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Participatory Technique Supporting Environmental Management: A Systematic and Bibliometric Review

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Abstract

The increasing need to manage natural resources sustainably, driven by population growth, requires the simultaneous use of Participatory Techniques (PT) and landscape planning for structured decision-making. We conducted a bibliometric and systematic review to provide an overview of PT usage, identifying evolution in scientific production. We considered the number of publications and citations, prominent journals, and highly cited articles on scientific papers published in the Web of Science database between 1993 and 2023. A total of 415 articles related to PT were identified. After content evaluation, 19 critical articles were selected that underpin the growing combined use of models and indices with PT, enhancing the robustness and credibility of decision-making processes.

Keywords

Participation, Landscape Planning, Decision-Making Process, Stakeholders, Sustainable Management

1. Introduction

Changes in land use and cover, mainly the agriculture expansion with the conversion of natural landscape linked to the increase in population and demand for resources, are responsible for the most significant negative impacts on the terrestrial and aquatic ecosystems since 1970, resulting in the degradation of the ecosystem services [1].

Ecosystem services, which are benefits arising from nature generated by human beings, can play a crucial role in achieving sustainable resource management, landscape planning, and creating resilient and multi-functional landscapes [2] [3]. Once we identify these services and understand how they are distributed, we can determine where interventions should be carried out. This information can guide us toward more effective environmental management and better protection of our natural environment [4].

Assessing ecological resources and ecosystem services is essential for effective environmental management and developing policies that improve community benefits [5]. Achieving this goal requires a comprehensive and multidisciplinary approach to environmental planning. Participatory research, which involves academic researchers, development organizations, and society in general, has been increasingly employed to meet these objectives [6]-[10]. This approach provides a platform for combining technical-scientific information with the knowledge and experience of decision-makers and citizens, making it an essential tool in environmental management.

The Participatory Technique (PT) involves experts, decision-makers, representatives of society, and other stakeholders in proposing and perceiving alternatives for managing local resources [11]-[14]. Thus, applying PT consists of structuring and evaluating alternatives and scenarios from different areas related to an objective and involving different opinions [10].

According to [11], PT seeks to obtain consensus among many interested parties, which adds greater robustness to the process [15]. For reference [16], group performance tends to be more effective than the direct aggregation of the choices of individual group members, and better decisions are made than the most highly qualified individual in a group.

The consensus process between actors is an interactive procedure that involves several rounds of negotiations, during which decision-makers agree to modify their statements [17]. Furthermore, it has been observed that divergent opinions and satisfaction with the solution promote creativity in decision-making, especially when there is active individual participation, which, in turn, is related to increased decision quality [18].

The authors used different PT application strategies to externalize public opinion. Reference [19] promoted a workshop with specialists, consultants, and public managers to define criteria for decision-making and obtain their respective importance through consensus between them. Reference [20] held meetings and interviews to define criteria weights and mapping, with the use of this combined approach of PT with the spatial analysis used in other diverse studies [21]-[23], who report synergistic effects, improving the potential of analyzes and contributing to more sustainable decision-making processes [24].

The use of web technologies in PT has grown in the last decade, [24] used decision-making software to develop a knowledge-sharing tool through web interaction [25]. Researchers mentioned that social networks offer a new way of enabling and facilitating participatory decision-making processes and generating a

new public sphere to support participant interaction and debate [26].

In this context, this paper used a bibliometric and systematic review of PT to understand the dynamics in which this technique was applied in environmental management, and how it has been approached in scientific studies. It also aims to present the main methods, tools, and stakeholders involved in the applications of PT. We expect this study to engage decision-makers in the environmental management of natural resources and support the development and implementation of participatory landscape public policies.

2. Methods

We structured this study to combine bibliometric analysis with a systematic review to obtain quantitative and qualitative data about PT application models and how they have been included in the decision-making process.

As quantitative support for the study, statistical methods and the evolution of scientific production were applied over 30 years through software and metadata exported from the scientific document database, and content analysis was carried out on the qualitative data of publications (**Figure 1**).

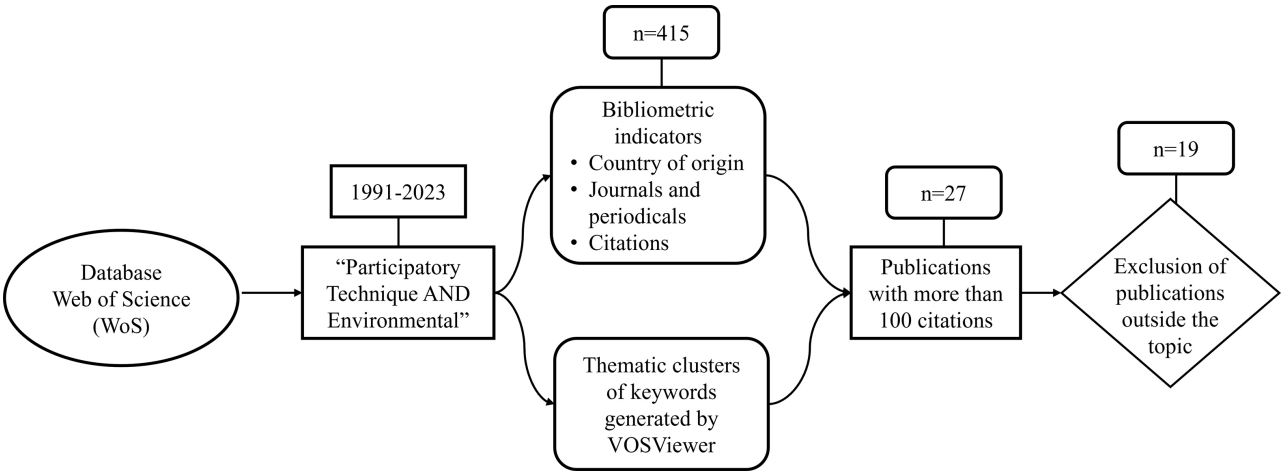

Figure 1. The framework developed for this systematic review between 1993 and 2023.

For the systematic review, we used the Web of Science (WoS) database, being a global and multidisciplinary platform that is compatible with the free bibliometric software VOSViewer 1.6.5 [27] and includes journals with a higher impact factor compared to databases such as Scopus [28].

We searched in the WoS main collection for terms in English in the titles and/or abstracts and/or authors as keywords. The terms used were "Participatory Technique" AND "Environmental," including the Boolean operator "AND" to search for articles that consider the two thematic dimensions of research, that is, Participatory Technique and Environmental.

We also selected complete and reviewed peer-reviewed scientific articles published between 1993 (the year of the first article with the terminology found) and 2023; thus, the metadata was exported from the database and analyzed in an

electronic spreadsheet (Excel).

From these data, we identified bibliometric indicators such as the most cited articles, countries, journals, and periodicals with the most publications areas of research that used PT, in addition to the thematic grouping (clusters) of keywords generated by the VOSViewer software. Subsequently, the selection criteria applied considered the most relevant publications being those with more than 100 citations, founded on the premise that authors cite more works that they consider significant in developing their research.

Based on reading the titles, keywords, and abstracts, the exclusion criteria adopted for articles that do not apply the Participatory Technique within an environmental management process or have no connection with the conservation of ecosystem services and, therefore, are not related to the subject discussed here.

As a result of this selection, we gathered the Impact Factor (IF) of the journals where the articles were published, as provided by the Journal Citation Reports—Clarivate Analytics. This IF analyzes how often an "average article" in these journals is cited within a given year or period [29] and is essential for evaluating and ranking scientific journals, shaping publication decisions, funding allocations, and advancing academic careers. Journals with higher IF are frequently seen as prestigious and influential within their fields, reflecting the quality and impact of their published research [30].

Furthermore, we identify how the Participatory Technique has been applied in decision-making processes considering environments and stakeholders and subsequently list the methods and tools used in applying the technique.

3. Results

3.1. The Temporal Evolution of Publications and Citations

The systematic review initially identified 415 scientific and review articles published with the terms used in the research, with the temporal evolution of publications and citations received in the WoS database.

There is a fluctuation in the number of citations over the years (**Figure 2**), with the maximum reached in 2007 with 1100 citations. The number of publications increased especially from 2019 onwards, highlighting the progressive use of the technique in academic work.

Among the main countries that used PT in publications (**Figure 3**), the United States of America appears in first place with 18.6%, while Brazil is in fifth place with approximately 6.5% of publications, together with Canada. Other countries that stand out are the United Kingdom, which is in second position with 13.5% of publications, and Australia and Spain, respectively, with the same number of publications responsible for 7.2%.

Regarding publication vehicle, the 415 articles analyzed were published in 266 different journals and periodicals. Sustainability presents the most significant number of publications with 17 articles, followed by the Journal of Environmental Management with 13 articles and Land Use Policy with 11 articles published.

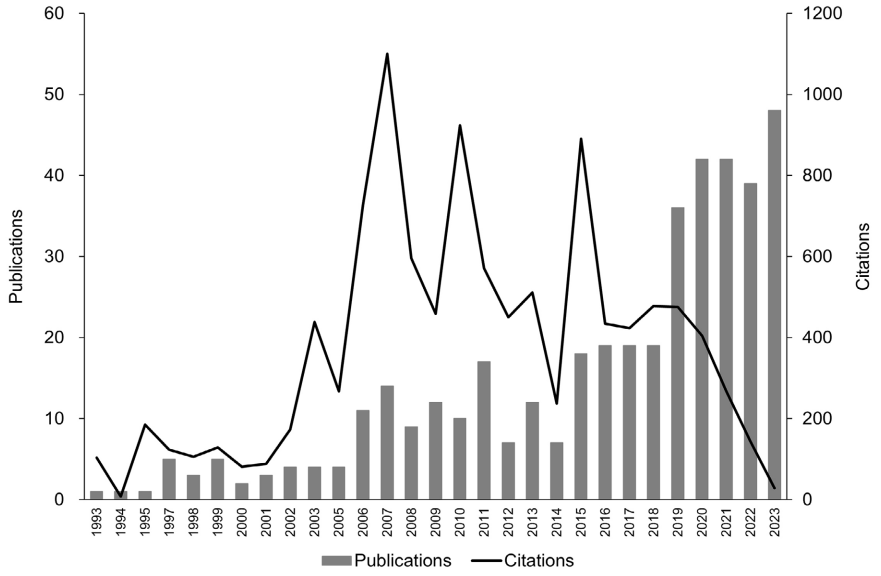

Figure 2. The evolution of publications and citations between 1993 and 2023 on the theme "Participatory Technique in environmental management" without any exclusion criteria.

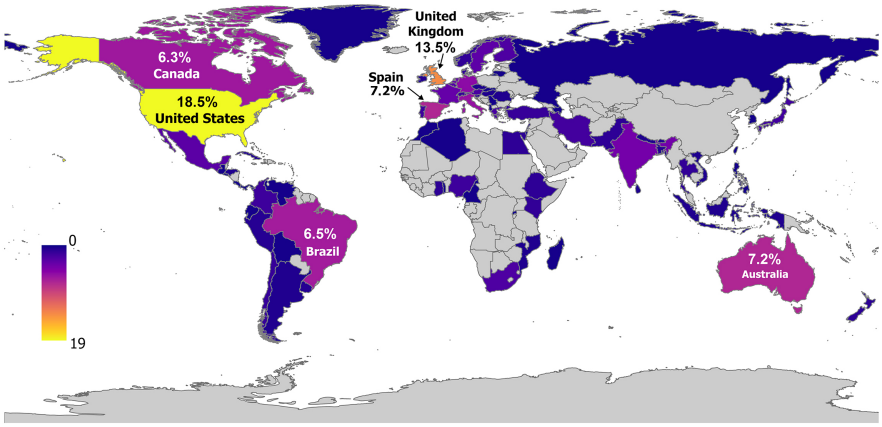

Figure 3. Percentage of publications between 1993 and 2023 by countries or regions without cut-off criteria.

Analyzing the thematic perspective of the initial portfolio (n = 415), we adopted a thematic grouping (cluster) of keywords from publications spanning the period 1993 to 2023. These publications had at least ten citations and keywords occurring at least twice. This clustering was performed using the bibliometric software VOSViewer 1.6.20, resulting in 11 clusters as represented in Figure 4.

The largest grouping, cluster #1, with 14 keywords, is colored red, and the others, respectively, cluster #2, with 13, are colored orange. Clusters #3 and #4, with 10, are colored dark blue and cyan. Clusters #5, 6, and 7 have nine keywords and colors yellow, purple, and dark green; clusters #8 and 9 with eight keywords and colors brown and pink, cluster #10 has six keywords and color gray and cluster #11 represented by light green color with four keywords.

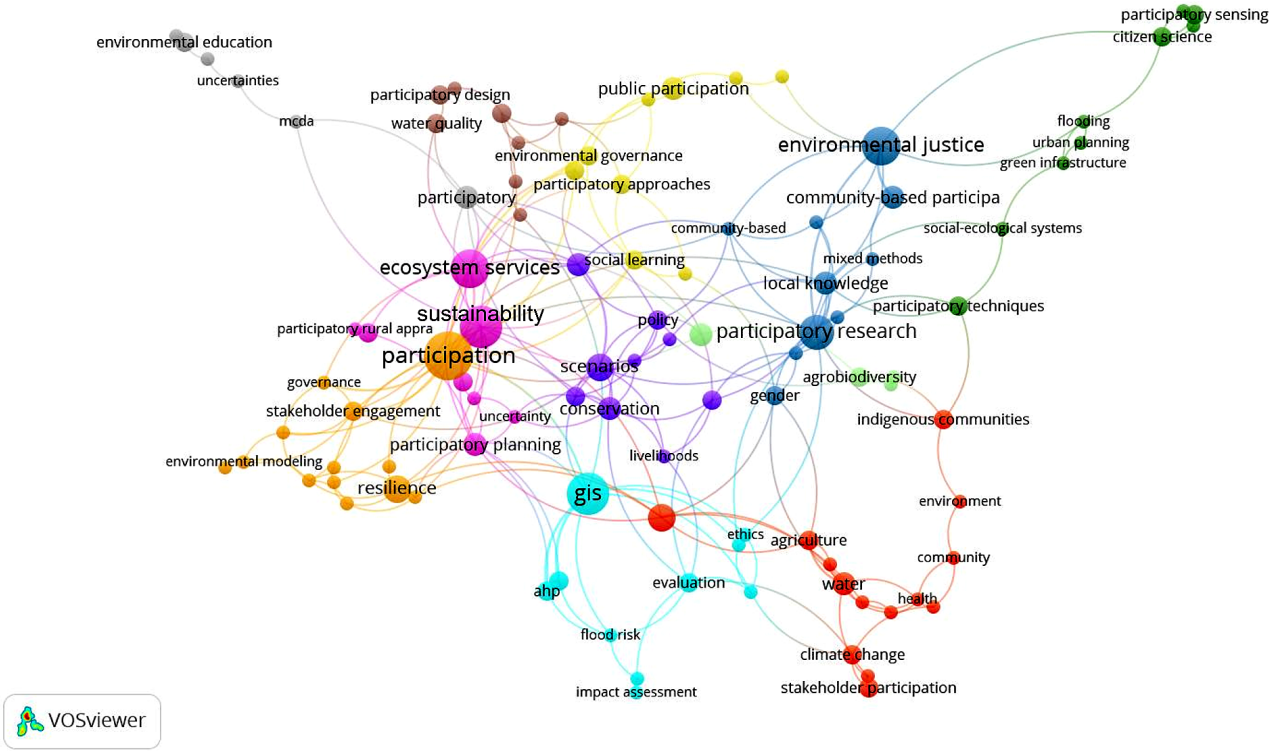

Figure 4. Mapping articles from the initial sample, with ten citations per publication cut-off criterion.

The numbering of the clusters is decreasing. Therefore, #1 identifies the largest group of keywords; the size of the spheres corresponds to the frequency of each keyword. The most frequent keywords were "Participation" (cluster #2), "GIS" (Geographic Information System) (cluster #4) "Sustainability" and "Ecosystem service" (cluster #9) and "Environmental justice" (cluster #3), "Participatory research" (cluster #3), "Scenarios" (cluster #6), "Sustainable development" (cluster #1) and "Resilience" (cluster #2) in that order.

Numerous studies reflected in the clusters found the use of GIS as a data analysis system that helps assess environmental risks and impacts in cases of floods carried out by [27] or risk of seismic activities by Nyimbili *et al.* (2018), including the participation of experts within the multicriteria analysis method to guide decision-making based, among other factors, on the knowledge and experiences of these experts [31] [32].

Within other clusters, studies project different land use scenarios and use the Participatory Technique to evaluate and define goals with popular participation and experts, as well as [32], which evaluated land use strategies for various ecosystem services and scenarios and included popular participation in planning in Vietnam [33]. We also identified indicators and participatory modeling tools with the participation of Non-governmental Organizations (NGOs), Universities, Government, and management agencies at different scales for managing areas and identifying problems [8] [33].

The citation analysis considered that authors were important in developing

their research. Therefore, the most cited works would influence the area more than the least cited ones [34]. Applying the filter of more than 100 citations per publication, we refined it to 19 publications (**Table 1**), with the most cited article with 332 citations by [35]. This article shows an integrated view of water resource management, emphasizing the need to analyze the complexity of the resource management process and develop appropriate methods to achieve each situation [36]. Reference [36], with 257 citations, appears as the second most cited. It involves the elaboration of extreme future scenarios using different types of land use in a test area in southern Denmark and including the participation of different groups of stakeholders to identify the respective interests of the future of rural areas and thus support possible planning and development processes for rural territories [37].

Table 1. Main articles cited, with a cut-off criterion of 100 citations per publication.

ID	Title	Citations	Journals	IF (2022)	Authors
1	The implications of complexity for integrated resources management	332	Environmental Modelling & Software	4.9	Pahl-Wostl (2007) [35]
2	Scenario visualization for participatory landscape planning - a study from Denmark	257	Landscape and Urban Planning	9.1	Tress and Tress (2003) [36]
3	An evaluation of monetary and non-monetary techniques for assessing the importance of biodiversity and ecosystem services to people in countries with developing economies	244	Ecological Economics	7	Christie *et al.* (2012) [37]
4	Developing qualitative scenario storylines for environmental change assessment	218	Wiley Interdisciplinary Reviews-Climate Change	9.2	Rounsevell and Metzger (2010) [38]
5	The Delphi technique in ecology and biological conservation: applications and guidelines	215	Methods in Ecology and Evolution	6.6	Mukherjee *et al.* (2015) [39]
6	Participatory indicator development: What can ecologists and local communities learn from each other?	192	Ecological Applications	5	Reed, Dougill and Baker (2008) [40]
7	Maps, numbers, text, and context - Mixing methods in feminist political ecology	185	Professional Geographer	1.8	Rocheleau (1995) [41]
8	Practical solutions for making models indispensable in conservation decision-making	183	Diversity and Distributions	1.29	Addison *et al.* (2013) [42]
9	Co-management policy can reduce resilience in traditionally managed marine ecosystems	177	Ecosystems	3.7	Gelcich *et al.* (2006) [43]
10	Agent-based modeling in ecological economics	176	Ecological Economics Reviews	7	Heckbert, Baynes and Reeson (2010) [44]
11	Regional energy planning through SWOT analysis and strategic planning tools. Impact on renewables development	170	Renewable & Sustainable Energy Reviews	15.9	Terrados, Almonacid and Hontoria (2007) [45]
12	Participatory noise mapping works! An evaluation of participatory sensing as an alternative to standard techniques for environmental monitoring	164	Pervasive and Mobile Computing	4.3	D'Hondt, Stevens, and Jacobs (2013) [46]

Continued

13	The ethics of Google Earth: Crossing thresholds from spatial data to landscape visualization	144	Journal of Environmental Management	8.7	Sheppard and Cizek (2009) [47]
14	Participatory decision making for sustainable development - the use of mediated modelling techniques	129	Land Use Policy	7.1	Antunes, Santos and Videira (2006) [23]
15	Reflections on use of participatory research for disaster risk reduction	124	Area	2.2	Mercer *et al.* (2008) [9]
16	Collaborative mapping of ecosystem services: The role of stakeholders' profiles	113	Ecosystem Services	7.6	García-Nieto *et al.* (2015) [48]
17	Soil-erosion and labor shortages in the andes with special reference to Bolivia, 1953-91 - Implications for conservation-with-development	103	World Development	6.9	Zimmerer (1993) [49]
18	Local perceptions of risk to livelihood in semi-arid Tanzania	101	Journal of Environmental Management	8.7	Quinn *et al.* (2003) [50]
19	Listening to locals on payments for environmental services	101	Journal of Environmental Management	8.7	Petheram and Campbell (2010) [51]

While citations measure the impact of individual articles, the Impact Factor (IF) is calculated for entire journals, reflecting their overall influence. Among the 19 main articles surveyed in this study, the lowest IF is 1.29 for the Diversity and Distributions journal, and the highest IF is 15.9 for the Renewable & Sustainable Energy Reviews journal.

In general, the Participatory Technique is used in research by applying different methods, which may or may not be combined, with different tools involving a set of stakeholders, as listed in Figure 5. The most used method within the universe of studies analyzed is interviews and/or informal conversations with interested parties. It was considered important to hold meetings and workshops that mobilize discussions about the research to be carried out and allow the exposure of participants' knowledge, experiences, and demands, in addition to applying structured questionnaires with open and closed questions, and other forms of social learning. Different tools were used to collect information or compose the PT application process.

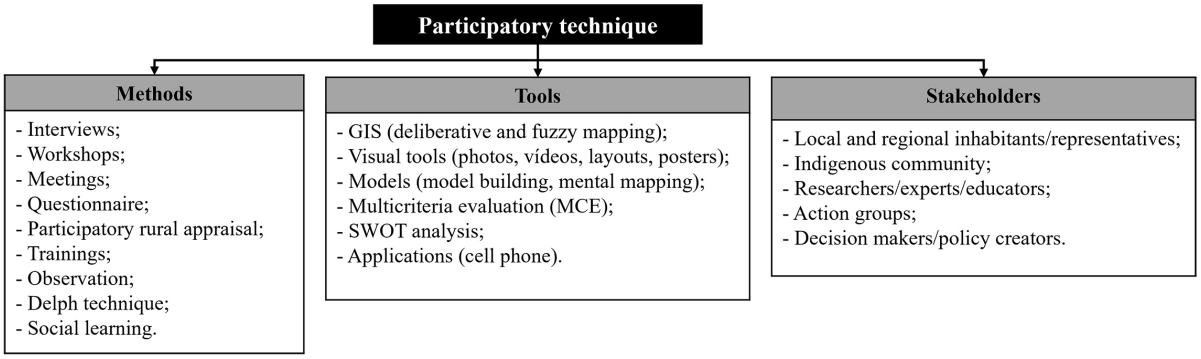

Figure 5. Main methods, tools, and stakeholders that supported the participatory technique.

The profile of the stakeholders varied depending on the objective of the research. Local inhabitants are involved in discussions and decision-making to gather comprehensive insights about their perspectives, needs, values, aspirations, and the socio-environmental and economic reality in which they live. In the process, experts may also be included, whose acquired knowledge and experiences can contribute to the development of public policies that address the population's needs, incorporating insights generated within academic spheres into public governance. We discussed the context of the three axes in the following item.

3.2. Participatory Technique in the Environmental Scope for Decision Making

The bottom-up strategy approached by the Participatory Technique leads to the integration of interested parties within an environmental planning and management process, which allows problems and needs to be brought from the lowest level of social organization, in terms of decision-making power, to the highest level, which is a different move from the traditional top-down strategy. In addition to promoting more active citizenship, this movement reduces distance and communication between those involved and considers social dynamics.

Reference [51] explored the perspective of the poorest population in an area where implementation of Payment for Environmental Services (PSA) programs was considered to guide program design using methods such as workshops and interviews and interactive visual tools presentation, pursuing to understand the willingness to participate and the level of adherence to the PSA [50]. Therefore, this bottom-up approach can offer efficient and continuous solutions for that population.

The Participatory Technique also explores a vast and integrative perspective within the scope of environmental management, especially when creating scenarios and developing more real models for decision-making.

Reference [38] provided an overview of this combination of scenario-creation techniques for evaluating environmental changes and participatory enrichment based on social learning methods on different global and regional scales, bringing credibility and validation [39].

Reference [36] brought different realistic scenarios together with the participation of interested parties (in this case, local representatives), proving to be a helpful tool for identifying interests and demands in future rural landscapes [39]. Reference [41] analyzed gender issues within rural communities and their connections with environmental and economic changes at different scales through a forestry tree-planting project [44]. The author concluded that the participatory approach enriches sustainable development initiatives.

In order to visualize future needs to assist decision-making [40] involved local farmers in the participatory method to develop robust indicators based on the integration of local community knowledge using interviews and a multicriteria assessment method as a tool, which are also accessible to a variety of users to

monitor and increase the sustainability of land management [41]. Reference [43] applied PT to managing marine ecosystems through a set of scenarios and co-management to achieve sustainable development using participatory rural assessment, respecting traditional communities and government agents [44].

Several studies used GIS to create scenarios and mappings, such as [46], which used participatory noise maps that collect user data through cell phone applications for monitoring ambient noise to improve accuracy and cover a wide range of scale applications [47]. In addition, [47] used Google Earth to visualize and share environmental data between laypeople and scientists and find application opportunities in planning and formulating public policies [48].

Reference [48] also explored the perception of the spatial distribution of supply and demand for ecosystem services between stakeholders with greater and lesser influence in the decision-making process in environmental management through deliberative mapping. In the workshops, they sought consensus among stakeholders and concluded that participatory mapping that integrates different stakeholders allows us to see the diversity of sources of knowledge and relationships between people and the environment [49].

Participatory Techniques in the economic sphere for valuing ecosystem services and environmental issues are used through monetary and non-monetary techniques that assess the importance of biodiversity and ecosystem services for people in countries with developing economies. In this context, the authors proposed workshops and interviews for sharing information and learning in decision-making processes [38]. According to [44], the use of modeling with dynamic behavior and heterogeneous characteristics contributes to research questions in ecological economics in the areas of natural resource management and changes in land use, modeling of urban systems, market dynamics, changes in consumer attitudes, innovation and diffusion of technology and management practices, common dilemmas and self-governance, and psychological aspects to human decision-making and behavior change [45]. Reference [45] aimed to develop sustainable energy and environmental preservation, combining participatory strategic planning with SWOT analysis (strengths, weaknesses, opportunities, and threats), proving to be effective in diagnosing problems and outlining actions in the future [46].

The combined application of TP methods with other tools proves to be effective in structuring decision-making [23], in some cases having multicriteria methods to support decision-making, facing a conflict of different criteria within a problem situation.

To evaluate the pressures suffered in the coastal area of Algarve in Portugal, popular participation was carried out through workshops. It was attended by researchers, NGOs, industry, and local/regional authorities to build consensus for sustainable development in the region [24]. Thus, decision-making must be well structured, using various modeling techniques that can support the process by improving communication and building trust [40] [43].

4. Conclusions

This systematic review underscores a noteworthy surge in the application and study of the Participatory Technique over the last decade, especially since 2019. This tendency in environmental management indicates the technique's role in decision-making processes by accommodating the diverse needs of managers, researchers, and affected communities. The result is the development of authentic strategies for conserving and preserving natural resources.

An important aspect of our findings lies in the efficacy of a combined approach. Integrating the PT with complementary methods and tools, such as SWOT analysis, multicriteria evaluation, GIS, and social learning, manifests synergistic effects.

This integration enhances individual tools' potential and significantly contributes to more informed decision-making processes, promoting sustainable development. Moreover, merging methodologies brings greater robustness and credibility to the overall process, underlining the need for holistic and interdisciplinary approaches in environmental management.

Despite these advancements, a critical observation emerges from a public policy perspective. The application of the Participatory Technique has yet to secure a priority status in decision-making processes, creating an information gap regarding outcomes and avenues for enhancing the PT. This highlights an opportunity for bridging the divide between research findings and actionable policy implementations.

We propose prioritizing Participatory Techniques in public policy deliberations, recognizing environmental issues' complex and dynamic nature. Effective decision-making should be adaptable and open, welcoming various perspectives and values. This strategic realignment holds the key to closing the gap, guaranteeing the comprehensive realization of the approach's benefits. In turn, it will contribute significantly to the collective enhancement of our natural resources and the well-being of the communities reliant upon them.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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