TeMA

Journal of Land Use, Mobility and Environment

print ISSN 1970-9889 e-ISSN 1970-9870
FedOA press - University of Naples Federico II

DOAJ anvur Rivista scientifica di classe A - 08/F1 Scopus WEB OF SCIENCE

Multilevel scientific approach to impacts of global warming on urban areas, energy transition, optimisation of land use and emergency scenario

Vol.18 n.2
August 2025

TeMA Journal was established with the primary objective of fostering and strengthening the integration between urban transformation studies and those focused on mobility governance, in all their aspects, with a view to environmental sustainability. The three issues of the 2025 volume of TeMA Journal propose articles that deal with the effects of Global warming, reduction of energy consumption, immigration flows, optimization of land use, analysis and evaluation of civil protection plans in areas especially vulnerable to natural disasters and multilevel governance approach to adaptation.

TeMA is the Journal of Land Use, Mobility and Environment and offers papers with a unified approach to planning, mobility and environmental sustainability. With ANVUR resolution of April 2020, TeMA journal and the articles published from 2016 are included in the A category of scientific journals. The articles are included in main scientific database as Scopus (from 2023), Web of Science (from 2015) and the Directory of Open Access Journals (DOAJ). It is included in Sparc Europe Seal of Open Access Journals, and the Directory of Open Access Journals.

TeMA Journal of
Land Use, Mobility and Environment

NEW CHALLENGES FOR XXI CENTURY CITIES:
Multilevel scientific approach to impacts of global warming on urban areas, energy transition, optimisation of land use and emergency scenario

2 (2025)

Published by
Laboratory of Land Use, Mobility and Environment
DICEA - Department of Civil, Building and Environmental Engineering
University of Naples Federico II, Italy

TeMA is realized by CAB - Center for Libraries at University of Naples Federico II using Open Journal System

Editor-in-Chief: Rocco Papa
print ISSN 1970-9889 | online ISSN 1970-9870
Licence: Cancelleria del Tribunale di Napoli, n°6 of 29/01/2008

Editorial correspondence
Laboratory of Land Use, Mobility and Environment
DICEA - Department of Civil, Building and Environmental Engineering
University of Naples Federico II
Piazzale Tecchio, 80
80125 Naples (Italy)

https://serena.sharepress.it/index.php/tema
e-mail: redazione.tema@unina.it

The cover image was created using an AI tool, taking into account the thematic content of the articles included in this issue.

TeMA - Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include: engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science and complex systems.
With ANVUR resolution of April 2020, TeMA Journal and the articles published from 2016 are included in A category of scientific journals. The articles published on TeMA are included in main international scientific database as Scopus (from 2023), Web of Science (from 2015) and the *Directory of Open Access Journals* (DOAJ). TeMA Journal has also received the *Sparc Europe Seal* for Open Access Journals released by *Scholarly Publishing and Academic Resources Coalition* (SPARC Europe). TeMA is published under a Creative Commons Attribution 4.0 License and is blind peer reviewed at least by two referees selected among high-profile scientists. TeMA has been published since 2007 and is indexed in the main bibliographical databases and it is present in the catalogues of hundreds of academic and research libraries worldwide.

TeMA Journal of
Land Use, Mobility and Environment

NEW CHALLENGES FOR XXI CENTURY CITIES:
Multilevel scientific approach to impacts of global warming on urban areas, energy transition, optimisation of land use and emergency scenario

2 (2025)

Contents

REVIEW NOTES

TeMA Journal of Land Use, Mobility and Environment

TeMA 2 (2025) 315-320
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6093/1970-9870/12350
Received 9th April 2025, Available online 31st August 2025

http://www.serena.unina.it/index.php/tema

REVIEW NOTES – Urban planning literature review

Exploring open and green space characteristics for climate change adaptation: a focus on flooding phoenomenon

Tonia Stiuso

Department of Civil, Building and Environmental Engineering
University of Naples Federico II, Naples, Italy
e-mail: tonia.stiuso@unina.it
ORCID: https://orcid.org/0009-0006-2474-8138

Abstract
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always remaining in the groove of rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of continuously updating emerging topics concerning relationships between urban planning, mobility, and environment, through a collection of short scientific papers written by young researchers. The Review Notes are made of five parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal. In particular, the Urban planning literature review section presents recent books and journals on selected topics and issues within the global scientific panorama.
For the second issue of TeMA Journal volume no. 18, this section provides a comprehensive overview of the challenges and solutions related to the role of open and green spaces in climate change adaptation, with particular attention to the urban flooding risks. Using a variety of scientific sources and practical resources, this contribution aims to identify the key characteristics of these spaces that can influence adaptation strategies, examining the solutions proposed in the scientific literature, specifically in books, journals, and reports.

Keywords
Open space; Green areas; Literature review; Climate change adaptation; Flooding risks

How to cite an item in APA format
Stiuso, T. (2025). Exploring open and green space characteristics for climate change adaptation: a focus on the urban heat island. *TeMA - Journal of Land Use, Mobility and Environment*, *18* (2), 315-320. https://doi.org/10.6092/1970-9870/12350

1. Introduction

Urban areas globally are becoming increasingly vulnerable to the effects of climate change, and among the most pressing challenges are flooding, which poses a growing threat to modern cities (Kabisch et al., 2017). The increased frequency of extreme weather events, coupled with rapid urbanisation and the expansion of impermeable surfaces, has generated favourable conditions for the occurrence of urban flooding (Duan et al., 2016). In this scenario, built open spaces and green areas emerge as key elements in climate adaptation strategies, offering multifunctional solutions capable of responding to both mitigation and adaptation needs (Lai, 2021). Numerous studies have highlighted the close relationship between urban morphology and flood risk, highlighting how the configuration, connectivity and characteristics of open spaces directly influence urban resilience in the face of flood events (Pauleit et al., 2017).

Traditional solutions based on engineering works such as drainage systems and concrete channels have often proven inadequate to cope with the increased intensity and frequency of extreme rainfall (Fletcher et al., 2015). This has encouraged a paradigm shift, directing planners and researchers towards the adoption of greening solutions, which enhance the role of green and open spaces in managing storm runoff. In this context, the concept of ecosystem services has become central to understanding how green and open spaces can effectively contribute to urban flood risk mitigation (Andersson et al., 2014; Mohamed Thariq & Mohamed Mujithaba Mohamed, 2024).

These environments provide regulating services through mechanisms such as infiltration, retention and evapotranspiration of water, while offering supply and support benefits that are critical to improving the quality of life in cities (Gómez-Baggethun & Barton, 2013). However, the effectiveness of such spaces in reducing hydraulic risk is highly dependent on: size, connectivity, soil condition and use, vegetation type and distribution within the urban fabric (Pennino, 2024).

2. Agreements and strategies developed at international level

Managing urban flooding through the strategic use of green and open spaces is increasingly recognised in major international agreements and strategies as a key component of climate change adaptation. The 2015 Paris Agreement laid the foundation for global climate action by emphasising the importance of ecosystem solutions (UNFCCC, 2015), while the UN Framework Convention on Climate Change promoted Nature-Based Solutions (NBS) as an integrated approach to address mitigation and adaptation simultaneously (UN, 2015). In parallel, the Sendai Framework for Disaster Risk Reduction (2015-2030) highlighted the role of green infrastructure in disaster risk reduction, encouraging the adoption of natural solutions in planning and reconstruction processes (UNDRR, 2015).

In the European context, the EU Green Infrastructure Strategy, defined by the 2013 Commission Communication, identified water management and flood prevention as central priorities, supported by the Floods Directive and the Water Framework Directive. The European Green Deal and the Biodiversity Strategy 2030 further consolidated these goals, promoting the creation of urban green spaces and ecological corridors to strengthen urban resilience.

Globally, the New Urban Agenda adopted during Habitat III in 2016 promoted sustainable cities through green space planning for climate adaptation, while the C40 Cities initiative provided operational guidelines for implementing green infrastructure in stormwater management (Ascione, 2025).

Finally, the UN Sustainable Development Goals, in particular SDG 11 and SDG 13, have set specific targets for universal access to urban green spaces and the implementation of ecosystem-based adaptation measures, supported by tools such as the UN-Habitat World Urban Database platform (UN-Habitat, 2016), which provides indicators to monitor the effectiveness of such interventions at a global scale.

3. Morphological characteristics of open spaces and their role during flooding events

From a hydrological perspective, green spaces act by reducing runoff through rain interception, soil infiltration and evapotranspiration (Staccione et al., 2024). Urban flooding can result from heavy rainfall, river flooding or coastal events, accentuated by the heat island effect and the presence of impermeable surfaces (Guerreiro et al., 2018).

The urban form strongly influences flooding risks, as elements such as building density, road network and distribution of green spaces modify the microclimate and water flows. The size of green spaces affects their effectiveness: large parks can retain significant volumes of water, but networks of small, well-distributed and connected spaces are often more functional (Salvadore et al., 2015).

Connectivity, whether along water flows, between urban and natural areas, or in the vertical structure of vegetation, enhances water management capacity. Studies have shown that the optimal size for flood management depends on the specific urban context and flood risk characteristics. In dense urban environments, even small pocket parks and green corridors can contribute significantly to flood risk reduction when strategically located and well connected (Liquete et al., 2016; Mora-Esteban, 2025). Vegetation also plays a crucial role: native species and trees with broad canopies can intercept large volumes of rainfall, while multiple vegetative layers improve soil stability and absorption; moreover, the strategic placement of green spaces, supported by risk mapping and hydrological modelling, maximises benefits, especially when located in upstream or flood-prone areas (Pauleit et al., 2017).

Solutions such as the renaturalisation of canals or the use of parks as temporary reservoirs show the potential of integrated and multidisciplinary planning (Shi et al., 2015). Furthermore, the effectiveness of green and open space strategies depends critically on soil characteristics, in particular infiltration capacity, water retention capacity and drainage properties. Urban soils often suffer from compaction, sealing and altered structure that reduce their natural water management functions (Morel et al., 2015). Restoring and improving soil quality is a key requirement for effective flood management.

4. Conclusion

The integration of green and open spaces into urban flood management strategies is an increasingly relevant approach to adapt to climate change. The hydrological performance of these spaces can be measured through indicators such as runoff reduction, peak flow attenuation, runoff delay and water quality improvement (Mguni et al., 2016). In addition to water management, green spaces offer multiple co-benefits: air quality improvement, carbon sequestration, biodiversity support, urban cooling and human well-being (Kabisch et al., 2017).

International case studies, such as the "Room for the River" programme in the Netherlands and "Gardens by the Bay" initiative in Singapore, demonstrate the feasibility and effectiveness of these solutions in different urban contexts, and success factors include political support, community involvement, adaptive management and integration of green infrastructure into overall urban planning. However, technical challenges persist, such as low permeability of urban soils and spatial constraints, as well as economic and institutional obstacles, including high initial costs and inadequate funding (Santoro, 2024).

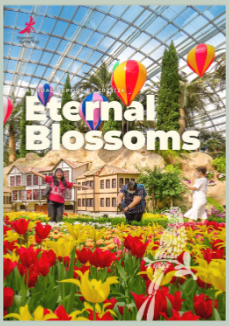
To overcome these limitations, investments in emerging technologies, innovative materials and more flexible planning and regulatory approaches are needed as the future requires interdisciplinary research aimed at more advanced predictive tools, integrated models and policies that incentivise primarily greening solutions (Barbarossa, 2021). Only through a systemic and collaborative transformation in urban management will it be possible to build more resilient and sustainable cities capable of effectively addressing climate challenges.

Room for the River Programme

The "Room for the River" programme in the Netherlands demonstrates the large-scale implementation of nature-based flood management, creating space for rivers to expand during flood events by providing recreational and ecological benefits (Klijn et al., 2009). This approach has influenced flood management strategies in many other countries, demonstrating the transferability of nature-based solutions across different contexts.

Retrieved from:
https://www.dutchwatersector.com/news/room-for-the-river-programme

Singapore: Gardens by the Bay



Singapore's Gardens by the Bay integrates green infrastructure throughout the urban fabric, with an emphasis on tropical rainfall management and flood risk reduction. The city's comprehensive approach includes green roofs, vertical gardens, park connectors and integrated stormwater management systems that demonstrate the potential for dense urban environments to incorporate extensive green infrastructure.

Retrieved from:
https://www.gardensbythebay.com.sg/en/about-us/about-the-gardens/annual-reports.html

Buenos Aires: De-paving/Green Streets

To combat urban flooding, Buenos Aires is converting paved streets into green spaces through its "Calles Verdes" (Green Streets) program. The approach reconnects residents with nature and enhances drainage, prioritising pedestrians over vehicles.
Launched in 2023, the project covers 49 blocks across 18 streets and integrates green infrastructure directly into the urban fabric.
Key points:

- Strong community participation;
- Designs must avoid unintended water accumulation;
- NBS foster social and environmental resilience.

Retrieved from:
https://www.c40knowledgehub.org/s/article/Urban-Flooding-Network-Building-Resilience-in-Cities?language=en_US

References

Andersson, E., Barthel, S., Borgström, S., Colding, J., Elmqvist, T., Folke, C., & Gren, Å. (2014). Reconnecting Cities to the Biosphere: Stewardship of Green Infrastructure and Urban Ecosystem Services. *AMBIO, 43* (4), 445-453. https://doi.org/10.1007/s13280-014-0506-y

Barbarossa, L., Pappalardo, V., & La Greca, P. (2021). Water-related risk reduction in urban development plans: Recommendations for resilient planning practices from a Sicilian case study investigation. *TeMA - Journal of Land Use, Mobility and Environment*, 7–23. https://doi.org/10.6093/1970-9870/7680

Duan, H. F., Li, F., & Tao, T. (2016). Multi-objective Optimal Design of Detention Tanks in the Urban Stormwater Drainage System: Uncertainty and Sensitivity Analysis. *Water Resources Management, 30* (7), 2213-2226. https://doi.org/10.1007/s11269-016-1282-1

European Commission (2019). *The European Green Deal*. Retrieved from: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

Fletcher, T. D., Shuster, W., Hunt, W. F., Ashley, R., Butler, D., Arthur, S., ... & Mikkelsen, P. S. (2015). SUDS, LID, BMPs, WSUD and more–the evolution and application of terminology surrounding urban stormwater management. *Urban Water Journal, 12* (7), 525-542. https://doi.org/10.1080/1573062X.2014.916314

Gómez-Baggethun, E., & Barton, D. N. (2013). Classifying and valuing ecosystem services for urban planning. *Ecological Economics, 86*, 235-245. https://doi.org/10.1016/j.ecolecon.2012.08.019

Guerreiro, S. B., Dawson, R. J., Kilsby, C., Lewis, E., & Ford, A. (2018). Future heat-waves, droughts and floods in 571 European cities. *Environmental Research Letters, 13* (3), 034009. https://doi.org/10.1088/1748-9326/aaaad3

Kabisch, N., Frantzeskaki, N., Pauleit, S., Naumann, S. (2016). Nature-based solutions to climate change mitigation and adaptation in urban areas: Perspectives on indicators, knowledge gaps, barriers, and opportunities for action. *Ecology and Society, 21* (2). https://doi.org/10.5751/es-08373-210239

Klijn, F., Asselman, N., & Van der Most, H. (2018). Compartmentalisation and risk reduction along the Rhine: does it work? *Hydrological Sciences Journal, 63* (11), 1525-1535. https://doi.org/10.1111/j.1753-318x.2009.01047.x

Lai, S., Isola, F., Leone, F., & Zoppi, C. (2021). Assessing the potential of green infrastructure to mitigate hydro-geological hazard: Evidence-based policy suggestions from a Sardinian study area. *TeMA - Journal of Land Use, Mobility and Environment*, 109–133. https://doi.org/10.6093/1970-9870/7411

Lepczyk, C. A., Aronson, M. F., Evans, K. L., Goddard, M. A., Lerman, S. B., & MacIvor, J. S. (2017). Biodiversity in the city: fundamental questions for understanding the ecology of urban green spaces for biodiversity conservation. *Bioscience, 67* (9), 799-807. https://doi.org/10.1093/biosci/bix079

Liquete, C., Udias, A., Conte, G., Grizzetti, B., & Masi, F. (2016). Integrated valuation of a nature-based solution for water pollution control. Highlighting hidden benefits. *Ecosystem Services, 22*, 392-401. https://doi.org/10.1016/j.ecoser.2016.09.011

Magni, F., Litt, G., & Carraretto, G. (2021). Metropolitan Cities supporting local adaptation processes. The case of the Metropolitan City of Venice. *TeMA - Journal of Land Use, Mobility and Environment*, *14* (2), 125–144. https://doi.org/10.6093/1970-9870/7948

Mguni, P., Herslund, L., & Jensen, M. B. (2016). Sustainable urban drainage systems: examining the potential for green infrastructure-based stormwater management for Sub-Saharan cities. *Natural Hazards, 82* (2), 241-257. https://doi.org/10.1007/s11069-016-2309-x

Mohamed Thariq, M. G., & Mohamed Mujithaba Mohamed, N. (2024). Environmental factors affecting living comfort perception in different localities in Sri Lanka. *TeMA - Journal of Land Use, Mobility and Environment*, *17* (3), 473–486. https://doi.org/10.6093/1970-9870/10865

Mora-Esteban, R., Conejo- Arrabal, F., Romero-Martínez, J. M., & Nebot-Gómez de Salazar, N. (2025). Problems and restoration strategies of urban mediterranean rivers in Spain. Guadalmedina river as a potential ecological corridor in the green-blue infrastructure of Malaga, Spain. *TeMA - Journal of Land Use, Mobility and Environment*, 55–77. https://doi.org/10.6093/1970-9870/11115

Morel, J. L., Chenu, C., & Lorenz, K. (2014). Ecosystem services provided by soils of urban, industrial, traffic, mining, and military areas (SUITMAs). *Journal of Soils and Sediments, 15* (8), 1659-1666. https://doi.org/10.1007/s11368-014-0926-0

Pauleit, S., Zölch, T., Hansen, R., Randrup, T. B., & Konijnendijk van den Bosch, C. (2017). Nature-based solutions and climate change–four shades of green. In *Nature-based solutions to climate change adaptation in urban areas*, 29-49. Springer. https://doi.org/10.1007/978-3-319-56091-5_3

Pennino, S. (2024). Global warming or global warning? A review of urban practices for adaptation to urban floods. *TeMA - Journal of Land Use, Mobility and Environment*, *17* (3), 517–524. https://doi.org/10.6093/1970-9870/11167

Salvadore, E., Bronders, J., & Batelaan, O. (2015). Hydrological modelling of urbanized catchments: a review and future directions. *Journal of Hydrology, 529*, 62-81. https://doi.org/10.1016/j.jhydrol.2015.06.028

Santoro, S., Mastrodonato, G., & Camarda, D. (2024). Managing local knowledge about NBS in spatial planning. A group model building approach. *TeMA - Journal of Land Use, Mobility and Environment*, *17* (2), 265–283. https://doi.org/10.6093/1970-9870/10810

Shi, Y., Sasaki, K., Ando, R., Leung, L. R., & Im, E. S. (2020). Effects of climate change on heating and cooling degree days and potential energy demand in the household sector of Japan. *Energy Policy, 140*, 111433. https://doi.org/10.3354/cr01360

Staccione, A., Essenfelder, A. H., Bagli, S. & Mysiak, J. (2024). Connected urban green spaces for pluvial flood risk reduction in the Metropolitan area of Milan. *Sustainable Cities and Society*, 105288–105288, https://doi.org/10.1016/j.scs.2024.105288

UN-Habitat (2016). *New Urban Agenda*. Habitat III. Quito: United Nations Human Settlements Programme. Retrieved from: https://unhabitat.org/the-new-urban-agenda-illustrated#:~:text=The%20New%20Urban%20Agenda%2C%20adopted%20at%20Habitat%20III,construction%2C%20development%2C%20management%20and%20improvement%20of%20urban%20areas

UN-Habitat (2020). *World Cities Report 2020: The Value of Sustainable Urbanization*. Nairobi: United Nations Human Settlements Programme. Retrieved from: https://unhabitat.org/wcr/2020/

UNDRR (2015). *Sendai Framework for Disaster Risk Reduction 2015-2030*. Geneva: United Nations Office for Disaster Risk Reduction. Retrieved from: https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030

UNFCCC (2015). *Accordo di Parigi*. Framework Convention on Climate Change. Paris: United Nations. Retrieved from: https://unfccc.int/process-and-meetings/the-paris-agreement

UN (2015). *Trasformare il nostro mondo: l'Agenda 2030 per lo Sviluppo Sostenibile*. New York: United Nations General Assembly. Retrieved from: https://sdgs.un.org/2030agenda

Author's profile

Tonia Stiuso

She is an engineer and research fellow at the Department of Civil, Architectural and Environmental Engineering at the University of Naples Federico II. Her research currently focuses on the theme of urban sustainability, in particular the study of gender inequalities and adaptation to climate change.