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Scientometric Exploration and Network Analysis of Urban Design Policies and Climate Change

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ABSTRACT

Aims This study aims to elucidate the knowledge structure, discursive patterns, and existing gaps in the field of urban design policy related to climate change.

Methodology This study was conducted using a scientometric method and a network analysis approach in 2025. Data were extracted from the Web of Science Core Collection using a comprehensive Boolean search string. Following the application of inclusion criteria and screening procedures based on the PRISMA framework, 343 articles were selected for analysis. Network analyses were performed using VOSviewer software to map keyword co-occurrence, country and author co-authorship, and source co-citation networks. CiteSpace software was employed to identify emerging concepts and track citation bursts. Complementary qualitative analysis was conducted on 40 highly cited articles using MAXQDA software. Article quality was assessed using the CASP checklist, and full counting and fractional counting methods were applied for network analysis.

Findings Knowledge production in the field of urban design and climate change is concentrated in developed countries (the United States, the United Kingdom, Germany, Australia) and China, while developing countries remain on the periphery. The co-authorship network reveals limited collaborations and small research clusters. The literature in this field has followed an evolutionary trajectory from development-oriented policymaking toward resilience, governance, and policy evaluation. Four main conceptual clusters were identified—physical-technical, ecological, governance, and vulnerability—yet the linkage between physical design and social justice–urban poverty remains weak. Qualitative analysis of the 40 highly cited articles indicates that institutional gaps (68%) and spatial justice (52%) are the most significant neglected priorities.

Conclusion The discourse on urban design policies in developing countries has not achieved the desired coherence. It is essential to reassess research priorities, strengthen scientific collaborations, systematically address climate justice, and integrate social, economic, and environmental dimensions into policymaking.

Keywords Climate Governance; Climate Change; Urban Design; Scientometric Approach

CITATION LINKS

[Aboagye & Sharifi, 2024] Urban ...; [Abubakar *et al.*, 2025] Urban ...; [Adeloye & Rustum, 2011] Lagos ...; [Adger, 2006] Vulnerability; [Ahern, 2011] From ...; [Ahsan *et al.*, 2011] Climate ...; [Ajibade, 2019] Planned ...; [Akomolafe *et al.*, 2024] Climate ...; [Alatas, 2003] Academic ...; [Albalawi, 2025] Urbanization ...; [Alderton *et al.*, 2021] Building ...; [Alhasaani *et al.*, 2025] Urban ...; [Alizadeh & Meshkini, 2025] On ...; [Almulhim & Cobbinah, 2024a] Framing ...; [Almulhim & Cobbinah, 2024b] Urbanization ...; [Alohan & Oyetunji, 2021] Hindrance ...; [Alsharif *et al.*, 2020] Research ...; [Amos, 2018] A ...; [Andal, 2022] Situating ...; [Andrić *et al.*, 2019] A ...; [Angelo & Wachsmuth, 2020] Why ...; [Anguelovski & Carmin, 2011] Something ...; [Anguelovski *et al.*, 2014] Variations ...; [Anguelovski *et al.*, 2018] Assessing ...; [Appau *et al.*, 2024] Enabling ...; [Araos *et al.*, 2016] Climate ...; [Araya-Munoz *et al.*, 2017] A ...; [Archer *et al.*, 2014] Moving ...; [Arioli *et al.*, 2020] Transportation ...; [Asad *et al.*, 2022] Traditional ...; [Asadzadeh *et al.*, 2022] Urbanization ...; [Asare & Tuffour, 2024] Urban ...; [Ashik *et al.*, 2023] Analyzing ...; [Asif *et al.*, 2023] People ...; [Awadh, 2018] Estidama ...; [Aydin & Kahraman , 2022] Mitigation ...; [Aylett, 2015] Institutionalizing ...; [Bai *et al.*, 2018a] Six ...; [Bai *et al.*, 2018b] New ...; [Balaban, 2019] Challenges ...; [Bardhan *et al.*, 2020] REST ...; [Barman *et al.*, 2023] Transfer ...; [Barrico & Castro, 2019] Sustainable ...; [Barros *et al.*, 2021] Design ...; [Betsill & Bulkeley, 2007] Looking ...; [Bhanye, 2025] A ...; [Bhardwaj & Khosla , 2021] Superimposition ...; [Bhawra *et al.*, 2023] Exploring ...; [Bichueti *et al.*, 2025] Climate ...; [Birkmann *et al.*, 2013] Framing ...; [Birkmann *et al.*, 2014] Assessment ...; [Bisarol, 2019] Coastal ...; [Blagojevic *et al.*, 2020] Adaptation ...; [Blanco *et al.*, 2009] Shaken ...; [Bonilla-Bedoya *et al.*, 2022] Urban ...; [Borie *et al.*, 2019] Mapping ...; [Boulanger, 2023] Urban ...; [Bowen *et al.*, 2014] A ...; [Buffam *et al.*, 2022] Priorities ...; [Bulkeley, 2010] Cities ...; [Bulkeley, 2013] Cities ...; [Bulkeley & Betsill, 2005] Rethinking ...; [Bulkeley & Betsill, 2013] Revisiting ...; [Bulkeley *et al.*, 2013] Climate ...; [Bulkeley & Castán Broto, 2013] Government ...; [Bulkeley & Castán Broto, 2015] Governing ...; [Bulkeley *et al.*, 2014] Contesting ...; [Bulkeley & Tuts, 2013a] Climate ...; [Bulkeley & Tuts, 2013b] Understanding ...; [Butsch *et al.*, 2017] Growing ...; [Canteiro *et al.*, 2024] Natural ...; [Carmin *et al.*, 2012] Urban ...; [Carmin *et al.*, 2013] Urban ...; [Carmona, 2019] Principles ...; [Castaldo *et al.*, 2025] Nature ...; [Castán Broto, 2017] Urban ...; [Castán Broto & Bulkeley, 2013] A ...; [Castán Broto *et al.*, 2015] Building ...; [Cavaco & Campello Torres, 2025] Climate ...; To be continued

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Introduction

In recent decades, climate change has become one of the most complex, multifaceted, and fundamental environmental, economic, and social challenges of the twenty-first century. This phenomenon is no longer regarded merely as a natural or technical problem, but as a "cumulative problem of development" whose roots lie in unjust consumption patterns, inefficient institutional structures, and power relations within urban planning and policymaking systems [Parmesan *et al.*, 2022]. Climate change has increasingly transformed not only the natural environment but also the spatial organization, social relations, economic structures, institutional mechanisms, and even the cultural identity of cities. These transformations have been more tangible and influential in cities, as the main centers of modern life and human interaction, than anywhere else.

Extensive research evidence shows that cities, on the one hand, account for a considerable share of the production and concentration of greenhouse gas emissions and, on the other hand, owing to high population density, the concentration of the most vital infrastructure, and the accumulation of spatial inequalities, experience the highest level of vulnerability to climate impacts [Parmesan *et al.*, 2022]. The rise in global mean temperature, the intensification of the urban heat island phenomenon, the frequency and severity of extreme events such as urban floods, severe storms, and prolonged heat waves, and the growing pressure on energy, water, transportation, and housing networks have confronted the horizons of urban development with deep, structural, and sometimes irreversible uncertainties [Sharma & Tomar, 2010]. Especially in the cities of developing countries, these destructive effects have become intertwined with urban poverty and spatial inequality because of rapid and unplanned urbanization, the uncontrolled expansion of informal settlements, chronic institutional weakness, the shortage of financial and technical resources, and the lack of risk management capacities. Such a structural overlap has placed the concept of climate justice at the heart of contemporary urban policymaking, not as a moral ideal but as an operational and strategic requirement [UN-Habitat, 2020].

In the climate policy literature, urban responses to climate change have mainly been categorized and conceptualized along two main axes, namely "mitigation of greenhouse gas emissions" and "adaptation to the irreversible consequences of climate change". In the last decades of the twentieth century and the early twenty-first century, the dominant focus of international and national policies was on mitigation; an approach that was formed mainly on the basis of technological interventions, energy optimization, and changes in consumption patterns at the macro scale [Parmesan *et al.*, 2022]. However, undeniable scientific evidence shows that even under the most optimistic mitigation scenarios, the effects and consequences of climate change will continue in the coming decades, and cities will inevitably face new climatic realities for which no similar experience has yet been recorded. This reality has doubled the need for serious, systematic, and urgent attention to adaptation strategies and the enhancement of urban resilience as an inseparable part of any urban development policymaking [Parmesan *et al.*, 2022]. Nevertheless, recent systematic reviews and meta-analyses show that mitigation and adaptation policies have mostly been formulated as two parallel, separate streams lacking spatial, physical, and institutional coherence. This structural separation and the absence of an integrated approach have weakened the overall effectiveness of policies, wasted limited resources, and even created internal conflicts between development goals and climate goals; a problem that has been seriously criticized in the recent literature as the "mitigation–adaptation gap".

Meanwhile, urban design, as one of the key tools of climate-oriented urban governance, has received less attention than it deserves on the agenda of research and of national and local policymaking, despite its high transformative potential. This historical neglect has stemmed partly from a purely aesthetic or traditional functional view of urban design and partly from its separation from macro policymaking and strategic planning. Contemporary studies show that when urban design is defined beyond individual, symbolic, and short-term projects and is formulated in the form of structural, long-term, participatory, and spatial-justice-based policies, it can have a significant, lasting, and multidimensional impact on reducing energy consumption, improving thermal and bioclimatic comfort, reducing carbon emissions, increasing resilience to natural hazards, and promoting spatial justice and public health. It does so by guiding the physical form of the city, determining density and population distribution patterns, distributing and organizing land uses, designing and managing the network of urban open and green spaces, organizing public and active transportation systems, and directing the behavioral patterns of residents [Carmona, 2019; Stead & Meijers, 2009]. Nevertheless, empirical evidence and structured reviews show that in many urban planning and design documents worldwide, mitigation and adaptation policies have been formulated separately, without synergy, and at best with an "aggregative" (not integrative) approach. This means that the conceptual, methodological, and operational links between climate policies and the physical fabric of the city have remained limited, marginal, and in many cases symbolic. This theoretical–practical gap is one of the most important obstacles to realizing resilient, low-carbon, and just cities in the face of climate change. The challenges of implementing climate-oriented urban design policies in developing countries are doubly intense, deep, and multidimensional because of their particular political, economic, social, and

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institutional contexts. Rapid and often unplanned urbanization, the growing and uncontrolled expansion of informal settlements and marginal housing, chronic and deep-rooted weakness of urban and regional institution-building, the lack of an efficient system for financing public infrastructure, and serious limitations in the technical, managerial, and executive capacity of local governments have all combined to make the capacity of these countries to formulate, implement, monitor, and revise climate-oriented urban design policies severely limited, fragile, and dependent on foreign aid. Developed countries, on the other hand, despite having higher institutional capacity, more extensive financial resources, and more coherent planning systems, face their own specific and complex challenges. Structural misalignment among different levels of governance (local, regional, national, and supranational), conflicts of interest among sectoral institutions and diverse stakeholders, constraints arising from spatial justice in the distribution of the benefits and costs of policies, and social and political resistance to physical urban change are among the most important obstacles that developed countries also struggle with in realizing climate-oriented urban design policies. Recent critical studies have shown that some seemingly progressive climate-oriented urban design interventions, especially urban regeneration projects, the greening of public spaces, and the improvement of clean transportation infrastructure, not only have failed to reduce the climate vulnerability of disadvantaged groups but in practice have acted as tools for "exclusive regeneration" and the "displacement of low-income populations" (gentrification), fueling the concentration of benefits in affluent areas and the intensification of spatial inequality and environmental injustice. These alarming findings further highlight the need for simultaneous and continuous analysis of the institutional, spatial, social, economic, and environmental dimensions of urban design policies and show that any climate-oriented policymaking that lacks serious attention to spatial justice, the empowerment of local communities, and the reform of unequal power structures not only will fail to achieve its goals but may also reproduce and exacerbate existing inequalities.

In the last decade, the concept of "nature-based solutions" has received increasing attention from researchers, planners, and policymakers as an emerging, multidimensional, and transformative approach in the discourse of climate-oriented urban design policies. Relying on natural processes, urban ecosystems, and green infrastructure, these solutions have the capacity to simultaneously achieve the goals of climate mitigation (through carbon sequestration and reduced energy consumption), adaptation to climate change (through flood management, temperature regulation, and increased biodiversity), and the improvement of urban quality of life (through better public health, increased social interaction, and environmental beautification); hence, they have been introduced in the urban policy literature as a "win–win solution". However, critical studies have shown that the effective and sustainable implementation of nature-based solutions requires an integrated institutional framework, a sustainable financing system, local capacity-building, and the genuine participation of local communities in decision-making, design, and implementation processes. In the absence of such contexts and structural prerequisites, these solutions often turn into short-term, showcase projects without structural impact, and sometimes even into tools for justifying unjust and uncoordinated policies.

Despite the remarkable growth of scientific output on urban design policies and climate change over the past two decades, previous systematic reviews and meta-analyses have mostly been limited to examining a single dimension of this field (such as mitigation, adaptation, resilience, or governance) and have rarely mapped the network-based, structural, and macro picture of global knowledge in this field, especially with a comparative approach between developed and developing countries. In addition, many previous reviews have been based on manual, descriptive, and sometimes methodologically non-transparent methods, which naturally entails limitations such as low reproducibility, a high probability of interpretive bias, an inability to process large volumes of scientific data, and an inability to identify hidden and emerging patterns. Hence, there is a significant knowledge gap in the field of climate-oriented urban design policies, namely the lack of a systematic, structural, and quantitative mapping of knowledge networks, conceptual streams, scientific collaboration patterns, and the theoretical foundations of this field at the global level, such that the positions of developed and developing countries in this scientific ecosystem can be analyzed comparatively and existing conceptual gaps can be identified objectively and through networks.

The aim of this study was to map the knowledge structure, conceptual clusters, scientific collaboration patterns, and theoretical foundations of the field of urban design policies and climate change over the period 2007 to 2025 and to comparatively examine the position of developing countries in the global knowledge network, using a scientometric and network analysis approach.

Methodology

With the aim of mapping the intellectual structure, evolutionary trends, and scientific collaboration networks in the field of urban design policies and climate change, this study employed a scientometric analysis approach. Relying on mathematical and statistical foundations, this interdisciplinary approach makes it possible to quantify and visualize the hidden relationships among huge volumes of scientific data [Donthu *et al.*, 2021]. The scientometric process in this study was designed and implemented within a

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three-stage framework comprising (1) tool selection, (2) data collection, and (3) data analysis.

A combination of complementary software packages was used for the network analyses and scientific visualization. VOSviewer 1.6.20 was chosen as the main tool for analyzing and mapping keyword co-occurrence, country and author co-authorship, and source co-citation networks. For complementary analyses such as identifying emerging concepts and tracking citation bursts, CiteSpace version 6.3 (release 1) was used. MAXQDA 2022 was employed for the complementary qualitative analysis of highly cited articles. In addition, the standard CASP checklist was used as a guide for quality scoring to assess the quality of the articles and to ensure the validity of the policy findings.

The statistical population of this study comprised all scientific documents indexed in the Web of Science Core Collection, including the Science Citation Index Expanded (SCI-EXPANDED), the Social Sciences Citation Index (SSCI), and the Emerging Sources Citation Index (ESCI). The systematic search was conducted from 22 to 26 November 2025. The Boolean search string in the topic field was constructed by combining terms related to three domains, "urban design", "climate change", and "policymaking", together with keywords related to developed and developing countries, as follows:

TS=(("urban design" OR "city design" OR "urban form" OR "street network" OR "public space") AND ("climate chang" OR "global warm" OR "GHG emission" OR "carbon mitigat" OR "climatic hazard") AND ("polic" OR "governance" OR "adaptation strateg" OR "resilience planning" OR "regulatory framework") AND ("developed countr" OR "developing countr" OR "Global North" OR "Global South" OR "OECD" OR "non-OECD"))

To increase validity and reduce bias, a language restriction (English-language articles only) and a document-type restriction (research and review articles only) were applied. At this stage, 628 initial records were retrieved.

To increase precision and thematic coherence, a set of inclusion and exclusion criteria was developed on the basis of the research objectives. Accordingly, articles were included in the final analysis if they: (1) focused directly on the link between urban design policies and components of climate change (including mitigation, adaptation, resilience enhancement, or climate governance); (2) were published between 2007 and 2025 (in line with the rise of climate debates following the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC); (3) were research articles or systematic reviews with an abstract, keywords, and a rich reference list; (4) had accessible full texts allowing accurate extraction of metadata and qualitative content analysis; and (5) had authors whose countries belonged to either the developed or the developing group according to the latest World Bank classification (based on gross national income) [World Bank, 2025].

The exclusion criteria were as follows: (1) purely technical or engineering articles that dealt only with climate modeling without reference to policy or governance aspects; (2) local studies that could not be generalized to the level of global policymaking; (3) articles that dealt only with urban design without addressing the climate component (or vice versa); and (4) articles without an abstract or standard keywords that could not be processed in the networks. In addition, non-scientific documents such as books, reports, conference papers, editorials, and editorial notes were excluded from the analysis.

To make the article selection process transparent and to increase reproducibility, the data refinement steps were documented according to the PRISMA guidelines. Although the present study is not a systematic review or meta-analysis, the use of the PRISMA framework has recently become common in bibliometric studies to transparently record the steps of data exclusion and inclusion [Page *et al.*, 2021]. Accordingly, the screening process was carried out in four stages. The initial search retrieved 628 records. Of these, 54 duplicate records (due to overlapping indexes or double entry) and 12 records with incomplete metadata (missing publication year or effective keywords) were removed. Thus, 562 records remained for the screening stage.

In the screening stage, the 562 records were examined on the basis of title and abstract by two independent reviewers. At this stage, 187 records were removed because of a lack of direct relevance to urban design (82 cases), the absence of a policy or governance approach (61 cases), or an exclusive focus on specific countries without reference to their level of development (44 cases). The remaining 375 records proceeded to full-text assessment.

The full texts of the 375 articles were obtained and examined more closely. Of these, 32 articles were removed because they lacked relevant keywords, made no reference to specific policies in the main text, were not available in full text, or dealt exclusively with landscape architecture or urban ecology without a link to policymaking. Finally, 343 articles that fully met the inclusion criteria were selected as the final sample, and their complete metadata (including title, abstract, keywords, reference list, and the institutional affiliations and countries of the authors) were extracted for the final analysis (Figure 1).

Given the mixed approach of this study (combining quantitative network analysis with in-depth policy interpretation), the qualitative assessment of the input documents plays a vital role in the validity of the final results. Therefore, the standard CASP checklist was used for the qualitative screening of the selected articles. This checklist, regarded as one of the most reliable critical appraisal tools in policymaking and social science

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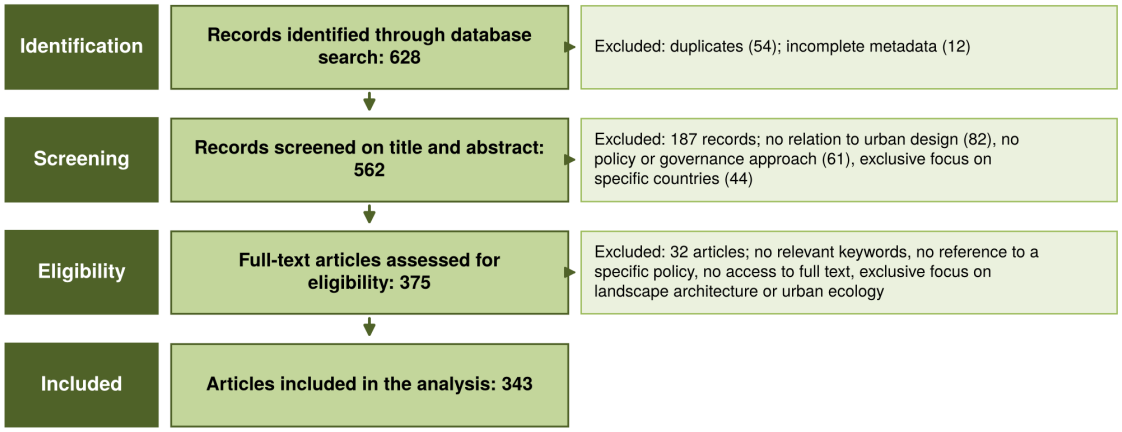

Figure 1) Screening and selection of articles according to the PRISMA standard (from 628 retrieved records to 343 articles included in the analysis)

studies, was localized in an abridged form suited to the nature of urban design policy research. To this end, the articles were scored on three key criteria: (1) clarity and explicitness of the research aim, (2) appropriateness of the methodology to the policy question posed, and (3) transparency in reporting policy and governance findings (score range 0 to 10).

It should be emphasized that in this study no article was removed from the quantitative network analysis merely because of a low CASP score, since in scientometrics even articles of weak methodological quality may be influential in citation networks, and removing them would lead to the loss of part of the knowledge structure. However, in the stage of deeper qualitative analysis (performed on 40 highly cited articles), the policy interpretations of articles that scored less than 5 out of 10 on the CASP checklist were weighted with greater caution and alongside the results of higher-scoring articles to prevent biased results from being presented in the discussion and conclusion.

After data extraction, preprocessing was carried out with the Thesaurus tool in VOSviewer to merge synonymous terms and remove very general keywords (such as "model", "approach", and "result"). A minimum occurrence threshold of 5 was set for keywords so that only concepts with considerable relative frequency entered the co-occurrence networks. For the analysis of co-authorship and co-citation networks, the full counting method was used for countries and authors, and the fractional counting method was used to moderate the influence of highly cited articles in the co-citation analysis.

Findings

An examination of the frequency of institutional affiliations extracted from the 343 scientific articles selected according to the PRISMA guidelines [Page *et al.*, 2021] showed that knowledge production in the field of urban design policies related to climate change has been highly concentrated in a limited number of countries (Table 1). Among them, China, the United States, and the United Kingdom were identified as the most influential countries in terms of research participation, which reflects the institutional capacity, research infrastructure, and continuous investment of these countries in research related to climate and urban design and planning [He *et al.*, 2016; Li *et al.*, 2024]. Previous studies have also emphasized the role of institutional capacity, multilevel governance, and scientific infrastructure in shaping and implementing urban climate policies [Bulkeley & Betsill, 2005; Bulkeley, 2010; Carmin *et al.*, 2013; Aylett, 2015]. After these countries, Australia and Germany also showed a considerable level of scientific participation, particularly through universities and research centers that have played a role in linking climate research, urban planning, resilience, and policymaking [Asadzadeh *et al.*, 2022; Hunt & Watkiss, 2011; Reckien *et al.*, 2018].

It is noteworthy that China is the only developing country in this set that has shown a pattern similar to developed countries in terms of the volume and institutional diversity of research participation. This situation is consistent with the expanding trend of research on low-carbon cities, energy transition, climate planning, and spatial transformation in Chinese cities [He, 2017; Jiang *et al.*, 2023; Liu *et al.*, 2023; Wang *et al.*, 2025; Wei *et al.*, 2025]. In contrast, the participation of other developing countries has been mainly scattered, limited to a few specific universities, and lacking broad institutional coherence; a situation that has also been noted in the literature on institutional capacity, climate governance, and resource constraints in the countries of the Global South [Dodman & Satterthwaite, 2008; Satterthwaite, 2011; Carmin *et al.*, 2012; Fünfgeld, 2010]. Abundant evidence from African and Asian cities shows that, because of infrastructural, institutional, and financial constraints, the path of low-carbon urban development and adaptation to climate change in these regions requires a path different from that of developed countries [Akomolafe *et al.*, 2024; Alohan & Oyetunji, 2021; Andal, 2022; Appau *et al.*, 2024; Asare & Tuffour, 2024].

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Table 1) Frequency distribution of publications by country and leading, highly cited universities

Rank	Country	Frequency	Percent of total	Participation level	Leading and highly cited universities
1	China	72	21.0	Very high	Chinese Academy of Sciences, Nanjing University, Sun Yat-sen University
2	United States	65	18.9	Very high	Harvard University, Massachusetts Institute of Technology, University of California Berkeley, University of California Davis, Stanford University
3	United Kingdom	54	15.7	Very high	University College London, University of Oxford, University of Cambridge, London School of Economics, University of London
4	Australia	38	11.1	High	Australian National University, University of Melbourne, University of Sydney, University of New South Wales Sydney, Royal Melbourne Institute of Technology
5	Germany	32	9.3	High	Technical University of Munich, Helmholtz Association, German Aerospace Center, Technical University of Berlin, Humboldt University of Berlin
6	India	24	7.0	Medium to high	Indian Institutes of Technology Delhi, Madras, and Bombay, Jadavpur University
7	Italy	18	5.2	Medium	Polytechnic University of Milan, University of Bologna, University of Naples Federico II
8	France	16	4.7	Medium	French National Centre for Scientific Research, Paris-Saclay University, AgroParisTech, University of Toulouse
9	Netherlands	14	4.1	Medium	Wageningen University & Research, Delft University of Technology, Erasmus University Rotterdam
10	Canada	12	3.5	Medium	University of Toronto, McGill University, University of British Columbia
11	Iran	8	2.3	Limited but significant	University of Tehran, Tarbiat Modares University, Shahid Beheshti University
12	South Africa	7	2.0	Limited but significant	University of Cape Town, University of the Witwatersrand, Stellenbosch University
13	Brazil	5	1.5	Limited	University of São Paulo, Federal University of Rio de Janeiro, Federal University of Rio Grande do Sul
14	Japan	4	1.2	Limited	Tokyo Institute of Technology, Kyoto University, Nagoya University
15	Sweden	3	0.9	Limited	Lund University, Stockholm University, Umeå University

The co-authorship network analysis (performed with scientometric and bibliometric tools such as VOSviewer and social network analysis methods [Cobo *et al.*, 2011; Donthu *et al.*, 2021; Ye & Ge, 2019; Zhang *et al.*, 2021]) showed that the structure of scientific collaboration in this field has been centralized, sparse, and dependent on small research clusters. The lack of expansion of the network into wider international clusters indicated that knowledge production in this part of the literature has remained dependent on limited research cores and closed in-group collaborations. From the perspective of developing urban climate science, such a structure can limit the capacity for knowledge transfer, diversity of perspectives, and cross-contextual learning; an issue that has also been emphasized in studies of climate knowledge networks and urban research agendas [McPhearson *et al.*, 2016; Bai *et al.*, 2018a; Hunter *et al.*, 2023].

The pattern of links showed that some researchers have played the role of central nodes in the flow of scientific production, in such a way that a large part of the scientific interactions has been organized through a few specific authors. On the one hand, this concentration indicates specialized consolidation in paths such as climate-oriented policymaking, urban governance, adaptation, and resilience; on the other hand, in the absence of broad interdisciplinary links, it can increase the risk of homogenization of theoretical and methodological frameworks. The need to build links among the disciplines of planning, urban design, climate science, governance, and the social sciences has also been emphasized in the recent literature on cities and climate [Solecki *et al.*, 2013; Bai *et al.*, 2018a; Lobo *et al.*, 2023].

From a policy analysis perspective, this pattern of limited collaboration carries a clear message for developing countries: the global knowledge network on urban design policies related to climate change has not yet reached the level of network maturity, institutional diversity, and balanced geographical distribution. Studies on climate governance in the Global South have shown that limited institutional capacity, financial resources, and unequal access to knowledge can reduce the ability of cities to shape adaptation policies independently [Dodman & Satterthwaite, 2008; Satterthwaite *et al.*, 2007; Carmin *et al.*, 2012; Koch, 2021; Satterthwaite, 2009]. Studies on urban governance in developing countries also emphasize that weak cross-sectoral coordination and the absence of coherent institutional frameworks are the main obstacles to the successful implementation of climate policies [Bhardwaj & Khosla, 2021; Deshpande, 2025; Fanaian & Fanaian, 2023; Fatti & Patel, 2013; Friend *et al.*, 2014].

Consequently, rather than resulting from broad synergy among universities, policymaking institutions, and different geographical regions, knowledge production in this field has been concentrated in a few specific research poles. This situation may lead to the reproduction of policies that are less adaptable to the diversity of

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the economic, institutional, and physical contexts of developing countries. Studies on climate policy transfer have also shown that urban policies may encounter institutional, political, and social differences when transferred between contexts [Fisher, 2014; Koch, 2018; Lizarralde *et al.*, 2020; Verdini *et al.*, 2025]. In this regard, concepts such as institutional lock-in and path dependency in urban planning indicate that changing development paths in the cities of the Global South requires a deep understanding of local contexts and going beyond imported models [Hetz & Bruns, 2014; Hetz & Bruns, 2016; Koch, 2018].

Overall, the co-authorship network showed that although an active scientific core has formed in this field, weak interregional and interdisciplinary links remain one of the structural gaps in the production of policy-oriented knowledge on climate and urban design; a gap that reinforces the need for comparative and participatory research and for the localization of policies in developing countries. The emphasis on participatory research, contextual knowledge, and transdisciplinary approaches has also been increasingly raised in urban climate studies of the Global South [Cilliers *et al.*, 2014; Hardoy *et al.*, 2019; Frota & Freitas, 2024; Petrillo & Bellaviti, 2018; Verdini *et al.*, 2025].

The analysis of the international collaboration network, based on country co-authorship, showed that knowledge production in the field of urban design policies related to climate change has had a multipolar but unbalanced structure in which a few countries have acted as hegemonic nodes of knowledge flow. At the center of gravity of the network were the United States, England, Germany, China, Australia, and India, which established the largest volume of scientific collaboration links with other countries. These countries have had a decisive position not only in terms of the number of scientific outputs but also in terms of their brokerage role in connecting different geographical clusters, and they have in practice shaped the main channels of climate-oriented knowledge exchange. The formation of international urban and climate research networks and the role of certain countries in connecting different scientific streams are consistent with studies that emphasize urban climate science networks and international collaboration [McPhearson *et al.*, 2016; Hunter *et al.*, 2023; Lobo *et al.*, 2023; Laino & Iglesias, 2023].

At the semi-peripheral level, countries such as Brazil, South Africa, Canada, the Netherlands, Sweden, France, and Spain were observed, which have often played a connecting role between the core of developed countries and developing countries.

The significant presence of South Africa, India, Bangladesh, Kenya, Nigeria, Vietnam, Indonesia, Thailand, and Egypt in the network also indicated that developing countries have gradually become more active players in the production of policy-oriented climate knowledge. However, the intensity and direction of their scientific links have still been mainly oriented towards the core countries, and they have had limited network independence. Research evidence from countries such as Bangladesh, Vietnam, and Indonesia shows that these countries face common challenges such as informal settlements, water management, and spatial inequality, which require local and participatory approaches [Ahsan *et al.*, 2011; Huq & Shafique, 2023; Ngoc *et al.*, 2024; Nguyen *et al.*, 2010; Setiadi *et al.*, 2020]. This situation is consistent with the evidence in the Global South literature on dependence on the scientific, financial, and institutional capacities of developed countries.

Studies on urban adaptation in developing countries have shown that local capacity, access to resources, governance structures, and international networks play a decisive role in shaping policy pathways [Carmin *et al.*, 2012; Carmin *et al.*, 2013; Friend *et al.*, 2014; Koch, 2021]. Research conducted in African cities such as Cape Town, Johannesburg, and Maputo has also emphasized the importance of local institutional capacity and the challenges arising from socio-economic inequalities in coping with climate change [Fatti & Patel, 2013; Hetz, 2016; Ho *et al.*, 2023; Zehra *et al.*, 2019].

From a policy analysis perspective, this configuration has shown that the dominant formulations in climate-oriented urban design policies have mainly been shaped on the basis of the institutional, financial, and governance experiences of developed countries and have then spread to developing countries. Consequently, the risk of a mismatch between policies and the institutional, economic, and spatial contexts of developing countries arises as a structural challenge in policy transfer. Studies on urban climate policies in different countries have also emphasized the importance of context, institutional capacity, and differences in governance structures [Bulkeley & Betsill, 2013; Fisher, 2014; Koch, 2018; Pazhuhan, 2023; Woiwode *et al.*, 2024]. Studies on urban planning in Turkey, Mexico, and Brazil also show that climate policies that ignore local institutional and social contexts may increase inequalities [Balaban, 2019; Di Giulio *et al.*, 2019; Munoz-Pizza *et al.*, 2023; Peker & Ataov, 2021; Rasch, 2016; Silva *et al.*, 2022].

In addition, the relative weakness of the links among developing countries in the network, for example among African, South Asian, and Latin American countries, shows that the exchange of localized experiences among countries with similar development problems has not yet reached maturity. This gap is also observed in the literature on climate planning and urban knowledge in the Global South, particularly in studies that emphasize local knowledge production, participatory processes, and non-Western-centered approaches [Frota & Freitas, 2024; Lizarralde *et al.*, 2020; Rahman *et al.*, 2023; Verdini *et al.*, 2025]. Studies on the transfer of climate policies in Latin America and Africa show that South–South cooperation can act as a key strategy for reducing dependence on North–South models and for

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Table 2) Cluster structure of the network of main concepts

No.	Cluster	Main concepts and keywords	Main focus and theme
1	Physical–technical cluster	Built environment, building, energy efficiency, thermal comfort, land use, heat island	Focus on the role of physical design, buildings, and the optimization of energy consumption in responding to climate change and reducing its consequences in urban environments [Creutzig *et al.*, 2015; Seto *et al.*, 2014; Sun *et al.*, 2022; Nandi *et al.*, 2025; Andrić *et al.*, 2019; Koc *et al.*, 2024; Kuittinen, 2023; Mapfumo *et al.*, 2024]
2	Ecological–infrastructural cluster	Green infrastructure, ecosystem services, biodiversity, water, urban sustainability	Shift of the literature towards nature-based solutions and green infrastructure, with emphasis on ecosystem services, biodiversity, water management, and urban sustainability [Castaldo *et al.*, 2025; Mirsafa *et al.*, 2025; Seidu *et al.*, 2025; De Oliveira *et al.*, 2025; Frantzeskaki *et al.*, 2019; Goyal & Biswas, 2025; Gebru *et al.*, 2025; Pimentel Da Silva *et al.*, 2022; Han *et al.*, 2025]
3	Governance–policymaking cluster	Governance, urban governance, policy, politics, justice, implementation	Responses to climate change are defined and implemented within institutional structures, policymaking, and political power relations, and issues such as justice and policy implementation are important [Bulkeley, 2010; Bulkeley & Betsill, 2013; Aylett, 2015; Liss *et al.*, 2025; Deshpande, 2025; Kochskaemper *et al.*, 2025; Peker & Ataov, 2021; Yadav *et al.*, 2024]
4	Vulnerability–resilience cluster	Vulnerability, risk, resilience, poverty, informal settlements	Focus on vulnerability and urban resilience capacity, especially in relation to poverty, informal settlements, and the specific conditions of cities in developing countries [Adger, 2006; Birkmann *et al.*, 2013; Meerow *et al.*, 2019; Eakin *et al.*, 2025; Sultana *et al.*, 2020; Ajibade, 2019; Bhanye, 2025; Moulds *et al.*, 2021; Rasch, 2016]

strengthening local capacities [Cavaco & Campello Torres, 2025; Lizarralde *et al.*, 2020; Rahman *et al.*, 2024].

Thus, the international collaboration network indicated that although the discourse of urban design policies and climate change has become global in nature, the power of knowledge production, theoretical direction, and policy authority remain strongly in the hands of developed countries. This imbalance highlights, as a strategic priority, the need to develop independent research networks in developing countries, to strengthen climate-oriented science diplomacy, and to move towards producing "context-sensitive, local, and justice-oriented" urban design policies for these countries [Koch, 2021; Petrillo & Bellaviti, 2018; Frota & Freitas, 2024; Verdini *et al.*, 2025].

The keyword co-occurrence network analysis showed that the concept of "climate change", as the central core and the densest conceptual node, forms the main axis of knowledge organization in this field and is directly linked to concepts such as city, cities, urbanization, sustainable development, mitigation, and adaptation. This pattern indicates that the dominant scientific discourse has framed climate change not as a purely environmental issue but as a deeply urban, developmental, and policy-oriented phenomenon; an issue that has also been emphasized in comprehensive reviews of cities and climate change [Hunt & Watkiss, 2011; Revi *et al.*, 2014; Bai *et al.*, 2018a; McPhearson *et al.*, 2016; Grimm *et al.*, 2008; IPCC, 2018; Revi, 2008].

The cluster structure of the network represented four main conceptual domains: (1) the physical–technical cluster; (2) the ecological–infrastructural cluster; (3) the governance–policymaking cluster; and (4) the vulnerability–resilience cluster (Table 2; Figure 2).

The keyword density map (Figure 2) clearly showed that the concepts of cities, adaptation, governance, and resilience, alongside climate change, have had the highest density; this indicates a gradual shift in the focus of research from purely mitigation-oriented approaches towards urban adaptation, governance, and resilience policies. This development is consistent with the theoretical literature on urban resilience and climate governance [Davoudi *et al.*, 2012; Davoudi *et al.*, 2013; Meerow *et al.*, 2016; Leichenko, 2011; Shi & Moser, 2021; Smit & Wandel, 2006; Wamsler, 2013].

In contrast, although concepts such as geographic information systems (GIS), remote sensing, and modeling have been present in the network, they have been located on the margins of conceptual density, which indicates that, alongside the growth of technological tools, the new policy literature pays considerable attention to the institutional, governance, and social dimensions of climate responses. Studies based on GIS and remote sensing in the cities of developing countries remain important for assessing hazards, urban form, heat islands, and access to green infrastructure [Fernandez & Schroeder, 2023; Nwogu *et al.*, 2025; Zuetell *et al.*, 2025; Zwirglmaier & Garschagen, 2024; Jia *et al.*, 2019; Shahfahad *et al.*, 2022; Sampurno *et al.*, 2023; Jamarkattel *et al.*, 2025; Odunsi & Rienow, 2024], but these tools alone cannot address institutional problems and social justice.

The strategic point for the present article is that the keywords developing countries, informal, vulnerability, poverty, and informal settlements are directly connected to the governance and resilience cluster; this shows that the scientific discourse essentially interprets climate change in the Global South within the framework of institutional inequalities, urban poverty, and the fragility of governance systems. This interpretation is also consistent with studies on the cities of the Global South, informal settlements, and just adaptation [Watson, 2009; Dodman & Satterthwaite, 2008; Chu, 2016a; Anguelovski & Carmin, 2011; Archer *et al.*, 2014; Eakin *et al.*, 2025; Huq & Shafique, 2023]. Empirical studies in various cities of the Global South, including

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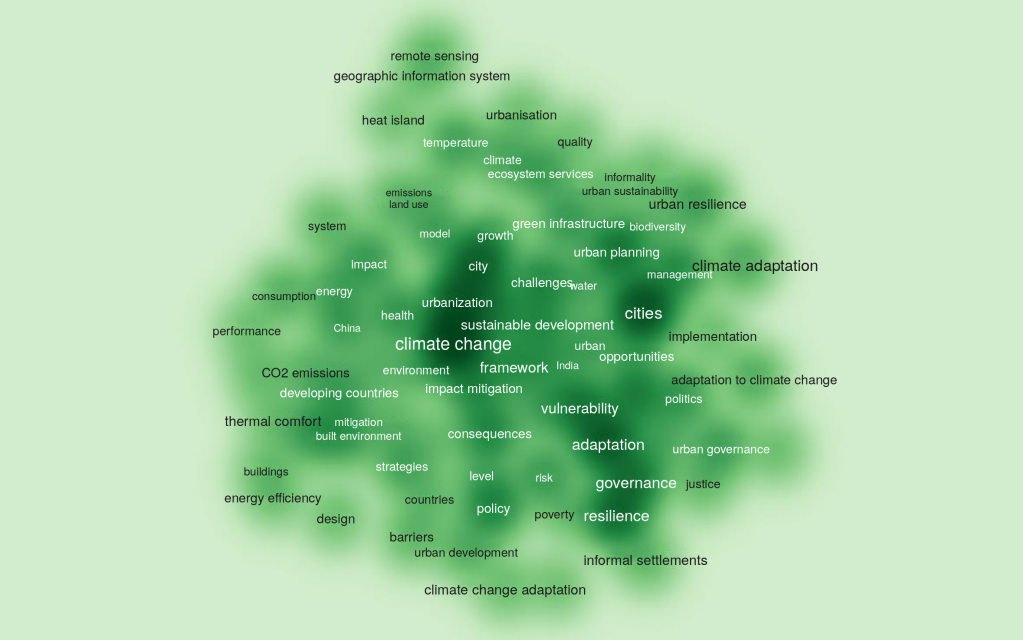

Figure 2) Density map of urban design policies and climate change based on keyword co-occurrence

in Peru, Bangladesh, and Kenya, show that informal settlements are highly vulnerable because of their exposure to climate hazards and the lack of adequate infrastructure and require special, justice-oriented urban design approaches [Fernandez & Schroeder, 2023; Piashi *et al.*, 2025; Zehra *et al.*, 2019; Sultana *et al.*, 2020].

However, the relative weakness of the link between the "physical design" cluster and the "justice and governance" cluster has indicated an important conceptual gap in the literature; a gap showing that urban design policies have not yet been systematically formulated in the service of climate justice and of reducing the vulnerability of disadvantaged groups. Studies on justice in climate adaptation, urban greening, and the distributional consequences of climate interventions have also shown that physical and environmental measures, in the absence of justice considerations, may even reproduce or intensify spatial inequalities [Anguelovski *et al.*, 2014; Bulkeley *et al.*, 2014; Shi *et al.*, 2016; Meerow *et al.*, 2019; Haque & Sharifi, 2024; Mabon & Shih, 2022; Mabon *et al.*, 2023].

Overall, the keyword co-occurrence analysis shows that the global literature on urban design policies and climate change is in transition from engineering-oriented approaches towards paradigms of governance, resilience, green infrastructure, and climate justice. However, the lack of full interconnection among urban design, governance, and social justice remains one of the theoretical and policy gaps in the context of developing countries; a gap that the present study directly seeks to fill [Shi *et al.*, 2016; Rahman *et al.*, 2023; Verdini *et al.*, 2025].

Temporal evolution of the research discourse

The results show that the evolution of knowledge in this field has moved from an initial focus on climate hazards and vulnerabilities towards urban adaptation and resilience and, in recent years, has turned to topics such as climate justice, energy transition, low-carbon cities, and nature-based solutions. This development indicates a transition from technical and reactive approaches towards integrated, social, and transformative approaches in urban design policies [Adger, 2006; Davoudi *et al.*, 2012; Meerow *et al.*, 2016; Sharifi *et al.*, 2021; Shi & Moser, 2021; Moser & Ekstrom, 2010; Smit & Wandel, 2006; Wamsler, 2013] (Table 3).

Source co-citation network analysis

The source co-citation network analysis, using VOSviewer and the fractional counting method recommended by several methodological studies [Boulanger, 2023; Cobo *et al.*, 2011; Donthu *et al.*, 2021; Page *et al.*, 2021], showed that the literature on urban design policies related to climate change has a stable classical core and several emerging conceptual waves. At the center of gravity of the network are classical works related to the cities of developing countries, risk, vulnerability, and climate planning. Among the sources in the present collection, the work of Watson [Watson, 2009] occupies an important position in linking urban planning, poverty, disadvantaged settlements, and development policymaking, and it is consistent with the literature that emphasizes the need to consider the social and spatial conditions of poor cities [Watson, 2009; Blanco *et al.*, 2009; Dodman & Satterthwaite, 2008; Satterthwaite, 2009].

Along this core lies a set of studies on urban risk, vulnerability, and adaptation that show a conceptual transition from "climate policy" to "resilience, risk reduction, and adaptive planning". This development can be seen in the literature through vulnerability

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Table 3) Evolution of issues, discourses, approaches, and dominant policy tools in research on urban design policies related to climate change

Period	Dominant discourse	Central issue	Dominant keywords	Policy objective	Dominant policy approach	Key tools and strategies
2007–2012	Climate risk and vulnerability	Consequences of climate change for cities and urban infrastructure	Climate risk, vulnerability, disaster management, urban consequences	Reducing vulnerability and managing hazards [Adger, 2006; Füssel, 2007; Hunt & Watkiss, 2011; Romero-Lankao & Dodman, 2011; Smit & Wandel, 2006; Shaw *et al.*, 2010; Anguelovski *et al.*, 2018; Chu *et al.*, 2016; De Angelis *et al.*, 2016; Dodman *et al.*, 2019; Friel *et al.*, 2011a; Friel *et al.*, 2011b; Hernandez Aguilar *et al.*, 2021; Jonsson *et al.*, 2015; Khalil & Al-Ahwal, 2021; Liu & Balk, 2020; Ziervogel *et al.*, 2017]	Climate risk management [Aboagye & Sharifi, 2024; Asif *et al.*, 2023; Bardhan *et al.*, 2020; Chu, 2016b; Dawson, 2017; Huang *et al.*, 2010; Marks & Pulliat, 2022; Parker *et al.*, 2025; Ramakreshnan *et al.*, 2019; Rodriguez *et al.*, 2019; Rosenzweig *et al.*, 2011; Rosenzweig *et al.*, 2018; Mundula & Balletto, 2019; Odemerho, 2015; Rabelo *et al.*, 2019; Rathnayaka *et al.*, 2023; Saleem *et al.*, 2013; Yang *et al.*, 2023]	Risk assessment, disaster risk reduction programs, early warning systems, infrastructure retrofitting [Füssel, 2007; Birkmann *et al.*, 2013; De Risi *et al.*, 2018; Adeloye & Rustum, 2011; Amos *et al.*, 2018; Asad *et al.*, 2022; Barros *et al.*, 2021; Bisarol, 2019; Canteiro *et al.*, 2024; Dawson *et al.*, 2011; Derdouri *et al.*, 2024; Dutta-Koehler, 2012; Hallegatte *et al.*, 2013; Head, 2010b; Horlings & Marschke, 2020; Irfan *et al.*, 2018; Jones *et al.*, 2017]
2013–2018	Climate resilience and governance	Capacity of cities to adapt to climate change	Urban resilience, adaptation, governance, institutional capacity	Enhancing resilience and multilevel governance [Davoudi *et al.*, 2013; Bulkeley *et al.*, 2013; Friend *et al.*, 2014; Carmin *et al.*, 2013; Aylett, 2015; Wamsler, 2013; Romero-Lankao *et al.*, 2016a; Romero-Lankao *et al.*, 2016b; Sanchez Rodriguez & Morales Santos, 2018; Swan *et al.*, 2025; Yang, 2023; Mawe *et al.*, 2025; Naess, 2023; Onyanta, 2016; Perry *et al.*, 2022; Reckien *et al.*, 2014; Ren *et al.*, 2011; Romero-Lankao & Rosenzweig, 2010; Sethi & Puppim De Oliveira, 2018; UN-Habitat, 2011; While *et al.*, 2004; Zhang & Ramos, 2022; Liu *et al.*, 2024a; Mashur *et al.*, 2023]	Urban adaptation and resilience [Ahern, 2011; Alhasaani *et al.*, 2025; Almulhim & Cobbinah, 2024a; Araos *et al.*, 2016; Araya-Munoz *et al.*, 2017; Barrico & Castro, 2019; Birkmann *et al.*, 2014; Blagojevic *et al.*, 2020; Borie *et al.*, 2019; Bulkeley & Tuts, 2013b; Choudhary & Neeli, 2018; Di Napoli *et al.*, 2023; Evans, 2011; Fünfgeld & McEvoy, 2011; Jimoh *et al.*, 2021; Joshua *et al.*, 2020; Krishnan *et al.*, 2023; Kumar *et al.*, 2025; Lin *et al.*, 2021; Mojtahedi & Oo, 2014; Mugisha *et al.*, 2025; Nsabimana *et al.*, 2023; Peng *et al.*, 2024; Petzold *et al.*, 2024]	Urban adaptation programs, participatory governance, integrated management, strengthening institutional capacity [Carmin *et al.*, 2013; Davoudi *et al.*, 2013; Friend *et al.*, 2014; Chu, 2016a; Abubakar *et al.*, 2025; Albalawi, 2025; Alizadeh & Meshkini, 2025; Almulhim & Cobbinah, 2024b; Bai *et al.*, 2018b; Barman *et al.*, 2023; Betsill & Bulkeley, 2007; Castán Broto, 2017; Das *et al.*, 2023; Das & Jain, 2022; Dubbeling, 2014; Farhangi *et al.*, 2021; Hurlimann *et al.*, 2025; Khosla & Bhardwaj, 2019; Khouma *et al.*, 2014; Kii *et al.*, 2017; Kocabas, 2014; Li *et al.*, 2023; Liu *et al.*, 2021]
2019–2025	Climate justice and sustainable transition	Climate inequalities, energy transition, and urban sustainability	Climate justice, energy transition, nature-based solutions, green infrastructure, low-carbon city	Achieving sustainable development and climate justice [Sharifi *et al.*, 2021; Anguelovski *et al.*, 2014; Shi *et al.*, 2016; Castaldo *et al.*, 2025; Mirsafa *et al.*, 2025; Frantzeskaki *et al.*, 2019; Haque & Sharifi, 2024; De Oliveira Rolo *et al.*, 2022; Diko & Hollstein, 2023; Dodman, 2009; Dong *et al.*, 2021; Ewane *et al.*, 2023; Ferreira *et al.*, 2023; Holtermann, 2020; Jiao *et al.*, 2025; Kayitete *et al.*, 2025; Liu *et al.*, 2025b; Liu *et al.*, 2024b; Malmqvist & Rundle, 2002; Moreno *et al.*, 2021; Nero *et al.*, 2017; Rizzo, 2020; Rojas *et al.*, 2022; Sandholz, 2016; Schubert, 2024; Seto *et al.*, 2012; Xiao *et al.*, 2025; Gallardo *et al.*, 2018]	Climate transition and sustainable development [Alsharif *et al.*, 2020; Gibberd, 2013; Hijriyah *et al.*, 2025; Iyer-Raniga & Dalto, 2016; Koren & Butler, 2006; Liu *et al.*, 2025a; Marome, 2017; Mukumba *et al.*, 2025; Ness, 2022; Omwoma *et al.*, 2017; Patz *et al.*, 2007; Persson *et al.*, 2015; Gaum & Laubscher, 2022; Harvey, 1996; Kilinc-Ata *et al.*, 2025; Lartey & Glaser, 2024; Lebel *et al.*, 2007; Lefevre, 2009; Li, 2024; Li *et al.*, 2010; Madson *et al.*, 2023; Mishra *et al.*, 2017; Nawaz *et al.*, 2022; Ness, 2023; Oguntona & Akinradewo, 2025; Ruhe *et al.*, 2013; Schüle *et al.*, 2013; Tareke, 2024; Wang *et al.*, 2024]	Green infrastructure, nature-based solutions, low-carbon cities, transit-oriented development, renewable energy, spatial justice [Sharifi *et al.*, 2021; Castaldo *et al.*, 2025; Mirsafa *et al.*, 2025; Seidu *et al.*, 2025; Buffam *et al.*, 2022; Chen *et al.*, 2020; Das *et al.*, 2025; De Oliveira *et al.*, 2011; Alderton *et al.*, 2021; Arioli *et al.*, 2020; Ashik *et al.*, 2023; Awadh, 2018; Aydin & Kahraman, 2022; Bhawra *et al.*, 2023; Bichueti *et al.*, 2025; Bowen *et al.*, 2014; Bulkeley & Tuts, 2013a; Butsch *et al.*, 2017; Cruz *et al.*, 2024; Das, 2025; Davoudi *et al.*, 2009; Doll & Balaban, 2013; Gadiaga *et al.*, 2025]

and risk frameworks [Adger, 2006; Füssel, 2007; Birkmann *et al.*, 2013] and then through urban resilience and adaptation approaches [Davoudi *et al.*, 2012; Davoudi *et al.*, 2013; Meerow *et al.*, 2016]. Foundational studies on vulnerability and adaptation also emphasize that understanding urban vulnerability requires simultaneous attention to its social, economic, institutional, and physical dimensions [Smit & Wandel, 2006; Romero-Lankao & Qin, 2011; Romero-Lankao & Gnatz, 2013; Moser & Ekstrom, 2010].

In the newer layers of the network, works on governance, climate experimentation, and urban adaptation policies appear as intermediary nodes. These studies play an important role in connecting the discourses of "multilevel governance", "urban adaptation", and "climate-oriented institutional policies" [Bulkeley & Betsill, 2005; Bulkeley, 2010; Bulkeley & Castán Broto, 2013; Chu, 2016a]. This network position shows that from the mid-2010s onwards, the focus of research shifted from "what policy is" to how climate adaptation

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is institutionally embedded in cities; a change that is also observed in studies on institutional capacity and local governance [Aylett, 2015; Koch, 2018; Pazhuhan, 2023; Luque *et al.*, 2013].

In the most recent layer of the network are works on the synergy of adaptation and mitigation, policy evaluation, resilience, and the link between urban design and climate justice. This trend is consistent with the study of Sharifi *et al.* [Sharifi *et al.*, 2021] on the synergy of adaptation and mitigation, as well as with more recent studies on the gap between policymaking and the implementation of adaptation plans [Sharifi *et al.*, 2021; Liss *et al.*, 2025; Grafakos *et al.*, 2019; Hurlimann *et al.*, 2021]. Moreover, the increasing attention to spatial and social justice in the recent literature indicates a move away from purely technical approaches towards a distributional assessment of climate policies [Shi *et al.*, 2016; Anguelovski *et al.*, 2014; Meerow *et al.*, 2019; Haque & Sharifi, 2024; Mabon & Shih, 2022].

In terms of the overall network structure, the co-citation pattern indicated that the literature of this field has followed an evolutionary path from development policymaking → resilience and risk management → adaptation governance → evaluation and integration of urban design policies. However, the conceptual distance between the early and the new clusters shows that the theoretical link between "urban design" and "climate justice and adaptive governance" has not yet reached full coherence; a gap that the present study seeks to examine in the context of developing countries.

Author co-citation network analysis

The author co-citation network analysis shows that the discourse of urban design policies related to climate change is organized around several distinct but interconnected intellectual poles, each representing a dominant paradigm in interpreting and coping with climate change in the urban context.

At the center of the network, authors such as Sharifi and Watson have appeared as intermediary nodes between theoretical clusters, playing a connecting role among the discourses of urban resilience, climate governance, and urban development in the Global South [Watson, 2009; Sharifi *et al.*, 2021; Sharifi *et al.*, 2023]. This network position indicates that the theoretical development of the field has moved from development-oriented planning towards integrated frameworks of resilience, adaptation, and climate-oriented governance.

In a separate but connected cluster are studies related to urban experimentation and innovation. This stream regards the city as an arena for experimenting with climate policies, institutional learning, and social innovation and emphasizes the transformative capacity of urban actions [Bulkeley & Castán Broto, 2013; Bulkeley & Castán Broto, 2015; Castán Broto & Bulkeley, 2013; Castán Broto *et al.*, 2015].

At another level, a cluster of studies represents the paradigm of risk, vulnerability, and adaptation in the Global South. This cluster focuses on institutional constraints, social fragility, spatial inequality, and the adaptive capacity of the cities of developing countries [Carmin *et al.*, 2012; Chu, 2016a; Anguelovski & Carmin, 2011; Romero-Lankao & Dodman, 2011; Satterthwaite *et al.*, 2007; Hetz, 2016].

Another cluster represents the stream of urban energy, low-carbon transition policies, and adaptation-oriented planning. This cluster has the strongest links with debates on physical design, energy efficiency, and urban systems and shows that climate-oriented urban design policies have gradually expanded from the purely building scale to the scale of energy–city systems. This trend can be observed in studies on urban energy consumption, urban form, transportation, and low-carbon transition [Dhakal, 2010; Creutzig *et al.*, 2015; Colenbrander *et al.*, 2017; Ho *et al.*, 2013; Jiang *et al.*, 2023].

On the other side of the network, the dimensions of poverty, social justice, informal housing, and adaptation policies in disadvantaged cities have been the focus. The connection of this cluster to the theoretical core of the network shows that the contemporary literature increasingly redefines climate change in connection with structural inequality and social vulnerability [Anguelovski *et al.*, 2014; Ajibade, 2019; Meerow *et al.*, 2019; Eakin *et al.*, 2025; Sultana *et al.*, 2020].

Overall, the author co-citation network shows that the discourse of urban design policies and climate change has passed through a multi-paradigm evolutionary path: from "urban development in developing countries" to "risk and vulnerability", "resilience and adaptive governance", and finally to "innovation, energy transition, and complex urban systems". However, the link between the "physical design and energy" cluster and the "social justice and urban poverty" cluster still lacks full theoretical coherence; a gap that the present study seeks to examine precisely through the analysis of climate-oriented urban design policies in developing countries.

Bibliographic coupling network analysis of documents

The bibliographic coupling network analysis of documents shows that the literature on urban design policies related to climate change is organized into several active, co-referencing, and intertwined research fronts, each relying on a common set of theoretical and policy sources. Four main clusters can be distinguished in this network, representing the axes of "resilience and governance", "risk and adaptation", "energy transition and urban systems", and "spatial policies and climate justice". The first cluster contains studies on resilience, governance, and the synergy of climate policies, in which the link among adaptation, mitigation, and the transformation of urban systems is prominent [Sharifi *et al.*, 2021; Sharifi *et al.*, 2023]. The coupling strength of this cluster shows that a large part of contemporary studies analyze urban design policies under the logic of structural transformation and the link among energy,

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urban form, and climate governance. This trend is consistent with studies on urban energy, urban form, and emission reduction [Creutzig *et al.*, 2015; Seto *et al.*, 2014; Sun *et al.*, 2022].

The second cluster contains the more classical works on urban risk, vulnerability, and adaptation, which have provided an important theoretical framework for analyzing climate policies [Adger, 2006; Birkmann *et al.*, 2013; Hunt & Watkiss, 2011; Blanco *et al.*, 2009]. The coupling of this cluster with new studies shows that the early conceptual frameworks remain reference points but have been reinterpreted in the form of urban design policies, adaptive governance, and resilience.

The third cluster has formed around studies on multilevel governance, urban energy policy, and policymaking in developing countries. The high density of links in this cluster shows that climate-oriented urban design policies in developing countries have been formulated above all in the context of institutional constraints, energy policies, and local governance capacities [Chu, 2016a; Fisher, 2014; Bhardwaj & Khosla, 2021; Pazhuhan, 2023].

In the fourth cluster, a set of new works centered on policy, spatial justice, strategic planning, and institutional adaptability can be observed. This cluster has the greatest overlap with studies on developing countries, inequality, informal housing, and weak institutional capacity [Angelo & Wachsmuth, 2020; Asadzadeh *et al.*, 2022; Lobo *et al.*, 2023; Bonilla-Bedoya *et al.*, 2022; Eakin *et al.*, 2025].

In terms of the overall network structure, the coupling pattern shows that the literature of this field has passed through a gradual but convergent path: from "risk and adaptation" to "governance and urban energy" and finally to "transformation of urban systems, climate justice, and design policies". However, the still relatively weak connection between the "energy transition–urban system" cluster and the "spatial justice–physical design" cluster shows that urban design policies have not yet been fully integrated with the logic of climate justice and urban poverty; a gap that has also been highlighted in studies of climate justice and urban adaptation [Shi *et al.*, 2016; Anguelovski *et al.*, 2014; Meerow *et al.*, 2019].

The analysis of citation networks and conceptual clusters shows that urban design policies have moved from reactive, hazard-control measures towards transformative and multidimensional strategies. In this period, attention to the link among the environmental, social, and economic dimensions of cities has increased, and approaches based on justice and sustainability have gained a more prominent position [Davoudi *et al.*, 2012; Sharifi *et al.*, 2021; Shi & Moser, 2021].

Theoretical and discursive cores

The source co-citation network analysis showed that the theoretical body of urban design policies related to climate change is organized on the basis of four main and interconnected discursive cores, each representing a dominant paradigm in explaining, policymaking, and acting in climate-oriented urban practice.

At the center of the network are classical sources such as Watson [Watson, 2009], Pelling [Pelling, 2011], Revi [Revi, 2008], Revi *et al.* [Revi *et al.*, 2014], and the body of studies on vulnerability, adaptation, and the cities of developing countries, which play the role of the theoretical backbone linking climate change, adaptation, development, and urban planning [Watson, 2009; Revi, 2008; Revi *et al.*, 2014; Pelling, 2011]. This concentration of authority shows that the dominant framework has, from the outset, rested on the link among climate risk, governance, and urban development in developing countries.

The first cluster of the network has represented the discourse of climate-oriented urban governance, institutional experimentation, and local action. The high density of links in this cluster shows that urban design policies, rather than having developed in a linear and top-down manner, have been formulated through processes of learning, institutional innovation, and local action [Anguelovski *et al.*, 2014; Archer *et al.*, 2014; Carmin *et al.*, 2012; Bulkeley & Castán Broto, 2013; Castán Broto *et al.*, 2015]. This cluster has shaped the theoretical basis for analyzing urban design policies as acts of multilevel governance.

The second cluster, focusing on studies of risk, vulnerability, urban systems, and multiple hazards, has represented the paradigm of risk and vulnerability. This cluster shows that climate-oriented urban design has increasingly been interpreted within the framework of the fragility of urban systems, multiple hazards, and adaptive capacity; this has provided the theoretical basis for physical and spatial resilience policies [Adger, 2006; Birkmann *et al.*, 2013; Douglas *et al.*, 2008; De Risi *et al.*, 2018].

The third cluster represents studies on resilience, adaptive planning, and socio-spatial justice. This cluster indicates the shift of the literature from "risk control" to "adaptive capability, institutional capacity, and climate justice" and shows that urban design policies are no longer merely tools for reducing damage but are also interpreted as mechanisms that shape the distribution of risk and opportunity in urban spaces [Davoudi *et al.*, 2012; Leichenko, 2011; Meerow *et al.*, 2016; Meerow *et al.*, 2019].

The fourth cluster, focusing on green infrastructure, urban ecosystems, ecosystem services, and nature-based solutions, belongs to the discourse of nature-oriented policies. This cluster indicates the consolidation of the transition from hard engineering solutions to nature-based solutions in climate-oriented urban design policies [Castaldo *et al.*, 2025; De Macedo *et al.*, 2025; De Oliveira *et al.*, 2025; Mirsafa *et al.*, 2025; Seidu *et al.*, 2025].

The strategic point of the network is that although these four clusters are theoretically strongly connected to one another, the direct link between the "physical–spatial design" cluster and the "social justice–urban poverty"

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cluster is still weaker than the other links. This gap in authority shows that the existing literature, despite extensive attention to resilience and governance, has not yet been able to systematically formulate urban design policies in the service of climate justice in developing countries. Evidence on urban greening, equity in access to ecosystem services, informal housing, and the distributional consequences of adaptation also underlines the importance of this gap [Anguelovski *et al.*, 2014; Haque & Sharifi, 2024; Sultana *et al.*, 2020; Eakin *et al.*, 2025].

Comparison of regional patterns

A comparison of regional patterns shows that developed countries have focused more on carbon emission reduction, energy transition, energy efficiency, technological innovation, and the transformation of urban systems, whereas developing countries are mainly confronted with the challenges of urban poverty, spatial inequality, informal settlements, and social vulnerability. This difference can be seen in the literature on low-carbon cities, energy consumption, and energy transition in developed countries, as well as in studies on poverty, vulnerability, and adaptation in the Global South [Creutzig *et al.*, 2015; Ho *et al.*, 2013; Colenbrander *et al.*, 2017; Akomolafe *et al.*, 2024; Dodman & Satterthwaite, 2008; Satterthwaite *et al.*, 2007; Romero-Lankao & Dodman, 2011].

In developing countries, the problem of climate change is often intertwined with existing problems of infrastructure shortage, informal settlements, poverty, unequal access to services, and limited governance capacity [Watson, 2009; Chu, 2016a; Anguelovski & Carmin, 2011; Zehra *et al.*, 2019; Du *et al.*, 2022; Ho *et al.*, 2023]. Hence, urban design policies in these contexts cannot focus only on emission reduction or technological solutions and must simultaneously consider the dimensions of adaptation, social justice, institutional capacity, and vulnerability reduction.

These differences show that climate-oriented urban design policies must be formulated in accordance with the economic, social, and institutional conditions of each region and that uniform models cannot be generalized globally. Studies on urban climate policies, policy transfer, and planning in the Global South have also emphasized the need for policy contextualization, stakeholder participation, local knowledge, and institutional capacity [Fisher, 2014; Hardoy *et al.*, 2019; Lizarralde *et al.*, 2020; Frota & Freitas, 2024; Verdini *et al.*, 2025].

Therefore, the findings of this study show that the future of climate-oriented urban design policies in developing countries requires a transition from the model of direct policy transfer towards context-sensitive, participatory, local, and justice-oriented policymaking; an approach in which physical design, governance, resilience, green infrastructure, poverty reduction, and climate justice are considered in an integrated manner [Shi *et al.*, 2016; Meerow *et al.*, 2019; Rahman *et al.*, 2023; Mirsafa *et al.*, 2025; Verdini *et al.*, 2025].

Qualitative analysis of highly cited articles

The results of the qualitative analysis of 40 highly cited articles with MAXQDA showed that the most important neglected priorities in the literature on climate-oriented urban design policymaking were, respectively, the institutional gap (68%) and spatial justice (52%). The quality assessment of the articles with the CASP checklist also showed that higher-scoring articles (10 out of 10) mainly addressed institutional and justice-oriented analyses, whereas lower-scoring articles (2 out of 10) focused more on technical and physical aspects. In addition, the citation burst analysis with CiteSpace showed that the concepts of "climate justice" and "adaptive governance" have had the strongest citation bursts in recent years (2022 onwards), which indicates a discursive shift in the global literature. Consistent with the network analysis, these findings confirmed the missing link between physical design and socio-economic justice as the main theoretical–practical gap.

Discussion

The aim of this study was to explain the knowledge structure, discursive patterns, and existing gaps in the field of urban design policymaking related to climate change. The findings of this study depict a deep and structural inequality in the global system of knowledge production on urban design policies and climate change. What emerges from the examination of the co-authorship, co-citation, and keyword co-occurrence networks not only confirms previous findings on the scientific dominance of developed countries [Gazni *et al.*, 2012] but also goes beyond them, revealing new dimensions of qualitative and theoretical inequality that have received less attention in previous bibliometric studies. Contrary to the common perception that reduces scientific inequality mainly to the "shortage of articles" from developing countries [King, 2004], our findings show that the main gap lies not in the volume of production but in theoretical authority and brokerage roles in the global knowledge network. In other words, developing countries, even where they have considerable scientific output (such as China, India, and Brazil), are still placed in a peripheral position, because the dominant theories, analytical frameworks, and main research paths are defined and directed by a small core of countries and specific authors. This finding is consistent with the theory of "epistemic hegemony" in science studies [Alatas, 2003; Connell, 2007], which emphasizes that epistemic colonialism is exercised not by preventing production but by determining "what is worth researching" and "how research should be done".

At the conceptual level, one of the most important achievements of this study is the identification of a deep theoretical gap between the "physical–technical design" cluster and the "social justice–urban poverty" cluster in the keyword co-occurrence network. This gap,

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which has been implicitly referred to in previous review studies [Bulkeley, 2013] but had never been measured quantitatively and through networks, shows that urban design, despite its high potential, is still regarded in the scientific literature as a "technical tool" for managing climate hazards rather than as a "socio-political project" for reducing inequality. This separation is clearly distant from recent critical approaches in urban planning that emphasize "spatial justice" and the "climate justice movement" [Fainstein, 2010; Schlosberg & Collins, 2013] and shows that the mainstream literature has not yet been able to free urban design from the dominance of a purely physical–functional view. This finding is fully consistent with the results of previous studies on the "depoliticization of urban design" in the face of climate change [Bulkeley, 2013] and confirms it at a broader level using network data. Hence, it seems that one of the main obstacles to formulating just urban design policies is not a lack of technical knowledge but precisely this "theoretical void" in linking design with social justice. This void, especially in developing countries where urban poverty and spatial inequality are intertwined with climate vulnerability, can lead to policies that on the one hand appear "green" and "resilient" but on the other hand reproduce or even intensify existing inequalities [Checker, 2011].

At the methodological level, the present study shows that the literature of this field is gradually moving from the production of descriptive knowledge to the production of evaluative knowledge. The emergence in recent years of a group of studies focusing on evaluating policy performance and measuring the effectiveness of urban design interventions (e.g., [Dong *et al.*, 2025; Sheehan & Fox, 2022]) indicates the theoretical maturity of this field and its movement towards "usable knowledge". This development is in line with the recommendations of international institutions such as the United Nations Human Settlements Programme [UN-Habitat, 2020] and the World Bank [World Bank, 2025], which emphasize the need for indicator development and evidence-based evaluation in urban climate policies. However, a noteworthy critical point is that these evaluations are mainly based on criteria derived from the context of developed countries and are by default regarded as "universal". This approach carries the risk of imposing incompatible criteria and, consequently, of presenting a distorted picture of the performance of developing countries [Escobar, 2011]. This finding is consistent with critical studies on "evidence-based policymaking" that emphasize the need to localize evaluation criteria [Nutley *et al.*, 2007; Head, 2010a] and highlights the need to develop context-sensitive and participatory evaluation frameworks for developing countries.

In terms of scientific collaboration patterns, one of the relatively unexpected results of this study is the very prominent role of China, as a developing country, at the heart of the global knowledge network. China behaves like developed countries not only in terms of the volume of output but also in terms of "theoretical authority" and its "brokerage role" in connecting different geographical clusters. This finding is consistent with previous studies on the emergence of China as a "scientific superpower" [Zhou & Leydesdorff, 2006; Leydesdorff & Wagner, 2009] and shows that the country's macro science policies and targeted investment in climate research (which form part of China's 2030 strategic plan) have been able to fundamentally transform its position in the global knowledge system. However, it is worth noting that other developing countries, even those with considerable population and size (such as India, Brazil, and Indonesia), do not enjoy such a position, and their pattern of participation remains limited, scattered, and dependent on the core. This intra-group inequality among developing countries shows that "being developed" or "being developing" alone is not sufficient to explain scientific position; rather, other components such as "institutional capacity", "targeted investment", and "macro science policies" play a decisive role. This finding is in line with the theory of "national research capacity" in science and technology studies [Freeman & Soete, 2009] and emphasizes that scientific development is not a linear and automatic process but requires deliberate interventions and strategic investments.

In contrast, the cautious but significant presence of Iran in eleventh place in the publication frequency table (with leading universities such as the University of Tehran, Tarbiat Modares University, and Shahid Beheshti University) indicates considerable scientific capacity in this country, which, despite serious structural constraints (such as scientific sanctions, limited resources, and restrictions on international collaboration), has been able to consolidate its presence in this field at the global level. This finding is consistent with previous studies on "scientific resilience" in countries facing sanctions [Fadaee, 2020] and shows that even under unequal conditions, local scientific capacities can serve as a platform for effective participation in global knowledge. However, Iran's scientific links with other developing countries (especially in West Asia and Africa) are very weak, and its pattern of collaboration is mainly organized along North–South lines (with Europe and North America). This weakness of South–South collaboration is a serious structural challenge not only for Iran but for most developing countries and shows that "scientific independence" and "reduced theoretical dependence" require the creation of alternative collaboration networks and the strengthening of regional science diplomacy.

At the policy level, the findings of this study have clear implications for developing countries. First, there is a need for a fundamental revision of national and regional research priorities so that the specific problems of these countries (such as urban poverty, informal settlements, institutional weakness, and spatial inequality) are

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placed at the center, not the margins, of research. Second, South–South scientific collaboration needs to be strengthened as a strategy for reducing theoretical dependence and exchanging localized experiences. Third, targeted investment in interdisciplinary research that redefines urban design as a justice-oriented tool in the face of climate change is important. These policy recommendations are fully in line with recent reports of international organizations such as the United Nations Development Programme (UNDP) and the United Nations Human Settlements Programme (UN-Habitat), which emphasize "climate justice" and "participatory urban design" as the main pillars of sustainable urban development. However, what these reports have addressed less, and what our findings highlight, is the deep gap between the "discourse of justice" at the international level and "actual practice" at the national and local levels. It seems that despite theoretical consensus on the importance of climate justice in scientific and political forums, in practice urban design policies are still dominated by technical and physical approaches and are rarely used as tools for reducing inequality and empowering local communities. This "discourse–practice" gap is one of the most important obstacles to realizing resilient and just cities in developing countries, and future research, instead of producing repetitive discourses, should focus on offering practical, context-sensitive, and participatory solutions to close this gap at local levels, with the genuine participation of local communities in the decision-making, design, implementation, and monitoring processes of urban policies.

Overall, the present study shows that the field of urban design policies and climate change, despite considerable quantitative growth and positive discursive developments, still faces deep structural challenges at the conceptual, institutional, and geographical levels. The most important of these challenges are: (a) the theoretical–practical gap between physical design and social justice, which acts as a serious obstacle to formulating context-sensitive and just policies, especially in developing countries; (b) the hegemonic concentration of knowledge production in developed countries and the systematic marginalization of developing countries, which leads to the reproduction of theoretical and methodological dependence and the neglect of the specific problems of these countries; and (c) weak South–South collaboration, which prevents the exchange of localized experiences and the formulation of context-sensitive solutions suited to local realities. In contrast, the strengths of the existing literature include the discursive transition from purely technical approaches to institutional and justice-oriented approaches, the emergence of new research fronts focusing on evaluating policy effectiveness, and a gradually increasing awareness of the need to integrate mitigation, adaptation, and justice in urban design policies. Hence, future research should focus on three main axes: first, developing local, context-sensitive, and participatory theoretical and methodological frameworks for evaluating climate-oriented urban design policies in developing countries; second, strengthening South–South scientific collaboration networks for exchanging experiences, building institutional capacity, and producing knowledge independent of the theoretical hegemony of the North; and third, moving from descriptive–analytical research towards intervention-oriented and pragmatic research that directly contributes to reforming institutional structures, redesigning policies, and reducing spatial inequalities in the cities of developing countries.

This study had some limitations. The data were extracted from only one database (Web of Science) and only from English-language research and review articles; therefore, articles indexed in other databases and sources in other languages, including Persian, were not examined. In addition, scientometrics shows the structure of knowledge and does not measure the practical effectiveness of policies. It is suggested that future studies also use data from other databases such as Scopus and examine the relationship between physical design and climate justice in case studies of cities in developing countries.

Conclusion

The discourse of urban design policymaking in the field of climate change, especially in developing countries, is still at the stage of institutional and theoretical formation. The structure of the citation network indicates the dominance of the research centers of developed countries over the production and direction of scientific knowledge, while the participation of developing countries in this process has remained limited. The publication pattern of the articles shows that leading journals play a key role in organizing debates on sustainability and environmental transition, but the dominant orientation of research has been towards technical and managerial aspects, and topics such as social justice and climate inequalities have been marginalized. Moreover, the link among adaptation policies, energy transition, and spatial justice is not sufficiently robust, and many urban design strategies lack coherent implementation support. The review of studies shows that the main focus has been on emission reduction, while the dimensions of social resilience, institutional adaptation, and urban quality of life have received less attention. The simultaneous use of systematic review and scientometrics has made it possible to identify research trends and gaps. Finally, urban design policies in developing countries have not yet reached a desirable level of coherence and localization, and enhancing local capacities, strengthening South–South collaboration, attending to climate justice, and integrating social, economic, and environmental dimensions into policymaking are among the most important paths ahead.

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