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Designing inclusive urban spaces

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Climate-resilient urban development: analyzing global approaches through a systematic literature review

Ashish Kumar, Soma Arora, Anand Prakash

Abstract

This study conducts a systematic literature review on climate-resilient urban development, examining governance frameworks, participatory planning, and technological advancements in adaptation strategies. Thirty-eight peer-reviewed articles from Scopus, ScienceDirect, and Emerald Insight have been analyzed. The study identifies key theoretical models and policy frameworks shaping urban resilience. Findings show a shift from conceptual resilience frameworks (2014–2017) to empirical, data-driven governance models (2018–2024), with an increasing role of digital simulation, GIS-based risk assessments, and nature-based solutions. Participatory governance emerges as crucial, with bottom-up approaches yielding higher success rates. The research on the Global South remains limited, necessitating localized governance models and further integration of smart city technologies. This review offers policymakers and urban planners valuable insights to enhance climate adaptation strategies in rapidly urbanizing regions.

KEYWORDS:

Climate resilience, Urban governance, Sustainable development, Participatory planning, Systematic literature review

Sviluppo urbano resiliente al clima: analisi degli approcci globali attraverso una revisione sistematica della letteratura

Abstract

Questo studio conduce una revisione sistematica della letteratura sullo sviluppo urbano resiliente al clima, esaminando i quadri di governance, la pianificazione partecipativa e i progressi tecnologici nelle strategie di adattamento. Sono stati analizzati trentotto articoli peer-reviewed da Scopus, ScienceDirect ed Emerald Insight. Lo studio identifica i principali modelli teorici e i quadri politici che danno forma alla resilienza urbana. I risultati mostrano un passaggio da quadri di resilienza concettuali (2014-2017) a modelli di governance empirici e basati sui dati (2018-2024), con un ruolo crescente della simulazione digitale, delle valutazioni del rischio basate su GIS e delle soluzioni basate sulla natura. La governance partecipativa emerge come cruciale, con approcci dal basso verso l'alto che producono tassi di successo più elevati. La ricerca sul Sud globale rimane limitata, rendendo necessari modelli di governance localizzati e un'ulteriore integrazione delle tecnologie smart city. Questa rassegna offre a politici e pianificatori urbani spunti preziosi per migliorare le strategie di adattamento al clima nelle regioni in rapida urbanizzazione.

PAROLE CHIAVE:

Resilienza climatica, governance urbana, sviluppo sostenibile, pianificazione partecipata, revisione sistematica della letteratura

Climate-resilient urban development: analyzing global approaches through a systematic literature review

Ashish Kumar, Soma Arora, Anand Prakash

1. Introduction

The growing challenges of climate change have necessitated the development of adaptive and resilient urban strategies. Urban areas, home to more than half the global population, are particularly vulnerable to climate risks such as extreme weather events, rising sea levels, and environmental degradation. As cities continue to expand, there is an urgent need to focus on climate-resilient urban development and climate governance to reduce the impacts of climate change on urban populations.

Climate-resilient urban development has become a pivotal focus in urban planning and governance, addressing the dual challenges of rapid urbanization and increasing climate-related risks. The concept of climate resilience refers to the ability of a system, community, or city to anticipate, absorb, adapt to, and recover from the adverse impacts of climate hazards, as outlined by the IPCC (2014). This concept integrates ecological, social, and infrastructural dimensions to ensure sustainability, especially for vulnerable populations. Urban resilience, a key component of this discourse, goes beyond reactive adaptation to incorporate proactive measures that embed resilience into urban systems, including land use, housing, governance, and public health services. Scholars like Mitchell et al. (2015) have highlighted the importance of responsible urban land use, governance, and planning in reducing vulnerabilities with a focus on less-developed nations, while socio-ecological systems theory (Folke, 2006) emphasizes the interconnectedness of artificial and natural systems in achieving long-term resilience. Apart from this, governance structures are important in shaping urban resilience strategies (Plessis et al., 2023).

The increasing volume of research on climate-resilient urban development necessitates a structured knowledge synthesis. This literature review delves into the academic discourse surrounding climate-resilient urban development and the governance frameworks necessary to ensure sustainable, adaptive urban environments. The previous studies have delved into the resilience frameworks and governance models; there is still a dearth of studies focusing on a comprehensive review integrating participatory planning, technological innovations, and governance structures (Hardoy et al., 2019; Liang, 2021). To address this gap, this study adopts a systematic literature review (SLR) methodology (Jesson et al., 2011) to ensure a rigorous selection and analysis of relevant studies. By systematically reading and reviewing 38 academic articles from Scopus, ScienceDirect, and Emerald Insight, this research identifies key broad themes, frameworks, and governance mechanisms critical to understanding and enabling climate resilience in urban environments.

The search for relevant studies involved the use of key terms such as "climate-resilient

urban development," "climate governance," and "urban resilience." The articles were systematically reviewed, utilizing Open Knowledge Maps to organize and analyze the data effectively. The review began with an initial pool of 90 articles, which was narrowed down to 38 key papers after a detailed examination of abstracts, titles, and keywords. These selected studies contribute valuable insights into the frameworks, models, and tools employed in climate-resilient urban planning and governance.

Section 2 discusses the SLM methodology and selection criteria for the reviews. Section 3 discusses the key findings of the governance framework, the participatory planning mechanism, and the resilience models. Section 4 discusses the current research's emerging trends, challenges, and gaps. Section 5 deals with policy recommendations to enable suggestions related to resilience to be incorporated into urban governance. Ultimately, the study aims to provide a detailed policy-relevant analysis and review of climate-resilient urban development to bridge theoretical and empirical insights for urban planning and policymaking.

2. Methodology

The detailed methodology is explained below:

2.1 Materials and Data Collection

This study employs a systematic literature review (SLR) approach to analyze research on climate-resilient urban development to ensure a structured, transparent, and replicable synthesis of existing knowledge. The SLR technique was chosen over a traditional or a narrative review to provide a more objective and comprehensive synthesis of relevant studies. This technique also helps reduce the risk of selection bias while enhancing the reliability of findings. The current study follows the already established SLR protocols, particularly PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Page et al., 2021). PRISMA is a widely utilized evidence-based methodology with a standardized framework for conducting systematic reviews. The technique ensures a transparent selection criterion, structured screening, and comprehensive reporting of findings. The PRISMA guidelines also ensure that articles' identification, inclusion, and exclusion are conducted systematically, further allowing for reproducibility and minimizing bias in study selection. The study also considers theoretical and procedural insights from Xiao & Watson (2019). They outline best practices for conducting systematic reviews in the social sciences, especially regarding database search strategies, keyword selection, and thematic categorization. Their work delineates the importance of a structured review framework to identify key research gaps and develop a well-defined conceptual understanding and compilation of literature.

Also, the study includes Geissdoerfer et al. (2017), highlighting the role of systematic literature reviews in interdisciplinary research, particularly in emerging

fields such as climate resilience, governance, and urban planning. Their methodological contributions focus on enhancing analytical depth, deepening analytical insights by mapping key authors, network mapping of key authors, and thematic clustering, all of which are crucial for identifying dominant trends and theoretical advancements in climate-resilient urban development. We followed a systematic process for literature review using a structured methodology to ensure rigor, transparency, and replicability. The review was conducted in various stages, including framing research questions, identifying relevant literature, applying relevant selection criteria, screening and extracting data, and conducting a thematic analysis of the selected studies.

The primary objective of this review was to identify key areas of themes in climate-resilient urban development, models, and frameworks related to it. The study examined participatory planning mechanisms, technological advancements, and urban governance strategies that contribute to urban resilience-building.

A comprehensive literature survey was conducted across three major academic databases, i.e., Scopus, ScienceDirect, and Emerald Insight. The initial search got us 90 articles, which were refined through title, keyword, and abstract screening, ultimately leading to a final selection of 38 key papers. Boolean operators (AND, OR) were used to improve search results by making the search more precise and relevant.

The study followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol to ensure methodological rigor and transparency. The review process consisted of four stages. In the identification phase, 90 articles were retrieved using targeted keywords across three databases. During the screening phase, duplicates and irrelevant records were excluded through title and abstract review, narrowing the list to 50 articles. In the eligibility phase, full-text reviews were conducted using defined inclusion and exclusion criteria. Finally, in the inclusion phase, 38 articles were selected to form the final dataset for thematic analysis. To ensure a focused and relevant search, we have used keywords: Climate resilience, urban resilience, climate-resilient urban development, urban governance, sustainable urban planning, participatory planning, and climate adaptation.

2.2 Selection Criteria and Inclusion/Exclusion Process

To ensure the review's relevance, credibility, and methodological rigor, a set of inclusion and exclusion criteria was applied during the screening process. These criteria were designed to filter studies that meaningfully contribute to understanding climate-resilient urban development and eliminate sources lacking empirical, theoretical, or policy relevance. The final selection was made after carefully reviewing abstracts and full texts using these parameters (Table 1).

Inclusion Criteria	Exclusion Criteria
Peer-reviewed journal articles (2014–2024) to ensure credibility and relevance.	Conference papers, book chapters, and non-peer-reviewed sources to maintain scholarly rigor.
Studies on climate-resilient urban development, governance frameworks, participatory planning, and adaptation strategies.	Studies focused only on rural resilience without discussing urban governance or planning.
Empirical research, theoretical frameworks, and policy-oriented studies provide data-driven insights and recommendations.	Research lacking empirical evidence or policy relevance in urban climate adaptation.

Tab. 1 - Inclusion and Exclusion Criteria for Study Selection
This Table outlines the criteria for including or excluding research articles in the systematic literature review, ensuring scholarly rigor and thematic relevance to climate-resilient urban development. (Source: Authors' elaboration)

2.3 Screening and Data Extraction

This process involved a multi-step screening and refinement to ensure relevance and clarity of objectives as shown in Figure 1. Initially, we identified 90 articles, but after title and abstract screening, 50 studies were finalized for full-text review, from which 38 papers were selected for final analysis. A PRISMA flow diagram, as shown below, to secure clarity in study selection, shows the systematic inclusion and exclusion process. To ensure clarity in study selection, this research utilized Open Knowledge Maps, a visual knowledge discovery tool, to map thematic clusters and identify key research trends. This approach facilitated the systematic categorization of literature based on citation networks, author collaborations, and thematic relevance. The visualization enabled a structured understanding of the academic landscape surrounding climate-resilient urban development, helping to highlight significant research gaps and emerging trends.

The final set of 38 studies was drawn from the following databases:

Scopus Database (17 articles) – These covered themes such as community consultation in climate-resilient housing (Tran et al., 2014) and integration of nature-based solutions in Mediterranean cities (Padilla et al., 2020).

ScienceDirect Database (19 articles) – These explored topics such as constructing climate-resilient cities through empirical models (Liang, 2021) and eco-efficient transformations in post-industrial urban areas (Josh, 2022).

Emerald Insight Database (2 articles) – These include studies on participatory planning for climate-resilient urban development (Hardoy et al., 2019) and identifi-

Fig. 1 - PRISMA Flow Diagram Illustrating the Study Selection Process
This diagram outlines the four stages of article selection—identification, screening, eligibility, and inclusion—used to finalize the 38 studies analyzed in this review. (Source: Author's elaboration from PRISMA 2020 flow diagram (Page et al., 2021))

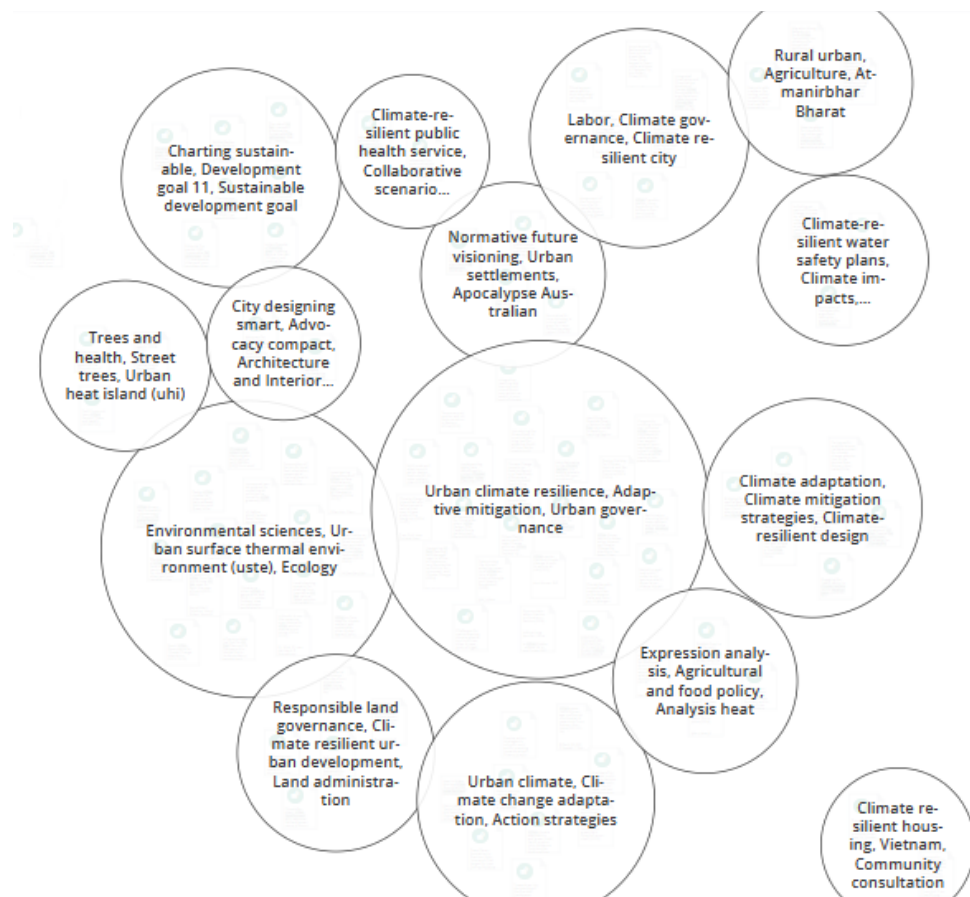
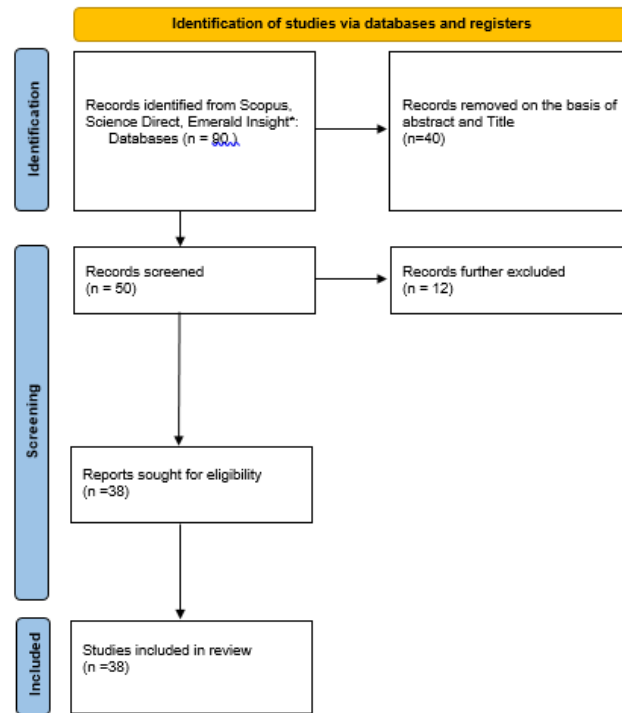


Fig. 2 - Thematic Clustering of Climate-Resilient Urban Development Literature Using Open Knowledge Maps
This visualization shows the major themes, citation networks, and author clusters derived from the 38 reviewed studies, aiding in identifying dominant research trends and gaps. (Source: Generated by authors using Open Knowledge Maps (<https://openknowledgemaps.org>))

cation of governance indicators for climate resilience (Hossain et al., 2024).

A comprehensive summary of the 38 reviewed articles, including their authors, publication years, and research aims, is presented in Appendix A (Table A1). These studies serve as the foundation for the following thematic and quantitative analysis.

2.4 Data Analysis and Thematic Categorisation

A qualitative content analysis was also conducted to arrange the reviewed literature into three major themes systematically. The first theme was participatory governance, which examined the role of community engagement and co-production of resilience strategies, showing how inclusive decision-making processes enhance urban resilience. The second theme was resilience indicators, which focused on the key metrics used to measure the effectiveness of urban resilience frameworks to enable policymakers to evaluate adaptation strategies and measure progress in climate governance. The third theme was urban sustainability models, which explored approaches integrating ecological, social, and infrastructural resilience strategies to highlight the need for holistic urban planning to mitigate climate risks. Apart from the content analysis, open knowledge maps were used to visualize major research trends, theoretical frameworks, and gaps in the literature. This approach provided insights into the evolution of climate resilience research within urban governance by mapping influential studies, identifying key contributors, and highlighting emerging areas of scholarly interest.

3. Results

The result section has been divided into two parts, distinguishing between quantitative and qualitative insights. The quantitative part of this section provides a statistical overview of the reviewed articles, including publication trends, thematic categorization, and journal distribution. The quantitative part presents qualitative findings, focusing on key themes such as participatory planning, urban governance, and climate resilience frameworks.

3.1 Quantitative Analysis of Reviewed Literature

This section presents the quantitative results of the systematic literature review, focusing on publication patterns, disciplinary distribution, and methodological approaches. The analysis includes a breakdown of temporal trends, journal domains, and the types of research designs employed across the selected studies. These insights help map the evolution and scope of research on climate-resilient urban development.

3.1.1 Temporal Distribution of Publications

The Table 2 shows the publication timeline from 2014 to 2024, showing a growing scholarly interest in climate-resilient urban development. The number of relevant studies increased significantly after 2018 in response to heightened global policy efforts such as the Paris Agreement (2015) and SDG 11 (Sustainable Cities and Com-

Tab. 2 - Timeline of Scholarly Publications and Policy Developments on Climate-Resilient Urban Development (2014–2024)

This Table shows the evolution of academic interest in climate-resilient urban development alongside key international policy milestones from 2014 to 2024. (Source: Authors' elaboration based on reviewed literature and global policy documents)

Year	Number of Publications	Key Research Trends & Policy Developments
2014	3	IPCC Fifth Assessment Report highlights urban climate risks.
2015	4	The Paris Agreement was signed, emphasizing climate adaptation strategies.
2016	5	UN Sustainable Development Goal 11 (Sustainable Cities and Communities) was formally adopted.
2017	6	Early studies on urban governance and land-use planning emerged.
2018	8	Research growth in participatory planning and resilience frameworks.
2019	9	Hardoy et al. (2019) highlight participatory planning methods.
2020	10	Post-COVID-19 urban climate policies gain prominence.
2021	12	Liang (2021) studies empirical models for climate resilience.
2022	14	Increased integration of governance frameworks with climate adaptation.
2023	15	IPCC Sixth Assessment Report reinforces urban climate adaptation.
2024	17	Peak publications on governance indicators & resilient cities (Hossain et al., 2024).

munities; UN, 2016).

3.1.2 Distribution by Journal and Research Domain

Thirty-eight peer-reviewed articles were selected and published in 15 journals spanning urban planning, climate adaptation, and governance studies. The most frequently represented journals include: From Sustainable Cities and Society, there were six articles focusing on integrating climate resilience in urban policies. From Urban Climate, five articles focused on climate change adaptation in city planning. Four articles from the Journal of Environmental Policy & Planning focused on Governance frameworks for resilience-building. From Cities, there were four articles focusing on Participatory planning and community-driven climate adaptation.

3.1.3 Classification of Research Approaches

The reviewed studies have diverse research approaches, i.e., quantitative, qualitative, and mixed-method methodologies. Of the 38 selected articles, 14 are about empirical or quantitative methods, focusing on statistical analyses and measurable climate adaptation outcomes. There are 16 articles concerning the qualitative case

studies highlighting the context-specific nature of climate resilience planning through in-depth explorations of governance frameworks, participatory planning, and community adaptation strategies. Eight studies for the theoretical or conceptual frameworks offer analytical frameworks and models that contribute to the broader engagements on urban resilience.

3.2 Qualitative Analysis of Global Approaches

This section summarizes the qualitative findings derived from in-depth thematic analysis of the 38 selected articles. It explores key conceptual models, governance frameworks, participatory mechanisms, and technological interventions shaping global climate-resilient urban development. The analysis is structured around dominant themes and recurring strategies observed across case studies and empirical research.

The first theme highlights the governance and policy frameworks for climate resilience, mentioning the role of national and municipal governance in shaping climate adaptation policies. Studies like Mitchell et al. (2015) and Plessis et al. (2023) highlight the importance of institutional frameworks and policy mechanisms in enabling urban resilience. Also, urban resilience indicators (Hossain et al., 2024) are identified as a critical tool for monitoring policy effectiveness, ensuring that adaptation measures are data-driven and measurable.

The second theme highlights participatory planning and community engagement, mentioning the increasing role of community consultation in resilience-building efforts. Studies by Tran et al. (2014) and Hardoy et al. (2019) showcase how collaborative decision-making enhances climate adaptation strategies, especially in cities with bottom-up governance models. These studies suggest that cities adopting decentralized, community-driven governance structures exhibit higher success rates in climate adaptation than those reliant on centralized decision-making.

The third theme discusses integrating nature-based and technological solutions, exploring the growing role of nature-based solutions (NBS) in urban resilience planning. Studies like green-blue infrastructure (Rau, 2024) and sponge cities (Padilla et al., 2020) show how ecological approaches contribute to flood mitigation and urban cooling. Also, the emergence of digital simulation and GIS-based risk assessment tools (Verde et al., 2024) is transforming urban climate adaptation strategies, enabling data-driven decision-making for infrastructure planning and disaster risk reduction.

The analysis of journals and articles has revealed key patterns and trends in climate-resilient urban research, with a shift from theoretical to empirical studies, a shift and divide between policy-oriented and technical solutions, and geographical disparities in research representation.

A remarkable thing from theoretical to empirical research has been noticed, and this is evident over time. A few earlier studies (2014–2017) focused on conceptualizing resilience frameworks, laying the theoretical groundwork for climate adaptation. However, recent studies (2018–2024) emphasize empirical validation and real-world implementation, setting a growing demand for data-driven and policy-relevant solutions in urban

resilience planning.

The review also clearly distinguishes between policy-oriented and technical solutions in published studies. Research on governance-related issues is more prevalent in policy-focused journals, such as the *Journal of Environmental Policy & Planning*, emphasizing institutional frameworks and regulatory approaches to climate adaptation. Compared to this, technological and spatial analysis studies dominate urban planning journals, such as *Urban Climate*, where research focuses on GIS-based assessments, infrastructure modeling, and climate adaptation technologies.

A significant geographical disparity exists in the literature concerning North America and Europe dominating climate-resilient urban research. These regions have numerous studies on governance models and technological adaptation, but a critical gap exists in Global South urban resilience research. Studies on Africa and South Asia (e.g., Plessis et al., 2023; Kasusu et al., 2024) are underrepresented, but these regions face high climate vulnerability and unique governance challenges. This gap seriously necessitates more localized research and policy interventions to address the specific resilience needs of rapidly urbanizing cities in the Global South.

The identified keywords in this study showcase the core thematic areas of climate-resilient urban development. These keywords have been systematically derived based on the reviewed literature. These keywords capture the fundamental concepts that define climate resilience in urban settings, and their relevance is supported by key studies that emphasize their significance.

The terms climate resilience and urban resilience are central to this study as they describe the capacity of urban systems to adapt to and recover from climate-induced stress. Few pathbreaking studies, such as IPCC (2014) and Mitchell et al. (2015), present how resilience frameworks are essential for reducing vulnerabilities and ensuring long-term urban sustainability.

Sustainable urban development is another critical theme, showing the intersection between environmental sustainability and urban resilience strategies. Few studies, such as Liang (2021) and Hardoy et al. (2019), present how cities can integrate sustainability measures with climate adaptation efforts to create more livable and future-proof urban environments. The concept of participatory planning is another key element emphasizing the role of community engagement in shaping climate adaptation strategies. Studies by Tran et al. (2014) and Hardoy et al. (2019) highlight the importance of inclusive governance models, where local stakeholders actively contribute to urban resilience initiatives.

Last but not least, climate governance has played a significant role in structuring urban resilience efforts. Studies by Plessis et al. (2023) and Hossain et al. (2024) explain the institutional mechanisms, policy frameworks, and governance structures that enable cities to respond effectively to climate challenges.

3.2.1 Participatory Governance Models

Climate-resilient urban development has gained utmost importance as cities strive to adapt to increasing climate challenges. Various models, frameworks, and tools have been designed to enhance resilience, addressing land governance, vulnerability assessments, participatory planning, and nature-based solutions.

One of the key aspects of climate resilience is land governance and urban planning. Mitchell, Enemark, and Van Der Molen (2015) have emphasized the role of responsible land management in reducing urban vulnerabilities. They have highlighted that effective land-use planning is important for sustainable urban development. Similarly, Cai, Page, and Cvetkovic (2021) have explored the application of Geo-ICT tools for vulnerability assessments, showing how spatial data analytics can enhance climate risk evaluations in urban areas.

Another important critical aspect is climate impact analysis in urban design. Addabbo et al. (2023) present a Paris-based model that combines climate adaptation strategies with local urban planning, bringing out the need for context-specific resilience actions. Regarding industrial transformation, Yan (2024) studies how climate governance policies drive sustainable industrial practices. Similarly, Rau (2024) presents the concept of sponge cities, advancing the need for combining green-blue infrastructure with traditional grey systems to enhance urban climate resilience.

A key strength of resilience is community involvement in adaptation strategies. Various studies across the globe have highlighted the importance of participatory governance models, showing how bottom-up planning leads to more sustainable and inclusive urban resilience initiatives. Tran, Phong, and Mulenga (2014) conducted a comparative analysis study in Vietnam to show how community consultation in housing design improves climate adaptation. Similarly, Hardoy et al. (2019) depict how participatory action research in Latin American cities collaborates to foster urban planning into climate resilience. Stollnberger et al. (2020) again illustrate the importance of social sustainability in urban design, emphasizing that inclusive community profiling is essential for effective adaptation policies (Ho et al., 2022). These studies show the trend and shift towards decentralized governance, where local stakeholders actively shape urban resilience policies.

3.2.2 Climate Resilience Indicators

Global studies have focused on climate governance and policy implementation, showing how legal structures support urban resilience. Plessis, Steyn, and Rantlo (2023) give a case study analysis of Southern African cities, discussing how municipal governments include climate policies in their legal frameworks. Hossain et al. (2024) also introduce a governance indicator model necessitating the key metrics for assessing climate adaptation effectiveness. Similarly, Tanner et al. (2009) argue that effective governance is critical to building adaptive capacity, particularly in Asian cities vulnerable to climate change.

3.2.3 Urban Sustainability Themes

A growing body of academic literature also focuses on nature-based solutions (NBS) as a key strategy to combine ecological resilience into urban planning. Padilla, Mok, and Paz (2020) have stated the importance of NBS in Mediterranean cities, showing how green infrastructure enhances climate adaptation. Similarly, Croce et al. (2021) explore the impact of green roofs and permeable pavements, clearly stating how urban surface modifications can improve climate resilience.

Urban resilience also applies to public health and sanitation. Climate risks exceed water, sanitation, and hygiene (WASH) systems vulnerabilities, demanding integrated climate adaptation strategies. Marcus (2023) explores barriers in aligning public health policies with climate-resilient WASH initiatives, particularly in the Lake Victoria Basin.

Innovative urban design approaches are also becoming increasingly valuable for climate resilience planning. Kraus and Scharf (2019) present a Vienna-based case study showing how GREENPASS technology complements and enables climate-sensitive urban architecture. Also, Mitchell et al. (2015) state the importance of combining land governance with urban sustainability to ensure that climate adaptation is embedded within long-term urban planning.

3.3 Similarities and Differences in Global Approaches

The literature surveyed for this study exhibits both similarities and differences in thematic focus, methodological approaches, and regional representation. The studies can be categorized into five major themes based on their contributions to climate-resilient urban development, as shown below:

There are 12 studies, viz 1, 3, 5, 7, 11, 12, 19, 20, 22, 23, 27, and 30, provide detailed discussions on conceptual models and assessment methodologies used to evaluate climate resilience in urban settings. These studies present theoretical and empirical insights into resilience planning.

Participatory Planning & Community Engagement – Six strides, viz. 2, 4, 6, 14, 15, and 26, focus on community participation, stakeholder consultation, and inclusive urban development in climate adaptation strategies. They present how decentralized decision-making enhances resilience.

Climate Governance & Policy Evaluation – 5 studies, viz. 8, 10, 16, 21, and 25, explore governance structures, legal frameworks, and policy enforcement mechanisms. These studies examine how national and municipal governments integrate climate resilience into urban governance models.

Empirical Case Studies & Regional Focus – There are a total of 4 studies, viz. 9, 12, 17, and 24, that analyze climate resilience strategies through city-specific case studies from various regions across the globe, such as Latin America, Southeast Asia, and Southern Africa, providing real-world evidence of adaptation efforts.

Socio-Ecological Models & Ecosystem Vulnerabilities – 3 studies, viz. 13, 18, and 28, use integrated socio-ecological models to assess urban vulnerabilities, presenting the interplay between environmental, social, and economic factors in climate resilience

planning.

Despite thematic overlaps, the reviewed studies in the paper differ in regional focus, methodological approach, and resilience strategies as shown below:

Regional Focus: Some studies, such as 2, 8, 9, and 24, deal with case studies from Latin America, Southern Africa, and Southeast Asia, whereas some others, such as 5, 13, and 22, explore European resilience frameworks, such as in Paris and Vienna.

Methodological Approaches: Several studies, such as 1, 7, and 19, depend on mathematical models and spatial analysis, whereas some other studies, such as 3, 4, and 6, discuss participatory methods and community-driven adaptation strategies.

Sector-Specific Focus: The studies, such as 9, 12, and 20, examine the role of urban health, WASH (water, sanitation, and hygiene) systems, and cross-sectoral planning, whereas some others, such as 1, 15, and 28, discuss green infrastructure, ecosystem services, and urban greening.

Governance vs. Technological Approaches: Articles 8, 10, and 18 explore policy implementation and legal frameworks, whereas 17 and 22 discuss technical urban planning systems and municipal regulations.

Nature-Based vs. Technological Innovations: Some studies, such as 2, 3, and 13, examine nature-based solutions (NBS) such as green roofs and urban parks, whereas others, such as 15 and 21, discuss smart cities, eco-city models, and digital simulation tools as urban adaptation solutions.

While Adobe stated that studies collectively contribute to the discourse on climate resilience, it is important to see how well their findings align with the stated research objectives. The following section presents the paper's key objectives, i.e., identifying governance frameworks, participatory planning mechanisms, and technological solutions, which are systematically addressed by the results.

The study aims to identify key governance structures, participatory planning mechanisms, and technological solutions in climate-resilient urban development. The findings have systematically categorized the various studies into policy-based adaptation strategies, community engagement in resilience planning, and technology-driven climate adaptation solutions, ensuring they align well with the study's objectives. To provide a brief and structured overview, the Table 3 maps the research objectives to specific studies, showing how the findings support the study's objectives.

Objective	Supporting Findings	Key References
Identify major governance frameworks	Policy-based adaptation strategies	Plessis et al. (2023), Hossain et al. (2024)
Assess participatory planning	Role of community engagement	Hardoy et al. (2019), Tran et al. (2014)
Explore technological and nature-based solutions	GIS tools, Green-Blue Infrastructure	Verde et al. (2024), Rau (2024)
Address research gaps in the Global South	Lack of studies on African and South Asian cities	Kasusu et al. (2024), Plessis et al. (2023)

Tab. 3 - Mapping of Study Objectives to Supporting Research Findings in Climate-Resilient Urban Development
This Table links the core objectives of the current study with the themes and findings from selected literature, highlighting governance frameworks, community participation, technological interventions, and regional research gaps. (Source: Authors' synthesis based on reviewed literature)

Urban resilience indicators (Hossain et al., 2024) have been identified as crucial in monitoring policy effectiveness and ensuring that climate adaptation measures are data-driven and measurable. Also, the importance of participatory governance models has been stressed with studies showing that bottom-up governance structures (Hardoy et al., 2019; Tran et al., 2014) lead to higher success rates in resilience-building efforts.

Based on the research gaps identified in governance structures, participatory models, and technological advancements, there is a need for further research and exploration. The following hypotheses can be framed in order to serve as a foundation for future research:

Hypothesis 1: Cities that implement bottom-up governance structures will show higher resilience to climate impacts as witnessed by participatory planning studies (Hardoy et al., 2019; Tran et al., 2014).

Hypothesis 2: Combining nature-based solutions (NBS) with digital simulation tools will enhance the effectiveness of urban adaptation strategies, as witnessed in studies on Green-Blue Infrastructure (Rau, 2024) and GIS-based assessments (Verde et al., 2024).

Hypothesis 3: Developing countries need localized policy frameworks rather than replicating models from the Global North, as recommended by governance gaps identified in Plessis et al. (2023) and Kasusu et al. (2024).

3.4 Timeline of Publications

The emergence of research on climate-resilient urban development has been through a distinct trajectory, seeing a shift from early conceptual models to quantitative and interdisciplinary frameworks over time, as shown below:

The period from 2014 to 2017 saw the early conceptualization and community consultation phase. During this time, research mainly focused on community-driven adaptation strategies and local governance frameworks. A notable study during this time by Tuan Anh Tran et al. (2014) has explored community consultation in climate-resilient housing in Vietnam, specifically dealing with the role of local participation in shaping urban resilience.

The period from 2018 to 2020 saw the Governance & Policy Integration phase. During this phase, studies expanded into land governance, participatory planning, and urban public health. Research focused on municipal decision-making processes and dealing with the role of governance structures in climate resilience (Mitchell et al., 2015; Hardoy et al., 2019).

The period of 2021–2022 saw the Quantitative & Data-Driven Approaches drive phase, where a shift was seen towards empirical modeling and vulnerability assessments. Zifeng Liang (2021) applied difference-in-differences modeling to study the climate-resilient city construction in China, marking a transition toward quantitative analysis in

resilience planning.

The period of 2023–2024 witnessed an interdisciplinary and integrated Resilience Strategies phase. Recent studies emphasized public health, ecosystem-based adaptation, and sustainable urban design. Research in Southern Africa and Latin America also explored localized adaptation models, bridging environmental, social, and infrastructural resilience strategies (Plessis et al., 2023; Hossain et al., 2024).

3.5 Analysis of Journals and Articles

The systematic review covers a diverse range of peer-reviewed journals, each contributing to understanding climate-resilient urban development. The distribution of articles across different journals, along with their key thematic areas and research priorities, is shown below (Tab. 4).

The dominance of governance and participatory planning studies within the journals listed in the Table above, such as Journal of Environmental Policy & Planning and Cities, denotes the growing emphasis on institutional adaptation mechanisms and stakeholder involvement. Meanwhile, technological and data-driven approaches have also become prevalent in urban sustainability-focused journals, such as Urban Climate and Sustainable Cities and Society. These findings present that climate-resilient urban development research is interdisciplinary, combining inputs from policy studies, environmental science, and urban planning.

Journal Name	Number of Articles	Key Research Themes
Sustainable Cities and Society	6	Integrating climate resilience into urban policies
Urban Climate	5	Climate adaptation strategies in urban planning
Journal of Environmental Policy & Planning	4	Governance frameworks for climate resilience
Cities	4	Participatory planning & community-driven adaptation
Environmental Research Letters	3	Urban climate vulnerability assessments
Urban Sustainability	2	Green infrastructure & ecosystem-based adaptation
International Journal of Urban Planning	2	Urban governance & regulatory mechanisms

Tab. 4 - Top Journals Publishing on Climate-Resilient Urban Development and Their Thematic Contributions
This Table presents the distribution of the 38 reviewed articles across peer-reviewed journals, highlighting the dominant thematic areas addressed by each publication outlet. (Source: Authors' compilation based on systematic literature review)

4. Conclusion and Future Directions

This systematic literature review underlines the increasing academic focus on climate-resilient urban development, with key focus areas such as governance frameworks, participatory planning, and technological innovations as key pillars of urban adaptation. Over the years, the research landscape has evolved from conceptual discussions on urban resilience to empirical and data-driven approaches that combine climate adaptation strategies into urban governance. The review presents that while governance and policy-based solutions have gained utmost attention, emerging trends point toward a growing interest in nature-based solutions (NBS), digital risk assessment tools, and interdisciplinary resilience strategies.

Despite all these advancements, several critical gaps remain in the literature. First, the research on climate resilience is heavily concentrated in North America and Europe, while cities in the Global South, such as Africa and South Asia, remain underrepresented (Kasusu et al., 2024). Given these regions' unique urbanization patterns and climate vulnerabilities, future research must focus on context-specific adaptation strategies rather than applying Global North models universally. Second, although urban health systems play a crucial role in climate resilience, there is limited integration of public health considerations within climate adaptation frameworks. Issues such as WASH (Water, Sanitation, and Hygiene) infrastructure and climate-induced health risks are often sidelined in resilience planning (Marcus, 2023), necessitating further exploration of cross-sectoral approaches incorporating health and urban climate governance.

Also, technological advancements in AI, GIS-based risk assessments, and digital simulation tools remain underutilized in urban resilience research and policy implementation. While some studies (e.g., Verde et al., 2024) highlight the potential of data-driven adaptation strategies, their practical application in real-world policymaking remains limited. Future research should explore how emerging smart city technologies can enhance climate adaptation efforts and strengthen urban resilience through predictive modeling and automated decision-making processes.

From a policy perspective, the findings of this study suggest several key recommendations for urban planners, decision-makers, and climate policymakers. First, strengthening governance frameworks is essential to institutionalizing climate resilience at the local and national levels. Cities must develop adaptive governance models that utilize climate risk assessments in urban policy decisions while ensuring regulatory coherence across sectors. Second, enhancing community participation in climate adaptation planning is crucial. Research shows that bottom-up governance structures and collaborative decision-making yield higher success rates in resilience-building efforts (Hardoy et al., 2019; Tran et al., 2014). Policymakers must create mechanisms for local stakeholder engagement, particularly in marginalized communities disproportionately affected by climate risks.

Also, using technology-driven and nature-based adaptation strategies should be a

priority. Cities must integrate digital risk assessment tools, AI-based climate forecasting, and NBS such as urban green infrastructure into their long-term resilience plans. Investing in climate-smart infrastructure that combines green and grey solutions can significantly enhance urban resilience while providing co-benefits for public health, biodiversity, and social equity.

This study presents the multidimensional nature of climate-resilient urban development, requiring an interdisciplinary approach that merges governance, community engagement, technological innovation, and ecological restoration. Although significant progress has been made in developing policy frameworks and adaptation strategies, future research must bridge the gaps in geographical representation, health-climate linkages, and digital resilience tools. By adopting localized, evidence-based, and inclusive adaptation approaches, cities worldwide can build sustainable and climate-resilient urban futures that effectively respond to evolving environmental challenges.

Appendix A: Reviewed Literature on Climate-Resilient Urban Development

Sr. No.	Literature	Aim
1	David Mitchell, Stig Enemark, Paul Van Der Molen - <i>Climate Resilient Urban Development: Why Responsible Land Governance is Important</i> (2015)	To discuss how rapid urbanization and climate change increase vulnerability in urban areas, focusing on the role of responsible land governance and land-use planning in promoting resilience and reducing vulnerabilities in less-developed nations.
2	Tuan Anh Tran, Tran Phong, Martin Mulenga - <i>Community Consultation for Climate Resilient Housing: A Comparative Case Study in Vietnam</i> (2014)	To examine the role of community consultation in developing resilient housing through case studies in Hue and Da Nang, Vietnam, highlighting gaps in urban governance and the importance of social relationships for resilience.
3	Wiriya Puntub, Stefan Greiving - <i>Advanced Operationalization Framework for Climate-Resilient Urban Public Health Care Services</i> (2021)	To propose a framework combining collaborative scenario planning and composite indicators to assess public health services' climate resilience in Khon Kaen, Thailand, emphasizing urban development and climate interactions.
4	Jorgelina Hardoy, Ebru Gencer, Manuel Winograd - <i>Participatory Planning for Climate Resilient and Inclusive Urban Development</i> (2019)	To highlight participatory planning methods in Latin America's small- and medium-sized cities to develop inclusive, climate-resilient urban development strategies through engagement with local stakeholders.

Tab. A1 - Summary of Reviewed Literature on Climate-Resilient Urban Development
This Table provides an overview of the 38 selected studies, summarizing key authors, publication years, and research aims relevant to climate-resilient urban development. (Source: Authors' compilation based on systematic literature review)

Sr. No.	Literature	Aim
5	Nicola Addabbo, Maria Fabrizia Clemente, Laura Quesada Ganuza, Riwa Abdel Khalek - <i>A Framework for Climate Resilient Urban Design: The Case of Porte de Montreuil, Paris</i> (2023)	To propose a methodological framework integrating climate impact analysis and local community needs to promote adaptation, mitigation, and resilience in Paris's Porte de Montreuil district.
6	Zipan Cai, Jessica Page, Vladimir Cvetkovic - <i>Urban Ecosystem Vulnerability Assessment for Climate-Resilient City Development</i> (2021)	To introduce a socio-ecological modeling approach using Geo-ICT to assess urban ecosystem vulnerability, applied to Nanjing, China, supporting urban resilience through data-driven policy and planning.
7	Zifeng Liang - <i>Assessment of the Construction of a Climate Resilient City: An Empirical Study Based on the Difference in Differences Model</i> (2021)	To empirically assess climate-resilient city construction using a difference-in-differences model, focusing on the interaction of urban policies and environmental change.
8	Anél Plessis, Nicolene Steyn, John Rantlo - <i>City-Level Law and Action for Climate-Resilient Development in Southern Africa</i> (2023)	To review eight cities in four southern African countries and evaluate how local governments utilize their powers for climate-resilient urban development, analyzing political and legislative efforts in climate adaptation and mitigation.
9	McEvoy, D., Iyer-Raniga, U., Ho, S., Mitchell, D., Jegatheesan, V., Brown, N. - <i>Integrating Teaching and Learning with Inter-Disciplinary Action Research in Support of Climate Resilient Urban Development</i> (2019)	Combine teaching and interdisciplinary action research to address urban challenges and enhance the Solomon Islands' adaptive capacity.
10	Marcus, H. - <i>Engaging the Health Sector in Climate-Resilient WASH Development</i> (2023)	To analyze barriers to integrating public health in climate-resilient WASH development, focusing on the Lake Victoria Basin, and suggest interdisciplinary collaborations for better adaptation outcomes.
11	Kraus, F., Scharf, B. - <i>Climate-Resilient Urban Planning and Architecture with GREENPASS Illustrated by the Case Study 'FLAIR in the City'</i> (2019)	To describe the GREENPASS technology for climate-resilient urban planning and its application in Vienna's first GOLD-certified residential building, focusing on green infrastructure's impact on thermal comfort, water retention, and carbon sequestration.

Sr. No.	Literature	Aim
12	David Mitchell, Stig Enemark, Paul Van Der Molen - <i>Climate Resilient Urban Development</i> (2015)	To propose ways that responsible governance of land tenure and effective land-use planning can reduce vulnerability, improve environmental sustainability, and support climate-resilient urban development.
13	Nicola Addabbo et al. - <i>A Framework for Climate Resilient Urban Design</i> (2023)	To propose a methodological framework integrating climate impact analysis with local planning priorities for resilient urban design, applied to Paris's Porte de Montreuil redevelopment.
14	Silvia Croce et al. - <i>Urban Surface Uses for Climate-Resilient and Sustainable Cities</i> (2021)	To review urban surface solutions and their environmental, social, and economic benefits in creating sustainable, resilient cities.
15	Zipan Cai et al. - <i>Urban Ecosystem Vulnerability Assessment for Climate-Resilient City Development</i> (2021)	To present an approach using socio-ecological modeling and Geo-ICT tools for assessing urban ecosystem vulnerability in Nanjing, China, to aid climate-resilient urban planning.
16	Mattia Leone, Jeffrey Raven - <i>Multi-Scale and Adaptive Mitigation Design for Climate-Resilient Cities</i> (2018)	To develop design methods addressing urban resilience through sustainable urban regeneration and retrofitting strategies across different scales.
17	Jorgelina Hardoy et al. - <i>Participatory Planning for Climate Resilient Urban Development</i> (2019)	To engage local governments in participatory planning for developing climate-resilient strategies in small-to-medium Latin American cities.
18	Anél Plessis et al. - <i>City-Level Law and Action for Climate-Resilient Development in Southern Africa</i> (2023)	To assess how local governments utilize legal powers for climate resilience and analyze challenges in governance strategies in Southern African cities.
19	Serene Ho et al. - <i>Community Profiling for Inclusive Urban Climate Adaptation</i> (2022)	To describe methods for gathering contextual data for inclusive climate-resilient urban planning, focusing on marginalized communities in the Solomon Islands.
20	Tendai Kasusu et al. - <i>Navigating Urban Planning and Management in Africa</i> (2024)	To explore evolving urban development frameworks in Africa, focusing on climate resilience and sustainable policies for cities.
21	Md. Maruf Hossain et al. - <i>Identification and Prioritization of Climate-Resilient Urban Governance Indicators</i> (2024)	To identify key indicators for urban governance that enhance accountability and climate resilience in Bangladesh.

Sr. No.	Literature	Aim
22	Sara Verde et al. - <i>Environmental Data, Modeling, and Digital Simulation for Evaluating Climate Adaptation Strategies</i> (2024)	To present workflows and protocols for evaluating urban adaptation strategies through digital modeling, with a case study of Marianella in Naples.
23	Hannah Marcus - <i>Engaging the Health Sector in Climate-Resilient WASH Development</i> (2023)	To explore barriers hindering the health sector's role in developing climate-resilient water, sanitation, and hygiene (WASH) systems in the Lake Victoria Basin.
24	Joshua Long, Jennifer L. Rice - <i>From Sustainable Urbanism to Climate Urbanism</i> (2018)	To critically assess the transition from sustainable urbanism to climate urbanism, focusing on social justice and urban climate action challenges.
25	Thomas Tanner et al. - <i>Urban Governance for Adaptation: Resilience in Ten Asian Cities</i> (2009)	To evaluate governance frameworks in Asian cities coping with severe climatic risks and building resilience.
26	Zifeng Liang - <i>Assessment of the Construction of a Climate Resilient City: An Empirical Study Based on the Difference in Differences Model</i> (2021)	The effect of the pilot policy of "Climate Resilient Cities" on regional climate resilience in China will be evaluated using the Difference in Differences model.
27	Jiale Yan - <i>Climate Governance and Industrial Ecological Transformation</i> (2024)	To explore the impact of climate governance actions on industrial ecological transformation, primarily through the climate-resilient city construction pilot policy.
28	Stefan Rau - <i>Climate Resilient Sponge Cities – Concepts and Tools to Integrate Green-Blue and Grey Systems</i> (2024)	To discuss integrating green-blue infrastructure with grey systems for urban resilience against flooding, heat, and other climate-related hazards.
29	Marielisa Padilla, Sophie Mok, Brenda Vaccari Paz - <i>Using Nature-Based Solutions to Create More Climate-Resilient, Green and Livable Mediterranean Cities</i> (2020)	To examine the use of Nature-Based Solutions (NBS) to enhance climate resilience and livability in Mediterranean cities like Castellón and Cannes.
30	Romana Stollnberger, Ernst Gebetsroither-Geringer, Ulrike Magerl - <i>Integrated Qualitative and Quantitative Analysis of Causal Urban Food-Water-Energy Relations towards More Climate-Resilient Cities</i> (2020)	To analyze the interrelations among food, water, and energy sectors and their integration to enhance urban climate resilience.

Sr. No.	Literature	Aim
31	Jobin Josh - <i>Importance of Reclamation of Post-industrial Areas Near Cities, Challenges to Overcome, and How It Changes City into Smart Cities</i> (2022)	To explore the reclamation of post-industrial areas and their role in transforming cities into eco-efficient, smart cities.
32	Eleanor Tonks, Sean Lockie - <i>Urban Transformation: From Single-Point Solutions to Systems Innovation</i> (2020)	To advocate for systems innovation in urban transformation to face climate change, focusing on low-carbon solutions and applying nature-based solutions.
33	Liz Root, Erwin van der Krabben, Tejo Spit - <i>Bridging the Financial Gap in Climate Adaptation: Dutch Planning Through a New Institutional Lens</i> (2015)	To examine spatial planning mechanisms for funding climate-resilient infrastructure.
34	Katrin Hagen et al. - <i>How to Make Existing Urban Structures Climate-Resilient?</i> (2021)	To discuss retrofitting strategies for dense urban areas with green and blue infrastructure.
35	Parfait Iradukunda et al. - <i>Integrated Multicriteria Decision Analysis in Climate-Resilient Infrastructure Development</i> (2023)	To review decision-making approaches for developing resilient infrastructure in flood-prone areas.
36	Arman Hashemi - <i>Climate Resilient Low-Income Tropical Housing</i> (2016)	To evaluate construction strategies for climate-resilient, low-income housing in tropical areas.
37	Tuan Anh Tran et al. - <i>Community Consultation for Climate Resilient Housing</i> (2014)	To examine community involvement in designing climate-resilient housing in post-disaster scenarios.
38	R Fleck et al. - <i>Urban Green Roofs to Manage Rooftop Microclimates: A Case Study from Sydney, Australia</i> (2022)	To study the performance of green roofs in mitigating urban heat island effects.

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