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Citizen science contributions to sustainable urban transformation, urban sustainability and urban planning: A systematic literature review

Isabelle Bonhoure [a,b], Beate Guba [c], Christian Peer [d], Ignasi Labastida [e], Josep Perelló [a,b,*]

[a] OpenSystems Research Group, Departament de Física de la Matèria Condensada, Universitat de Barcelona, Martí i Franquès, 1, 08028 Barcelona, Spain
[b] Universitat de Barcelona Institute of Complex Systems UBICS, Martí i Franquès, 1, 08028 Barcelona, Spain
[c] Technische Universität Wien, Bibliothek, 1040 Wien, Austria
[d] Technische Universität Wien, future.lab Research Center, 1040 Wien, Austria
[e] Learning and Research Resources Centre (CRAI), Universitat de Barcelona, Baldiri Reixac, 1, 08028 Barcelona, Spain

A R T I C L E I N F O

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A B S T R A C T

Urban areas face complex sustainability challenges that demand new approaches to knowledge production. While citizen science (CS) is increasingly recognised as a promising avenue in scientific research, its specific contributions to urban sustainability, sustainable urban transformation, and urban planning remain insufficiently synthesised. This systematic literature review analyses academic publications that explicitly reference CS to clarify its current and potential roles in these domains. Our review identifies a marked increase in scholarly attention—between 2022 and 2024—reflecting the growing recognition of CS as a valuable approach for addressing urban sustainability issues. Using the bibliometric-network tool VOSviewer, we reveal three major thematic clusters: (1) biodiversity, ecology, and conservation; (2) methodologies and practices; and (3) humans and communities. Well-established strands, especially in biodiversity and conservation, highlight the long-standing integration of CS into species monitoring, ecological assessment, and food-production initiatives. The role of citizens emerges as highly diverse, ranging from experiential experts to collaborative data producers. More recent work points to emerging interdisciplinary applications linking community engagement with environmental health, public health, and climate change. Despite this momentum, key gaps remain. These include the limited participation of underserved communities as well as still weak integration with environmental and climate-justice frameworks. Addressing these gaps is critical for fulfilling the transformative role that supranational bodies already assign to CS in tackling contemporary urban sustainability challenges.

1. Introduction

Sustainable urban transformation is a complex and multidimensional process addressing a variety of sustainability issues, being climate change and resilience one of the most pressing ones (UN-Habitat, 2024). Sustainable urban transformation involves viewing cities not just as sites of challenges but as opportunities for sustainability (McCormick et al., 2013). Achieving this transformation requires active collaboration among diverse stakeholders and the integration of different perspectives, bodies of knowledge, and expertise (Wamsler et al., 2013).

Sustainable urban transformation is not solely a technological issue. It is fundamentally a social, organizational, economic, cultural, and political challenge (McCormick et al., 2013). Inter- and transdisciplinary research and action, co-created and collaborative governance and planning are possible key leverage strategies for this transformative change (Nevens et al., 2013; Smedby & Neij, 2013; Trencher et al., 2013). Among these strategies, experimentation and the collaborative production of knowledge have consistently played a crucial role in urban settings (Gehl, 2010; Healey, 1997; Marshall, 2009). Over time, the values and principles guiding these practices have shifted, reflecting broad societal, technological, and environmental changes. Citizen participation occupies an increasingly pivotal position in urban planning, informing decision-making processes and contributing to the creation of more inclusive, adaptive, and responsive urban environments (Arnstein, 1969; Friedmann, 2020; Innes & Booher, 2004). Lately, the discussion around citizen participation in urban planning has also

* Corresponding author at: Despatx 3.22, Departament de Física de la Matèria Condensada, Universitat de Barcelona, Martí i Franquès, 1. Barcelona E-08028, (Spain).
E-mail address: josep.perello@ub.edu (J. Perelló).

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gained intensity, focusing mainly on the methodological approaches (Foroughi et al., 2023; Jiménez-Caldera et al., 2024; Li et al., 2020), the tools able to facilitate participation (Kahila-Tani et al., 2019; Wilson et al., 2019) and the collectives that can participate to knowledge coproduction (Ataol et al., 2019; Hewidy & Harsia, 2025). Urban planning is closely linked to urban sustainability, which refers to the application of sustainability principles in cities, encompassing societal, economic, and environmental dimensions (Finco & Nijkamp, 2001; Huang et al., 2015; Jenks & Jones, 2008; Pallathadka et al., 2023). This connection has been recognised for over two decades (Næss, 2001). Numerous studies also highlight that integrating urban planning with blue-green infrastructure and ecological approaches is an emerging and promising practice (Ahern, 2013; Puchol-Salort et al., 2021).

Sustainable urban transformation, urban sustainability, and urban planning are thus deeply interconnected fields in which citizen participation and engagement are becoming increasingly important. Alongside civil society and local communities, a range of additional actors participate in the three fields, notably the public and private sectors and knowledge and research institutions (Ernst et al., 2016; Wolfram et al., 2016). While international and supranational bodies also play an important role in the fields of urban transformation and sustainability (Langer, 2025), urban planning tends to involve actors with a more local focus, such as planning professionals, facilitators, and mediating or support organizations (Nared & Bole, 2020). Perspectives on urban transformation and urban sustainability are still the subject of debate (Elmqvist et al., 2019; Hölscher & Frantzeskaki, 2021; Huang et al., 2015; Wolfram et al., 2016). By contrast, participatory urban planning is generally associated with a more consensual process, encompassing preparation, engagement, deliberation and co-creation, decision-making, and implementation, as well as subsequent feedback, monitoring, and evaluation. The approaches used can vary considerably, from design-thinking methodologies to applications of artificial intelligence (AI) (Du et al., 2024; Raynor et al., 2017).

When considering citizen participation and knowledge production beyond the fields of urban transformation, sustainability, and planning, citizen science (CS) emerges as an approach gaining significant relevance and visibility across disciplines, policy spheres, and international research agendas. In recent years, international organizations and research bodies have increasingly recognised CS as a strategic component of science policy and open science frameworks (OECD, 2025). CS can be broadly understood as the active engagement of the general public in scientific research tasks (Vohland et al., 2021) and can contribute among others to sustainability transformation by shaping research agendas, mobilizing resources and facilitating socio-technical co-evolution (Sauermann et al., 2020). However, debates about terminology—particularly in the United States—have added complexity to this expansion (Auerbach et al., 2019; Haklay et al., 2021).

Several organizations and practitioners have proposed rebranding citizen science (CS) as *community science* to avoid associations with legal citizenship status and to promote greater inclusivity (Cooper et al., 2021). However, community science has a long-standing history within environmental justice movements, where it refers specifically to community initiated, advocacy-driven research (Ottinger, 2010). A broad rebranding of CS therefore risks appropriating or diluting this established meaning, particularly because that not all CS practices place community leadership or advocacy at their core (Haklay et al., 2021). It is also important to recognize the extensive tradition of participatory research—including action research, participatory action research, community-based environmental research, and other forms of emancipatory or democratic inquiry—that have long addressed questions of community involvement and the coproduction of knowledge (Kindon et al., 2010). Furthermore, citizen observatories—predominantly in Europe—create structured, networked systems for monitoring environmental or societal phenomena, often integrating volunteers in co-design and data governance (Soacha-Godoy et al., 2025; Wehn et al., 2015).

Several bibliometric studies analysed the evolution of CS through the associated publications' records. Some years ago, Ottinger (2010) demonstrated the growing use of the term "citizen science" in scientific articles and the increasing acceptance of participatory practices. Kullenberg and Kasperowski (2016) confirmed this trend while emphasizing the predominance of the scientific contributions, at that time, in the field of biology, conservation and ecology. Bautista-Puig et al. (2019) later identified four major clusters based on keywords co-occurrence in CS publications, labelled as HEALTH, BIO, GEO and PUBLIC. By comparing these clusters during different time periods, they identified different growing trends within an increasingly richer and complex CS landscape. Bibliometric studies also provided detailed information on how CS contributes to scientific disciplines such as for example social sciences and humanities in a broad level (Tauginienė et al., 2020) but also more specific disciplines such as earth science (Odenwald, 2020) or ecology (Castagneyrol et al., 2023). Other efforts are oriented to specific topics: sustainable agriculture (Ebitu et al., 2021), water resources management (De Filippo et al., 2021) or healthcare (Ciasullo et al., 2022). The impact of CS has also been reviewed in the literature referring to educational and scientific outcomes (Finger et al., 2023; Hadjichambi et al., 2023) or the changes in participants' attitudes, behaviours and knowledge (Somerwill & Wehn, 2022). Bibliometric studies on CS are also able to identify most significant journals and authors (Barui & Mazumder, 2023; Hajibayova et al., 2021; Pelacho et al., 2021).

Besides, CS has the potential to tackle societal challenges and to foster new policies (Schade et al., 2021). Especially, CS has been proven to be able to significantly interact with the growing relevance field of sustainability policies (Criscuolo et al., 2023) and to help monitoring and achieving the Sustainable Development Goals (SDGs) (Ballerini & Bergh, 2021; Fraisl et al., 2026, 2023, 2020). Sauermann et al. (2020) also argue that CS can be key in problem identification and research agenda setting on complex societal challenges, in mobilizing human and financial resources to accelerate transitions that are required to be encompassed with socio-political processes, and on facilitating the coevolution related to topics that involve new techno-scientific solutions but also social elements.

In urban contexts, SDG3 (Good health and wellbeing), SDG11 (Sustainable cities and communities), and SDG13 (Climate action) were identified as predominantly addressed by CS practices (Liu et al., 2023). Croese et al. (2021) also convincingly reported how SDG11 indicators could be co-produced using CS in Angola and Mozambique cities, where data availability for SDG 11 indicators is scarce. A number of CS case studies are also reported, demonstrating how CS can bring to the table new scientific information that could not be obtained otherwise and that can foster new urban policies, as for example in the case of air pollution (O'Regan et al., 2024; Perelló et al., 2021) or urban heat islands (Calhoun et al., 2024).

Overall, there is a lack of comprehensive knowledge on how CS contributes worldwide to the broad and evolving field of sustainable urban transformation and urban sustainability. To our best knowledge, systematic literature review or bibliometric studies have not specifically addressed this gap. Concerning Urban Planning and CS, we are only aware of one recent publication identifying CS related publications classified by WoS under the Urban Studies and Regional Urban Planning (USRUP) field (Beck & Mitkiewicz, 2025). Whereas CS has demonstrated its potential to address various sustainability challenges (Ballerini & Bergh, 2021; Criscuolo et al., 2023; Fraisl et al., 2026, 2023, 2020; Sauermann et al., 2020), a deeper understanding of the current state of research in urban contexts is needed. This knowledge would help guide future CS initiatives in this field and maximize their policy impact.

Therefore, the main research question explored in this paper is: *RQ1-What are the contributions of CS to sustainable urban transformation, urban sustainability and urban planning?* Through a systematic literature review, we identify and analyse relevant studies to map the key themes addressed in this field. To gain a deeper and more nuanced understanding, we also examine the following secondary research questions:

RQ2- What are the key topics where CS bring or potentially could bring new insights? and RQ3- What are the possible roles of citizens when envisioning CS contributions in this field? To address these questions, we employed a two-step comparative systematic literature search and analysis process.

2. Methodology

2.1. Main principle of the bibliometric analysis

To address our research questions, we adopt a systematic literature review (SLR) approach. In urban settings, a similar approach has been taken to, for instance, explore sustainability (Falana et al., 2025; Pekdemir et al., 2025; Sharifi et al., 2024), citizen engagement (Foroughi et al., 2023) or urban design (Pia & Bezboruah, 2025). SLR analyses a comprehensive body of literature on a specific topic within a defined period. The approach uses a replicable and transparent process to minimize bias and ensure traceability in data processing (Denyer & Tranfield, 2009). SLR is particularly suitable for developing empirically validated theoretical frameworks (Levy & J. Ellis, 2006). In this SLR, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 (PRISMA 2020) protocol was followed (Page, McKenzie, et al., 2021; Page, Moher, et al., 2021). The PRISMA 2020 protocol is a recognised framework created to enhance the transparency and reproducibility of systematic reviews. Although it was primarily designed to evaluate the effect of health interventions, it has been used in many other fields to perform SLRs, including those encompassing an urban perspective (Falana et al., 2025; Foroughi et al., 2023; Pekdemir et al., 2025; Pia & Bezboruah, 2025; Sharifi et al., 2024; Son et al., 2023).

Our systematic SLR was conducted using two distinct databases to minimize publication bias: (1) Web of Science (WoS) and (2) Scopus. While both databases primarily index peer-reviewed journals and have some overlap, Scopus includes a broader range of European journals and conferences, whereas WoS focuses more on high-impact English publications (Mongeon & Paul-Hus, 2016; Zhu & Liu, 2020). To complement the bibliographic databases search, we also used handsearching and a triple screening of the records, both of which are described in detail below.

The search keywords were collaboratively defined by the authors of this manuscript, incorporating perspectives from diverse disciplinary backgrounds and specifically targeting urban planning (see Table 1). An initial search using the phrase "sustainable urban transformation" yielded a limited number of records —58 in WoS and 67 in Scopus—and none when combined with "citizen science" (see search #5 in Table 2). To ensure comprehensive coverage of the sustainable urban transformation and urban sustainability domains, additional keywords such as "cities," "sustainability," and "development" were introduced while retaining the exact phrase "citizen science" (see search #7, 9 and 11). In addition, the keyword "urban planning" was combined with "citizen science" and led to a relevant number of records (see search #13). Just as a reference, keyword searches for "citizen observatory/ies" and "community-based environmental monitoring", combined with "urban" were conducted in WoS (accessed 30 January 2026). Compared with the broader search using "citizen science", these queries yielded very few results for the first term (9 records) and none for the second.

Table 1
Search keywords collaboratively selected for the literature search.

Thematic field 1: citizen science	Thematic field 2: sustainable urban transformation and urban planning
"citizen science"	"sustainable urban transformation*" / "urban sustainability transformation*" "urban" / "city" / "cities" "sustainable" / "sustainability" "transformation*" / "development" "urban planning"

Table 2
List of search sequences in WoS and Scopus for building Datasets I, II and III.

Search	String and Booleans	WoS[a]		Scopus[a]	
		Accessed 09-09-22	Accessed 17-09-24	Accessed 12-09-22	Accessed 17-09-24
#1	"citizen science"	8002	10,744	7563	10,755
#2	"sustainable urban transformation*"	58	79	67	116
#3	"urban sustainability transformation*"	25	38	21	33
#4	#2 OR #3	82	116	87	148
#5	#1 AND #4	0	0	0	0
#6	"urban" AND ("sustainable" OR "sustainability") AND "transformation*"	3701	4721	3968	5780
#7	#1 AND #6	10	12	6	11
#8	("urban" AND ("sustainable" OR "sustainability")) OR ("urban" AND "transformation*") OR (("sustainable" OR "sustainability") AND "transformation*")	98,040	120,206	111,648	149,994
#9	#1 AND #8	145	202	128	216
#10	("urban" OR "city" OR "cities") AND ("sustainable" OR "sustainability") AND ("transformation*" OR "development*")	48,138	61,666	62,026	82,416
#11	#1 AND #10	82	115	73	111
#12	"urban planning"	25,794	40,720	73,285	79,972
#13	#1 AND #12	60	92	72	110
#14	**#7 OR #9 OR #11 OR #13**	**198**	**286**	**194**	**315**

[a] in WoS, the search was done by Topic (Title, abstract and indexing) and in Scopus by Title, abstract and keywords.

2.2. Search protocol

Using strings and Boolean operators, relevant records were retrieved. Two searches were respectively performed in September 2022 and in September 2024, to better investigate the most recent publications trends. The bibliographic databases search sequence is detailed in Table 2. The list of records retrieved through the WoS and Scopus databases were further combined and screened as reported in a flow diagram based on PRISMA 2020 template (see Fig. 1). To handle the records retrieved, we used Zotero, an Open-Source reference management software. The first search done in sequence (September 2022) through WoS and Scopus produced a total of 198 references and 194 references, respectively (search #14, Table 2). Local languages may play a significant role in urban transformation processes literature, but our search was limited to English papers so that all authors could assess the content of all search results.

These records were complemented by handsearching done by 5 researchers from 5 different institutions with the goal to include publications that did not appeared in the initial search but nevertheless were situated at the intersection of "sustainable urban transformation/urban sustainability/urban planning" and "citizen science". This handsearching produced 82 new records and mitigated retrieval biases that always exist in bibliographic database searches. After removing 166 duplicated references (see Fig. 1), a list of 308 references was critically assessed, based on the reading of the full texts, by 3 researchers from 3 different

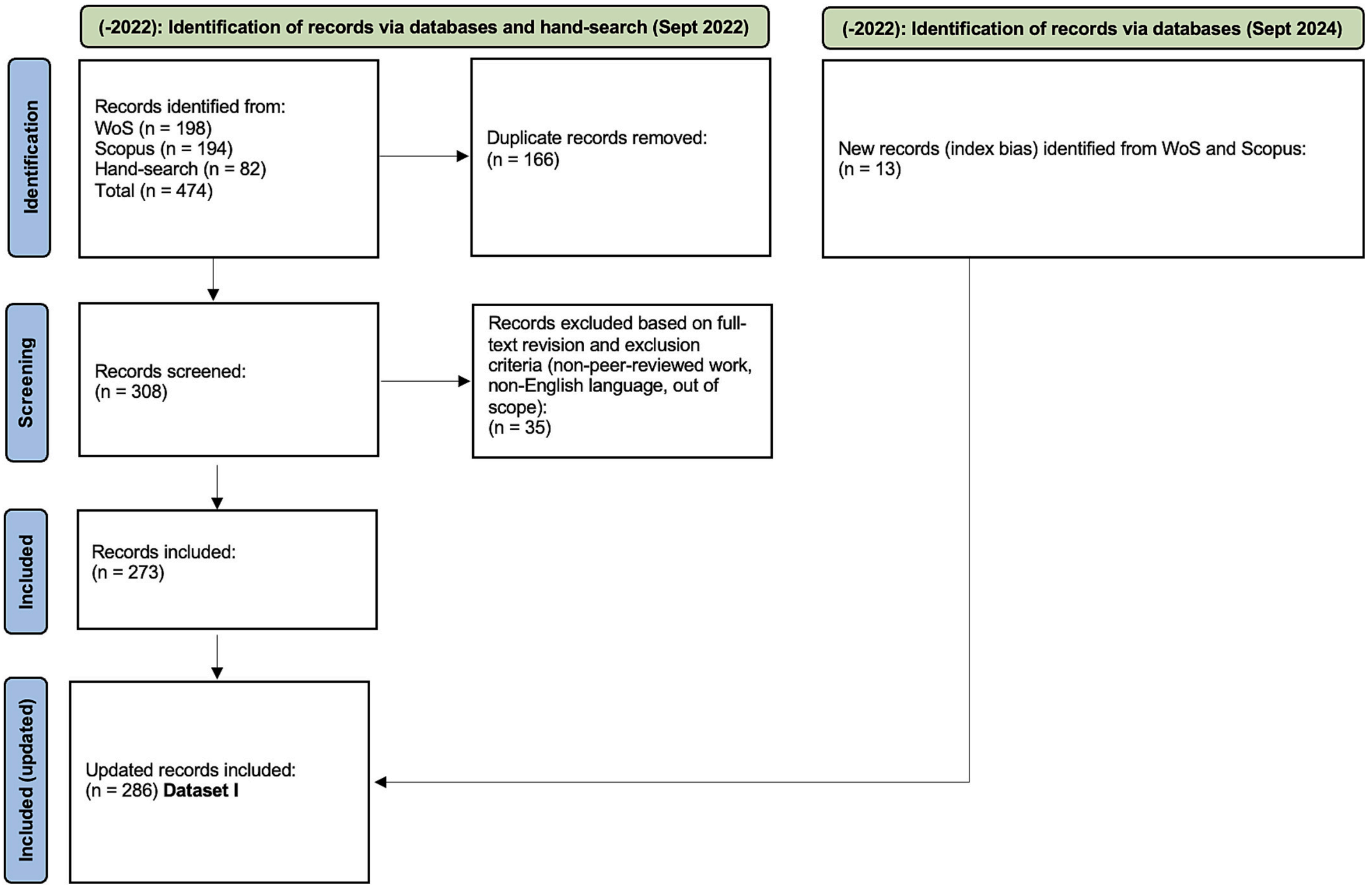

Fig. 1. The PRISMA literature selection process for Dataset I.

institutions and having different expertise (IB, BG and CP). In a first stage, the researchers independently reviewed the full texts. The criteria established for the exclusion and inclusion of the records were the following: 1) only peer-reviewed works were included (articles, conferences proceedings, books' chapter or full books). Presentations or non-published works, such as reports or master theses, were excluded, as well as editorial contents; 2) records written in another language than English were excluded; 3) only references addressing the three components of the search were included: a) citizen science, b) in an urban context, and c) related to sustainable transformation and/or sustainability and/or planning. When one component was not present, the reference was excluded. Each researcher established a proposed list of excluded references. The references excluded by the 3 researchers were automatically excluded. The other references proposed for exclusion by only one or two researchers were discussed case by case until consensus was obtained. Examples of out of scope excluded references are Havas et al. (2022) because the urban context was not present or Sartirana et al. (2020) because the citizen science perspective was not included. After the exclusion of 35 papers, a dataset of 273 references was obtained.

A second and identical search was done in September 2024. WoS and Scopus databases searches produced a total of 286 and 315 records, respectively (search #14, Table 2). The same identification process was followed as before (see Fig. 1 and Supplementary Material, Fig. S1) and the sum of records (Scopus, WoS and handsearching) underwent a triple screening. The resulting dataset was then compared with the first dataset records retrieved in September 2022 (273 references, see above and Fig. 1). 125 new records were identified.

From these 125 records, 13 corresponded to documents published before the first keywords search date in September 2022. The references were not retrieved when the first search was done, due to their late indexation in WoS and Scopus. To correct for the retrieval bias, the 13 references were added to the dataset for 2022 and produced the final Dataset I (286 records, see Fig. 1). A specific dataset was also created to analyse trends within a short and recent period (from September 2022 to September 2024, Dataset II: 112 records). It is also possible to merge the two datasets covering the whole period until September 2024 (Dataset III: 398 records). The characteristics of the three datasets finally analysed are summarized in Table 3. In all .ris files, three pairs of terms were merged, following the UK English spelling: neighbourhood and neighborhood, urbanisation and urbanization and policymaker and policy maker. The final .ris files for Datasets I, II and III can be downloaded elsewhere (Bonhoure et al., 2026).

2.3. *Mapping terms in Dataset I (–2022) and Dataset II (2022–2024)*

VOSviewer software (version 1.6.20) was used to construct and visualize bibliometric-weighted networks based on the records from

Table 3
Overview of the Datasets I, II and III.

Dataset name	Date range of records publication	Number of records	Additional information
Dataset I	Until Sept 12, 2022	286	Analysed through VOSViewer (Fig. 2, Tables 3, 6 and 7)
Dataset II	From Sept 13, 2022 until Sept 17, 2024	112	Analysed through VOSViewer (Fig. 3 and Table 8)
Dataset III (Dataset I + Dataset II)	Until Sept 17, 2024	398	Used for thematic screening of records (Tables 4 and 5)

Datasets I and II (see Figs. 2 and 3). To address our research questions, we generated term networks, two-dimensional maps where the co-occurring terms in titles or abstracts are connected and grouped. To avoid as much as possible biases, all associated keywords within the records were discarded because criteria may strongly differ across publications and publishers. A pair of terms is linked if they appear together in the same record and their link strength indicates the number of co-occurrences across all the records of a dataset. The total link strength of a given term is finally calculated as the sum of its link strengths with all other co-occurring terms. A higher total link strength suggests that the term has a strong thematic connection within the dataset, whereas a lower total link strength indicates a weaker or more indirect relationship with other terms.

VOSviewer automatically generates clusters of terms by applying an optimization algorithm that maximizes the density of links within each group of terms. In this process, terms with strong co-occurrence relationships are grouped together, forming distinct, non-overlapping clusters, where each term belongs to only one cluster. Each cluster can be interpreted as representing a shared topic, method, or approach, based on the terms it contains.

More detailed information describing the algorithms used in VOSviewer can be found in a set of papers (Van Eck & Waltman, 2014, 2010). It has been demonstrated that terms co-occurrence analysis of a given literature set can effectively represent research hotspots and predicts future areas that may acquire more importance, and thus help researchers to identify aspects that have not yet been studied (Dai et al., 2024; Khatibi et al., 2025; Sepehri & Sharifi, 2025).

Dataset I

The titles and abstracts of the 286 records contain 8473 terms. The minimum number of occurrences for a term was set to 10 and 238 terms met the set threshold. After the VOSviewer relevance filter, 143 terms were finally selected for the analysis and 20 were manually removed, because they were associated with geographic information (e.g. *world*, *China*, etc.) or were too unspecific and thus did not bring relevant information (e.g. *article*, *order*, etc.). The list of the removed terms can be found in the Supplementary Material (Table S1).

Dataset II

The titles and abstracts of the 112 records contain 3993 terms. The minimum number of occurrences for a term was set to 10 and 89 terms met the set threshold. After the VOSviewer relevance filter, 53 terms were finally selected for the analysis. Out of these 53 terms, 10 were deleted, following the same criteria as to the Dataset I (see above and the Supplementary Material Table S1).

Dataset III

Dataset III merges Datasets I and II covering the whole period until September 2024 (398 records).

Conceptual publications screening: We want to identify references able to bring new conceptual insights to the research question: *RQ3- What are the possible roles of citizens when envisioning CS contributions in this field*? The 398 records from Dataset III were critically scanned by one author (IB) and those papers proposing conceptual approaches to envision CS contribution to sustainable urban transformation/urban sustainability/urban planning were selected. Papers selected were then also critically reviewed by the other authors. The six publications finally selected are listed and described in Table 4.

Species, garden and biodiversity publications screening: We want to characterize these important topics (see below) in relation to the research question *RQ2- What are the key topics where CS bring or potentially could bring new insights*? Again, the 398 records from Dataset III were critically scanned by one author (IB), identifying the records

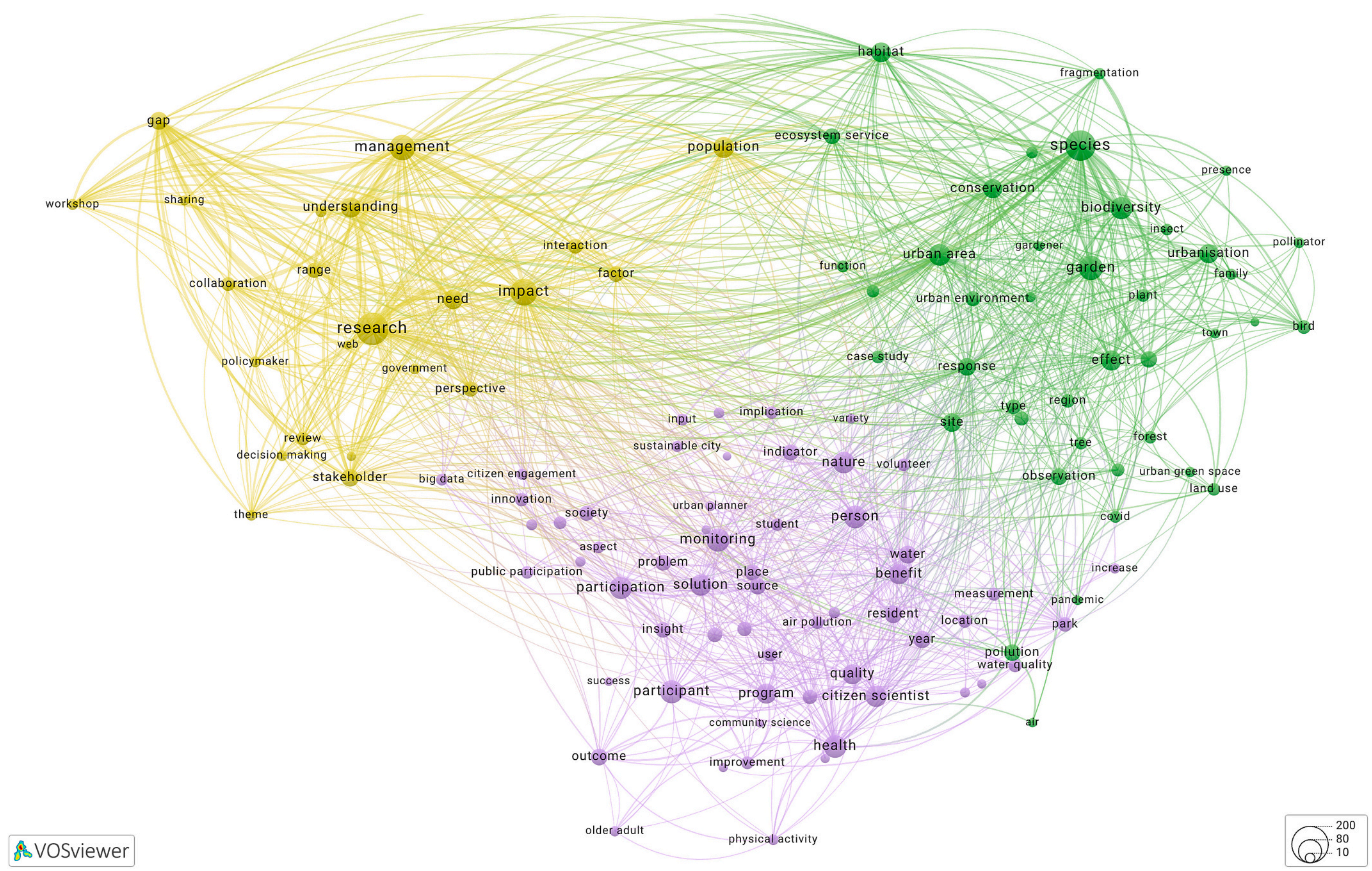

Fig. 2. Overview of the 3 clusters corresponding to Dataset I. Only links with a strength equal o superior to 10 are displayed. Green cluster is named Cluster 1 (CL1), yellow cluster is named Cluster 2 (CL2) and purple cluster is named Cluster 3 (CL3). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

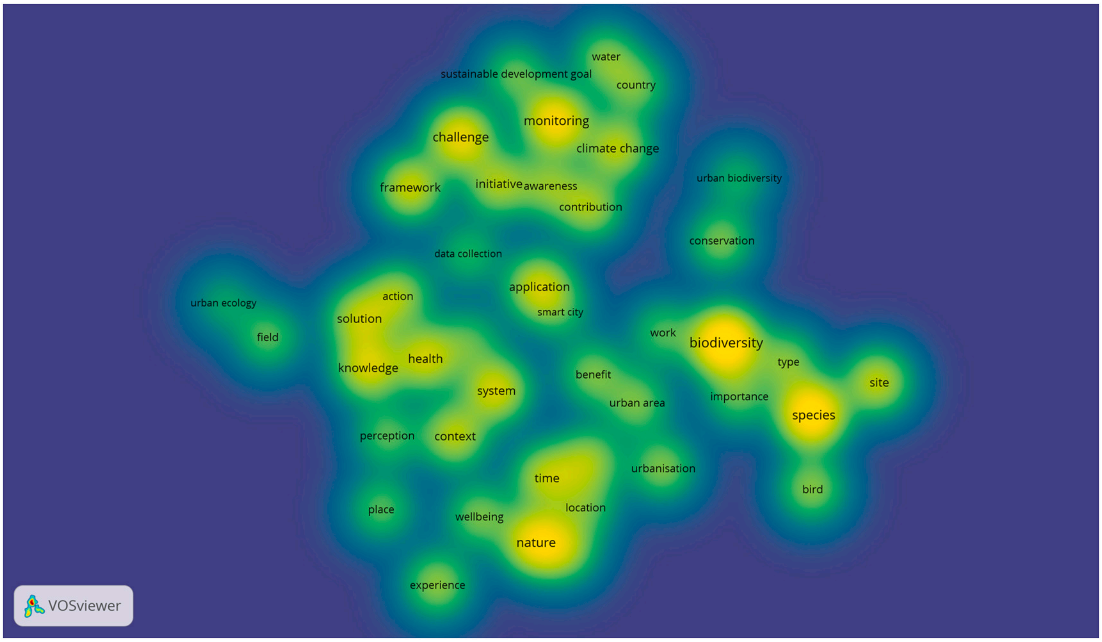

Fig. 3. Density map of the terms corresponding to Dataset II.

related to terms in Dataset I: *species, garden,* and *biodiversity*. Papers selected were then also critically reviewed by the other authors. For the 31 publications finally selected, the data collection methods and digital tools were identified based on full text reading and are reported in Table 5.

3. Results

The number of records retrieved in the initial search keywords experienced a marked growth between 2022 and 2024. If we consider that search #14 (see Table 2) roughly represents the intersection of CS with sustainable urban transformation, urban sustainability and urban planning, it experienced an increase of 44.4% for WoS and of 62.4% for Scopus. In their SLR related to CS and USRUP, Beck and Mitkiewicz (2025) also observe a sharp increase of records related to sustainability. Within the same period, the number of records corresponding to the search "citizen science" only (search #1, Table 2) grew in a smaller proportion: 34.3% for WoS and 42.2% for Scopus, respectively. Consequently, the proportion of publications focusing on the intersection of CS with sustainable urban transformation, urban sustainability and urban planning shows a stronger relative growth than that observed for CS publications overall.

3.1. Clusters analysis for Dataset I (–2022)

The network built by VOSviewer for Dataset I (–2022) is represented in Fig. 2. The 123 terms have 4675 links in total and a total link strength of 42,752. VOSviewer software automatically organised the terms into three clusters, which have been arbitrarily associated to three distinct colours: green if it belongs to cluster CL1, yellow cluster if it belongs to CL2, and purple if it belongs to CL3. As detailed hereafter, CL1 is related to biodiversity, ecology and conservation while CL2 is an overarching cluster related to methodologies and practices and CL3 focuses on humans and communities. Table 6 displays the ten terms with the greatest number of occurrences for each of the three clusters, the number of links of each term jointly with their total link strength, as well as the total number of terms for each cluster.

In CL1, we can observe three important features: (i) 5 out of the top 10 terms refer to ecology and green spaces: *species* (131 occurrences), *garden* (83), *biodiversity* (69), *habitat* (55), *conservation* (52); (ii) 3 out of 10 refer to an urban component: *urban area* (67), *urbanisation* (52) and *site* (48) and (iii) 2 out of 10 can be related to the research process: *effect* (57) and *response* (44). The human component mostly appears through human-made urban spaces such as *garden*, *domestic garden* or *green space*. *Garden* is the second most occurrent term and is strongly linked to other CL1 terms like *species* (link strength 115), *habitat* (97) and *conservation* (85) (see Supplementary Material Fig. S2). This is to be related to the fact that numerous CS projects dealing with biodiversity rely on the observations done in gardens. The Top 10 terms have all a comparable number of links (ranging from 76 to 108). However, when looking at their total link strengths, we can observe some disparities. While *species* also possesses the largest total link strength (2814), *urban area* (1800) and *habitat* (1764) occupy the second and third positions in the largest total link strength ranking, despite ranking fourth and sixth in terms of occurrences. All in all, the term *species* is central in CL1 across all metrics, underscoring its pivotal role. Beyond CL1 and as shown in Fig. S3 in Supplementary Material, *species* maintains strong connections with CL2 terms, notably *research* (link strength = 112, 4.0% of the total link strength of *species*) and *management* (link strength = 104, 3.7%). These connections highlight the robustness and longstanding focus on species observation in urban habitats within CS.

In CL2, the first three terms regarding occurrence are *research* (148), *impact* (101) and *management* (92), as shown in Table 6. These three terms are occupying a notable place, compared to the next seven in the ranking, whose number of occurrences range from 62 to 33. *Impact* and *management* terms are stronger connected to CL1 than to CL3. *Research* has a comprehensive role (see Fig. S4 in Supplementary Material), having the greatest number of links (119) and total link strength (4192). This can be related to the fact that CS is above all a research methodology and thus *research* is strongly connected with a wide number of other terms. Overall, the meaning of the CL2 terms relates to overarching methodologies and practices, divided into what (*research*), how (*management, review, collaboration*) and why (*impact, understanding, need*). As *research* has a considerable role in the network, we further analysed its connections, inside and outside CL2. Inside CL2, *research* has a link strength greater or equal to 30 with 18 terms. The four terms having the highest link strength with research within CL2 are *gap* (link strength 383), *management* (350), *impact* (273) and *understanding* (242) emphasizing crucial aspects in CS practice. Outside CL2, *research* is connected with 14 terms with a link strength greater or equal to 30: six

Table 4
Title, citation, typology and main conceptual visions of selected conceptual papers.

Title of the papers	Reference	Paper typology	Potentials of CS for sustainable urban transformation, urban sustainability and urban planning
Exploring the entry points for citizen science in urban sustainability initiatives	(Colston et al., 2015)	Conceptual reflection	- Ensure that communities are at the centre of urban development - Promote transdisciplinary community-led model - Recognize citizens as "experts-by-experience" - Promote more power sharing by professional scientists, resulting in a greater focus on social and environmental justice
Citizen Design Science: A strategy for crowd-creative urban design	(Mueller et al., 2018)	Conceptual Reflection Tool description	- Promote a shift from a smart city to a responsive city where citizens are "experts by experience" - Provide ICT solutions to collect a large amount of data - Participate to the creation of new "Citizen Design Science" discipline as a merge between CS, Citizen Design and Design Science
Pathways to urban sustainability: How science can contribute to sustainable development in cities	(Bansard et al., 2019)	Conceptual reflection	- Enhance citizens' awareness on urban sustainability and their knowledge of the local environment - Can potentially induce a behavioural change - Urban transdisciplinary research can foster capacity building, counter the lack of local level data and produce actionable knowledge related to urban local issues
Citizen Science: involving citizens in research projects and urban planning	(Franco & Cappa, 2021)	Conceptual reflection Examples analysis	- Promote technology-mediated interactions between citizens and public organizations - Provide high quantity of data at low cost - Provide useful tools to urban planners to solve social and environmental problems
Citizens and cities: Leveraging citizen science and big data for sustainable urban development	(Cappa et al., 2022)	Conceptual reflection Review of papers	- Collect and analyse data for socially and environmentally oriented projects in a rapid and convenient way - Function as a source of big data, by asking for additional information from citizens involved in CS projects - Produces environmental, social, and economic for the sustainable development of urban areas
Advancing equitable 'resilience imaginaries' in the Global South through dialogical participatory mapping: Experiences from informal communities in Brazil	(Pitidis et al., 2024)	Conceptual reflection Case study	- Contribute to the new "dialogical participatory mapping" approach - Foster the role of formerly marginalized voices in the advancement of local urban policies - Contribute to the production of alternative "counter city" visions

belong to CL1 (*species*, 112; *habitat*, 104; *urban area*, 95; *ecosystem service*, 61; *response,* 47; and *conservation, 31*) and eight belong to CL3 (*participation*, 48; *person,* 46; *health*, 36; *citizen engagement*, 35; *big data*, 32; *outcome*, 31; *participant*, 30; and *citizen scientist*, 30). These terms point us to which aspects could be considered when delineating the main research trends of the current SLR. While the research trends related to CL1 are strongly focused on the identification of species in urban areas, the research trends related to CL3 are more diverse, as they are represented by at least three approaches. Namely, five out of these eight terms identified in CL3 relate to citizen participation and engagement (*participation*, *person*, *citizen engagement*, *participant* and *citizen scientist*), two relate to research outputs (*big data* and *outcome*) and one to a particular research field, *health*. Finally, interestingly, the term *policy-maker* is well connected (see Fig. S5 in Supplementary Material) to other CL2 terms, but it only shows weak connections with a limited number of CL1 terms (*urban area*, link strength 16, *habitat*, 15 and *species*, 14) and CL3 terms (*outcome*, 12, *health*, 12 and *program*, 10).

In CL3, we can identify different thematic subgroups of terms when observing the network of Fig. 2 and considering Table 6. The first one refers to citizens' participation in research: *participant* (occurrences, 75), *person* (73), *participation* (71), and *citizen scientist* (63). The second one is related to wide thematic scopes covered in CS in urban contexts: *health* (73) and *nature* (66). The third one deals with methodologies and outcomes: *monitoring* (75), *solution* (64), *benefit* (58) and *program* (57). CL3 has more terms (59) than CL1 (41) and CL2 (23). However, CL3 has several terms sharing almost equal importance and thus differing from the presence of central ones in CL1 and CL2, namely *species* and *research*. The top 3 terms with regards to occurrences (*participant*, 75, *monitoring, 75,* and *health*, 73) are linked with the CL1 and CL2 but also with most of the terms of CL3 (see Figs. S6, S7 and S8 from the Supplementary Material). The third term with regards to occurrences, *health* can potentially be framed taking two different perspectives. To determine which one is dominant, we retrieved the Dataset I records where the term *health* was present in the title. The first approach is focused exclusively on human health and corresponds to the majority of references retrieved (Allen, 2020; Chrisinger et al., 2018; Fermeglia & Pedrosa, 2022; Grazuleviciene, Andrusaityte, Dedele, et al., 2020; Grootjans et al., 2022; Ottaviano et al., 2019; Rubio et al., 2022; Sarmiento et al., 2020; Van Geenhuizen & Suman, 2021; Vander Meer, 2022; Vandevijvere et al., 2019; Wood et al., 2022). The second approach takes a broader perspective through "One Health" and "Planetary Health" concepts, but it is much less extensive in terms of number of references retrieved. For instance, "One Health" term appears in only 2 records (Ellwanger et al., 2022; Manikam et al., 2020). Besides, the CL3 terms *community member*, *neighbourhood* and *community science* appear with no connection with CL1. This could thus be related to a markedly different way to understand CS compared to those practices more focussed biodiversity and

Table 5
Title, citation, and CS data collection methods reported in Dataset III records including the terms species, garden and biodiversity.

Title of the paper	Citation	Data collection methods
Making the case for gardens: Estimating the contribution of urban gardens to habitat provision and connectivity based on hedgehogs (*Erinaceus europaeus*)	(App et al., 2022)	Garten App
A combined approach to classifying land surface cover of urban domestic gardens using citizen science data and high resolution image analysis	(Baker et al., 2018)	Online survey
Birds seen and not seen during the COVID-19 pandemic: The impact of lockdown measures on citizen science bird observations	(Basile et al., 2021)	iNaturalist platform
Unprecedented Density and Persistence of Feral Honey Bees in Urban Environments of a Large SE-European City (Belgrade, Serbia)	(Bila Dubaic et al., 2021)	Data collection by beekeepers
Can citizen science provide a solution for bat friendly planning?	(Border et al., 2022)	Online survey
Predicting the likely impact of urbanisation on bat populations using citizen science data, a case study for Norfolk, UK	(Border et al., 2017)	Online survey
How to build a biodiverse city: environmental determinants of bird diversity within and among 1581 cities	(Callaghan et al., 2021)	GBIF platform
Capitalizing on opportunistic citizen science data to monitor urban biodiversity: A multi-taxa framework	(Callaghan et al., 2020)	iNaturalist platform
Heterogeneous urban green areas are bird diversity hotspots: insights using continental-scale citizen science data	(Callaghan et al., 2019)	eBird platform
Productivity and Efficiency of Community Gardens: Case Studies from the UK	(Caputo et al., 2023)	Gardener handbook
Productivity, resource efficiency and financial savings: An investigation of the current capabilities and potential of South Australian home food gardens	(Csortan et al., 2020)	Gardener written data collection
Citizen Science Approach for Assessing the Biodiversity and Ecosystem Service Potential of Urban Green Spaces in Ghana	(Damptey et al., 2022)	Written answers in semi-structured questionnaire
Mapping abundance distributions of allergenic tree species in urbanized landscapes: A nation-wide study for Belgium using forest inventory and citizen science data	(Dujardin et al., 2022)	Observations.org digital platform
Private gardens in a town immersed in a National Park: Potential for conservation and highly valued under COVID lockdown	(Elizalde & Lambertucci, 2022)	Online surveys
Butterfly Diversity in a Rapidly Developing Urban Area: A Case Study on a University Campus.	(Fang et al., 2004)	Field observation and sampling
Species Richness and Composition of Forest Birds in Urban Parks and Reserves of Buenos Aires City, Argentina	(Godoy et al., 2024)	eBird platform
Data-integration of opportunistic species observations into hierarchical modeling frameworks improves spatial predictions for urban red squirrels	(Grabow et al., 2022)	Camera trap and online platform
Domestic gardens as favorable pollinator habitats in impervious landscapes	(Levé et al., 2019)	Online platform
Prioritizing green spaces for biodiversity conservation in Beijing based on habitat network connectivity	(Lv et al., 2019)	Online platform
Colonization and habitat selection of a declining farmland species in urban areas	(Mayer & Sunde, 2020)	App or web-based module
Nectar gardens on school grounds reconnect plants, birds and people	(Mnisi et al., 2021)	Field observation sessions
The case for citizen science in urban agriculture research	(Pollard et al., 2017)	Online survey
Influence of landscape matrix on urban bird abundance: evidence from Malaysian citizen science data	(Puan et al., 2019)	Online survey
Urban Planning Insights from Tree Inventories and Their Regulating Ecosystem Services Assessment	(Rossi et al., 2022)	Field data collection / App
Evaluating the use of intervarsity bioblitz as an engagement and reporting tool for biodiversity in green and blue spaces on urban campuses: a case study of Irish universities	(Ryan-Fogarty et al., 2022)	Bioblitz
The 'GartenApp': Assessing and communicating the ecological potential of private gardens	(Schneider et al., 2020)	Garten App
Towards Ecological Management and Sustainable Urban Planning in Seoul, South Korea: Mapping Wild Pollinator Habitat Preferences and Corridors Using Citizen Science Data	(Serret et al., 2022)	App
Exploring the secret gardens of the city: An assessment of human-nature interactions on informal green space using citizen science data	(Stanford et al., 2024)	iNaturalist platform
Discovering urban nature: citizen science and biodiversity on a university campus	(Tiago et al., 2024)	iNaturalist platform
Research Note: Garden-owner reported habitat heterogeneity predicts plant species richness in urban gardens	(Young et al., 2019)	Questionnaire
Using remote-sensing and citizen-science data to assess urban biodiversity for sustainable cityscapes: the case study of Athens, Greece	(Ziliaskopoulos & Laspidou, 2024)	GBIF platform

conservation from CL1. The human health becomes relevant in this context as *health* is linked to *community member* and *neighbourhood*. *Physical activity* and *older adult* are also placed in the periphery of CL3, in the vicinity of community-related terms. Finally, although they belong to CL1, two terms no related to biodiversity, namely *pollution* and *air*, keep a close distance with CL3, demonstrating their bridging role in-between CL1 and CL3 and their relation to human wellbeing.

Table 7 displays the 15 newest terms with regards to the average publication date of associated records. Most of them belong to CL3

Table 6
List of top 10 terms (rank based on their occurrences) for each cluster of Dataset I. The number of links and the total link strength are also provided, as well as the total number of terms for each cluster (CL1, CL2 and CL3).

Terms	Occurrences	Links	Total link strength	Total number of terms
CL1				
species	131	102	2814	
garden	83	76	1475	
biodiversity	69	97	1302	
urban area	67	108	1800	
effect	57	108	1246	41
habitat	55	97	1764	
conservation	52	106	1181	
urbanisation	52	92	974	
site	48	94	801	
response	44	106	1121	
CL2				
research	148	119	4192	
impact	101	117	3199	
management	92	109	3354	
population	62	102	1648	
understanding	57	113	2159	23
need	53	103	1682	
gap	45	96	2874	
stakeholder	44	102	1539	
factor	35	96	982	
perspective	33	98	831	
CL3				
participant	75	106	1043	
monitoring	75	104	881	
health	73	108	1287	
person	73	107	1077	
participation	71	108	923	59
nature	66	104	1003	
solution	64	102	880	
citizen scientist	63	103	895	
benefit	58	107	1116	
program	57	100	937	

Table 7
List of top 15 terms with the most recent average publication year as provided by VOSviewer for Dataset I, the terms in green belong to CL1 and the ones in purple to CL3.

Rank	Term	Average publication year
1	*community science*	2021.40
2	*concentration*	2021.36
3	*pandemic*	2021.23
4	*covid*	2021.20
5	*air*	2021.42
6	*citizen engagement*	2020.65
7	*air pollution*	2020.60
8	*urban green space*	2020.53
9	*sustainable development goal*	2020.55
10	*forest*	2020.45
11	*health*	2020.41
12	*society*	2020.34
13	*air quality*	2020.33
14	*park*	2020.33
15	*measurement*	2020.33

(*community science, concentration, citizen engagement, air pollution, sustainable development goal, health, society, air quality, park and measurement*) and to CL1 (*pandemic*, *covid*, *air*, *urban green space* and *forest*). None of the newest terms are associated with CL2. This cluster is characterized by terms linked to an older average year of publication, such as *research* (2018.91), *impact* (2019.08), and *management* (2018.67), reflecting the overarching nature of CL2 within the field. The *pandemic* and *covid* terms can easily be related to enhanced observation of urban biodiversity during the Covid lockdown, as observed in several records (Basile et al., 2021; Elizalde & Lambertucci, 2022). Besides, the presence of the term *community science* reflects the exponential growth in publications aimed at enhancing community leadership or advocacy driven research and other forms of emancipatory or democratic inquiry in CS practices. To provide a point of comparison, a simple topic search for "community science" in WoS identified 46 publications in 2019, 88 in 2020, 222 in 2021, 279 in 2022, and 284 in 2023 (WoS, accessed February 21, 2025), indicating that the growth of community science extends beyond the CS scholarship itself.

Finally, urban air quality research is represented by three different terms: *air*, *air pollution* and *air quality*. When screening the Dataset I records containing the term *air* in their titles, 15 records could be retrieved (Cabrini et al., 2021; da Schio, 2020; DeSouza, 2022; Fermeglia & Pedrosa, 2022; Hsu et al., 2020; Kaginalkar et al., 2022; Kenis, 2020; Lepenies & Zakari, 2021; Lu et al., 2022; Mahajan et al., 2021; Rickenbacker et al., 2019; Schaefer et al., 2021; Sirbu et al., 2015; Tubridy et al., 2022; Van Brussel & Huyse, 2019). Some air quality-related papers highlight the community science and community engagement perspective (Hsu et al., 2020; Mahajan et al., 2021; Van Brussel & Huyse, 2019) whereas other focus on underserved or disadvantaged communities and an environmental justice perspective (Kenis, 2020; Lu et al., 2022; Rickenbacker et al., 2019; Tubridy et al., 2022).

To summarize, CL1 is related to biodiversity, ecology and conservation while CL2 is an overarching methodologies and practices cluster displaying what (*research*), how (*management, review, collaboration*) and why (*impact, understanding, need*). Lastly, CL3 is having a marked human-centred dimension as it relates to *participation*, human *health* and *community* and contains many of the most recent terms, in terms of average year of publication.

3.2. Analysis for Dataset II (2022–2024)

Fig. 3 shows the density map generated by VOSviewer based on the 43 terms identified in Dataset II. Although the dataset is too small for a meaningful clustering analysis, it reveals noteworthy insights. Notably, only 20 of these terms did appear in the cluster analysis of Dataset I, suggesting that the field is evolving as shown in Table 8. *Biodiversity* ranks first in terms of occurrences in Dataset II, despite being 11th in Dataset I, highlighting its growing relevance. *Species* maintains the same ranking as in Dataset I, while the top four terms were also present in the network built from Dataset I. Three of these belong to CL1 (*biodiversity*, *species*, and *monitoring*), and one belongs to CL3 (*nature*). For 15 out of the 20 terms, the number of links ranges from 36 to 40, thus revealing a strong connection in-between most of the terms. In terms of total link strength, *biodiversity* (total link strength 631), *nature* (551) and *species*

Table 8
For Dataset II, list of Top 20 terms (rank based on their occurrences). The Dataset II terms that were already present in Dataset I are displayed in bold.

Rank	Term	Occurrences	Links	Total link strength
1	***biodiversity***	**61**	**40**	**631**
2	***species***	**56**	**37**	**520**
3	***monitoring***	**45**	**38**	**383**
4	***nature***	**40**	**40**	**551**
5	*challenge*	40	36	485
6	*knowledge*	34	40	410
7	*system*	34	40	333
8	*application*	32	40	283
9	***health***	**32**	**40**	**358**
10	*framework*	32	39	379
11	***site***	**30**	**32**	**367**
12	*climate change*	29	38	320
13	*context*	29	38	274
14	***solution***	**28**	**40**	**341**
15	***initiative***	**26**	**35**	**207**
16	*contribution*	25	39	238
17	*action*	25	38	351
18	*experience*	23	35	293
19	***bird***	**22**	**26**	**346**
20	*awareness*	21	32	255

(520) are the top 3 terms, which again demonstrates their relevance. Emerging research trends are further indicated by new terms such as *climate change* (rank 13), *action* (rank 17), and *awareness* (rank 20), which were absent from the Dataset I network. A closer examination of Dataset II suggests that climate change-related studies are primarily linked to nature-based solutions (Best et al., 2023; Teerlinck et al., 2024), although challenges related to water supplies are also noted (Treacy, 2022). The term *health* shows minimal change in ranking, dropping slightly from 8th in Dataset I to 9th in Dataset II. A similar trend as in Dataset I is observed among records with the term *health* in their title: one record in Dataset II refers to planetary health (Bhandari, 2024), while four focus on human health (Giovanardi et al., 2023; Hunter et al., 2022; Santos-Tapia et al., 2024; Schmidt et al., 2022).

3.3. Conceptual references analysis for Dataset III

CS and sustainable urban transformation, along with urban sustainability and urban planning more broadly, have developed along distinct paths, each shaped by its own history and unique features. Although research exploring their intersection is still limited, emerging studies highlight the potential of CS to contribute to more sustainable urban futures. Following the protocol outlined in the Methods section, six relevant articles were identified, with their key features summarized in Table 4.

The first conceptual reference analysing the potential of CS for sustainable urban transformation was published by Colston et al. (2015). At a time when CS was far less widespread than it is today, the paper made a bold case for leveraging CS to place communities at the centre in urban development and recognize citizens as "experts-by-experience." It advocates for community-led CS projects and urges professional scientists to share their power, emphasizing a stronger focus on social and environmental justice.

A second conceptual reference also recognizes citizens as "experts-by-experience," but this time within an ICT-driven context. The aim is to shift the focus from smart cities to responsive cities shaped by citizen needs and capable of collecting large volumes of data (Mueller et al., 2018). The paper conceptually and practically explores the intersection of CS, Citizen Design, and Design Science, introducing a new term: Citizen Design Science. The authors propose ICT solutions to address the lack of representativity in traditional face-to-face workshops, where urban planning solutions are co-designed. After a thorough literature review, they present a toolkit that enables citizens to actively participate in Citizen Design Science projects aimed at participatory urban planning. This approach introduces CS as a way of generating quantitative data. The article is being highly cited (109 citations in Web of Science and 139 in Scopus, as of January 21, 2025), but a more limited number of studies explicitly reference the Citizen Science Design term (9 papers in Web of Science, based on a topic search for "Citizen Design Science"; 11 papers in Scopus, based on a search in title, abstract, and keywords, both consulted on January 21, 2025).

Bansard et al. (2019) take a broader view of urban transdisciplinary research but emphasize that CS has a direct impact on participants. According to their article, CS raises awareness of sustainability issues, enhances citizens' understanding of their local environment, and motivates behavioural change. Additionally, they highlight how sharing data collected through field research can help address the lack of local-level data—an obstacle to developing effective sustainability policies. The authors stress the importance of building trust and fostering a sense of shared ownership as fundamental starting points for participatory research. They also emphasize the need to engage diverse stakeholders in defining research questions, arguing that this inclusivity is essential for generating actionable knowledge on urban sustainability challenges.

Franco and Cappa (2021) analysed the role of CS in participatory urban planning, focussing on how advancements in technology have facilitated technology-mediated interactions between citizens and public organizations, making CS an increasingly "effective tool". They reviewed recent research on CS in urban contexts—specifically, its application to the relationship between cities and citizens. The authors highlight that the vast amount of data generated through CS enhances its impact, contributing to the development of smarter cities. Similar to Mueller et al. (2018), they present CS as a way of generating quantitative data. This data-driven approach not only improves urban planning but also raises public awareness of key issues and strengthens community engagement. They emphasize that citizen participation is most effective when it relates to issues "they care about", such as the development of their city or neighbourhood. Moreover, Franco and Cappa (2021) advocate for greater trust from public administrations in citizen-led CS initiatives, citing the high volume of data, the effectiveness of bottom-up approaches, and the cost-efficiency of such projects. Ultimately, they conclude that CS provides urban planners with valuable tools to address social and environmental challenges.

The same authors have contributed to another paper that directly addresses the role of CS in sustainable urban development, this time focusing on the collection of big data as a by-product of citizen participation (Cappa et al., 2022). They propose the concept of "citizen-sourcing" as a hybrid of CS and big data collection. According to them, this approach could offer environmental, social, and economic benefits for the sustainable development of urban areas, while significantly reducing the costs associated with data collection. In this paper, the participants in CS projects are described as "common citizens," a term that may implicitly suggest a power imbalance, particularly in terms of diversity or when the aim is precisely to place at the centre of the research the perspective of those in most vulnerable situations, most underserved and marginalized.

In contrast, a more recent reference takes a fundamentally different perspective, exploring the conceptual and practical inclusion of marginalized voices in participatory urban planning, with a focus on resilience policies (Pitidis et al., 2024). The authors argue that "citizen engagement in this case is not merely a means to facilitate the data collection process, but an opportunity for social learning for both citizens and researchers, through which they acquire greater awareness of the components undergoing change." The reference introduces the methodology of dialogical participatory mapping. Testing this approach demonstrated its effectiveness not only in generating accurate data but also in fostering the equitable development of resilience strategies for marginalized urban communities. The paper from Pitidis et al. (2024) complements the vision from Franco and Cappa (2021) regarding participatory urban planning and confirms that CS could enhance citizens' participation in urban planning from different perspectives.

Fig. 4 is intended to synthesise the distinct approaches to the role of citizens identified in the conceptual papers identified. The figure does not seek to represent all actors, processes, and key dimensions involved; rather, it deliberately focuses on citizens and local communities as central actors in sustainable urban transformation and urban planning. Although simplified, the figure bridges the extensive debate on citizen roles in CS (Land-Zandstra et al., 2021; Senabre Hidalgo et al., 2021; Shirk et al., 2012) with the context of urban sustainability and urban planning, presenting three distinct approaches. **Approach 1** positions participants as experts by experience, whose lived insights provide valuable direction for research. **Approach 2** views participants primarily as cost-effective urban data collectors following structured protocols. **Approach 3** adopts a broader smart city perspective, emphasizing tech-driven, large-scale data accumulation where citizens contribute passively. Each approach has its own strength when considering data collected. In **Approach 1**, participants primarily generate granular local data that directly address urban concerns. In **Approach 2**, they primarily collect standardized data using digital tools. In **Approach 3**, they passively provide data that contributes to large-scale datasets without deep engagement. Notably, these approaches can be combined within the same CS project. By simplifying complex dynamics behind CS projects implementation, Fig. 4 encourages reflection on how CS can be strategically integrated into urban sustainability and planning

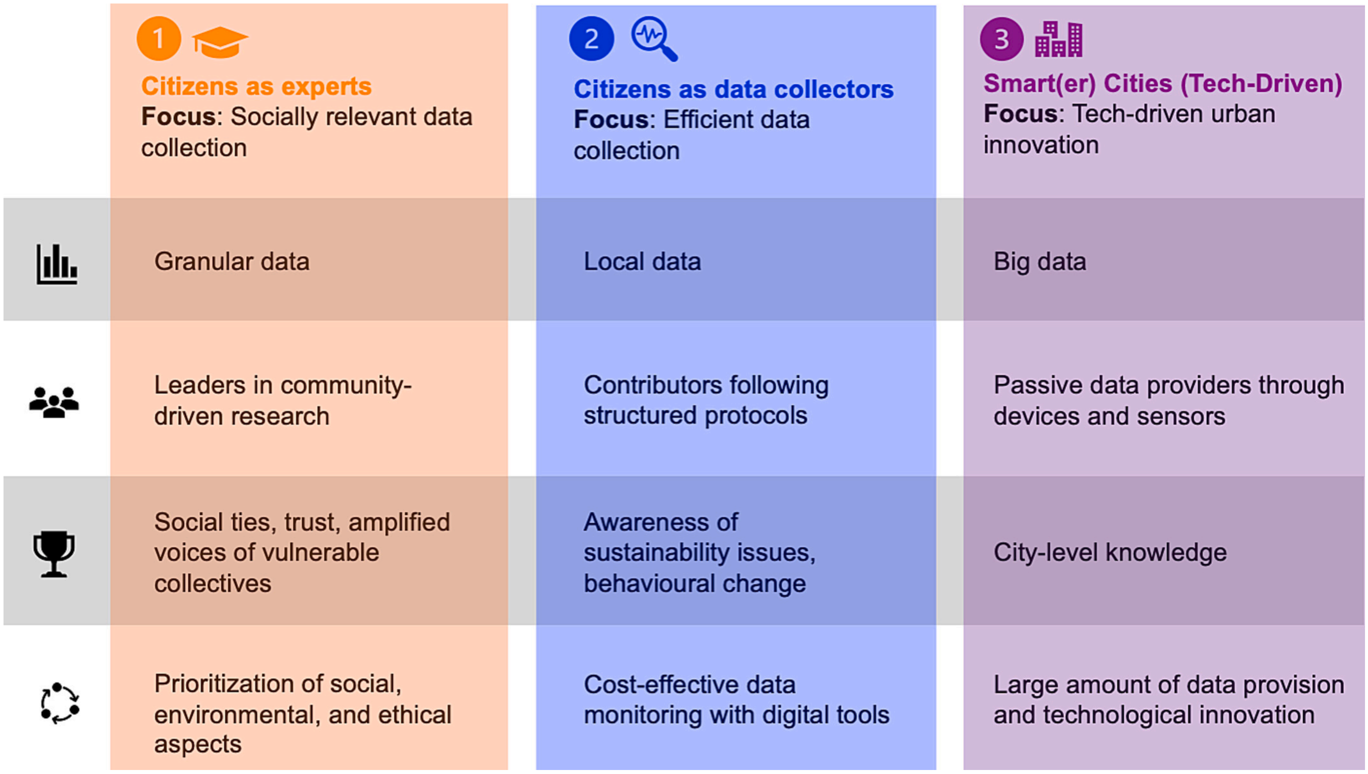

Fig. 4. Three distinct conceptual approaches to the role of citizens identified in the systematic literature review. The icons represent, from top to bottom: type of data collected, citizens' roles, outcomes for citizens, and citizen-science contributions to urban sustainability and planning.

initiatives.

3.4. Biodiversity references analysis from Dataset III

The screened references in the previous section primarily focus on urban transformation and planning. Despite the clear identification of the term *biodiversity* in the Datasets I and II VOSviewer analysis, we were unable to find any conceptual paper offering a structured and overarching framework connecting CS and biodiversity in urban contexts. The prospective paper *Research Agenda on Biodiversity and Ecosystem Functions and Services in European Cities* (Pinho et al., 2021) highlights the need to further standardize sampling protocols and support bottom-up CS initiatives to bridge the gap between biodiversity and urban governance and planning. Similarly, Voigt-Heucke et al. (2023) examined the role of CS in urban biodiversity monitoring and conservation in Berlin. While they found a significant number of initiatives and activities, they emphasized the need for greater interaction with policy-makers and enhanced data sharing. Other references focus on specific fields or topics. Rivkin et al. (2019) identify CS as a valuable approach for evolutionary ecology through relevant data collection while Planillo et al. (2021) comparatively analyse different sampling schemes to optimize the CS contribution to urban planning, specifically in relation to bird distribution.

The data collection methods and the digital tools being used are key elements in CS projects related to biodiversity. A better knowledge of these methods can help understanding the role that the CS research linked to ecology, biology and conservation is playing in the context studied. The records of the Dataset III were again manually screened for this purpose. We first filtered those related to one or more of top 3 terms in Dataset I CL1—*species, garden,* and *biodiversity*—which are linked to ecology, biodiversity, and conservation. The data collection methods and digital tools reported in these records are summarized in Table 5. The studies are diverse in many aspects. Some investigate given animals' species present in urban environments (e.g. hedgehogs, birds, bees, pollinators, bats, butterflies and squirrels) whereas other focus on monitoring urban biodiversity, conservation potential or food production of urban gardens or urban green spaces. Geographically speaking, the studies are spanned across different continents. Regarding data collection methods, the CS research reported in the references employs a variety of approaches. Many initiatives rely on digital platforms, with 17 references using tailor-made applications, online surveys, or interactive tools. Eight studies utilize well-established biodiversity monitoring platforms, such as iNaturalist (4), GBIF (2), and eBird (2). Additionally, six studies adopt alternative methods, including paper-based questionnaires, field observations, sampling, and camera traps. This screening indicates that biodiversity and conservation studies in urban environments predominantly use well-established methodologies. While some require training for citizen scientists, they generally do not involve high levels of complexity or methodological innovation, as these approaches have been widely tested and validated in CS projects over the years. It is worth noting that CS projects related to biodiversity can also inform urban planning efforts aimed at protecting existing urban fauna and flora (Border et al., 2022, 2017; Rossi et al., 2022).

4. Discussion

We have explored the contributions of citizen science (CS) to sustainable urban transformation, urban sustainability and urban planning through a systematic literature review (SLR). Our analysis is based on search keywords reported in Table 1. Following the sequence outlined in Table 2, Fig. 1 and Fig. S1 (Supplementary Material), we have three distinct datasets, described in Table 3. Dataset I includes records up to 2022 (see Fig. 1). Dataset II contains records from 2022 to 2024. Dataset III integrates data from the two previous datasets, covering publications up to 2024 (see Table 3).

Our findings reveal a rapid increase in the number of records that explicitly reference CS over time, with a particularly pronounced acceleration between 2022 and 2024. This surge is driven by a notable rise in both CS-related publications and those related to urban sustainability and urban planning (corresponding to searches #1, 10 and 12 in Table 1). The growing academic interest in CS within this context has motivated the SLR presented in this paper.

4.1. RQ1-what are the contributions of CS to sustainable urban transformation, urban sustainability and urban planning?

Dataset I VOSviewer network analysis of terms with co-occurrences (see Fig. 2) shows that contributions of CS to sustainable urban transformation, urban sustainability and urban planning are diverse and complex, reflecting the coexistence of multiple visions within the field. The network analysis however can identify three clusters in which we can pinpoint topics and approaches of CS contributions to these topics.

The first cluster (CL1 in Dataset I) corresponds to the biodiversity, ecology and conservation topics. The main approach here mainly focuses on specific animal species observation in its urban habitat (gardens or green spaces) whereas other side approaches include for example biodiversity assessment or food production in domestic gardens. The second cluster (CL2 in Dataset I) deals with methodologies and practices related to CS and sustainable urban transformation or urban sustainability. The term *research* has a comprehensive role and is closely linked to research instruments such as *management* or *collaboration* or research outcomes, like *impact* or a better *understanding* of a given topic. The third cluster (CL3 in Dataset I) adopts a human-centred perspective, and the main actors are referred to as *citizen scientists*, *participants* or *neighbours*. While the topics include human health or nature benefits, the approaches rely on citizens' participation and community and neighbourś engagement, building on one of the actors that intervene in sustainable urban transformation, urban sustainability and participatory urban planning: civil society and local communities. In the forthcoming paragraphs, we further elaborate the nature of these contributions.

4.2. RQ2- what are the key topics where CS bring or potentially could bring new insights?

In terms of established topics, biodiversity, ecology, and conservation (CL1 in Dataset I) play a central role. These topics are primarily associated with terms such *as species, garden, biodiversity* and *conservation*. This finding agrees with another recent SLR study on CS in urban studies and regional urban planning that identified the field of “biodiversity and urban ecological conservation” as a major theme with a growing number of associated records (Beck & Mitkiewicz, 2025). This thematic focus also aligns with the dominant scope of CS publications beyond sustainable urban transformation and urban sustainability. For instance, during the 2012–2017 period, Bautista-Puig et al. (2019) identified Environmental Sciences and Ecology as the top two Web of Science (WoS) categories under which CS articles were published, accounting for 14% and 13% of total publications, respectively. A recent search in WoS database with the topic “citizen science” produced 1850 records for the year 2024, the top two WoS research areas being “Environmental Sciences Ecology” (1103 records) and Biodiversity Conservation (638 records) (WoS, accessed March 14, 2025). Beyond CS, Pauna et al. (2018) conducted a SLR on articles related to *ecosystem services*—a term present in CL1—and identified *biodiversity* and *conservation* among the top five most frequently occurring terms. In addition, the environmental and ecological dimension is one of the key dimension of urban transformation and urban sustainability (Elmqvist et al., 2019; Wu, 2014). The predominance can thus likely be explained by the centrality of environmental and ecological dimensions within urban transformation and sustainability as well as by the long-term integration of CS practices in environmental science and ecology.

This thematic focus on biodiversity, ecology, and conservation also follows a well-established trajectory with solid methodologies in the CS broad context (Frigerio et al., 2021). CS studies within this thematic focus primarily relies on field observations. These observations are often conducted in private or community gardens but also in public spaces such as parks, green areas, and urban forests (see Table 5). The research scope is diverse, covering topics such as species monitoring (App et al., 2022; Bila Dubaic et al., 2021; Grabow et al., 2022), general biodiversity studies (Callaghan et al., 2020; Damptey et al., 2022), food production (Caputo et al., 2023; Pollard et al., 2017), among others. Despite its long-standing presence, CS research still faces challenges, including the lack of standardized sampling protocols, limited support for bottom-up initiatives, difficulties in engaging with policymakers, and inadequate scientific data sharing (Pinho et al., 2021; Voigt-Heucke et al., 2023). Addressing these barriers remains essential for strengthening CS biodiversity-related contributions to urban sustainability and urban planning.

To identify future trends, we looked at the top 15 terms with the most recent average publication year in Dataset I (covering publications until 2022, see Table 7). Notably, human-centred and community-based are emergent perspectives, represented by cluster CL3 and terms such as *community science*, *citizen engagement* and *society*. This list also includes *health*, which is primarily associated with research on human health-related topics as well as *air quality*, a domain related to community science and environmental justice scholarship —both of which have longer-standing traditions that precede contemporary CS. Additionally, expected short-term trends related to COVID-19 and pandemic appear, though these may not persist over time. Expanding the analysis to the top 20 terms from a more recent period (2022–2024, see Table 8 and Fig. 3, Dataset II) confirms the continued prominence of biodiversity, ecology, and conservation whereas human health research continues to be relevant and new terms such as *climate change* or *action* emerge.

By combining these observations with the information obtained from the three clusters identified in Dataset I, three key trends can be identified:

1. The Rise of Community Science and higher compromise with Citizen Engagement.

There is an increasing number of publications referencing *community science*, which is the most recent term of Dataset I. The terms *citizen engagement* and *society* are also the 6th and the 12th most recent terms, respectively. These terms all belong to the human-centred perspective cluster (CL3), where *community member* and *neighbourhood* appeared. Importantly, these terms were not linked to the biodiversity-related cluster (CL1), suggesting that this branch of CS follows a distinct trajectory, focusing on neighbourhoods and social aspects rather than biodiversity monitoring. A closer examination of Dataset III, specifically filtering records containing neighbourhood(s) or neighbour(s) in their title, further supports this hypothesis. Among the 13 records identified, only one (Johnson et al., 2018) addresses biodiversity/ecology/conservation, specifically focusing on mosquito control. Another study examines nature-based solutions for urban heat islands (Abu Ali et al., 2021). The remaining records fall into two thematic areas:

- Research on vulnerable neighbourhoods, often described as deprived (Grootjans et al., 2022; Magnussen & Elming, 2015), stigmatized (Fell et al., 2021), low-income (Enqvist et al., 2022), disadvantaged (Winter et al., 2016) or vulnerable (Hendricks et al., 2018). These variations in terminology explain why this trend was not immediately visible in the VOSviewer analysis.
- Health-related research focusing on neighbourhood well-being, including studies on older adults' health (Barrie et al., 2019; Tuckett et al., 2018), physical activity (Zieff et al., 2018), chronic stress (Chrisinger & King, 2018), hypertension (Grazuleviciene, Andrusaityte, Grazulevicius, & Dedele, 2020) and health in deprived areas (Grootjans et al., 2022). The subsequent paragraph offers further elaboration.

2. The Growing Role of Human Health

Human health is an emerging and increasingly prominent topic. Recent research addresses broad public health issues, such as environmental health, healthy aging, and health risk assessments (Allen, 2020; Chrisinger & King, 2018; Fermeglia & Pedrosa, 2022; Grazuleviciene, Andrusaityte, Grazulevicius, & Dedele, 2020; Grootjans et al., 2022; Ottaviano et al., 2019; Rubio et al., 2022; Sarmiento et al., 2020; Van Geenhuizen & Suman, 2021; Vander Meer, 2022; Vandevijvere et al., 2019; Wood et al., 2022). As noted earlier, some of these human health studies adopt a community perspective, linking them to the rise of community science and citizen engagement approaches in publications with CS term in title or abstract. Environmental health studies dealing with air quality include a community science dimension (Hsu et al., 2020; Mahajan et al., 2021) or focus on underserved and disadvantaged communities (Lu et al., 2022; Rickenbacker et al., 2019). This observation further supports the rise of community science and citizen engagement in CS scholarship. Additionally, these studies are often related to urban planning outputs with the final aim to improve citizens' health and wellbeing. The urban planning perspective is for example considered in relation to air and noise pollution (Fermeglia & Pedrosa, 2022), healthy park environments (Rubio et al., 2021) and urban traffic (Van Geenhuizen & Suman, 2021).

3. Climate Change as an Emerging Research Focus

Climate change is becoming an important theme, with research mainly addressing urban heat through nature-based solutions (Abu Ali et al., 2021; Best et al., 2023; Teerlinck et al., 2024; Wamsler et al., 2020) and urban heat island monitoring (Alonso, 2019; Kousis et al., 2021; Lehnert et al., 2021). Other studies explore climate change impacts on water supply challenges (Treacy, 2022) and urban flood resilience (Prashar et al., 2024; Ramsey et al., 2019). A growing number of studies also examine the impact of flooding on marginalized communities (Wolff et al., 2021). A community science (Groulx et al., 2021), resilience and co-design (Neset et al., 2021) as well as action-oriented (Trajber et al., 2019) focus in climate-change related studies are also present. The growing relevance of climate change-related papers was also spotted by Beck and Mitkiewicz (2025) in a SLR of a close thematic field. More generally speaking, the potential of CS for climate governance and action has been underlined in a recent review (Freschi et al., 2024), concluding that CS can contribute towards different angles and topics to climate change-related studies in an urban context.

An overview of the data further reveals three key topics that have not yet been fully developed, although they hold significant potential:

1. Action- and social impact-oriented projects

Partial findings suggest that recent studies (2022–2024, Dataset II) are increasingly action- and social impact-oriented, as evidenced by the presence of terms such as *solution, action,* and *awareness* in the top 20 terms. However, further evidence is needed to confirm this trend, making it one of the most important opportunity niches for future CS initiatives, considering that structural, behavioural and cultural change are already key processes in urban transformation and sustainability (Allam et al., 2024; Hölscher & Frantzeskaki, 2021). While collaboration between CS projects and the public sector holds great potential for advancing urban sustainability, no strong empirical evidence has yet emerged to establish it as a major research trend and the use of the CS data by governments and local authorities is still limited (Fritz et al., 2022). Future studies should explore whether a stronger role of public sector (e.g. municipalities or civil society organizations) would potentiate the policy impact in CS in this field, since it is an already important element of innovative urban transformation and sustainability governance (Burch et al., 2018).

2. The participation of residents in vulnerable situations

A deeper analysis of Dataset III can offer further insights, particularly regarding the participation of residents in vulnerable situations. For example, Abascal et al. (2024) involves the Nairobi slum dwellers in the research, to improve the statistics on urban population and thus to allocate the proper resources to this population. In the paper of Soebarto (2022), older people living in Adelaide bring their perspective concerning public and green spaces and indoor thermal comfort, in a city planned for working-age demographic. Newman et al. (2020) partnered with Manchester (TX, USA) residents exposed to elevated levels of pollutants during flood disasters and produced a new participatory master urban planning plan, able to produce a pollution decrease. Rickenbacker et al. (2019) validated a community-based environmental justice model, working with underserved communities, to investigate indoor and outdoor air pollution. The book "Toxic truths: environmental justice and citizen science in a post-truth age" (Davies & Mah, 2020) is also providing a number of case studies targeting collaborative data analysis, visual pollution, air and groundwater pollution, industrial contaminated sites and oil and gas facilities (Allen, 2020; Da Silva, 2020; Kenis, 2020; Little, 2020; Lopez-Navarro, 2020; Pasetto & Iavarone, 2020; Shamasunder et al., 2020). These publications pinpoint a growing importance of the environmental and climate justice focus within CS projects. For example, some authors study climate change-related health risks using CS in an urban scope (Corburn, 2022, 2017), although this publication was not spotted in the SLR as it does not mention explicitly the sustainability or urban planning scope.

3. Environmental and climate justice CS projects

The relatively small number of records on environmental and climate justice in this SLR can be attributed to the lack of integration between urban sustainability and justice-related fields, despite their closely related thematic frameworks. A Web of Science (WoS) search for the terms "urban sustainability" and "climate justice" retrieved only seven records (WoS, accessed 25-02-2025). Similarly, a search for "urban sustainability" and "environmental justice" produced just 114 records, with a significant focus on green gentrification (Anguelovski et al., 2018; Rigolon & Collins, 2023). These findings confirm that environmental and climate justice perspectives remain underdeveloped in CS related to urban sustainability and sustainable urban transformation. This presents an important research opportunity for future CS projects. Concerning urban planning, its interaction with climate justice remains limited (43 records, WoS, accessed 25-02-2025), whereas the environmental justice implications of urban planning is a more consolidated topic, with a consistent increase in yearly records since 2021 (640 records, WoS, accessed 25-02-2025). CS has the potential to address urban sustainability and urban planning challenges from the perspective of the most affected neighbourhoods, ensuring that environmental and climate justice concerns are organically embedded in research. Issues such as urban extreme heat, flooding, air, soil, and water pollution are inherently linked to urban sustainability and planning while also disproportionately affecting vulnerable communities. These communities can become active participants in CS projects aimed at tackling their specific challenges. Namely, some citizen-generated datasets have been already considered by local authorities to influence urban planning processes in relation to environmental and climate justice. For example, the project CurieuzeNeuzen, that started in 2016 when 2000 citizens studied the air quality levels in and around Antwerp (Belgium) (Van Brussel & Huyse, 2019), put the topic of air quality higher on the national political agenda and is now mentioned in the Flemish Air Policy Plan 2030. With the aim of increasing flood resiliency and decrease exposure to contaminants, in Manchester (TX, USA), a community-scaled master plan has been generated by engaging residents of a marginalized neighbourhood, public health researchers and researchers from landscape architecture and urban planning (Newman et al., 2020). These powerful examples demonstrate the feasibility of the use of CS to influence urban planning but are still to date scarce.

4.3. RQ3- what are the possible roles of citizens when envisioning CS contributions in this field?

Fig. 4 examines the citizens' role through the analysis of six conceptual papers. These six conceptual papers, listed in Table 4, do not have relation with biodiversity, conservation and ecology and reveals a broad range of approaches, addressing topics such as urban planning, sustainable development or environmental justice. The proposed role of citizen scientists varies significantly—from experts by experience to passive data collectors—, as well as the type of data potentially collected and the contributions to urban sustainability. The analysis of conceptual papers could go further in future research by systematically interweaving participatory research approaches to the specific context of urban development processes.

The studies identified in Dataset III include diverse participatory methodologies and tools such as collaborative mapping, photovoice, collective measurements and data interpretation, volunteered geographic information, co-design, and discourse analysis, among others. In terms of research focus, the studies address a wide array of topics, including human health, pollution (air, water, and soil), climate change, census data, infrastructure management, spatial accessibility, and meteorology. Urban planning plays a central role in these topics, offering various opportunities for citizen participation, such as the use of advanced digital tools or the strengthening of participatory processes focused on the most vulnerable communities. Unlike the well-established biodiversity-related research, this field is relatively new, with multiple emerging themes developing simultaneously. This may explain some of the challenges observed, such as the lack of a unified research vision. The conceptualisation of the citizen scientist's role also varies across studies, and interdisciplinary integration remains limited. These aspects invite further reflection on the contested understandings of CS discussed earlier in the Introduction. A more precise definition of citizen—as an individual endowed with rights and responsibilities—can be useful, yet it also reveals the limitations of an individualistic framing of participation. CS can thus be understood as a practice through which individuals—and, most importantly, communities—articulate claims related to human rights, such as the right to a healthy environment or the right to participate in urban planning and decision-making processes.

In another level, the VOSviewer analysis highlights another actor beyond the participant or the citizen scientist: the *policymaker*. This term appears within Cluster 2—an overarching methodologies and practices cluster containing terms such as *research*, *impact*, and *management*—and is well connected to other terms within this methodological space. However, it shows only weak links to terms in other thematic clusters, such as *urban area*, *habitat*, *species*, or *health*. This pattern suggests that the role of policymakers in CS scholarship remains underexplored, indicating substantial scope for further investigation into how their involvement is conceptualised and enacted. It is also important to note that this interpretation should not be generalised to the entire public sector, which is likely represented in the dataset through a much broader set of terms.

Finally, the potential of CS to support action-oriented climate research, identified in this SLR, is also recognised at the supranational level. In its most recent assessment report, the Intergovernmental Panel on Climate Change (IPCC), for example, refers to CS in relation to near-term climate change mitigation and adaptation actions (p. 107; Calvin et al., 2023). The most recent UN Climate Change Conference (COP30) goes a step further by proposing a Global Public Digital Infrastructure for Climate, in which CS is framed not only as a data source but also as a mechanism for integrating bottom-up community processes and empowering local actors (pp. 14, 18, 74, 88; Lemos and ITS Rio, 2025). More broadly, the OECD and UNESCO similarly promote CS as a means to address policy priorities (OECD, 2025) and to advance Open Science strategies (UNESCO, 2021). Recognising the transformative role that supranational frameworks already attribute to CS is essential for steering its continued expansion and ensuring that future CS initiatives meaningfully address the gaps identified in this review.

5. Study limitations

5.1. Inter- and transdisciplinary scope

The SLR covers a broad range of disciplines, each with distinct publication cultures. For example, urban planning research may be underrepresented, as academics in this field do not consistently publish in indexed journals.

5.2. Language selection scope

Selecting articles in English only excludes potentially interesting scientific papers in other languages, whereas local languages in particular play an important role in local urban transformations.

5.3. Terminology variations

The term citizen science is not used universally across all disciplines or countries. Alternative expressions, such as “participatory sciences” or “community science”, were not directly explored in this SLR. Also, searches using related keywords such as “citizens observatory/ies” and “community-based environmental monitoring” yielded very few results when combined with “urban”. This does not imply that these approaches are irrelevant; rather, it indicates that these specific terms were not captured through our SLR. Given that the dataset already includes nearly 400 records using citizen science as a keyword, we chose to focus on this term in the present manuscript. Nevertheless, incorporating additional terminology in future analyses could help determine whether different labels correspond to distinct thematic trends.

6. Conclusion

Through this systematic literature review (SLR), we have examined the contributions of citizen science (CS) to sustainable urban transformation, urban sustainability and urban planning. Our findings reveal a substantial increase in research activity, particularly between 2022 and 2024, demonstrating the growing academic interest in CS to approach to urban sustainability and urban planning. The VOSviewer network analysis identified three major thematic clusters: (1) biodiversity, ecology, and conservation; (2) methodologies and practices; and (3) humans and communities (3). These clusters highlight the diverse ways in which CS contributes to sustainable urban transformation, from environmental monitoring to participatory urban planning and health-related research.

Our analysis also identified several key established topics, the topic around biodiversity, ecology, and conservation terms being the most prominent. CS initiatives in this domain are often linked to species monitoring, urban greening, and conservation efforts in both private and public spaces. Despite its long-standing presence, biodiversity-related CS research continues to face persistent challenges, including the need for further methodological standardisation. Beyond biodiversity, we identified emerging conceptual approaches that integrate CS with urban planning, environmental justice, and sustainable development. This broader perspective suggests a shift towards CS that address complex urban sustainability challenges, which are somewhat still underdeveloped.

Future trends indicate an increasing focus of CS scholarship on community science and citizen engagement, as well as the growing role of human health and climate change-related research. Urban planning plays a relevant role in these trends, especially in relation to the improvement of human health. Studies exploring residents' well-being, environmental health risks, and climate change adaptation strategies through CS are gaining traction. However, our review also highlights underdeveloped opportunity niches, including the integration of CS with policy in a broader list of urban issues and the active participation of marginalized communities in sustainability research. While environmental and climate justice perspectives are gaining attention, there is still a weak integration of the CS and urban sustainability literature with environmental and climate-justice frameworks. Joining forces with other participatory urban planning processes involving communities in a vulnerable situation, which often do not use the CS term, is an opportunity to further develop CS approaches by further considering perspectives from community science, action research, community based environmental research or any other form of participatory research. Overall, this SLR highlights the potential of CS to address urban sustainability challenges by promoting inclusive participation and generating actionable insights, aligning with supranational bodies that have already called for the expansion of CS practices. Future research should prioritize the integration of CS within the public sector, the further development of standardized methodologies, and the amplification of marginalized voices in sustainability efforts. By advancing these areas, CS can serve as a transformative tool for achieving equitable and resilient urban futures.

CRediT authorship contribution statement

Isabelle Bonhoure: Writing – original draft, Visualization, Validation, Investigation, Data curation, Conceptualization. **Beate Guba:** Writing – review & editing, Validation, Investigation, Conceptualization. **Christian Peer:** Writing – review & editing, Validation, Investigation, Conceptualization. **Ignasi Labastida:** Writing – original draft, Investigation. **Josep Perelló:** Writing – original draft, Validation, Supervision, Investigation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary Information

Supplementary figures and tables to this article can be found online at https://doi.org/10.1016/j.cities.2026.107056.

Data availability

The .ris files of the three datasets are openly accessible in Zenodo (Bonhoure et al., 2026).

References

Abascal, A., Georganos, S., Kuffer, M., Vanhuysse, S., Thomson, D., Wang, J., … Wolff, E. (2024). Making urban slum population visible: Citizens and satellites to reinforce slum censuses. In *Remote Sensing and Digital Image Processing* (pp. 287–302). Springer Science and Business Media B.V.. https://doi.org/10.1007/978-3-031-49183-2_14

Abu Ali, M., Alawadi, K., & Khanal, A. (2021). The role of green infrastructure in enhancing microclimate conditions: A case study of a low-rise neighborhood in Abu Dhabi. *Sustainability, 13*, 4260. https://doi.org/10.3390/su13084260

Ahern, J. (2013). Urban landscape sustainability and resilience: The promise and challenges of integrating ecology with urban planning and design. *Landscape Ecology, 28*, 1203–1212. https://doi.org/10.1007/s10980-012-9799-z

Allam, Z., Sharma, A., & Cheshmehzangi, A. (2024). LiFE in the city: Behavioural changes can drive urban sustainability goals. *Cities, 151*, Article 105163. https://doi.org/10.1016/j.cities.2024.105163

Allen, B. L. (2020). Making effective participatory environmental health science through collaborative data analysis. In T. Davies, & A. Mah (Eds.), *Toxic truth*. Manchester University Press. https://doi.org/10.7765/9781526137005.00012.

Alonso, L. (2019). The use of citizen science in the characterization of the Lyon's urban heat and cool islands. In *Proc. IEEE Int. Conf. Mobile data manage* (pp. 387–388). Institute of Electrical and Electronics Engineers Inc.. https://doi.org/10.1109/MDM.2019.00-18

Anguelovski, I., Connolly, J. J. T., Masip, L., & Pearsall, H. (2018). Assessing green gentrification in historically disenfranchised neighborhoods: A longitudinal and spatial analysis of Barcelona. *Urban Geography, 39*, 458–491. https://doi.org/10.1080/02723638.2017.1349987

App, M., Strohbach, M. W., Schneider, A.-K., & Schröder, B. (2022). Making the case for gardens: Estimating the contribution of urban gardens to habitat provision and connectivity based on hedgehogs (Erinaceus europaeus). *Landscape and Urban Planning, 220*, Article 104347. https://doi.org/10.1016/j.landurbplan.2021.104347

Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of Planners, 35*, 216–224. https://doi.org/10.1080/01944366908977225

Ataol, Krishnamurthy, & Van Wesemael. (2019). Children's participation in urban planning and design: A systematic review. *Children, Youth and Environments, 29*, Article 27. https://doi.org/10.7721/chilyoutenvi.29.2.0027

Auerbach, J., Barthelmess, E. L., Cavalier, D., Cooper, C. B., Fenyk, H., Haklay, M., … Shanley, L. (2019). The problem with delineating narrow criteria for citizen science. *Proceedings of the National Academy of Sciences, 116*, 15336–15337. https://doi.org/10.1073/pnas.1909278116

Baker, F., Smith, C. L., & Cavan, G. (2018). A combined approach to classifying land surfece cover of urban domestic gardens using citizen science data and high resolution image analysis. *Remote Sensing, 10*(4). https://doi.org/10.3390/rs10040537

Ballerini, L., & Bergh, S. I. (2021). Using citizen science data to monitor the sustainable development goals: A bottom-up analysis. *Sustainability Science, 16*, 1945–1962. https://doi.org/10.1007/s11625-021-01001-1

Bansard, J. S., Hickmann, T., & Kern, K. (2019). Pathways to urban sustainability how science can contribute to sustainable development in cities. *GAIA - Ecological Perspectives for Science and Society, 28*, 112–118. https://doi.org/10.14512/gaia.28.2.9

Barrie, H., Soebarto, V., Lange, J., Corry-Breen, F. M., & Walker, L. (2019). Using citizen science to explore neighbourhood influences on ageing well: Pilot project. *Healthcare, 7*. https://doi.org/10.3390/healthcare7040126

Barui, T., & Mazumder, S. (2023). Mapping global scientific output on citizen science from 2012 to 2021: A Scientometric analysis. *Journal of Data Science, Informetrics, and Citation Studies, 2*, 65–76. https://doi.org/10.5530/jcitation.2.2.10

Basile, M., Russo, L. F., Russo, V. G., Senese, A., & Bernardo, N. (2021). Birds seen and not seen during the COVID-19 pandemic: The impact of lockdown measures on citizen science bird observations. *Biological Conservation, 256*. https://doi.org/10.1016/j.biocon.2021.109079

Bautista-Puig, N., De Filippo, D., Mauleón, E., & Sanz-Casado, E. (2019). Scientific landscape of citizen science publications: Dynamics, content and presence in social media. *Publications, 7*, 12. https://doi.org/10.3390/publications7010012

Beck, D., & Mitkiewicz, J. (2025). A systematic literature review of citizen science in urban studies and regional urban planning: Policy, practical, and research implications. *Urban Ecosystem, 28*, 85. https://doi.org/10.1007/s11252-025-01693-8

Best, L., Schwarz, N., Obergh, D., Teuling, A. J., Van Kanten, R., & Willemen, L. (2023). Urban green spaces and variation in cooling in the humid tropics: The case of Paramaribo. *Urban Forestry & Urban Greening, 89*. https://doi.org/10.1016/j.ufug.2023.128111

Bhandari, M. P. (2024). Citizen science and its applicability for sustainability and a healthy planet. *Academic Environmental Science and Sustainability, 1*. https://doi.org/10.20935/AcadEnvSci7270

Bila Dubaic, J., Simonovic, S., Plecas, M., Stanisavljevic, L., Davidovic, S., Tanaskovic, M., & Cetkovic, A. (2021). Unprecedented density and persistence of feral honey bees in urban environments of a large SE-European city (Belgrade, Serbia). *Insects, 12*, Article 1127. https://doi.org/10.3390/insects12121127

Bonhoure, I., Guba, B., Peer, C., Labastida, I., & Perelló, J. (2026). Databases for a systematic literature review on citizen science contributions to sustainable urban transformation, urban sustainability and urban planning. *Zenodo*. https://doi.org/10.5281/zenodo.19370274

Border, J. A., Gillings, S., Reynolds, T., Neeve, G., & Newson, S. E. (2022). Can citizen science provide a solution for bat friendly planning? *Landscape and Urban Planning, 223*. https://doi.org/10.1016/j.lurbplan.2022.104402

Border, J. A., Newson, S. E., White, D. C. J., & Gillings, S. (2017). Predicting the likely impact of urbanisation on bat populations using citizen science data, a case study for Norfolk, UK. *Landscape and Urban Planning, 162*, 44–55. https://doi.org/10.1016/j.landurbplan.2017.02.005

Burch, S., Hughes, S., Romero-Lankao, P., & Schroeder, H. (2018). Governing urban sustainability transformations: The new politics of collaboration and contestation. In T. Elmqvist, X. Bai, N. Frantzeskaki, C. Griffith, D. Maddox, T. McPhearson, … M. Watkins (Eds.), *Urban planet* (pp. 303–326). Cambridge University Press. https://doi.org/10.1017/9781316647554.017.

Cabrini, F., Cavallo, C., & Scalenghe, R. (2021). An early beginning of citizen science: Adolescents experiencing urban energy usages and air pollution. *Adolescents, 1*, 225–251. https://doi.org/10.3390/adolescents1030018

Calhoun, Z. D., Black, M. S., Bergin, M., & Carlson, D. (2024). Refining citizen climate science: Addressing preferential sampling for improved estimates of urban heat. *Environmental Science & Technology Letters, 11*, 845–850. https://doi.org/10.1021/acs.estlett.4c00296

Callaghan, C. T., Bino, G., Major, R. E., Martin, J. M., Lyons, M. B., & Kingsford, R. T. (2019). Heterogeneous urban green areas are bird diversity hotspots: Insights using continental-scale citizen science data. *Landscape Ecology, 34*(6), 1231–1246. https://doi.org/10.1007/s10980-019-00851-6

Callaghan, C. T., Ozeroff, I., Hitchcock, C., & Chandler, M. (2020). Capitalizing on opportunistic citizen science data to monitor urban biodiversity: A multi-taxa framework. *Biological Conservation, 251*. https://doi.org/10.1016/j.biocon.2020.108753

Callaghan, C. T., Poore, A. G. B., Major, R. E., Cornwell, W. K., Wilshire, J. H., & Lyons, M. B. (2021). How to build a biodiverse city: Environmental determinants of bird diversity within and among 1581 cities. *Biodiversity and Conservation, 30*(1), 217–234. https://doi.org/10.1007/s10531-020-02088-1

Calvin, K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P. W., Trisos, C., … Ha, M. (2023). In H. Lee, & J. Romero (Eds.), *IPCC, 2023: Climate change 2023: Synthesis report. Contribution of working groups I, II and III to the sixth assessment report of the intergovernmental panel on climate change*. IPCC, Geneva, Switzerland: Intergovernmental Panel on Climate Change (IPCC). https://doi.org/10.59327/IPCC/AR6-9789291691647. Core Writing Team.

Cappa, F., Franco, S., & Rosso, F. (2022). Citizens and cities: Leveraging citizen science and big data for sustainable urban development. *Business Strategy and the Environment, 31*, 648–667. https://doi.org/10.1002/bse.2942

Caputo, S., Schoen, V., & Blythe, C. (2023). Productivity and efficiency of community gardens: Case studies from the UK. *Land, 12*. https://doi.org/10.3390/land12010238

Castagneyrol, B., Bedessem, B., & Julliard, R. (2023). Is ecology different when studied with citizen scientists? A bibliometric analysis. *Ecology and Evolution, 13*, Article e10488. https://doi.org/10.1002/ece3.10488

Chrisinger, B., & King, A. (2018). Stress experiences in neighborhood and social environments (SENSE): A pilot study to integrate the quantified self with citizen science to improve the built environment and health. *International Journal of Health Geographics, 17*. https://doi.org/10.1186/s12942-018-0140-1

Chrisinger, B., Ramos, A., Shaykis, F., Martinez, T., Banchoff, A., Winter, S., & King, A. (2018). Leveraging citizen science for healthier food environments: A pilot study to evaluate corner stores in Camden, New Jersey. *Frontiers in Public Health, 6*. https://doi.org/10.3389/fpubh.2018.00089

Ciasullo, M. V., Carli, M., Lim, W. M., & Palumbo, R. (2022). An open innovation approach to co-produce scientific knowledge: An examination of citizen science in the healthcare ecosystem. *European Journal of Innovation Management, 25*, 365–392. https://doi.org/10.1108/EJIM-02-2021-0109

Colston, N. M., Vadjunec, J. M., & Wakeford, T. (2015). Exploring the entry points for citizen science in urban sustainability initiatives. *Current Opinion in Environment Sustainability, 17*, 66–71. https://doi.org/10.1016/j.cosust.2015.11.006

Cooper, C. B., Hawn, C. L., Larson, L. R., Parrish, J. K., Bowser, G., Cavalier, D., … Wilson, S. (2021). Inclusion in citizen science: The conundrum of rebranding. *Science, 372*, 1386–1388. https://doi.org/10.1126/science.abi6487

Corburn, J. (2017). Concepts for studying urban environmental justice. *Current Environmental Health Reports, 4*, 61–67. https://doi.org/10.1007/s40572-017-0123-6

Corburn, J. (2022). Water and sanitation for all: Citizen science, health equity, and urban climate justice. *Environment and Planning B: Urban Analytics and City Science, 49*, 2044–2053. https://doi.org/10.1177/23998083221094836

Criscuolo, L., L'Astorina, A., Van Der Wal, R., & Gray, L. C. (2023). Recent contributions of citizen science on sustainability policies: A critical review. *Current Opinion in Environmental Science & Health, 31*, Article 100423. https://doi.org/10.1016/j.coesh.2022.100423

Croese, S., Dominique, M., & Raimundo, I. M. (2021). Co-producing urban knowledge in Angola and Mozambique: Towards meeting SDG 11. *npj Urban Sustainability, 1*, 8. https://doi.org/10.1038/s42949-020-00006-6

Csortan, G., Ward, J., & Roetman, P. (2020). Productivity, resource efficiency and financial savings: An investigation of the current capabilities and potential od South Australian home food gardens. *Plos ONE, 15*(4). https://doi.org/10.1371/journal.pone.0230232

Da Silva, M. (2020). Making sense of visual pollution: The "Clean City" law in Sao Paulo, Brazil. In *Toxic truths: Environmental justice and citizen science in a post-truth age*.

Dai, Y., Hasanefendic, S., & Bossink, B. (2024). A systematic literature review of the smart city transformation process: The role and interaction of stakeholders and technology. *Sustainable Cities and Society, 101*, Article 105112. https://doi.org/10.1016/j.scs.2023.105112

Damptey, F. G., Opuni-Frimpong, N. Y., Arimiyaw, A. W., Bentsi-Enchill, F., Wiafe, E. D., Abeyie, B. B., … Opuni-Frimpong, E. (2022). Citizen science approach for assessing the biodiversity and ecosystem service potential of urban green spaces in Ghana. *Land, 11*. https://doi.org/10.3390/land11101774

Davies, T., & Mah, A. (Eds.). (2020). *Toxic truths: Environmental justice and citizen science in a post-truth age*. Manchester, UK: Manchester University Press. open access e-books.

De Filippo, D., Sanz Casado, E., Berteni, F., Barisani, F., Bautista Puig, N., & Grossi, G. (2021). Assessing citizen science methods in IWRM for a new science shop: A bibliometric approach. *Hydrological Sciences Journal, 66*, 179–192. https://doi.org/10.1080/02626667.2020.1851691

Denyer, D., & Tranfield, D. (2009). Producing a systematic review. In *The sage handbook of organizational research methods* (pp. 671–689). Thousand Oaks, CA: Sage Publications Ltd.

DeSouza, P. (2022). Political economy of air pollution in Kenya. *Urban Forum, 33*, 393–414. https://doi.org/10.1007/s12132-022-09464-w

Du, J., Ye, X., Jankowski, P., Sanchez, T. W., & Mai, G. (2024). Artificial intelligence enabled participatory planning: A review. *International Journal of Urban Sciences, 28*, 183–210. https://doi.org/10.1080/12265934.2023.2262427

Dujardin, S., Stas, M., Van Eupen, C., Aerts, R., Hendrickx, M., Delcloo, A. W., … Dendoncker, N. (2022). Mapping abundance distributions of allergenic tree species in urbanized landscapes: A nation-wide study for Belgium using forest inventory and citizen science data. *Landscape and Urban Planning, 218*, Article 104286. https://doi.org/10.1016/j.landurbplan.2021.104286

Ebitu, L., Avery, H., Mourad, K. A., & Enyetu, J. (2021). Citizen science for sustainable agriculture – A systematic literature review. *Land Use Policy, 103*, Article 105326. https://doi.org/10.1016/j.landusepol.2021.105326

Elizalde, L., & Lambertucci, S. A. (2022). Private gardens in a town immersed in a national park: Potential for conservation and highly valued under COVID lockdown. *Landscape and Urban Planning, 226*. https://doi.org/10.1016/j.landurbplan.2022.104481

Ellwanger, J. H., Byrne, L. B., & Bogo Chies, J. A. (2022). Examining the paradox of urban disease ecology by linking the perspectives of urban one health and ecology with cities. *Urban Ecosystems, 25*, 1735–1744. https://doi.org/10.1007/s11252-022-01260-5

Elmqvist, T., Andersson, E., Frantzeskaki, N., McPhearson, T., Olsson, P., Gaffney, O., Takeuchi, K., & Folke, C. (2019). Sustainability and resilience for transformation in the urban century. *Nature Sustainability, 2*, 267–273. https://doi.org/10.1038/s41893-019-0250-1

Enqvist, J., Ziervogel, G., Metelerkamp, L., van Breda, J., Dondi, N., Lusithi, T., … Yalabi, M. (2022). Informality and water justice: Community perspectives on water issues in Cape Town's low-income neighbourhoods. *International Journal of Water Resources Development, 38*, 108–129. https://doi.org/10.1080/07900627.2020.1841605

Ernst, L., De Graaf-Van Dinther, R. E., Peek, G. J., & Loorbach, D. A. (2016). Sustainable urban transformation and sustainability transitions; conceptual framework and case study. *Journal of Cleaner Production, 112*, 2988–2999. https://doi.org/10.1016/j.jclepro.2015.10.136

Falana, J., Osei-Kyei, R., & Tam, V. W. Y. (2025). Critical barriers and success strategies to stakeholder partnership towards achieving net zero emissions building: A systematic literature review. *Cities, 163*, Article 106061. https://doi.org/10.1016/j.cities.2025.106061

Fang, S.-Q., Li, Y.-P., Pan, Y., Wang, C.-Y., Peng, M.-C., & Hu, S.-J. (2004). Butterfly diversity in a rapidly developing urban area: A case study on a University Campus. *Diversity, 16*(1), 1–20. https://doi.org/10.3390/d16010004

Fell, T., Rydenstam, T., Buli, B. G., King, A. C., & Bälter, K. (2021). Citizen science in Sweden's stigmatized neighborhoods. *Sustainability, 13*, Article 10205. https://doi.org/10.3390/su131810205

Fermeglia, M., & Pedrosa, K. (2022). Planning for citizens' health: Towards an integrated approach to air and noise pollution in the EU. *Journal for European Environmental & Planning Law, 19*, 9–30. https://doi.org/10.1163/18760104-19010003

Finco, A., & Nijkamp, P. (2001). Pathways to urban sustainability. *Journal of Environmental Policy and Planning, 3*, 289–302. https://doi.org/10.1002/jepp.94

Finger, L., Van Den Bogaert, V., Schmidt, L., Fleischer, J., Stadtler, M., Sommer, K., & Wirth, J. (2023). The science of citizen science: A systematic literature review on educational and scientific outcomes. *Frontiers in Education, 8*, Article 1226529. https://doi.org/10.3389/feduc.2023.1226529

Foroughi, M., De Andrade, B., Roders, A. P., & Wang, T. (2023). Public participation and consensus-building in urban planning from the lens of heritage planning: A systematic literature review. *Cities, 135*, Article 104235. https://doi.org/10.1016/j.cities.2023.104235

Fraisl, D., Campbell, J., See, L., Wehn, U., Wardlaw, J., Gold, M., … Fritz, S. (2020). Mapping citizen science contributions to the UN sustainable development goals. *Sustainability Science, 15*, 1735–1751. https://doi.org/10.1007/s11625-020-00833-7

Fraisl, D., See, L., Bowers, R., Seidu, O., Fredua, K. B., Bowser, A., … McCallum, I. (2023). The contributions of citizen science to SDG monitoring and reporting on marine plastics. *Sustainability Science, 18*, 2629–2647. https://doi.org/10.1007/s11625-023-01402-4

Fraisl, D., See, L., MacFeely, S., Moorthy, I., Ulrich, G.-S., Seidu, O., Grey, F., Schütz, S., & McCallum, I. (2026). Why citizen science is now essential for official statistics. *Communications Sustainability, 1*, 2. https://doi.org/10.1038/s44458-025-00008-4

Franco, S., & Cappa, F. (2021). Citizen science: Involving citizens in research projects and urban planning. *TeMA - Journal of Land Use, Mobility and Environment, 14*(1), 114–118. https://doi.org/10.6092/1970-9870/7892

Freschi, G., Menegatto, M., & Zamperini, A. (2024). Conceptualising the link between citizen science and climate governance: A systematic review. *Climate, 12*, 60. https://doi.org/10.3390/cli12050060

Friedmann, J. (2020). *Planning in the public domain: From knowledge to action*. Princeton University Press. https://doi.org/10.2307/j.ctv10crf8d

Frigerio, D., Richter, A., Per, E., Pruse, B., & Vohland, K. (2021). Citizen science in the natural sciences. In K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, M. Ponti, … K. Wagenknecht (Eds.), *The science of citizen science* (pp. 79–96). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-58278-4_5.

Fritz, S., See, L., & Grey, F. (2022). The grand challenges facing environmental citizen science. *Frontiers in Environmental Science, 10*, Article 1019628. https://doi.org/10.3389/fenvs.2022.1019628

Gehl, J. (2010). *Cities for people*. Washington, DC: Island Press.

Giovanardi, M., Trane, M., & Pollo, R. (2023). Environmental sensing and simulation for healthy districts: A comparison between field measurements and CFD model. In *The urban book series* (pp. 921–933). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/978-3-031-29515-7_82.

Godoy, I. N., Gorleri, F. C., Cristaldi, M. A., & Leveau, L. M. (2024). Species richness and composition of forest birds in urban parks and reserves of Buenos Aires City, Argentina. *Animals, 14*(4), 1–11. https://doi.org/10.3390/ani14040602

Grabow, M., Louvrier, J. L. P., Planillo, A., Kiefer, S., Drenske, S., Boerner, K., … Kramer-Schadt, S. (2022). Data-integration of opportunistic species observations into hierarchical modeling frameworks improves spatial predictions for urban red squirrels. *Frontiers in Ecology and Evolution, 10*. https://doi.org/10.3389/fevo.2022.881247

Grazuleviciene, R., Andrusaityte, S., Dedele, A., Grazulevicius, T., Valius, L., Kapustinskiene, V., & Bendokiene, I. (2020). Environmental quality perceptions and health: A cross-sectional study of citizens of Kaunas, Lithuania. *International Journal of Environmental Research and Public Health, 17*. https://doi.org/10.3390/ijerph17124420

Grazuleviciene, R., Andrusaityte, S., Grazulevicius, T., & Dedele, A. (2020). Neighborhood social and built environment and disparities in the risk of hypertension: A cross-sectional study. *International Journal of Environmental Research and Public Health, 17*. https://doi.org/10.3390/ijerph17207696

Grootjans, S. J. M., Stijnen, M. M. N., Kroese, M. E. A. L., Ruwaard, D., & Jansen, I. M. W. J. (2022). Citizen science in the community: Gaining insight in community and participant health in four deprived neighbourhoods in the Netherlands. *Health & Place, 75*, Article 102798. https://doi.org/10.1016/j.healthplace.2022.102798

Groulx, M., Winegardner, A., Brisbois, M. C., Fishback, L. A., Linde, R., Levy, K., & Booth, A. (2021). Place and transformative learning in climate change focused community science. *Facets, 6*, 773–794. https://doi.org/10.1139/facets-2021-0003

Hadjichambi, D., Hadjichambis, A. C., Adamou, A., & Georgiou, Y. (2023). A systematic literature review of K-12 environmental citizen science (CS) initiatives: Unveiling the CS pedagogical and participatory aspects contributing to students' environmental citizenship. *Educational Research Review, 39*, Article 100525. https://doi.org/10.1016/j.edurev.2023.100525

Hajibayova, L., Coladangelo, L. P., & Soyka, H. A. (2021). Exploring the invisible college of citizen science: Questions, methods and contributions. *Scientometrics, 126*, 6989–7003. https://doi.org/10.1007/s11192-021-04050-6

Haklay, M., Dörler, D., Heigl, F., Manzoni, M., Hecker, S., & Vohland, K. (2021). What is citizen science? The challenges of definition. In K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, M. Ponti, … K. Wagenknecht (Eds.), *The science of citizen science* (pp. 13–33). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-58278-4_2.

Havas, V., Lokke, S., & Kornov, L. (2022). Exploring scientific discourse on marine litter in Europe: Review of sources, causes and solutions. *Sustainability, 14*. https://doi.org/10.3390/su14137987

Healey, P. (1997). *Collaborative planning*. London: Macmillan Education UK. https://doi.org/10.1007/978-1-349-25538-2

Hendricks, M. D., Meyer, M. A., Gharaibeh, N. G., Van Zandt, S., Masterson, J., Cooper, J. T., Jr., … Berke, P. (2018). The development of a participatory assessment technique for infrastructure: Neighborhood-level monitoring towards sustainable infrastructure systems. *Sustainable Cities and Society, 38*, 265–274. https://doi.org/10.1016/j.scs.2017.12.039

Hewidy, H., & Harsia, E. (2025). Let them speak: Insurgent planning and urban justice. *Cities, 162*, Article 105918. https://doi.org/10.1016/j.cities.2025.105918

Hölscher, K., & Frantzeskaki, N. (2021). Perspectives on urban transformation research: Transformations in, of, and by cities. *Urban Transformations, 3*, 2. https://doi.org/10.1186/s42854-021-00019-z

Hsu, Y.-C., Cross, J., Dille, P., Tasota, M., Dias, B., Sargent, R., … Nourbakhsh, I. (2020). Smell Pittsburgh: Engaging community citizen science for air quality. *ACM Transactions on Interactive Intelligent Systems, 10*. https://doi.org/10.1145/3369397

Huang, L., Wu, J., & Yan, L. (2015). Defining and measuring urban sustainability: A review of indicators. *Landscape Ecology, 30*, 1175–1193. https://doi.org/10.1007/s10980-015-0208-2

Hunter, R. F., Rodgers, S. E., Hilton, J., Clarke, M., Garcia, L., Ward Thompson, C., … GroundsWell Consortium. (2022). GroundsWell: Community-engaged and data-informed systems transformation of urban green and blue space for population health - a new initiative. *Wellcome Open Research, 7*, 237. https://doi.org/10.12688/wellcomeopenres.18175.1

Innes, J. E., & Booher, D. E. (2004). Reframing public participation: Strategies for the 21st century. *Planning Theory and Practice, 5*, 419–436. https://doi.org/10.1080/1464935042000293170

Jenks, M., & Jones, C. (Eds.). (2008). *Sustainable city form, future city*. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-1-4020-8647-2.

Jiménez-Caldera, J., Durango-Severiche, G. Y., Pérez-Arévalo, R., Serrano-Montes, J. L., Rodrigo-Comino, J., & Caballero-Calvo, A. (2024). Methodological proposal for the inclusion of citizen participation in the management and planning of urban public spaces. *Cities, 150*, Article 105008. https://doi.org/10.1016/j.cities.2024.105008

Johnson, B. J., Brosch, D., Christiansen, A., Wells, E., Wells, M., Bhandoola, A. F., … Fonseca, D. M. (2018). Neighbors help neighbors control urban mosquitoes. *Scientific Reports, 8*. https://doi.org/10.1038/s41598-018-34161-9

Kaginalkar, A., Kumar, S., Gargava, P., Kharkar, N., & Niyogi, D. (2022). SmartAirQ: A big data governance framework for urban air quality management in smart cities. *Frontiers in Environmental Science, 10*. https://doi.org/10.3389/fenvs.2022.785129

Kahila-Tani, M., Kytta, M., & Geertman, S. (2019). Does mapping improve public participation? Exploring the pros and cons of using public participation GIS in urban planning practices. *Landscape and Urban Planning, 186*, 45–55. https://doi.org/10.1016/j.landurbplan.2019.02.019

Kenis, A. (2020). Science, citizens, and air pollution: Constructing environmental (in)justice. In T. Davies, & A. Mah (Eds.), *Toxic truths* (pp. 282–300). Manchester University Press. https://doi.org/10.7765/9781526137005.00029.

Khatibi, M., Khaidzir, K. A. M., Syed Mahdzar, S. S., & Sharifi, A. (2025). Revisiting the neighborhood definition in view of the 15-minute neighborhood and sustainable neighborhood concepts. *Cities, 162*, Article 105986. https://doi.org/10.1016/j.cities.2025.105986

Kindon, S., Pain, R., & Kesby, M. (2010). Participatory action research approaches and methods: Connecting people, participation and place. Reissue 2010. ed. In *Routledge studies in human geography*. London New York: Routledge Taylor & Francis Group.

Kousis, I., Pigliautile, I., & Pisello, A. L. (2021). Intra-urban microclimate investigation in urban heat island through a novel mobile monitoring system. *Scientific Reports, 11*. https://doi.org/10.1038/s41598-021-88344-y

Kullenberg, C., & Kasperowski, D. (2016). What is citizen science? – A scientometric meta-analysis. *PLoS One, 11*, Article e0147152. https://doi.org/10.1371/journal.pone.0147152

Land-Zandstra, A., Agnello, G., & Gültekin, Y. S. (2021). Participants in citizen science. In K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, M. Ponti, … K. Wagenknecht (Eds.), *The science of citizen science* (pp. 243–259). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-58278-4_13.

Langer, P. (2025). Navigating urban sustainability: The role of contextual factors and transformative capacities. *Energy Research and Social Science, 130*, Article 104424. https://doi.org/10.1016/j.erss.2025.104424

Lehnert, M., Geletič, J., Kopp, J., Brabec, M., Jurek, M., & Pánek, J. (2021). Comparison between mental mapping and land surface temperature in two Czech cities: A new perspective on indication of locations prone to heat stress. *Building and Environment, 203*. https://doi.org/10.1016/j.buildenv.2021.108090

Lemos, R., & ITS Rio. (2025). *Digital public infrastructure for climate: The missing backbone for climate action* (Commissioned by Ambassador André Corrêa do Lago, President of COP30). COP30.

Lepenies, R., & Zakari, I. S. (2021). Citizen science for transformative air quality policy in Germany and Niger. *Sustainability, 13*. https://doi.org/10.3390/su13073973

Levé, M., Baudry, E., & Bessa-Gomes, C. (2019). Domestic gardens as favorable pollinator habitats in impervious landscapes. *Science of the Total Environment, 647*, 420–430. https://doi.org/10.1016/j.scitotenv.2018.07.310

Levy, Y., & J. Ellis, T. (2006). A systems approach to conduct an effective literature review in support of information systems research. *Informing Science. International Journal of Emerging Transdisciplines, 9*, 181–212. https://doi.org/10.28945/479

Li, W., Feng, T., Timmermans, H. J. P., Li, Z., Zhang, M., & Li, B. (2020). Analysis of citizens' motivation and participation intention in urban planning. *Cities, 106*, Article 102921. https://doi.org/10.1016/j.cities.2020.102921

Little, P. (2020). Witnessing e-waste through participatory photography in Ghana. In *Toxic truths: Environmental justice and citizen science in a post-truth age*.

Liu, H.-Y., Ahmed, S., Passani, A., & Bartonova, A. (2023). Understanding the role of cities and citizen science in advancing sustainable development goals across Europe: Insights from European research framework projects. *Frontiers in Sustainable Cities, 5*, Article 1219768. https://doi.org/10.3389/frsc.2023.1219768

Lopez-Navarro, M. (2020). Legitimating confrontational discourses by local environmental groups: The case of air quality monitoring in a Spanish industrial area. In *Toxic truths: Environmental justice and citizen science in a post-truth age*.

Lu, T., Liu, Y., Garcia, A., Wang, M., Li, Y., Bravo-villasenor, G., … Han, B. (2022). Leveraging citizen science and low-cost sensors to characterize air pollution exposure of disadvantaged communities in Southern California. *International Journal of Environmental Research and Public Health, 19*. https://doi.org/10.3390/ijerph19148777

Lv, Z., Yang, J., Wielstra, B., Wei, J., Xu, F., & Si, Y. (2019). Prioritizing green spaces for biodiversity conservation in Beijung based on habitat network connectivity. *Sustainability, 11*(7). https://doi.org/10.3390/su11072042

Magnussen, R., & Elming, A. L. (2015). Cities at play: Children's redesign of deprived neighbourhoods in minecraft. In R. Munkvold, & L. Kolas (Eds.), *Presented at the proceedings of the 9th European conference on games based learning (ECGBL 2015)* (pp. 331–337).

Mahajan, S., Luo, C.-H., Wu, D.-Y., & Chen, L.-J. (2021). From do-it-yourself (DIY) to do-it-together (DIT): Reflections on designing a citizen-driven air quality monitoring framework in Taiwan. *Sustainable Cities and Society, 66*. https://doi.org/10.1016/j.scs.2020.102628

Manikam, L., Bou Karim, Y., Boo, Y. Y., Allaham, S., Marwaha, R., Parikh, P., … On behalf of the Childhood Infections and Pollution Consortium. (2020). Operationalising a one health approach to reduce the infection and antimicrobial resistance (AMR) burden in under-5 year old urban slum dwellers: The childhood infections and pollution (CHIP) consortium. *One Health, 10*. https://doi.org/10.1016/j.onehlt.2020.100144

Marshall, S. (2009). *Cities design and evolution*. Abingdon, Oxon; New York, NY: Routledge.

Mayer, M., & Sunde, P. (2020). Colonization and habitat selection of a declining farmland species in urban areas. *Urban Ecosystems, 23*, 543–554. https://doi.org/10.1007/s11252-020-00943-1

McCormick, K., Anderberg, S., Coenen, L., & Neij, L. (2013). Advancing sustainable urban transformation. *Journal of Cleaner Production, 50*, 1–11. https://doi.org/10.1016/j.jclepro.2013.01.003

Mnisi, B. E., Geerts, S., Smith, C., & Pauw, A. (2021). Nectar gardens on school grounds reconnect plants, birds and people. *Biological Conservation, 257*. https://doi.org/10.1016/j.biocon.2021.109087

Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of web of science and scopus: A comparative analysis. *Scientometrics, 106*, 213–228. https://doi.org/10.1007/s11192-015-1765-5

Mueller, J., Lu, H., Chirkin, A., Klein, B., & Schmitt, G. (2018). Citizen design science: A strategy for crowd-creative urban design. *Cities, 72*, 181–188. https://doi.org/10.1016/j.cities.2017.08.018

Næss, P. (2001). Urban planning and sustainable development. *European Planning Studies, 9*, 503–524. https://doi.org/10.1080/09654310120049871

Participatory research and planning in practice. In Nared, J., & Bole, D. (Eds.), *The urban book series*, (2020). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-28014-7.

Neset, T.-S., Wilk, J., Cruz, S., Graça, M., Rød, J. K., Maarse, M. J., … Andersson, L. (2021). Co-designing a citizen science climate service. *Climate Services, 24*, Article 100273. https://doi.org/10.1016/j.cliser.2021.100273

Nevens, F., Frantzeskaki, N., Gorissen, L., & Loorbach, D. (2013). Urban transition labs: Co-creating transformative action for sustainable cities. *Journal of Cleaner Production, 50*, 111–122. https://doi.org/10.1016/j.jclepro.2012.12.001

Newman, G., Shi, T., Yao, Z., Li, D., Sansom, G., Kirsch, K., … Horney, J. (2020). Citizen science-informed community master planning: Land use and built environment changes to increase flood resilience and decrease contaminant exposure. *International Journal of Environmental Research and Public Health, 17*. https://doi.org/10.3390/ijerph17020486

Odenwald, S. F. (2020). A citation study of earth science projects in citizen science. *PLoS One, 15*, Article e0235265. https://doi.org/10.1371/journal.pone.0235265

OECD. (2025). *Embedding citizen science into research policy*. OECD Science, Technology and Industry Policy Papers. https://doi.org/10.1787/a1cfb1a8-en

O'Regan, A. C., Grythe, H., Hellebust, S., Lopez-Aparicio, S., O'Dowd, C., Hamer, P. D., … Nyhan, M. M. (2024). Data fusion for enhancing urban air quality modeling using large-scale citizen science data. *Sustainable Cities and Society, 116*, Article 105896. https://doi.org/10.1016/j.scs.2024.105896

Ottaviano, M., Eugenia Beltran-Jaunsaras, M., Gabriel Terius-Padron, J., Garcia-Betances, R. I., Gonzalez-Martinez, S., Cea, G., … Arredondo Waldmeyer, M. T. (2019). Empowering citizens through perceptual sensing of urban environmental and health data following a participative citizen science approach. *Sensors, 19*. https://doi.org/10.3390/s19132940

Ottinger, G. (2010). Buckets of resistance: Standards and the effectiveness of citizen science. *Science, Technology & Human Values, 35*, 244–270. https://doi.org/10.1177/0162243909337121

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, Article n71. https://doi.org/10.1136/bmj.n71

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., … McKenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. *BMJ, 372*, Article n160. https://doi.org/10.1136/bmj.n160

Pallathadka, A., Chang, H., & Ajibade, I. (2023). Urban sustainability implementation and indicators in the United States: A systematic review. *City and Environment Interactions, 19*, Article 100108. https://doi.org/10.1016/j.cacint.2023.100108

Pasetto, R., & Iavarone, I. (2020). Environmental justice in industrially contaminated sites: From the development of a national surveillance system to the birth of an international network. In *Toxic truths: Environmental justice and citizen science in a post-truth age*.

Pauna, V., Le Guyader, G., Buonocore, E., & Franzese, P. P. (2018). The scientific research on ecosystem services: A bibliometric analysis. *Ecological Questions, 29*(3), 1. https://doi.org/10.12775/EQ.2018.022

Pekdemir, S., Guaralda, M., & Limb, M. (2025). The missing link: Circularity in urban design - a systematic review of circular paradigms for resilient and self-sustaining cities. *Cities, 162*, Article 106007. https://doi.org/10.1016/j.cities.2025.106007

Pelacho, M., Ruiz, G., Sanz, F., Tarancón, A., & Clemente-Gallardo, J. (2021). Analysis of the evolution and collaboration networks of citizen science scientific publications. *Scientometrics, 126*, 225–257. https://doi.org/10.1007/s11192-020-03724-x

Perelló, J., Cigarini, A., Vicens, J., Bonhoure, I., Rojas-Rueda, D., Nieuwenhuijsen, M. J., Cirach, M., Daher, C., Targa, J., & Ripoll, A. (2021). Large-scale citizen science provides high-resolution nitrogen dioxide values and health impact while enhancing community knowledge and collective action. *Science of The Total Environment, 789*, Article 147750. https://doi.org/10.1016/j.scitotenv.2021.147750

Pia, N. A., & Bezboruah, K. (2025). Urban design strategies for creating child-friendly neighborhoods: A systematic literature review. *Cities, 162*, Article 105919. https://doi.org/10.1016/j.cities.2025.105919

Pinho, P., Casanelles-Abella, J., Luz, A. C., Kubicka, A. M., Branquinho, C., Laanisto, L., … Moretti, M. (2021). Research agenda on biodiversity and ecosystem functions and services in European cities. *Basic and Applied Ecology, 53*, 124–133. https://doi.org/10.1016/j.baae.2021.02.014

Pitidis, V., Coaffee, J., & Lima-Silva, F. (2024). Advancing equitable 'resilience imaginaries' in the global south through dialogical participatory mapping: Experiences from informal communities in Brazil. *Cities, 150*. https://doi.org/10.1016/j.cities.2024.105015

Planillo, A., Fiechter, L., Sturm, U., Voigt-Heucke, S., & Kramer-Schadt, S. (2021). Citizen science data for urban planning: Comparing different sampling schemes for modelling urban bird distribution. *Landscape and Urban Planning, 211*. https://doi.org/10.1016/j.landurbplan.2021.104098

Pollard, G., Roetman, P., & Ward, J. (2017). The case for citizen science in urban agriculture research. *Future of Food: Journal on Food, Agriculture and Society, 5*, 9–20.

Prashar, N., Lakra, H. S., Kaur, H., & shaw, R. (2024). Urban flood resilience: Mapping knowledge, trends and structure through bibliometric analysis. *Environment, Development and Sustainability, 26*, 8235–8265. https://doi.org/10.1007/s10668-023-03094-3

Puan, C. L., Yeong, K. L., Ong, K. W., Ahmad Fauzi, Yahya, M. S., & Khoo, S. S. (2019). Influence of landscape matrix on urban bird abundance: Evidence from Malaysian citizen science data. *Journal of Asia-Pacific Biodiversity, 12*(3), 369–375. https://doi.org/10.1016/j.japb.2019.03.008

Puchol-Salort, P., O'Keeffe, J., Van Reeuwijk, M., & Mijic, A. (2021). An urban planning sustainability framework: Systems approach to blue green urban design. *Sustainable Cities and Society, 66*, Article 102677. https://doi.org/10.1016/j.scs.2020.102677

Ramsey, M. M., Munoz-Erickson, T. A., Melendez-Ackerman, E., Nytch, C. J., Branoff, B. L., & Carrasquillo-Medrano, D. (2019). Overcoming barriers to knowledge integration for urban resilience: A knowledge systems analysis of two-flood prone communities in San Juan, Puerto Rico. *Environmental Science & Policy, 99*, 48–57. https://doi.org/10.1016/j.envsci.2019.04.013

Raynor, K. E., Doyon, A., & Beer, T. (2017). Collaborative planning, transitions management and design thinking: Evaluating three participatory approaches to urban planning. *Australian Planner, 54*, 215–224. https://doi.org/10.1080/07293682.2018.1477812

Rickenbacker, H., Brown, F., & Bilec, M. (2019). Creating environmental consciousness in underserved communities: Implementation and outcomes of community-based environmental justice and air pollution research. *Sustainable Cities and Society, 47*, Article 101473. https://doi.org/10.1016/j.scs.2019.101473

Rigolon, A., & Collins, T. (2023). The green gentrification cycle. *Urban Studies, 60*, 770–785. https://doi.org/10.1177/00420980221114952

Rivkin, L. R., Santangelo, J. S., Alberti, M., Aronson, M. F. J., de Keyzer, C. W., Diamond, S. E., … Johnson, M. T. J. (2019). A roadmap for urban evolutionary ecology. *Evolutionary Applications, 12*, 384–398. https://doi.org/10.1111/eva.12734

Rossi, L., Menconi, M. E., Grohmann, D., Brunori, A., & Nowak, D. J. (2022). Urban planning insights from tree inventories and their regulating ecosystem services assessment. *Sustainability, 14*. https://doi.org/10.3390/su14031684

Rubio, M. A., Guevara-Aladino, P., Urbano, M., Cabas, S., Mejia-Arbelaez, C., Espinosa, P. R., … Sarmiento, O. L. (2022). Innovative participatory evaluation methodologies to assess and sustain multilevel impacts of two community-based physical activity programs for women in Colombia. *BMC Public Health, 22*. https://doi.org/10.1186/s12889-022-13180-2

Rubio, M. A., Triana, C., King, A. C., Rosas, L. G., Banchoff, A. W., Rubiano, O., … Sarmiento, O. L. (2021). Engaging citizen scientists to build healthy park environments in Colombia. *Health Promotion International, 36*, 223–234. https://doi.org/10.1093/heapro/daaa031

Ryan-Fogarty, Y., Carlin, C. M., Kirakowski, T., Kirrane, M. J., Lysaght, L., & Reidy, D. T. (2022). Evaluating the use of intervarsity Bioblitz as an engagement and reporting tool for biodiversity in green and blue spaces on urban campuses: A case study of Irish Universities. *Biology and Environment-Proceedings of the Royal Irish Academy, 122B*(3), 181–200. https://doi.org/10.1353/bae.2022.0012

Santos-Tapia, C., Verderau, M., Borràs, S., Flórez-Santasusana, M., Flórez, F., Morales, J. J., … Ubalde-López, M. (2024). Citizen science and social innovation as citizen empowerment tools to address urban health challenges: The case of the urban health citizen laboratory in Barcelona, Spain. *PLoS One, 19*, Article e0298749. https://doi.org/10.1371/journal.pone.0298749

Sarmiento, O. L., Higuera-Mendieta, D., Wilches-Mogollon, M. A., Guzman, L. A., Rodriguez, D. A., Morales, R., … Diez Roux, A. V. (2020). Urban transformations and health: Methods for TrUST-a natural experiment evaluating the impacts of a mass transit cable car in Bogota, Colombia. *Frontiers in Public Health, 8*. https://doi.org/10.3389/fpubh.2020.00064

Sartirana, D., Rotiroti, M., Zanotti, C., Bonomi, T., Fumagalli, L., & De Amicis, M. (2020). A 3D geodatabase for urban underground infrastructures: Implementation and application to groundwater management in Milan metropolitan area. *ISPRS International Journal of Geo-Information, 9*. https://doi.org/10.3390/ijgi9100609

Sauermann, H., Vohland, K., Antoniou, V., Balázs, B., Göbel, C., Karatzas, K., … Winter, S. (2020). Citizen science and sustainability transitions. *Research Policy, 49*, Article 103978. https://doi.org/10.1016/j.respol.2020.103978

Schade, S., Pelacho, M., Van Noordwijk, T., Vohland, K., Hecker, S., & Manzoni, M. (2021). Citizen science and policy. In K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, M. Ponti, … K. Wagenknecht (Eds.), *The science of citizen science* (pp. 351–371). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-58278-4_18.

Schaefer, K., Lande, K., Grimm, H., Jenniskens, G., Gijsbers, R., Ziegler, V., … Budde, M. (2021). High-resolution assessment of air quality in urban areas-a business model perspective. *Atmosphere, 12*. https://doi.org/10.3390/atmos12050595

da Schio, N. (2020). Self-portraits of personal exposure to air pollution: On where and when people are exposed, and on why it is difficult to avoid. *Human Ecology, 48*, 465–479. https://doi.org/10.1007/s10745-020-00176-y

Schmidt, E. K., Verzola, A., & Graversen, E. K. (2022). Exploring the potential of citizen science: Science transformation through citizen involvement in health, conservation and energy research. In G. Kragh, & K. H. Nielsen (Eds.), *proceedings of science presented at the proceedings of science*. Sissa Medialab Srl.

Schneider, A.-K., Strohbach, M. W., App, M., & Schroeder, B. (2020). The `GartenApp': Assessing and communicating the ecological potential of private gardens. *Sustainability, 12*(1). https://doi.org/10.3390/su12010095

Senabre Hidalgo, E., Perelló, J., Becker, F., Bonhoure, I., Legris, M., & Cigarini, A. (2021). Participation and co-creation in citizen science. In K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, M. Ponti, … K. Wagenknecht (Eds.), *The science of citizen science* (pp. 199–218). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-58278-4_11.

Sepehri, B., & Sharifi, A. (2025). X-minute cities as a growing notion of sustainable urbanism: A literature review. *Cities, 161*, Article 105902. https://doi.org/10.1016/j.cities.2025.105902

Serret, H., Andersen, D., Deguines, N., Clauzel, C., Park, W.-H., & Jang, Y. (2022). Towards ecological management and sustainable urban planning in Seoul, South Korea: Mapping wild pollinator habitat preferences and corridors using citizen science data. *Animals, 12*(11). https://doi.org/10.3390/ani12111469

Shamasunder, B., Blickley, J., Chan, M., Collier-Oxandale, A., Sadd, J., Navarro, S., Wong, N., & Hannigan, M. (2020). Crude justice: Community-based research amid oil development in South Los Angeles. In *Toxic truths: Environmental justice and citizen science in a post-truth age*.

Sharifi, A., Allam, Z., Bibri, S. E., & Khavarian-Garmsir, A. R. (2024). Smart cities and sustainable development goals (SDGs): A systematic literature review of co-benefits and trade-offs. *Cities, 146*, Article 104659. https://doi.org/10.1016/j.cities.2023.104659

Shirk, J. L., Ballard, H. L., Wilderman, C. C., Phillips, T., Wiggins, A., Jordan, R., … Bonney, R. (2012). Public participation in scientific research: A framework for deliberate design. *Ecology and Society, 17*, Article art29. https://doi.org/10.5751/ES-04705-170229

Sirbu, A., Becker, M., Caminiti, S., De Baets, B., Elen, B., Francis, L., … Van den Bossche, J. (2015). Participatory patterns in an international air quality monitoring initiative. *PLoS One, 10*. https://doi.org/10.1371/journal.pone.0136763

Smedby, N., & Neij, L. (2013). Experiences in urban governance for sustainability: The constructive dialogue in Swedish municipalities. *Journal of Cleaner Production, 50*, 148–158. https://doi.org/10.1016/j.jclepro.2012.11.044

Soacha-Godoy, K., Prakash, P., Álvarez, A., Tejada, A. G., López-Borrull, A., Salvador, X., … Piera, J. (2025). Research infrastructures in citizen science: State of knowledge and taxonomic framework as a pathway to sustainability. *Citizen Science: Theory and Practice, 10*, 21. https://doi.org/10.5334/cstp.831

Soebarto, V. (2022). Sustainability for whom? Cities and buildings through the lens of older people. *IOP Conference Series: Earth and Environmental Science, 1007*, Article 012004. https://doi.org/10.1088/1755-1315/1007/1/012004

Somerwill, L., & Wehn, U. (2022). How to measure the impact of citizen science on environmental attitudes, behaviour and knowledge? A review of state-of-the-art approaches. *Environmental Sciences Europe, 34*, 18. https://doi.org/10.1186/s12302-022-00596-1

Son, T. H., Weedon, Z., Yigitcanlar, T., Sanchez, T., Corchado, J. M., & Mehmood, R. (2023). Algorithmic urban planning for smart and sustainable development: Systematic review of the literature. *Sustainable Cities and Society, 94*, Article 104562. https://doi.org/10.1016/j.scs.2023.104562

Stanford, H. R., Hurley, J., Garrard, G. E., & Kirk, H. (2024). Exploring the secret gardens of the city: An assessment of human-nature interactions on informal green space using citizen scence data. *Urban Forestry and Urban Greening*, 98. https://doi.org/10.1016/j.ufug.2024.128414

Tauginienė, L., Butkevičienė, E., Vohland, K., Heinisch, B., Daskolia, M., Suškevičs, M., … Prüse, B. (2020). Citizen science in the social sciences and humanities: The power of interdisciplinarity. *Palgrave Communications, 6*, 89. https://doi.org/10.1057/s41599-020-0471-y

Teerlinck, J., Wittemans, K., Beele, E., Dewaelheyns, V., Steen, T., & Somers, B. (2024). What can nature-based solutions in domestic gardens contribute to climate change adaption in Western-Europe? A systematic review. *Frontiers in Environmental Science, 12*. https://doi.org/10.3389/fenvs.2024.1430739

Tiago, P., Leal, A. I., Rosário, I. T., & Chozas, S. (2024). Discovering urban nature: Citizen science and biodiversity on a university campus. *Urban Ecosystems, 27*, 1609–1621. https://doi.org/10.1007/s11252-024-01526-0

Trajber, R., Walker, C., Marchezini, V., Kraftl, P., Olivato, D., Hadfield-Hill, S., … Fernandes Monteiro, S. (2019). Promoting climate change transformation with young people in Brazil: Participatory action research through a looping approach. *Action Research, 17*, 87–107. https://doi.org/10.1177/1476750319829202

Treacy, J. (2022). Urban water supplies in developing countries with a focus on climate change. In *Water and climate change: Sustainable development, environmental and policy issues* (pp. 95–113). Elsevier. https://doi.org/10.1016/B978-0-323-99875-8.00007-0.

Trencher, G. P., Yarime, M., & Kharrazi, A. (2013). Co-creating sustainability: Cross-sector university collaborations for driving sustainable urban transformations. *Journal of Cleaner Production, 50*, 40–55. https://doi.org/10.1016/j.jclepro.2012.11.047

Tubridy, F., Mölter, A., Lennon, M., & Pilla, F. (2022). Citizen science and environmental justice: Exploring contradictory outcomes through a case study of air quality monitoring in Dublin. *Local Environment, 27*, 622–638. https://doi.org/10.1080/13549839.2022.2068143

Tuckett, A., Freeman, A., Hetherington, S., Gardiner, P., King, A., & On behalf of Burnie Brae Citizen Scientists. (2018). Older adults using our voice citizen science to create change in their neighborhood environment. *International Journal of Environmental Research and Public Health, 15*, Article 2685. https://doi.org/10.3390/ijerph15122685

UNESCO. (2021). *UNESCO recommendation on open science*. UNESCO. https://doi.org/10.54677/MNMH8546

UN-Habitat. (2024). *World cities report 2024 cities and climate action*.

Van Brussel, S., & Huyse, H. (2019). Citizen science on speed? Realising the triple objective of scientific rigour, policy influence and deep citizen engagement in a large-scale citizen science project on ambient air quality in Antwerp. *Journal of Environmental Planning and Management, 62*, 534–551. https://doi.org/10.1080/09640568.2018.1428183

Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics, 84*, 523–538. https://doi.org/10.1007/s11192-009-0146-3

Van Eck, N. J., & Waltman, L. (2014). Visualizing bibliometric networks. In Y. Ding, R. Rousseau, & D. Wolfram (Eds.), *Measuring scholarly impact* (pp. 285–320). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-10377-8_13.

Van Geenhuizen, M., & Suman, A. B. (2021). Urban traffic and health risk: What is the role for citizen participation in transport planning?. In *Transport in human scale cities* (pp. 188–201). Edward Elgar Publishing Ltd.

Vander Meer, E. (2022). Green infrastructure mapping for adaptation, biodiversity, and health and wellbeing: A tool development case study in Edinburgh. In *Palgrave studies in sustainable business in association with future earth*. Springer Nature.

Vandevijvere, S., Williams, R., Tawfiq, E., & Swinburn, B. (2019). A food environments feedback system (FoodBack) for empowering citizens and change agents to create healthier community food places. *Health Promotion International, 34*, 277–290. https://doi.org/10.1093/heapro/dax079

Vohland, K., Land-Zandstra, A., Ceccaroni, L., Lemmens, R., Perelló, J., Ponti, M., … Wagenknecht, K. (2021). Editorial: The science of citizen science evolves. In K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, M. Ponti, … K. Wagenknecht (Eds.), *The science of citizen science* (pp. 1–12). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-58278-4_1.

Voigt-Heucke, S. L., Müller, M., & Rostin, J. (2023). How citizen science projects contribute to urban biodiversity monitoring and conservation frameworks—A German case study. *Citizen Science: Theory and Practice, 8*. https://doi.org/10.5334/cstp.585

Wamsler, C., Alkan-Olsson, J., Bjorn, H., Falck, H., Hanson, H., Oskarsson, T., … Zelmerlow, F. (2020). Beyond participation: When citizen engagement leads to undesirable outcomes for nature-based solutions and climate change adaptation. *Climatic Change, 158*, 235–254. https://doi.org/10.1007/s10584-019-02557-9

Wamsler, C., Brink, E., & Rivera, C. (2013). Planning for climate change in urban areas: From theory to practice. *Journal of Cleaner Production, 50*, 68–81. https://doi.org/10.1016/j.jclepro.2012.12.008

Wehn, U., Rusca, M., Evers, J., & Lanfranchi, V. (2015). Participation in flood risk management and the potential of citizen observatories: A governance analysis. *Environmental Science & Policy, 48*, 225–236. https://doi.org/10.1016/j.envsci.2014.12.017

Wilson, A., Tewdwr-Jones, M., & Comber, R. (2019). Urban planning, public participation and digital technology: App development as a method of generating citizen involvement in local planning processes. *Environment and Planning B: Urban Analytics and City Science, 46*, 286–302. https://doi.org/10.1177/2399808317712515

Winter, S. J., Goldman Rosas, L., Padilla Romero, P., Sheats, J. L., Buman, M. P., Baker, C., & King, A. C. (2016). Using citizen scientists to gather, analyze, and disseminate information about neighborhood features that affect active living. *Journal of Immigrant and Minority Health, 18*, 1126–1138. https://doi.org/10.1007/s10903-015-0241-x

Wolff, E., French, M., Ilhamsyah, N., Sawailau, M. J., & Ramírez-Lovering, D. (2021). Collaborating with communities: Citizen science flood monitoring in urban informal settlements. *Urban Planning, 6*, 351–364. https://doi.org/10.17645/up.v6i4.4648

Wolfram, M., Frantzeskaki, N., & Maschmeyer, S. (2016). Cities, systems and sustainability: Status and perspectives of research on urban transformations. *Current Opinion in Environment Sustainability, 22*, 18–25. https://doi.org/10.1016/j.cosust.2017.01.014

Wood, G. E. R., Pykett, J., Daw, P., Agyapong-Badu, S., Banchoff, A., King, A. C., & Stathi, A. (2022). The role of urban environments in promoting active and healthy aging: A systematic scoping review of citizen science approaches. *Journal of Urban Health, 99*, 427–456. https://doi.org/10.1007/s11524-022-00622-w

Wu, J. (2014). Urban ecology and sustainability: The state-of-the-science and future directions. *Landscape and Urban Planning, 125*, 209–221. https://doi.org/10.1016/j.landurbplan.2014.01.018

Young, C., Frey, D., Moretti, M., & Bauer, N. (2019). Research Note: Garden-owner reported habitat heterogeneity predicts plant species richness in urban gardens. *Landscape and Urban Planning, 185*, 222–227. https://doi.org/10.1016/j.landurbplan.2019.01.013

Zhu, J., & Liu, W. (2020). A tale of two databases: The use of web of science and Scopus in academic papers. *Scientometrics, 123*, 321–335. https://doi.org/10.1007/s11192-020-03387-8

Zieff, S. G., Musselman, E. A., Sarmiento, O. L., Gonzalez, S. A., Aguilar-Farias, N., Winter, S. J., … King, A. C. (2018). Talking the walk: Perceptions of neighborhood characteristics from users of open streets programs in Latin America and the USA. *Journal of Urban Health, 95*, 899–912. https://doi.org/10.1007/s11524-018-0262-6

Ziliaskopoulos, K., & Laspidou, C. (2024). Using remote-sensing and citizen-science data to assess urban biodiversity for sustainable cityscapes: The case study of Athens, Greece. *Landscape Ecology, 39*(9). https://doi.org/10.1007/s10980-024-01793-4