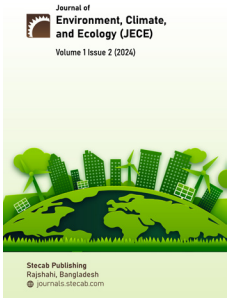

Journal of Environment, Climate, and Ecology (JECE)

Volume 1 Issue 2, (2024)

https://doi.org/10.69739/jece.v1i2.135

https://journals.stecab.com/index.php/jece

Published by
Stecab Publishing

Review Article

Urban Green Infrastructures and Its Impacts on the Urban Environment: A Review

[1]Mohammad Miakhel, [1]Amjad Ahmad Abdulrahimzai, [1]Ahmadullah Habib, *[1] Mohammad Mukhlis Behsoodi

About Article

Article History

Submission: September 03, 2024
Acceptance : October 14, 2024
Publication : October 17, 2024

Keywords

Environment, Green Infrastructure, Green Spaces, UGI, Urban

About Author

[1] Civil Engineering Department, Alfalah University, Jalalabad, Afghanistan

Contact @ Mohammad Mukhlis Behsoodi
mukhlis.behsoodi@gmail.com

ABSTRACT

Urban green infrastructure plays a crucial role in preserving a green urban environment, thus contributing significantly to human health. The absence of such infrastructure can lead to environmental challenges, particularly in the face of escalating global urbanization. Green urban infrastructure proves essential for maintaining cleanliness in urban areas, especially as major cities worldwide grapple with escalating air pollution exacerbated by the inadequate presence of green spaces, green roofs, green walls, and domestic and private gardens emerge as noteworthy contributors to mitigating these challenges. As the global population steadily increases, a collective effort is imperative to enhance green infrastructure and cultivate public awareness to address the pressing issue of air pollution in cities. Green spaces serve as a pivotal indicator of urban verdancy, offering a myriad of benefits, including environmental cleanliness, the creation of recreational spaces, the promotion of health and well-being, the facilitation of children's mental development, the presentation of aesthetically pleasing urban landscapes, temperature reduction, and pollution mitigation. This comprehensive review analyzed 60-70 studies on urban green infrastructures and their impacts on the urban environment. A library research methodology was used, focusing on literature from Google Scholar published in the last two decades which delves into the multifaceted aspects of urban environmental cleanliness, providing valuable insights for policymakers, and urban planners with a profound understanding of their impacts. Stakeholders can proactively implement measures to enhance cleanliness in the urban environment.

Citation Style:

Miakhel, M., Abdulrahimzai, A. A., Habib, A., & Behsoodi, M. M. (2024). Urban Green Infrastructures and Its Impacts on the Urban Environment: A Review. *Journal of Environment, Climate, and Ecology, 1*(2), 9-15. https://doi.org/10.69739/jece.v1i2.135

1. INTRODUCTION

"Green spaces" are described by the Environmental Protection Agency as "parks, community gardens, and cemeteries," with particular reference to "land that is partially or completely covered with grass, trees, shrubs, or other vegetation." (Nieuwenhuijsen, 2020). Originally, parklands, greenbelts, swamps, forests, or floodways within and adjacent to cities were considered part of "green" infrastructure, offering an enhanced standard of living and providing "ecosystem services" like flood prevention and water filtration (Foster *et al*., 2011). Specialists in natural resources increasingly use the term "green infrastructure," referring to a connected system of green space that preserves the purposes and values of the natural ecosystem while benefiting the human population (Benedict & MacMahon, 2002). In this article, "green infrastructure" is defined as a system of multipurpose green areas throughout a designated area, providing benefits to both existing and new communities and supporting the creation of an excellent built and natural environment. This concept encompasses natural resource areas such as wetlands, forests, streams, wildlife habitats, parks, forests, working farms, ranches, and other conservation areas (Kambites & Owen, 2006). The popularity of urban green spaces has surged due to rapid urbanization, raising concerns and discussions in urban planning. International literature identifies various applications for urban green spaces, including aesthetic, practical (health and leisure), pedagogical, technical (storm water management), symbolic, speculative (urban exploitation resource), and ecological purposes. The term "green infrastructure" refers to the natural surroundings that separate towns, cities, and villages, providing numerous social, economic, and environmental advantages through green spaces, waterways, gardens, woodlands, street trees, and open countryside (Sandström, 2002). Green infrastructure plays a significant role in addressing public health challenges, such as combating obesity, as evidenced by the over $8.2 billion spent annually in the UK to counter the effects of poor diet, inactivity, and a sedentary lifestyle (Mell, 2016). Recognizing its importance, the European Commission unveiled a definition of "green infrastructure" in 2013, emphasizing its role in territorial development and space planning across member states. In addressing previous concerns, green infrastructure proves crucial as it constitutes a network of green and blue spaces planned and maintained to provide various ecosystem services, particularly important in urban areas (Monteiro *et al.,* 2020).

2. LITERATURE REVIEW

2.1. Urban Green Infrastructure (UGI)

Urban Green Infrastructure (UGI) functions as a vital tool to improve water retention and permeability in densely populated areas, alleviate the impact of the urban heat island, and enhance human well-being and biodiversity. The interdependence between healthy living environments and human wellness becomes apparent through the ability of urban green spaces to boost social capital. Green Infrastructure (GI) comprises semi-natural structures specifically crafted to enhance the quality of life in urban settings. Noteworthy benefits of GI encompass temperature reduction, pollution mitigation, storage of biological carbon, and the improvement of human health and well-being (Monteiro *et al.,* 2020). While domestic gardens are commonly recognized as a critical component of green infrastructure, their precise contribution is rarely comprehensively assessed, posing a challenge in determining their relative significance within the broader urban green space. This raises a notable question: should urban planners prioritize allocating future green spaces near buildings to include private gardens? Despite their substantial role in urban green infrastructure, the specific impact of domestic gardens on delivering ecosystem services remains uncertain (Sangkakool *et al*., 2018). Urban Green Infrastructure (UGI) serves as a gateway to sustainable urban development. UGI is characterized by the processes guiding the expansion of green and blue spaces, as well as the multifunctional networks encompassing these areas. It holds the potential to significantly contribute to achieving policy objectives, including enhancing social cohesion, safeguarding biodiversity, promoting public health, providing recreational opportunities, stimulating local economic growth, and assisting cities in adapting to a changing climate (Pauleit *et al.,* 2019).

2.2. Types of Urban Green Infrastructure

2.2.1. Green Roofs

Green roofs, positioned atop buildings, comprise vegetated surfaces with plants typically cultivated on a specific substrate material. The implementation of green roofs has been suggested as a means to enhance sustainability in urban areas. These roofs contribute to sustainability by reducing building temperatures and manifesting a carbon-sequestering effect. The existence of flora and soil media that can both absorb and hold air pollutants at the building size is what causes this impact (Shafique *et al.,* 2020). Given these attributes, green roofs hold particular significance and relevance. Additionally, green roofs positively influence the microclimate of the surrounding neighborhood, enhancing comfort within urban settings. Particularly in urban areas prone to heat waves and stormwater flooding, the installation of green roofs emerges as one of the most effective strategies for mitigating the impact of climate change (Sangkakool *et al.,* 2018).

2.2.2. Green Walls

Green walls, also known as vegetated walls, are structures that involve the cultivation of plants on vertical surfaces, creating a living wall of vegetation. The most basic form of a green wall entails plants naturally climbing and colonizing these vertical structures. These walls have been proposed as integral components of Green Infrastructure (GI) with the specific purpose of regulating temperatures in both residential and commercial structures within urban areas. The effectiveness of a green wall system depends on the selection of robust plant species capable of enduring the environmental conditions prevalent on vertical surfaces. These plants should exhibit resistance to diseases, nutrient deficiencies, and chemical toxicity to thrive in this unique setting (Chiquet *et al.,* 2013). The primary objective of green walls extends beyond temperature regulation; it is to establish ecological and biodiversity networks within urban environments (Collins *et al.,* 2017). By incorporating green walls, urban areas aim to enhance the overall sustainability, aesthetics, and environmental quality of the built environment.

2.2.3. Domestic Gardens

The extensive allotment areas dispersed throughout the city, along with locally utilized private gardens, collectively constitute a significant portion of the "green space" within urban areas. The prevalence of domestic gardens underscores their importance in this context. However, there exists a noteworthy lack of information regarding the dimensions, composition, and associated characteristics of this valuable resource. Addressing this gap, this study presents the first comprehensive audit, focusing on Sheffield's domestic gardens as a model study system (Gaston *et al.,* 2005). The findings of this study reveal that between 22% and 36% of the urban area is comprised of domestic gardens. While these gardens play a substantial role in the framework of urban green infrastructure, their precise contribution to the provision of ecological services remains uncertain (Cameron *et al.,* 2012). This study seeks to shed light on the significance of domestic gardens within the urban landscape, contributing valuable insights that can enhance our understanding of their role in fostering ecological sustainability and overall urban well-being.

2.2.4. Public Parks and Community Gardens

To fulfill their role in providing ecosystem services for cities and towns, both community gardens and parks face specific opportunities and challenges. Community gardens have the potential to rejuvenate underutilized park landscapes and transform them into vibrant public green spaces. However, community gardens stand out for their unique ability to contribute services related to agriculture and food production within the realm of public green spaces. The cultivation of food in these communal spaces can influence individuals to make healthier and more sustainable dietary choices. The establishment of two distinct public entities—community gardens and other forms of green space—now operates largely independently, offering the potential to benefit urban communities by supplying essential ecosystem services(Middle *et al.,* 2014). The findings reveal that between 22% and 36% of the urban area is comprised of domestic gardens. While these gardens play a significant role in urban green infrastructure, their precise contribution to the provision of ecological services remains uncertain (Larson *et al.,* 2016).

2.2.5. Private Gardens

The importance of private gardens in urban areas extends beyond aesthetics, as they serve as significant green spaces providing essential resources for both humans and wildlife. These spaces contribute to biodiversity by offering food sources and sanctuaries for various animals, particularly invertebrates. Despite their importance, studying private gardens poses challenges due to the diverse range of living and non-living factors that can impact invertebrate abundance. Biotic variables include the types of plants and their arrangement, while abiotic factors encompass environmental conditions such as temperature, humidity, and soil composition. Additionally, the influence of neighbouring landscapes adds complexity to understanding the dynamics of invertebrate populations within these private green spaces. Addressing these challenges is crucial for effective conservation and sustainable urban planning (Muratet & Fontaine, 2015).

2.2.6. Street Trees

Street trees are typically categorized as social, economic, or environmental assets. Their significant social impact stems from their positive influence on people's health, making them crucial for fostering thriving urban communities. In addition to benefiting human well-being, street trees provide a habitat for urban wildlife, with some species becoming more prevalent in cities than in the natural vegetation surrounding them. Street trees also serve as a vertical barrier, separating sidewalks from roads. Furthermore, these trees play a vital role in environmental conservation. They contribute to stormwater management by absorbing substantial amounts of rainfall, and they aid in reducing air pollution by absorbing particulates from the air through their leaves and branches. Overall, street trees offer a multifaceted set of benefits, making them integral components of urban landscapes (Mullaney *et al.,* 2015).

2.2.7. Urban Lawns

Urban lawns indeed provide several ecological benefits; however, they also have potential environmental drawbacks related to water consumption, biodiversity loss, nitrogen and phosphorus runoff, and habitat destruction for wildlife (Zhou *et al.,* 2009). Lawns occupy a considerable portion of land surface (Medl *et al.,* 2017). Estimates indicate that there are 163,800 km2 of lawns in the US, and this area continues to expand rapidly. While lawns contribute to the aesthetic appeal of urban areas and offer recreational spaces, it's crucial to carefully consider and manage their environmental impact to guarantee sustainability and reduce adverse effects on natural resources and ecosystems (Raciti *et al.,* 2008).

2.2.8. Vertical Greening System

A vertical greening system encompasses any system designed to add greenery to vertical surfaces. These systems heavily rely on plants, involving the practice of covering buildings with vegetation. This approach yields positive effects on the environment, economy, society, and health, making it an integral aspect of sustainable architectural design (Wang *et al.,* 2022). The term "vertical greening systems" (VGS) can also encompass bio walls, vertical gardens, or green-wall technologies. While vertical greening systems have been in existence for some time, their significance is growing as cities aim to be more sustainable, and environmental concerns become more prominent (Pérez-Urrestarazu *et al.,* 2015). Both in the summer and winter, vertical and horizontal greening significantly impact the urban environment and the thermal performance of buildings. In warmer climates, vertical greening becomes crucial during the summer to provide cooling potential on building surfaces (Perini *et al.,* 2011). The techniques involved in vertical greening, such as green walls and façade systems, are not new. Green walls and green façades represent the two primary types of vertical greening systems. Implementing these systems to mitigate temperatures in construction canyons is a viable strategy (Medl *et al.,* 2017).

2.3. Effects of Urban Green Infrastructure

Urban green infrastructure (UGI) directly influences the interior space in terms of climate, air quality, acoustics, and aesthetics. Beyond these factors, there are additional benefits to human welfare and the economy associated with greenery. When considering the advantages of climate regulation services, UGI often leads to reduced energy costs by modifying indoor temperatures. Deciduous vegetation is particularly beneficial, though evergreen vegetation can also reduce building temperatures in winter, potentially increasing energy consumption (Kaluarachchi, 2021). Furthermore, slower wind speeds facilitated by UGI may impede heat escape from sun-exposed surfaces and diminish the efficiency of open windows during summertime by slowing air infiltration (Wang *et al.,* 2014). Urban areas face increased risks of disaster damage due to rising precipitation, a consequence of impermeable surface expansion and climate change. In densely populated, highly developed regions, UGI serves as a valuable alternative to traditional mitigation measures. Sea level rise, excessive precipitation, and other climate change-related issues, and global warming, are frequently linked to urbanization. As global urbanization accelerates city population growth and alters the urban microclimate, public health is significantly impacted. Despite UGI's demonstrated ability to reduce urban warming and improve thermal comfort, research indicates that groves with a higher number of trees exhibit the best cooling capacity among various UGI types. Although the daily average air temperature decrease is relatively small (maximum 0.3 ℃), the findings emphasize the effectiveness of well-planned and adequately vegetated urban green spaces (Kim & Kim, 2017).

2.4. Benefits of Urban Green Infrastructure

The ecological services that green infrastructure (GI) and urban forests (UF) provide, Including trees on roadways, alongside streams, in parks, and not just in woodlands but also on rooftops, offer significant benefits to urban and vulnerable populations (O'Brien *et al.,* 2017). Urban agriculture plays a crucial role in addressing the lack of access to food by serving as a social safety net, enabling individuals and communities to produce and share healthy foods (Lin *et al.,* 2017). Urban agriculture can help communities and individuals produce and share healthy foods by providing social safety nets to fight food insecurity (Medl *et al.*, 2017). The definition of urban green infrastructure (UGI) is landscape features that concurrently benefit society, the environment, and the economy (Van Oijstaeijen *et al.,* 2020). These features provide spaces for people to visit, traverse, enjoy, protect, and care for, contributing to the creation of attractive and livable environments in urban areas (O'Brien *et al.,* 2017). The multifaceted advantages of UGI extend beyond aesthetics, enhancing the quality of life for urban residents. City infrastructure plays a vital role in facilitating the use of public areas for civic, commercial, and leisure activities. The provision of public services, such as transportation, water use, and waste treatment, is integrated into urban infrastructure to make it more accessible and convenient for people. This interconnected approach aims to create well-rounded urban environments that cater to the diverse needs of the population (Kaluarachchi, 2021).

2.5. The Impacts of Urban Green Infrastructure on Urban Environment

The articles included in this special issue emphasize the critical role of urban green infrastructure (UGI) in sustainable growth. Drawing from various international case studies, ideas, and assessment techniques across different fields, the research underscores the importance of UGI for fostering a thriving urban ecosystem and ensuring good living conditions for city dwellers (Breuste *et al.,* 2015). Specifically, By promoting and enhancing ecosystem services linked to reduced flooding risk, mitigated urban heat islands, improved air quality, reduced building energy consumption, carbon storage, preservation of wildlife habitat, and the provision of recreational and leisure amenities that improve the well-being of urban residents, UGI shows promise in enhancing urban resilience (Zuniga-Teran *et al.,* 2020). In the context of a particular city, research highlights that accessible lawns and water bodies are crucial park attributes positively influencing respondents' self-reported health and well-being. Proximity to green spaces has a positive effect on residents' mental health, particularly when individuals are satisfied with neighborhood green spaces. This emphasizes the subjective evaluation of green spaces in people's living environment as a significant factor (Wu *et al.,* 2022). Various UGI strategies, including well-established ones like urban park networks and urban forestry (including street trees), as well as newer approaches like green roofs, are discussed. Green infrastructure, with its numerous advantages, plays a pivotal role in adapting to the changing climate, mitigating temperature rise, and addressing more frequent and intense heat waves. Crucially, UGI is essential for reducing the absorption of solar radiation by construction materials during the day and releasing it at night (Gaffin *et al.,* 2012). Green infrastructure has many advantages, especially when it comes to adjusting to the changing climate to mitigate the effects of temperature rise and more frequent and intense heat waves. Reducing the amount of solar radiation absorbed by building materials like pavement, walls, and roofs during the day and released at night requires the use of green infrastructure (Lin *et al.,* 2016).

3. METHODOLOGY

This review paper employs a library research methodology aimed at synthesizing existing literature on urban green infrastructures and their impacts on the urban environment. A comprehensive search was conducted across various academic databases, including Google Scholar and specialized academic search engines, to identify relevant studies published within the last two decades. This timeframe was prioritized to capture recent developments and trends in the field.The selection process involved establishing clear inclusion and exclusion criteria. Only peer-reviewed studies focused on urban green infrastructure and its environmental impacts were included, while papers that did not meet these criteria were excluded from the review. Initially, 60-70 papers were identified through this systematic search, and after applying the established criteria, a total of 40 studies were selected for detailed analysis. The selected literature was categorized based on different types of green infrastructure, such as parks, green roofs, and urban

forests, along with their associated environmental benefits. This categorization facilitated a critical analysis of the findings, allowing for the identification of gaps in the existing body of work.

In addition to the literature review, informal discussions were conducted with urban planners and policymakers. These conversations provided valuable context and insights into the practical applications of the research, enhancing the understanding of how urban green infrastructures can be effectively implemented in urban planning. The resulting synthesis of the literature aims to inform stakeholders, including urban planners and policymakers, providing guidance for future urban planning efforts to enhance environmental quality in urban settings. Through this comprehensive approach, the study seeks to contribute meaningfully to the discourse on urban sustainability and resilience.

4. RESULTS AND DISCUSSION

This review highlights the critical role of urban green infrastructure (UGI) in enhancing environmental quality and addressing the challenges posed by rapid urbanization. The findings indicate that various forms of UGI, including green roofs, green walls, domestic gardens, and public parks, significantly contribute to mitigating air pollution and improving urban climates. UGI acts as a natural regulator, reducing indoor temperatures and energy costs, particularly through the strategic use of deciduous trees that provide shade in the summer. The ecological benefits of UGI extend beyond climate regulation, offering vital services such as stormwater management, carbon sequestration, and biodiversity enhancement. These green spaces not only improve the aesthetic value of urban areas but also promote ecological connectivity, which is essential for sustaining urban wildlife. The analysis emphasizes that well-planned green spaces can effectively alleviate urban heat islands and manage rainfall, thus increasing urban resilience in the face of climate change.

Moreover, the review underscores the importance of community engagement in the development and maintenance of UGI. Accessible parks and gardens foster social interactions and improve overall livability, making urban environments more attractive and functional. The evidence presented supports the need for collaborative efforts among policymakers, urban planners, and local communities to prioritize and enhance green infrastructure as a fundamental strategy to combat environmental degradation. Finally, the integration of UGI into urban planning is essential for creating sustainable, livable cities. By recognizing the multifaceted benefits of green infrastructure, stakeholders can make informed decisions that promote the expansion and preservation of urban green spaces, ultimately leading to healthier and more resilient urban environments.

5. CONCLUSION

Urban green infrastructure has emerged as a pivotal factor in enhancing environmental quality and fostering resilient urban ecosystems, yielding significant benefits for citizen well-being and the broader environment. This comprehensive review highlights the critical importance of urban green spaces—including green roofs, green walls, and domestic/private gardens—in mitigating the adverse effects of rapid urbanization, particularly the escalating challenges of air pollution in major cities worldwide. The findings emphasize the urgent need to strengthen green infrastructure as global populations grow, alongside fostering public awareness as fundamental strategies for addressing environmental degradation and promoting sustainable urban living. The manifold benefits of urban green areas extend beyond improving environmental cleanliness and providing recreational opportunities; they also enhance urban resilience, support biodiversity, and improve overall quality of life.

These advantages underscore the necessity for collaborative efforts among policymakers, urban planners, and communities to prioritize the expansion and preservation of green spaces within urban landscapes. Achieving a harmonious balance between urban development and the integration of green infrastructure is essential for creating cleaner, greener, and more livable cities.

By recognizing the substantial positive impacts of urban green infrastructure detailed in this review, stakeholders are better equipped to make informed decisions and implement policies that prioritize the incorporation and preservation of green areas in city design. Additionally, promoting public awareness of the critical significance of green infrastructure and encouraging active participation in its development and maintenance are vital for realizing sustainable urban growth and nurturing healthier urban environments for future generations.

REFERENCES

Benedict, M. A., & MacMahon, E. T. (2002). Green infrastructure: Smart conservation for the 21st century. *Renewable Resources Journal, 20*(3), 12–17.

Breuste, J., Artmann, M., Li, J., & Xie, M. (2015). Special Issue on Green Infrastructure for Urban Sustainability. *Journal of Urban Planning and Development, 141*(3), 1–5. https://doi.org/10.1061/(asce)up.1943-5444.0000291

Cameron, R. W. F., Blanuša, T., Taylor, J. E., Salisbury, A., Halstead, A. J., Henricot, B., & Thompson, K. (2012). The domestic garden - Its contribution to urban green infrastructure. *Urban Forestry and Urban Greening, 11*(2), 129–137. https://doi.org/10.1016/j.ufug.2012.01.002

Chiquet, C., Dover, J. W., & Mitchell, P. (2013). Birds and the urban environment: The value of green walls. *Urban Ecosystems, 16*(3), 453–462. https://doi.org/10.1007/s11252-012-0277-9

Collins, R., Schaafsma, M., & Hudson, M. D. (2017). The value of green walls to urban biodiversity. *Land Use Policy, 64*, 114–123. https://doi.org/10.1016/j.landusepol.2017.02.025

Foster, J., Lowe, A., & Winkelman, S. (2011). THE VALUE OF GREEN INFRASTRUCTURE The Center for Clean Air Policy. *The Center for Clean Air Policy. New York.*

Gaffin, S. R., Rosenzweig, C., & Kong, A. Y. Y. (2012). Adapting to climate change through urban green infrastructure. *Nature Climate Change, 2*(10), 704. https://doi.org/10.1038/nclimate1685

Gaston, K. J., Warren, P. H., Thompson, K., & Smith, R. M. (2005). Urban domestic gardens (IV): The extent of the resource and its associated features. *Biodiversity and Conservation, 14*(14), 3327–3349. https://doi.org/10.1007/s10531-004-9513-9

Kaluarachchi, Y. (2021). Potential advantages in combining smart and green infrastructure over silo approaches for future cities. *Frontiers of Engineering Management, 8*(1), 98–108. https://doi.org/10.1007/s42524-020-0136-y

Kambites, C., & Owen, S. (2006). Renewed prospects for green infrastructure planning in the UK. *Planning Practice and Research, 21*(4), 483–496. https://doi.org/10.1080/02697450601173413

Kim, S. Y., & Kim, B. H. S. (2017). The effect of urban green infrastructure on disaster mitigation in Korea. *Sustainability, 9*(6), 1026. https://doi.org/10.3390/su9061026

Larson, L. R., Jennings, V., & Cloutier, S. A. (2016). Public parks and wellbeing in urban areas of the United States. *PLoS ONE, 11*(4), 1–20. https://doi.org/10.1371/journal.pone.0153211

Lin, B. B., Meyers, J., Beaty, R. M., & Barnett, G. B. (2016). Urban green infrastructure impacts on climate regulation services in Sydney, Australia. *Sustainability, 8*(8), 788. https://doi.org/10.3390/su8080788

Lin, B. B., Philpott, S. M., Jha, S., & Liere, H. (2017). Urban Agriculture as a Productive Green Infrastructure for Environmental and Social Well-Being. *Advances in 21st Century Human Settlements*, 155–179. https://doi.org/10.1007/978-981-10-4113-6_8

Medl, A., Stangl, R., & Florineth, F. (2017). Vertical greening systems – A review on recent technologies and research advancement. *Building and Environment, 125*, 227–239. https://doi.org/10.1016/j.buildenv.2017.08.054

Mell, I. C. (2008, June). Green infrastructure: concepts and planning. In *FORUM ejournal* (Vol. 8, No. 1, pp. 69-80). Newcastle, UK: Newcastle University.

Middle, I., Dzidic, P., Buckley, A., Bennett, D., Tye, M., & Jones, R. (2014). Integrating community gardens into public parks: An innovative approach for providing ecosystem services in urban areas. *Urban Forestry and Urban Greening, 13*(4), 638–645. https://doi.org/10.1016/j.ufug.2014.09.001

Monteiro, R., Ferreira, J. C., & Antunes, P. (2020). Green infrastructure planning principles: An integrated literature review. *Land, 9*(12), 525. https://doi.org/10.3390/land9120525

Mullaney, J., Lucke, T., & Trueman, S. J. (2015). A review of benefits and challenges in growing street trees in paved urban environments. *Landscape and Urban Planning, 134*, 157–166. https://doi.org/10.1016/j.landurbplan.2014.10.013

Muratet, A., & Fontaine, B. (2015). Contrasting impacts of pesticides on butterflies and bumblebees in private gardens in France. *Biological Conservation, 182*, 148–154. https://doi.org/10.1016/j.biocon.2014.11.045

Nieuwenhuijsen, M. J. (2020). Green Infrastructure and Health. *Annual Review of Public Health, 42*, 317–328. https://doi.org/10.1146/annurev-publhealth-090419-102511

O'Brien, L., De Vreese, R., Atmiş, E., Stahl Olafsson, A., Sievänen, T., Brennan, M., ... & Almeida, A. (2017). Social and environmental justice: diversity in access to and benefits from urban green infrastructure–examples from Europe. *The urban forest: Cultivating green infrastructure for people and the environment*, 153-190.

O'Brien, L., De Vreese, R., Kern, M., Sievänen, T., Stojanova, B., & Atmiş, E. (2017). Cultural ecosystem benefits of urban and peri-urban green infrastructure across different European countries. *Urban Forestry and Urban Greening, 24*, 236–248. https://doi.org/10.1016/j.ufug.2017.03.002

Pauleit, S., Ambrose-Oji, B., Andersson, E., Anton, B., Buijs, A., Haase, D., Elands, B., Hansen, R., Kowarik, I., Kronenberg, J., Mattijssen, T., Stahl Olafsson, A., Rall, E., van der Jagt, A. P. N., & Konijnendijk van den Bosch, C. (2019). Advancing urban green infrastructure in Europe: Outcomes and reflections from the GREEN SURGE project. *Urban Forestry and Urban Greening, 40*, 4–16. https://doi.org/10.1016/j.ufug.2018.10.006

Pérez-Urrestarazu, L., Fernández-Cañero, R., Franco-Salas, A., & Egea, G. (2015). Vertical Greening Systems and Sustainable Cities. *Journal of Urban Technology, 22*(4), 65–85. https://doi.org/10.1080/10630732.2015.1073900

Perini, K., Ottelé, M., Fraaij, A. L. A., Haas, E. M., & Raiteri, R. (2011). Vertical greening systems and the effect on air flow and temperature on the building envelope. *Building and Environment, 46*(11), 2287–2294. https://doi.org/10.1016/j.buildenv.2011.05.009

Raciti, S. M., Groffman, P. M., & Fahey, T. J. (2008). Nitrogen retention in Urban lawns and forests. *Ecological Applications, 18*(7), 1615–1626. https://doi.org/10.1890/07-1062.1

Sandström, U. G. (2002). Green infrastructure planning in urban Sweden. *Planning Practice and Research, 17*(4), 373–385. https://doi.org/10.1080/02697450216356

Sangkakool, T., Techato, K., Zaman, R., & Brudermann, T. (2018). Prospects of green roofs in urban Thailand–A multi-criteria decision analysis. *Journal of cleaner production, 196*, 400-410.

Shafique, M., Xue, X., & Luo, X. (2020). An overview of carbon sequestration of green roofs in urban areas. *Urban Forestry*

and Urban Greening, 47, 126515. https://doi.org/10.1016/j.ufug.2019.126515

Van Oijstaeijen, W., Van Passel, S., & Cools, J. (2020). Urban green infrastructure: A review on valuation toolkits from an urban planning perspective. *Journal of Environmental Management, 267*(December 2019), 110603. https://doi.org/10.1016/j.jenvman.2020.110603

Wang, P., Wong, Y. H., Tan, C. Y., Li, S., & Chong, W. T. (2022). Vertical Greening Systems: Technological Benefits, Progresses and Prospects. *Sustainability, 14*(20). https://doi.org/10.3390/su142012997

Wang, Y., Bakker, F., de Groot, R., & Wörtche, H. (2014). Effect of ecosystem services provided by urban green infrastructure on indoor environment: A literature review. *Building and Environment, 77*, 88–100. https://doi.org/10.1016/j.buildenv.2014.03.021

Wu, W., Liu, Y., & Gou, Z. (2022). Green infrastructure and urban wellbeing. *Urban Forestry and Urban Greening, 68*(January), 127485. https://doi.org/10.1016/j.ufug.2022.127485

Zhou, W., Troy, A., Morgan Grove, J., & Jenkins, J. C. (2009). Can money buy green? demographic and socioeconomic predictors of lawn-care expenditures and lawn greenness in urban residential areas. *Society and Natural Resources, 22*(8), 744–760. https://doi.org/10.1080/08941920802074330

Zuniga-Teran, A. A., Staddon, C., de Vito, L., Gerlak, A. K., Ward, S., Schoeman, Y., Hart, A., & Booth, G. (2020). Challenges of mainstreaming green infrastructure in built environment professions. *Journal of Environmental Planning and Management, 63*(4), 710–732. https://doi.org/10.1080/09640568.2019.1605890