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# Editorial: Blue-Green Infrastructure: key to sustainable urban development

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## KEYWORDS

Blue-Green Infrastructure, climate change, geospatial analysis, nature-based solutions, water conservation

Editorial on the Research Topic

[Blue-Green Infrastructure: key to sustainable urban development](#)

Water (Blue) and vegetation (Green) form an integral part of human existence. Rapid urbanization has led to the neglect of naturally available resources on which settlements were built. The over-exploitation of water bodies, topography, and natural vegetation is the reason the developed world is facing multiple issues today, such as the urban heat island effect, pollution, flooding, groundwater depletion, and deteriorating environmental quality, among others. An approach that integrates “blue” water-based elements (e.g., rivers, wetlands, and ponds) with “green” land-based features (e.g., parks, trees, and gardens) creates resilient, nature-based networks and leads to Sustainable development. In today’s context, planners are required to give attention to these naturally available resources to improve the quality of life for residents/citizens. The inclusion of Blue-Green Infrastructure (BGI) in urban development plans promotes sustainable development and also addresses the concerns raised in the WHO’s Sustainable Development Goals (SDGs).

During the development of this Research Topic, we encountered numerous concerns and challenges, foremost the absence of methods and methodologies to achieve climate resilience, biodiversity, and improved public health and environmental quality. In urban areas, the provision of continuous path for pedestrian and fauna movement through BGI helps improve connectivity while also acting as ecological ‘lungs’ that enhance air quality and as ‘sinks’ that absorb pollutants and urban runoff in densely populated environments. It also contributes to addressing green mobility and urban flooding simultaneously. Urban flooding has become a frequent phenomenon and a key concern due to the impact of climate change, land use, and land cover changes, coupled with an increase in vulnerable areas and population.

This Research Topic consists of four research articles. In the study *Integrating “Life cycle assessment into green infrastructure: a systematic review and meta-analysis of urban sustainability strategies”* (Khalifi et al.), the authors searched several prominent academic databases (Web of Science, Science Direct, and Google Scholar) using keywords related to Life Cycle assessment (LCA), Life cycle costing (LCC), Green Infrastructure (GI), urban sustainability indicators, and environmental indicators (including carbon emissions, water footprint, energy use, land use, and air pollution). LCA showed a positive correlation with

water footprint and a negative correlation with energy consumption, suggesting a water-energy trade-off. Social LCA, on the other hand, showed a positive correlation with air pollution, highlighting concerns about social health. The study observed that Asia and Europe lead the research on BGI; however, Europe demonstrates higher policy effectiveness in sustainability as compared to Asia, particularly in energy efficiency and air quality. The study concludes that, while GI is vital for urban sustainability, current LCA methodologies have limitations in fully capturing its benefits, particularly concerning long-term carbon offsetting and ecosystem services. Standardizing LCA methodologies, integrating environmental, economic, and social evaluations, and developing financial incentives are critical for the effective policymaking and practical application of GI to achieve resilient and sustainable urban futures.

The second article, “*Conceptual framework to incorporate drainage solutions in the urban open space system*” (Miguez et al.) introduced a new zoning category, Hydrological Interest Area (HIA), using four criteria: legally protected areas, coastal lowlands, flat open spaces (with slopes up to 0.5%), and riverine flood-prone regions. The proposed framework’s effectiveness was evaluated using the Urban Flow-Cell Model (MODCEL), a hydrological-hydrodynamic simulation tool, to map flood extents under current, expansion, and proposed design scenarios. This assessment focuses on reducing water depths and consequently flood exposure. The framework was tested in the Bambu Watershed, where it demonstrated significant reductions in flood exposure. The design alternative scenario showed a considerable decrease in water depths, especially downstream. Road exposure to floods over 0.15 m dropped from 33 to 35 km to 25 km, and buildings exposed to depths over 0.30 m decreased from over 8,000 to approximately 3,700. Major damage (over 1.00 m) saw a dramatic reduction from 353 to 363 to just 2 buildings. The study demonstrated that application of this framework significantly reduces flood risk, water depths, and the exposure of buildings and roads, particularly in critical areas, while promoting multifunctional land use and a harmonious relationship between the natural and built environments.

The research article “*Impact assessment of green infrastructure and urban growth on stormwater runoff through geospatial modelling*” (George et al.) assessed stormwater runoff (SWR) under four scenarios: baseline, past, severe, and green. Using a Cellular Automata–Markov model based on historical land-use data and driving factors such as distance from roads, residential areas, and slope. Green infrastructure (GI) suitability analysis was conducted using the Analytic Hierarchy Process (AHP). Peak runoff for all scenarios was estimated using the rational method, which incorporates runoff coefficients derived from land use/land cover (LULC) data and rainfall intensities. The implementation of Green Infrastructure (GI) in the “Green Scenario” resulted in a reduction of peak runoff by 16% compared to the baseline scenario and by 18% compared to the severe scenario. The research concluded that urban growth significantly increases SWR, exacerbating urban flood risks due to the reduction of green spaces. The study demonstrates that implementing green infrastructure (GI) through suitability analysis and urban planning guidelines can effectively

mitigate these risks by reducing peak runoff. These findings highlight the importance of integrating GI into urban planning to improve resilience against urban flooding.

The final article in this Research Topic, “*Promoting integrated blue–green infrastructure for urban resilience—lessons learned from case studies*” (Jagadisan) employed a case study approach to analyze various international and national examples of Blue-Green Infrastructure (BGI) projects from China, Portland, and India. The methodologies involve reviewing evidence, analyzing project outcomes, and drawing lessons from these diverse implementations to understand the benefits of integrated BGI for urban resilience and wellbeing. The research concludes that integrated BGI is a crucial component for addressing the climate change crisis and enhancing urban resilience and wellbeing. Lessons learned from various case studies highlight the universal value of integrated BGI in promoting health, both physical and mental. These findings advocate for practitioners to promote BGI, integrate it into policy and planning, and design BGI projects to maximize health benefits, thereby supporting decision-makers in prioritizing holistic, socially inclusive BGI initiatives.

In summary, the insights outlined in this issue reiterate that integrating BGI has the potential to transform urban areas into sustainable environments. With growing urbanization and the cumulative effects of ongoing climate change, ignoring natural ecosystems in urban areas has amplified vulnerabilities and disasters, such as flooding, heat stress, pollution, and environmental degradation. BGI offers an integrative and nature-based solution (NBS) that can restore the ecosystem and also enhance the resilience of urban areas.

The research articles in this issue presented a number of tools, such as Life Cycle Assessment, hydrological modeling, and geospatial analysis, to measure the multiple benefits of BGI. They also highlight the benefits and constraints faced during the implementation of BGI solutions. Furthermore, they discuss gaps in standardized methodologies, long-term evaluations, and policy integration frameworks. The experiences drawn from diverse case studies underscore that the implementation of BGI needs an interdisciplinary team and strong institutional support, and a one-size-fits-all approach cannot work for BGI. Integration of BGI into urban development and policy not only provides solutions to environmental issues but also aligns with the broader objectives of global sustainability.

Finally, this issue implores planners, policymakers, and researchers to adopt integrated and evidence-based approaches and prioritize BGI to achieve a sustainable, resource-efficient, people-centric, and climate-resilient urban future.

## Author contributions

KG: Writing – original draft, Writing – review & editing. KP: Writing – original draft, Writing – review & editing. RB: Writing – review & editing. DI: Writing – review & editing. TK: Writing – review & editing.

## Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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