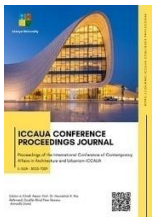

ICCAUA Proceedings Journal
Proceedings of the international conference of contemporary affairs in architecture and urbanism-ICCAUA
Volume 9 (December 2026), 2610198

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

DOI: https://doi.org/10.38027/ICCAUA2026EN0198

Climate Change Impacts on Urban Environmental Systems: A Review-Based Analysis with Emphasis on Sustainable Urban Resilience

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Received: 20.04.2026
Revised: 22.06.2026
Accepted: 01.07.2026
Available online: 10.07.2026

This article has been selected and peer-reviewed for publication in this journal as part of the 9th International Conference of Contemporary Affairs in Architecture and Urbanism, held on 7–8 May 2026 in Istanbul, Türkiye.

Abstract

Climate change intensifies interconnected risks to urban environmental systems, threatening ecological integrity, infrastructure performance, and human well-being. This study examines climate change impacts on urban environmental systems and identifies resilience strategies supporting urban adaptation. A semi-systematic review of peer-reviewed literature from Scopus and Web of Science (2020–2025) was conducted using predefined inclusion criteria and thematic analysis. The findings identify four dominant urban climate risks-heat stress, flooding, air pollution, and water scarcity-affecting critical environmental subsystems including green spaces, water infrastructure, and air quality regulation. three major resilience pathways are highlighted: integrated governance and planning, nature-based solutions, and adaptive infrastructure systems. By synthesizing fragmented research through a socio-ecological resilience framework, this study provides a reproducible analytical approach to support evidence-based urban climate adaptation and planning.

Keywords: Climate change; Urban environmental systems; Urban resilience; Nature-based solutions; Climate adaptation.

1. Introduction

Rapid urbanization combined with accelerating climate change has intensified pressures on urban environmental systems worldwide. Cities are increasingly exposed to compound climate risks such as heatwaves, flooding, air pollution episodes, and water scarcity, which interact across ecological, social, and infrastructural domains (IPCC, 2022; Zscheischler et al., 2020). These interconnected risks challenge the capacity of urban systems to maintain functionality and sustainability under conditions of uncertainty.

Urban resilience has emerged as a central framework for addressing climate-related urban challenges. Resilience emphasizes the capacity of urban systems to absorb disturbances, adapt to change, and transform when existing structures become untenable (Meerow et al., 2022). However, resilience is often conceptually conflated with sustainability or climate adaptation, resulting in theoretical ambiguity. While sustainability focuses on long-term resource balance and intergenerational equity, resilience highlights dynamic system responses to shocks and stresses (Sharifi, 2023). Clarifying this distinction is essential for understanding climate impacts on urban environmental systems.

Despite a rapidly expanding literature on climate change and cities, existing research remains fragmented. Many studies address single hazards, sector-specific vulnerabilities, or isolated adaptation measures, limiting their integrative value for urban planning and policy (Bulkeley et al., 2021). There is a clear need for systematic syntheses that connect climate risks, urban environmental subsystems, and resilience strategies within a coherent theoretical framework.

Climate change has emerged as one of the most pressing global challenges of the twenty-first century, affecting environmental, social, and economic systems at multiple scales. Urban areas are particularly vulnerable due to their high population density, concentration of infrastructure, and dependence on complex environmental systems. The impacts of climate change in cities are becoming increasingly visible through rising temperatures, more frequent heat waves, extreme precipitation events, flooding, water scarcity, and declining environmental quality.

According to recent studies, urban populations are expected to experience increasing exposure to climate-related hazards over the coming decades. Rapid urbanization, combined with inadequate planning and environmental degradation, may further intensify these risks. Consequently, cities are facing growing pressure to strengthen their adaptive capacity and develop effective resilience strategies capable of reducing vulnerability and supporting sustainable development.

Urban environmental systems play a fundamental role in maintaining the functionality and livability of cities. Recent studies have emphasized the importance of nature-based solutions and integrated governance approaches for enhancing

urban resilience (Ahern, 2021; Newell et al., 2021; Aziz Amen & Ali, 2025; Leal Filho et al., 2022). These systems include water resources, green infrastructure, biodiversity, air quality, public health services, transportation networks, and energy systems. Climate-related disruptions affecting any of these components can generate cascading consequences throughout the broader urban system, highlighting the need for integrated approaches to climate adaptation and resilience planning.

In recent years, the concept of urban resilience has gained significant attention among researchers, planners, and policymakers. Urban resilience emphasizes the ability of cities to anticipate, withstand, adapt to, and recover from environmental, social, and economic disturbances. As climate risks continue to intensify, resilience-based planning approaches are increasingly recognized as essential tools for achieving long-term urban sustainability and environmental security. Urban climate adaptation increasingly requires interdisciplinary and systems-based approaches that integrate environmental, social, technological, and governance dimensions (Bai et al., 2022; Elmqvist et al., 2021; McPhearson et al., 2022; Aziz Amen, 2022).

1.1 Research Gap

Despite the growing body of literature on climate change impacts, urban sustainability, and resilience planning, existing studies often examine these themes separately. Many studies focus on specific climate hazards such as flooding, heat stress, or air pollution, while others emphasize resilience strategies without explicitly linking them to vulnerable urban environmental subsystems. As a result, there remains a lack of integrative reviews that systematically connect climate risks, affected urban environmental systems, and corresponding resilience responses within a unified analytical framework.

Furthermore, recent urban resilience research has increasingly highlighted the importance of systems thinking and socio-ecological perspectives. However, limited attention has been given to synthesizing how climate-related risks interact across multiple environmental subsystems and how resilience strategies can simultaneously address these interconnected vulnerabilities. This gap restricts the development of comprehensive and evidence-based approaches for urban climate adaptation and environmental management.

Therefore, this study addresses this gap by conducting a semi-systematic review that integrates climate risks, vulnerable urban environmental systems, and dominant resilience strategies into a coherent conceptual framework.

1.2 Research Objectives

The primary objective of this study is to develop an integrated understanding of how climate change affects urban environmental systems and how resilience strategies can reduce these impacts. Through a semi-systematic review of recent literature, the study aims to identify the major climate risks affecting urban areas, examine the most vulnerable urban environmental subsystems, and synthesize dominant resilience strategies adopted in response to these challenges.

In addition, the study seeks to establish conceptual linkages between climate hazards, environmental vulnerabilities, and resilience pathways using a systems-thinking perspective. By integrating these dimensions within a single analytical framework, the research contributes to the advancement of urban resilience scholarship and supports more effective climate adaptation planning and environmental decision-making in cities.

2. Materials and Methods

This study adopts a semi-systematic literature review methodology to synthesise interdisciplinary research on climate change impacts and urban environmental resilience. This approach is particularly suitable for fields characterised by conceptual diversity and fragmented evidence, as it enables structured comparison while allowing thematic flexibility and theory development (Sharifi, 2023). The methodological design directly addresses the identified research gap by providing a transparent and reproducible framework linking climate risks, urban environmental systems, and resilience strategies. The overall structure of study is illustrated in Figure 1.

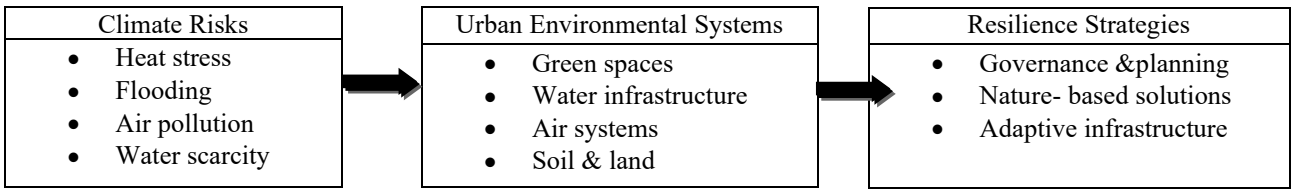

Figure 1. Methodological framework illustrating the relationship between climate risks, urban environmental systems, and resilience strategies.

2.1 Study Design

A semi-systematic review was employed to integrate empirical and conceptual studies across urban studies, environmental science, and climate adaptation literature. Unlike purely systematic reviews, this approach allows critical interpretation and conceptual synthesis while maintaining methodological rigor and traceability.

2.2 Data Sources and Search Strategy

A semi-systematic literature review approach was employed to identify and synthesize relevant studies addressing climate change impacts on urban environmental systems and resilience strategies. The review process was designed to ensure transparency, consistency, and reproducibility in the selection and analysis of the literature.

The literature search was conducted using two major academic databases: Scopus and Web of Science, which are widely recognized as reliable sources of high-quality peer-reviewed scientific publications. These databases were selected due to their comprehensive coverage of environmental science, climate change, urban studies, and sustainability research.

A combination of keywords was used to retrieve relevant studies, including “climate change”, “urban environmental systems”, “urban resilience”, “climate adaptation”, “nature-based solutions”, “urban sustainability”, “heat stress”, “flooding”, and “environmental vulnerability”. Boolean operators (AND, OR) were applied to refine the search process and improve the relevance of the results.

The search focused primarily on articles published between 2020 and 2025 to ensure that the review reflected recent scientific developments and emerging resilience strategies. Additional seminal studies and influential reports were also consulted where necessary to provide theoretical and conceptual context.

The initial database search generated a broad set of publications. Following the removal of duplicate records and the application of predefined eligibility criteria, the remaining studies were screened based on their titles, abstracts, and full texts. The selected articles were then subjected to qualitative synthesis and thematic analysis to identify recurring climate risks, vulnerable urban environmental subsystems, and dominant resilience strategies reported across the literature.

2.3 Inclusion and Exclusion Criteria

To ensure the relevance and quality of the reviewed literature, explicit inclusion and exclusion criteria were established prior to the screening process. The inclusion criteria focused on peer-reviewed journal articles published in English that addressed climate change impacts, urban environmental systems, urban resilience, climate adaptation, sustainability, or related topics. Studies published between 2020 and 2025 were prioritized to capture recent developments and emerging trends in urban climate resilience research.

The review included studies examining environmental, social, infrastructural, and governance dimensions of urban resilience. Articles presenting conceptual frameworks, empirical findings, case studies, comparative analyses, and review-based evidence were considered eligible for inclusion. Publications indexed in Scopus and Web of Science were given priority due to their academic quality and reliability.

The exclusion criteria eliminated publications that were not directly related to urban environmental systems or climate resilience. Conference abstracts, editorials, opinion papers, non-peer-reviewed documents, duplicate records, and studies lacking sufficient methodological transparency were excluded from the analysis. Studies focusing exclusively on rural environments or unrelated environmental issues were also removed from the final dataset.

The application of these criteria ensured that the selected literature was scientifically rigorous, relevant to the objectives of the study, and capable of supporting a comprehensive synthesis of climate risks, environmental vulnerabilities, and resilience strategies in urban contexts.

2.4 Screening and Selection Process

An initial screening of titles and abstracts was conducted to assess thematic relevance. Eligible studies then underwent full-text review. Only articles meeting all inclusion criteria were retained for analysis, ensuring consistency and analytical depth.

2.5 Data Analysis and Synthesis

A qualitative thematic analysis approach was employed to synthesize the selected literature. Following the screening and selection process, the included studies were carefully reviewed and coded according to their primary themes, findings, and conceptual contributions. The analysis focused on identifying recurring patterns related to climate risks, vulnerable urban environmental subsystems, and resilience strategies.

The selected studies were systematically categorized into thematic groups. First, climate-related risks affecting urban systems were identified and classified. Second, the environmental subsystems most vulnerable to climate change impacts were examined. Third, resilience strategies and adaptation measures reported across the literature were synthesized and grouped according to their dominant characteristics.

A systems-thinking perspective guided the analytical process, enabling the exploration of interactions between climate hazards, environmental vulnerabilities, and resilience responses. This approach facilitated the development of an integrated conceptual framework linking risks, impacts, and adaptation pathways within urban environmental systems.

The synthesized findings were then interpreted in relation to existing resilience theories and contemporary urban sustainability literature. This analytical strategy allowed the study to move beyond a descriptive review and generate broader insights regarding effective climate adaptation and resilience planning in urban environments.

3. Results

3.1 Major Climate Risks Affecting Urban Environmental Systems

The reviewed literature consistently identifies climate change as one of the most significant threats to the sustainability and functionality of urban environmental systems. Rapid urbanization, population growth, and increasing environmental pressures have intensified the exposure of cities to climate-related hazards. As a result, urban areas are experiencing a growing range of environmental, social, and infrastructural challenges associated with climate change.

One of the most frequently reported climate risks is the increasing occurrence and intensity of urban heat waves. Rising temperatures contribute to the urban heat island effect, whereby densely built environments absorb and retain heat more efficiently than surrounding rural areas. Heat stress negatively affects public health, increases energy demand for cooling, reduces labor productivity, and places additional pressure on urban infrastructure and ecosystem services.

Flooding represents another major climate-related threat. Increased precipitation intensity, extreme rainfall events, sea-level rise, and inadequate drainage systems contribute to higher flood risks in many urban regions. Flooding can damage transportation networks, housing, water infrastructure, and public facilities while simultaneously increasing economic losses and social vulnerability.

Water scarcity is also emerging as a critical challenge in numerous cities around the world. Prolonged droughts, changing precipitation patterns, and increasing water demand have reduced the availability of freshwater resources. Urban water shortages can affect household consumption, industrial production, ecosystem health, and overall urban resilience.

Air quality deterioration constitutes an additional climate-related concern. Climate change can intensify air pollution through increased temperatures, altered atmospheric conditions, and more frequent wildfires. Poor air quality is associated with respiratory diseases, cardiovascular problems, and reduced quality of life, particularly among vulnerable populations.

Furthermore, extreme weather events such as storms, hurricanes, and prolonged droughts have become more frequent and severe in many regions. These events often generate cascading impacts across urban systems, disrupting critical infrastructure, economic activities, environmental services, and community well-being. The interaction of multiple climate hazards frequently amplifies urban vulnerability and complicates adaptation efforts.

Overall, the literature indicates that climate risks rarely occur in isolation. Instead, they interact across multiple urban environmental subsystems, creating complex challenges that require integrated and systems-based approaches to resilience planning and climate adaptation (IPCC,2022; Leal Filho et al.,2022;Sharifi, 2023).

3.2 Vulnerable Urban Environmental Subsystems

The literature reveals that climate change affects multiple urban environmental subsystems simultaneously, often generating interconnected impacts that extend beyond individual sectors. The vulnerability of these subsystems depends on their exposure, sensitivity, and adaptive capacity within specific urban contexts.

Urban water systems are among the most vulnerable environmental subsystems. Climate change affects both water quantity and water quality through altered precipitation patterns, prolonged droughts, and increased flooding events. Water infrastructure faces growing pressure as cities attempt to meet increasing demand while coping with declining resource availability and climate-related disruptions.

Urban green spaces and ecosystems are also highly sensitive to climate variability. Rising temperatures, drought conditions, and extreme weather events can reduce vegetation health, biodiversity, and ecosystem functionality. Since urban green infrastructure contributes significantly to temperature regulation, stormwater management, and air quality improvement, its degradation may weaken overall urban resilience.

Public health systems represent another critical subsystem affected by climate change. Heat waves, air pollution, water-related diseases, and climate-induced disasters increase health risks for urban populations. Vulnerable groups, including elderly individuals, children, and low-income communities, often experience disproportionate impacts due to limited adaptive capacity and unequal access to resources.

Transportation infrastructure is increasingly exposed to climate-related hazards. Flooding, heat stress, and extreme weather events can disrupt mobility networks, damage roads and public transportation systems, and reduce accessibility to essential services. These disruptions may generate significant economic losses and affect the functioning of urban areas.

Energy systems are similarly vulnerable to climate change impacts. Rising temperatures increase electricity demand for cooling, while extreme weather events can damage power generation and distribution infrastructure. Energy disruptions often create cascading effects across multiple urban sectors, further increasing systemic vulnerability.

In addition, urban governance and institutional systems can be indirectly affected by climate-related pressures. Increasing environmental risks require greater coordination, planning capacity, and policy responsiveness. Weak governance structures may limit the implementation of effective adaptation measures and hinder long-term resilience planning.

The reviewed literature suggests that these subsystems should not be analyzed independently. Instead, their interconnected nature highlights the importance of integrated urban management approaches capable of addressing multiple vulnerabilities simultaneously while strengthening overall resilience capacity (Newell et al.,2021; Elmqvist et al.,2021; Hsu et al.,2023).

3.3 Dominant Urban Resilience Strategies

The reviewed studies identify a wide range of resilience strategies that cities are adopting to reduce climate-related risks and strengthen their adaptive capacity. These strategies are increasingly recognized as essential components of sustainable urban development and long-term climate adaptation planning.

One of the most frequently discussed approaches is the implementation of nature-based solutions. Green roofs, urban forests, wetlands, green corridors, and permeable surfaces contribute to reducing urban heat island effects, improving stormwater management, enhancing biodiversity, and strengthening ecosystem services. Nature-based solutions are often considered cost-effective and multifunctional adaptation measures capable of generating environmental, social, and economic benefits simultaneously.

Climate-resilient urban planning represents another major strategy identified in the literature. This approach involves integrating climate considerations into land-use planning, infrastructure development, housing policies, and urban growth management. By incorporating climate risk assessments into planning processes, cities can reduce exposure to hazards and improve long-term resilience outcomes.

Infrastructure adaptation measures are also widely reported. These include upgrading drainage systems, enhancing flood protection infrastructure, modernizing transportation networks, improving water management facilities, and strengthening energy systems. Resilient infrastructure investments help reduce the vulnerability of critical urban services while improving the capacity of cities to respond to climate-related disruptions.

Technological innovation plays an increasingly important role in urban resilience. Smart city technologies, environmental monitoring systems, geographic information systems (GIS), early warning systems, and climate data analytics support evidence-based decision-making and improve risk management capabilities. These technologies enable urban managers to anticipate hazards, monitor environmental conditions, and implement more effective adaptation strategies.

Community engagement and participatory governance are frequently highlighted as critical dimensions of resilience building. Public awareness programs, stakeholder participation, collaborative planning processes, and community-based adaptation initiatives contribute to strengthening social resilience and improving the effectiveness of climate adaptation policies. Local knowledge and citizen involvement can significantly enhance the legitimacy and sustainability of resilience interventions.

Institutional capacity building and policy integration are equally important. Effective climate adaptation requires coordination among government agencies, private organizations, researchers, and local communities. Strong governance structures, supportive regulatory frameworks, and long-term strategic planning are essential for implementing successful resilience initiatives.

Overall, the literature demonstrates that urban resilience cannot be achieved through a single intervention. Instead, successful adaptation depends on combining environmental, technological, infrastructural, social, and institutional strategies within an integrated framework capable of addressing the complex and interconnected nature of urban climate risks (Wamsler, 2023; Solecki et al., 2022; Ziervogel et al., 2022).

4. Discussion

The findings of this review demonstrate that climate change has become a multidimensional challenge affecting nearly all components of urban environmental systems. The literature consistently highlights the increasing frequency and intensity of climate-related hazards, including heat waves, flooding, droughts, and extreme weather events, which collectively threaten environmental sustainability and urban resilience.

One of the most important findings of this study is the strong interconnection between climate risks and urban environmental subsystems. Rather than affecting individual sectors independently, climate hazards generate cascading impacts across water resources, green infrastructure, public health systems, transportation networks, and energy systems. This interconnected nature of urban vulnerability supports the growing emphasis on systems-thinking approaches within contemporary resilience research.

The review further reveals that urban resilience strategies are becoming increasingly diversified. While traditional infrastructure-based adaptation measures remain important, recent studies demonstrate a growing shift toward integrated

approaches that combine technological innovation, nature-based solutions, governance reforms, and community participation. This trend reflects the recognition that climate adaptation requires coordinated actions across multiple sectors and stakeholders.

Another important observation concerns the role of urban governance in resilience building. The effectiveness of adaptation measures depends not only on technical interventions but also on institutional capacity, policy integration, and stakeholder collaboration. Cities with stronger governance structures generally exhibit greater adaptive capacity and are better positioned to implement long-term climate resilience strategies.

The findings also highlight the growing importance of nature-based solutions within urban climate adaptation frameworks. Green infrastructure interventions provide multiple co-benefits, including temperature regulation, biodiversity conservation, stormwater management, and improvements in human well-being. As a result, these approaches are increasingly viewed as essential components of sustainable urban resilience planning.

From a theoretical perspective, this study contributes to the existing literature by integrating climate risks, environmental vulnerabilities, and resilience strategies within a single analytical framework. While previous studies often examine these dimensions separately, the present review emphasizes their interdependence and demonstrates the value of adopting a holistic perspective when addressing climate adaptation challenges in urban environments.

Overall, the results suggest that future urban resilience efforts should prioritize integrated planning approaches capable of simultaneously addressing environmental, infrastructural, social, and governance-related vulnerabilities. Such approaches are likely to improve the effectiveness of climate adaptation policies and strengthen the long-term sustainability of urban systems.
An additional implication of the findings relates to the growing need for interdisciplinary collaboration in urban climate adaptation. Addressing complex climate challenges requires cooperation among environmental scientists, urban planners, engineers, policymakers, public health experts, and local communities. The integration of knowledge from multiple disciplines can improve the design and implementation of resilience strategies while enhancing their long-term effectiveness.

Furthermore, climate adaptation should be viewed not only as an environmental necessity but also as an opportunity to promote sustainable urban transformation. Investments in resilient infrastructure, green spaces, ecosystem restoration, and climate-sensitive urban planning can simultaneously generate environmental, economic, and social benefits. Such approaches contribute to healthier, more inclusive, and more sustainable urban environments while reducing future climate-related risks.

The literature increasingly emphasizes that resilience is a dynamic and evolving process rather than a fixed outcome. Consequently, cities must continuously monitor climate risks, evaluate adaptation measures, and update resilience strategies in response to changing environmental conditions and emerging challenges. Adaptive governance and continuous learning will remain essential components of successful urban resilience initiatives in the coming decades.
These findings are consistent with recent studies highlighting the role of adaptive governance and transformative resilience in urban systems (Wamsler, 2023; Ziervogel et al., 2022; Solecki et al., 2022).

Recent studies have highlighted the importance of green infrastructure, ecosystem services, and spatial planning in supporting urban resilience and sustainable development. Furthermore, transformative adaptation approaches have been increasingly recognized as effective pathways for addressing complex urban climate challenges (Anguelovski et al., 2022; Frantzeskaki et al., 2021; Haase, 2021; Wilson & Piper, 2021; Sharifi & Khavarian-Garmsir, 2023).

4.1 Limitations and Future Research Directions

Despite its contributions, this study has several limitations. First, the review focused primarily on English-language publications indexed in major academic databases, which may have excluded relevant studies published in other languages or regional sources. Second, the review relied on secondary data and existing literature, limiting the ability to assess real-world implementation outcomes of resilience strategies.

Future research should expand the geographical scope of analysis and examine how resilience strategies perform under different socio-economic, environmental, and governance conditions. Comparative studies across cities and regions may provide valuable insights into the contextual factors influencing adaptation success. Furthermore, future investigations could employ empirical methods, including case studies and quantitative assessments, to evaluate the effectiveness of specific resilience interventions in urban settings.

Additional research is also needed to explore emerging technologies, climate governance innovations, and integrated adaptation frameworks capable of addressing increasingly complex urban climate risks. Such efforts will contribute to the development of more effective and evidence-based resilience strategies for sustainable urban futures.

5. Conclusions

Climate change represents one of the most significant challenges facing contemporary urban environmental systems. Through a semi-systematic review of recent literature, this study examined the major climate risks affecting urban areas,

identified the most vulnerable environmental subsystems, and synthesized dominant resilience strategies reported across the academic literature.

The findings demonstrate that urban climate risks extend beyond isolated environmental impacts and generate interconnected challenges affecting water systems, green infrastructure, public health, transportation networks, energy systems, and urban governance. These interconnected vulnerabilities highlight the necessity of adopting integrated and systems-based approaches to urban resilience planning.

The review further indicates that effective resilience building requires a combination of adaptation strategies, including nature-based solutions, resilient infrastructure development, technological innovation, participatory governance, and institutional capacity strengthening. No single strategy is sufficient to address the complexity of climate-related urban challenges. Instead, successful adaptation depends on coordinated and multidisciplinary approaches capable of addressing multiple vulnerabilities simultaneously.

A key contribution of this study is the development of an integrated perspective that links climate hazards, environmental vulnerabilities, and resilience strategies within a unified conceptual framework. By synthesizing recent evidence from diverse fields, the study contributes to the growing body of knowledge on urban climate resilience and supports more informed environmental planning and decision-making processes.

The results underscore the importance of incorporating resilience principles into urban policy, environmental management, and sustainable development strategies. As climate change continues to intensify, cities must adopt proactive adaptation measures that enhance their capacity to withstand, respond to, and recover from environmental disruptions.

Future research should focus on empirical assessments of resilience interventions, comparative analyses across different urban contexts, and the evaluation of emerging adaptation technologies. Such efforts will further strengthen the scientific foundation for resilient and sustainable urban development in an era of accelerating climate change.
The findings of this review also emphasize the importance of integrating climate resilience into long-term urban development policies. Cities that proactively incorporate adaptation measures into planning processes are more likely to reduce future environmental risks and enhance the well-being of urban populations. Such integration can support sustainable development goals while strengthening environmental governance and institutional preparedness.

Moreover, the increasing complexity of climate-related challenges highlights the necessity of adopting flexible and adaptive management approaches. Urban decision-makers should continuously evaluate emerging risks, update resilience strategies, and promote stakeholder engagement to ensure effective and equitable adaptation outcomes. Strengthening collaboration between governments, researchers, and local communities will be essential for building resilient and sustainable cities in the future.

Finally, this review highlights the urgent need for cities to transition from reactive responses toward proactive and resilience-oriented planning frameworks. As climate uncertainty continues to increase, urban environmental systems must be managed through integrated, evidence-based, and forward-looking approaches. Strengthening resilience today will significantly improve the capacity of future cities to cope with environmental challenges while maintaining sustainability, environmental quality, and human well-being.

In conclusion, enhancing urban resilience is not only a response to climate change but also a strategic pathway toward achieving sustainable, adaptive, and environmentally secure cities for future generations.

The integration of scientific knowledge, effective governance, and community participation will remain essential for successful urban climate adaptation and long-term sustainability.

These findings provide valuable insights for researchers, planners, and policymakers working toward resilient urban futures.

Acknowledgements
The author acknowledges the contributions of previous researchers whose published studies informed this review.

Funding
This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Conflicts of Interest
The author reports no conflicts of interest.

Data Availability Statement
The data supporting the findings of this study are derived from publicly available peer-reviewed literature indexed in Scopus and Web of Science databases.

Institutional Review Board Statement
Not applicable.

CRediT Author Statement
Shahrzad Amirsarvari: Conceptualization; Methodology; Formal analysis; Investigation; Writing – original draft; Writing – review & editing.
The author has read and approved the final manuscript.

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