

Chapter 21

Smart Cities and Blue–Green Infrastructure: The Role of Machine Learning in Sustainable Solutions

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ABSTRACT

Smart cities are increasingly adopting sustainable practices to improve urban living while addressing environmental concerns. One key component of this movement is blue-green infrastructure (BGI), which integrates water management (blue) and vegetation (green) systems to enhance urban resilience, biodiversity, and sustainability. In tandem with these efforts, machine learning (ML) plays a critical role in optimizing the design, implementation, and maintenance of BGI in smart cities. ML algorithms provide the ability to process large datasets from sensors, weather forecasts, and environmental variables to create predictive models that enhance decision-making in urban planning. This paper explores the convergence of smart city initiatives, blue-green infrastructure, and machine learning, examining how advanced data-driven technologies can support sustainable urban development. Key applications include real-time monitoring of water management systems, pre-

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dicting environmental impacts, optimizing resource allocation, and automating the management of green spaces. The integration of machine learning with blue-green infrastructure offers cities a transformative pathway toward more sustainable, resilient, and efficient environments.

INTRODUCTION

Urbanization is transforming the landscape of cities worldwide, leading to increased population density, resource consumption, and environmental challenges. As cities continue to grow, there is an urgent need to develop sustainable solutions that enhance urban living while mitigating environmental impacts. This need has given rise to the concept of smart cities, which leverage advanced technologies to improve the quality of life for residents while addressing ecological concerns.

The evolution of smart cities involves the integration of information and communication technologies (ICT) to create interconnected urban environments. These cities utilize data collected from sensors, devices, and social media to inform decision-making and enhance service delivery. However, as urban areas expand, the challenges of managing water resources, biodiversity, and public spaces become increasingly complex. This complexity necessitates innovative approaches that blend technology with ecological considerations. The literature on Blue-Green Infrastructure (BGI) highlights its crucial role in promoting sustainable urban environments and mitigating climate-related challenges. Islam et al. (2024) utilized geospatial and machine learning techniques to evaluate the cooling effects of BGI in metropolitan areas, demonstrating its potential for enhancing urban thermal comfort. Similarly, Jia and Zhang (2021) explored the economic benefits of urban green and blue spaces in Wuhan, showcasing how big data and machine learning can inform urban planning. Innovations in BGI have been emphasized by de Oliveira et al. (2022), who addressed both local and global urban challenges, while Visan and Mone (2023) highlighted the importance of computer-supported management systems for effective BGI implementation. The critical analysis of BGI in developing countries was conducted by de Macedo et al. (2021), underlining the need for tailored approaches to enhance urban resilience. Keita and Kourouma (2024) further emphasized the significance of BGI in enhancing urban resilience and sustainability, particularly in the context of climate change. Zhang et al. (2020) modeled a business case for BGI using the water-sensitive cities toolkit, illustrating its economic viability. Krivtsov et al. (2023) discussed BGI's multifaceted benefits in achieving urban flood resilience, water security, and biodiversity. The challenges and opportunities for BGI planning in Stockholm were presented by Suleiman (2021), while Gupta et al. (2024) focused on BGI's effectiveness in mitigating the Urban Heat Island effect. Chen et al. (2021)

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