Integrating Green Infrastructure in Urban Planning: A Case Study Approach

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Abstract: *In recent years, green infrastructure has been extensively used as a strategy to mitigate adverse environmental effects due to rapid urbanization. Vegetated spaces play an important role in moderating and improving urban environments for more comfortable and healthier living conditions. This study investigates integration of green infrastructure, specifically green roofs and rain gardens, into urban planning to enhance environmental sustainability. A case study approach is used to examine implementation of green infrastructure elements in three cities, such as New York City (USA), Copenhagen (Denmark), and Singapore. The findings reveal common challenges faced by these cities such as high installation and maintenance costs, technical and structural concerns, policy and regulatory barriers, and lack of public awareness to integrate green infrastructure. Successful strategies for overcoming these challenges include strong policy support, public-private partnerships, integrated planning, awareness programs, and providing technical training for professionals. Future research which includes expanding sample size and diversity, exploring government and industry support, and assessing social equity impacts are recommended.*

Keywords: *Green Infrastructure, Green Roofs, Rain Gardens, Stormwater Management, Urban Heat Island, Biodiversity, Energy Savings, Public-Private Partnerships*

1. INTRODUCTION

Urbanization has transformed cities worldwide, leading to significant environmental challenges such as increased stormwater runoff and urban heat islands [1, 2]. Traditional urban planning methods, often focused on gray infrastructure, such as concrete drainage systems and extensive road networks, which have proven insufficient in addressing environmental issues [3, 4]. More recently, there is a growing interest in incorporating green infrastructure into urban planning, which refers to network of natural and semi-natural systems that provide ecological, economic, and social benefits [5, 6]. It includes features like green roofs

[7], rain gardens [8], permeable pavements [9], and urban forests [10], which mimic natural processes to enhance urban resilience and sustainability. Green infrastructure offers a holistic approach to urban planning by integrating natural elements into the built environment, thereby providing multiple ecosystem services [11]. These services include stormwater management [12-14], air quality improvement [15-17], urban heat island mitigation [18, 19], biodiversity enhancement [20], and improved human health and well-being [21]. Features like green roofs provide shade, insulation, and cooling through evapotranspiration, reducing the need for heating and cooling in buildings to save energy [22]. Rain gardens capture and filter stormwater, managing runoff and improving water quality [23]; and create habitats for various species, enhancing urban biodiversity [24]. Permeable surfaces allow water to infiltrate, reducing runoff and recharging groundwater [25]. Urban forests provide shade and cooler microclimate, reducing heat islands and improving air quality [26]. Vegetations adjacent to rivers and streams filter pollutants, provide habitat, and alleviate floods [27]. Natural landscape amidst development enhances property values and attracts investment [28]. The implementation and maintenance of green infrastructure create jobs in landscaping, construction, and environmental management [29]. Access to natural green spaces improve mental health and well-being, reducing stress and promoting relaxation [14], and enhance the visual appeal of urban areas, creating more attractive and livable environments [30]. Green infrastructure projects often involve community participation, fostering social cohesion and a sense of ownership [31]. Despite its numerous benefits, the implementation of green infrastructure faces several challenges, including technical, financial, policy, and awareness barriers. By examining successful case studies and implementation strategies, this study provides a foundation for understanding how green infrastructure can be effectively integrated into urban planning to enhance environmental sustainability.

2. METHODOLOGY

The research adopts a qualitative case study approach for an in-depth examination of specific instances of green infrastructure implementation and provides rich, contextual insights into the benefits, challenges, and strategies associated with such projects. It involves the literature review to identify key concepts and theoretical perspectives on green infrastructure. The selection of case studies is conducted on criteria such as geographic diversity, type of green infrastructure implemented, and available data. Case studies of three cities selected for this study are New York City (USA), Copenhagen (Denmark), and Singapore. These are chosen based on their innovative approaches to green infrastructure and their varying climatic, economic, and social contexts. These cities have implemented significant green infrastructure projects, making them ideal for a comparative analysis.

The data collection and data analysis are performed through site visits, interviews, and document analysis, to identify common themes, challenges, and successful strategies. Site visits to green infrastructure projects in each city provided firsthand observations of their implementation and impact. These visits allow for the collection of visual and descriptive data on the design, construction, and performance of green roofs and rain gardens. Semi-structured interviews with key stakeholders, such as urban planners, policymakers, architects, and environmental experts, are conducted to gather qualitative data on the benefits, challenges, and strategies associated with green infrastructure. The interview questions are designed to elicit detailed responses about the planning, implementation, and maintenance of green infrastructure projects. Policy documents, project reports, academic articles, and other relevant materials are analyzed to gain insights into

the regulatory, financial, and technical aspects of green infrastructure implementation. This method helps to triangulate data from site visits and interviews, providing a well-rounded perspective on the case studies.

The data collected are then analyzed using thematic analysis. This qualitative analysis method involves identifying, analyzing, and reporting patterns (themes) within the data. The steps of thematic analysis include 1) *Familiarization:* Immersing in the data by reading and re-reading interview transcripts, field notes, and documents. 2) *Coding:* Generating initial codes from the data that are relevant to the research questions. 3) *Theme Development:* Collating codes into potential themes and reviewing these themes to ensure they accurately reflect the data. 4) *Defining and Naming Themes:* Refining the specifics of each theme and generating clear definitions and names. 5) *Writing Up:* Weaving together the analytic narrative and data extracts to answer the research questions.

3. CASE STUDIES

3.1. New York City, USA

New York City has implemented various green infrastructure projects, including green roofs and rain gardens, through initiatives like the Green Infrastructure Program. These projects have demonstrated significant environmental benefits, such as reduced stormwater runoff and urban heat islands improved water quality [32]. The city's Green Infrastructure Program has been instrumental in promoting the installation of green roofs and rain gardens across various neighborhoods. Green roofs in New York City have significantly reduced stormwater runoff, helping to mitigate flooding and reduce the burden on the city's drainage system. Green roofs provide insulation, leading to notable energy savings, particularly during summer months. However, the initial costs of installing green roofs can be prohibitive, limiting widespread adoption. The existing buildings may require structural modifications to support the additional weight of green roofs. While rain gardens have also reduced flooding in residential areas and improved water quality by filtering pollutants from stormwater before it enters the drainage system. However, regular maintenance is essential to ensure the functionality and aesthetics of rain gardens, posing a challenge for some property owners. New York City's Green Infrastructure Program provides financial incentives, such as tax abatements, to encourage the installation of green roofs and rain gardens. Collaborations between the city government, private developers, and community organizations have been key to successful implementation.

3.2. Copenhagen, Denmark

Copenhagen has integrated green infrastructure as a central component of its Climate Plan, aiming to become carbon-neutral by 2025. The city's approach emphasizes and integrates green roofs and rain gardens into the city's stormwater management strategy, enhancing urban resilience to flooding [33]. Green roofs have helped reduce urban heat islands by providing cooling through evapotranspiration. They have increased urban biodiversity by providing habitats for various species. While the city mandates green roofs for new buildings, existing buildings face regulatory hurdles in retrofitting green roofs. Rain gardens play a crucial role in managing stormwater and reducing flood risk in Copenhagen's low-lying areas. However, there is a need to increase public awareness about the benefits and maintenance of rain gardens to ensure community support. Copenhagen's Climate Plan integrates green infrastructure into broader urban planning

efforts, ensuring cohesive and effective implementation. The city conducts extensive public education and outreach programs to promote the benefits of green infrastructure.

3.3. Singapore

Singapore has embraced green infrastructure as part of its vision to be a "City in a Garden." The Skyrise Greenery Incentive Scheme promotes green roofs and vertical gardens, effectively reducing urban heat islands and improving aesthetic value. The ABC Waters Program includes rain gardens to improve water quality and provide recreational spaces [34]. Green roofs have improved the aesthetic value of buildings, making the city more attractive. These roofs contribute to Singapore's sustainability goals by reducing energy consumption. Despite incentives, the high costs of installation can be a barrier for some property owners. Rain gardens have enhanced water filtration, reduced runoff, and improved water quality. However, the ongoing maintenance costs of rain gardens can be a concern for some stakeholders. Singapore's Skyrise Greenery Incentive Scheme provides substantial financial support to encourage the adoption of green roofs. Strong government leadership and commitment to green infrastructure are critical to its successful implementation.

3.4. Comparative Analysis for Case Studies

As shown in Table 1, for New York City, the primary benefits are stormwater management and energy savings. Green roofs help mitigate flooding and reduce energy costs. For Copenhagen, the focus is on urban heat island mitigation and biodiversity enhancement. Green roofs reduce surface temperatures and support urban wildlife. And for Singapore, benefits include urban aesthetics and energy savings, contributing to the city's sustainability and attractiveness.

Table 1: Summary of Green Roofs Benefits and Challenges

City	Benefit	Challenge
New York City	Stormwater Management	High Installation Costs
	Energy Savings	Structural Concerns
Copenhagen	Urban Heat Island Mitigation	Policy Barriers
	Biodiversity Enhancement	Policy Barriers
Singapore	Urban Aesthetics	Cost Barriers
	Energy Savings	Cost Barriers

As shown in Table 2, for New York City, rain gardens primarily improve water quality by filtering pollutants. For Copenhagen, the main benefit is flood control, essential in low-lying areas prone to flooding. And for Singapore, rain gardens enhance water filtration, reducing runoff and improving water quality.

Table 2: Summary of Rain Gardens Benefits and Challenges

City	Benefit	Challenge
New York City	Water Quality Improvement	Maintenance Requirements
Copenhagen	Flood Control	Public Awareness
Singapore	Water Filtration	Maintenance Costs

As shown in Table 3, New York City utilizes all strategies, with a strong emphasis on policy support, financial incentives, and public-private partnerships. Copenhagen focuses on integrated planning and education/outreach, with limited use of financial incentives. And Singapore emphasizes government leadership and financial incentives to drive green infrastructure adoption.

Table 3: Comparative Analysis of Green Infrastructure Strategies

Strategy	New York City	Copenhagen	Singapore
Policy Support	Yes	Yes	Yes
Public-Private Partnerships	Yes	Yes	No
Integrated Planning	Yes	Yes	Yes
Education and Outreach	Yes	Yes	Yes
Financial Incentives	Yes	No	Yes
Government Leadership	Yes	Yes	Yes

Successful strategies for integrating green infrastructure include strong policy support, financial incentives, public-private partnerships, integrated urban planning, and effective education and outreach programs. These strategies have been instrumental in overcoming challenges and maximizing the benefits of green infrastructure. The case studies of New York City, Copenhagen, and Singapore demonstrate the significant potential of green infrastructure to enhance environmental sustainability in urban areas. By examining the benefits, challenges, and successful strategies associated with green roofs and rain gardens, this chapter provides valuable insights for policymakers, urban planners, and other stakeholders. The comparative analysis highlights the importance of tailored approaches to green infrastructure, considering the unique contexts of different cities. The findings underscore the need for continued investment, innovation, and collaboration to advance the integration of green infrastructure in urban planning.

Similarly, this study provides a visual representation of the benefits and strategies associated with green roofs and rain gardens, offering valuable insights into how different cities are leveraging green infrastructure to enhance environmental sustainability. Figure 1 illustrates the various benefits of green

roofs in New York City, Copenhagen, and Singapore. The benefits include stormwater management, energy savings, urban heat island mitigation, biodiversity enhancement, and urban aesthetics.

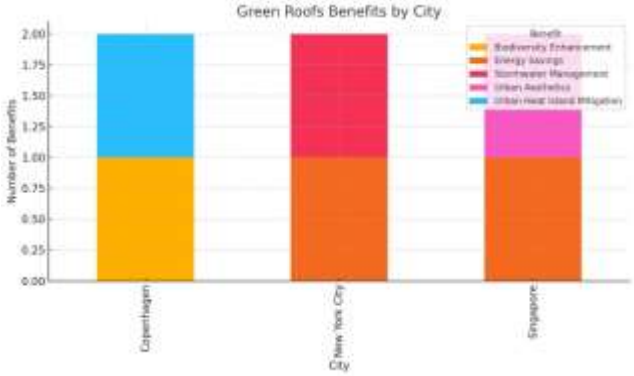

Figure 1: Green Roofs Benefits by City

For New York City, the primary benefits are stormwater management and energy savings. Green roofs help mitigate flooding and reduce energy costs. Copenhagen focuses on urban heat island mitigation and biodiversity enhancement, where green roofs reduce surface temperatures and support urban wildlife. For Singapore, benefits include urban aesthetics and energy savings, contributing to the city's sustainability and attractiveness.

Figure 2 shows the benefits of rain gardens in New York City, Copenhagen, and Singapore. The benefits include water quality improvement, flood control, and water filtration.

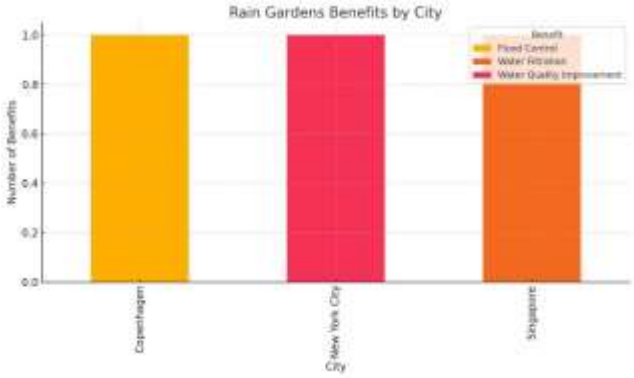

Figure 2: Rain Gardens Benefits by City

For New York City, rain gardens primarily improve water quality by filtering pollutants. In Copenhagen, the main benefit is flood control, essential in low-lying areas prone to flooding. For Singapore, rain gardens enhance water filtration, reducing runoff and improving water quality.

Figure 3 highlights the different strategies adopted by New York City, Copenhagen, and Singapore to integrate green infrastructure. Strategies include policy support, public-private partnerships, integrated planning, education and outreach, financial incentives, and government leadership.

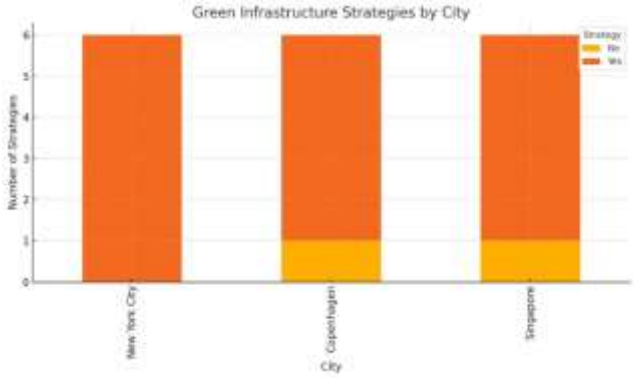

Figure 3: Green Infrastructure Strategies by City

New York City utilizes all strategies, with a strong emphasis on policy support, financial incentives, and public-private partnerships. Copenhagen focuses on integrated planning and education/outreach, with limited use of financial incentives. Singapore emphasizes government leadership and financial incentives to drive green infrastructure adoption.

4. DISCUSSION

4.1. Environmental Benefits

Green roofs and rain gardens have significantly improved stormwater management in all three cities. In New York City, green roofs have reduced stormwater runoff, mitigated flooding and easing the burden on the city's drainage system. Rain gardens have enhanced water quality by filtering pollutants before they enter the drainage system. Similarly, in Copenhagen and Singapore, rain gardens play a crucial role in managing stormwater and reducing flood risk, especially in low-lying areas. Green roofs in Copenhagen have effectively reduced urban heat islands by providing cooling through evapotranspiration. This has led to lower surface temperatures, making urban areas more comfortable during hot weather. New York City and Singapore have also benefited from the cooling effects of green roofs, contributing to improved urban climate resilience. Green roofs in Copenhagen have increased urban biodiversity by providing habitats for various species, including birds and insects. This has enhanced the ecological value of urban areas, contributing to overall environmental health. Similar benefits have been observed in New York City and Singapore, where green roofs and rain gardens support urban wildlife and promote biodiversity.

4.2. Economic Benefits

Green roofs provide insulation, leading to significant energy savings, particularly during summer months. This is evident in New York City and Singapore, where green roofs have reduced the need for air conditioning, lowering energy costs for building owners. The energy-saving benefits of green roofs contribute to the overall economic sustainability of urban areas. Proximity to green infrastructure, such as green roofs and rain gardens, has enhanced property values in all three cities. Properties near green infrastructure are more attractive to potential buyers and tenants, leading to higher demand and increased

property prices. This economic benefit underscores the importance of integrating green infrastructure into urban planning. The implementation and maintenance of green infrastructure create jobs in landscaping, construction, and environmental management. This is particularly evident in New York City, where green infrastructure projects have generated employment opportunities and supported local economies.

4.3. Social Benefits

Access to green spaces and nature has been shown to improve mental health and well-being. In Copenhagen and Singapore, green roofs and rain gardens provide residents with green spaces for relaxation and recreation, contributing to improved mental health outcomes. These benefits highlight the importance of incorporating green infrastructure into urban environments to enhance the quality of life for residents. Green infrastructure enhances the visual appeal of urban areas, creating more attractive and livable environments. This is evident in Singapore, where green roofs and vertical gardens have improved the aesthetic value of buildings, making the city more visually appealing. The aesthetic benefits of green infrastructure also contribute to increased property values and community satisfaction. Green infrastructure projects often involve community participation, fostering social cohesion and a sense of ownership. In New York City and Copenhagen, community engagement in the planning and implementation of green infrastructure has strengthened social ties and promoted civic involvement. This social benefit underscores the importance of involving communities in green infrastructure projects.

4.4. Common Challenges

The initial costs of installing green roofs and rain gardens can be prohibitive, limiting widespread adoption. This is a common challenge faced by all three cities. Additionally, the ongoing maintenance costs of green infrastructure can pose a financial burden for property owners and municipalities.

Implementing green infrastructure requires specialized knowledge and skills in design, construction, and maintenance. Structural concerns, such as the ability of existing buildings to support the additional weight of green roofs, can also pose challenges. Addressing these technical and structural concerns is crucial for the successful integration of green infrastructure.

Inadequate policies and regulations can hinder the implementation of green infrastructure. In Copenhagen, existing buildings face regulatory hurdles in retrofitting green roofs. Similarly, New York City and Singapore have encountered policy barriers that limit the adoption of green infrastructure. Developing supportive policies and regulatory frameworks is essential for promoting green infrastructure.

Limited public and stakeholder awareness about the benefits of green infrastructure can impede its adoption. Increasing awareness and understanding of green infrastructure's environmental, economic, and social benefits is crucial for driving demand and support. Education and outreach efforts are necessary to address this challenge.

4.5. Successful Strategies

Strong policy frameworks and incentives are crucial for promoting green infrastructure. New York City's Green Infrastructure Program provides financial incentives, such as tax abatements, to encourage the installation of green roofs and rain gardens. Copenhagen's Climate Plan mandates green roofs for new buildings, and Singapore's Skyrise Greenery Incentive Scheme offers substantial financial support.

Collaborations between governments, private sector, and communities facilitate the funding, design, and implementation of green infrastructure projects. Public-private partnerships leverage resources and expertise, enhancing project success. This strategy has been effective in New York City and Copenhagen.

Integrating green infrastructure into broader urban planning efforts ensures cohesive and effective implementation. Copenhagen's Climate Plan exemplifies this approach, incorporating green infrastructure into the city's overall resilience strategy. Integrated planning is essential for maximizing the benefits of green infrastructure.

Increasing awareness among stakeholders about the benefits of green infrastructure can drive demand and support. Education and outreach programs, such as those conducted in Copenhagen and Singapore, engage the public and encourage community participation. This strategy is vital for fostering a culture of sustainability.

5. CONCLUSION

The case studies demonstrated significant environmental benefits of green infrastructure: Green roofs and rain gardens effectively reduce stormwater runoff, mitigate flooding, and improve water quality by filtering pollutants. Green roofs reduce surface temperatures through evapotranspiration, contributing to cooler urban environments. Rain gardens support urban biodiversity by providing habitats for various species, including birds and insects.

The economic benefits of green infrastructure include green roofs provide insulation, leading to reduced energy consumption for heating and cooling. Proximity to green infrastructure enhances property values and attracts investment. The implementation and maintenance of green infrastructure generates employment opportunities in landscaping, construction, and environmental management.

The social benefits of green infrastructure are also significant as it provides access to natural green spaces and improves mental health and well-being. It enhances the visual appeal of urban areas, creating more attractive and livable environments. Green infrastructure projects often involve community participation, fostering social cohesion and a sense of ownership.

The initial costs and ongoing maintenance of green infrastructure can be prohibitive. Specialized knowledge and skills are required for the design, construction, and maintenance of green infrastructure. Inadequate policies and regulations can hinder the adoption of green infrastructure. Limited public and stakeholder awareness about the benefits of green infrastructure can impede its adoption.

Strong policy frameworks and financial incentives are crucial for promoting green infrastructure. Collaborations between governments, private sector, and communities facilitate the funding, design, and implementation of green infrastructure projects. Incorporating green infrastructure into broader urban planning efforts ensures cohesive and effective implementation. Increasing awareness and understanding of green infrastructure's benefits through education and outreach programs engages the public and encourages community participation.

6. RECOMMENDATIONS

Based on the findings, the following recommendations are proposed for policymakers and urban planners:

Develop and enforce policies that mandate and incentivize green infrastructure. Financial incentives, such as tax abatements and grants, can offset initial costs and encourage adoption. Regulatory frameworks should prioritize green infrastructure and remove barriers to its implementation.

Collaborate with private sector and community organizations to leverage resources and expertise for green infrastructure projects. Public-private partnerships can enhance the funding, design, and implementation of green infrastructure, ensuring its success and sustainability.

Ensure that green infrastructure is incorporated into broader urban planning efforts to achieve cohesive and effective implementation. Integrated planning can maximize the environmental, economic, and social benefits of green infrastructure, contributing to overall urban resilience and sustainability.

Increase awareness and understanding of green infrastructure's benefits through education and outreach programs. Engage communities in the planning and implementation of green infrastructure projects to foster a sense of ownership and social cohesion. Education and outreach efforts can drive demand and support for green infrastructure.

Offer training programs for professionals to address technical and structural concerns in the design, installation, and maintenance of green infrastructure. Building capacity and expertise in green infrastructure is essential for its effective implementation and long-term success.

7. REFERENCES

1. Hernández-Hernández M, Olcina J, Morote Á-F. Urban Stormwater management, a tool for adapting to climate change: From risk to resource. Water. 2020; 12(9): 2616.
2. Santamouris M, Ding L, Osmond P. Urban heat island mitigation. Decarbonising the Built Environment: Charting the Transition. 2019: 337-55.
3. Fletcher TD, Shuster W, Hunt WF, Ashley R, Butler D, Arthur S, et al., editors. SUDS, LID, BMPs, WSUD and more – The evolution and application of terminology surrounding urban drainage2015 2015; Great Britain: Taylor & Francis.
4. Fan X, Matsumoto T. Comparative Analysis on Urban Flood Countermeasures Based on Life Cycle Thinking: A Comparison between Enhancing of Drainage Capacity Project and Sponge City. Environments. 2020; 7(7): 51.
5. Demuzere M, Orru K, Heidrich O, Olazabal E, Geneletti D, Orru H, et al. Mitigating and adapting to climate change: Multi-functional and multi-scale assessment of green urban infrastructure. Journal of environmental management. 2014; 146: 107-15.
6. Elena C, Stefano F, Roberto D, Francesco V. Comparison of blue-green solutions for urban flood mitigation: A multi-city large-scale analysis. PLoS ONE. 2021; 16(1): e0246429.
7. Ercolani G, Chiaradia EA, Gandolfi C, Castelli F, Masseroni D. Evaluating performances of green roofs for stormwater runoff mitigation in a high flood risk urban catchment. Journal of Hydrology. 2018; 566: 830-45.

8. Sharma R, Malaviya P. Management of stormwater pollution using green infrastructure: The role of rain gardens. Wiley Interdisciplinary Reviews: Water. 2021; 8(2): e1507.
9. Kayhanian M, Li H, Harvey JT, Liang X. Application of permeable pavements in highways for stormwater runoff management and pollution prevention: California research experiences. International Journal of Transportation Science and Technology. 2019; 8(4): 358-72.
10. Escobedo FJ, Giannico V, Jim CY, Sanesi G, Lafortezza R. Urban forests, ecosystem services, green infrastructure and nature-based solutions: Nexus or evolving metaphors? Urban Forestry & Urban Greening. 2019; 37: 3-12.
11. Tzoulas K, Korpela K, Venn S, Yli-Pelkonen V, Kaźmierczak A, Niemela J, James P. Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. Landscape and urban planning. 2007; 81(3): 167-78.
12. Burns MJ, Fletcher TD, Walsh CJ, Ladson AR, Hatt BE. Hydrologic shortcomings of conventional urban stormwater management and opportunities for reform. Landscape and Urban Planning. 2012; 105: 230-40.
13. Berndtsson JC. Green roof performance towards management of runoff water quantity and quality: A review. Ecological Engineering. 2010; 36(4): 351-60.
14. Tong P, Yin H, Wang Z, Trivers I. Combining stormwater management and park services to mitigate climate change and improve human well-being: a case study of sponge city parks in shanghai. Land. 2022; 11(9): 1589.
15. Akbari H, Pomerantz M, Taha H. Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas. Solar energy. 2001; 70(3): 295-310.
16. Webber JL, Fletcher TD, Cunningham L, Fu G, Butler D, Burns MJ. Is green infrastructure a viable strategy for managing urban surface water flooding? Urban Water Journal. 2020; 17(7): 598-608.
17. Nowak DJ, Hirabayashi S, Bodine A, Greenfield E. Tree and forest effects on air quality and human health in the United States. Environmental pollution. 2014; 193: 119-29.
18. Lan H, Lau KK-L, Shi Y, Ren C. Improved urban heat island mitigation using bioclimatic redevelopment along an urban waterfront at Victoria Dockside, Hong Kong. Sustainable Cities and Society. 2021; 74: 103172.
19. Oberndorfer E, Lundholm J, Bass B, Coffman RR, Doshi H, Dunnett N, et al. Green Roofs as Urban Ecosystems: Ecological Structures, Functions, and Services. BioScience. 2007; 57(10): 823-33.
20. Williams NS, Lundholm J, Scott MacIvor J. Do green roofs help urban biodiversity conservation? Journal of applied ecology. 2014; 51(6): 1643-9.
21. Benedict MA, McMahon ET. Green infrastructure: linking landscapes and communities: Island press; 2012.
22. Getter KL, Rowe DB. The role of extensive green roofs in sustainable development. HortScience. 2006; 41(5): 1276-85.
23. Davis AP, Hunt WF, Traver RG, Clar M. Bioretention technology: Overview of current practice and future needs. Journal of environmental engineering. 2009; 135(3): 109-17.
24. Goddard MA, Dougill AJ, Benton TG. Scaling up from gardens: biodiversity conservation in urban environments. Trends in ecology & evolution. 2010; 25(2): 90-8.
25. Zachary Bean E, Frederick Hunt W, Alan Bidelspach D. Evaluation of four permeable pavement sites in eastern North Carolina for runoff reduction and water quality impacts. Journal of Irrigation and Drainage Engineering. 2007; 133(6): 583-92.
26. Gill SE, Handley JF, Ennos AR, Pauleit S. Adapting cities for climate change: the role of the green infrastructure. Built environment. 2007; 33(1): 115-33.

27. Mitsch WJ, Bernal B, Hernandez ME. Ecosystem services of wetlands. Taylor & Francis; 2015. p. 1-4.
28. Zhang S, Zevenbergen C, Rabé P, Jiang Yong JY. The influences of sponge city on property values in Wuhan, China. 2018.
29. Bowler DE, Buyung-Ali L, Knight TM, Pullin AS. Urban greening to cool towns and cities: A systematic review of the empirical evidence. Landscape and urban planning. 2010; 97(3): 147-55.
30. White EV, Gatersleben B. Greenery on residential buildings: Does it affect preferences and perceptions of beauty? Journal of Environmental Psychology. 2011; 31: 89-98.
31. Colding J, Barthel S. The potential of 'Urban Green Commons' in the resilience building of cities. Ecological economics. 2013; 86: 156-66.
32. Brears RC. New York City Becoming a Blue-Green City Through Blue-Green Infrastructure. Blue and Green Cities: The Role of Blue-Green Infrastructure in Managing Urban Water Resources: Springer; 2023. p. 155-74.
33. Xu H, Liu L, Ding P, editors. Building Climate Resilient City through Multiple Scale Cooperative Planning: Experiences from Copenhagen. IOP Conference Series: Materials Science and Engineering; 2021: IOP Publishing.
34. Liao K-H. The socio-ecological practice of building blue-green infrastructure in high-density cities: what does the ABC Waters Program in Singapore tell us? Socio-Ecological Practice Research. 2019; 1(1): 67-81.