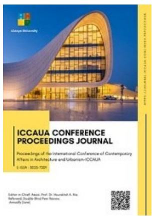

# ICCAUA Proceedings Journal

*Proceedings of the international conference of contemporary affairs in architecture and urbanism-ICCAUA*

*Volume 8 (December 2025), Pages 563–575*

Journal homepage: https://journal.iccaua.com/

ICCAUA Proceedings Journal

**DOI:** https://doi.org/10.38027/ICCAUA2025EN0294


# Sustainable and Energy-Efficient Urban Space Design: Theoretical Framework and Case Studies in Water Management


* [1] Assist. Prof. Dr. **Pelin Keçecioğlu Dağlı** , [2] **Gizem Bostancı**

[1] Department of Landscape Architecture, Faculty of Engineering, Architecture and Design, Bartın University, Bartın, Türkiye

[2] Department of Landscape Architecture, Graduate School, Bartın University, Bartın, Türkiye

[1] E-mail: pkececioglu@bartin.edu.tr , [2] E-mail: gzmbstnci@gmail.com



**Abstract**

This study examines the role of water management in the context of sustainability and energy efficiency in urban areas. It emphasizes the necessity of effective water management strategies to preserve the urban water cycle, ensure energy savings, and support ecosystem integrity. The study explores sustainable water management principles and green infrastructure applications within a theoretical framework, analyzing innovative design solutions such as rainwater harvesting, greywater reuse, and permeable surfaces. Selected successful case studies at both national and international levels are evaluated in terms of their integration into urban space design. Ultimately, this study proposes a roadmap for designing energy-efficient and environmentally sustainable urban spaces by introducing policies and technological solutions that promote the efficient use of water resources in cities.



**Keywords:** Sustainable water management; Water-Sensitive urban design; Green infrastructure; Energy efficiency in cities, Urban landscape.

**Received:** 18 January 2025
**Revised:** 6 June 2025
**Accepted:** 18 June 2025
**Available online:** 5 July 2025





The publisher maintains a neutral stance concerning jurisdictional claims in published maps and institutional affiliations.
This article has been selected and peer-reviewed for publication in this journal as part of the 8th International Conference of Contemporary Affairs in Architecture and Urbanism, held on 8–9 May 2025 in Alanya, Türkiye.


## 1. Introduction

Water has vital importance not only for human life but also for the sustainability of cities. However, global challenges such as rapid urbanization, population growth, and climate change put increasing pressure on water resources, disrupting the water cycle, and threatening the balance of ecosystems (Helmreich et al., 2025; Riaz et al., 2025). In this context, water must not be regarded merely as an infrastructural element. Rather, it should be recognized as a spatial component that significantly influences the livability, resilience, and ecological integrity of urban environments (Riaz et al., 2025; Adigun et al., 2025).

Traditional water management systems tend to prioritize the rapid drainage of stormwater from urban areas. However, this approach not only impedes the natural replenishment of water resources but also gives rise to new problems such as increased flood risk, polluted runoff, strain on infrastructure, and rising energy costs (Duymuş et al., 2024). In contrast, nature-based solutions, such as rainwater harvesting, greywater reuse, permeable surfaces, and green infrastructure, facilitate the management of water without disrupting its natural cycle (Aksu, 2022). These strategies also enhance urban resilience in the face of climate change (Lindner & Stamm, 2025). Accordingly, sustainable water management and water-sensitive urban design approaches are gaining increasing importance (Farhadi et al., 2025). Nature-based strategies and technological innovations not only promote the efficient use of water but also reduce energy consumption and strengthen ecosystem services. For instance, green roofs, permeable pavement systems, rain gardens, and constructed wetlands enhance soil–water interactions while offering multiple benefits such as flood control and groundwater recharge (Riaz et al., 2025). Greywater reuse, particularly in residential and commercial buildings, stands out as an effective method for promoting water conservation (Adigun et al., 2025).

Globally, cities are striving to develop new policies and design approaches to ensure water security, foster energy-efficient systems, and maintain ecological balance. In this regard, the sustainable and integrated management of water represents not only an environmental necessity but also a strategic imperative for social well-being and urban resilience (Ministry of Agriculture and Forestry, 2022; Helmreich et al., 2025). This study examines the reciprocal relationship between water management and energy efficiency in urban spaces, focusing on spatial design approaches that prioritize the sustainable use of water. It offers a theoretical framework while also analyzing selected successful national and international practices to explore how water management can be more effectively integrated into urban planning. The research thus aims to present a comprehensive perspective on how water management can be aligned with urban energy efficiency and environmental sustainability goals.

The study is guided by key questions concerning how water management can be integrated with energy efficiency, which innovative practices have proven successful at national and international levels, how water-sensitive urban and landscape design approaches contribute to sustainability goals, and what strategic recommendations can be developed for urban managers and policymakers. In response to these questions, the study investigates how water management policies and design strategies can enhance urban livability, and based on its findings, proposes a roadmap for developing energy-efficient and ecologically sustainable urban areas.

In conclusion, this research provides a holistic framework that addresses a wide range of stakeholders from urban planners and environmental engineers to local authorities and academics, highlighting the critical role of water management in urban sustainability. In doing so, it lays a scientific foundation for innovative planning and design practices of the future and contributes to the development of policies and technologies that support the efficient, equitable, and sustainable use of water resources.

## 2. Material and Methods

This study aims to examine the role of water management in sustainable and energy-efficient spatial design in urban areas through a multidimensional approach that incorporates both a theoretical framework and practical case studies. The research is structured around three main phases: a literature review, the evaluation of case studies, and the development of design recommendations:

1. To establish the theoretical framework of the research, national and international academic studies and projects related to urban water management were reviewed. Particular attention was given to topics such as rainwater harvesting, greywater reuse, permeable surfaces, energy-efficient landscape design, and nature-based solutions. The literature review served to define the conceptual basis of the study and contributed to the development of the evaluation criteria used in the subsequent analysis.
2. In the second phase, a selection of successful water management projects implemented across various geographies and scales was compiled and categorized under thematic headings. Each case study was assessed using analytical criteria such as scope of implementation, integration with the landscape, contribution to sustainability, user experience, and economic dimensions. This approach enabled both a comparative analysis of practices in diverse contexts and an understanding of how they contribute to landscape architecture from the perspective of sustainable water management.
3. Finally, based on the findings derived from the theoretical framework and case study analysis, design recommendations were developed for sustainable water management in urban areas. These proposals aim not only to promote environmental sustainability and energy efficiency but also to generate landscape-based, holistic solutions that enhance urban quality of life.

## 3. Sustainable Water Management in Urban Areas: Significance, Approaches and Applications

### 3.1. The Importance of Urban Water Management

Water management in urban areas plays a crucial role in achieving sustainability and energy efficiency goals. Increasing urbanization and population density exert significant pressure on water resources, posing a threat to the equilibrium of ecosystems. Consequently, the efficient and sustainable use of water has become a fundamental component of urban planning (Adigun et al., 2025). While traditional stormwater systems are designed to rapidly discharge water from urban environments, such systems may lead to the depletion of groundwater levels and the deterioration of water quality. Furthermore, they often prove insufficient during heavy rainfall events, thereby increasing the risk of flooding. In response, sustainable stormwater management models have been developed to preserve the natural water cycle, support groundwater recharge, and offer ecologically-based solutions (Müftüoğlu & Perçin, 2015; Hamel et al., 2024; Adigun et al., 2025).

Sustainable water management not only safeguards water resources but also promotes energy conservation. Practices such as rainwater harvesting and greywater reuse help reduce the amount of energy required for water transport and treatment. In turn, this decreases overall energy consumption, enhances the efficient use of water, and mitigates negative environmental impacts (Gates, 2023).

Beyond environmental sustainability, water management in urban areas carries significant economic and social implications (Wan Rosely & Voulvoulis, 2024). Effective water management can lower infrastructure costs and reduce flood risks, thereby contributing to public welfare (Ministry of Agriculture and Forestry, 2022). Reducing water loss and leakage, especially in large metropolitan areas, can result in substantial economic savings. At the same time, sustainable water management practices support productivity across agriculture, industry, and service sectors, fostering stability and efficiency in water-dependent production processes (Delgado et al., 2024). The prevention or mitigation of water-related disasters such as floods directly reduces both tangible and intangible economic losses (Li et al., 2025). Moreover, investments in green infrastructure and nature-based solutions can decrease long-term maintenance costs, placing a more sustainable burden on public budgets (Delgado et al., 2024). Within this framework, water management emerges not only as an environmental policy tool but also as a strategic component of economic development. Access to clean and safe water is a fundamental requirement for public health, while water scarcity or contamination can lead to the spread of disease, reduced quality of life, and deepening social inequalities (Wan Rosely & Voulvoulis, 2024). Thus, sustainable water management also becomes a means of fostering social inclusion.

Integrating water management strategies into urban planning processes has become essential for the design of sustainable and energy-efficient urban spaces. The effectiveness of water management directly influences the success of such design efforts. Accordingly, sustainable water management is of paramount importance. In this regard, green infrastructure and nature-based solutions-along with smart water management systems, rainwater harvesting, and greywater recycling-have emerged as key tools for supporting environmental, economic, and social sustainability in contemporary cities (Mekonnen & Hoekstra, 2011; Kınacı, 2017; Kırtorun & Karaer, 2018; Öztaş Karlı, 2020; Koç, 2022). The disruption of the urban water cycle adversely affects both infrastructure and quality of life, underscoring the urgent need for sustainable, holistic, and innovative solutions.

### 3.2. Principles of Sustainable Water Management and Integrated Approaches

The progressive degradation of natural resources has led to a decline in both the quantity and quality of water, making the efficient use of water resources increasingly necessary (Lindner & Stamm, 2025; Öztaş & Çelikyay, 2018; Öztaş Karlı & Artar, 2021). Sustainable water management refers to the efficient, equitable, and innovative preservation and administration of water resources to meet current and future needs. This approach seeks to balance ecological integrity with social and economic demands. Reducing water consumption, preventing pollution, encouraging reuse, and enhancing resilience to climate change are among the core goals of this process (Özkan et al., 2013; Kırtorun & Karaer, 2018). One successful example of this approach is Singapore, which has achieved significant energy savings by recycling more than 40% of its water through the "PUB Water Story" program (Tortajada, 2006).

Sustainable water management extends beyond technical solutions and must be addressed through social, ecological, and governance dimensions. In this context, this study examines innovative and nature-based solutions implemented at the urban scale under five thematic categories:

**Rainwater Management and Harvesting Systems:** In urban areas, rainwater quickly enters sewer systems as surface runoff, resulting in both water loss and increased pressure on infrastructure (Adigun et al., 2025). Rainwater harvesting systems, implemented through rooftops and permeable surfaces, allow for the collection, filtration, and reuse of water. These systems support the water cycle and help mitigate flood risks (Li et al., 2025).

**Greywater Recovery and Multi-Purpose Water Use:** The treatment and reuse of greywater (wastewater generated from household activities) is an effective strategy for reducing water consumption (Wand & Davies, 2018). Reclaimed greywater can be utilized in toilet flushing, landscape irrigation, and cleaning services. This approach is particularly valuable in water-stressed cities, as it improves resource efficiency (Kumar et al., 2021).

**Integration of Green Infrastructure:** Green infrastructure practices support the filtration, storage, and infiltration of water through nature-based solutions (Novotny, 2010; EPA, 2013; Fletcher et al., 2015). Elements such as permeable pavements, green roofs, rain gardens, and urban wetlands serve not only water management purposes but also help regulate the microclimate (Benedict & McMahon, 2006; EPA, 2013; Gates, 2023; Yanık, 2023; Riaz et al., 2025). These features also contribute to biodiversity enhancement within urban ecosystems (Yanık, 2023).

**Water Conservation and Behavior-Oriented Applications:** Efficient water use requires not only technical measures (Hamel et al., 2024) but also a cultural transformation (Kumar et al., 2021). Tools such as educational programs, smart water meters, and feedback mechanisms can shift user consumption habits. This behavioral shift bridges individual awareness with collective impact (Kumar et al., 2021; Dias & Ghisi, 2024).

**Climate Adaptation and Innovative Design Approaches:** Global climate change necessitates the development of new strategies in water management. Challenges such as droughts, intense rainfall, and flash flooding highlight the need for flexible and resilient infrastructure solutions (Yuan et al., 2024). Climate-responsive planning, when implemented in tandem with nature-based systems, promotes long-term sustainability (Farhadi et al., 2025).

## 4. Case Studies: Thematic Classification and Explanation

The selected case studies are examined under thematic categories, each associated with a specific water management technique or landscape design application. This thematic classification aims to clearly define the content and contributions of each project (Table 1). By grouping the cases into categories, the analysis not only reveals the variety of water management strategies but also highlights their impact within the context of landscape and environmental sustainability. In addition, the projects are analyzed from various perspectives such as user experience, aesthetic integration, and economic sustainability. In this way, both the shared features and unique approaches of the different applications are detailed, offering a more comprehensive perspective on the integration of water management into urban landscapes.

**Table 1.** Thematic classification and brief description of selected case studies.

| Case Studies | Thematic Classification | Description |
|---|---|---|
| **Singapur – ABC Waters Program** | Rainwater Management and Harvesting Systems, Integration of Green Infrastructure | Landscape-based water management in open spaces such as parks and waterfronts |
| **Portland – Green Streets Program** | Integration of Green Infrastructure | Stormwater filtration systems ıntegrated into streetscapes |
| **Hamburg – HWC Jenfelder Au Residential Region** | Greywater Recovery and Multi-Purpose Water Use, Integration of Green Infrastructure, Water Conservation and Behavior-Oriented Applications, Climate Adaptation and Innovative Design Approaches | Centralized wastewater and energy recovery system in residential open spaces |
| **Philadelphia – Green City, Clean Waters Program** | Greywater Recovery and Multi-Purpose Water Use, Integration of Green Infrastructure | City-wide multi-scale water management approach integrated with landscape solutions |
| **Fukuoka – Sustainable Water Management and Treatment Program** | Integration of Green Infrastructure, Climate Adaptation and Innovative Design Approaches | Integration of urban parks and nature-based water purification systems |
| **İstanbul – ITU Green Campus Project** | Rainwater Management and Harvesting Systems, Integration of Green Infrastructure | Campus-wide multi-scale water management approach ıntegrated with landscape solutions |

## 5. Case Studies: Introduction, Analysis and Description

### 5.1. Singapore – Active, Beautiful, Clean Waters (ABC Waters) Program

Despite its limited land area, Singapore has emerged as a global model in ensuring water security through the effective management of its water resources. The country's water management strategy is based on four key sources: local rainwater harvesting, imported water, reclaimed water (NEWater), and desalinated seawater. This diversified approach aims to reduce external dependency and secure a sustainable water supply. As a pioneer in urban water management, Singapore has developed extensive infrastructure to collect and reuse rainwater. One of the most prominent initiatives in this context is the Active, Beautiful, Clean Waters (ABC Waters) Programme (Tortajada, 2007). Within this programme, rainwater harvesting systems have been integrated into urban parks, reservoirs, and ponds. The collected rainwater is treated at water purification facilities and reused as potable water (Figure 1). The ABC Waters Programme not only supports the natural water cycle but also minimizes energy consumption in water processing (PUB, 2024). Moreover, under its integrated water management efforts, Singapore has implemented the "PUB Water Story" initiative, through which more than 40% of the national water supply is reclaimed, contributing significantly to energy savings (Tortajada, 2006).

**Figure 1.** Images from the application of the ABC Waters Program (PUB, 2024).

The case studies have been examined in detail within the framework of the analytical criteria defined for this study. In this context, the ABC Waters Programme is presented in Table 2 with a comprehensive, multi-dimensional evaluation.

**Table 2.** Evaluation of the Active, Beautiful, Clean Waters (ABC Waters) Program according to the defined analytical criteria.

| Analysis Criteria | Description |
|---|---|
| **Application Name** | **Active, Beautiful, Clean Waters (ABC Waters) Program** – Singapore |
| **Scope of the Application** | It is an integrated water management program launched at the national level and being implemented in urban open spaces (riverbanks, parks, lake surroundings). It covers both new projects and the transformation of existing infrastructure. |
| **Applied Strategy** | The program involves rainwater management, integration of natural drainage systems, use of permeable surfaces, and enhancement of water's visual and recreational value. Additionally, biofilter systems and phytoremediation areas are used for water purification. |
| **Integration with Landscape** | Water lines, channels, and lake edges have been redesigned and integrated with green infrastructure, transforming them into active public landscape areas that engage with the urban population. Landscape systems have been created, connected with pedestrian paths, recreation areas, and green corridors. |
| **Contribution to Sustainability** | By reducing surface runoff of rainwater, the program minimizes flood risks, naturally improves water quality, and contributes to biodiversity. In terms of ecosystem services, it enhances air quality, regulates microclimates, and generates social benefits. |
| **User Experience and Social Impact** | The program has been supported by public awareness campaigns. The waterfronts have been made aesthetic, accessible, and safe, increasing public usage. Participatory planning processes and environmental education have supported the community. |
| **Cost and Management Structure** | Investments have been managed by the state's PUB (Public Utilities Board), with joint projects developed in collaboration with the private sector. Long-term maintenance plans have been established, and public-private partnerships have been encouraged. |

**The table was originally structured by the authors, based on data from PUB (2024) and USS (2017).*

### 5.2. Portland – Green Streets Program

The Green Streets program is designed using plants and soil to slow, filter, and clean the flow of rainwater from streets and sidewalks (Figure 2). While traditional stormwater management directs surface runoff into infrastructure pipes, Green Streets applications aim to manage this water on-site before it reaches the sewer system. In Portland, the Environmental Services Bureau constructs and maintains such green infrastructure systems in different parts of the city. By using permeable surfaces in stormwater management, it has prevented urban flooding. The permeable asphalt used on streets allows rainwater to be absorbed by the soil, while green infrastructure elements support the natural filtration of water. This application not only conserves water but also contributes to the preservation of the water cycle, while providing energy savings (City of Portland, 2025). The Green Streets Program in Portland has reduced floodwater by 85% through rain gardens (Lukes et al., 2008). Additionally, Green Streets have been shown to reduce peak flows from their drainage areas by at least 80% and up to 94%. Green Street facilities filter water to reduce total suspended solids by 90%, organic pollutants/oils by 90%, and heavy metals by more than 90%. This results in a 40% cost reduction compared to a traditional pipe upsizing and replacement project, along with three ASLA General Design Awards of Honor (City Parks Alliance, 2025).
The Green Streets Program has been examined in detail within the framework of the analysis criteria established in this study, as shown in Table 3.

**Figure 2.** Images from the application of the Green Streets Program (Blanchard, 2016).

**Table 3.** Evaluation of the Green Streets Program according to the defined analytical criteria.

| Analysis Criteria | Description |
|---|---|
| **Application Name** | **Green Streets Program** – Portland, USA |
| **Scope of the Application** | The Green Streets Program in Portland is an initiative aimed at managing stormwater across the infrastructure network surrounding the city. The program has been implemented in the streets and neighborhoods within the city and focuses on the natural filtration and on-site storage of rainwater before it is directed to the drainage system. |
| **Applied Strategy** | For stormwater management, various landscaping elements such as permeable surfaces, biological filters, green roofs, and systems designed to infiltrate water directly into the ground are used. This strategy reduces the surface runoff of rainwater, minimizing flood risks, and ensures natural purification of the water. |
| **Integration with Landscape** | The project has been integrated into Portland's urban landscape. Various green infrastructure components (bio-filtration systems, rainwater storage tanks, permeable asphalt) are incorporated with the landscape elements along the streets and avenues. This integration has created green spaces that are both effective in managing water and aesthetically appealing. |
| **Contribution to Sustainability** | While improving water quality through natural purification methods, the program also helps prevent flooding by facilitating the storage of water in the city. This practice has the potential to reduce energy consumption and offers significant ecosystem benefits. The use of green infrastructure plays a crucial role in reducing carbon emissions. |
| **User Experience and Social Impact** | The Green Streets program has been supported by community awareness efforts and participatory planning methods. Portland residents have directly benefited from environmental advantages and gained more knowledge about water management. This initiative has increased the sense of environmental responsibility among city dwellers, providing social benefits. |
| **Cost and Management Structure** | The project is managed by the City of Portland's Bureau of Environmental Services and Bureau of Transportation and has been supported by various public-private partnerships. Infrastructure investments and maintenance costs have been minimized with a focus on long-term sustainability goals. The program helps local governments achieve their environmental, social, and economic sustainability objectives. |

**The table was originally constructed by the authors based on data from Lukes et al. (2008); Perry (2008), Blanchard (2016), City of Portland (2025) and City Parks Alliance (2025).*

### 5.3. Hamburg – Hamburg Water Cycle (HWC) Jenfelder Au Residential Region

In traditional wastewater systems, domestic wastewater is collected in a single pipeline. In the Hamburg Water Cycle (HWC) system, however, wastewater is separated according to its characteristics to enable more ecological and efficient reuse. In the Jenfelder Au residential region in Hamburg (Figure3), water-saving vacuum toilet technology has been used, and separate wastewater collection, drainage, and treatment systems have been established for households. Black water (toilet waste) is used for energy production, while grey water (bathroom and kitchen waste) is treated separately and used for agricultural irrigation (European Commission – CINEA, 2025). Additionally, low-energy water treatment technologies are implemented to reduce the carbon footprint (Hamburg Wasser, 2025). The main goal of the project is to demonstrate the technical, environmental, and economic feasibility of an integrated and decentralized wastewater disposal and energy production system for an urban residential area in Hamburg. This concept is the first large-scale implementation combining known technologies with new and innovative example (European Commission – CINEA, 2025). The concept takes a holistic approach by treating water and energy infrastructure as interconnected and complementary areas. This way, both drinking water resources are protected, and the wastewater generated is utilized for energy production (Hamburg Wasser, 2025).

**Figure 3.** Jenfelder Au, created on the 35 hectare former barracks site (Hamburg Wasser, 2025).

**Table 4.** Evaluation of the HWC Jenfelder Au Residential Region according to the defined analytical criteria.

| Analysis Criteria | Description |
|---|---|
| **Application Name** | **Hamburg Water Cycle (HWC) Jenfelder Au Residential Region** – Hamburg, Germany |
| **Scope of the Application** | Jenfelder Au is a residential area developed in line with Hamburg's vision for sustainable urbanization. This project adopts an integrated approach that combines various factors such as stormwater management, energy efficiency, green infrastructure, and social sustainability. In addition to improving the existing infrastructure, the project aims to minimize the environmental footprint of newly constructed residences. |
| **Applied Strategy** | Rainwater has been managed on-site through environmentally friendly drainage systems. Thanks to permeable surfaces and green roofs, rainwater is temporarily stored on-site, preventing rapid surface runoff. Additionally, sustainable energy solutions such as greywater recycling and green energy production have been integrated into the system. |
| **Integration with Landscape** | The open spaces in the residential area are equipped with green spaces supported by natural water treatment systems. This not only ensures the efficient management of water but also creates areas where residents can interact with the natural landscape. Social and public spaces are designed as elements that enhance the aesthetic value of water and green areas. |
| **Contribution to Sustainability** | The Jenfelder Au project makes significant contributions to sustainability. The direct on-site management of rainwater helps reduce flood risks and contributes to the preservation of water quality. Additionally, green roofs and biodiversity-enhancing landscaping improve the ecosystem services in the area, promoting the integration of nature with urban life. |
| **User Experience and Social Impact** | The residents of Jenfelder Au can actively engage in water conservation and recovery efforts. This not only creates social benefits but also raises environmental awareness. The area serves as an example in terms of both social and environmental sustainability. |
| **Cost and Management Structure** | The project was implemented in collaboration with local authorities and supported by public-private partnerships. Costs have been optimized considering long-term environmental benefits, as well as advantages such as energy efficiency and water conservation. Maintenance and management processes in the area are regularly monitored by local authorities to ensure the continuity of sustainable practices. |

**The table was originally structured by the authors, based on data from Biederbeck (2017), Schelbert et al. (2023), European Commission – CINEA (2025) and Hamburg Wasser (2025).*

### 5.4. Philadelphia – Green City, Clean Waters Program

The "Green City, Clean Waters" program by the Philadelphia Water Department is a 25-year initiative launched to improve stormwater management and reduce water pollution in the city. Initiated in 2011, the program aims to reduce the amount of stormwater entering Philadelphia's combined sewer system by 2036, as well as reduce pollution by 85%. The program focuses on green infrastructure solutions that reduce the entry of stormwater into the sewer system by absorbing or evaporating it. These include rain gardens, permeable sidewalks, tree trenches, and green roofs (Figure 4,5). This approach not only improves water quality but also provides environmental, economic, and social benefits by creating green spaces. The project has managed billions of gallons of stormwater and created local job opportunities (Philadelphia Water Department).
The Green City, Clean Waters Program is presented in a multidimensional evaluation in Table 5.

**Figure 4.** Osage Avenue green infrastructure, autumn and early spring (Fries, 2023).

**Figure 5.** Rainwater garden, pedestrian bridge, and walkway at Centennial Commons, early spring (Fries, 2023).

**Table 5.** Evaluation of the Green City, Clean Waters Program according to the defined analytical criteria.

| Analysis Criteria | Description |
|---|---|
| **Application Name** | **Green City, Clean Waters Program** – Philadelphia, USA |
| **Scope of the Application** | The Green City, Clean Waters program is a 25-year green infrastructure initiative launched to prevent flooding and water pollution caused by Philadelphia's combined sewer system. The program aims to reduce surface runoff and ensure natural treatment of stormwater through on-site management. |
| **Applied Strategy** | Various green infrastructure practices, such as bioretention rain gardens, green roofs, permeable sidewalks, and water-retaining tree trenches, are employed to control surface runoff. This approach reduces the load on wastewater treatment systems while allowing stormwater to be absorbed by the ground and naturally filtered. |
| **Integration with Landscape** | The program is designed to become an integral part of the urban landscape. Green infrastructure solutions are incorporated into public spaces and street furniture, enhancing both environmental function and aesthetic value. Parks, schoolyards, and sidewalks have been transformed into landscape elements that also serve stormwater management purposes. |
| **Contribution to Sustainability** | Green City, Clean Waters presents a vision for an infrastructure that aligns with natural systems by restructuring the urban water cycle. The project provides multifaceted environmental benefits, such as reducing flooding, improving water quality, lowering urban temperatures, and reducing the carbon footprint. |
| **User Experience and Social Impact** | Community involvement has played a crucial role in the program's success. Educational programs, volunteer activities, and neighborhood-focused initiatives have engaged local residents, making them an active part of stormwater management. This approach has raised environmental awareness and strengthened the community's sense of responsibility for the areas they inhabit. |
| **Cost and Management Structure** | Managed by the Philadelphia Water Department (PWD), the program offers a more cost-effective and flexible solution compared to traditional gray infrastructure investments. It aligns with local and regional environmental regulations and is at the core of long-term water management plans. |

**The table was originally constructed by the authors, based on data from ULI Developing Urban Resilience (2021), Fries (2023) and Philadelphia Water Department (2025).*

### 5.5. Fukuoka – Sustainable Water Management and Treatment Program

Fukuoka City, due to its limited water resources, has developed various water management strategies. These strategies are implemented to overcome water scarcity and ensure a sustainable water supply. The city, in cooperation with neighboring cities and towns, procures water from outside the region. A treatment facility has been established to convert seawater into drinking water. Water is transported from agricultural areas to meet the city's water needs. A reservoir system has been created to store water for use when required. Water distribution is adjusted according to demand to improve efficiency. Technological systems are used to detect and prevent water leaks. To maintain water quality, the forests in the watershed areas are protected and rehabilitated (Fukuoka Waterworks Bureau, 2013). Despite water scarcity, Fukuoka effectively utilizes its water resources through sustainable management strategies (Figure 6).

The case study is examined in detail according to the analysis criteria and is presented in Table 6.

**Figure 6.** Fukuoka City in Japan (Euro News, 2021).

**Table 6.** Evaluation of Fukuoka Sustainable Water Management and Treatment Program according to the defined analytical criteria.

| Analysis Criteria | Description |
|---|---|
| **Application Name** | **Fukuoka Sustainable Water Management and Treatment Program** – Fukuoka, Japan |
| **Scope of the Application** | One of the driest large cities in Japan, Fukuoka has developed innovative policies and infrastructure solutions to manage its limited water resources sustainably. The program offers a comprehensive framework that includes both urban water conservation and innovative treatment technologies. |
| **Applied Strategy** | Throughout the city, low water consumption systems, greywater recycling, dual water distribution networks, rainwater harvesting systems, and high-efficiency water treatment technologies have been implemented. Additionally, long-term education and participation programs have been conducted to raise public awareness about water consumption. |
| **Integration with Landscape** | In urban open spaces, particularly public buildings and park areas, rainwater harvesting and storage systems have been integrated into landscape design. These systems are also used for irrigating green spaces, ensuring the direct reuse of water. The use of permeable pavement in city parks is also part of the rainwater management approach. |
| **Contribution to Sustainability** | Fukuoka's strategies have created a resilient urban model against climate change and water scarcity by focusing on the conservation of natural resources. The city has successfully reduced per capita water consumption well below the national average while also increasing the rate of water reuse. |
| **User Experience and Social Impact** | In Fukuoka, community participation plays a crucial role in the success of the program. Residents have adopted water-saving devices in their homes and are conscious about the recovery systems. Activities led by local governments continually reinforce public awareness of the value of water. |
| **Cost and Management Structure** | Managed by the Fukuoka Waterworks Bureau, this program has been supported by long-term planning and investment decisions. By effectively utilizing resources and reassessing their usage, high-tech solutions have been achieved at low costs. Furthermore, these solutions have ensured both environmental and economic sustainability. |

**The table is structured by the authors based on the data from Fukuoka Waterworks Bureau (2013).*

### 5.6. İstanbul – ITU Green Campus Project

At Istanbul Technical University (ITU) Maslak Campus, a new design based on sustainable landscape design principles has been implemented on a previously asphalt-covered parking area located along the main transportation axis of the campus, with various social functions in front of the buildings (Figure 7). In this context, permeable concrete has been used to reduce surface runoff and ensure the direct infiltration of rainwater into the ground. High permeability, materials that enhance spatial perception, prioritize pedestrian/cyclist usage, accommodate easy movement for disabled users, and contribute to the sustainability of natural life have been incorporated into the design with appropriate details. Additionally, rainwater collected from impermeable surfaces has been directed to biological channels created within the design, aiming to purify the water and return it to the environment in a cleaner form. Plant species that consume minimal water, are suitable for the climate, and contribute character to the space in every season have been preferred. These plants are organized in accordance with the campus's landscaping principles. The areas beneath the existing plane trees have been supported with low water and maintenance-requiring plants, increasing the ecological value of the space and enhancing biodiversity (HET Landscape & Urban Design, 2015, İTÜ Yeşil Kampüs). The ITU Green Campus Project is thoroughly examined in Table 7.

Figure 7. Images from the application of ITU Green Campus Project (HET Landscape & Urban Design, 2015).

**Table 7.** Evaluation of ITU Green Campus Project according to the defined analytical criteria.

| Analysis Criteria | Description |
|---|---|
| **Application Name** | **ITU Green Campus Project** – İstanbul, Türkiye |
| **Scope of the Application** | This project, located at Istanbul Technical University (ITU) Maslak Campus, has been developed based on sustainable landscape design principles around the campus's hard-surfaced parking lots and transportation axes. The project offers a holistic solution in terms of rainwater management, permeable surface design, and the use of local plants around buildings that serve social spaces on the campus (such as guesthouses, banks, and dining units). |
| **Applied Strategy** | In the implementation, permeable concrete surfaces have been used to allow rainwater to directly infiltrate into the ground. Additionally, surface runoff collected from impermeable surfaces is directed to biological channels within the design. Through this system, rainwater is filtered and returned to the natural water cycle in a cleaner form, while also being used to irrigate the plant areas around the campus. |
| **Integration with Landscape** | The project aims to integrate sustainable landscape design with buildings and infrastructure. The plant cover beneath the plane trees has been supported with low water and maintenance-requiring species, thereby enhancing the continuity of the natural vegetation and strengthening biodiversity. The biological channel systems have been placed in a way that preserves the natural appearance and contributes to the landscape aesthetics. |
| **Contribution to Sustainability** | The project contributes to environmental sustainability by both managing water on-site and reducing energy consumption. Permeable surfaces and biological filtration systems aim to restore the natural water cycle within the city, while plant choices that conserve water optimize resource use. In this way, microclimate conditions have been improved, and nature-based solutions have been encouraged within the city. |
| **User Experience and Social Impact** | This project, applied in the campus area actively used by university students, academics, and visitors, also serves as an environmental education space that raises awareness among users. The water management and landscape components have been placed in an observable and understandable manner, making sustainability principles an integral part of daily use. |
| **Cost and Management Structure** | The project has been carried out by the university and developed through academic expertise and practical implementation under the sustainable campus goals. With its low maintenance costs, long-lasting materials, and use of local plants, it is an exemplary model of economic sustainability. The process was carried out through the collaboration of the university's environmental and civil engineering departments with the landscape architecture unit. |

**The table was originally structured by the authors, based on data from HET Landscape & Urban Design (2015) and ITU Yeşil Kampüs sources.*

## 7. Comparison Of Case Studies Based On Thematic Categories

The case studies have been compared based on their sustainable water management practices and their relationship to landscaping.

The "Rainwater Management and Harvesting Systems" category involves systems that allow the collection and storage of rainwater from roofs and impermeable surfaces for reuse. The goal in these applications is to complete the water cycle on-site, reduce surface runoff, and create alternative irrigation sources. Examples in this category include the Singapore – ABC Waters Program, and Istanbul – ITU Green Campus Project. The ABC Waters Program stands out with natural water management solutions in public open spaces. The ITU Green Campus Project, on the other hand, develops an integrated rainwater management model at the campus scale, utilizing rainwater harvesting, biological channels, and permeable surfaces.

The "Greywater Recovery and Multi-Use Water Systems" category focuses on the recovery of wastewater (especially greywater) and its utilization in various applications. The examples of Hamburg – HWC Jenfelder Au Residential Area and Philadelphia – Green City, Clean Waters Program fall under this category. Both examples incorporate the integration of centralized and decentralized systems along with greywater recovery. While the Hamburg example addresses the relationship between energy and water, the Philadelphia example integrates the city's infrastructure with ecological solutions to bring sustainability to a broader scale.

The "Green Infrastructure Integration" category encompasses applications where water management is integrated with green infrastructure systems through nature-based solutions. Examples in this category include Portland – Green Streets Program, Fukuoka – Sustainable Water Management and Treatment Program, Singapore – ABC Waters Program, Hamburg – HWC Jenfelder Au Residential Area, Philadelphia – Green City, Clean Waters Program, and Istanbul – ITU Green Campus Project. The Portland application directs rainwater through bioretention cells at the street scale, while Singapore and Fukuoka stand out with large-scale, systematic green infrastructure planning. Hamburg and Philadelphia examples integrate both infrastructure and superstructure to transform water into environmental and social benefits. The ITU example integrates green infrastructure into campus landscaping with permeable surfaces, biological channels, and drought-tolerant plants.

Finally, the "Climate Adaptation and Innovative Design Approaches" category includes examples that contribute to the fight against climate change and offer unique solutions in terms of form and design. This category include Fukuoka – Sustainable Water Management and Treatment Program, and Hamburg – HWC Jenfelder Au Residential Area. The Fukuoka example aligns with resilient infrastructure models to address urban water stress, while the Hamburg model creates inter-system synergy by integrating renewable energy and wastewater management.

These examples demonstrate the importance of developing innovative and energy-efficient solutions in urban water management. Each project serves as a good model for sustainable spatial design. The widespread adoption of such practices, both nationally and internationally, will contribute significantly to the conservation of water resources and achieving energy efficiency goals.

## 8. Conclusion and Recommendations

This study highlights the crucial role of water management in the design of sustainable and energy-efficient spaces within urban areas. Under the increasing pressure of urbanization, the preservation of the water cycle has become a priority not only for environmental but also for economic and social sustainability. Approaches such as rainwater harvesting, greywater recycling, and the reduction of impermeable surfaces enable cities to use their water resources more efficiently while also contributing significantly to energy savings and ecosystem health.

The national and international examples analyzed in this study demonstrate the applicability of these strategies in different contexts and scales. These examples provide important insights into how nature-based solutions can be integrated into urban planning processes. In this context, it is essential to continue integrating and expanding various practices that support sustainable water management in urban spaces.

For these approaches to be effective and widespread, holistic regulations are also needed at the policy and management levels. Effective policy frameworks, active roles of local governments, and partnerships with the private sector are decisive for the success of this process. Legal regulations prioritizing energy conservation should be developed, with financial incentives provided in this direction. Smart water management systems and digital technologies should be utilized to monitor consumption and losses in real-time, supporting data-driven decision-making processes.

Moreover, achieving behavioral change is critical for sustainability. Awareness campaigns targeting all sectors of society will contribute to the more conscious use of water in daily life by encouraging the transformation of individual behaviors. Educational programs on water conservation and public awareness campaigns will foster lasting changes in individual water use habits. Technological applications like smart metering systems can enhance the traceability of water consumption and strengthen individuals' tendencies to save water.

As the effects of climate change become increasingly felt in cities, there is a need to rethink water management in the context of climate adaptation. Drought-resistant infrastructure systems should be planned together with nature-based solutions. The use of local and drought-tolerant plant species in urban landscapes will not only reduce water consumption but also support biodiversity. Nature-based solutions developed in this context will increase the capacity to adapt to extreme climate events such as droughts and sudden rainfall.

In conclusion, urban design strategies centered around sustainable water management not only enable the protection of natural resources but also make it possible to create resilient, livable, and environmentally harmonious cities in the face of the climate crisis. In this process, landscape architects play a critical role in implementing energy-efficient and nature-based solutions that consider the water cycle at the design scale. Holistic policies, innovative technologies, and interdisciplinary collaborations will shape the infrastructure for this transformation, guiding the path toward the sustainable cities of the future.

**Acknowledgements**

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

**Conflict of Interests**

The Authors declare that there is no conflict of interest.

**References**

Adigun, P. O., Ibuotenang, N. D., & Shaibu, S. E. (2025). Sustainable urban water management: Reuse, recycling and climate-resilient strategies. *International Journal of Scientific Research in Science, Engineering and Technology, 12*(1), 122–135. https://doi.org/10.32628/IJSRSET251217

Aksu, G. A. (2022). Kentsel peyzaj planlamada sürdürülebilir yağış suyu yönetim stratejilerinin geliştirilmesi: Kastamonu Üniversitesi Kuzeykent Yerleşkesi örneği [Development of sustainable rainwater management strategies in urban landscape planning: The case of Kastamonu University Kuzeykent Campus]. *Avrupa Bilim ve Teknoloji Dergisi, 35*, 34–46. https://doi.org/10.31590/ejosat.1062637

Benedict, M. A., & McMahon, E. T. (2006). *Green infrastructure: Linking landscapes and communities*. Island Press.

Biederbeck, A. (2017). Integrated wastewater and energy management: HAMBURG WATER Cycle® implementation in the Jenfelder Au. Available online: https://www.staging.connective-cities.net/fileStorage/Veranstaltungen/Praktikerworkshop_Amman/Dokumente/EN_HAMBURG_Integrated_Wastewater_and_Energy_Management_Biederbeck.pdf (accessed 10 April 2025).

Blanchard, N. (2016). National Association of City Transportation Officials. Available online: https://nacto.org/wp-content/uploads/Portland-The-Evolution-of-Green-Street-Infrastructure.pdf (accessed 10 April 2025).

City of Portland. (2025). About green streets. Available online: https://www.portland.gov/bes/stormwater/about-green-streets (accessed 10 April 2025).

City Parks Alliance. (2025). Portland's green street program. Available online: https://cityparksalliance.org/resource/portland-green-street-program/ (accessed 10 April 2025).

Delgado, A., Rodriguez, D. J., Amadei, C. A., & Makino, M. (2024). Water in circular economy and resilience (WICER) framework. *Utilities Policy, 87*, 101604. https://doi.org/10.1016/j.jup.2023.101604

Dias, T. F., & Ghisi, E. (2024). Urban water consumption: A systematic literature review. *Water, 16*(6), 838. https://doi.org/10.3390/w16060838

Duymuş, H., Çabuk, S. N., & Çabuk, A. (2024). Ecological planning and design for disaster resilient and sustainable cities. In *Hazards and disaster resilient cities*. Özgür Publications. https://doi.org/10.58830/ozgur.pub455.c1947

Environmental Protection Agency (EPA). (2013). Green infrastructure opportunities and barriers in the Greater Los Angeles region. Available online: https://www.epa.gov/sites/default/files/2015-10/documents/council_watershed_health_gi_report.pdf (accessed 10 April 2025).

Euro News. (2021). Japonya'dan sürdürülebilir enerji hamlesi: Otonom ve çevreci şehirler [Sustainable energy initiative from Japan: Autonomous and eco-friendly cities]. Available online: https://tr.euronews.com/next/2021/01/11/japonya-dan-surdurulebilir-enerji-hamlesi-otonom-ve-cevreci-sehirler (accessed 10 April 2025).

European Commission – CINEA. (2025). Hamburg Water Cycle - Jenfelder Au. Available online: https://webgate.ec.europa.eu/life/publicWebsite/project/LIFE10-ENV-DE-000158/hamburg-water-cycle-jenfelder-au#environmental-issues (accessed 10 April 2025).

Farhadi, R., Soltanifard, H., & Alizadeh, B. (2025). Enhancing climate resilience through urban landscape design: Strategies for green infrastructure and adaptation. In *Urban climate and urban design. Urban sustainability*. Springer, Singapore. https://doi.org/10.1007/978-981-96-1521-6_7

Fletcher, T. D., Andrieu, H., & Hamel, P. (2015). Understanding, management and modelling of urban hydrology and its consequences for receiving waters: A state of the art. *Advances in Water Resources, 51*, 261–279.

Fries, D. (2023). Green City, Clean Waters, Philadelphia's 25-year plan for stormwater management. Available online: https://www.terrain.org/2023/unsprawl/philadelphia-green-city/ (accessed 10 April 2025).

Fukuoka Waterworks Bureau. (2013). Waterworks technologies of Fukuoka City. Available online: https://www.city.fukuoka.lg.jp/mizu/somu/shisei/documents/06English.pdf (accessed 10 April 2025).

Gates, E. G. (2023). Green infrastructure: Creating resilient cities through sustainable water management. *Tappwater, A Bluewater Company*. Available online: https://tappwater.co/en-us/blogs/blog/green-infrastructure-resilient-cities-sustainability (accessed 10 April 2025).

Hamburg Wasser. (2025). Abwasser neu denken [Rethinking wastewater]. Available online: https://www.hamburgwasser.de/umwelt/vorsorge/hamburg-water-cycle/ (accessed 10 April 2025).

Hamel, P., Ding, N., Cherqui, F., Zhu, Q., Walcker, N., Bertrand-Krajewski, J. L., Champrasert, P., Fletcher, T. D., McCarthy, D. T., Navratil, O., & Shi, B. (2024). Low-cost monitoring systems for urban water management: Lessons from the field. *Water Research X, 22*, 100212. https://doi.org/10.1016/j.wroa.2024.100212

HET Landscape & Urban Design. (2015). ITU Green Campus Project. Available online: https://hetpeyzaj.com/itu-green-campus-project/ (accessed 10 April 2025).

Helmreich, B., Deeb, M., Eben, P., Egerer, M., Kollmann, J., Schulz, S., Pauleit, S., Weisser, W. W., & Schloter, M. (2025). Converting infiltration swales to sustainable urban drainage systems can improve water management and biodiversity. *Frontiers in Environmental Science, 12*, 1524239. https://doi.org/10.3389/fenvs.2024.1524239

İTÜ Yeşil Kampüs. Available online: http://yesilkampus.mozaik-test.itu.edu.tr/yesil-kampus/surdurulebilir-peyzaj-anlayisi (accessed on 10 April 2025).

Kınacı, C. (2017). Su Yönetiminde Temel Kavramlar ve Bileşenler; Türkiye'de Su Yönetimi. Available online: http://cdn.istanbul.edu.tr/statics/subilimleri.istanbul.edu.tr/wp-content/uploads/2017/09/SU_BILIMLERI_FAK_ACILIS_DERSI_22.09.2017.pdf (accessed on 10 April 2025).

Kırtorun, E., & Karaer, F. (2018). Suyun yönetimi ve suyun sürdürülebilirliği. *Sürdürülebilir Mühendislik Uygulamaları ve Teknolojik Gelişmeler Dergisi, 1*(2), 151-159.

Koç, C. (2022). Entegre Kentsel su yönetimi, kentsel su güvenliği ve değerlendirme yöntemi üzerine bir çalışma. *Avrupa Bilim ve Teknoloji Dergisi, 38*, 282-295. https://doi.org/10.31590/ejosat.1104414

Kumar, M., Sharma, A., Tabhani, N., & Otaki, Y. (2021). Indoor water end-use pattern and its prospective determinants in the twin cities of Gujarat, India: Enabling targeted urban water management strategies. *Journal of Environmental Management, 288,* 112403. https://doi.org/10.1016/j.jenvman.2021.112403

Li, W., Fu, X., Gao, T., & Wang, X. (2025). Assessing the performance of centralized blue-green infrastructure in dynamic stormwater storage and runoff assignment. *Urban Forestry & Urban Greening, 104,* 128631. https://doi.org/10.1016/j.ufug.2024.128631

Lindner, A., & Stamm, J. (2025). Integrating climate change adaptation and water resource management: A critical overview. *Standards, 5*(1), 4. https://doi.org/10.3390/standards5010004

Lukes, R., Kloss, C., & Low Impact Development Center (2008). Managing Wet Weather with Green Infrastructure. Municipal Handbook. Green Streets. Available online: https://dep.wv.gov/WWE/Programs/stormwater/MS4/guidance/handbooks/Documents/Incentive%20Mechanisms%20Municipal%20Handbook.pdf (accessed on 10 April 2025).

Mekonnen, M. M., & Hoekstra, A. Y. (2011). The green, blue and grey water footprint of crops and derived crop products. *Hydrology and Earth System Sciences, 15,* 1577–1600. https://doi.org/10.5194/hess-15-1577-2011

Ministry of Agriculture and Forestry (2022). Yağmur Suyu Hasadı Rehber Dokümanı/2022. Available online: https://www.tarimorman.gov.tr/SYGM/Belgeler/Su%20Kaynaklar%C4%B1%20%C4%B0klim%20Proje/Ya%C4%9Fmur%20Suyu%20Hasad%C4%B1%20Rehber%20Dok%C3%BCman%C4%B1.pdf (accessed on 10 April 2025).

Müftüoğlu, V., & Perçin, H. (2015). Sürdürülebilir kentsel yağmur suyu yönetimi kapsamında yağmur bahçesi. *İnönü Üniversitesi Sanat Ve Tasarım Dergisi, 5* (11), 27-37. https://doi.org/10.16950/std.34364

Novotny, V. (2010). *Water Centric Sustainable Communities: Planning, Retrofitting, and Building the Next Urban Environment.* John Wiley & Sons.

Özkan, E., Aydın, B., Hurma, H., & Aktaş, E. (2013). Su kaynaklarının sürdürülebilir kullanımında su yönetiminin önemi. *Türk Bilimsel Derlemeler Dergisi, 6* (1), 150-153.

Öztaş Karlı, R.G., & Artar, M. (2021). Kentsel su yönetiminde ara olarak su ayak izi ve mavi-yeşil altyapı. *Ege Üniversitesi Ziraat Fakültesi Dergisi, 58* (1), 145-162. https://doi.org/10.20289/zfdergi.851375

Öztaş, R.G., & Çelikyay, H.S. (2018). Alternative indicator on water management in planning: Water footprint. In Proceedings of the V. International Multidisciplinary Congress of Eurasia (pp.319-323).

Öztaş Karlı, R.G. (2020). *Su ayak izi nedir?* In: Su ve Ürünleri Araştırma Dinamikleri (pp. 85-109), İKSAD.

Perry, K. (2008). Portland's Green Streets, SW 12th Avenue. Available online: https://courses.washington.edu/gehlstud/gehl-studio/wp-content/themes/gehl-studio/downloads/Autumn2008/Portland_Green_Streets.pdf (accessed on 10 April 2025).

Philadelphia Water Department. Green City Clean Waters. Available online: https://water.phila.gov/green-city/ (accessed on 10 April 2025).

Public Utilities Board (PUB) (2024). ABC Waters Design Guidelines. 5th Edition. Available online: https://www.pub.gov.sg/-/media/PUB/Reservoirs/ABC/PDF/ABC_Waters_Design_Guidelines.pdf (accessed on 10 April 2025).

Riaz, A., Nijhuis, S., & Bobbink, I. (2025). The role of spatial planning in landscape-based groundwater recharge: A systematic literature review. *Water, 17*(6), 862. https://doi.org/10.3390/w17060862

Schelbert, V., Lüthi, C., & Binz, C. (2023). Hamburg Water Cycle in the Jenfelder Au, Hamburg, Germany. Available online: https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/schwerpunkte/sesp/Lighthouse/hamburg_synthesis_report.pdf (accessed on 10 April 2025).

Tortajada, C. (2006). Water Management in Singapore. *International Journal of Water Resources Development, 22*(2), 227–240.

Tortajada, C. (2007). Water Management in Singapore. Available online: https://knowledge.csc.gov.sg/ethos-issue-02/water-management-in-singapore/ (accessed on 10 April 2025).

ULI Developing Urban Resilience (2021). Green City, Clean Waters. Available online: https://developingresilience.uli.org/case/green-city-clean-waters/ (accessed on 10 April 2025).

Urban Systems Studies (USS) (2017). The Active, Beautiful, Clean Waters Programme: Water as an Environmental Asset. Available online: https://isomer-user-content.by.gov.sg/50/7a481fd0-e545-417e-a14b-e414efee6694/rb172978-mnd-abc-water.pdf (accessed on 10 April 2025).

Wan Rosely, W.I.H., & Voulvoulis, N. (2024). System thinking for sustainable water management: The use of system tools in sustainability transitions. *Water Resource and Management, 38*, 1315–1337. https://doi.org/10.1007/s11269-023-03723-6

Wang, K., & Davies, E.G.R. (2018). Municipal water planning and management with an end-use based simulation model. *Environmental Modelling & Software, 101,* 204-217. https://doi.org/10.1016/j.envsoft.2017.12.024

Yanık, S. (2023). Kentlerde İklim Değişikliğine Uyum Çerçevesinde Yeşil Altyapi Uygulamalari: Avrupa ve Türkiye Yeşil Başkentlerinin İrdelenmesi. Yüksek Lisans Tezi. Selçuk Üniversitesi, Fen Bilimleri Enstitüsü, Peyzaj Mimarlığı Anabilim Dalı.

Yuan, Y., Zheng, Y., Huang, X., & Zhai, J. (2024). Climate resilience of urban water systems: A case study of sponge cities in China. *Journal of Cleaner Production, 451,* 141781. https://doi.org/10.1016/j.jclepro.2024.141781