners in designing buildings and city layouts that enhance the natural ventilation.

Qiao and Luo introduced a novel deep learning framework to analyze the complex, nonlinear demand for urban green spaces. Moving beyond single-indicator assessments, an autoencoder was employed to integrate environmental data, such as land surface temperature and CO_2 concentration, with social indicators, such as population density. The findings revealed significant variations in demand for green space across different locations, providing a data-based tool to determine optimal locations for green infrastructure development. This work exemplifies the shift toward using artificial intelligence (AI) to better understand and address the multifaceted needs of both urban environments and their inhabitants.

The power of digitization to create change extends beyond specific applications to the broader realms of economic policy and governance. Jiang et al. examined the relationship between the digital economy and urban ecological development. Using an advanced double machine learning method with data from 282 Chinese cities, they proved strong evidence that the digital economy can improve ecological resilience and recovery. The analysis further revealed that this effect occurs mainly through promoting green innovation, improving environmental efficiency, and optimizing industrial structures. Similarly, Zhang et al. assessed the impact of industrial digitization on the synergistic reduction of pollution and carbon emissions. The findings confirm that digitization has direct positive impacts and generates beneficial spatial spillover effects, promoting cleaner practices in neighboring regions by using more renewable energy and developing greener industrial processes.

Finally, to bridge the gap between broad policy initiatives and real-life human behavior, Wang et al. introduced a mobile crowdsensing framework of "CrowdRadar", which was designed to assess the safety risks associated with green travel modes, such as cycling and walking. By leveraging mobile edge devices, computer vision, and deep learning, the developed system can detect high-risk behaviors in real time while protecting user privacy. The authors emphasized that a sustainable city must prioritize safety first and highlighted how citizen-centered data can provide detailed insights to help create urban settings that better support low-carbon transportation.

In summary, the articles in this Research Topic provide a clear picture of the rapidly evolution of intelligent and digital technologies in urban studies. This Research Topic shows that digital innovations are equipping us with the essential tools to address the challenges of urban growth, from drone mapping floodwaters to AI models that analyze park usage to digital economies that foster green growth and smartphones that help secure safer streets. Although creating sustainable and resilient cities is challenging, these studies in the Research Topic demonstrate that big data and smart technologies can play a critical role in advancing this future transition.

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