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EDITED AND REVIEWED BY
Riccardo Buccolieri,
University of Salento, Italy

*CORRESPONDENCE
Cristina M. Monteiro,
✉ cmonteiro@ucp.pt

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Editorial: Urban nature-based solutions and green infrastructure as strategies for climate change adaptation

Cristina Matos^{1,2}, Cristina M. Monteiro^{3*}, Cristina Santos^{1,4},
Ana Briga-Sá^{2,5} and Monzur Alam Imteaz⁶

¹CIIMAR – Centro Interdisciplinar de Investigação Marinha e Ambiental, Matosinhos, Portugal, ²Escola de Ciências e Tecnologia- Departamento de Engenharias, UTAD - Universidade de Trás os Montes e Alto Douro, Vila Real, Portugal, ³CBQF - Centro de Biotecnologia e Química Fina, Escola Superior de Biotecnologia - Universidade Católica Portuguesa, Porto, Portugal, ⁴Departamento de Engenharia Civil, FEUP - Faculdade de Engenharia da Universidade do Porto, Porto, Portugal, ⁵CQ-VR-Centro Química Vila Real, Vila Real, Portugal, ⁶Swinburne University of Technology, Hawthorn, VIC, Australia

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Editorial on the Research Topic

[Urban nature-based solutions and green infrastructure as strategies for climate change adaptation](#)

The consequences of climate change, such as flooding, urban heat island effects, heat waves, and air pollution, pose serious threats to urban environments, which are exacerbated by the significant increase in impervious surfaces. The European Union (EU) is committed to tackling these impacts and aims to become the world's first climate-neutral continent, in line with the key climate and energy targets launched last decade. Nature-based Solutions (NbS) are designed to use our environmental resources without significantly altering the natural habitat; this not only reduces our carbon footprint but also renders cost-effective solutions. NbS measures are proven to benefit our environment and are likely to increase urban resiliency to climate change. However, as an emerging concept, they need further investigation. This Research Topic focused on urban NbS research (rain gardens and green infrastructure, such as green roofs and green walls) and aimed to welcome a Research Topic of high-quality research outputs on minimizing climate change impacts. The published contributions will allow the scientific community to shed light on the technical solutions to improve urban sustainability and resiliency, with a focus on NbS solutions to mitigate the effects of climate change.

[Applegate and Tilt](#) published an interesting paper on how the concept of urban resiliency is operationalized across spatial scales. This paper is an important contribution to the Research Topic, as much of the work about green cities falls under the concepts of urban resiliency, Green Infrastructure (GI), and Ecosystem Services (ES). This study seeks to understand the criteria considered for the planning, development, implementation, and maintenance of urban resiliency at the city and international levels. The present work, by clarifying wide-ranging terms like resiliency, ecosystem services, and Green Infrastructure, performs a comparative analysis that provides a detailed understanding of the similarities and differences between plans

from a national perspective, along with an analysis of city-to-city comparisons. The results suggest that there are differences in the focus on key aspects of resiliency and the strategies suggested for resilient cities. Key differences were found in the importance placed on transportation, the future role of GI, and the definitions of ES, which may have potential impacts on the outcomes of resiliency project development and maintenance. Another important aspect is that urbanization presents sustainability challenges for the natural environment, resources, and ecological systems, while high levels of pollution and disconnection from the natural environment can adversely impact the health and wellbeing of urban residents.

O'Sullivan et al. examined findings from community focus groups that explored perceptions of a proposed sustainable urban development in Wales, United Kingdom (Biophilic urbanism and biophilic design) that included the incorporation of nature and green infrastructure within the city in order to positively affect human health and wellbeing, in addition to benefiting environmental, social, and economic sustainability. This research looked at how community members understood and negotiated possible development impacts on the social, environmental, and economic landscape of the city by drawing on their own experiences.

Also approaching social aspects, Sturiale et al. surveyed the citizens of Catania (Italy) and analyzed the perception of GI in tackling the effects of climate change. This study revealed the level of awareness of climate change, the value attributed to GI, and finally the willingness to pay to contribute to the maintenance of GI in the city. The results showed that the citizens involved perceive GI as strategic elements of urban quality of life, although they are not always aware of their positive impact on climate change. This type of study is important because understanding citizens' views will be a strategic tool for planning and managing public investments in GI as solutions to improving the quality of life in the urban ecosystem.

Khajah et al. presented work in a completely different area within the NbS. They analyzed the efficiency of a multistage vertical flow mesocosm-constructed wetland system, an NbS, in treating domestic wastewater with a high nitrogen (N) load. This study demonstrated the benefits of step-feeding strategies in tidal flow-constructed wetlands as a cost-effective solution to minimize external carbon input and achieve effective N removal.

Published papers on this Research Topic add significant knowledge regarding the implementation of NbS and GI in urban environments in several aspects.

Applegate and Tilt published paper, adds knowledge to the current literature, in the systematization criteria on the several terms used to describe city urban resiliency in all the dimensions (planning, development, implementation and maintenance), showing that differences in the way problems are framed can impact resiliency planning at different scales. Furthermore, the novelty of the presented methodology of analyzing planning documents, lies within its possibility to be employed on other cities, allowing its comparison between different scales, and providing detailed understanding of the similarities and differences in resiliency concepts which may have potential impacts on outcomes for resiliency project development and maintenance.

The novelty of the paper published by O'Sullivan et al. is related to biophilic urbanism and design and its aim to be sustained by

communities, offering an approach to sustainable urban development and establishing positive human-nature connections. Furthermore, the present paper has an innovative feature with respect to the current literature when trying to address the gap related to the design phase and adoption of biophilic design in high-rise buildings and the possible social or cultural impacts that may be experienced as a result.

The originality of the work by Sturiale et al. lies in the potential of the approach used to become an effective and widely used tool for planning urban GI's implementation and involving citizens in GI's co-management (planning and monetary contribution). It was concluded that the involvement of the population will contribute to the easy acceptance of strategic public investments for the implementation of GI and to changing the attitude of citizens in terms of recognition and awareness of the importance of urban greening and the related benefits on climate change mitigation, which for some citizens are still questionable, confirming that there is still a cultural gap that must be urgently addressed.

From a different GI perspective, the value of the study by Khajah et al. lies in the design and development of a multistage vertical flow constructed wetland with a tidal flow strategy coupled with a step-feed approach that was able to efficiently treat synthetic domestic wastewater, removing high concentration levels of organic and nitrogen loads, through diverse bacterial metabolic pathways.

The different contributions show that NbS is on the agenda and that its benefits should be further developed and researched, taking into account social, economic, and environmental aspects. In general, NbS systems are perceived by stakeholders as a cost-intensive burden, as they require significant initial investments. However, a payback period analysis considering all social and environmental benefits often depicts a true cost-benefit picture of such a system. Future studies should focus on case studies of such payback period analysis that translate some intangible environmental benefits.

Author contributions

CMa: Writing—original draft. CMO: Writing—review and editing. CS: Writing—review and editing. AB-S: Writing—review and editing. MI: Writing—review and editing.

Conflict of interest

The authors declare that the research 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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