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Review Article

Assessing Landscape Planning Strategies for Riverine Flood Management: An Exploration of Implemented Projects

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Community engagement,
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Collaboration.

Abstract

This paper explores the role of landscape architecture in flood control and mitigation through an analysis of case studies from diverse geographical regions. Despite the historical emphasis on engineering solutions, there is growing recognition of the importance of integrating landscape planning and design principles into flood resilience strategies. The case studies highlight various landscape architecture strategies, such as nature-based solutions, green infrastructure, and community engagement, employed to mitigate flood risks and enhance resilience. The findings underscore the significance of interdisciplinary collaboration, stakeholder engagement, and innovative design approaches in addressing the complex challenges of flood control. Furthermore, the paper identifies key research directions for future investigation, including innovative design and technology, nature-based solutions, community engagement, climate adaptation, and cross-disciplinary collaboration.

1. Introduction

The exploration of landscape architecture strategies in flood control has been comparatively limited, despite the widely acknowledged potential of landscape planning and design to positively impact flood mitigation efforts [1]. Particularly in densely populated coastal regions, landscape planning often takes a backseat to engineering-focused approaches aimed at bolstering flood resilience [1]

Flood mitigation strategies typically fall into two primary categories: resistance and resilience [2]. Resistance strategies involve the construction of riverbanks to channel floodwaters along predetermined paths, while resilience strategies focus on diverting floodwater into natural or constructed reservoirs, wetlands, and depressions during peak flood events. This enables a gradual reintroduction of collected water back into the original river channel through natural processes [3]. These approaches align with the feasibility of a paradigm shift in river restoration while simultaneously offering potential scenarios that successfully tackle the issues of flooding, water quality, and ecology in response to the increasing urbanization [4]. The central objective of this study is to extract practical strategies for landscape design and planning from successfully implemented projects addressing river floods. Through a meticulous analysis of these projects, invaluable insights can be unearthed to guide future landscape planning and design endeavors aimed at effective flood mitigation [1].

Expanding upon this foundation, it is crucial to recognize the intricate interplay between landscape architecture and flood control. Landscape architecture offers a holistic approach that goes beyond mere engineering solutions, integrating ecological principles, and aesthetic considerations to create resilient environments

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capable of withstanding and adapting to flood events[5]. In densely populated coastal areas, where the threat of flooding looms large, the quality of landscape planning often remains overshadowed by more traditional engineering interventions. However, by embracing landscape architecture strategies, coastal communities can harness the inherent resilience of natural systems to bolster their defenses against flooding while simultaneously enhancing the aesthetic and ecological value of their surroundings [6].

Within the realm of flood mitigation, the distinction between resistance and resilience strategies underscores the importance of adopting multifaceted approaches [7]. While resistance measures such as engineered riverbanks provide crucial protection against floodwaters, resilience strategies offer complementary solutions by leveraging natural features such as wetlands and depressions to absorb and dissipate excess water, thereby reducing the impact of floods on vulnerable communities and ecosystems[2,5,7]. By delving into past projects that have successfully tackled river floods, this study seeks to extract valuable lessons and best practices that can inform future landscape planning and design efforts. Through a comprehensive analysis of these case studies, we aim to identify the key factors contributing to their success and explore how similar approaches can be tailored to address the unique challenges faced by different regions and communities. Ultimately, by bridging the gap between landscape architecture and flood control, we can unlock innovative solutions that not only enhance the resilience of our built environment but also promote the sustainable coexistence of human societies and natural ecosystems in the face of a changing climate and increasingly frequent extreme weather events[5,7].

2. Implemented Projects

In the realm of landscape design and planning aimed at mitigating the impacts of floods, a thorough examination and utilization of existing experiences are paramount. This entails a meticulous study of past projects to gain a profound understanding of the subject matter. Accordingly, projects pertinent to flood mitigation have been meticulously chosen and scrutinized to distill key insights and lessons learned. A comprehensive summary of the methodologies employed and the outcomes achieved is presented in Table 1, serving as a valuable resource for informing future endeavors in landscape planning and design targeted at flood resilience.

2.1. The Los Angeles River

The Los Angeles River, stretching approximately 51 miles from its *inception* in the rural expanse of San Fernando within the city of Los Angeles to its final destination at the expansive harbor and the Pacific Ocean, has long been a critical feature of the region's landscape [8](Figure 1.a).

However, the river's natural equilibrium has been profoundly disrupted by the relentless march of urbanization, as uncontrolled growth spurred by rapid population increases encroached upon its once pristine boundaries. Historically, the Los Angeles River existed in a stable symbiosis with its surrounding environment, its seasonal ebbs and flows a testament to its inherent balance. The volume of water coursing through its channel varied distinctly with the changing seasons, indicating a delicate equilibrium that necessitated careful stewardship. Yet, this equilibrium has been grievously disrupted by the unchecked proliferation of construction within its vicinity[8].

Over time, the consequences of this unchecked urban expansion have become increasingly dire. The river's natural capacity to accommodate fluctuating water levels has been severely compromised, leading to catastrophic floods during years of heightened precipitation. The encroachment upon its natural width and boundaries, coupled with the disregard for its inherent ecological limits, has transformed once-predictable watercourses into unpredictable torrents of destruction. The consequences of this disregard for the river's natural dynamics have been starkly evident throughout history. Devastating floods in 1914, 1934, and 1938 prompted urgent intervention by the US Army Corps of Engineers, leading to the construction of extensive concrete channels spanning more than 51 miles of the river's length. These measures, while mitigating immediate flood risks, represented a stark acknowledgment of the profound consequences of neglecting the river's natural balance. Despite these interventions, the relentless march of urban development continues unabated, exacerbating the risk of severe flooding and further imperiling the lives and livelihoods of those residing along its banks. Unless urgent action is taken to reconcile the demands of urbanization with the imperatives of ecological stewardship, the specter of catastrophic floods will continue to loom large over the city of Los Angeles, underscoring the urgent need for a more harmonious relationship between humanity and the natural world [9].

This project encompasses a significant stretch of 32 miles along the Los Angeles River within the city limits of Los Angeles. Detailed methodologies employed and outcomes achieved in this endeavor are succinctly summarized in Table 1.

Figure 1. The Los Angeles River from the past to present [9].

2.2. Iowa River

The Iowa River, extending over 520 kilometers and situated within the watershed of the Mississippi River, holds significant importance. Approximately 105 kilometers of its length traverse the state of Iowa[10] (Figure 2).

Recognizing the heightened risk of flooding stemming from excessive construction in its vicinity, the University of Iowa has prioritized efforts to address the challenges posed by the Iowa River. While past initiatives have focused primarily on flood mitigation, the river's potential as a recreational asset and its role in enhancing the surrounding environment have been overlooked.

To rectify this oversight, a comprehensive plan was devised in 1995 by the University of Massachusetts' landscape architects' group. Central to this plan was the recognition of the Iowa River and its environs as an interconnected ecological system, necessitating a holistic approach to environmental management aimed at mitigating flooding occurrences[10].

This project targets a one-mile segment of the Iowa River coursing through the University of Iowa, spanning between the Redparks Bridge and the Burlington Street Dam. Notable aspects of the project include extensive vegetation coverage and the distinct topographical features distinguishing the eastern and western sections of the river.

In addressing the challenges posed by flooding, the project area has been subdivided into nine distinct zones, each characterized by varying levels of vulnerability and flood risk. Tailored solutions to mitigate flooding and minimize associated damages have been proposed for each zone based on its unique characteristics. A comprehensive summary of the methodologies employed and outcomes achieved in this project is provided in Table 1.

Figure 2. Location of The Iowa River [11].

2.3. The Rhine River

The Rhine River, boasting a length of 1320 kilometers and an expansive basin covering 218,500 square kilometers, stands as the largest river in western Europe. Originating from the Alpine region of Switzerland, it meanders through France and Germany before coursing into the Netherlands, ultimately emptying into the North Sea. However, like many rivers, the natural equilibrium of the Rhine has been disrupted by the encroachment of commercial, industrial, agricultural, and residential activities along its banks, exerting excessive pressure on its drainage basin.

In a specific region within the Rhineriver basin, spanning Germany and the Netherlands, the threat of flooding looms large due to the dense concentration of construction, agricultural, and industrial endeavors in close proximity to the river. In response to this heightened risk, a comprehensive design and planning initiative was launched to mitigate flooding vulnerabilities in these susceptible areas. This pioneering effort, dubbed "Room for the River," was spearheaded by water management authorities in the Netherlands, with a key emphasis on curtailing construction within floodplains and embracing a nature-based design ethos to harness the inherent resilience of the river system [12].

Initiated by the Dutch Government in 2007, the Room for the River Program emerged as a pivotal response to the escalating challenge of rising water levels in rivers. This ambitious endeavor aimed to effectively address this pressing issue through a multifaceted approach encompassing a range of strategic interventions. Key measures included the reduction of floodplain levels, establishment of water buffers, relocation of levees, deepening of side channels, and construction of flood bypasses. Over the course of its implementation, the program encompassed over 30 distinct projects, the majority of which were successfully completed by the conclusion of 2018 [13].

At its core, the primary objective of the Room for the River Program was to mitigate the occurrence of floods by employing a multidisciplinary strategy that integrated landscape planning principles with flood risk management protocols. This comprehensive approach relied on sophisticated tools such as computer modeling and mathematical data analysis to inform decision-making processes[12,13].

Notably, the Netherlands recently finalized the implementation of the Room for the Rivers program along the Rhine and Meuse Rivers in response to escalating river discharges. However, the future application of creating additional space for the river is now subject to scrutiny, driven by concerns regarding the perceived weaknesses of existing flood defenses. Regardless, reinforcing these defenses remains imperative. To chart the most optimal policy trajectory for the remainder of the century, a comprehensive understanding of the benefits and costs associated with individual interventions and strategic alternatives for flood mitigation is indispensable[14].

For a detailed presentation of the methodologies employed and outcomes achieved in the Room for the River Program, refer to Table 1 [14]

2.4. The Brisbane River

The Brisbane River, boasting a length of 305 kilometers, stands as the longest river in the state of Queensland, Australia, winding its way through the southwest region of the state. A significant portion of approximately 120 kilometers courses northwest of the city of Brisbane. Notably, the river traverses through the Somerset and Wivenhoe dams, critical water sources for Brisbane, erected in 1984 in response to the devastating floods of 1974, with the intention of mitigating flood risks [15](Figure 3).

Despite cautioned warnings, many held the belief that the construction of these dams would effectively eliminate flood risks to Brisbane [16]. However, the events of January 2011 served as a harsh reminder of the city's vulnerability to severe flooding. Ranking as the second most severe flood in a century, this event inundated almost the entire catchment area of the Brisbane River, inflicting substantial financial and human losses upon Brisbane and its neighboring cities. It is worth noting that this deluge marked the largest flood event since the construction of the Wivenhoe and Somerset dams in 1984 [16].

In response to the devastating inundation, proposals have been formulated to relocate residential dwellings from flood-prone areas to elevated terrain beyond the floodplain [16]. Extensive high-level analyses have been conducted to assess flood risks and devise adaptation strategies aimed at bolstering the preparedness and resilience of urban communities and critical infrastructure industries to effectively mitigate future flood events. These measures encompass a spectrum of actions, including implementing mitigation strategies in areas with low flood risk or high climate adaptation capacity, prioritizing preparedness in areas with moderate flood risk and high climate adaptation capacity, emphasizing response in areas with high flood risk and moderate climate adaptation capacity, and prioritizing recovery in areas with very high flood risk and low climate adaptation capacity [16,17].

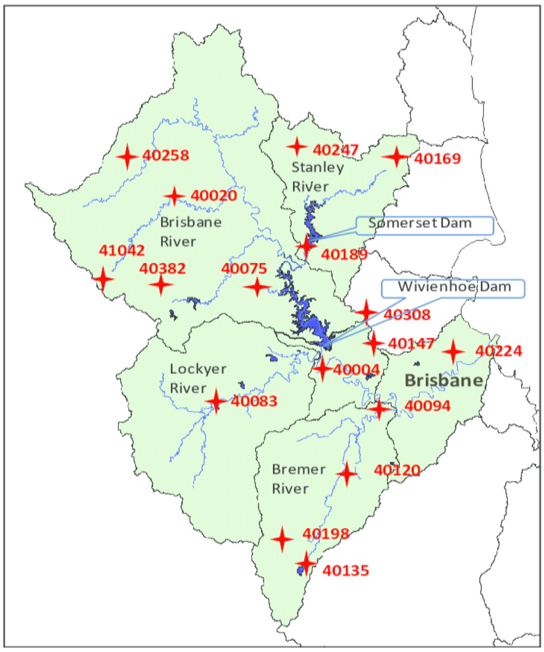

Figure 3. Location of The Brisbane River [18].

2.4. The Thames River

This project is dedicated to mitigating flood occurrences through a multifaceted approach that integrates landscape planning and flood risk management methodologies. Situated in a brownfield area adjacent to the Thames River, the project leverages advanced computer modeling and mathematical data analysis techniques to inform its strategies[19].

A key aspect of the project involves the creation of multi-purpose recreational and functional spaces[20]. By repurposing the brownfield area, the project not only enhances the quality of the surrounding environment but also fosters the development of safe and enjoyable spaces for the community. These spaces serve dual purposes: recreational enjoyment for residents and visitors, while also playing a crucial role in flood control and reduction[19].

Moreover, the project incorporates soft surfaces to increase permeability. This strategic use of permeable surfaces facilitates the absorption of rainwater and runoff, thereby reducing surface water runoff and alleviating pressure on existing drainage systems during periods of heavy rainfall[21]. Through a holistic approach that combines innovative design strategies with cutting-edge technology, this project endeavors to create a resilient and sustainable urban environment along the Thames River, simultaneously enhancing the community's quality of life and reducing the risk of flood-related hazards.

Figure 4. Expected view of project [22].

Table 1 is provided to present an executive summary of fundamental theories, methods and findings of aforementioned project studied.

2.5. Japan Experiences

Japan's history is marked by recurrent flood disasters, with records dating back to the mid-6th century. However, the most significant modern flood damage occurred during the Isewan Typhoon in 1959 [23]. In response to these ongoing challenges, Japan enacted the Japan River Law in 1896, with the primary aim of swiftly redirecting floodwaters to the sea. Initially, flood control efforts focused on managing high water levels through measures such as straightening river channels and constructing levees. However, during the Showa period (1926–1989), the difficulty in acquiring land for levee enhancements led to a shift in strategy towards constructing multipurpose dams [21]

To address escalating flood risks resulting from rapid urbanization during the 1960s and 1970s, Japan formulated the Comprehensive Flood Risk Management Measures (CFRMMs) in 1980. These measures were specifically tailored to enhance river conditions and manage runoff effectively in highly urbanized watersheds[24].

Moreover, Japan has increasingly turned to green infrastructure (GI) as a strategic flood-risk management tool, leveraging the capabilities of ecosystems to mitigate flood damages sustainably [25]. This approach has gained prominence due to its ability to offer long-term solutions to the escalating risk of river floods.

Two distinct approaches are employed in managing flood risks using retention/detention ponds. The first method involves storing rainwater in floodplain areas to minimize runoff entering main channels, thereby alleviating flood peaks in both agricultural and urban regions. The second approach, known as "Yusuichi," entails temporarily storing river water in adjacent reservoirs to mitigate flood peaks by gradually releasing water back into main channels once floodwaters subside [25].

Flood-control basins, typically comprising man-made levees encircling reservoirs, serve multiple functions such as providing sports facilities, agricultural land, urban parks, and wildlife habitats [25]. These basins play a crucial role in mitigating flood impacts across Japan and have been systematically constructed throughout the country. (Figure 5)

Several management techniques have been observed to effectively meet the dual objectives of flood-control basins: mitigating the risks associated with disasters while also providing habitats for various species.

In order to enhance the sustainable management of green infrastructure (GI), including flood-control basins, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) introduced the GI Public-Private Partnership Platform in March 2020. This platform serves as a collaborative effort, bringing together diverse stakeholders, including national and local governments, private companies, research institutes, non-profit organizations (NPOs), and citizens. With a shared vision of fostering sustainable and appealing urban development through the utilization of flood-control basins, the platform actively engages in several key initiatives[25,26].

Firstly, the platform focuses on the promotion of GI, advocating for the widespread adoption of green infrastructure practices in flood-control projects. By raising awareness and providing educational resources, the platform seeks to encourage the incorporation of GI elements into urban planning and development processes[25,27].

Additionally, the platform drives the advancement of construction and management technologies related to green infrastructure. Through research and development initiatives, innovative approaches and techniques are identified and disseminated to enhance the effectiveness and efficiency of flood-control basin projects. Furthermore, the platform explores innovative financing techniques to support the implementation and maintenance of green infrastructure projects. By facilitating partnerships between public and private entities and exploring alternative funding mechanisms, such as public-private partnerships and green bonds, the platform aims to ensure the long-term sustainability of GI initiatives[27].

Overall, the GI Public-Private Partnership Platform plays a crucial role in fostering collaboration and driving progress towards sustainable urban development through the utilization of flood-control basins and other green infrastructure solutions.

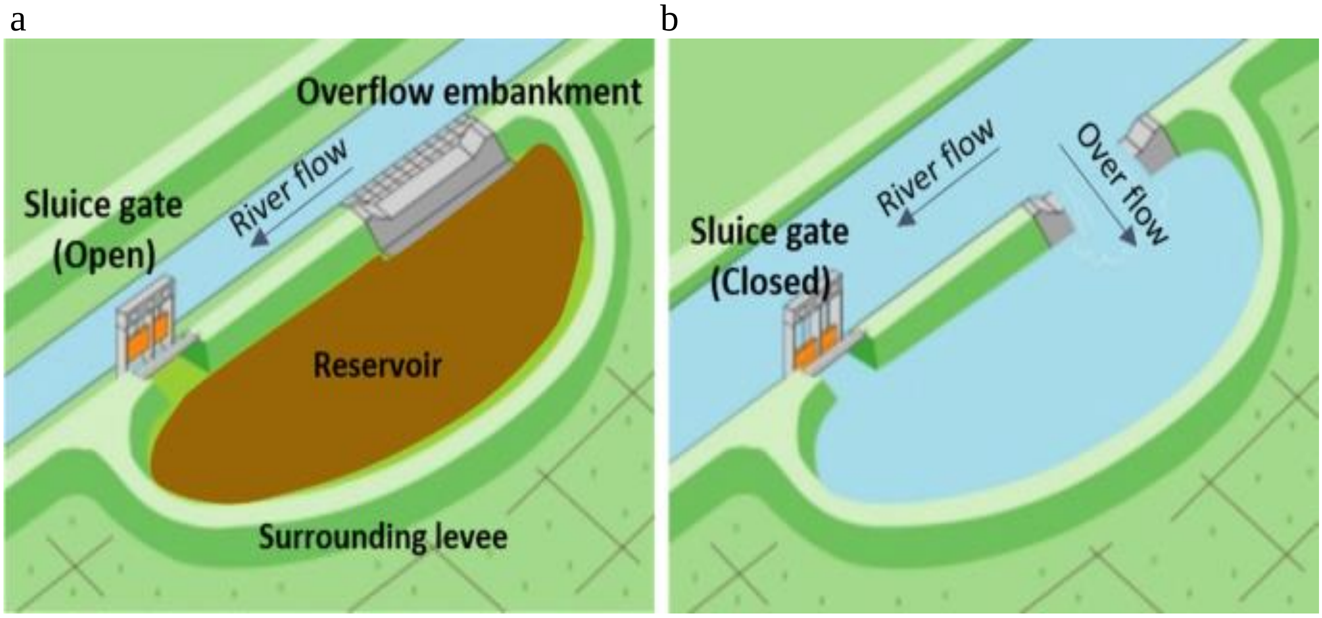

Figure 5. Illustration of a flood-control basin. (Ishiyama,et al2022) (a) Normal flow. (b) High flow

Table 1. Executive summary of implemented projects.

Case study/Flood event	Aim and scopes	Fundamental theories	Method	Results
Los Angeles River/1914,1934,1938	• Restoring the ecosystem of the region • Secure access to the riverbank • Controlling and reducing the occurrence of floods • Reducing industrial pollution • Reviving people's connection with the river	• Reducing water flow intensity in critical areas • Terracing the walls of the channel • Creating reservoirs in critical areas • Strengthening vegetation cover • Establishing a pocket park adjacent to the river • Restoring burned lands adjacent to the river • Creating bike and pedestrian paths along the river to facilitate water flow during floods	• Interview with people • Qualitative research through observation and data collection	• Creating recreational spaces near the river • Creating a sense of belonging for citizens towards the river • Reducing the risk of floods • Reviving the ecosystem near the river
Iowa River/ 1993	• Reducing erosion • Reducing the occurrence of floods • Putting the river at the center of attention	• Slope stabilization • Reducing the slope of the land • Zoning	• Qualitative research through observation and data collection.	• Reducing the occurrence of floods • Reducing erosion • Creating recreational spaces near the river
Rhine River/ 1993, 1994	• Reducing pollution • Reducing the risk of flooding • Restoring the ecosystem	• Paying attention to the geomorphological and hydrological characteristics of the river • Widening the river mouth in the areas of entry into the urban area • Creating branching flows in critical areas • Removing solid obstacles in the movement of water flow • Storing excess flow upstream • Implementing room river strategies • Considering the river as a unified and cohesive system in relation to its bed	• Qualitative research through observation and data collection. • Statistical analysis	• Reducing the occurrence of floods Revitalizing the local ecosystem • Creating recreational spaces adjacent to the river
Brisbane River/2011	• Reducing the occurrence of floods and the damages and losses resulting from them. • Enhance the preparedness and resilience of urban communities and critical infrastructure industries to effectively mitigate future flood events	• Using the conditions that occurred in the 2011 flood as design standards. • Surveying the watershed of the river and accurately measuring its morphological changes • Modeling precipitation patterns	• Qualitative research through observation and data collection. • Quantitative research	• Creating new design standards.
Thames River	• Reducing the occurrence of floods and revitalizing the ecosystem.	• Terracing the riverbanks • Creating recreational spaces near the river • Using soft surfaces and multi-purpose open spaces	• Qualitative research through observation and data collection.	• Creating recreational spaces around the river • Revitalizing people's connection with the river • Reducing the occurrence of floods
Japan Experiences	• Enhancing the ecological conditions of flood-prone basins to safeguard the biodiversity of wetland organisms. • integration of GI into conventional flood-control measures	-	-	-

Table 2. Strategies related to landscape design resilience

Strategy	Aim and Definition	Principal form of practice	Application area
Blue-green infrastructure	An internationally acknowledged and widely recognized strategy for addressing urban flood resilience and climate-related issues leverages the advantages of incorporating urban green spaces and natural water flows. [28]	Green and roofs, Urban forestry, rain gardens, downspout interrupters, bioswales, man-made wetlands, green streets, green water infrastructure.	US, UK and EU
Sponge city	A novel urban planning approach has been introduced in China, which prioritizes flood management through the reinforcement of green infrastructures rather than solely relying on drainage systems.[29]	Managing and utilizing rainwater in a sustainable way to reduce flooding, enhance overall urban resilience, green roofs, permeable pavements, rain gardens, retention ponds, and wetlands	China
Water sensitive urban design	Merge urban planning and design with the management of the urban water cycle. Its objective is to replicate natural systems to mitigate adverse effects on the natural water cycle and the water bodies that receive it. (Wollondilly,2020)	Mitigate risks such as flash flooding, pollution of fresh and marine receiving waters, and water scarcity	Australia
Best Management Practices	A tool designed for stormwater management to attain enhancement in water quality and adherence to regulatory standards.[30]	Mitigate the impact of stormwater runoff. adopt optimal management techniques. aim to minimize the influx of pollutants and sediment into water bodies during storm events.	US
Low Impact Development	known as North American terminology, has gained popularity in various regions across the globe. An approach to mitigate the effects of increased impervious surfaces [31]	Reduce stormwater management costs by considering a site's natural features in the design, A variety of methods and technologies to effectively manage stormwater drainage in a more environmentally friendly way compared to traditional systems	US, New Zealand
Nature Based Solution	Using natural or modified ecosystems to manage runoff. restoration of riverine ecosystems and their social and environmental benefits. (5)	Supporting biodiversity and securing ecosystem services, using floodplains to manage floodwaters	North America, India, Africa, European Union
Sustainable Urban Drainage	Sustainable drainage is a viable alternative and supplement to conventional methods in achieving long-term sustainability in system design.	Mitigation of microplastic pollution, Bioswales, Permeable Pavement, Wetlands, Detention basin	UK
Room For Water	As a paradigm shift aligns seamlessly with the current shift towards embracing the concept of 'living with water'. (6)	Green roofs, permeable pavement, rain gardens, and other sustainable infrastructure to prevent flooding, improve water quality, and enhance biodiversity	Netherlands
Urban River Revitalization	Focusing particularly on ongoing efforts to clean up Foshan's polluted River. mitigate the flow of harmful substances into the river system through the implementation of infrastructure enhancements that effectively capture, redirect, and/or treat the pollutants. (7)	Installation of infrastructure works aims to address the issue of a malodorous, repugnant, and contaminated urban waterway by implementing necessary measures for its purification	Japan
Clean River Scheme	DC Water is implementing a comprehensive infrastructure program, which encompasses the utilization of green infrastructure (GI), to mitigate the occurrence of combined sewer overflows (CSOs) into the waterways of the District.	Remove trash, debris, and pollution from rivers and promote conservation efforts to maintain clean water sources	Korea
Active Beautiful and Clean	An initiative by the Singapore government aimed at improving the physical surroundings, encouraging an active lifestyle, and nurturing a feeling of communal responsibility and pride.	Parks, green spaces, and recreational facilities	Singapore

3. Conclusion and Future Research Directions

The findings presented in this paper illuminate the diverse strategies and approaches employed globally to address the challenge of flood control and mitigation. Through an examination of case studies from various regions, including the United States, Europe, Australia, and Japan, several key themes emerge regarding the management of flood risk and the role of landscape architecture in enhancing resilience.

One of the prominent observations is the recognition of landscape architecture as a valuable tool in flood mitigation efforts. Despite the historical focus on engineering solutions such as levees and concrete channels, there is a growing acknowledgment of the importance of integrating landscape planning and design principles into flood control strategies. This shift reflects a broader understanding of the interconnectedness between natural systems and human-built environments, highlighting the need for holistic approaches to flood risk management.

The case studies reviewed demonstrate a range of landscape architecture strategies employed to mitigate flood risks, including the creation of flood-control basins, the restoration of natural river systems, and the implementation of green infrastructure solutions. For example, initiatives such as the "Room for the River" program in the Netherlands and the Comprehensive Flood Risk Management Measures (CFRMMs) in Japan emphasize the importance of nature-based approaches in enhancing flood resilience. These projects not only aim to reduce the impact of flooding but also contribute to the creation of multifunctional spaces that provide ecological, recreational, and social benefits to communities.

Furthermore, the role of collaboration and stakeholder engagement emerges as a critical factor in successful flood mitigation projects. The establishment of public-private partnerships, as exemplified by the GI Public-Private Partnership Platform in Japan, underscores the importance of collective action in advancing sustainable flood control solutions. By bringing together government agencies, private companies, research institutions, non-profit organizations (NPOs), and citizens, these partnerships facilitate the exchange of knowledge, resources, and expertise necessary for effective flood risk management.

Looking ahead, future research efforts should focus on several key areas to further advance our understanding of flood control and mitigation and develop innovative strategies for enhancing resilience:

- **Innovative Design and Technology:** Research should focus on developing innovative design approaches and technologies that integrate landscape architecture principles with cutting-edge engineering solutions. This includes exploring the potential of advanced materials, digital modeling techniques, and sensor technologies to enhance the effectiveness and resilience of flood control infrastructure.
- **Nature-Based Solutions:** There is a growing recognition of the importance of nature-based solutions in flood control and mitigation. Future research should further explore the ecological benefits of green infrastructure, including its role in enhancing biodiversity, improving water quality, and providing ecosystem services. Additionally, studies on the socio-economic benefits of nature-based approaches can help build the case for their widespread adoption and integration into urban planning and development practices.
- **Community Engagement and Social Equity:** Effective flood control and mitigation strategies must prioritize community engagement and address issues of social equity and environmental justice. Future research should explore innovative approaches to stakeholder participation and decision-making processes, ensuring that the needs and perspectives of diverse communities are incorporated into flood resilience planning and implementation efforts.
- **Climate Adaptation and Resilience:** With the increasing frequency and intensity of extreme weather events driven by climate change, there is a pressing need to develop adaptive strategies that enhance the resilience of communities to floods. Future research should focus on assessing the vulnerability of urban areas to climate-related hazards, identifying adaptation pathways, and evaluating the effectiveness of resilience measures.
- **Cross-Disciplinary Collaboration:** Addressing the complex challenges of flood control and mitigation requires interdisciplinary collaboration across fields such as landscape architecture, engineering, urban planning, ecology, and social sciences. Future research should foster greater collaboration and knowledge exchange among researchers, practitioners, policymakers, and community stakeholders.

By prioritizing research in these key areas, we can advance our collective understanding of flood control and mitigation and develop innovative strategies that promote resilience, sustainability, and equity in the face of a changing climate.

Conflict of Interest Statement

The authors declare no conflict of interest.

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