RESEARCH PAPER

KNOWLEDGE CO-PRODUCTION PRACTICES TO PROMOTE CLIMATE RESILIENCE IN GLOBAL CITIES: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT. Climate change presents complex challenges for cities worldwide, requiring innovative and collaborative approaches to enhance resilience and adaptability. In response to this phenomenon, knowledge co-production plays a vital role in integrating diverse perspectives to address climate-related risks and promote adaptive urban environments. This research aims to investigate current consensus on how knowledge co-production is operationalised, particularly in climate resilience and urban settings. This study follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol to identify, screen, and analyse relevant publications systematically. A total of 36 publications were reviewed to examine the types of disturbances, the dimensions of stakeholder engagement, and current practices of knowledge co-production. The findings highlight the growing significance of knowledge co-production in addressing climate-related challenges through strong stakeholder engagement, local knowledge integration, and effective science–policy interfaces. Moreover, these processes require balanced and meaningful participation among all stakeholders, particularly local community involvement, to ensure that initiatives can be scaled up and become systemic rather than fragmented.

KEYWORDS: knowledge co-production; climate resilience; city resilience; systematic literature review

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INTRODUCTION

Climate change has become an increasingly significant global concern, particularly as rapid urbanisation accelerates the growth of cities worldwide. The number of global megacities rose from 10 in 1990 to 34 in 2023 (Statistisches Bundesamt 2023). The urban population increased from 1 billion in 1960 to 4.6 billion in 2023, around 57.34% of the world's population, with more than half residing in the Asia and Pacific region (World Bank 2024; Asian Development Bank 2022). These cities are often located near rivers and coastlines. This makes them more prone to various climate-related risks (Handayani et al. 2020; Rudiarto et al. 2018) and contributes to the emergence of wicked urban problems.

Resilience appears as a promising concept for cities that require more robust and adaptive strategies to address complex urban problems. It is defined as the ability of an ecological system to maintain its functionality or persist under change (Holling 1973). Furthermore, Folke et al. (2011) explained it as the capacity of systems to adapt across different time and space scales. Attention to resilience in urban settings has grown in both academic and policy discussions, particularly as cities seek to maintain resilience during rapid urban development (Wang and Xue 2018). Meerow et al. (2016) described urban resilience as the capacity of cities to respond to specific threats, such as climate change or flooding, while also addressing broader systemic risks. Moreover, resilience greatly depends on how communities manage economic and social pressures and recover from them effectively (Handayani et al., 2019; Walisser et al., 2005).

Building urban resilience requires a transdisciplinary perspective that integrates social, economic, cultural, and physical dimensions (Jabareen, 2013). This approach also helps address challenges such as unclear roles and weak stakeholder commitment while fostering stronger

collaboration (Krellenberg & Barth, 2014; Matsuura & Razak, 2019). In this context, knowledge co-production plays a vital role in integrating diverse perspectives to address climate-related risks and promote adaptive urban systems (Ambole et al., 2019; Dunn et al., 2017; Aguilar-Barajas et al., 2019).

In the last decade, knowledge co-production has become more widely recognised as an approach to address complex problems linked to climate change and urbanization (Visconti 2023; Djenontin and Medow 2018). This growing interest is driven by the increasing need for decision-makers to navigate complex problem contexts involving diverse stakeholders (Culwick et al. 2019). Urban Living Labs (ULLs) have become one of the most practical forms of knowledge co-production, providing an experimental platform where stakeholders, researchers and policymakers collaboratively design, test and refine innovative urban solutions in real-life contexts (Voytenko et al. 2016; Nesti 2018).

This paper presents a systematic review of knowledge co-production to examine its epistemological, methodological, and practical aspects in promoting climate resilience in global cities. The systematic review follows guidelines from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Page et al., 2021a; Page et al., 2021b). The term 'knowledge co-production' is, however, relatively new in city planning and city resilience strategy. Accordingly, this research aims to identify current consensus on how knowledge co-production is operationalised, particularly in climate resilience and urban settings. Given the above background, three critical questions guide the review: (1) to what extent do current practices of knowledge co-production in global cities promote climate resilience, (2) what levels of stakeholder engagement are involved, and (3) what types of climate-related disturbances are addressed and how.

The structure of this study is organised into several parts. First, the introduction provides background context for the systematic literature review of knowledge co-production. Second, the literature on urban resilience and the development of knowledge co-production is summarised. Third, the methods section offers a brief explanation of the PRISMA framework and its application in this review. The results then present findings that address the three proposed questions. Finally, the discussion highlights trends in the use of knowledge co-production for urban resilience and offers concluding reflections.

LITERATURE REVIEW: RESILIENCE AND KNOWLEDGE CO-PRODUCTION

Resilience is often linked to the disturbance it seeks to address. Meerow et al. (2016) define resilience in an urban setting as the capacity of a city and its urban systems to absorb initial damage, reduce impacts from a disturbance, adapt to change, and modify systems that constrain current or future adaptive capacity. Ribeiro and Gonçalves (2019) define disturbances as events that occur during the process of reaching equilibrium. Disturbances can include natural disasters, climate conditions, calamities, crises, and disruptive events. Moreover, Ribeiro and Gonçalves (2019) define city resilience as a structure that consists of the capacity of the city to absorb initial impacts, reduce disturbance effects, adapt to change, and rapidly modify systems that limit the current or future adaptive capacity of its urban systems. There is a broad consensus that cities must become resilient to a wider range of shocks and stresses, particularly in terms of preparedness to address climate change challenges. Climate change is one of many stresses that cities face, creating an urgent need to build resilience (Leichenko 2011). In this study, disturbances are used as a framework for assessing how knowledge co-production supports urban resilience in the face of climate-related issues.

Knowledge co-production emerged from the introduction of Mode 2 science. This approach emphasises transdisciplinary methods and the inclusion of various stakeholders and experts (heterogenomy). Mode 1 and Mode 2 represent different ways of producing knowledge and conducting research (Nowotny, Scott, and Gibbons 2003). The change from the traditional, discipline-focused Mode 1 to the dynamic, socially distributed, and application-focused Mode 2 indicates an increasing emphasis on producing knowledge for practical use.

Knowledge co-production is a collaborative process where diverse expertise and actors come together to create context-specific knowledge tailored for sustainability research (Norström et al. 2020). It is guided by four fundamental principles: context-based, pluralistic, goal-oriented, and interactive processes, which serve as the foundation for high-quality co-production initiatives (Djenontin and Meadow 2018). The evolution of knowledge co-production reflects its emergence as a strategic response to the complex challenges of modern society. There is a notable trend towards the active participation of non-academic stakeholders in research endeavours (Norström et al. 2020). This shift highlights the growing recognition of the importance of engaging a wide range of perspectives and knowledge systems to effectively tackle sustainability issues and foster holistic solutions.

Collaboration between academics and non-academics is a cornerstone of successful knowledge co-production. This approach emphasises the value of integrating diverse viewpoints and expertise to address sustainability challenges. By bringing together different actors and knowledge domains, co-production processes can harness collective wisdom and insights, which are necessary to navigate complex sustainability issues and drive positive change. Practical guidance in the literature also offers researchers, practitioners, and funders a roadmap for meaningful engagement in co-productive practices and a framework for assessing the effectiveness and impact of such collaborative efforts (Norström et al. 2020). In this study, knowledge co-production is assessed by analysing the knowledge produced through the project, the initiator, and the stakeholders involved in the co-production.

Knowledge co-production principles, such as co-defining problems, integrating diverse knowledge sources, and fostering iterative, two-way engagement (Djenontin and Meadow 2018), are central to the operation of Urban Living Labs (ULLs). Within ULLs, co-creation processes combine formal and informal participation. They may involve shared or selective ownership and are supported by a mix of intrinsic and extrinsic incentives (Puerari et al. 2018). These arrangements help bridge the gap between policy and practice, ensuring that interventions respond more effectively to local needs.

European examples illustrate the role of ULLs in climate adaptation and mitigation. In Amsterdam, a citizen-led air-quality monitoring project has been established, while in Turin, environmental sensors support community-based action (Nesti 2018). In Naples, participatory mapping and design workshops aligned scientific risk assessments with community priorities, addressing socio-spatial vulnerabilities and shaping municipal regeneration plans (Visconti 2023). Experiences from the Global South provide further insight: in Johannesburg, CityLabs demonstrate how long-term partnerships and iterative engagement can embed resilience thinking, even in resource-constrained environments (Culwick et al. 2019).

METHODS

Systematic Literature Review Process

The systematic literature review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020). This protocol is designed to enhance transparency, consistency, and comprehensiveness in systematic reviews. By adhering to PRISMA, researchers ensure their reviews are conducted and reported with high methodological rigour. The protocol encourages authors to provide detailed information about the review's design, search strategy, selection criteria, data extraction, and synthesis methods. The inclusion of PRISMA in systematic review reporting serves as a valuable tool, promoting clarity in research communication, aiding in the critical evaluation of studies, and ultimately contributing to the reliability and credibility of evidence-based decision-making processes.

Publications included in the review were identified using the Scopus database. The search was conducted using interchangeable keywords: 'knowledge co-production' or 'co-production of knowledge'. The data collection criteria were as follows:

- Search within: Article title, Abstract, Keywords
- Publication years: earliest date possible to May 2025
- Subject area: Social Sciences, Environmental Science, Earth and Planetary Sciences
- Document type: Article, Book chapter, Conference paper
- Language: English

Search Query

In May 2025, a search query was conducted in Scopus using the keywords 'knowledge co-production' OR 'co-production of knowledge.' Publication years ranged from the earliest date available to 2025. The search was limited to titles, abstracts, and keywords (TITLE-ABS-KEY) and restricted to journal articles, book chapters, and conference papers. Table 1 outlines the criteria for article inclusion and exclusion.

Search Results

The query yielded 1053 records on the Scopus website. Further screening was performed to remove irrelevant records based on the predefined criteria. A single keyword was used because most relevant papers would have been excluded if additional inclusion criteria keywords were applied, which would lead to more irrelevant results. The initial screening was conducted using the base keywords 'knowledge co-production' or 'co-production of knowledge' in the abstract, keywords, or title. The results were then filtered to include only articles that mentioned urban areas as the study location.

The records were checked for duplicates, and four duplicates were removed (see Figure 1). The remaining records were then checked against the predefined criteria for title and keywords, which resulted in the removal of 958 records. The remaining records (n = 91) were screened using the abstract within the set criteria, and 42 additional records were excluded. The final screening involved evaluating full records for accessibility through open access or institutional subscriptions. Five records that were inaccessible were excluded. The final set of 36 records was selected for the analysis.

The final selection of 36 publications was analysed to answer the research questions and categorised into four areas: types of disturbance; stakeholder engagement; current practices of knowledge co-production; and produced knowledge. The list of reviewed publications with brief summaries is presented in Appendix 1.

RESULTS

General Observations

From the initial pool of 1053 publications, knowledge co-production publications first appeared in 2002 and began to rise in the early 2010s. The distribution of publications per year is shown in Figure 2. Approximately 66% of these were published in the past five years (2020–2025), indicating the recent recognition of the importance of knowledge co-production in environmental research. The trend in publications related to knowledge co-production has increased steadily, with notable growth after 2013.

All 36 selected publications were journal articles. No book chapters or conference papers met the inclusion criteria. Of these, the most commonly published journal outlets were *Environmental Science and Policy* (8 publications) and *Sustainability* (3 publications). Figure 3 provides an overview of the publication trends of the selected 36 knowledge co-production publications from 2010 to 2023. The number of publications has steadily increased over time, with a significant surge observed in 2016 (4 publications) and peaking in 2022 (5 publications).

This upward trend reflects growing interest and engagement in knowledge co-production within academic discourse. Additionally, a notable increase in publications is observed from 2016 onwards, highlighting a heightened focus on this topic in recent years. These findings demonstrate the evolving landscape of knowledge co-production research and its increasing significance in scholarly discussions. The distribution of case studies also highlights regional differences. Europe accounts for the largest number of cases (26), followed by Africa (22), North America (11), Asia (4), and Oceania (2).

Keyword Linkages

Figure 4 illustrates the frequency and co-occurrence patterns related to knowledge co-production within the scope of the papers examined in this study. The size of a

Table 1. Article inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Base dimensions: Knowledge co-production OR co-production of knowledge **Base criteria:** Scope of topic Climate change Disaster resilience Urban resilience Sustainability study Relevant study mentioning urban area Relevant study mentioning practices of knowledge co-production **Validation criteria:** Relevant study to this paper's research aim and research questions	• Irrelevant publications to research theme (climate change/ resilience/disaster resilience) • Knowledge co-production not in the urban resilience field • Irrelevant study to this paper's research aim and research questions

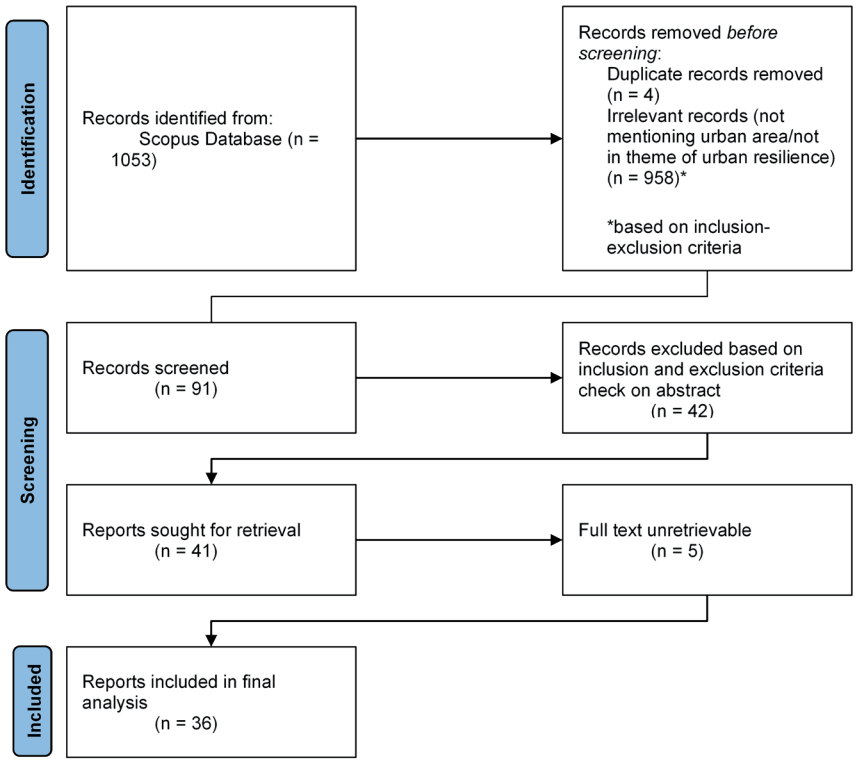

Fig. 1. Literature selection process

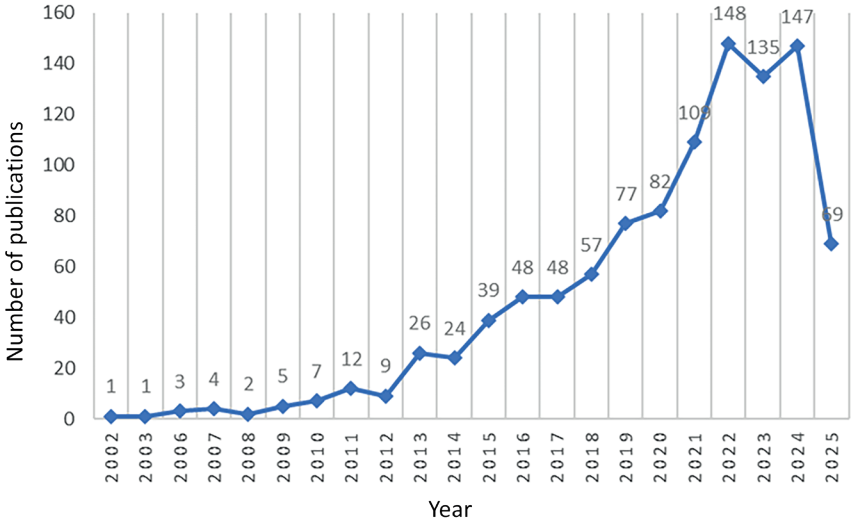

Fig. 2. Number of publications in the initial article pool by year (1,053 publications in total)

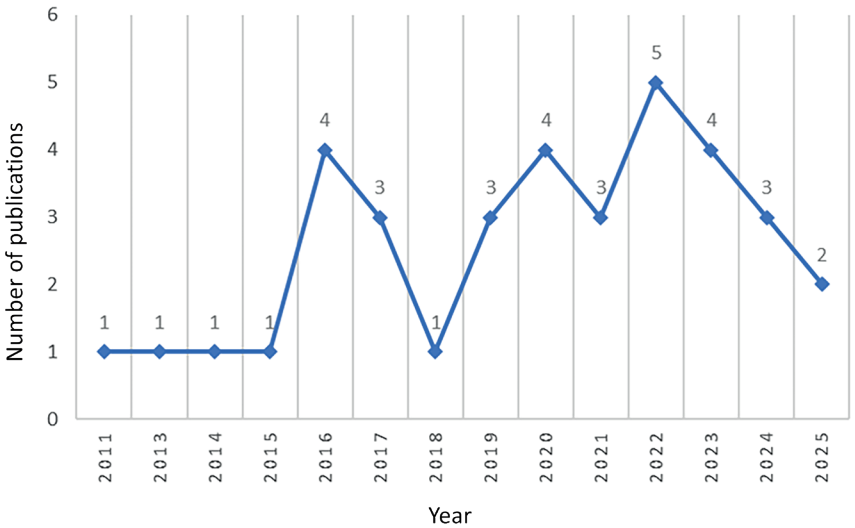

Fig. 3. Distribution of the final set of 36 records included in this study by year

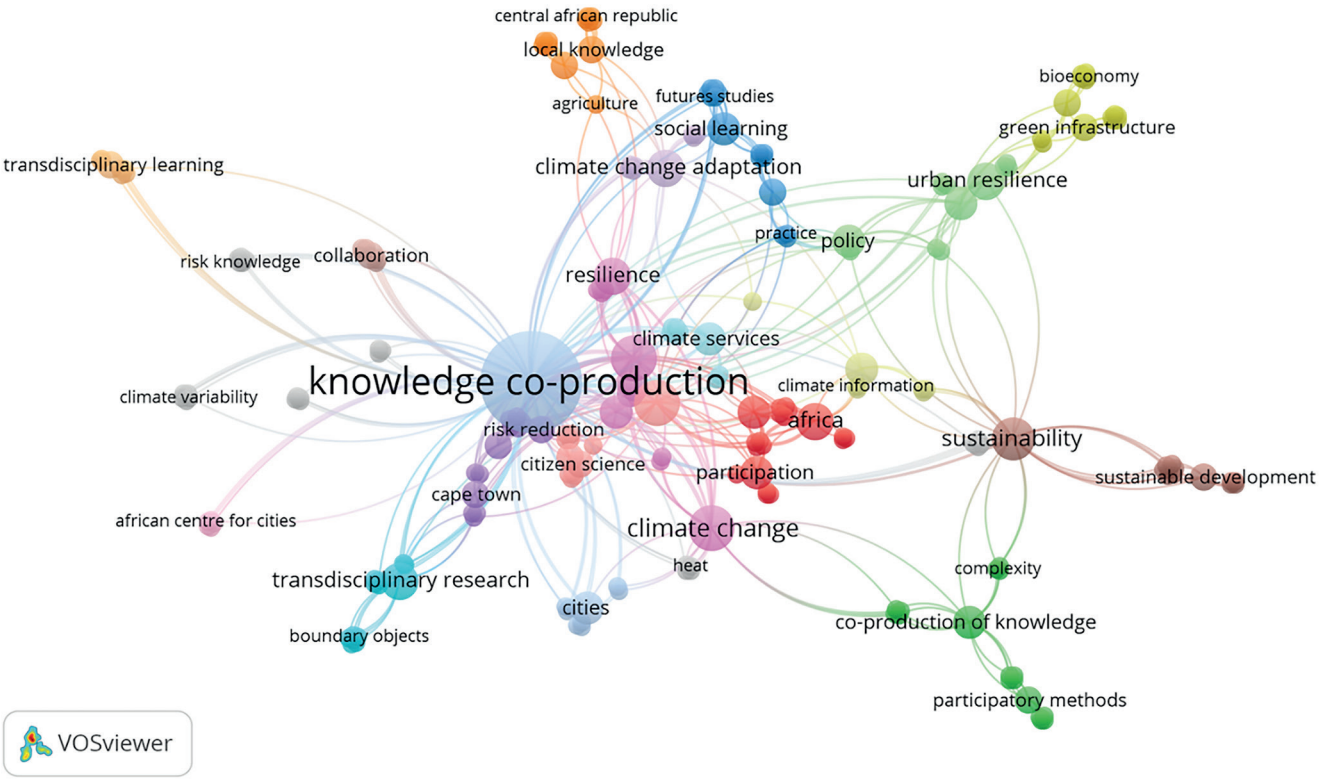

Fig. 4. Keyword linkages

Note: The keyword 'Africa' appears because several authors listed it as a keyword, unlike other locations mentioned only in titles or abstracts.

node represents its degree or frequency, and the edge indicates the frequency of co-occurrence. Research hotspots in knowledge co-production were identified by analysing the co-occurrence of frequent keywords. The minimum co-occurrence number for a keyword was set at 1. This threshold was chosen to highlight frequent keywords, given the relatively small article pool. A total of 232 keywords extracted from the pooled articles were clustered based on their similarities, resulting in 24 clusters.

The network visualisation illustrates the centrality of 'knowledge co-production' within the research landscape, as indicated by its prominent size and position. It is strongly linked to terms such as 'climate change,' 'resilience,' 'participation,' and 'sustainability,' which reflect its thematic relevance to environmental and urban research. Notably, clusters of keywords like 'urban resilience,' 'green infrastructure,' and 'sustainable development' suggest a growing focus on applied outcomes and policy integration. The presence of terms such as 'citizen science,' 'local knowledge,' 'social learning,' and 'transdisciplinary research' reinforces the participatory and collaborative nature of knowledge co-production.

Current Practices of Knowledge Co-Production

Current practices of knowledge co-production involve collaborative efforts between diverse stakeholders. These include researchers, policymakers, practitioners, and community members. Such initiatives aim to address complex environmental challenges effectively. Several tools and frameworks are used to help dialogue, mutual learning, and the co-creation of knowledge. For example, in the context of urban water management and climate change adaptation, frameworks like the Water Sensitive Cities (WSC)concept and the WSC index help assess cities' resilience to climate impacts. These frameworks combine multiple indicators and self-assessment processes, encouraging exchange, mutual learning, and greater awareness among participating cities (Dunn et al. 2017).

Learning networks and joint learning processes are also pivotal. Tools such as community engagement strategies, cross-border cooperation mechanisms, and collective innovation platforms help facilitate knowledge exchange and co-production among diverse actors. For instance, the Sustainable Urban Neighbourhoods (SUN) project in the Euregio Meuse-Rhine (Valkering et al. 2013) uses concerted public and private action to foster community engagement and cross-border cooperation, enabling the exchange and co-production of technical, attitudinal, and innovative knowledge across various boundaries.

Additionally, mapping approaches are increasingly used to identify hot spots for sustainability transitions in cities. This allows stakeholders to visualise and analyse different land-use scenarios and their environmental impacts (Visconti 2023). By communicating the consequences of induced land-use change and identifying areas for transition, mapping helps in informed decision-making and supports stakeholder engagement in co-design processes.

Regional case studies further demonstrate the variety of practices. In Québec, research on multi-loop social learning processes in water governance used semi-structured interviews to identify challenges such as limited capacity and the perceived credibility of organisations. Opportunities to overcome these barriers include renewing partnerships and exploring innovative tools for knowledge co-production (Medema et al. 2015). Similarly, in Chile, the Resilience-Whell tool and participatory methods were applied to address urban drought resilience. Key resilience factors identified include education, preparedness, technology transfer, and citizen participation (Aldunce et al. 2016). This bottom-up approach bridges the science-policy interface and enables the co-production of key knowledge for building resilience. Additionally, in Alleppey, Kerala, India, the CANALPY initiative focuses on capacity building and knowledge co-production to address sanitation challenges. It creates a platform for collaborations, dialogues, and discussions on sanitation, water quality, and pollution, emphasising the importance

of considering practical, socio-political, institutional, and competence-related challenges in knowledge sharing and capacity building (Pillai and Narayanan 2022).

In brief, current practices of knowledge co-production use various tools and frameworks, including assessment methods, collaborative platforms, and mapping approaches. These mechanisms facilitate dialogue, mutual learning, and the co-creation of knowledge among diverse stakeholders. In doing so, they help cities face complex environmental challenges, strengthen resilience, and advance sustainable development through informed decision-making and collective action.

Produced Knowledge in Observed Cities

The knowledge co-production projects from the literature pool showcase a diverse array of insights that come from collaborative endeavours across multiple research domains. Figure 5 summarises the knowledge produced from the selected articles. A recurring theme is the emphasis on stakeholder engagement and inclusive learning. By involving a wide range of stakeholders, such as community members, experts, policymakers, and academics, these projects utilise a wealth of tacit knowledge and expertise. This inclusive approach not only enriches the understanding of various related issues like climate variability, sustainable energy transitions, and urban ecosystem services but also fosters a sense of shared ownership and credibility in the generated knowledge. Through interdisciplinary collaborations and participatory methodologies, these processes have yielded valuable knowledge to address complex challenges and informed decision-making processes in urban environments.

Furthermore, knowledge co-production initiatives have led to the development of practical tools and frameworks for decision-making and policy formulation. From standardised indicator sets for monitoring weather impacts to tailored indicators for assessing urban water systems, these projects have introduced structured methodologies for evaluating resilience, identifying trade-offs, and guiding sustainable urban development practices. This policy-relevant knowledge aligns with decision-makers' needs, enhancing the effectiveness of urban planning and management strategies. Moreover, the collaborative nature of these knowledge co-production projects has not only produced valuable insights into intricate urban challenges but has also nurtured a culture of reflective engagement, critical analysis, and continuous learning. By fostering shared understanding among stakeholders, integrating diverse perspectives, and advocating for transparency and accountability in decision-making processes, the knowledge produced serves as a cornerstone for informed decision-making, strategic planning, and sustainable urban development.

Stakeholder Engagement in Knowledge Co-Production

Edelenbos et al. (2011) highlight that stakeholder engagement in knowledge co-production involves different levels of interaction. At the highest level, significant interactions require open communication and active participation in collaborative activities involving specialists, bureaucrats, and stakeholders. Regular meetings and deliberate efforts to integrate knowledge from diverse domains underscore the commitment to fostering a common understanding. However, a fully supported knowledge base is often challenging to achieve even with these efforts.

In contrast, medium interaction is characterised by one-way communication and strategic or symbolic joint activities. These often lack genuine intent to establish a shared knowledge base. Differences in assumptions and values can hinder meaningful dialogue, resulting in consultative rather than collaborative interaction.

At the lowest level, little or no interaction suggests a lack of engagement. Disagreements and misunderstandings among actors prevent meaningful interactions, leading to a reduction or cessation of joint efforts. In extreme cases, knowledge development occurs in isolation, excluding alternative perspectives and values. Effective stakeholder engagement in knowledge co-production requires concerted efforts to foster open communication, acceptance of diverse viewpoints, and active collaboration towards the creation of a shared knowledge base. However, Edelenbos et al. (2011) do not explicitly address the role of the general public (for example, indigenous people or citizens) in their framework.

The initiation of knowledge co-production varies across projects. Some are led by researchers or academic

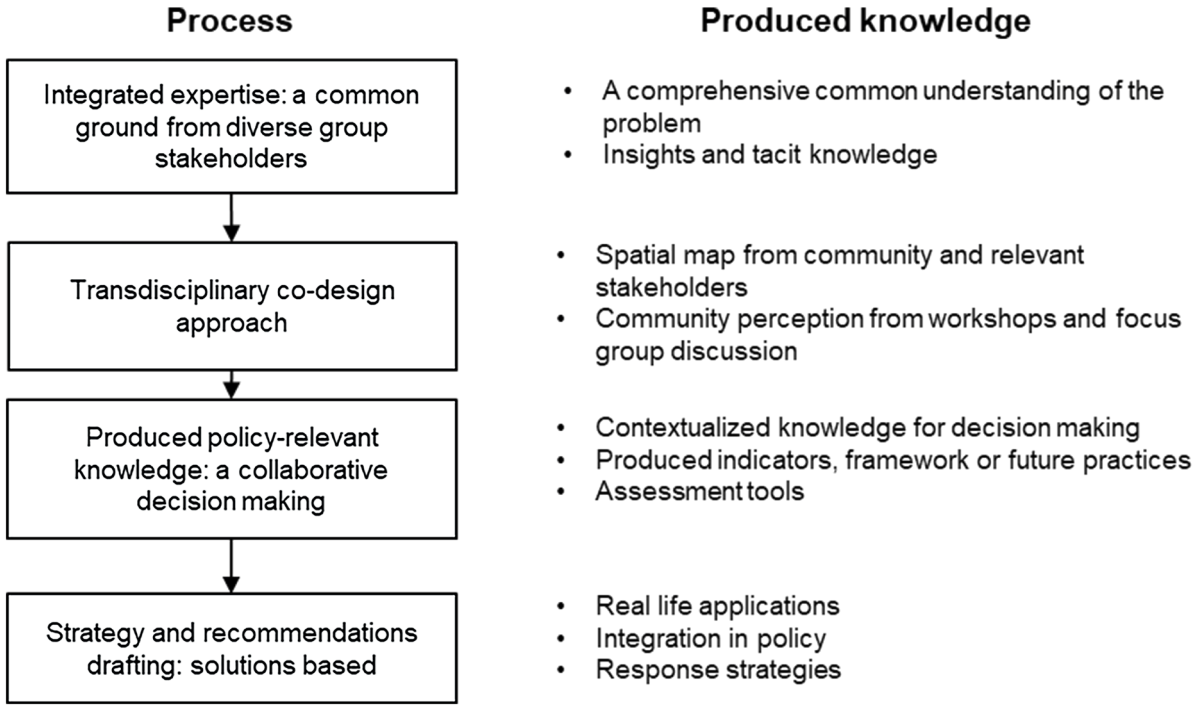

Fig. 5. Produced knowledge based on simplified processes from pooled articles

institutions, while others are spearheaded by government agencies or practitioners (see Figures 6). Out of the 36 articles analysed, 17 papers identify academic institutions and/or research teams as the primary initiators, emphasising their central role in shaping collaborative research agendas and fostering partnerships for sustainable urban development. This prevalence of researcher-led initiatives underscores the importance of academic leadership in promoting knowledge co-production as a transformative approach to addressing complex urban challenges and building resilience in diverse contexts.

Other initiators mentioned in the 36 articles include government agencies (4 papers) and collaborative efforts between government, NGOs, and the private sector (13 papers). Two articles do not specify any initiator, though these projects appear to have been the result of broader collaboration. While 36 publications were analysed, the total number of initiators identified is 37. This is because one publication presented two different case studies with different initiators.

Various studies highlight the importance of engaging stakeholders from different sectors, including government agencies, community stakeholders, and research teams, in the co-production of knowledge. For example, government agencies at the state level, community stakeholders, and project team members are often actively involved in initiatives related to urban resilience (Aguilar-Barajas et al. 2019; Yumagulova and Vertinsky 2019), climate change adaptation (Borquez et al. 2017; Lorencová et al. 2018; Özerol et al. 2020; Nicolletti et al. 2020), and sustainable water governance (Edelenbos et al. 2011; Dunn et al. 2017; Medema et al. 2015; O'Donnell et al. 2020) in different regions such as Canada, Mexico, and the Netherlands (Aguilar-Barajas et al. 2019; Frantzeskaki and Kabisch 2016; Haque et al. 2023; Özerol et al. 2020; Yumagulova and Vertinsky 2019). Together, these stakeholder groups contribute diverse perspectives and expertise, broadening understanding of complex environmental challenges.

Furthermore, the successful integration of stakeholder knowledge with expert and bureaucratic knowledge emerges as a key factor in the co-production process. Studies discuss how practitioners from different sectors, including GIS experts, policymakers, and community representatives, collaborate to develop shared understandings and a common language for decision-making in areas such as urban environmental governance, disaster risk reduction, and climate resilience (Edenlenbos et al. 2011; Tiitu et al. 2021). The interaction between stakeholders with varying backgrounds and expertise levels is recognised as beneficial for creating a more holistic knowledge base and addressing complex problems in climate change, water management, and urban planning.

Moreover, the process of stakeholder engagement in knowledge co-production often involves establishing clear communication channels, conducting regular group meetings, and facilitating transdisciplinary dialogues. Researchers highlight the importance of inclusive approaches that engage a wide range of stakeholders, from scientists to local community members, in discussions and workshops aimed at developing innovative solutions for environmental challenges. By fostering collaboration and knowledge sharing among diverse stakeholder groups, projects in various regions such as Africa, India, and the Philippines have enhanced collective reflection, learning, and innovation development for sustainable urban development and climate adaptation (Tonisson et al. 2020; Edenlenbos et al. 2011).

Types of Disturbances Urban Area Faced in Terms of Resilience

Various types of disturbances affecting urban resilience are discussed, highlighting the multifaceted challenges cities face in building and maintaining resilience. One key type of disturbance is the increasing frequency and intensity of climate-related hazards (see Table 2), such as floods, heatwaves, and storms. These pose significant threats to urban areas (Frantzeskaki and Kabisch 2016). Extreme weather events mentioned in several sources are categorised using the taxonomy based on Stephenson (2008) and Radović (2020). These include tropical cyclones and hurricanes, extratropical cyclones, convective and mesoscale phenomena, floods, drought, heat waves, cold waves/spells, and fog. These hazards not only impact infrastructure and the built environment but also have far-reaching consequences on the social, economic, and

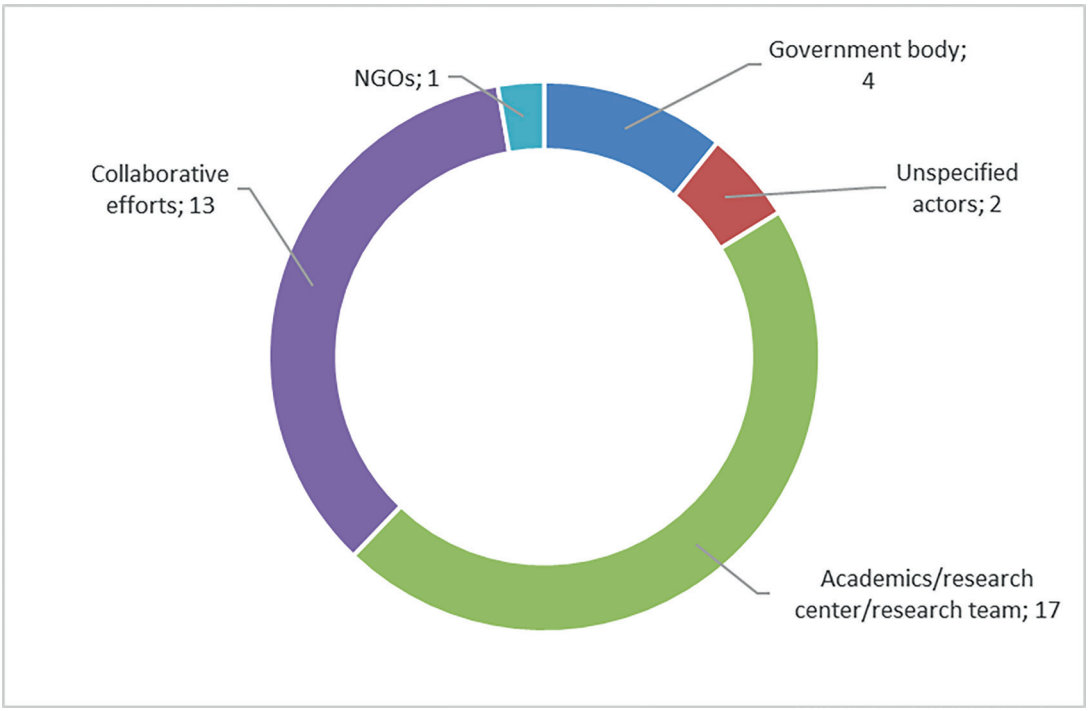

Fig. 6. Initiators in knowledge co-production projects

environmental fabric of cities, emphasising the need for robust resilience strategies (Aguilar-Barajas et al. 2019). Additionally, the articles highlight disruptions caused by rapid urbanisation, population growth, and land-use changes. These strain resources, worsen vulnerabilities, and challenge the adaptive capacity of urban systems (Visconti 2023).

Moreover, the literature stresses the importance of understanding and addressing socio-economic disturbances that undermine urban resilience. Inequality, poverty, and social exclusion are recognised as critical factors that amplify the impacts of hazards and hinder effective resilience-building efforts (Visconti 2023). By examining the interconnectedness of social dynamics with environmental and physical disruptions, the articles emphasise the need for inclusive and equitable approaches to resilience that address underlying social vulnerabilities and promote community well-being (Borquez et al. 2017). Furthermore, governance-related disturbances, including fragmented decision-making processes, a lack of coordination among stakeholders, and institutional barriers, are identified as significant challenges to enhancing urban resilience (Aldunce et al. 2016). These governance issues impede the implementation of effective policies and strategies, limiting cities' ability to respond proactively to disturbances and shocks. Table 2 summarises the types of disturbances explored in the 31 selected articles.

When navigating the complex landscape of urban disturbances and resilience, the articles advocate for integrated and holistic approaches that consider the interconnected nature of challenges faced by cities. By recognising the full range of disturbances, from climate-related hazards to socio-economic inequalities and governance barriers, urban resilience initiatives can be better tailored to address the root causes of vulnerabilities and enhance adaptive capacity (Aldunce et al. 2016). Through collaborative efforts that engage stakeholders across sectors and disciplines, cities can develop comprehensive resilience strategies that build on local knowledge, foster innovation, and promote sustainable urban development (Pillai and Narayanan 2022). Addressing disturbances comprehensively and proactively enables cities to enhance their resilience capacities and create more adaptive, inclusive, and sustainable urban environments.

In addition to strengthening city resilience, several conditions are essential for embedding Urban Living Labs (ULLs) in climate resilience agendas. These include: (1) municipal leadership and support to institutionalise successful experiments (Kronsell & Mukhtar-Landgren, 2018); (2) safe, neutral spaces that build trust and encourage participation (Culwick et al. 2019); (3) integration of local and scientific knowledge to produce contextually appropriate solutions (Visconti 2023); and (4) physical and symbolic

Table 2. Case studies according to types of disturbances

Types of disturbances	Description	Authors
Climate hazard		
Drought (climate-induced)	Climate-induced drought caused by prolonged periods of abnormally low precipitation.	Aldunce et al. (2016), Borquez et al. (2017), Mpofu-Mketwa et al. (2023)
Floods & flash floods	Floods triggered by climate change impacts. Flash floods are triggered by extreme weather events.	Aguilar-Barajas et al. (2019), Dunn et al. (2017), Haque et al. (2023), Tian et al. (2022)
Heavy rains, typhoons, and hurricanes	Extreme weather events related to disasters caused by climate change impacts.	Özerol et al. (2020), Tian et al. (2022)
Heat waves and urban heat islands	Heat events exceeding 30°C caused climate change impacts and hotspots caused by urban activities.	Lorencová et al. (2018)
Air pollution and black carbon emission	Pollution caused by industries and the transportation sector; black carbon emission refers to PM2.5.	Tonisson et al. (2020), Visconti (2023)
Marine submersion (coastal flooding due to sea level rise, storms, tsunamis, cyclones)	Marine submersion refers to coastal flooding events caused by the rising sea level and extreme weather phenomena such as storms, cyclones, tsunamis, or storm surges.	Heinzlef et al. (2024)
Urban system		
Governance-management challenges		
Conflicting interest among stakeholders (management crisis), government instability	Diverse stakeholder interests and balancing power dynamics.	Edenlenbos et al. (2011), Schmidt et al. (2024)
Flood risk (water management system)	Strategies, coping mechanisms, and adaptation measures of water management systems.	Medema et al. (2015), O'Donnell et al. (2020), Yumagulova and Vertinsky (2019), Onyima et al. (2025)
Water security stress (scarcity problem)	Water demand exceeds supply.	Odume et al. (2021)
Urban growth challenges		
Urban growth and development (i.e. urban encroachment, green space development, land use change)	Balancing urban growth with environmental conservation.	Frantzeskaki and Kabisch (2016), Morzillo et al. (2022), Nochta et al. (2021), Larondelle et al. (2016), Adams et al. (2023), Esmail et al. (2024)

spaces that sustain visibility and engagement (Puerari et al. 2018). Among the 36 studies reviewed, some explicitly reference ULLs (Schmidt et al. 2024; Visconti 2023), while others describe ULL-like co-production approaches (Aguilar-Barajas et al. 2019; Edelenbos et al. 2011; Frantzeskaki and Kabisch 2016; Johnson et al. 2022). These findings align with the broader literature, which positions ULLs as both conceptual and practical mechanisms for resilience. By combining knowledge co-production principles with experimental, place-based governance, ULLs create a pathway from knowledge generation to actionable, adaptive strategies. Their flexibility makes them particularly well-suited to addressing complex climate challenges in diverse urban contexts, complementing the approaches observed in the reviewed studies.

DISCUSSION

Knowledge co-production plays an essential role in promoting climate resilience. This relevance is reflected in the reviewed literature, where 12 of the analysed articles explicitly discuss the use of knowledge co-production to address various types of climate-related disturbances. Polk and Kain (2015) further suggest that no single actor has the capacity to address such complexity, and therefore collaborative and inclusive action is necessary. This process also redefines the role of science from a sole producer of expertise to a collaborative partner in shared understanding (Valve et al. 2023). It not only bridges disciplinary and institutional boundaries but also increases the credibility and adaptability of climate resilience strategies (Schmidt et al. 2024).

Despite its potential, the implementation of knowledge co-production remains limited in both scope and depth. Several initiatives have been conducted under short-term funding and project-based frameworks, leading to discontinuity once external support ends (Ryan and Bustos 2019; Mills et al. 2022; Miguel et al. 2025). Furthermore, there is a lack of sustained commitment from stakeholders to maintain these collaborative efforts over time (Harvey et al. 2019). Consequently, the outcomes remain fragmented rather than systemic.

Several previous studies indicate that knowledge co-production has already been initiated in various forms, for example, through urban living labs (ULLs). These have successfully raised awareness and encouraged collaboration (Miguel et al. 2025; Noble and Enseñado 2022; Cuomo et al. 2021; Evans et al. 2015). However, these efforts remain scattered and have not yet resulted in substantial or systemic change. Thus, knowledge co-production has so far functioned more as a tool for dissemination and education rather than as a transformative approach to resilience.

The degree to which communities are involved also plays a crucial role. Figure 7 further illustrates that community participation within co-production processes often remains consultative rather than co-initiated. Communities are typically invited to provide opinions or validation on predetermined agendas instead of being recognised as initiators or equal partners (Rosen and Painter 2019). This highlights the need for more authentic collaboration, which not only values diverse knowledge systems but also redistributes power and agency, allowing local actors to shape the direction of climate resilience efforts themselves (Cooke et al. 2017; Eaton et al. 2021).

To ensure that knowledge co-production contributes meaningfully to climate resilience, there is a growing need to increase its application and enhance its impact. This requires institutionalisation, equitable power-sharing, sustained investment, and continuous learning. Institutionalisation means embedding co-production practices within formal planning frameworks and governance structures so that they continue beyond project cycles (Pearsall et al. 2022; Vara-Sánchez et al. 2021). Equitable power-sharing involves recognising all stakeholders, including local communities, as knowledge holders and decision-makers, not just as participants offering advice (Pearsall et al. 2022; Gaffy et al. 2022; Rosen and Painter 2019). Sustained investment provides the long-term financial and organisational support needed to maintain collaboration and implementation (McGeown et al. 2023; van der Graaf et al. 2023). Continuous learning allows for reflexive adjustments through iterative evaluation and shared learning mechanisms (Rosen and Painter 2019; Wardani et al. 2025). By taking these steps, knowledge co-production can move from simply generating ideas to producing outcomes with greater impact.

CONCLUSIONS

This systematic literature review, conducted following the PRISMA protocol, highlights the important role of knowledge co-production in improving urban resilience and promoting sustainable urban development in the context of climate change. By combining insights from various publications, the study shows the critical importance of stakeholder involvement, the inclusion of local knowledge, and effective science-policy connections in building resilient urban systems. The findings emphasise the need for joint efforts and knowledge sharing to deal with the many challenges caused by climate-related disturbances and to encourage adaptable actions in cities worldwide. In the future, it will be essential to incorporate knowledge co-production principles and urban living labs into urban planning and policy-making processes. Doing so can help cities lessen the effects of climate change more effectively

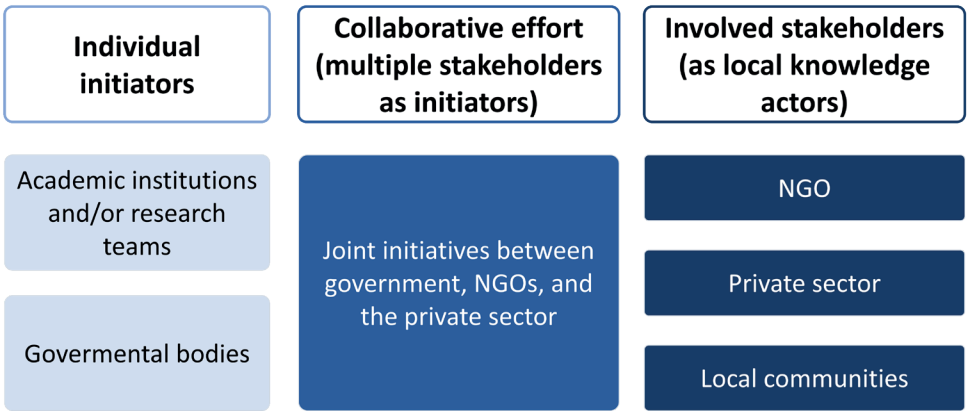

Fig. 7. Stakeholders involved in knowledge co-production

and protect the welfare of urban populations. Additionally, there is increasing awareness of knowledge co-production as a key strategy for improving urban resilience and addressing vulnerabilities related to climate change. By encouraging open decision-making processes and fostering collaboration between different disciplines, cities can use various types of knowledge to build their capacity to adapt and improve their ability to withstand environmental shocks. The results of this review underline the potential of knowledge co-production to transform and shape sustainable and resilient urban futures. Ongoing research, initiatives to build capacity, and policy actions will be vital to support its integration into urban resilience strategies across the globe.

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