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Review article

Strengthening urban resilience through landscape architecture: A comprehensive review of strategies and best practices

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Abstract

This literature review aims to provide a comprehensive analysis of the relationship between landscape architecture and resiliency. The review explores various aspects of resiliency in the context of landscape architecture, including ecological, social, and economic dimensions. It examines the role of landscape architecture in creating resilient landscapes and addressing challenges such as climate change, urbanization, and natural disasters. By reviewing key scholarly works, case studies, and professional literature, this study offers insights into the strategies, approaches, and best practices employed by landscape architects to enhance resiliency in the built environment. The literature review also highlights some challenges and limitations faced by landscape architects and identifies areas for future research and innovation. It explores the concept of resiliency and its dimensions, discusses the role of landscape architecture in promoting resiliency, and presents case studies highlighting resilient coastal landscapes, urban parks, and water management systems. The findings emphasize the significance of landscape architecture in fostering resiliency and its potential to address environmental, social, and economic challenges in an increasingly uncertain world. Overall, this study contributes to the body of knowledge surrounding landscape architecture and its role in creating resilience. The review concludes by identifying research gaps and suggesting potential avenues for future investigations.

Keywords: Climate change, Resiliency, Landscape architecture, Natural disasters, Urbanization.

Introduction

One of the central tenets of urban resiliency is the recognition that cities are complex, adaptive systems characterized by intricate networks of physical infrastructure, social dynamics, and governance structures (Desouza & Flanery, 2013). Consequently, enhancing resiliency requires a holistic approach that addresses the interdependencies among these various components and their capacity to withstand and recover from disruptions.

Climate change and natural disasters are among the most pressing challenges facing cities globally. As extreme weather events become more frequent and intense, urban areas must adapt their built environments, infrastructure, and emergency management strategies to mitigate risks and enhance resilience (Leichenko, 2011). This includes measures such as fortifying buildings and infrastructure against extreme weather, implementing early warning systems, and developing robust evacuation and recovery plans.

Beyond physical resilience, urban resiliency also encompasses economic and social dimensions. Economically resilient cities possess diversified economies, robust financial systems, and the capacity to

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adapt to changing market conditions and technological disruptions (Briguglio *et al*., 2009). Socially resilient cities prioritize equity, inclusivity, and community engagement, ensuring that all segments of the population have access to essential resources and services and that their voices are heard in decision-making processes (Wardekker *et al*., 2010).

Institutional and governance structures play a crucial role in fostering urban resiliency. Effective governance frameworks that promote collaboration, transparency, and adaptability are essential for coordinating resilience efforts across various sectors and stakeholders (Biggs *et al*., 2012). Furthermore, integrating resilience principles into urban planning, policymaking, and decision-making processes can help cities anticipate and proactively address potential risks and vulnerabilities.

Importantly, urban resiliency is not a static state but rather a continuous process of adaptation and transformation. As cities evolve and face new challenges, their resilience strategies must be regularly re-evaluated and adjusted to reflect changing circumstances and emerging risks (Campanella, 2006). This iterative process requires ongoing monitoring, learning, and innovation, as well as the willingness to embrace new approaches and technologies.

In recent years, there has been a growing recognition of the importance of urban resiliency among policymakers, researchers, and practitioners. International organizations, such as the United Nations and the World Bank, have developed frameworks and initiatives to support cities in enhancing their resilience (United Nations Office for Disaster Risk Reduction, 2017; World Bank, 2020). Additionally, numerous cities worldwide have implemented resilience strategies, ranging from infrastructure upgrades and disaster preparedness plans to initiatives focused on social cohesion, economic diversification, and governance reform. Despite these efforts, significant challenges remain in translating the concept of urban resiliency into tangible, effective, and equitable practices. Limitations in resources, capacity, and political will can hinder the implementation of resilience strategies, particularly in cities with limited financial means or fragile governance structures. Additionally, the complex and context-specific nature of urban resilience poses challenges in developing universally applicable solutions, necessitating tailored approaches that account for the unique characteristics and needs of each city.

Looking ahead, the pursuit of urban resiliency will become increasingly imperative as cities grapple with the compounding effects of climate change, rapid urbanization, and other global challenges. Fostering resilience will require sustained efforts from multiple stakeholders, including policymakers, urban planners, civil society organizations, and the private sector. By embracing a holistic, adaptive, and collaborative approach to urban resiliency, cities can enhance their capacity to withstand shocks and stresses, safeguard the well-being of their residents, and ensure long-term sustainability and prosperity.

The field of landscape architecture plays a vital role in shaping and designing the built environment to enhance its resilience in the face of various challenges. In recent years, the concept of resiliency has obtained significant attention as a guiding principle for designing landscapes that can withstand and adapt to a rapidly changing world (Kwak *et al*. 2021; Xie, 2022). Resilient landscapes are critical in the face of increasing global challenges, including climate change impacts, rapid urbanization, and socio-economic vulnerabilities. Landscape architecture plays a pivotal role in creating spaces that not only withstand such challenges but also thrive and adapt over time. This comprehensive literature review delves into the multifaceted aspects of landscape architecture and resiliency, aiming to uncover key insights and strategies to promote resilience in diverse landscapes. This comprehensive literature review aims to delve into the relationship between landscape architecture and resiliency, exploring the theoretical foundations, practical strategies, and case studies that highlight the role of landscape architecture in creating resilient environments (Benedetti & Gargiulo, 2018).

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Landscape architecture encompasses the planning, design, and management of outdoor spaces, to generate functional, aesthetically pleasing, and sustainable environments. The challenges posed by factors such as climate change, rapid urbanization, and natural disasters have emphasized the importance of integrating resiliency principles into landscape architecture practice. Resiliency refers to the capacity of a system to absorb disturbances, adapt to changes, and maintain its basic function and structure (Ahern, 2011; Hamin & Gurran, 2009). In the context of landscape architecture, resiliency involves designing landscapes that can endure shocks and stresses while fostering ecological, social, and economic welfare (Masoud & Holland, 2022).

The purpose of this literature review is to provide a comprehensive analysis of the relationship between landscape architecture and resiliency. By synthesizing existing knowledge and scholarship, this review aims to identify key concepts, strategies, and approaches used in landscape architecture to enhance resiliency. The review will examine the multidimensional aspects of resiliency including ecological, social, and economic dimensions, and explore how landscape architecture interventions can contribute to the creation of resilient landscapes.

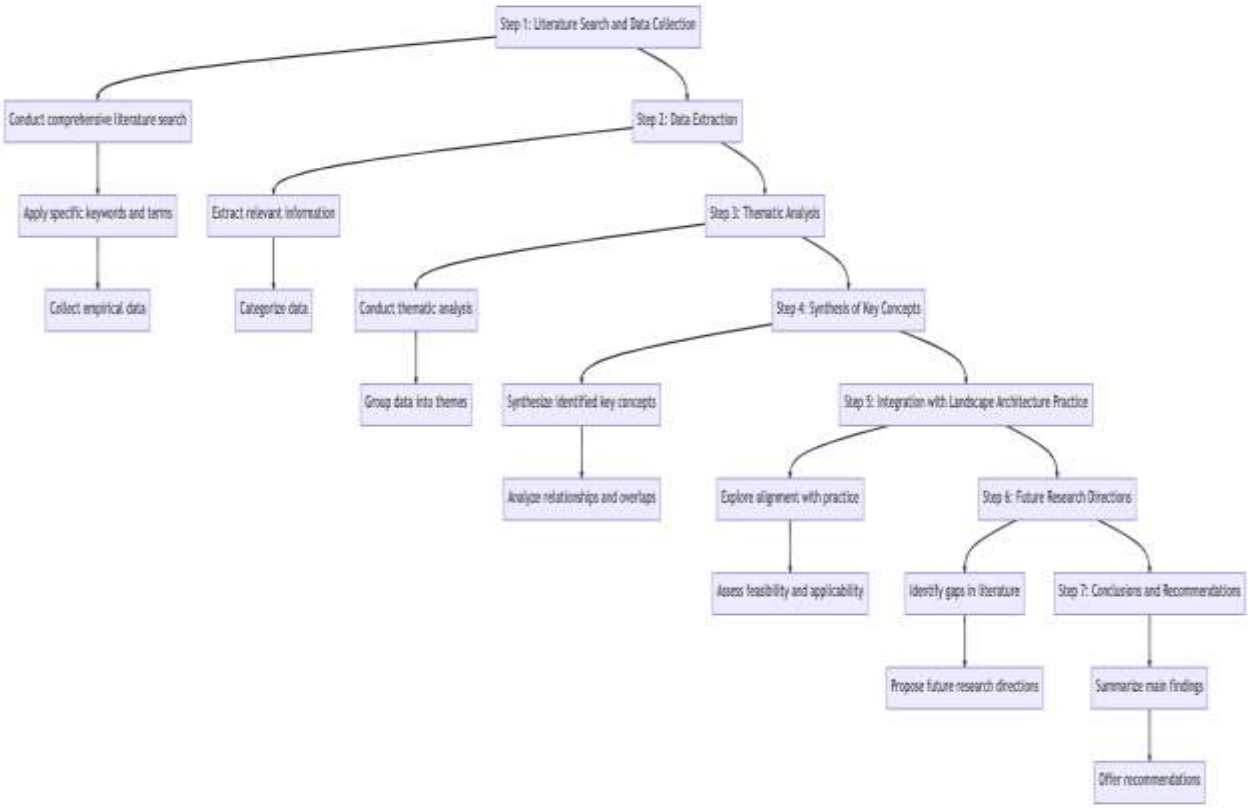


Figure 1. Landscape architecture resiliency process.

Methodology

The methodology employed in this literature review involves a systematic and rigorous approach to gathering and analyzing empirical data. This literature review follows a systematic

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approach to gather and analyze relevant scholarly works, case studies, and professional literature. A comprehensive search strategy included of academic databases will be conducted using keywords such as "landscape architecture", "resiliency", "ecological resilience", "social resilience", "economic resilience", "climate change", "urbanization", and "natural disasters." The search will be limited to articles published in English and will focus on works from the past decade to ensure the inclusion of recent developments in the field. Furthermore, references from selected articles will be examined to identify additional sources that might contribute to the review. Inclusion and exclusion criteria were applied to select relevant articles that focused on ecological, social, and economic dimensions of resilience in landscape architecture. Data extraction involved meticulously gathering pertinent information, concepts, strategies and approaches from the selected literature. Thematic analysis was applied to identify recurring patterns, connections, and trends across various studies. This analysis enabled the synthesis of empirical evidence, theoretical frameworks, and emerging themes related to landscape architecture and resiliency. The primary research question guiding this comprehensive review is: "How does landscape architecture contribute to enhancing the resilience of landscapes, considering ecological, social, and economic dimensions?

The inclusion criteria for the literature selection will prioritize studies that explicitly explore the relationship between landscape architecture and resiliency, with a particular emphasis on empirical evidence, case studies, and theoretical frameworks. The selected literature will be critically reviewed, and key findings and insights will be synthesized to provide a comprehensive understanding of the subject matter.

This literature review intends to present a comprehensive overview of the current knowledge surrounding landscape architecture and its role in raising resiliency by adopting a rigorous and systematic methodology. The findings of this review will contribute to the existing body of knowledge, identify research gaps, and provide valuable insights for landscape architects, researchers, and policymakers involved in the design and planning of resilient landscapes.

Conceptual Framework and Dimensions

Resiliency

Resiliency is a multidimensional concept that has attained significant consideration across various disciplines, including landscape architecture. Though there is no universally accepted definition, resiliency generally refers to the capacity of a system, whether natural or human-made, to absorb disturbances, adapt to changes, and maintain its core function and structure. In the context of landscape architecture, resiliency encompasses the ability of landscapes to endure shocks and stresses, recover from disturbances, fostering sustainability and well-being while encountering dynamic and uncertain conditions (Benedetti & Gargiulo, 2018; Ribeiro & Gonçalves, 2019).

Ecological resilience focuses on the capacity of ecosystems and natural systems to absorb and recover from disturbances while maintaining their essential function and structure. It emphasizes the interconnectedness of species, habitats, and ecological processes, recognizing that a diverse and robust ecosystem is more resilient to environmental changes (Masnavi *et al*., 2019) (Hauer & Schmid, 2015). Landscape architects play a crucial role in elevating ecological resilience through strategies such as preserving biodiversity, restoring degraded ecosystems, promoting sustainable land management practices, and integrating green infrastructure elements that enhance ecosystem services and functions (Miller & Huxley, 2014).

Social resilience pertains to the capacity of communities, individuals, and social systems to cope with and recover from shocks and stresses while maintaining their essential social functions, structures, and

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identities. In the context of landscape architecture, social resilience involves designing and creating spaces that support community cohesion, social interactions, and a sense of place (Meerow *et al*., 2019; Berardi 2016). Landscape architects contribute to social resilience by designing inclusive and accessible public spaces, promoting participatory planning processes, and integrating cultural and historical contexts into the built environment (Krasny *et al*., 2019 b).

Economic resilience is defined as the capacity of an economic system to tolerate and recover from shocks and disruptions while preserving its productivity and stability. In landscape architecture, economic resilience involves designing landscapes that support sustainable economic development, promote local economies, and create employment opportunities. Landscape architects contribute to economic resilience by integrating green infrastructure, promoting maintainable land-use practices, and considering long-term economic viability in the design and planning process. (Shi *et al*., 2023; Roseland 2012).

Table 1. A comparative table for ecological resiliency, social resiliency, and economic resiliency.

Aspect	Ecological Resiliency	Social Resiliency	Economic Resiliency
Definition	The capacity of an ecosystem to recover from disturbances, adapt to changes, and maintain its functions and structures over time.	The ability of a community or society to withstand and recover from shocks, disruptions, and changes while preserving essential social functions and structures.	The capacity of an economic system to bounce back from economic shocks, maintain stability, and adapt to changing conditions while sustaining essential economic functions.
Focus	Biodiversity, ecosystem services, natural resources, climate change resilience.	Community cohesion, social capital, health and well-being, social support networks.	Economic diversification, stability, employment, financial systems, business adaptability.
Indicators	Species diversity, habitat connectivity, ecosystem productivity, resistance to invasive species.	Social cohesion, community engagement, access to healthcare, education, and social services.	GDP growth[1], employment rate, inflation rate, foreign trade balance, economic diversification index. 1. Gross Domestic Product (GDP) growth refers to the increase in the value of all goods and services produced within a country's borders over a specific period, typically measured on a quarterly or annual basis. It is one of the most widely used indicators to assess the economic performance and growth of a country.
Strategies	Habitat restoration, conservation, sustainable land-use planning, pollution control.	Community-based disaster preparedness, social safety nets, inclusive governance.	Diversified economy, contingency planning, innovation, investment in infrastructure.
Importance	Sustains ecosystem services vital for human well-being and support biodiversity conservation.	Enhances community stability and solidarity during crises, and fosters social cohesion.	Promotes economic stability, employment opportunities, and sustainable development.

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Aspect	Ecological Resiliency	Social Resiliency	Economic Resiliency
Challenges	Fragmentation of habitats, climate change impacts, loss of biodiversity.	Inequality, social exclusion, and lack of access to resources and services.	Market fluctuations, income disparities, and overreliance on specific industries.

Note: Resilience is a complex and multi-dimensional concept, and the above table offers only a brief comparison.

Understanding three aspects of resiliency i.e., ecological, social, and economic dimensions provides a comprehensive framework for landscape architects to evaluate and address the challenges and opportunities in creating resilient landscapes. The analysis of the provided data in the table indicates that social resiliency enhances community stability and solidarity during crises by fostering social cohesion. On the other hand, economic resiliency promotes economic stability, employment opportunities, and sustainable development within the community. Therefore, both social and economic resiliency play crucial roles in contributing to community stability by ensuring social cohesion, solidarity during crises, economic stability, employment opportunities, and sustainable development. These factors collectively help in maintaining a stable and resilient community in the face of challenges and uncertainties.

Based on the analysis of the table data, social cohesion contributes to community stability by enhancing community stability and solidarity during crises. It fosters social cohesion within the community, which plays a vital role in maintaining stability and resilience in the face of challenges and uncertainties. The promotion of social cohesion helps in building strong relationships, trust, and support networks within the community. This sense of unity and connectedness among community members enables them to come together, support each other, and work collaboratively towards common goals, ultimately leading to a more stable and resilient community. Social cohesion acts as a foundation for community stability by fostering a sense of belonging, cooperation, and mutual support, which are essential elements for creating a harmonious and resilient community environment. The lack of social cohesion within a community may hinder effective crisis response. Social cohesion plays a crucial role in crises by fostering unity, cooperation, and mutual support among community members. When there is a strong sense of social cohesion, community members are more likely to come together, collaborate, and support each other during crises, leading to a more effective and coordinated response.

On the other hand, the absence of social cohesion can create barriers to effective crisis response. Without a strong sense of community solidarity and cooperation, it may be challenging for community members to work together, share resources, and coordinate efforts during emergencies. This lack of unity and collaboration can impede the community's ability to respond effectively to crises and mitigate the impact of the situation.

Therefore, social cohesion plays a vital role in enhancing crisis response within a community by promoting collaboration, mutual support, and unity among community members, ultimately contributing to a more resilient and effective response to emergencies and crises.

Regarding some interactions observed among such dimensions, landscape architects can develop holistic strategies and interventions that promote long-term sustainability and welfare in both natural and human systems. The following sections will delve deeper into the theoretical foundations, practical strategies, and case studies that exemplify the role of landscape architecture in enhancing each dimension of resiliency (Zeunert, 2017).

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Although ecological, social, and economic resilience are often discussed as distinct dimensions, they are interconnected and can mutually reinforce one another (Krasny *et al*., 2019a). Recognizing interactions and synergistic impacts between these mentioned dimensions is crucial for landscape architects to create integrated and holistic approaches to resiliency (Roseland, 2012).

Ecological resilience contributes to social resilience by providing ecosystem services that support human well-being, such as clean air and water, food production, and natural hazard mitigation. For example, green spaces and urban parks can enhance social cohesion, mental health, and physical well-being, as they can provide ecological functions like habitat for wildlife and stormwater management (Shuib *et al*., 2015; Berardi, 2016; McPhearson, *et al*. 2016; Kolimenakis, *et al*., 2021; Hagan, 2015).

Investments in ecological resilience have some economic profits obtained by industry support such as ecotourism, sustainable agriculture, and renewable energy. Healthy ecosystems enhance the productivity of natural resources, resulting in economic advantages. Moreover, green infrastructure and nature-based solutions provide cost-effective alternatives for infrastructure development and maintenance (Hauer and Schmid, 2015).

Social resilience can support economic resilience through developing social capital, community networks, and innovation. Strong social connections and community engagement can give rise to increased economic opportunities, entrepreneurship, and local economic development. Furthermore, inclusive, and equitable economic systems contribute to social stability and well-being (Roseland, 2012).

Landscape architects can leverage these interactions and synergies by employing integrated design approaches that consider the interdependencies among ecological, social, and economic systems (McPhearson *et al*., 2016). By incorporating principles of resilience into their practice, landscape architects can create landscapes that not only address immediate challenges but also promote long-term sustainability and well-being. The subsequent sections will explore the theoretical foundations, strategies, and case studies that exemplify the role of landscape architecture in raising resiliency in the context of climate change, urbanization, and natural disasters.

Theoretical Foundations of Landscape Architecture and Resiliency

*The Role of Landscape Architecture in Resiliency***:** Landscape architecture plays an important role in elevating resiliency by integrating ecological, social, and economic considerations into the design and planning of outdoor spaces (Zeunert, 2017). By taking a holistic approach that considers the interactions between the built and natural environments, landscape architects can create landscapes that are adaptable, sustainable, and capable of sustaining various challenges (Masoud & Holland, 2022).

Landscape architects act as stewards of the environment, applying their expertise to promote sustainable land-use practices, preserve biodiversity, and restore ecosystems. They have the skills for analyzing and evaluating vulnerabilities and capacities of landscapes and identifying opportunities for resilience-building interventions. Through their knowledge of site planning, vegetation selection, and water management, landscape architects can contribute to the creation of resilient landscapes that support both natural and human systems.

Landscape Planning and Design Strategies for Resiliency: To increase resiliency, landscape architects employ a range of planning and design strategies that integrate the principles of adaptability, flexibility, and redundancy (Tebyanian, 2016; De Groot *et al*., 2010). These strategies include:

Green infrastructure: Landscape architects incorporate green infrastructure elements such as rain gardens, green roofs, and bioswales to manage stormwater, reduce flood risk, and improve water quality. These nature-based solutions not only enhance ecological resilience but also provide social and economic profits

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by generating attractive and functional spaces for recreation and promoting energy efficiency (Voghera & Giudice, 2019; Miller & Huxley, 2014).

Multi-functional landscapes: Landscape architects design landscapes that serve multiple functions and subsequently can adapt to changing requirements. For example, public parks are designed to provide recreational spaces, enhance biodiversity, and act as natural buffers against climate-related hazards. By integrating multiple functions, these landscapes contribute to both social and ecological resilience (Cerreta *et al*., 2021).

Landscape architects embrace adaptive design principles to create flexible and responsive landscapes. They consider future climate projections, changing land-use patterns, and evolving social dynamics while designing spaces. Landscape architects can easily increase the conformity of landscape with alterations by changing the incorporation of elements (Masoud & Holland, 2022).

Integrating Resiliency Principles into Landscape Architecture Practice

Integrating resiliency principles into landscape architecture practice requires collaboration, interdisciplinary approaches, and community engagement. Landscape architects work closely with planners, architects, engineers, and other stakeholders to ensure that resilience is considered at every stage of the design and planning process (Shivakoti, 2019). Community engagement and participatory design processes are essential in creating resilient landscapes that meet the needs and aspirations of local communities. By involving stakeholders in decision-making, landscape architects can gain insights into the social and cultural dynamics of a place, leading to designs that promote social cohesion and community ownership (Shivakoti, 2019).

Moreover, landscape architects leverage technological advancements, data-driven analysis, and simulation tools to inform their design decisions. Applying geographic information systems (GIS), remote sensing, and modeling techniques gives rise to assessing landscape vulnerabilities, evaluating design alternatives, and simulating the performance of resilient interventions (Kwak *et al*., 2021).

Landscape architects are now at the forefront of creating resilient landscapes via integrating theoretical foundations, strategic approaches, and community engagement that respond to the complex challenges of the modern world. The subsequent sections will delve into specific aspects of resiliency, comprising climate change resilience, urbanization resilience, and resilience in the face of natural disasters, providing further insights into the role of landscape architecture in addressing these issues (Hamin & Gurran, 2009).

Landscape Architecture and Climate Change Resiliency

Climate change presents significant challenges to landscapes, including rising temperatures, increasing frequency and intensity of extreme weather events, and shifting precipitation patterns (Mertens, 2021). Landscape architects have a crucial role in adapting landscapes to these changing conditions. They employ design strategies such as:

Climate-responsive planting: Landscape architects select plant species that are resilient to changing climate conditions, including drought-tolerant plants (Xerophytes) (such as *Tamarix* L.), native species, naturalized species (*Ailanthus altissima* that is naturalized to Iran due to its adaptivity to the environmental conditions), and species with high adaptive capacity in terms of temperature changes (such as *Pinus* L.). This approach ensures that landscapes can withstand water scarcity, temperature fluctuations, and other climate-related stressors (Alizadeh & Hitchmough, 2019) (Tamminga *et al*., 2020).

Water management: Landscape architects integrate sustainable water management strategies into their designs, such as rainwater harvesting, greywater recycling, and efficient irrigation systems. By

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diminishing water use and managing stormwater runoff, landscapes become more resilient to water scarcity and flooding (Dolman, 2021).

Heat island mitigation: Landscape architects employ strategies to mitigate urban heat islands, where urban areas experience significantly higher temperatures compared to surrounding rural areas. They incorporate green roofs, urban forests, and strategic placement of vegetation to provide shade, reduce heat absorption, and improve microclimates (Lafortezza *et al*., 2016; Mertens, 2021).

In addition to adaptation, landscape architects contribute to mitigating climate change impacts by reducing greenhouse gas emissions and promoting sustainable design practices. They employ strategies such as:

Sustainable transportation planning:

Landscape architects design transportation systems that prioritize active modes of transportation, such as walking, cycling, and public transit. By promoting sustainable transportation options, they assist reduce carbon emissions from private vehicles and alleviate the impacts of transportation-related greenhouse gas emissions.

Carbon sequestration: Landscape architects integrate vegetation and tree planting strategies to enhance carbon sequestration and contribute to carbon offset efforts. They consider the role of forests, urban green spaces, and natural landscapes in capturing and storing carbon, thus helping mitigate the impacts of climate change (Colding & Barthel, 2017).

Sustainable materials and construction: Landscape architects promote the use of sustainable materials and construction practices in their projects. This includes considering life cycle assessments, using recycled or locally sourced materials, and designing for durability and longevity. These practices reduce the carbon footprint associated with landscape construction and maintenance.

Green infrastructure, which includes parks, green spaces, and natural habitats, is a key strategy employed by landscape architects to enhance climate change resilience (Miller & Huxley, 2014). They integrate green infrastructure into urban design to provide multiple benefits, including:

Stormwater management: Green infrastructure elements, such as bioswales and permeable pavements, help manage stormwater by reducing runoff, enhancing infiltration, and improving water quality (Elmqvist *et al.*, 2019). These strategies mitigate the impacts of increased rainfall intensity and reduce the strain on traditional stormwater infrastructure (Miller & Huxley, 2014).

Urban cooling: Green spaces, urban forests, and green roofs contribute to urban cooling by providing shade, reducing heat absorption, and promoting evapotranspiration. This helps combat the urban heat island effect and improves the thermal comfort of cities (Lafortezza *et al*., 2016).

Biodiversity conservation: Landscape architects prioritize biodiversity conservation in their designs by creating habitats, preserving green corridors, and integrating native and exotic plant species (Colding & Follke, 2009). Biodiverse landscapes are more resilient to climate change impacts, as they support ecological processes, enhance ecosystem services, and provide habitat for diverse species (Cadenasso *et al*., 2007).

By integrating climate change resilience strategies into their designs, landscape architects play a critical role in creating landscapes that can adapt to and mitigate the impacts of climate change. The following sections will further explore the role of landscape architecture in enhancing resilience in the context of urbanization and natural disasters.

Landscape Architecture and Urbanization Resilience

As urbanization continues to shape the built environment, landscape architects are essential in creating resilient cities and urban landscapes. They employ strategies to address the challenges associated with urbanization, including population growth, infrastructure demands, and social inequalities (Pickett *et al*.,

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2004). Some key considerations and design strategies include:

Compact and connected urban form: Landscape architects advocate for compact and connected urban forms to promote walkability, reduce the need for long-distance travel, and enhance access to amenities. By designing mixed-use developments, integrating green spaces, and prioritizing public transportation, they create more resilient and sustainable urban environments (Lafortezza *et al*., 2016). Landscape architects integrate green infrastructure into urban design, such as urban parks, green roofs, and vertical gardens. These elements provide multiple benefits, including stormwater management, urban cooling, air purification, and recreational opportunities. Green infrastructure enhances the resilience of cities by improving ecological function, mitigating climate change impacts, and enhancing quality of life (Alizadeh & Hitchmough, 2019).

Social inclusivity and equitable access: Landscape architects prioritize social inclusivity and equitable access to urban spaces. They design public spaces that are inclusive and accessible to people of diverse ages, abilities, and socioeconomic backgrounds (Harris *et al*., 2023). By fostering social cohesion and addressing social inequalities, resilient urban landscapes promote community well-being and enhance the overall resilience of cities (Garmestani & Allen, 2014).

Urban brownfields, abandoned or underutilized industrial sites, pose challenges to urban resilience (Boano & Zetter, 2016). Landscape architects play a significant role in transforming these sites into resilient and productive spaces. Strategies employed include:

Remediation and ecological restoration: Landscape architects integrate ecological restoration techniques to remediate contaminated brownfield sites, enhancing their ecological resilience. By reintroducing native and exotic plant species, creating wetlands, and improving soil health, they can restore ecological functions and create valuable green spaces within urban areas (Hauer & Schmid, 2015; Kuo, 2015).

Adaptive reuse and mixed-use development: Landscape architects advocate for adaptive reuse of brownfield sites, transforming them into vibrant and mixed-use developments. By repurposing existing infrastructure, they reduce resource consumption, promote sustainable urban growth, and enhance economic resilience (Podeszwa, 2018).

Community engagement and participatory design: Landscape architects engage local communities in the transformation of brownfield sites. Through participatory design processes, they incorporate community input and aspirations into the design, ensuring that the transformed spaces meet the needs and desires of the surrounding residents. This approach fosters social resilience and community ownership of the revitalized landscapes (Boano & Zetter, 2016).

Resilient urban landscapes have a profound impact on social well-being and quality of life. Landscape architects contribute to social resilience by designing spaces that prioritize human health, community engagement (Tzoulas *et al*., 2007), and cultural identity (Samuelsson, 2021). Some strategies employed include:

Health-promoting landscapes: Landscape architects create spaces that encourage physical activity, mental well-being, and social interaction (Kuo, 2015). They design parks, greenways, and active transportation corridors that promote physical fitness, reduce stress, and improve overall health outcomes. Access to nature and green spaces has been linked to improved mental health and well-being (Svendsen, 2009; Downton, 2013).

Place-making and cultural identity: Landscape architects integrate cultural elements and local context into urban design, creating spaces that celebrate and preserve cultural identity. By incorporating cultural heritage, public art, and design elements that reflect the community's history and values, landscape architects strengthen social cohesion and promote a sense of place (Othman *et al*., 2013; Buser *et al*.,

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2013).

Community gardens and urban agriculture: Landscape architects promote urban agriculture and community gardens as a means to enhance food security, community resilience, and social interaction. These spaces foster community engagement, provide opportunities for skill-sharing, and contribute to sustainable food production within urban areas (Orsini *et al*., 2013).

By considering the unique challenges and opportunities of urbanization, landscape architects contribute to the creation of resilient urban landscapes that enhance social well-being, ecological function, and economic vitality. The subsequent sections will explore the role of landscape architecture in enhancing resilience in the face of natural disasters and conclude the comprehensive literature review.

Landscape Architecture and Resilience in the Face of Natural Disasters

Natural disasters, such as hurricanes, floods, earthquakes, and wildfires, pose significant threats to communities and landscapes (Zeunert, 2017). Landscape architects contribute to resilience by employing strategies that focus on preparedness and mitigation, including:

Hazard mapping and risk assessment: Landscape architects analyze and map areas prone to natural hazards, assess vulnerabilities and develop strategies to mitigate risks. By understanding the spatial distribution of hazards, they can guide land-use planning and design interventions that reduce exposure and vulnerability (Rus *et al*., 2018).

Natural and nature-based solutions: Landscape architects employ natural and nature-based solutions to mitigate the impacts of natural disasters (Downton, 2013). This includes incorporating green infrastructure, such as coastal wetlands, floodplain restoration, and vegetative buffer zones, to provide natural protection against storms, floods, and erosion. These solutions enhance ecological resilience while reducing the vulnerability of communities (Hauer & Schmid, 2015; Lafortezza *et al*., 2018).

Resilient infrastructure design: Landscape architects design infrastructure that is resilient to natural disasters. This includes considering factors such as elevation, flood-resistant materials, and strategic placement of critical infrastructure. By integrating natural systems and innovative engineering approaches, they create infrastructure that can sustain and recover from disasters more effectively (Charlesworth & Fien, 2022).

In the aftermath of natural disasters, landscape architects play an important role in post-disaster recovery and reconstruction. They employ strategies that facilitate the recovery process and contribute to long-term resilience, such as:

Landscape rehabilitation and restoration: Landscape architects engage in the rehabilitation and restoration of damaged landscapes following disasters. They assess the ecological impacts, promote habitat restoration, and integrate resilient planting strategies to accelerate natural recovery processes (Charlesworth & Fien, 2022).

Community engagement and participatory design: Landscape architects involve affected communities in the recovery and reconstruction process. Through participatory design workshops and engagement activities, they ensure that community needs, preferences, and cultural values are incorporated into the design of post-disaster landscapes. This approach fosters community resilience, ownership, and social cohesion.

Integrating social and economic recovery: Landscape architects consider the social and economic dimensions of post-disaster recovery. They design landscapes that support economic recovery by creating employment opportunities, preserving cultural heritage, and promoting tourism. Moreover, they focus on creating inclusive and accessible spaces that support the welfare and social recovery of affected

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communities.

Case Studies

Community-Based Resilience Hubs: A Case Study of Oakland's EcoBlock Model

Introduction

In the face of increasing climate risks and other urban hazards, cities around the world are exploring strategies to enhance resilience at the community level. One innovative approach that has gained traction is the development of resilience hubs – physical spaces that serve as central nodes for coordinating preparedness efforts, distributing resources during emergencies, and promoting long-term climate adaptation within local neighborhoods. The city of Oakland, California, has emerged as a pioneering example of this model through its EcoBlock Resilience Hubs initiative.

Background

Oakland's Resilience Hubs grew out of a collaboration between the city government, community-based organizations, and resident groups, sparked by concerns over the disproportionate impacts of climate change and disasters on marginalized communities. The EcoBlock initiative, launched in 2015, aimed to mobilize neighborhood-level action by empowering residents to transform their blocks into resilient, sustainable, and self-reliant units.

The Hub Model

At the core of Oakland's approach are the Resilience Hubs themselves – strategically located facilities within neighborhoods that serve as multifunctional spaces for resilience-building activities. These hubs are designed and operated through a community-led process, ensuring that programming and services are tailored to the specific needs and priorities of the surrounding area.

Key features and functions of the Resilience Hubs include:

1. Emergency Preparedness and Response Coordination: The hubs serve as centralized locations for distributing emergency supplies, providing shelter, and coordinating neighborhood-level response efforts during disasters or climate-related events.
2. Resilience Education and Training: Workshops, classes, and hands-on demonstrations are offered to educate residents on topics such as disaster preparedness, urban gardening, renewable energy, and climate adaptation strategies.
3. Community Organizing and Capacity Building: The hubs facilitate community organizing efforts, fostering social cohesion and empowering residents to advocate for their resilience needs and participate in decision-making processes.
4. Resource Sharing and Mutual Aid: Residents can access shared resources (e.g., tools, equipment, and community gardens) and engage in mutual aid networks facilitated by the hubs.
5. Green Infrastructure and Sustainability Initiatives: Many hubs incorporate sustainable features like renewable energy systems, rainwater harvesting, and urban agriculture projects, serving as demonstrations of climate resilience in action.

Funding and Partnerships: The Oakland Resilience Hubs initiative is supported through a combination of municipal funding, grants from philanthropic organizations, and public-private partnerships. Collaborations with community groups, non-profits, universities, and private sector stakeholders have been crucial in providing resources, expertise, and long-term sustainability for the hubs.

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Impacts and Challenges: Early evaluations of the Resilience Hubs have highlighted their positive impacts on community resilience, social cohesion, and overall preparedness. Residents report feeling more informed, empowered, and connected to their neighbors through the hubs' activities. However, challenges persist, including securing long-term funding, addressing accessibility barriers for some community members, and ensuring equitable representation in decision-making processes.

As a result, Oakland's EcoBlock Resilience Hubs exemplify an innovative, community-driven approach to building urban resilience from the ground up. By centering the needs and leadership of residents, and fostering partnerships across various sectors, the initiative has demonstrated the potential for resilience hubs to serve as catalysts for social and environmental transformation. As cities worldwide grapple with complex resilience challenges, models like Oakland's offer valuable insights and lessons for empowering communities and promoting inclusive, equitable resilience-building efforts. Community responses have generally been positive, though with some areas for improvement noted:

Positive Community Responses

Increased sense of preparedness: Residents report feeling more informed and better equipped to handle emergencies and climate risks after participating in the hubs' disaster preparedness training and resource distributions.

Fostering social cohesion: The hubs have provided valuable spaces for community organizing and relationship building. Many residents indicate the initiatives have strengthened their connections to neighbors.

Empowerment and agency: By putting communities in the lead for designing and operating the hubs, the model has empowered residents to take an active role in building their resilience.

Promoting sustainability: Initiatives like urban gardens, renewable energy projects, and sustainability workshops at the hubs have raised environmental awareness and inspired lifestyle changes.

Resource accessibility: Access to shared resources like tools, emergency supplies, and educational programming is seen as a major benefit, especially for underserved communities.

Areas for Improvement

*Equity and inclusion challenges***:** While aiming for inclusivity, some have raised concerns that certain marginalized groups still face barriers to fully accessing or shaping the hubs' activities.

Long-term sustainability questions: Overreliance on grants/temporary funding sources casts uncertainty on the hubs' ability to maintain operations and programming sustainably.

Limited capacity in some neighborhoods: In areas with fewer pre-existing community networks or organizational partners, launching and sustaining hubs has proven more difficult.

Coordination across multiple hubs: As more hubs emerge, ensuring consistent communication and coordination across the decentralized network remains an ongoing challenge.

Overall, testimonials from engaged residents highlight how the Resilience Hubs have fostered a greater sense of community ownership and self-determination in building resilience. However, there are recognized needs to bolster equity measures, secure more reliable resource streams, and cultivate participation from underrepresented groups to make the model as inclusive and impactful as possible long term.

Resilient Coastal Landscapes; Coastal area

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Introduction

In this case study, we investigate landscape architecture projects that are dedicated to enhancing the resilience of coastal areas against climate alteration impacts, including sea-level rise and storm surges (Resilience Learning Modules from Middle East and West Asia Resilience Case Studies, n.d.). Our focus is on discovering design strategies and interventions that not only provide protection to coastal communities and ecosystems but also promote their long-term sustainability and adaptability (Beatley, 2016).

Design Strategies

Dune Restoration: Dunes play a significant role in protecting coastal areas from storm surges and erosion. Landscape architects employ strategies for dune restoration, which involve rebuilding and reinforcing natural dunes. This is achieved through the strategic placement of vegetation, sand fencing, and sand nourishment. The restored dune systems act as natural barriers, absorbing wave energy and reducing the risk of coastal flooding (Beatley, 2016).

Wetland Creation: Wetlands offer significant ecological advantages and serve as a buffer against coastal hazards. Landscape architects design projects that involve the creation or restoration of wetlands in coastal areas. These wetlands help to absorb floodwaters, attenuate wave energy, and provide habitat for diverse plant and animal species. They act as natural filters, improving water quality and reducing the impacts of pollutants on coastal ecosystems (McPhearson *et al*., 2016).

Natural Barriers: Landscape architects also incorporate natural barriers into coastal landscape designs to provide additional protection. These may include the strategic placement of vegetation, such as salt-tolerant plants (Halophytes), mangroves, or coastal grasses, along with the creation of offshore reefs or breakwaters. These natural barriers help dissipate wave energy, reduce erosion, and provide habitat for marine life.

Living Shorelines: Living shorelines are another design approach employed by landscape architects in coastal resilience projects. They involve the use of natural elements, such as marshes, oyster reefs, or submerged aquatic vegetation, along with strategically placed hard structures, to stabilize shorelines and mitigate erosion. Living shorelines offer ecological advantages, increase habitat diversity, and provide protection against wave action while maintaining the natural character of coastal areas (Hauer & Schmid, 2015).

Integrated Coastal Zone Management: Landscape architects also play a vital role in the development of integrated coastal zone management plans. These plans consider the interactions between land and water, incorporating land-use planning, ecological restoration, and coastal infrastructure design. By considering the entire coastal zone holistically, landscape architects ensure that resilience measures are integrated into broader planning frameworks, promoting the long-term sustainability of coastal communities and ecosystems (Beatley, 2016).

Through the exploration of resilient coastal landscape projects, this case study highlights the importance of landscape architecture in addressing the challenges posed by climate change in coastal areas. By implementing design strategies such as dune restoration, wetland creation, and the use of natural barriers, landscape architects contribute to the protection, adaptability, and sustainability of coastal communities and ecosystems. This case study underscores the critical role of landscape architecture in promoting resilience in coastal landscapes, ensuring their long-term viability in the face of changing environmental conditions (McPhearson *et al*., 2016).

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Resilient Urban Parks

Location: Urban area of Middle East and West Asia

Introduction

In this case study, we examine how landscape architecture plays a vital role in enhancing the resilience of urban parks in the context of climate change and urban challenges. Urban parks serve as essential green spaces that provide numerous environmental, social, and economic benefits (Resilience Learning Modules from Middle East and West Asia Resilience Case Studies, n.d.). Through the integration of green infrastructure, sustainable stormwater management, and social programming, landscape architects contribute to the adaptive capacity of urban parks, making them more resilient and better equipped to bear and respond to changing environmental situations (Tsagkari, 2021; Czerniak & Hargreaves, 2015).

Design Strategies

Green Infrastructure: Landscape architects incorporate green infrastructure elements into the design of urban parks to enhance their resilience. This includes features such as rain gardens, bioswales, green roofs, and permeable pavements. These elements help manage stormwater runoff, reduce the strain on urban drainage systems, and mitigate the risk of flooding. By integrating green infrastructure, parks can act as natural water management systems, reducing the impact of heavy rainfall events and improving overall park resilience (Miller & Huxley, 2014).

Sustainable Stormwater Management: Landscape architects implement bearable stormwater management techniques in urban park designs. These techniques comprise the use of retention ponds, rainwater harvesting systems, and water-sensitive design principles. By managing stormwater effectively, parks can minimize water-related risks, improve water quality, and support biodiversity. Sustainable stormwater management also helps replenish groundwater reserves and maintain the health of adjacent ecosystems (Cadenasso *et al*., 2007).

Social Programming: Resilient urban parks go beyond their ecological functions and actively engage the surrounding communities. Landscape architects incorporate social programming elements into park designs, such as community gardens, recreational facilities, and spaces for social interactions. These programming elements foster community engagement, social cohesion, and welfare, which are essential aspects of building resilient communities. By promoting social connections and inclusivity, urban parks become vital spaces for community resilience.

Climate-responsive Design: Landscape architects employ climate-responsive design strategies to anticipate and adapt to climate change impacts. This includes considering the projected alterations in temperature, precipitation patterns, and extreme weather events. By incorporating shade structures, heat-resilient plant species, and appropriate microclimatic design, urban parks can mitigate the urban heat island effect and provide comfortable outdoor spaces for recreation and relaxation in a changing climate (Alizadeh & Hitchmough, 2019).

Biodiversity Conservation: Landscape architects prioritize biodiversity conservation in urban park designs. They integrate native and exotic plantings, habitat creation, and wildlife-friendly features to support local ecosystems. Enhancing biodiversity within urban parks contributes to ecological resilience, as diverse ecosystems are better equipped to resist disturbances and adapt to changing conditions.

Through the analysis of resilient urban park projects, this case study emphasizes the crucial role of landscape architecture in creating parks that are resilient to climate change and urban challenges. By integrating green infrastructure, sustainable stormwater management, social programming, climate-

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responsive design, and biodiversity conservation, landscape architects contribute to the adaptive capacity and long-term resilience of urban parks. These resilient parks not only provide essential environmental advantages but also foster social connections, promote community welfare, and enhance the overall resilience of urban areas (Miller & Huxley, 2014).

Resilient Water Management Systems

Introduction

This case study examines landscape architecture projects that focus on resilient water management systems. With increasing water scarcity, extreme weather events, and urbanization, there is a growing need to design and implement innovative strategies to manage water resources effectively. Landscape architects play an important role in developing resilient water management systems that address these challenges while ensuring sustainable water supply, flood control, and ecosystem health (Resilience Learning Modules from Middle East and West Asia Resilience Case Studies, n.d.).

Design Strategies

Integrated Water Management: Landscape architects employ an integrated approach to water management, considering the entire water cycle and its interconnected components. This includes capturing and reusing stormwater, promoting water conservation practices, and implementing green infrastructure elements such as rain gardens, bioswales, and permeable surfaces. Integrated water management systems help minimize the strain on traditional water supply sources, reduce flood risks, and enhance the resilience of water resources (Pauleit *et al*., 2017).

Water-Sensitive Urban Design: Landscape architects incorporate water-sensitive urban design principles into their projects. This approach aims to mimic natural water systems and processes, allowing for the efficient capture, treatment, and reuse of water within urban environments. Water-sensitive design elements may include constructed wetlands, retention ponds, and biofiltration systems. These features help improve water quality, reduce runoff, and enhance the resilience of water management systems.

Climate Adaptation Strategies: Landscape architects incorporate climate adaptation strategies into water management designs. They consider projected climate change effects, such as increased rainfall intensity or prolonged droughts, to develop resilient systems. This may involve the use of rainwater harvesting systems, underground storage tanks, and smart irrigation technologies to optimize water use and reduce dependence on traditional water sources. By adapting to changing climate conditions, water management systems become more resilient and sustainable (Alizadeh & Hitchmough, 2019).

Ecosystem Restoration and Conservation: Landscape architects prioritize the renewal and conservation of natural ecosystems as part of resilient water management projects. They incorporate features that boost habitat restoration, such as the creation of wetlands, riparian buffers, and aquatic habitats. These elements enhance biodiversity, improve water quality, and support the overall ecological health of the water management systems (Gómez-Baggethun & Barton, 2013).

Stakeholder Engagement and Education: Landscape architects emphasize stakeholder engagement and education in the development of resilient water management systems. They collaborate with communities, local authorities, and water agencies to ensure that projects align with community requirements and values. Education and awareness programs are implemented to promote water conservation practices, bring up a sense of ownership, and build long-term resilience within the community.

Through the exploration of resilient water management system projects, this case study highlights the

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significant role of landscape architecture in addressing water-related challenges. By integrating integrated water management approaches, water-sensitive urban design principles, climate adaptation strategies, ecosystem restoration, and stakeholder engagement, landscape architects contribute to the development of resilient water management systems. These systems ensure sustainable water supply, reduce flood risks, enhance ecosystem health, and promote community resilience in the face of changing hydrological conditions. (Cadenasso *et al*., 2007).

Evaluating Resiliency in Landscape Architecture Projects

Performance Metrics and Indicators: This section discusses the importance of establishing performance metrics and indicators to assess the resilience of landscape architecture projects. We explore criteria such as ecological functionality, social engagement, economic viability, and long-term adaptability as means to evaluate the effectiveness of resilient design strategies (Boano & Zetter, 2016).

Monitoring and Assessment Tools: Here, we explore monitoring and assessment tools used to measure and track the performance of landscape architecture projects in enhancing resilience. We discuss techniques such as post-occupancy evaluations, remote sensing, and community feedback surveys that help identify strengths, weaknesses, and opportunities for improvement.

Future Directions and Challenges in Landscape Architecture and Resiliency:

As we strive to build a more sustainable and resilient world, the field of landscape architecture continues to evolve and face new opportunities and challenges. The future of landscape architecture and resiliency presents exciting directions that can shape our environment and improve the well-being of communities. However, several challenges must be addressed to ensure effective implementation and meaningful impact. Here, we explore some key future directions and challenges in the field:

Future Directions:

Climate-Responsive Design: With the intensification of climate change impacts, future landscape architecture must prioritize climate-responsive design strategies. Integrating climate data, predictive modeling, and scenario planning can inform resilient landscape design that proactively adapts to future climate uncertainties. Landscape architects will play a pivotal role in creating spaces that mitigate the effects of extreme weather events, support biodiversity, and ensure long-term environmental sustainability.

Regenerative Design: Moving beyond sustainable practices, regenerative design aims to restore and enhance ecosystems, making landscapes healthier and more resilient. Future landscape architecture will increasingly embrace regenerative principles, emphasizing ecological restoration, carbon sequestration, and water management. By incorporating regenerative strategies, landscape architects can actively contribute to addressing environmental degradation and supporting ecosystem services.

Smart and Connected Landscapes: Advancements in technology offer opportunities to create smart and connected landscapes that respond dynamically to changing conditions. Internet of Things (IoT) technology, sensors, and data analytics can be integrated into landscape design to optimize resource use, improve energy efficiency, and enhance adaptive management. These smart landscapes will foster a symbiotic relationship between nature and technology, providing real-time data for informed decision-making.

Nature-Based Solutions: Nature-based solutions, such as green infrastructure, natural water retention systems, and urban forests, will be increasingly integrated into landscape architecture projects. These

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solutions not only enhance ecological resilience but also offer co-benefits for communities, such as improved air quality, mental well-being, and enhanced recreational opportunities. Nature-based design will play a crucial role in promoting biodiversity and fostering human-nature connectivity.

Community-Driven Design: Future landscape architecture will place a stronger emphasis on community-driven design, ensuring that local communities actively participate in the planning and decision-making process. Engaging diverse stakeholders, including vulnerable and marginalized groups, will foster inclusivity, cultural relevance, and social equity in landscape interventions. Empowering communities to take ownership of their environments will result in more meaningful and resilient landscapes.

Challenges:

Funding and Resources: A major challenge for landscape architecture and resiliency projects is securing adequate funding and resources. Resilient landscape designs often require long-term investments, and public and private funding sources may be limited. Landscape architects will need to advocate for the value of resiliency in landscape interventions and explore innovative financing mechanisms to support their projects.

Policy and Regulatory Barriers: Policy and regulatory barriers can hinder the implementation of innovative landscape architecture and resiliency strategies. Outdated zoning codes, building regulations, and planning policies may impede the integration of nature-based solutions and sustainable design practices. Landscape architects must collaborate with policymakers to advocate for resilient design principles and update regulations to support sustainable landscapes.

Public Awareness and Education: Despite the growing importance of landscape resiliency, public awareness and education remain challenges. Communicating the significance of landscape architecture and the benefits of resilient design to the general public and stakeholders is crucial. Landscape architects will need to engage in public outreach and educational initiatives to build support and understanding for their projects.

Long-Term Maintenance and Management: Ensuring the long-term maintenance and management of resilient landscapes is essential for their success. Designing for resilience involves ongoing monitoring, adaptive management, and regular maintenance to sustain ecological functionality and prevent degradation. Collaborative efforts between landscape architects, local authorities, and communities are vital to establishing robust management plans.

Cultural and Ethical Considerations: Resilient landscape design must be sensitive to cultural and ethical considerations, especially when working with indigenous communities or areas of cultural significance. Landscape architects must respect traditional knowledge, preserve cultural heritage, and ensure that design interventions align with local values and aspirations.

So, the future of landscape architecture and resiliency presents promising opportunities to create sustainable, adaptive, and culturally rich environments. Embracing climate-responsive design, regenerative principles, technology integration, nature-based solutions, and community engagement will be key to building resilient landscapes. Overcoming challenges related to funding, policy, public awareness, maintenance, and cultural considerations will require collaborative efforts and innovative approaches from landscape architects and stakeholders. By addressing these future directions and challenges, landscape architecture can lead the way in creating a more resilient and harmonious relationship between people and the environment.

Conclusion

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This comprehensive literature review has discovered the intersection of landscape architecture and resiliency. It highlighted the conceptual framework and dimensions of resiliency, including ecological, social, and economic dimensions. It discussed the role of landscape architecture in raising resiliency in the face of climate changes, urbanization, and natural disasters. Landscape architecture, as a proactive agent of change, has the potential to transform the built environment into resilient and sustainable landscapes. The integration of ecological principles, social engagement, and innovative design strategies can create spaces that adapt to changing conditions, nurture cultural identity, and promote well-being. To address future challenges, landscape architects must collaborate across disciplines, prioritize climate adaptation, engage communities, and ensure equitable access to resilient landscapes.

Landscape architects contribute to resiliency through employing various strategies, such as green infrastructure (Pauleit *et al*., 2017), adaptive design, and community engagement. They integrate theoretical foundations, strategic approaches, and interdisciplinary collaboration in order to generate landscapes adaptable, sustainable, and capable of withstanding challenges.

By embracing the principles of resiliency, landscape architects have the potential to shape a more resilient future. Through their expertise, they can develop ecological health, enhance social well-being, and promote economic vitality (Berardi, 2016). As the world continues to face complex and interconnected challenges, landscape architecture remains a critical discipline in creating landscapes that are resilient, sustainable, and capable of supporting human and natural systems in the face of dynamic and uncertain conditions.

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