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Systematic Review

Conceptualising the Link between Citizen Science and Climate Governance: A Systematic Review

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Abstract: Multilevel and decentralised governance approaches involving different social actors are increasingly relevant to collectively tackling climate-induced vulnerabilities. Among emergent governance experimentations, citizen science (CS) is a transversal scientific practice characterised by the involvement of citizens in various phases of the scientific process. We performed a PRISMA systematic review of the scientific literature in order to conceptualise the interface between CS and climate governance. The included 44 studies were coded following the thematic analysis method. Information about temporal and geographical distribution, main research designs and methods, climate governance domains and levels of analysis was extracted. Among the most significant results, we stress the existence of a two-way link between CS and climate governance: CS beyond data gathering can facilitate climate change adaptation—namely, counteracting disaster risk, food insecurity and mental health distress due to changing climate, promoting health and wellbeing, and environmental conservation—until systemic changes are made. Conversely, inclusive governance structures and processes may provide support to initiate CS projects. We also discuss the role of psychosocial and justice issues—as well as digital CS—throughout the selected literature, and the implications for future lines of research and policy.

Keywords: climate change; governance; citizen science; systematic review

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1. Introduction

1.1. Climate Change Governance

According to a report from the United Nations Environment Programme [1], without a structural overhaul of the current production and consumption system to initiate a sharp decrease in greenhouse gas emissions, the goal of the Paris Agreement to keep the average global temperature growth within a limit of 2 °C, preferably 1.5 °C, is doomed to fail. The policies in place will lead to a temperature increase of 2.8 °C by the end of the century, with deleterious effects on the planet. Anthropogenic climate change is a serious threat to life on earth, causing the loss of biodiversity, the degradation of ecosystems and endangering millions of people's lives [2]. Climate change's negative effects on physical and mental health, and psychosocial and emotional wellbeing are also well recognised [3–7], resulting in a pressing global health crisis [8].

Climate change has also been framed as a global problem in which ecological, social, economic, normative and human dimensions are entangled [9,10]. As such, it involves a constellation of divergent interests, values and perspectives; hence there is a need to broaden the scope of stakeholders involved in scientific–political processes, thereby developing novel research and policy paradigms, epistemologies and methods [10,11].

In order to navigate such a growing complexity and bolster community resilience, a governance perspective becomes mandatory. Governance can be understood as the set of institutional and non-institutional processes, structures and tools through which public, private and community actors interact to respond to social problems at different geographical or political levels [2,12]. The debate on governance emerged in political and environmental science as an alternative or broader angle on the issue of governing insofar as it is attested that contemporary socioecological issues are complex and pervasive to such an extent that they cannot be managed by governments as the only legitimate actors [12]. Since international agreements and regulatory instruments are meant to fail to engender a significant reconfiguration without effective incorporation into concrete actions across different arenas and social levels [13], climate governance cannot be limited to formal political arenas but must be complemented with decentralised and multilevel processes based on the active involvement of stakeholders and civil society [14–16].

To foster a transition towards polycentric and interactive governance systems, greater emphasis must be placed on the capacities of citizens in interfacing with institutions [17,18]. Besides the ability to access information, the Aarhus Convention [19] acknowledges and defends the right of citizens to participate in environmental decision-making and justice. The "right to science" granting citizens' involvement in research is also established as a fundamental human right by the Universal Declaration of Human Rights and by the International Covenant on Economic, Social and Cultural Rights [20]. According to the IPCC, then, climate change development and adaptation projects that integrate local scientific and professional knowledge are more effective and sustainable than those that do not include such integration [2]. This paradigm shift has introduced a range of non-hierarchical and network organisational forms based on shared responsibility among multiple actors, and multilevel and multisectoral partnerships [12,16]. In recent years, there has been a spread of numerous inclusive processes for managing socio-environmental problems of adaptation and mitigation, based on partnerships between the public sector and key stakeholders, or the broader participation of civil society, e.g., [21,22]. According to a literature review by Cattino and Reckien, public participation can positively influence both climate adaptation and mitigation toward system change [23]. For example, as Haustein and Lorson argued, citizen involvement was vital in co-producing risk governance at the municipal level in a German case study [24]. Along a similar line, Mees and colleagues advanced three heuristic typologies of flood risk governance co-production, considering the different roles citizens can play within it [25]. Some studies have highlighted the potential of deep public participation beyond tokenistic forms in nature-based solutions (NbS) to tackle climate-related urban issues and produce social benefits such as social learning, enhanced motivation, sense of belonging and equity [26–28]. The relevance of community engagement and co-creation has been promoted also in the field of mitigation; for instance, regarding energy issues such as the social acceptability of climate infrastructure delivery which has become mandatory to the transition to a low-carbon society [29] and the civic involvement in energy communities [30].

However, the fruitfulness of public participation in climate governance does not always occur in a straightforward manner, due to different barriers at the individual and institutional levels [31–33]. Efforts are needed to overcome obstacles such as too-complex governance structures and power asymmetries, as well as to navigate group dynamics and cognitive/emotional shortcomings [28,33]. To this end, emerging participatory methods and strategies that harness the full potential of public engagement become increasingly relevant [31,34,35]. In this vein, the notion of collective experimentation [36,37] and, in particular, of "climate change experiments" labels the numerous collaborative platforms, arranged especially in urban contexts, in which private and public actors, scholars and citizens seek to co-produce innovative solutions to address local problems, sparkling, in turn, a reconfiguration of regulatory tools, institutional systems and urban practices [38–40].

1.2. Citizen Science

Among these collective governance experiments, citizen science (CS) is a transversal and emerging scientific mode of enquiry characterised by the active participation of citizens in various phases of the scientific process in different contexts and with different levels of engagement [41]. Some common features qualifying CS initiatives are the collection of scientific data, the involvement of volunteers, and the consideration of problems, injustices and controversies of socioecological and political relevance [42], as well as public health concerns [43,44]. The positive outcomes of CS include more and better scientific data obtained through new and creative research methods, greater adequacy with local needs and concerns, a motivational drive for behavioural change and improved transparency, together with greater social understanding and trust in science [45]. CS displays a marked kinship with community science, e.g., [46] whose peculiar pillars are that the leading actors are the community members, rather than scientists or government officials; an emphasis on local knowledge and social learning, collective action and empowerment; and the commitment towards more sustainable governance systems. Furthermore, notions of civic science [47] and community-based monitoring (CBM) [48] can be gathered under the same conceptual umbrella.

CS is a powerful tool for collectively imagining innovative ways to tackle serious problems, such as the climate crisis. Yet this is made possible only by reconfiguring the relationship between society and scientific rationality [49]; that is, a double challenge, epistemological and sociopolitical, that questions the way of understanding science and the quality of the obtained knowledge, as well as the identity and range of social actors legitimated to take part in such a collective enterprise [50]. On an epistemological terrain, this reveals an intrinsic relationship with science and technology studies (STS) and post-normal science (PNS). The former interdisciplinary academic field seeks to put into dialogue technoscientific, policy and social aspects of innovation processess unfolding through policymaking and collective action, and foregrounds the active involvement of different social actors as epistemic subjects [51]. The later paradigm, coined by Funtowicz and Ravetz in the 1990s, refers to a critical and innovative social practice of science which outlines a path of democratisation of knowledge and expertise involving all the stakeholders affected by a problem in an extended peer community; promoting the usability of knowledge as the main quality criterion, and overcoming the dichotomy between facts and values, and the boundaries between science and politics [11]. In particular, we state that CS and climate governance approaches meet each in the concept of co-production of knowledge and policy. This superordinate and polysemic construct [52], introduced separately in the fields of political science and public administration [53], and of STS [51], refers to iterative and participatory processes involving a multiplicity of actors and skills in producing practical and context-specific knowledge, favouring at the same time the acquisition of capacities and the development of collaborative networks [54]. The so-called "participatory shift" of governance systems [55] and the hoped-for movement towards democratisation of science [11,44] find a reference in the research agenda of the European Union; for example, in the context of the Horizon 2020 Science with and for Society programme, and in the principles of Responsible Research and Innovation (RRI), where public engagement takes three different forms: co-design of activities, co-creation of new knowledge, and co-evaluation of policies and governance [45,56].

As emerges from the classic work by Alan Irwin, CS has its roots in the critical debate that in the 1980s began to question the limits and possibilities of modern science in the face of the worst outcomes of scientific and technological progress on citizens' lives [44]. Indeed, since its first steps, CS has been intimately linked to the environmental and health concerns produced by the current technological–productive system; that is to say, the question of risk in daily life. The role of CS in assisting environmental policymaking, and national and local decision-making to produce social innovation and public empowerment, has also been addressed [57–59]. Remarkably, in the CS literature, issues of governance are explored above all with respect to environmental challenges and the risks they pose to human and environmental health. Indeed, the new channels for collecting environmental data and emerging forms of active community engagement require a profound revision of the traditional social and power structures and relationships that define areas of exclusive competence of the experts, scientists or political authorities [60]. Recently, at the European level, it has been recognised that CS can play a central role in the various phases of environmental policy formulation—that is, problem identification, policy definition, implementation, monitoring and evaluation—as well as in achieving the Sustainable Development Goals (SDGs) in the United Nations Agenda 2030; such as strengthening social cohesion through various forms of partnerships and participation, yielding a global understanding of citizenship and promoting health and sustainable lifestyles [61–65]. Furthermore, as Göbel and collaborators argue, a governance framework brings to the fore political dimensions—sometimes latent and neglected—of CS practice [66]. Wehn and colleagues have recently advanced a comprehensive assessment framework of CS projects also entailing the governance domain that considers impacts on formal and informal decision-making processes and institutions, data management and power relations [67]. Therefore, among future lines of research, to facilitate sustainable development, greater attention to governance issues related to CS initiatives is recommended [68]. We argue that especially when dealing with climate governance issues, the science–policy interface—i.e., how co-produced scientific knowledge can inform policies and management or promote sociotechnical innovation, and conversely how governance frameworks may benefit or hinder the effectiveness of climate-related CS—would deserve greater elaboration.

2. Aim and Rationale of the Study

Having retraced the epistemological foundations of CS and its recent developments in the field of environmental research and policy, as well as its expected integration into governance frameworks, we ask what the place of CS could be in confronting the governance of complex issues generated or heightened by the ever-worsening climate crisis we witness. In parallel, we ask whether governance structures, processes and principles could hinder or back CS and analogue practices. To the best of our knowledge, no previous work has systematically examined how the relationship between CS and governance unfolds and is conceptualised in the existing scientific literature with specific reference to climate-induced challenges.

Previous literature reviews have explored governance aspects of environmental CS initiatives without a clear reference to climate change impacts. For instance, Conrad and Hilchey reviewed the literature about community-based environmental monitoring initiatives aimed at natural resources conservation, illustrating different governance modes and participation patterns, and their most relevant social benefits [48]. Similarly, Vasiliades and colleagues reviewed the literature about participation in nature-based CS, directing attention to the roles, agency and relevance attributed to citizens [69]. Instead, our review explores a diverse range of climate-related problems, with the intention to embrace the different governance areas dealing with both the roots and consequences of climate change, virtually encompassing mitigation, adaptation and conservation issues. That is to say that we preferred to adopt a broad angle of observation, not choosing in advance to limit the field of inquiry to a single precise governance arrangement.

Furthermore, our work is inspired by Göbel and collaborators who—drawing from Jasanoff's conceptualisation of the mutual dependence of technoscience and politics, e.g., [51] and insights from a European case study—pointed out four main meanings CS can assume about governance: not only as a way of collecting data, but also an object of research policy that must be regulated, a political tool to achieve specific objectives and, finally, a form of sociotechnical governance which allows people to directly address a common problem through locally relevant practices, techniques and skills, without relying primarily on institutional structures [66]. In a similar vein, acknowledging the interlinkage between science, politics and society, we ask how CS and climate governance influence each other, not precluding in advance our gaze on the one-way relationship. Finally, we used a systematic approach, taking into consideration a broad pool of scientific literature.

Against this background, we set three specific research objectives, as follows:

1. Explore the state of the art and provide a descriptive synthesis of the scientific literature about the interchanges between climate governance and CS, with regard to

temporal and geographical distribution, main research designs and methods, climate governance scopes and levels of analysis.

2. Conceptualise the interface between CS and climate governance as it emerges from the comparison of the selected studies.
3. Outline the main themes, issues and perspectives characterising the CS–governance nexus in the selected literature.

3. Materials and Methods

In line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [70,71], we followed a three-step work flow comprising three subsequent phases: identification of records, screening and inclusion [Figure 1].

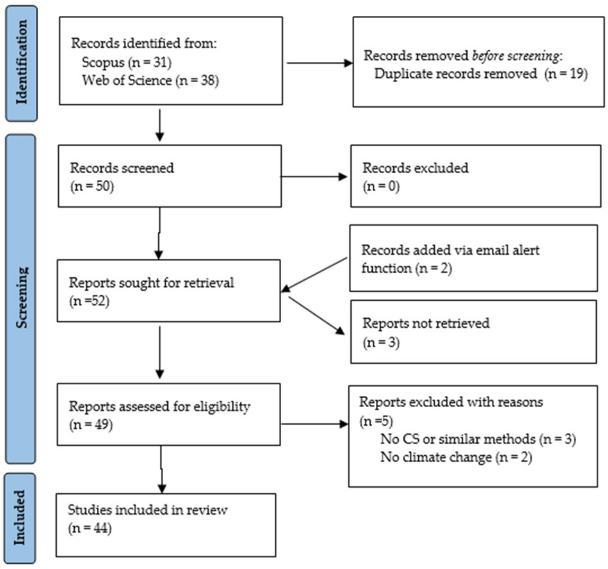

Figure 1. PRISMA flow diagram.

3.1. Data Source, Search Strategy and Identification

The identification phase started on April 2023, when we scanned two electronic databases; namely, Web of Science (Clarivate) and Scopus. The research team comprised one professor, one researcher and a PhD student, all with extensive training in social psychology and social sciences research methodology. We set a search query to identify literature jointly addressing CS, climate change and governance. In order to widen the scope of identified records, we added the most common synonyms of CS to our syntax, obtaining the following search query which was run in both databases to find records containing the selected terms in the title, abstract or keywords: "climate change" AND governance AND ("citizen science" OR "community science" OR "civic science" OR "participatory monitoring" OR "crowd-sourced science").

We then set a language filter, narrowing our search to English-language publications. However, no limitations were applied with respect to the timeline, study area and source type. In this way, an initial corpus of 69 records (38 from Web of Science and 31 from Scopus) was obtained. Finally, we created an email alert function in both databases to track future publications that may have met the eligibility criteria.

3.2. Eligibility Criteria

Records identified through database searches were assessed for eligibility based on the following inclusion criteria:

- The studies had to investigate climate-related issues; i.e., climate change had to play a clear role in the genesis of the problems under scrutiny;
- The issue had to be addressed within a governance framework;

- Clear reference to CS or adjacent practices.

Publication exclusion was therefore based on the following reasons:

- The issues under scrutiny did not originate from climate change;
- A lack of a governance framework;
- No reference to CS or similar methods.

3.3. Process of Research Selection: Screening and Inclusion

After removing the duplicates obtained from the first phase of identification (19 records), we identified 50 records to be screened. The second phase consisted of screening the titles and abstracts of previously identified records to select studies that were in line with the eligibility criteria and relevant to the rationale and aims of our study. In this step, no reports were excluded, as we preferred to perform a deeper reading of the full texts before making a definitive choice of inclusion or exclusion. Nevertheless, three reports could not be retrieved by the authors due to a lack of access. Two publications obtained from the email alert function were selected for inclusion in the eligibility evaluation.

Each of these 51 studies was then thoroughly read and recorded in a Microsoft® Excel® spreadsheet in alphabetical order by author, extracting information relating to the title, year and journal of publication, research design and method of data collection, country of conducted studies, level and scope of analysis, theoretical framework, research objectives and key findings. This Microsoft® Excel® spreadsheet was shared with the research team for cross-referencing and research quality purposes. As can be seen in Figure 1, during this phase, five reports were excluded because they did not meet the inclusion criteria we set. In particular, in-depth reading revealed that three of them were not about CS or similar approaches, and two did not address issues clearly related to climate change. At the end of the full-text screening phase, we obtained 44 studies (37 journal articles, six book chapters and one conference proceeding) to be included in the systematic review and qualitative synthesis, which follows.

3.4. Data Extraction and Analysis

After being recorded in Microsoft® Excel® (version number 2308), the studies were carefully analysed through thematic analysis [72–74], which is a structured qualitative technique of data analysis to identify thematic patterns through the data and provide a qualitative synthesis.

We followed an abductive logic of analysis that combined deductive and inductive reasoning [75–77]. This analytical approach consists of an iterative movement between the raw material (i.e., strings of text from the selected publications) and emerging thematic nuclei in order to generate the best possible explanation or conceptualisation of the data [77]. Combining the attention to specific theoretical frameworks and concepts and an open attitude toward novel insights from the analysed material, this approach seeks a balance between induction (from data to thematic abstraction) and deduction (from theoretical categories to data), strengthening both the rigor of the analysis and its generative potential [75].

Specifically, the areas to be investigated were established based on the identified research aims and informed by the main issues and frameworks in the existing literature known to the authors. In particular, we set these thematic categories to be explored:

- Timeline and geographical focus;
- Methodological approach;
- Climate governance scopes and scales;
- Relationships between the governance dimension and the practice of CS.

At the same time, according to the principles of analytic abduction [75–77], we decided to keep track and code text strings endorsing some emergent themes across the studies under review, which were not anticipated by the preliminary considerations; thereby giving us the opportunity to generate unexpected insights.

The software package Atlas.ti 23 was used to ease the process of data analysis that followed the phases identified by Braun and Clarke [72]: rereading and familiarisation of the full-text articles included in this review; initial coding, that is, naming strings of text or paragraphs with short notes that highlight interesting features of the text; code grouping; and theme building. In line with the abductive approach, themes were developed through an iterative process of repeated comparisons by noting analogies or relationships between coded strings and going back and forth across the listed phases. The authors often discussed and confronted each other about the emergent themes to consolidate the results and ensure accuracy and relevance.

4. Results

4.1. Temporal and Geographical Distribution

Figure 2 illustrates a growing trend in the timeline of selected publications. Notably, the graph showcases that all studies have been published from 2014 onwards—the majority of them (84.10%) since 2019—thus revealing the novelty of the specific research field under scrutiny. The maximum production occurred in 2022, when eleven works were published.

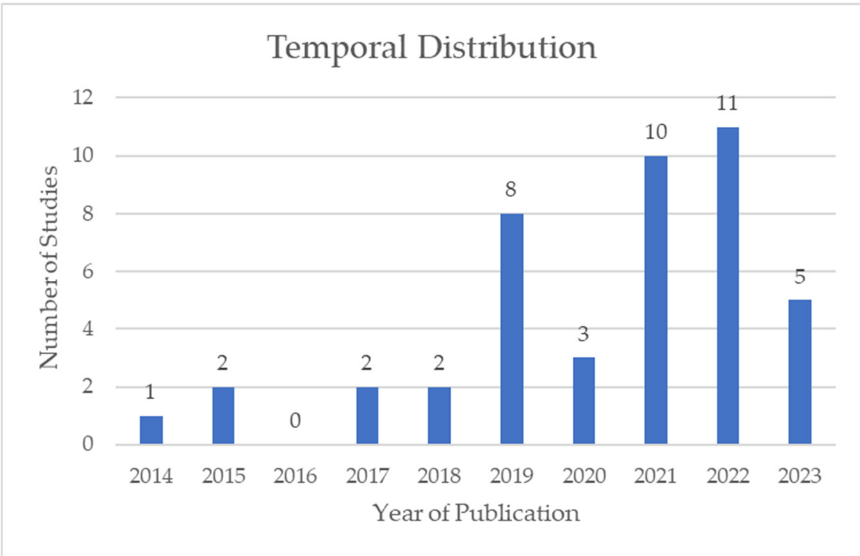

Figure 2. Temporal distribution of the studies included in the systematic review.

Figure 3 shows the geographical distribution of the selected studies, that is the countries where empirical works were carried out, as well as the geographical focus of theoretical and perspective articles, when reported. Alongside the prominence of Western countries, particularly the USA, Canada and the UK, we found a broad geographical spectrum with respect to the number of included studies, covering 32 different countries. Nevertheless, the African continent is underrepresented, as is West and Central Asia and East Europe.

One interesting feature is that the study area often exceeds the national borders and embraces geographical regions or ecosystems characterised by the presence of relevant natural elements or resources, whose conditions are being impacted by climate change; i.e., the Baltic Sea [78], the Himalayan region [79,80], river basins [81–83], groundwater aquifers [84], forests [85,86], coral reef [87] and migratory flyways [88]. Three publications focus on the European context, especially delving into EU policy, regulations and research agendas, and their link with the practice of CS [89–91]. Among studies with a multifocal approach that collect data in different countries, six are comparative case studies [92–97], and two are conceptual articles which include case studies being discussed [98,99].

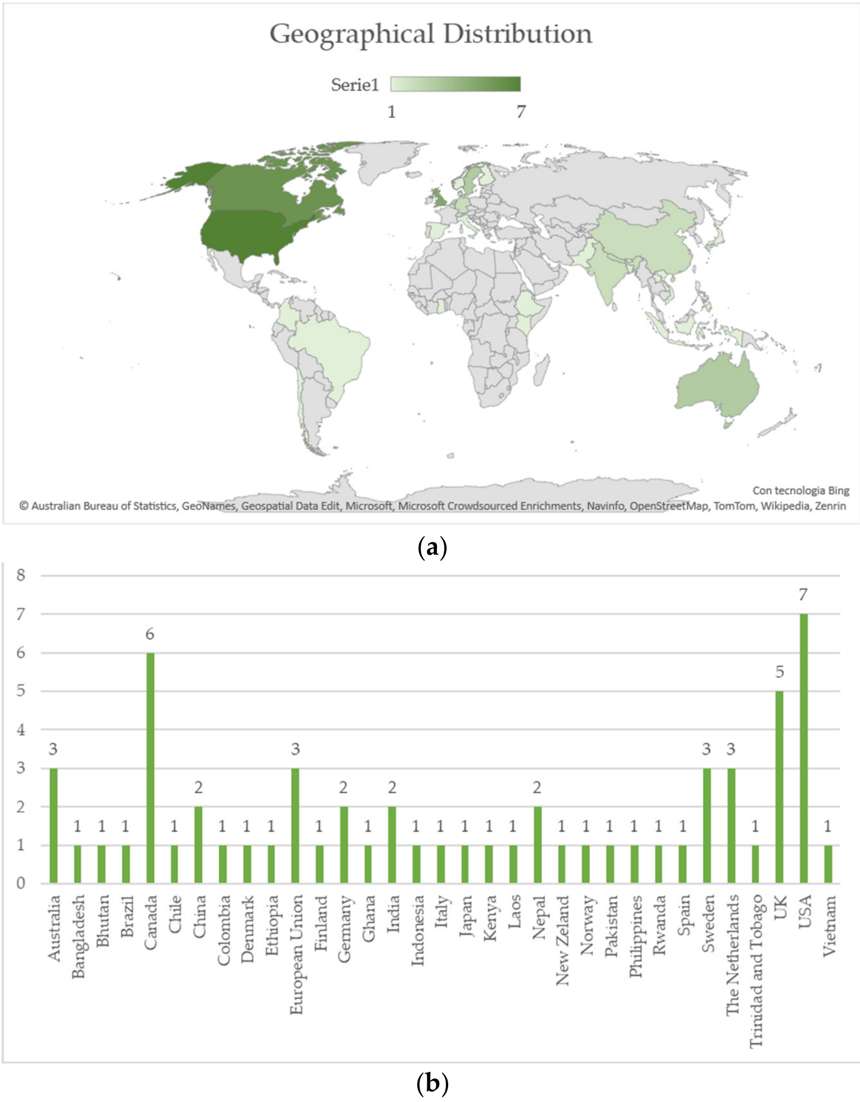

Figure 3. (**a**,**b**) Geographical distribution of the publications included in the systematic review.

4.2. Governance Scope and Scale

Table 1 categorises the selected studies based on the specific climate governance scope they address. We identified two main governance domains: climate change adaptation and environmental conservation. Although the field of environmental conservation—with issues of biodiversity and pollution monitoring, together with ecology and biology—has been the most extensively explored by the CS tradition and community-based approaches [100–102], in our review, the increasingly important scope of climate change adaptation emerges as a well-represented sphere as well, with 24 (54.55%) studies. Regarding adaptation issues, besides prototypical adaptation themes such as climate change policy and disaster management, we outline a deepening of food security in food systems and the way they are impacted by climate and environmental changes, and entangled with health issues [89,98,103,104]. Within the studies primarily dealing with conservation, water governance is the most prominent theme, to the extent that water and water ecosystems, such as watersheds and river basins, are emblematic examples of socioecological commons whose governance requires a collective action approach and shared regulation [16,84,105]. Moreover, themes of forests [86,106] and oceans [87,107,108] health protection and resilience boost a holistic approach to climate-related health risks which acknowledges the non-separateness of human and non-human communities [89].

Table 1. Governance scope and related codes of the studies included in the systematic review.

Governance Scope	n (%)	References	Main Codes
Adaptation	24 (54.55%)	[78,80,89,91,94–98,103,104,106,109–120]	Climate change policies and practices [95,109,110,112,114,117,119] Climate change adaptation governance [91,94,97,111,113,118] Climate action [104,109,114,117,120] Food systems governance [89,98,103,104] Disaster management [80,115] Biosecurity risk monitoring [106] Infrastructure assessment [116] Governance of environmental heritage [78] Urban forest governance [96]
Conservation	20 (45.45%)	[79,81–88,90,92,93,99,107,108,121–125]	Water governance [81,82,84,85,92,99] Biodiversity conservation [79,88,90,124] Forest governance [86,93] Fishery resources management [83,107,123] Natural resources management [122] Coral reef conservation [87] Ocean conservation [108] Land governance [124] Urban FWE (food–water–energy nexus) [125]
Total	44 (100%)		

Table 2 displays the governance scales of the included studies. The whole selected literature elaborates on the local scale of governance; indeed, CS, community science, and the action research line of enquiry, since their beginnings, have always consisted of context-specific approaches aimed at addressing local instances and involving local inhabitants affected by issues harming their living environment [126]. Notwithstanding, several works have attempted to implement a two- or multiple-level perspective. Specifically, 11 publications (25.00%) investigate the cross-scale relationships between local processes and national/international dynamics, exploring the possibilities of upscaling, mainstreaming and replicating virtuous local initiatives towards system transformation, as well as the influence exerted by macroscopic governance dynamics and frameworks on particular contexts [109,117,122].

Table 2. Level of governance of the studies included in the systematic review.

Governance Scale	n (%)	References
Local	29 (65.90%)	[78–82,84,85,87,91–99,103,104,110,111,113,116,118,119,121,124,125]
Local/National	3 (9.09%)	[83,106,114,123]
Cross-scale	11 (25.00%)	[86,88–90,107–109,112,115,117,120,122]
Total	44 (100%)	

Interestingly, while some locally based studies focus on geographical regions and ecosystems, e.g., [78,79,87] or specific affected communities, e.g., [103,104], many others have an urban focus, as they choose cities and towns as their unit of analysis [91,98,109,112,125]. The intrinsic complexity of urban systems, in which a plurality of actors are meant to find solutions to socioecological challenges exacerbated by the climate crisis, establishes the need for integrative management approaches [125]. For example, Mitra and colleagues advanced citizen entrepreneurship as a valid pathway of urban experimentation to the collaborative governance of urban commons [91].

4.3. Research Designs and Methods

As outlined in Figure 4, out of the 44 included studies, 24 (54.55%) are empirical—as they involve data collection and analysis—while 20 (45.45%) are non-empirical. Among the empirical studies, participatory case studies are the most numerous 15 (34.09%); this is consistent with the principle of the direct involvement of participants throughout the research process at the ground of CS, community science and other similar participative research methods. The others are represented by six (13.64%) case studies, two (4.55%) surveys, and one (2.27%) experimental paper. The 20 non-empirical publications included 12 (27.27%) theoretical and perspective articles, four (9.09%) literature reviews, and four (9.09%) summaries, commentaries or introductions to special issues.

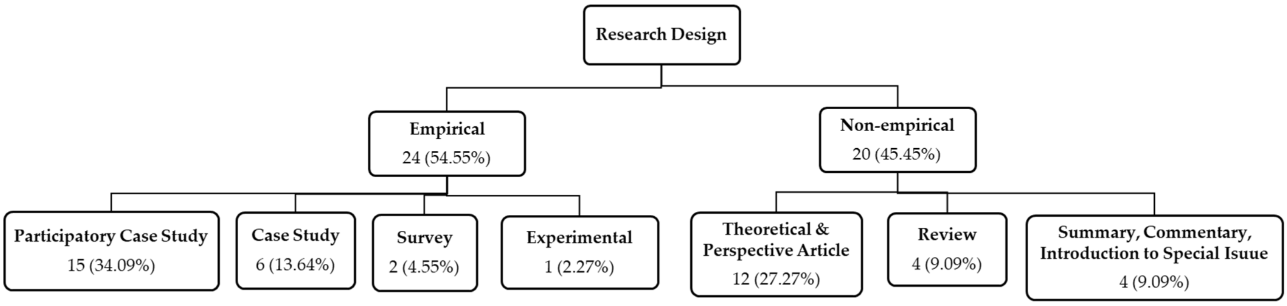

Figure 4. Research design of articles included in the systematic review. Note. Participatory Case Study: [78,80,82,87,88,92,96,104,106,111,112,116,124]; Case Study: [83,93–95,97,114]; Survey: [81,88]; Experimental: [120]; Theoretical and Perspective Article: [90,91,98,103,107–109,113,115,117–119]; Review: [121–123,125]; Summary, Commentary, Introduction to Special Issue: [79,89,99,110].

As depicted in Figure 5, of the empirical studies, 11 (45.83%) use mixed methods, eight (33.33%) adopt a qualitative approach and five (20.83%) use quantitative methods.

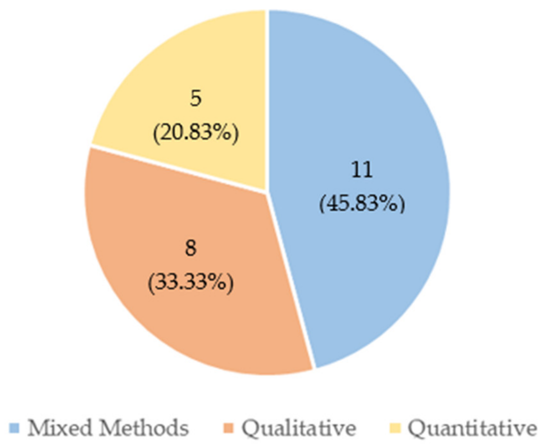

Figure 5. Methodological approach of empirical studies. Note. Mixed Methods: [80,83,84,87,96,97,104,106,114,116,124]; Qualitative: [78,85,86,92,94,95,111,112]; Quantitative: [81,82,88,93,120].

Further interesting features of the empirical studies have been identified in Table 3. Twelve publications (50.00%) implement digital and web-based tools such as smartphone apps, sensors and Geographic Information Systems (GIS) mapping in the research process. Nine studies (37.50%) gather geospatial and visual data, such as maps, photos and videos, or leverage visual representations such as artistic performances and installations. For example, Jetoo and Kouri investigated images and meanings of environmental heritage in the Baltic Sea region, as well as the perception of climate-related risks, by analysing both texts and photographs produced by the participants [78]. Visualisation has been portrayed as a suitable means to do place-informed participatory research, fostering engagement over time, facilitating access to complex environmental issues for different age and ability groups, making community aspirations and climate-related experiences tangible, and providing a meaningful connection with everyday life that counteracts the effects of psychological distance [78,112].

Table 3. Further characteristics of the empirical studies.

Further Characteristics of the Empirical Studies	n (%)	References
Implement Digital Tools	12 (50.00%)	[80–82,86,96,97,104,106,112,116,120,124]
Gather Geospatial or Visual Data	9 (37.50%)	[78,80,84,87,96,97,112,116,124]

4.4. Conceptualising the Link between Citizen Science and Governance

Regarding the nuclear research question concerning the relationship between CS and climate governance (see Section 2), as it is meant and discussed through the selected literature, we identified four themes and one sub-theme, as reported in Table 4. The two themes—Citizen Science Beyond Data Provision and Governance as Enabling Framework—were deductively identified. They are overarching and core themes since they properly relate to the CS–governance link, and then they describe the structure of junctures and relations between the CS and governance domains; that is to say, between science and policy. The three themes—Social and Psychological issues, Digital Citizen Science and Justice-based Approaches—were inductively identified. They refer to issues and lenses emerging from the reviewed articles which contribute to characterising the specific nexus under scrutiny in a more nuanced and comprehensive fashion.

Table 4. Themes and sub-themes that describe the link between CS and climate governance.

Themes and Sub-Themes	n (%)	References	Description
1. Citizen Science Beyond Data Provision	44 (100%)	[78–99,103,104,106–125]	Dealing with climate governance issues, the value of CS is not limited to data provision, rather it becomes a real co-production substantiating different co-management and co-design initiatives, collective decision- and policymaking, where citizens take an active role.
1.1 Toward System Change	19 (43.18%)	[82,84,88,91,96–98,103,104,106,111,112,114–118,120,125]	The inclusion of CS in climate governance may lead to system transformation and sociotechnical innovation, self-governance and empowerment of local communities
2. Governance as Enabling Framework	20 (45.45%)	[83,84,87,89,90,92,95,96,98,99,103,107–110,115,117,119,120,125]	Governance structures and processes, policies and regulations can both help or hinder the initiation of CS projects and their quality. Brokerage actors or bodies are relevant to support collective governance and research processes.
3. Social and Psychological Issues	41 (93.18%)	[78,79,81–92,94–99,103,104,106–112,114–125]	Participation in climate-related CS enhances capacity building and community resilience. Citizen perceptions, interests and views are always at stake in the CS-governance junction, and thus conflict resolution approaches and social learning become fundamental. Factors influencing behaviour change and motivation are also important.
4. Digital Citizen Science	25 (56.81%)	[79–81,86,89,91,92,94,96,97,99,103,104,106–109,112,113,116,118,120,122–124]	New technologies could serve as a vital contribution to the effective implementation of CS in the climate governance domain, enabling equitable participation and community engagement. However, they risk exacerbating existing inequalities linked to access to technology.
5. Justice-based Approaches	16 (38.63%)	[79,83,84,90,93,103,104,107,108,110,115–119,122,124]	CS projects must consider and address gender and social inequalities by promoting the active involvement of marginalised groups affected by climate impacts.

4.4.1. Theme 1: Citizen Science beyond Data Provision

Although one defining feature of CS is the involvement of volunteers in data collection [41,42], when it comes to unveiling the links between this scientific methodology and the domain of governance, a conceptual and practical leap becomes mandatory. All of the selected publications stress the value of CS and kindred practices beyond collecting and providing relevant environmental data to scientific or political agencies and institutions. We report a clear transition from the conventional conceptualisation of CS as an individualistic endeavour in the form of crowdsourcing and tokenistic projects, to a marked collective and community imprint, e.g., [98,117].

The described scientific and political practices engage stakeholders and laypeople from the very beginning in the tasks of identifying objectives, priorities and suitable methods, and throughout the whole research and policy crafting process [89]; valorising diverse sources of knowledge, local and traditional expertise and worldviews [83], as well as transdisciplinary climate scholarship and governance [84,117]. The one-way flow of data from volunteers to groups of experts who initiate and control the research process becomes a two-way information and knowledge exchange beyond consultation and information [85,106,115]. The integration of plural views into co-management and co-design of policies, plans and research projects [78,92,106,118] is well expected. For instance, the enhancement of local knowledge and cultural worldviews in watershed management appeared to be the most relevant step towards active community participation in local water governance, since it bolstered community abilities [85]. Furthermore, community-based monitoring (CBM) has been proven to play a fundamental role in local planning and decision-making regarding natural resources management and forest conservation [82,93,122]. Active community engagement in climate change policymaking and co-design within an urban setting resulted in several positive outcomes on public awareness and governance effectiveness [112]. Co-designing research and co-producing climate and environmental knowledge with researchers, governmental actors and stakeholders were relevant for addressing climate challenges and protecting the marine ecosystem of the Columbian coral reef [87].

Furthermore, collective decision-making [93,98,99,104,111,122] opens up a deliberative and political dimension intertwining with the scientific practices of asking research questions, gathering useful data and drawing inferences, and assigns a more prominent and influential role to citizens in local climate decisions and policymaking; in this way, deepening the top-down–bottom-up nexus between institutional actors and laypeople. To this end, CS may be implemented into consultation and deliberation fora, such as citizen juries [110,117].

Subtheme 1.1: Toward System Change

Notably, 19 (44.19%) analysed studies address the CS–governance nexus with respect to the potential of CS and participatory methods to produce some form of system transformation and sociotechnical innovation. Sociotechnical innovation describes the movement towards new, improved governance modes and societal configurations suited to tackling and limiting climate impacts; i.e., more decentralised and participatory governance frames [88,115], implying the redistribution of authority and new roles and responsibilities to be negotiated [106,115]; as well as self-governance and empowerment of local communities [97,104,116]. This systemic change is facilitated through transformative research projects, such as urban governance experiments [106,125] and CS initiatives; these mostly originate from the commitment of non-governmental and civil society actors and organisations, with a marginal role for formal institutions and experts [98,112,118] and a parallel acknowledgement of citizens as real agents of change [91,117]. For example, Grant and collaborators portrayed the process of co-designing information and communications technology (ICT) for biosecurity risk monitoring with stakeholders as a mode of sociotechnical innovation towards a system shift [106]. Woelfle-Erskine showed how transdisciplinary collaborations in a CS project held in one water-scarce salmon-bearing watershed in California reconfigured governance structures, regulatory frameworks, scientific methods and cultural water use practices [84]. CS was also depicted as a catalyst for food system transformation in urban contexts [98]. Nevertheless, Bremer and colleagues empirically showed the limits of CS in impacting governance structures and processes. Assessing the contributions of CS on local adaptive governance in a monsoon-prone area, they found a moderate influence of CS on local adaptive decision-making (i.e., political capital), while the impact on institutional arrangements (i.e., institutional capital) was scarce [111].

4.4.2. Theme 2: Governance as Enabling Framework

Whereas CS and participatory research methods, as stated above, can support the rearrangement of governance processes and structures, the reverse relation is equally valid: 20 (45.45%) selected publications stress the enabling role of existing governance frameworks in providing affordances to initiating and shoring up CS projects. In particular, the United Nations blueprint of the 17 Sustainable Development Goals (SDGs) within the 2030 Agenda for Sustainable Development [127] has been advanced as a legitimating framework for participatory processes fostering food system change [98] and community governance of coral reefs [87], deepening the scope of action for science with regard to urban sustainability [109], addressing climate action and clean water challenges [120], enhancing the role of smart urban forestry in urban sustainability [96], and mainstreaming information and communication technologies (ICTs) into adaptive decision-making [99].

At the level of the European Union, EU policy, especially the Responsible Research and Innovation principles [128], has been advanced to promote and give legitimacy to new environmental monitoring systems based on CS. The Open Science paradigm [129] and the One Health framework within the EU research agenda have been used to enhance data sharing, and availability and participatory assessment of emerging food risks [89]. Moreover, Hermoso and colleagues included CS among different forms of citizens' and stakeholders' engagement in biodiversity conservation fostered by the EU Biodiversity Strategy for 2030 [90,130].

With respect to governance structures and processes, knowledge and dialogue platforms must be provided in order to spawn chances to perform CS and improve co-governance [92]. Polycentric and multilevel configurations of governance [131] are considered essential to grant the integration of empirical research under the CS frame in policy, properly addressing community challenges such as food–energy–water (FEW) security in cities [125]. In this vein, Ostrom's investigation of institutional and organisational features, such as communication and information arrangements influencing co-management and community interactions, is also discussed [99,105,115,125]. According to Kythreotis and collaborators, institutional bodies—both scientific and political—should implement more cultural and gender-inclusive programmes and criteria that facilitate the participation of all social actors in climate change governance [117]. As claimed by Guldi, community science could be a viable solution only if it is paired with marked reframing of governance and information infrastructures [115]. In fact, governance structures can also exercise an impeding role, as dated and inadequate regulations and norms, together with power imbalances, could counteract the beginning and feasibility of CS initiatives [84,117].

Furthermore, in this context, the issues of facilitation and brokerage [94,103,110,117,119] have received considerable attention, underscoring the need to identify intermediary actors or bodies with the task of scaffolding collective governance and research processes—i.e., reducing the efforts of participation for laypeople, with the provision of information, useful instruments and technological literacy—in this way, facilitating communication and building a bridge between expert and lay expertise [110,119]. A further important goal of facilitation lies in granting process fairness and inclusiveness for all interested voices and navigating uneven power relations [92,117,119]. Conflict resolution approaches could complement brokerage tasks by reducing opinion gaps and pursuing common perspectives and goals [92,117]. The brokerage function can be performed by different typologies of actors or institutions. For instance, an advisory council composed of elders, traditional knowledge keepers, key decision-makers, youths and researchers played a decisive role in promoting climate change adaptation within a subarctic Indigenous community in Canada, maintaining long-term collaboration, and respecting and representing local needs [103]. Kythreothis and colleagues argued that universities may be the most suitable bodies to catalyse CS projects, since they reflect and dialogue with a plurality of cognitive, spiritual and aesthetic placements [117]. Takao and collaborators stressed the important contribution of expert citizens to fostering equal democratic dialogue and mutual comprehension between experts and citizens [119].

4.4.3. Theme 3: Social and Psychological Issues

Almost all of the selected literature (93.18%) displays some reference to cultural, social and psychological processes of significance regarding the relationship between governance and CS. This theme refers to social impacts and assets—both at the personal and at the community level—that are linked with the different ways in which science and governance meet through the practice of CS, meaning that the two-pole relationship between CS and governance must be read within the context of the many interchanges it establishes with the societal and relational milieu.

Specifically, CS initiatives should provide capacity building and community resilience in the face of climate change challenges, empowering local communities with useful instruments and skills to prevent and tackle climate impacts, e.g., [81,88,124] and health-related risks [103,104]. Conrad and colleagues found that data accessibility provided by monitoring tools for local water management yielded a significant increase in four indicators of adaptive capacity: information diversity, cognitive social capital, leadership and proactivity [81]. Through land management case studies, Raschke and colleagues [124] explored and showed how digital community science approaches could contribute to developing the dimensions of community resilience previously identified by Patel and collaborators, i.e., local knowledge, community networks and relationships, communication, health, governance and leadership, resources, economic investment, preparedness and mental outlook [132].

Furthermore, community perceptions, concerns [78,91,96] and mental models [96,106], together with different stakeholders' interests, priorities and views [92,112,117], are recognised as essential elements which cannot be ignored by project managers to achieve social acceptability of plans and policies [78,106]. Many publications emphasise the importance of lay knowledge, local cultural worldviews and contextual expertise built through lived experience [79,83,85,110,119,125]. Talking about aspirations and shared fears and hopes for the future may drive individual, societal and system transformation, leveraging the emergence of new environmental imaginaries [84] and narratives of change [97,117]. For this purpose, conflict resolution approaches [92,117] and the social learning theory, e.g., [133] have been raised as valuable means to co-create new shared values and meanings [106], fostering critical reflection and perspective transformation through community science [92,106,114]. Moreover, the group dynamics underlying the tension between cohesion and particular interests are due to consideration in collective intelligence-based CS [120].

In this regard, effective participatory research and governance strategies should encompass a thorough consideration of attitude and behaviour change dynamics [94,108,114,117], as well as issues of maintaining motivation and engagement over time [78,88,92,95,97,108], and investigate the related underpinning psychosocial processes. For example, Gharesifard and Wehn, following the Theory of Planned Behaviour (TPB) [134], identified a list of drivers and barriers to public participation in citizen weather observatories, stating that comprehension of these factors is mandatory to engage citizens in climate change adaptation [94]. The construct of place attachment, which conveys the emotional fold of the overarching concept of sense of place, has been portrayed as a potentially important factor in this domain [96,108,114]. Examining the role of place and transformative learning in favouring critical reflection within community science, Groulx and colleagues found that the experience of new places could increase awareness and trigger critical reasoning [114].

4.4.4. Theme 4: Digital Citizen Science

This theme is endorsed by a broad spectrum, i.e., 56.81%, of included publications. It is widely recognised that digital devices and new technologies could serve as a vital contribution to the effective implementation of CS in the climate governance domain. First, they provide the chance to collect a diverse repertoire of data—quantitative measurements, audio, videos and photos of environmental and weather conditions—with increased extensive spatial and temporal coverage [80,103,106,109,113,122,124]. Moving beyond data collection, digital information-sharing platforms can facilitate early detection and warning of climate-related hazards [103], community-based environmental monitoring [99], inclusive adaptive decision-making, e.g., [99,104], knowledge co-creation [103,118] and co-management of natural resources and ecosystems [79,81,96].

We found several arguments and practical examples supporting the beneficial integration of a wide array of new technologies in climate-related participatory research and policy; namely, Volunteered Information Systems (VGI) [113], remote sensing (RS) [80,96], Artificial Intelligence (AI) applications [96,104,122], Geographic Information Systems (GIS) methodology [80,96,112,116], and low-cost sensors and devices [8,97]. For example, Participatory-GIS (P-GIS) tools have been used to support the co-design of climate policies and strategies to address flood risk, increases in temperature and pollution in an action research project in East London [112]. Pauleit and collaborators reviewed a series of new technologies which may uphold sustainable urban forestry and stressed both the advantages in terms of environmental justice and co-management, and the pitfalls they entail [96].

In fact, the selected literature is traversed by substantial ambivalence regarding the impact of new technologies. On one hand, it reveals their sound potential to enable equitable participation and community engagement in climate governance and research. Since they are becoming more and more accessible and cheap, these devices could advance the expected democratisation of science and enhance active public involvement in governance [96,103,104,106,124], at the same time yielding data ownership and sovereignty to local communities and marginalised groups, and hence community empowerment and self-governance [103,118]. On the other hand, these methods could exacerbate existing social inequalities, to the extent that they may not be able to overcome the digital divide: although costs are ever lower, smartphones and internet connections are still necessary to take part in these digital-based projects; moreover, digital skills are required, which may be difficult to acquire, especially for older people [96,99,107,108,112,113,122]. In line with this, we report a consistent co-occurrence of this theme with the following, i.e., Justice-Based Approaches, echoing the need to integrate digital CS methodologies with environmental and social justice cogitation to avoid shoring up the digital divide [79,103,104,107,116,118].

With respect to theoretical frameworks pertaining to this theme, we point out the digital sustainability framework within the Information System (IS) research [118] and the notion of connective action, which is complementary to collective action, as well as the sociotechnical innovation systems (STIS) theory, both in the field of information and communication technologies (ICTs) [99,106].

4.4.5. Theme 5: Justice-Based Approaches

Finally, several studies (38.63%) in the selected corpus witness thorough attention to justice issues concerning CS practice and climate governance that is acknowledged to heighten existing gender and social inequalities [2,110,117]. From a human rights-informed perspective, they stress the importance of giving an active role to marginalised communities and vulnerable social groups—such as women [107,117] and Indigenous peoples [103,104,107,118]—who have been disproportionally affected by climate change impacts [107,115,116]. Participatory projects must consider and address these imbalances by promoting the active involvement of these groups in co-management, decision-making and climate research and policy [90,93,116,117], underlining the value of traditional Indigenous knowledge and the importance of its integration with Western and official scientific paradigms or institutional processes [103,104,108,115].

Among the justice-based theoretical perspectives, we specifically indicate the intersectional lens unveiling the overlap of gender, social and cultural inequalities [107]; Indigenous, feminist and postcolonial STS [84]; the environmental justice scholarship with the scientific modes of enquiry developed in its tradition, such as popular epidemiology, CS, street science and community science [110,115,119]; and the Two-Eyed Seeing approach [135]; i.e., the integration of Western and Indigenous knowledge systems as a co-learning pathway to achieve more creative and valuable solutions [84,103,104,117,124]. For example, in a participatory case study implementing a decolonial lens to digital CS, Indigenous community members affected by climate change impacts were actively involved from the project design to its evaluation in order to foster adaptation; namely, counteracting food insecurity and mental health distress due to changing climate [103,104].

5. Discussion

The climate crisis is posing unprecedented challenges to ecosystems and species, hence the need for effective governance mechanisms and arrangements to mitigate its impacts and adapt to changing conditions. CS, as a co-production approach at the interface between science and policy, can play a pivotal role in the participatory turn characterising collaborative and multilevel governance systems which are considered of paramount importance to deal with climate change and its concrete, local manifestations. Therefore, we carried out a systematic reviewed of the scientific literature that deals with climate change issues from a governance perspective, and implements or discusses CS applications.

5.1. An Overview of the Selected Literature

We found a relatively scarce base of studies (44 included in this review); yet a clear increase in publications in the last five years was observed.

Interestingly, we noticed that the included literature covered a wide geographical scope, often overcoming national borders and embracing vulnerable ecosystems and affected regions [78–82,87,88]. Moreover, water and food governance, as well as ecosystem protection appeared to be important areas in which CS is being applied to counteract climate impacts. This is in line with the need not to forget the interchange between planetary and human health when dealing with the risks stemming from the climate crisis and cascade environmental changes, and thus the One Health approach [89,136]. The marked focus on the local scale was usually matched with the attempt to upscale context-specific initiatives and consider the cross-level interplay between policy domains [86,88–90,107–109,112,115,117,120,122]. Above all, a spotlight on urban contexts and cities as the favoured unit of analysis was found. In fact, cities have been portrayed as hotspots of experimentation to build climate resilience and sustainability [91,98,109,112]. This finds a normative reference in the eleventh Sustainable Development Goal (SDG11): Making cities and human settlements inclusive, safe, resilient and sustainable [109,127].

With regard to climate governance issues scrutinised under CS or adjacent perspectives, we found developments in both the conservation and adaptation domains (see Section 4.2). In our opinion, this is a promising result, as nature-based CS has traditionally been much more concerned with environmental conservation issues than with climate adaptation [100–102], and participatory investigations on climate change adaptation are still scant [137,138]. In parallel, we noted a lack of CS integration into initiatives aimed at addressing mitigation challenges toward a low-carbon society.

Under a methodological stance, 15 (34.09%) of the reviewed studies were participatory case studies in which CS and related practices are treated as real methodological approaches entailing the active engagement of citizens and stakeholders throughout the whole research process. Notwithstanding, only 24 (54.455%) of the selected studies were empirical. More applied research is therefore needed to present concrete examples of CS replying to climate governance challenges and implementing well-defined criteria serving impacts and effectiveness assessment.

The mixed-methods approach, leveraging different modes of enquiry and often integrating visual and digital techniques, was the most prevalent among the empirical studies included in the review. This is consistent with the emphasis on the integration of perspectives, different knowledge systems and personal attitudes in the basis of CS and post-normal science [11]. In fact, the implementation of visual methods such as the use of photographs, videos, drawings and maps has been proven to leverage interdisciplinary expertise, imaginative processes, tacit knowledge and inner dimensions involved in deliberative processes, risk management and collective experimentation [139–141].

5.2. The CS-Governance Nexus

Remarkably, we illustrated various two-way relationships between CS and climate governance, showing how CS and akin approaches can contribute to addressing problems like climate change, not only through the provision of environmental data, but also through favouring co-management, collective decision-making and sociotechnical innovation (see Section 4.4.1).

With respect to the main theoretical underpinnings of the CS–governance interface, we documented an intimate kinship with the theoretical and practical tradition of action research; specifically with Participatory Action Research (PAR) and Community-based Participatory Research (CBPR) projects, e.g., [104,110,115]; as well as a foundation in epistemologies which distinguish from normative, official science, such as post-normal science, e.g., [11,110,111]. In the field of STS, we found mentions of the Actor–Network Theory (ANT) and Jasanoff's notion of civic epistemology and concept of co-production [55,78,84,106,110,142]. Ostrom's concept of the commons and collective action theory were also mentioned, e.g., [91,95,131]. Regarding the level of public participation, we found reference to Arnstein's ladder of participation [106,143], Rowe's typology of public engagement [112,144], and Haklay's levels of participation in CS [113,117,145]. Moreover, Kythreotis and colleagues proposed a further level of CS beyond Haklay's classification; i.e., citizen social science (CSS) [117]. Regarding this, we argue that when dealing with governance, CS is better understood as CCS, since, by integrating contributions from the theoretical tradition of PAR and the concept of collective experiments from STS, it acknowledges citizens as active co-learners and important agents of research and policy change [117,146].

Moreover, our results uphold the STS framework as a suitable lens for understanding the dynamics related to the CS–governance nexus [147], to the extent that it questions the separation between science and politics, and delves into the co-production and legitimation of knowledge in complex social, political and technological systems where scientific facts and social values cannot be separated [11,51]. CS can be considered a form of social innovation in itself or an innovative practice leading to social innovation, particularly with respect to the processual dimension related to governance and participation [57]. CS is meant to advance innovation and open science by operating at the threshold of scientific, social and political spheres, thus changing the normative relationships between them [148]. In line with Göbel and colleagues [66], we state that CS can advance sociotechnical innovation, steering changes in norms, institutional structures and relational processes, and manifesting as a form of self-governance. Moreover, as we illustrated, governance structures and relations can support CS projects but conversely institutional barriers such as uneven power relations, organisational arrangements and unfit regulations may hinder the possibility of doing participatory research [33,117,138]. Thus, the analysis of the multiple synergies and interferences between climate-oriented CS and governance frameworks deserves deeper consideration.

5.3. Inductive Themes

In line with our results, other studies outline the potential of emerging technologies in supporting CS collaborative data collection, management, quality control, communication between users and motivation [149–151]; at the same time favouring wider and more diverse public participation and implying the risk of digital marginalisation [149].

Interestingly, regarding the fourth and fifth themes and their high co-occurrence, Berti Suman and Alblas argue that advancements in law and technology marked a turning point in the CS historical trajectory. The close relationship between reactive and autonomous CS initiatives and justice claims, especially those linked to industrial risks, played an important part in emancipating citizens from the role of human sensors and legitimating their epistemic competence in monitoring and influencing official decisions. This breakthrough has been assisted and boosted by AI-based and geo-information technologies that can make citizen-led scientific initiatives more accessible and impactful [126].

With respect to the sharp presence of social and psychological issues in the selected corpus, Tauginiené and colleagues found that, albeit with a still marginal place within the CS framework, social sciences and humanities are becoming more prominent, especially regarding projects addressing serious problems such as climate change [152]. Social sciences could help to undertake a "co-reflexive process", providing theoretical lenses, concepts and methodologies to address social barriers to participation and leverage the potential of multiple cultural perspectives, context-specific knowledge systems and embodied experience [147,152,153]. They could also help us to understand people's motivation, maintain engagement and guide learning processes [152]. Indeed, the act of "sensing" the environment at the basis of CS practice, in addition to concerning data collection, has been understood as emotional engagement with ecological issues [126]. Concepts of sense of place, place attachment, identity and dependence [154] may prove to be vital in research about climate-concerned CS. Some authors have explored the potential of sense of place scholarship in informing social–ecological systems research, particularly with respect to social engagement, resilience and transformative capacity building [155–157].

Moreover, the impacts of nature-based or environmental CS initiatives also manifest through behaviour change and learning, as well as sparking community action [102,158] and promoting health [43]. Therefore, a governance perspective on climate change issues should not forget to consider processes of change, learning and resistance at the individual level of analysis. Lasting sociopolitical shifts towards sustainability cannot be achieved without parallel transformations involving personal values, beliefs, habits and capacities [2,159,160]. Hence, there is a need for integrated and holistic approaches to climate change governance [159–161], spanning multiple interconnected spheres of transformation: from the reconfiguration of sociopolitical structures to the promotion of social and transformative learning processes, favouring the acquisition of skills and the evolution of habits, social identities and collective imaginaries [148,162,163]. In this regard, the vital need to incorporate psychosocial and mental health considerations into climate adaptation policy and governance has been reported, e.g., [161,164,165].

Overall, these final remarks pave the way for transdisciplinary exchanges and cross-fertilisation in CS, encouraging the collaboration of experts in a specific field of interest with computer scientists, justice scholars, and behavioural and social scientists, e.g., [151]; this is particularly significant within a governance perspective dealing with serious problems such as the climate crisis.

6. Limitations

This study has several limitations. First, if on the one hand our choice to screen two scientific databases (Web of Science and Scopus) as the only data sources ensured the quality of the scientific material we read, on the other significant climate-related CS projects may have been omitted as they were not reported in peer-reviewed literature. Future studies may try to map these works by performing a wider website analysis. Moreover, the phase of record identification was complicated by the terminological elusiveness characterising the category of CS-related methods. To include the widest spectrum of scientific works meeting the research objectives and eligibility criteria, we added some common synonyms of CS in the search query. However, some important studies implementing participatory methods in climate governance may have been omitted. Future studies may consider this and try to identify and analyse a more diverse corpus of CS-related projects. Furthermore, in this phase, the set language filter could have implied the omission of interesting non-English language works. Given this, we are aware that the selected corpus of publications cannot be considered a representative sample of all projects and works on the topic under consideration. However, it has been selected and analysed through a scientific and rigorous methodology, so we believe it may inspire researchers and practitioners in the field.

Second, given the limited number of identified articles, we chose not to limit our analysis on a specific climate governance domain—such as mitigation, adaptation or conservation—preferring to provide a wider account of the climate governance initiatives with a CS imprint. An insight into one precise climate governance sector may be a topic for future reviews.

Lastly, our thematic synthesis is informed by notions that emerged from the data and is inevitably influenced by the authors' scientific background, knowledge and training. To ensure the validity of our results, we repeatedly confronted the emerging themes and discussed incongruencies to maintain a rigorous analytical posture. However, further attempts to map and interpret this recent and increasing literature from divergent and multiple standpoints and through different methods of analysis are definitely worthwhile.

7. Conclusions

Given the alarming impacts of climate change on the planet and local communities, it is increasingly important to involve local people in climate decision-making, management and governance in order to ensure the legitimacy feasibility and local relevance of these processes. To this end, CS is considered a very promising approach. We sorted the results from a systematic review of the scientific literature concerning climate change governance and CS-related processes. Our work provides the following insights from which important tasks for scholars and practitioners can be derived.

A variety of climate governance challenges and contexts was noted: from urban settings to vulnerable ecosystems, regions and communities. Water and forest ecosystem governance and food security appeared to be important areas in need of more and more consideration due to the changing climate. The focus on the local level is often matched with cross-scale analysis spanning context-specific dynamics and national and international policies. This multilevel and multifocal perspective should be kept in mind and enhanced to find solutions to increasingly pervasive and interconnected climate-induced issues and related public health risks.

Climate change adaptation turned out to be an important area in addition to environmental conservation. Given the increasingly devastating impacts of climate change on socioecological systems and the need to build community resilience, we push scholars and practitioners to engage in this domain, carrying on CS projects dealing with adaptation challenges, i.e., fostering preparedness, co-design of adaptation policies and disaster risk reduction plans; thus contributing to health promotion and safety though context-grounded knowledge, e.g., [166,167]. Furthermore, we encourage initiation of CS projects and case studies addressing mitigation challenges, e.g., [168].

A prevalence of participatory case studies, but a relative scarcity of empirical research, was observed. More applied research is thus needed, together with the development of evaluation criteria encompassing social and environmental justice indicators and psychosocial dimensions. The potential of mixed-methods approaches, digital CS and visual methods to involve and integrate different stakeholders' contributions should also be leveraged.

Our research helps to enlarge the spectrum of connections between climate governance and CS, emphasising the two-way nexus between the scientific and political domains, proceeding beyond the themes of data collection and the degree of public participation. Practitioners and project brokers may consider the multifaced and complex character of the CS–climate governance relationship deserving attention to be paid to the multilevel processes and factors steering or hindering transformation towards sustainability; i.e., how CS projects can inspire transformation in behaviour, worldviews, political and organisational systems, and how governance modes can foster or counteract these processes of change and adaptation. In order to strengthen top-down–bottom-up communication and mutual enrichment, the innovative contribution of spontaneous forms of local activism and self-governance must be recognised and empowered, as well as the rearrangement of norms and procedures towards more inclusive and democratic paradigms.

Lastly, the prominence of psychosocial issues, and digital and justice considerations raises the need to build transdisciplinary working groups, with specific professional figures holding brokerage and facilitation functions to better care for participants' vulnerabilities, rights and transformative qualities, and support effective collaboration between all involved social actors.

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