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Participatory monitoring for water management: a bibliometric analysis

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Abstract
Communities play a central role in participatory water monitoring by contributing their local knowledge, engaging in data collection, and participating in decision-making related to the management and implementation of solutions. A systematic review was carried out in four phases under the PRISMA methodology. In phase 1, the study topic was defined. Phase 2 involved defining guiding questions and searching databases such as Scopus, Scielo, and Google Scholar. In phase 3, eligibility criteria and the search equation were established. Finally, in phase 4, review articles were selected, and the information was processed using VOSviewer software, followed by qualitative and quantitative analyses. Finally, it was determined that the studies conducted by various authors do not present participatory monitoring methodologies that are easy and affordable to apply in all community contexts. Each context must be analyzed individually. Additionally, most studies indicate that parameter measurements are not conducted in situ, highlighting a research gap in the application of participatory monitoring.

Keywords: participatory-community monitoring; water; water quality; community

Monitoreo participativo para la gestión del agua: un análisis bibliométrico

Resumen
Las comunidades desempeñan un papel central en el monitoreo participativo del agua aportando su conocimiento local, comprometiéndose en la recopilación de datos e involucrándose en la toma de decisiones relacionadas con la gestión e implementación de soluciones. Se realizó una revisión sistemática a través de 4 fases bajo la metodología PRISMA, en la fase 1 se definió el tema de estudio, en la fase 2 la definición de preguntas orientadoras y la búsqueda en bases de datos como Scopus, Scielo y Google Scholar, la fase 3 definición de los criterios de elegibilidad y la ecuación de búsqueda, por último, en la fase 4, se realizó la selección de los artículos de revisión y el procesamiento de la información a través del software VOSviewer y los respectivos análisis cualitativos y cuantitativos. Finalmente, se definieron aquellos estudios realizados por los diferentes autores que no presentan metodologías de monitoreo participativo fáciles y asequibles de aplicar en todos los contextos comunitarios, cada contexto debe ser analizado de manera diferente, adicional, la mayoría de los estudios muestran que la medición de parámetros no se realizan in situ, lo que se puede considerar como vacío investigativo al aplicar monitoreo participativo.

Palabras clave: monitoreo participativo-comunitario; agua; calidad del agua; comunidad.

1 Introduction

Ecosystem services (ESS) are those benefits provided by ecosystems to the population [1]. Among these, there are provision services, where water supply is outlined according to the Millennium Ecosystem Assessment. This assessment emphasizes water's fundamental role in the well-being of all living beings and its importance in the sustainable

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development and management of territories.

Water is a renewable resource; however, it is also finite, with both natural and anthropogenic uses [2]. Efficient management of water in the context of sustainability involves balancing economic interests derived from water uses with the sustainable administration of the resource [3], protecting quality and promoting responsible use practices. Implementing adequate strategies in terms of water governance promotes the conservation, reuse, and protection of watersheds. This ensures fair distribution in terms of water uses, benefiting all community members [4].

Currently, the use of Participatory Monitoring (PM), an approach that involves community collaboration in data collection and problem identification, is being promoted. This method varies in the level of engagement, ranging from supporting scientific research to a full commitment to problem-solving and adjusting monitoring strategies based on available needs and resources [1]. In this way, it can be defined that participatory monitoring contributes to the formation of links between society and academia for the understanding of various socio-ecological problems [5].

Around the world, various experiences have been evidenced as a result of scientific and social collaboration applied to the MP of water resources in countries such as Canada [6], Colombia [7], Mexico [1,8] Kenya [9] and, Switzerland [10], the importance of the role played by entities, such as Global Water Watch, in providing conceptual and methodological support to establish and certify community monitoring networks in nations such as Argentina, Brazil, Ecuador, Mexico and Peru is emphasized. It has also influenced this process in the Philippines, Thailand and Kenya [11].

It is crucial to define the problem before starting monitoring, as this allows us to understand conflicts in the basin and water use, such as territorial disputes or access difficulties. Identifying these problems is essential to establish the parameters and monitoring points necessary to develop an effective program. This can be achieved with the help of actors and experts from the area of influence, including them as leaders of the process [12]. Likewise, according to this same source, citing Walker et- al [13], water management actors must understand its complexity from the initial interest in its conservation to the implementation of collaborative projects. This involves the contribution of experts in the field, utilizing technology for the dissemination of updated information, and engaging the community through mobile applications, social networks, and community radio stations. These efforts are crucial to ensuring the success of water resource monitoring and management projects.

This article reviews studies published from 2014 to 2023 related to community-participatory water monitoring. It explores research trends and identifies knowledge gaps through networking using VOSviewer software, which helps analyze the behavior and correlations within the literature on this topic. This analysis will enable the academic and scientific community to identify primary publications and topics associated with the study focus. It will also pinpoint research gaps to be explored, highlight authors and research institutions addressing these issues, identify countries showing significant interest, and assess cooperation among researchers.

2 Methodology

The systematic review was conducted following the PRISMA methodology guidelines. Initially, a keyword search was performed to formulate the search equation. The processing of information followed the sequence outlined in Fig. 1, illustrating the procedure for analyzing the research processes that have been consolidated for the study of community-participatory water monitoring processes. The procedure is based on four main phases. First, the research topic was defined, and the search began with keywords. This was followed by a clear definition of the problem, which was consolidated into research guiding questions. Next, the search equation was defined, and finally, the process and analysis of the information were carried out.

The review had the following research questions:

Are there studies that implement clear and easy-to-execute monitoring methodologies in communities?

Are communities really involved in the implementation of community monitoring?

Are the parameters taken in situ during the monitoring?

In this article, a systematic review of the published scientific literature in relation to community-participatory water monitoring has been carried out. For its preparation, the guidelines of the PRISMA statement have been taken into account [14] for the correct conduct of the systematic review. Fig. 2 details the process of developing the methodology in its different phases.

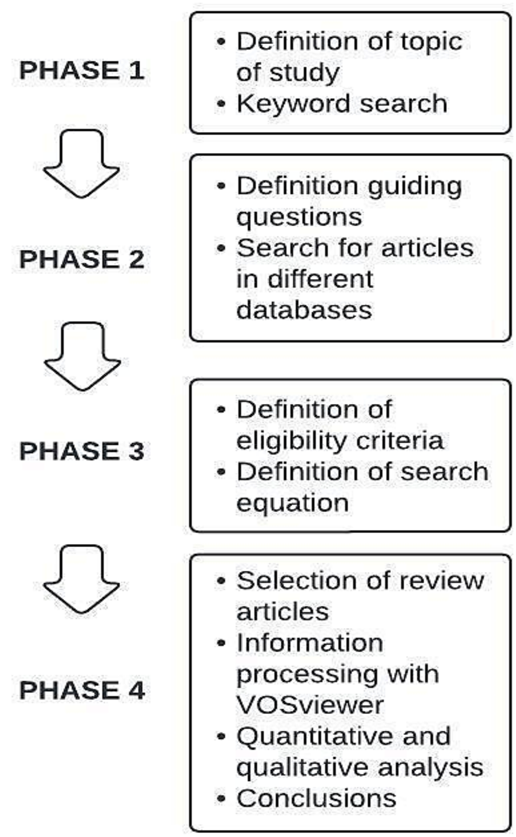

Figure 1. Phases of the Methodology.
Source: the authors.

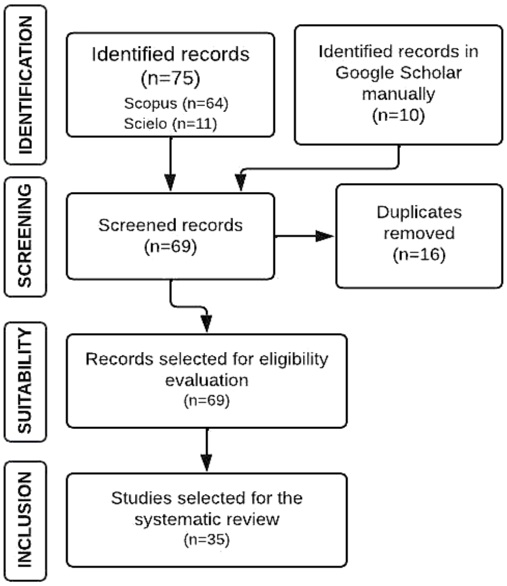

Figure 2 PRISMA flowchart in four levels.
Source: the authors.

2.1 Initial searching

The first searches were carried out in July 2023 by combining the terms "participatory" "water" "monitoring" in the Scopus, Scielo databases, and manually in Google Scholar. Following this, it was found necessary to expand the search using a combination with the operator "OR" to include the term "community". This search yielded a considerable number of results, some of which were not very relevant to the review as they were not related to the study subject. However, they provided a global perspective on the breadth of the topic under investigation. Participatory monitoring extends beyond water to include monitoring at the forest level and biodiversity, among other areas.

2.2 Systematic Search

The systematic search was carried out in Scopus, Scielo and Google Scholar, taking into account the established time range from 2014 to the present 2023.

The combination of terms that yielded the best results in search engines was as follows:

("community") AND ("water") AND ("monitoring") OR ("participatory")

In this way, the inclusion and exclusion criteria were defined:

2.3 Inclusion criteria

1. These are research articles and doctoral work
2. That they use participatory monitoring as a method.
3. That bias is studied in an environmental context.
4. Published between 2014 and 2023, including both.
5. That they have monitoring field data.
6. That it shows the gaps in the investigation.
7. That they are articles where monitoring techniques are shown that are easy to execute with the communities.
8. That they really involve the communities when executing the CCM.

2.4 Exclusion criteria

1. Studies that refer to wetland monitoring and not to community-participatory wetland monitoring are excluded.
2. Studies that have performed the monitoring, but the analysis of the results has been carried out in the laboratory, are excluded.
3. Those studies that do not contain results of the parameters measured in the field are excluded.
4. Those studies that do not perform the measurement of parameters in situ are excluded.

Specifically, 85 articles were obtained: 64 from Scopus, 11 from Scielo, and 10 from Google Scholar. Following the criteria mentioned earlier, articles were selected and screened based on their titles and abstracts. Sixteen duplicate articles were identified and removed, resulting in 69 articles for the systematic review—35 included and 34 excluded.

The qualitative analysis involved reading the abstracts of each included article to extract relevant information that aligned with the eligibility criteria. For the quantitative analysis, articles were manually categorized by year and country due to their dispersion across different databases. Graphs were then created to visualize and interpret the findings of the analysis.

Additionally, the VOSviewer software was executed for the articles found in Scopus (64) to establish the co-occurrence analysis of the publications made between different countries, taking into account that at least five documents have been published on the subject.

Additionally, bibliometric networks were generated by combining keywords through co-occurrence to analyze the relationships declared by the authors, aiming for enhanced visualization of these connections. Subsequently, citations per document were analyzed, considering a minimum of 10 citations per document. Additionally, citations registered in journals were taken into account, considering a minimum of five documents per journal.

3 Results and discussion

3.1 Quantitative analysis

The year of publication was the first selection criterion. As shown in Fig. 3, the research found that the largest number of articles corresponded to the years 2021 (13) and 2020 (10), and to a lesser extent to the years 2013 (1) and 2019 (3). It is important to note that the article corresponding to the year 2013 does not meet the time range defined in the selection criteria, however, Burgos et. Al [15], mentions 2 of the 3 most relevant keywords in this study (see Fig. 6.): Water quality and community or community-based monitoring, keeping a high correlation with the study topic, which is why it was included in the study.

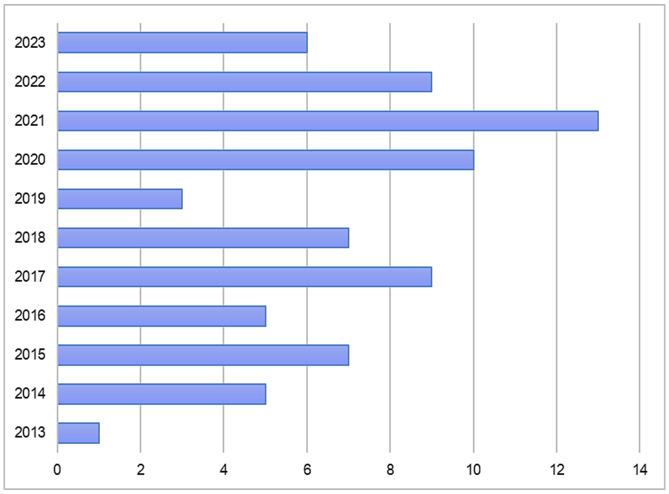

Figure 3. Distribution of articles by year of publication.
Source: the authors.

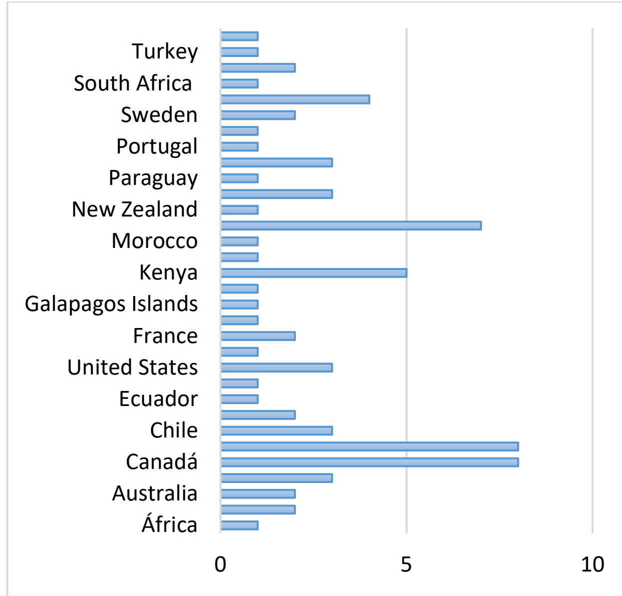

Figure 4. Distribution of articles by year of publication.
Source: the authors.

In relation to the country where the investigations were carried out, a predominance of investigations was observed (Fig. 4) in Colombia (8), followed by Canada (8) and Mexico (7). In addition to this, international collaborations were found between different countries such as Argentina, Peru and Colombia (3) and studies carried out in Kenya (5), Switzerland (4), and the Netherlands (3). The predominance of research in Colombia is attributed to the issues highlighted by Casso-Hartmann et al. [16] in La Toma, regarding the challenges in accessing safe, treated water. These challenges stem from the lack of water, sanitation, and hygiene infrastructure in rural communities, which correlates with findings discussed by Ulloa et al. [17] in 2021, within the context of Latin American countries like Argentina, Peru, and Colombia, communities have organized themselves to establish networks between academia, Non-Governmental Organizations (NGOs), and social organizations. These efforts aim to foster knowledge appropriation processes for decision-making and seek funding sources that support local monitoring and advocacy regarding community water resources management. This underscores the necessity to investigate the phenomenon of community monitoring of water quality.

In that which converges the countries with the greatest number of studies, which meet the conditions of inclusion of this study, the thematic or problematic axis arises from mining activities, in Colombia and Latin America, respectively, Casso-Hartman et. Al, [16] and Ulloa et. Al [17], and in Canada, Gérine-Lajoie et. Al [18], this means that the impacts of economic activities are monitored in a participatory manner to assess the water quality governed by Himley [19]. The pre-existence of economic activities tends to generate greater research interest.

3.2 Qualitative analysis

There is a lack of focus on participatory community monitoring techniques in research involving productive activities. Espinoza and Blanco [7], emphasize the importance of selecting independent laboratories to conduct analyses, as exemplified by the Universidad Nacional de Cuyo in the province of Mendoza, which is perceived to maintain autonomy from mining interests. This, together with what was emphasized by Ulloa et. Al [17], emphasizes the importance of selecting monitoring methods based on the autonomy of the laboratory or individual conducting the assessments. This ensures objectivity and independence in research outcomes, particularly in contexts involving productive activities such as mining.

In the analyzed articles, a methodological approach was identified that outlines the execution of community monitoring in micro-watersheds, with the Río Frío in the Valle del Cauca department serving as a reference. Five phases stand out: analysis of the need, review of national standards, comparison with international models, identification of priority elements, and analysis of local experiences. It is proposed to apply monitoring at three levels: Basic (education and awareness), Advanced (pollution monitoring) and Strategic (ensuring long-term quality). The choice of level will depend on the specific characteristics and needs of each community [12], this can be related to what was found in the methodology established by Mateus et al. [20] in the context of the Galapagos Islands, a simple methodology was established for *in situ application in* monitoring areas prioritized by the community. Physicochemical parameters of water supplied by the water treatment plant for human consumption were analyzed, revealing concerns among participants about the presence of copper and water hardness. Additionally, microbiological and physicochemical analyses of household-level water were conducted to verify its quality.

This approach can help to adequately define what would be the most convenient level to apply the monitoring according to the characteristics of the community where it will be implemented, since each one has different complexities, and according to Burgos et al. Al [15], attention to the sanitary protection of the water consumed by communities must take into account strategic planning for water security. On the other hand, in monitoring water quality, it is essential to instruct participants from the beginning, with the collaboration of the academic community and experts. Likewise, it is necessary to schedule at least two field trips in different seasons of the year to ensure the continuous participation of the community and evaluate how water quality varies with different climates.

In Mexico, various studies have been conducted regarding the subject analyzed in this review. One of these studies mentions a portion of the methodology where monitoring was conducted through collaboration between the community and academia, with voluntary participation supported by research projects. Before each field excursion, the place, date, and time were coordinated, involving 3 to 6 participants who alternated in applying supervision techniques and recording data on field sheets [1]. As a result of this work, they obtained data on water quality parameters from three springs in the study area using MCP.

3.3 Analysis with VOS viewer Software

The analysis in this software was carried out with the information obtained in the Scopus database, which was composed of 48 articles, where it was possible to obtain that, in total, 29 countries have contributed with publications on community-participatory water monitoring Fig. 5. It should be noted that the United States and Canada lead the scientific production with 12 and 8 publications, followed by the Netherlands with 6 and Mexico with 4 publications. These countries in addition to having the largest output of publications, also exhibit substantial collaboration in terms of joint publications.

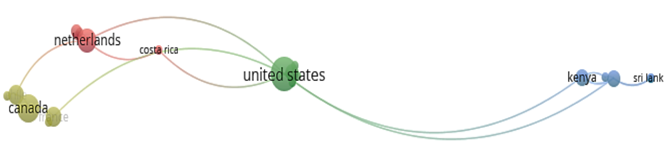

Figure 5. Collaboration of Scientific Production Between Countries.
Source: the authors.

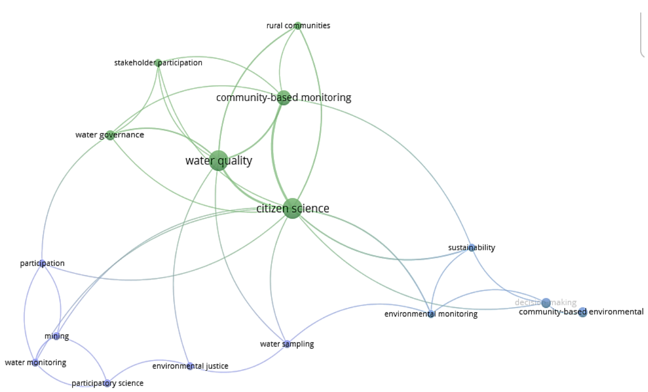

Figure 6. Keywords related to the topic of study.
Source: the authors.

The results from the co-occurrence analysis of keywords reveal that trends in community-participatory water monitoring are closely linked to citations concerning water quality, community monitoring, citizen science, water governance, and rural communities. Fig. 6 illustrates that citizen science, water quality, and community monitoring are the most relevant topics in this context.

4 Conclusions

Most research into community-participatory water monitoring has concentrated on devising strategies to engage communities and gain their approval for executing various projects in their territories. However, these efforts often fall short of truly involving communities, as genuine community involvement necessitates collaborative efforts to empower them in both the processes to be undertaken and the technical knowledge required regarding water resources.

Community-participatory monitoring can become established as an indispensable tool for social empowerment and community decision-making. With this in mind, community engagement can enhance the quality of collected data because local residents possess intricate knowledge about their environment. This knowledge can help prevent errors or misunderstandings during data collection processes. Engaging communities in monitoring projects not only addresses project-specific issues, but also strengthens local capacity and improves territories. Local training and skills development can have long-term benefits for the community.

Variations in climate can affect water quality in a variety of ways, as changes in climate conditions have a direct impact on water bodies and hydrological processes. These effects go hand in hand with precipitation and runoff, temperature changes, extreme weather events, among others. All these alterations can directly and indirectly impact water quality, disrupting natural processes and augmenting pollutant loads in water bodies. These changes can have repercussions for human health, aquatic biodiversity, and overall water resources.

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