Biodiversity and Conservation
https://doi.org/10.1007/s10531-024-02999-3

COMMENTARY

The importance of traditional communities in biodiversity conservation

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Received: 5 September 2024 / Revised: 15 November 2024 / Accepted: 7 December 2024

Abstract
More than one-third of the world's high-biodiversity areas are inhabited by traditional communities, which possess deep knowledge and a unique relationship with the environment, resulting in sustainable management of natural resources. However, the importance of these communities is not always highlighted; therefore, this study conducts a mapping of scientific literature on the importance of these communities in biodiversity conservation, identifying trends, gaps, and areas of focus. A total of 519 articles from the Scopus and Web of Science databases were analyzed. The highest scientific productivity was recorded in 2022 ($n=59$; 11.36%), and the Journal of Ethnobiology and Ethnomedicine was the most prolific on the subject. Brazil ($n=128$; 24.66%) and India ($n=94$; 18.11%) were the countries with the highest scientific output, while India ($n=80$; 15.41%) and Brazil ($n=58$; 11.17%) were the most studied. However, the USA leads in scientific collaboration networks. The main contributions of traditional communities to biodiversity conservation included management and sustainable use of natural resources (71.29%) and cultural and traditional practices (46.43%). The results reflect the growing recognition of the importance of traditional communities in nature conservation. Conservation policies and strategies should recognize and incorporate the knowledge and practices of these communities to strengthen environmental preservation and promote social justice and equity. Only by acknowledging the value of these communities' actions will it be possible to combat neocolonialism, where they are viewed or considered merely as subjects of study or as labor to be exploited for data generation, without due recognition of their importance.

Keywords Conservation · Indigenous communities · Traditional ecological knowledge · Resource management · Cultural practices · Neocolonialism

Communicated by Antony Brown.

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Published online: 26 December 2024

Introduction

Biodiversity conservation is an action that needs to be prioritized globally in light of increasing environmental threats, primarily those resulting from climate change and habitat loss and fragmentation (Ridwan et al. 2023; Levis et al. 2024). In megadiverse regions such as the Amazon (Qin et al. 2023; Da Silva et al. 2024), these threats are intensified by anthropogenic activities, aimed at using natural areas for agriculture (Oliveira-Junior and Juen 2019), mining (Birben et al. 2019; Tollefson 2021), road construction (Peres and Terborgh 1995), energy generation, and urbanization (Birben et al. 2019), significantly contributing to biodiversity decline (Qin et al. 2023). The rapid extinction of species, often before they are even scientifically cataloged (Sousa et al. 2024), underscores the urgency of actions to mitigate the devastating impacts on global biodiversity and establish effective conservation strategies, as highlighted by the Kunming-Montreal Global Biodiversity Framework of the United Nations Convention on Biological Diversity (Senior et al. 2024).

One way to try to curb changes and maintain biodiversity and ecosystem services has been the creation of Protected Areas (PAs), which have proven to be very effective over the years (Ribeiro et al. 2021; Ma et al. 2024). However, conceptual or recognition issues still persist, such as the fact that biodiversity conservation is often exclusively associated with uninhabited PAs (Berkes and Davidson-Hunt 2006). However, there is growing recognition of the importance of traditional communities in the protection and sustainable management of natural resources (Ridwan et al. 2023). Studies indicate that lands managed by traditional communities have biodiversity levels comparable to those of protected areas, highlighting the effectiveness of these management practices (Schuster et al. 2019; Sousa et al. 2024). Where more than a third of the areas of great biodiversity are located in territories inhabited by traditional communities, such as riverside communities, Afro-descendants and indigenous populations (Berkes and Davidson-Hunt 2006; Silva 2019; Levis et al. 2024).

These communities possess profound knowledge and connection with local fauna and flora (Ellis et al. 2021; Sousa et al. 2024), with decades and often centuries of experience and ancestral practices in sustainable natural resource management (Ridwan et al. 2023), including the identification of beneficial plants and the responsible management of biological resources, among other traditional activities that are crucial in biodiversity conservation through these sustainable practices (Ellis et al. 2013, 2021; Sousa et al. 2024). Land use techniques based on knowledge passed down through generations are fundamental in mitigating negative impacts on ecosystems (Uprety et al. 2012; Ellis et al. 2021). Recognizing the importance of traditional communities not only preserves forest resources sustainably but also avoids frequent conflicts with conservation authorities, which often arise from conventional protection strategies (Mohammed et al. 2017; Uddin et al. 2019; Ridwan et al. 2023). This less contentious and more cost-effective approach to enforcing wildlife and forest resource protection laws represents a significant contribution to global biodiversity conservation (Ridwan et al. 2023).

However, recent global challenges, such as climate change and the COVID-19 pandemic, have introduced new complexities to biodiversity conservation. The pandemic redirected many scientific efforts toward health issues and limited international collaboration, further exposing inequalities in research capacity (Riccaboni and Verginer 2022). Countries in the Global South, in particular, faced severe restrictions and limited access to resources, highlighting the structural barriers affecting scientific production (McAlvay et al. 2021). In

this context, the role of traditional communities has become even more relevant, as many of these communities remained resilient and continued to apply sustainable environmental management practices during the crisis (Vandebroek et al. 2020; Pickering et al. 2023).

Despite the growing recognition of the importance of traditional communities in biodiversity conservation, systematic assessment of the role of these communities is often neglected (Sousa et al. 2024; Levis et al. 2024), or information on biodiversity and sustainable management practices is frequently dispersed and fragmented in the scientific literature (Urbano et al. 2024). Organizing and analyzing these data to identify patterns and gaps is essential for fully understanding how these communities contribute to conservation (Li et al. 2023). Fernández-Llamazares et al. (2024) highlight the importance of challenging the accuracy of widely accepted statistics, such as the unfounded claim that '80% of the world's biodiversity is in the territories of Indigenous peoples.' This misconception underscores how unverified data can distort public perception and policies, emphasizing the critical need to base discussions about the role of traditional communities in conservation on solid and reliable evidence. Without a comprehensive assessment, it is difficult to direct conservation policies and strategies that effectively integrate traditional and scientific knowledge. This study aims to address this gap by conducting a detailed scientometric analysis, providing a consolidated view of the contributions of traditional communities to biodiversity conservation, and identifying priority areas for future research. An effective approach to better understand how the integration of traditional and scientific knowledge is being applied is scientometrics, a methodology that uses quantitative techniques to reveal trends, gaps, and solutions in specific scientific studies (Oliveira-Junior et al. 2022). This method has been gaining recognition for its ability to provide a comprehensive view of integrative practices between traditional and scientific knowledge, identifying both successful cases and challenges in implementing these approaches (Oliveira-Junior et al. 2022; Guerrero-Moreno and Oliveira-Junior 2024a).

Therefore, the objective of this study is to map the scientific literature that explores the importance of traditional communities in biodiversity conservation, highlighting trends, gaps, and areas of greater global scientific relevance. We start from the following hypotheses: (i) There is an increase in academic production on the role of traditional communities, driven by growing recognition of traditional knowledge; (ii) Academic growth is uneven, with greater output in the Global North due to superior access to resources and research infrastructure. To achieve this purpose, we evaluated five guiding questions: (i) What are the characteristics of research on the importance of traditional communities in biodiversity conservation (in terms of annual production and the most relevant journals)? (ii) What are the patterns of scientific collaboration (leading countries in academic production, most studied countries, and collaboration networks)? (iii) What are the emerging themes and most commonly used keywords in the literature? (iv) Which traditional population groups (Indigenous, non-Indigenous, or both) are most frequently studied? (v) What have been the contributions of traditional communities to biodiversity conservation as addressed in the research? This type of analysis provides information that clarifies the research context and serves as a foundation to direct future research efforts to the areas that need it most.

Materials and methods

Search and selection process

To investigate trends and gaps in the scientific literature on traditional communities in biodiversity conservation, we conducted a comprehensive literature review of published scientific articles. We used two main databases, Scopus (Elsevier) and Web of Science (WoS) (Clarivate Analytics), selected due to the extensive coverage of Scopus in indexed journals and the specialization in specific areas offered by WoS (Guerrero-Moreno and Oliveira-Junior 2024b). This combination was chosen to ensure a comprehensive representation of the scientific literature in various disciplines (Hernández-González et al. 2016; Zhu and Liu 2020).

Keywords were selected based on synonyms found in the literature on traditional communities in biodiversity conservation. The search strategy adopted on both platforms (WoS and Scopus) was: TITLE-ABS-KEY (traditional AND communities AND biodiversity AND conservation) AND (LIMIT-TO (DOCTYPE,“ar”)).

Inclusion and exclusion criteria

During the database search process, we excluded reviews, conference proceedings, and book chapters, limiting the search exclusively to peer-reviewed scientific articles, as they represent the most reliable source for literature reviews in their complete versions (De Oliveira et al. 2019; Garza-Reyes 2015). In the document search, results were limited to scientific articles published between 1994 and 2024. This time frame was chosen because the first article found in our search on the topic was published from 1994 onwards, concluding with the most recent documents as of the search period (June 2024) to include the maximum number of articles possible.

We did not restrict the search to a specific domain area, as this is a multidisciplinary topic. This approach allowed us to obtain a larger volume of records, ensuring sample representativeness for a global view. The linguistic criterion was also not considered for exclusion. Although there is a debate about the impact of linguistic criteria on scientometric analysis, we chose to include publications regardless of the language of publication. It is argued that this approach allows for a more comprehensive identification and synthesis of relevant evidence, considering that publications in different languages may offer unique contexts and perspectives (Van Raan 2005; Walpole 2019). The search was conducted on June 24, 2024, in the WoS and Scopus databases.

Integration and data cleaning

We conducted searches in the Scopus and WoS databases, resulting in 1607 and 1786 articles, respectively, which were downloaded in CSV format for consolidation. We used RStudio (Version 4.3.1) to merge the data and automatically remove duplicates, resulting in a final database of 2708 documents (Caputo and Kargina 2022). RStudio was chosen for its robustness in statistical and scientometric analysis (Kasaraneni and Rosaline 2024). Integrating the two databases reduced the risk of losing relevant data. We manually reviewed the articles to eliminate remaining duplicates, as variations in references may escape the

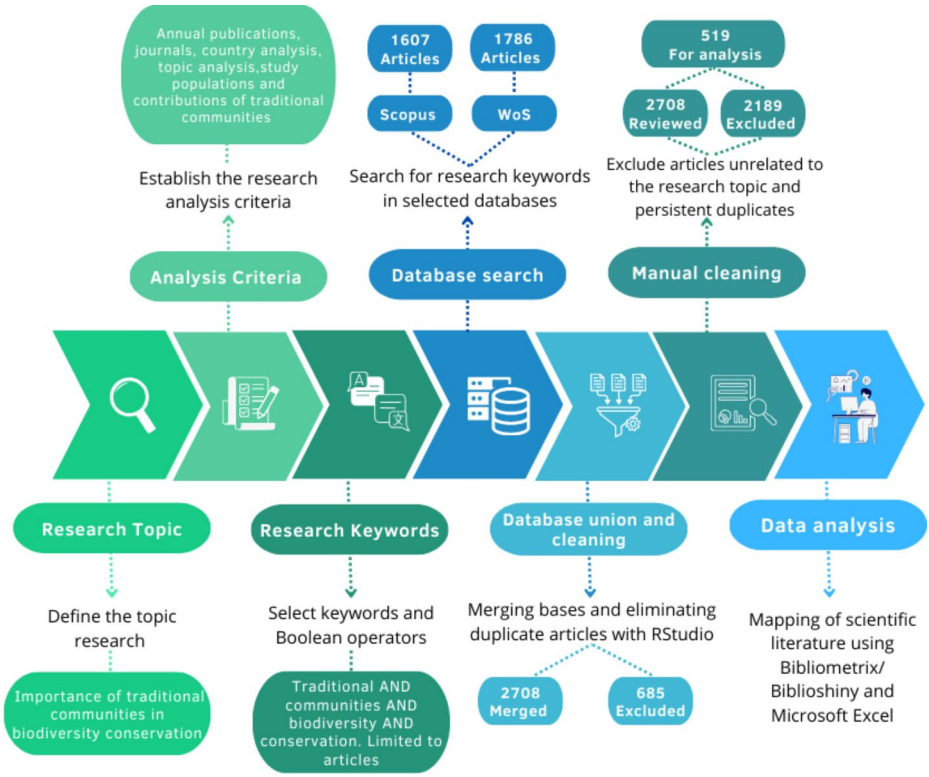


Fig. 1 General illustration of the methodology used for search, consolidation, cleaning, and analysis of data from articles on the importance of traditional communities in biodiversity conservation, focusing on the Web of Science and Scopus databases

software (Guerrero-Moreno and Oliveira-Junior 2024b). We then generated an Excel file to meticulously analyze titles, abstracts, keywords, materials, and methods, aiming to identify: (i) annual production; (ii) most relevant journals; (iii) countries analysis (countries with the highest academic output and most studied/ collaboration networks and most cited countries); (iv) Topic analysis (most frequently used keywords/ thematic map/ topic clustering) (v) study populations (indigenous/non-indigenous); (vi) contributions of traditional communities to biodiversity conservation. Only articles related to the topic were included. After this process, we selected 519 articles for detailed analysis (Fig. 1).

Classification and organization of information

The information contained in the articles was organized and classified according to study populations and the contributions of communities to biodiversity conservation as follows:

Study Populations: (a) Indigenous – research describing the role of Indigenous peoples or specific ethnic groups in biodiversity conservation; (b) Non-indigenous – studies focusing on the contributions of non-Indigenous traditional populations such as riverine communities, peasants, or Afro-descendants.

Contributions of Traditional Communities: (a) Sustainable Management and Use of Natural Resources – studies focusing on the importance and impact of sustainable agriculture, sustainable use of medicinal plants, or sustainable fishing; (b) Cultural and Traditional Practices – publications addressing traditional ecological knowledge, rituals, taboos, and cultural ceremonies as biodiversity conservation strategies; (c) Habitat Conservation and Restoration – research describing practices associated with reforestation, the creation and management of protected areas, as well as ecosystem renewal; (d) Community Monitoring and Management – articles addressing practices for monitoring resource abundance and changes, protecting specific species and habitats, temporary collection restrictions, and resource management and distribution; (e) Environmental Education and Awareness – works describing activities and worldviews that promote the care and preservation of nature, environmental ethics, community environmental education practices, or intergenerational awareness of nature conservation.

Data analysis

To evaluate the six (i–vi) criteria of analysis, we reviewed the information extracted from the articles in the database. We expressed the following data through histograms: (i) annual production; (ii) most relevant journals; (iii) countries with the highest academic output; and (v) study populations (indigenous/non-indigenous). To analyze the impact and relevance of journals, we used the Hirsch index (h-index), which is defined as the number xxx of articles that are cited xxx times. For example, if the h-index is 5, there are 5 journal publications that are cited at least 5 times (Aria and Cuccurullo 2017). Using Bibliometrix/Biblioshiny, we created a choropleth map, a word cloud, and a dendrogram for the following criteria: (iii) collaboration networks and most cited countries; (iv) most used keywords and trending topics, respectively. Finally, for criterion (vi) (contributions of traditional communities to biodiversity conservation), we created a frequency chart where each circle is scaled according to the number of occurrences of the categories.

Results and discussion

Annual scientific production

After the cleaning and review process, 519 articles remained, with the highest scientific productivity occurring between 2020 and 2024, producing 265 articles, equivalent to 51.05% of the total production, with 2023 ($n=59$; 11.36%) being the year of highest scientific output. In contrast, the lowest academic production was recorded in 1995 and 1997, both with only one publication (0.19%) (Fig. 2).

This increase in scientific production related to the topic may be associated with events and legal milestones that reinforced the importance of traditional communities in biodiversity conservation. For example, the Convention on Biological Diversity (CBD), adopted during the United Nations Conference on Environment and Development (UNCED) in 1992 (Earth Summit), came into force on December 29, 1993 (Mitrotta 2020), emphasizing the importance of involving traditional communities in conservation, promoting research, and funding collaborative projects that integrated this knowledge with scientific efforts (Sterling

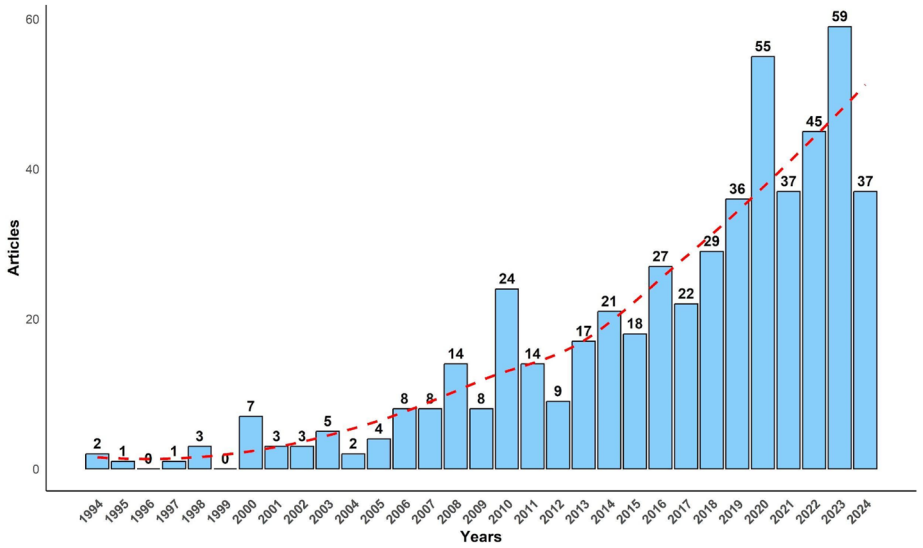


Fig. 2 Annual scientific production on the importance of traditional communities in biodiversity conservation. Databases used: Scopus and Web of Science (WoS). The blue bars represent the number of articles published per year, while the red line indicates the knowledge curve over the period from 1994 to 2024

et al. 2017). Additionally, in 2007, the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) recognized their rights and their relationship with biodiversity conservation (Redvers et al. 2023). Despite a decline in scientific production in 2021, likely due to the impact of the COVID-19 pandemic, which redirected research focus towards health rather than biological sciences (Riccaboni and Verginer 2022), many traditional communities also faced severe closures and restrictions during the pandemic (Pickering et al. 2023), which hindered collaboration and contribution from these communities to scientific research, further exacerbating the decline and global impact on research.

We can observe that the recognition of the importance of traditional knowledge has been progressively incorporated into environmental policies (Sterling et al. 2017), influencing strategic changes in conservation (Bohensky and Maru 2011; Reyes-García 2023). Increased funding for conservation projects by governments, NGOs, and international foundations has driven research and publication on these topics (Sterling et al. 2017). Social movements and activists have been crucial in promoting the importance of these communities in international forums and the media (McMillen et al. 2016; Reyes-García 2023).

The knowledge accumulation curve, represented by the smoothed line in the graph, shows a long-term trend of growth in scientific production. In turn, the percentage growth rate reflected an increase in academic production of 35.48% per year. This demonstrates a continuous rise in academic output, leading to significant progress in recognizing and valuing the contributions of traditional communities to biodiversity conservation, as well as a growing interest among researchers in the topic, allowing for a better understanding of its impacts, potentials, gaps, and trends.

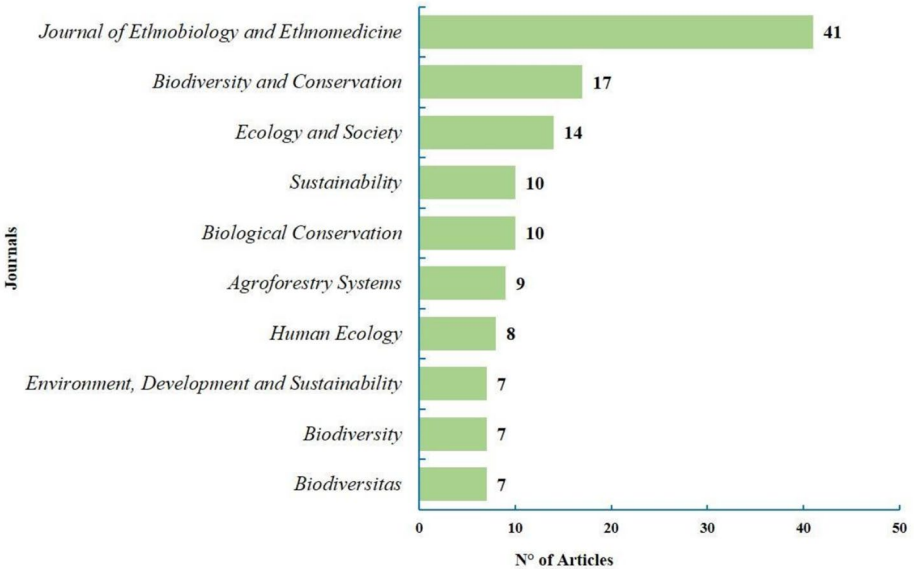


Fig. 3 Scientific articles on the importance of traditional communities in biodiversity conservation by publishing journals. The top ten journals with the highest number of publications. Databases used: Scopus and Web of Science

Most relevant journals

The five journals with the most publications on traditional communities in biodiversity conservation were, respectively, *Journal of Ethnobiology and Ethnomedicine* ($n=41$; 7.90%), *Biodiversity and Conservation* ($n=17$; 3.28%), followed by *Ecology and Society* ($n=14$; 2.70%), *Sustainability* ($n=10$; 1.93%), and *Biological Conservation* ($n=10$; 1.93%) (Fig. 3).

The *Journal of Ethnobiology and Ethnomedicine* is an international and interdisciplinary journal focusing on research that links culture with biology and medicine. This journal is relevant for studies on traditional communities because it focuses on the interaction between humans, plants, and animals within cultural and medicinal contexts. *Biodiversity and Conservation* is dedicated to the study of biological diversity at all levels, exploring the variety of life in ecosystems and the impacts of human activities. This broad focus makes it a significant reference for research on the role of traditional communities in biodiversity conservation.

On the other hand, *Ecology and Society* publishes work on the interaction between humans and their natural, social, and built environments. It is particularly relevant for studies investigating how cultural practices and local ecological knowledge of traditional communities contribute to biodiversity conservation. *Sustainability* is an interdisciplinary journal focusing on research related to sustainability and sustainable development. The significant number of publications in this journal highlights the importance of sustainable practices of traditional communities for biodiversity conservation. Finally, *Biological Conservation* focuses on fundamental and applied research on conservation biology. This journal is important for studies exploring evidence-based conservation strategies, often related to traditional practices of local communities.The *Journal of Ethnobiology and Ethnomedi-*

cine has received the highest number of articles on traditional communities in biodiversity conservation due to its interdisciplinary focus and prestige in the field of ethnobiology and ethnomedicine. The journal has achieved success and prestige within the research community, as evidenced by the constant flow of high-quality submissions, indicating strong demand for a dynamic and proactive journal (Pieroni 2006).

The analysis of the Hirsch (h) indices of the journals reveals that articles on the importance of traditional communities in biodiversity conservation are widely published in interdisciplinary journals such as *Journal of Ethnobiology and Ethnomedicine* (h = 21), *Ecology and Society* (h = 11), and *Sustainability* (h = 8). These data indicate that this field of study is considered relevant and valuable to researchers and scholars across various disciplines. However, scientific articles related to biodiversity conservation are also being published in specialized journals such as *Biodiversity and Conservation* (h = 11), *Biological Conservation* (h = 6), and *Conservation Biology* (h = 5). Based on this, it can be inferred that the *Journal of Ethnobiology and Ethnomedicine* (h-index = 21), which is interdisciplinary, not only has the highest academic output but also publishes significant and relevant research in the field that is being cited by the academic community.

Countries analysis

Countries with the greatest academic production/most studied countries

Among the countries with the highest scientific output on the contributions of traditional communities to biodiversity conservation, Brazil ($n = 128$; 24.66%), India ($n = 94$; 18.11%), and the USA ($n = 85$; 16.38%) stand out (Fig. 4).

In Brazil, the combination of stringent environmental legislation and substantial investments from NGOs and international institutions results in a favorable environment for sci-

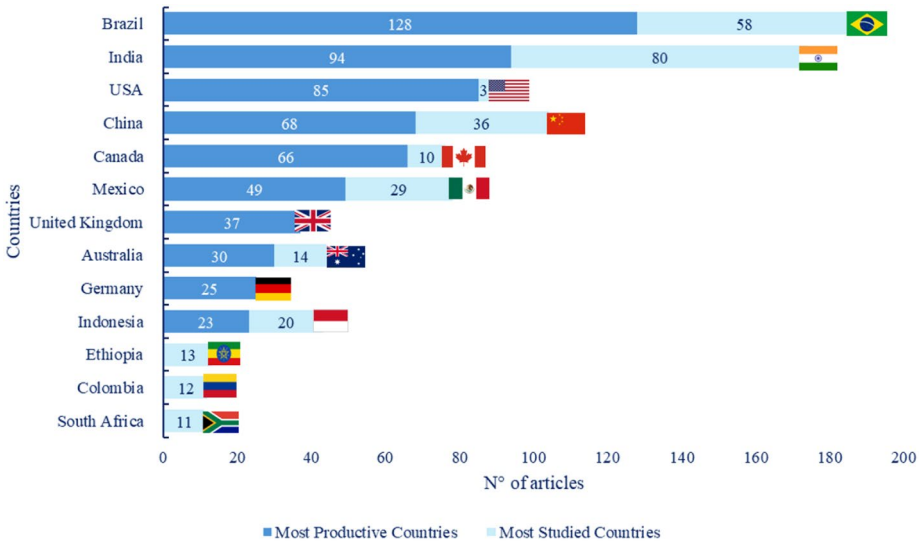


Fig. 4 The 10 countries with the highest academic production and most studied regarding the importance of traditional communities in biodiversity conservation. Databases used: Scopus and Web of Science

entific research on biodiversity conservation (Silva et al. 2021; Zhu 2023). Additionally, sustainable land management by traditional communities attracts many studies, highlighting it as a model for effective conservation practices (Sousa et al. 2024; Medeiros et al. 2023). In India, sustainable management practices and traditional ecological knowledge are widely researched topics, driving scientific output (Rist et al. 2010). Indian government policies encourage the preservation of biodiversity and traditional cultures, creating a conducive environment for research in this field (Kapoor and Usha 2020). In the United States, global leadership in scientific research is supported by a robust infrastructure, substantial funding, and world-renowned research institutions (Guerrero-Moreno and Oliveira-Junior 2024b). The country has high innovation rates and significant funding for scientific research and development, fostering the creation of research centers (Kreier 2022). Moreover, environmental and traditional community protection policies further incentivize research in biodiversity conservation (Kimmerer 2002; Rasmussen 2023).

Among the most studied countries are India ($n=80$; 15.41%), Brazil ($n=58$; 11.18%), and China ($n=36$; 6.93%). This prominence can be attributed to various country-specific factors that justify their notable position in studies related to the importance of traditional communities in biodiversity conservation. India's prominence is linked to its ecological and cultural diversity and the sustainable management practices of its traditional communities in biodiversity conservation (Challa et al. 2023). The country features a rich variety of ecosystems, from the Himalayas to the tropical forests of the south, providing a wide range of contexts for conservation studies (Kapoor and Usha 2020; Challa et al. 2023). For this reason, traditional practices are extensively studied as they are crucial in biodiversity conservation (Parween and Marchant 2022). Moreover, the Indian government implements policies that support research on conservation and the role of traditional communities (Bisht et al. 2020).

Brazil is also extensively researched due to its enormous biodiversity and the significant presence of traditional communities (Levis et al. 2024). The Amazon, for example, is one of the most biodiverse ecosystems in the world and attracts global researchers (Ridwan et al. 2023; Loureiro et al. 2024). The sustainable management practices carried out by traditional communities are of great scientific interest due to their effectiveness in preserving biodiversity (Silva et al. 2021; Sousa et al. 2024; Medeiros et al. 2023). Additionally, Brazil has various conservation programs and policies that encourage research on the role of traditional communities in environmental management (De Sousa et al. 2022). The global significance of the Amazon and other biodiversity areas in Brazil continues to attract international researchers interested in conservation and sustainability studies (Takahashi et al. 2023).

China is also a significant focus of research due to its vast diversity of ecosystems and government policies that promote biodiversity conservation (Xu et al. 1999). The country has established 2750 nature reserves, covering about 14.88% of its total land area (Huang et al. 2023). Many of these reserves have implemented community-based ecotourism as a sustainable strategy (Guerrero-Moreno and Oliveira-Junior 2024b). The substantial actions by the Chinese government for biodiversity conservation, combined with the involvement of local communities in sustainable practices, attract a considerable number of researchers (Luo and Zheng 2008).

A broader analysis of the results shows that academic production regarding the importance of traditional communities in biodiversity conservation is strongly represented by countries in the Global North or developed countries. Among these, the USA stands out with 16.37% of the publications; the United Kingdom with 7.13%; Germany with 4.82%; Can-

ada with 12.72%; and Australia with 5.78%. These countries have well-established research institutions and significant economic resources, enabling research across various domains and the formation of global collaborations (Guerrero-Moreno and Oliveira-Junior 2024b). The migration of researchers from the Global South to the Global North also contributes to this high scientific output, as these researchers have access to better resources, infrastructure, and collaboration opportunities (Fu et al. 2022), although they continue conducting research in the Global South. Another point worth mentioning is that the high costs of publishing in prestigious academic journals are a significant barrier for researchers from the Global South, contributing to greater inequality in academic production. Researchers from developing countries may struggle to publish in high-impact journals, which in turn affects their visibility and ability to influence the field (Vessuri et al. 2014; Ergin and Alkan 2019).

On the other hand, the countries most studied in relation to the role of traditional communities in biodiversity conservation are predominantly from the Global South or developing countries: India (18.11%), Brazil (11.18%), China (6.93%), Mexico (5.59%), and Indonesia (3.85%). Similar results were obtained by Wardle et al. (2018) and Guerrero-Moreno and Oliveira-Junior (2024a, b). The representation of Global South countries reflects two important aspects: the differential distribution of biodiversity hotspots within developing countries and the adoption of sustainable and conservation practices as part of national policies and strategies (Veliz et al. 2023; Huang et al. 2023). These countries are leveraging their natural, economic, social, and cultural resources to promote research, conserve biodiversity, and generate sustainable income for local populations (Guerrero-Moreno and Oliveira-Junior 2024b).

In this context, discussions on sustainability also reveal a marked contrast between the views and approaches of the Global North and the Global South. Leff (2004) emphasizes that the dominant paradigm of sustainability, primarily promoted by the Global North, has historically been biased towards economistic and technocentric perspectives, perpetuating not only social and environmental inequalities but also disregarding local knowledge and the sustainable practices of the Global South. Indigenous and peasant practices, often rendered invisible by hegemonic narratives, have significantly contributed to the sustainable management of natural resources; however, in a globalized context, scientific disciplines tend to impose validation methods and criteria that determine which knowledge is considered socially valid (Pérez and Argueta 2011). This relates to the fact that sustainability strategies promoted by the Global North often impose a one-size-fits-all model of development, in contrast with the concept of "sentipensar," which integrates feeling and thinking as a form of knowledge that challenges the separation between nature and culture imposed by Western thought (Escobar 2014). Consequently, it is essential to adopt an environmental rationality that redefines nature in political, social, economic, and cultural terms, and that counters the over-economization of the world (Leff 2004).On the other hand, upon conducting a thorough review of the author affiliations for each article, it was found that only 3 (0.57%) of the 519 scientific publications analyzed included authors belonging to the traditional communities inhabiting the study areas. This finding is consistent with studies such as Arrivabene et al. (2024), which concluded that studies on ethnobiology rarely report on the participation of Indigenous peoples and local communities or other local actors in formulating their research questions and designing their studies. From a post-colonial perspective, this phenomenon is not new, as for decades researchers have benefited from visits to former colonies in the Global South to study their flora, fauna, and sometimes people, often with

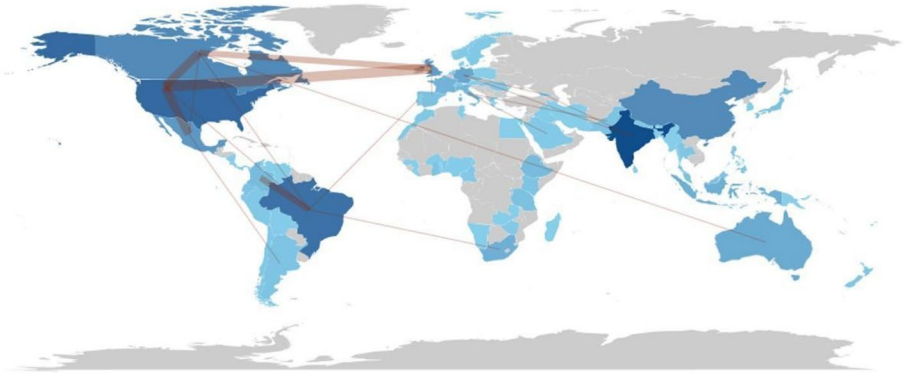
little or no involvement from local scientists and communities (Culotta et al. 2024). The latter have often been used merely as study subjects, labor, or sources of information to be exploited for data generation (Fricker 2007). This phenomenon has been described by some authors as "parachute research," which constitutes one facet of scientific colonialism, where the center of knowledge and scientific production is located outside the specific country (Raja et al. 2022), reducing it to merely a study area. In general, large amounts of data and samples are collected in the Global South but are stored in museums and servers located in the Global North, where they may remain difficult to access for researchers in the South who lack the means or resources to access them (Vorontsova et al. 2020).

To address this neocolonial gap, more equitable and balanced collaborations between the Global North and Global South are necessary, involving contributions and participation from all parties to develop research agendas based on mutual trust (Nuñez et al. 2021). Collaborations with developed countries will continue to be essential for research work, as they have the means and financial resources necessary for robust studies, house some important collections in museums and universities, and because reciprocal and fair agreements are needed for scientific advancement (Trisos et al. 2021). Scientists worldwide are beginning to form equitable alliances, taking control and utilizing local funds and talents to explore issues of concern in their countries while respecting traditional community knowledge (Culotta et al. 2024). For this to occur effectively, it is essential for professionals from all fields to actively challenge not only colonialism but also racism and other oppressive structures embedded in their institutions, projects, and practices, promoting the repatriation of biocultural heritage, the accessibility of research, and the realignment of priorities to support community-driven research (McAlvay et al. 2021). However, this alone is insufficient for the decolonization processes, as public policies and funding sources are needed to ensure and protect the development of local research (Trisos et al. 2021). Increasing the visibility and relevance of voices and perspectives from the Global South is essential to challenge a status quo in which authors from the Global North tend to write under the assumption that their approaches and theories are global and universally applicable, using Global South countries exclusively as sources of data and case studies (Ergin and Alkan 2019).

Collaboration networks and most cited countries

The analysis of collaboration networks identified the USA as a central actor in the scientific collaboration network, with a high frequency of collaborations with the United Kingdom (5), Canada (4), and Mexico (4) (Fig. 5). Brazil also stands out, collaborating significantly with Colombia (3), Canada (2), Portugal (2), South Africa (2), and the USA (2) (Fig. 5).

The collaborations between countries reflect an intense exchange of knowledge and the formation of strategic alliances that can lead to higher-impact research (Piovezan-Borges et al. 2022). Examples of such networks include the Monarch Conservation Science Partnership (MCSP), a international collaboration between the USA, Canada, and Mexico that combines existing policies and new research efforts (Diffendorfer et al. 2023). Another example is Conservation Evidence, a global initiative with over 1,100 collaborators from various countries, developing tools and guidelines for evidence-based conservation practices (Christie et al. 2022). These scientific collaboration networks enhance the effectiveness of conservation initiatives by combining diverse perspectives and expertise (Nature Editorial 2021).



From	To	Frequency	Country	TC	Average Article Citations (%)
USA	United kingdom	5	India	1211	18.10
USA	Canada	4	USA	800	22.20
USA	Mexico	4	Brazil	794	15.90
Brazil	Colombia	3	Australia	696	36.60
Canada	United kingdom	3	Canada	462	19.20
Brazil	Canada	2	China	420	12.00
Brazil	Portugal	2	Italy	258	32.20
Brazil	South africa	2	Nepal	242	60.50
Brazil	USA	2	South africa	242	18.60
Canada	Australia	2	United kingdom	221	17.00

Fig. 5 Publications on the Importance of traditional communities in biodiversity conservation. The choropleth map shows the intensity of collaboration between countries: darker areas (dark blue) indicate higher frequency of collaborations, while lighter areas (light blue) indicate lower collaboration. Gray areas represent countries with no reported academic production on the topic. Red lines connect countries that collaborate with each other in publications. The table below the map highlights the most cited countries in the field, showing the total number of citations (TC) and the average citations per article for each country. Databases used: Scopus and Web of Science

In addition to collaboration networks, the analysis of citations by country revealed interesting patterns of academic influence. India has the highest total number of citations (1211), followed by the USA (800) and Brazil (794). However, the average citations per article vary significantly, with Nepal (60.50%), Australia (36.60%), and Italy (32.20%) standing out respectively. These data indicate that while some countries publish a large volume of articles, the influence of these articles, as measured by the number of citations, can be higher in countries with lower production but high-quality work (Caon et al. 2020). The high number of citations from Nepal may also be attributed to the focus on relevant and globally impactful topics, international collaborations, and the uniqueness of the country's ecosystems and challenges (Larivière et al. 2015; Yegros-Yegros et al. 2015; Paudel et al. 2023). These factors can contribute to the visibility and influence of the scientific work produced, resulting in a significantly high average number of citations.

Our results highlight the importance of international collaborations and the influence of publications on biodiversity conservation (Piovezan-Borges et al. 2022; Nature Editorial 2021). Additionally, studies show that traditional communities employ a variety of cultural practices and local knowledge for the sustainable management of natural resources (Sterling et al. 2017; Levis et al. 2024; Yang et al. 2024), contributing significantly to nature conser-

vation (Challa et al. 2023). These practices include the protection of forest areas based on religious and cultural beliefs, as observed in the Western Himalayas and among indigenous tribes in India (Uniyal et al. 2006). In turn, the demarcation and protection of indigenous lands are as effective as conservation areas in protecting endangered species and mitigating climate change (Lima et al. 2024). However, the marginalization of indigenous communities due to socioeconomic and political changes has also led to biodiversity loss (Challa et al. 2023). Therefore, it is crucial to recognize and integrate the role of these communities and their territories into conservation efforts (Berkes and Davidson-Hunt 2006). The results reflect that integrating traditional knowledge and global scientific cooperation can promote more effective and sustainable strategies for ecosystem preservation. International collaboration and recognition of the value of traditional practices are thus essential for successful biodiversity conservation.

Topic analysis

Most used keywords

Word clouds are a visual representation of the most important keywords in a text, where the size of each word is determined by the number of times it appears in each scientific article (*frequency*). Thus, larger words are generally placed in the center or in prominent positions, while less frequent words are smaller and located at the edges or in less prominent areas (Mulay et al. 2020). In line with this, the five most frequent keywords in the analyzed articles are *conservation* ($n=65$; 12.52%), *biodiversity* ($n=65$; 12.52%), *traditional knowledge* ($n=42$; 8.09%), *traditional ecological knowledge* ($n=37$; 7.12%), and *ethnobotany* ($n=31$; 5.97%), respectively, reflecting the intersection between traditional ecological practices and knowledge and modern conservation efforts (Fig. 6). Also highlighted are terms such as *indigenous knowledge*, *sustainability*, *protected areas*, and *climate change*, as indigenous

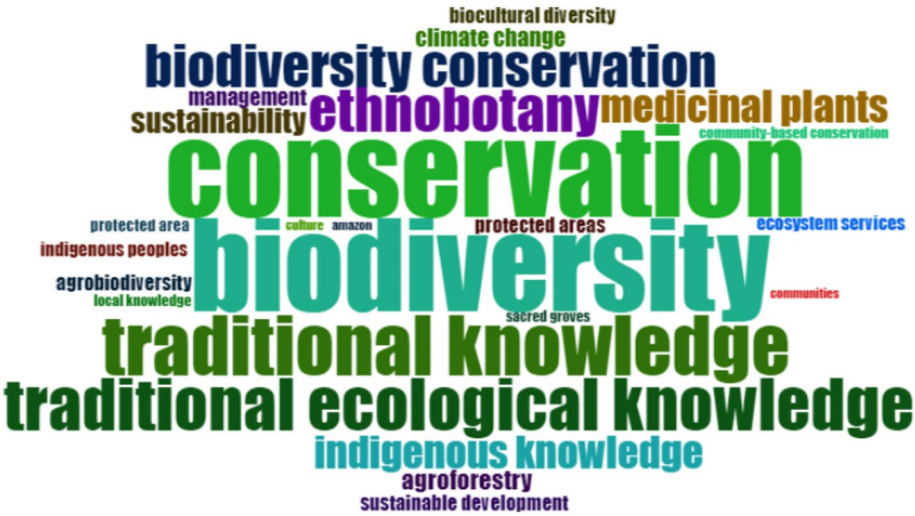


Fig. 6 Word cloud created with the most relevant keywords from scientific articles on the importance of traditional communities in biodiversity conservation. Databases used: Scopus and Web of Science

lands and knowledge play a crucial role in biodiversity conservation, sustainable development, and reducing the impact of climate change globally (Lima et al. 2024).

Traditional ecological knowledge plays a crucial role in monitoring, responding to, and managing ecosystem processes and functions, with a special focus on ecological resilience through adaptive management. This approach acknowledges that environmental conditions will always change, requiring communities to develop new strategies to maintain resource availability over time (Berkes et al. 2000). In line with this, authors such as Vandebroek et al. (2020) highlight the importance of adaptive co-management, which relies on cycles of discussion and knowledge exchange among diverse groups to identify problems and generate shared visions and actions that sustain socioecological resilience in times of change. Studies show how traditional communities, such as the Hani, apply their knowledge to preserve and enhance biodiversity (Yang et al. 2018), and how shamans from the Tukano people in Colombia monitor species abundance through random scheduling of hunting excursions (Berkes et al. 2000). Traditional knowledge can complement scientific ecology by promoting culturally relevant and effective sustainable management practices in mitigating climate change (Berkes 2018).

Among the keywords, indigenous knowledge is fundamental in conservation studies. For example, Tibetan traditional ecological knowledge offers valuable alternatives for biodiversity conservation and adaptation to climate change, highlighting its cultural and social importance beyond environmental aspects (Yin and Zhang 2020; Yang et al. 2024). Posey (1999) argues that cultural and spiritual values are central to the appreciation and preservation of life, emphasizing how many cultures view nature as an extension of society. Similarly, Challa et al. (2023) reinforce that integrating local knowledge is an overlooked key to the success of conservation and development programs.

The discussion on sustainability and ethnobotany highlights the potential of ethnobotanical practices in contributing to sustainable conservation. However, a study on African traditional knowledge systems indicates that, although these systems contribute to conservation, they may lack adequate development in conservation knowledge and awareness, due to a focus on superstition and fear rather than an explicit conservation purpose (Simelane 2009). This underscores the need for educational programs that address these gaps and promote a deeper understanding of the ecological importance of traditional practices.

Studies show that indigenous knowledge is crucial in conservation efforts, contributing to species recovery, habitat restoration, and the maintenance of traditional livelihoods through collaborations with local communities (Wilder et al. 2016). Civil society groups in the Global South are documenting biodiversity and advocating for conservation using citizen science and biodiversity informatics within the framework of traditional knowledge and sustainable development (Dhandapani et al. 2019).

Thematic map

The thematic map shows the evolution of the use of keywords such as Amazon, climate change, agrobiodiversity, traditional ecological knowledge, biodiversity, conservation, biodiversity conservation, local communities, livelihoods, and community conservation over the years (Fig. 7). There is a significant increase in the use of these terms starting from 2015, with notable peaks in 2019 and 2020.

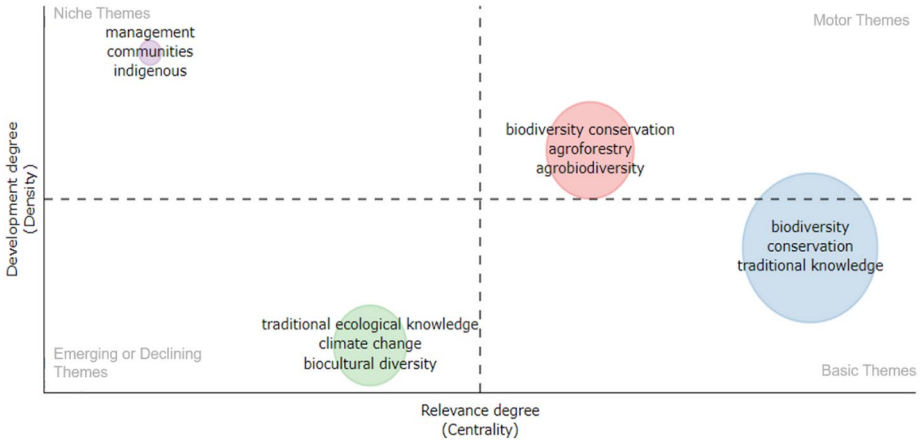


Fig. 7 The thematic map on the importance of traditional communities in biodiversity conservation (based on data from Scopus and Web of Science, 1994 to 2024) categorizes the main research topics into four quadrants: Basic Themes (high centrality and low density), Driving Themes (high centrality and high density), Niche Themes (low centrality and high density), and Emerging or Declining Themes (low centrality and low density). The size of the bubbles represents the relative frequency of each theme in the literature, while the position on the X-axis (degree of centrality) and the Y-axis (degree of development) indicates its relevance and maturity within the field of study

The thematic map illustrates the complex interaction between traditional communities and biodiversity conservation. The arrangement of topics into four distinct quadrants provides valuable insights into the areas of research that are central to academic studies, as well as those that are emerging or in a specific niche. The relevance of themes such as "biodiversity conservation" and "traditional knowledge" in the Basic Themes quadrant highlights the importance of these fundamentals as pillars of conservation research (Cardinale et al. 2012). These themes, being highly central, demonstrate a concentration of studies focused on integrating indigenous and local knowledge into conservation practices, an area that, while well-established, still faces significant challenges related to implementation and legal and practical recognition (Levis et al. 2024; Yang et al. 2024).

In the Driving Themes quadrant, "agroforestry" and "agrobiodiversity" are identified as areas of dense research, reflecting the growing importance of these sustainable practices in promoting biodiversity (Burgarella et al. 2019). The strong presence of these themes suggests that agroforestry not only aids in biodiversity conservation but also strengthens the food and economic security of traditional communities, offering a replicable model for integrated conservation (Altieri et al. 2015).

On the other hand, niche themes such as "management," "communities," and "indigenous," despite being less central, have high density, indicating a deep specialization in these topics within smaller academic circles. This underscores a strong connection between community management and conservation, although these topics may still be marginalized in broader discussions on biodiversity conservation (Levis et al. 2024).

Emerging or declining themes such as "traditional ecological knowledge," "climate change," and "biocultural diversity" reflect potential areas for new research. The emergence of these themes is critical as it indicates a response to global change dynamics (Lapola et al. 2023; Nobre et al. 2016), suggesting that topics like climate change are beginning to

receive more attention in the context of traditional communities. This shift could transform how these communities are perceived and integrated into conservation policies (Levis et al. 2024; Yang et al. 2024).

In summary, the thematic map reveals a rich compilation of topics central to understanding the interaction between traditional communities and biodiversity conservation. The analysis suggests not only the need to continue exploring well-established areas but also to expand research to include emerging themes that could influence the effectiveness of conservation policies and the sustainability of community practices. Integrating these diverse topics will be crucial in addressing the complex challenges faced by traditional communities and the environment in the current global context.

Topic clustering

The dendrogram is a tree-like diagram used to visually represent hierarchical clustering. This type of diagram is essential in statistics, data analysis, and data science, as it facilitates understanding how individual elements are grouped based on their similarities or distances (Negri 2022). Each node represents a group of data points, and the height at which the two groups merge reflects the dissimilarity between them. Thus, the dendrogram presented illustrates the hierarchical relationship between relevant terms in the field of conservation and biodiversity, showing how these terms, cluster based on their similarities and frequencies of occurrence (Fig. 8).

The first cluster includes terms such as *protected areas*, *biocultural diversity*, *traditional ecological knowledge*, and *climate change*. This group highlights the interconnection between protected areas, biocultural diversity, traditional ecological knowledge, and climate change. Protected areas are essential for biodiversity conservation, serving as refuges for endangered species and critical ecosystems, as well as for the development of sustain-

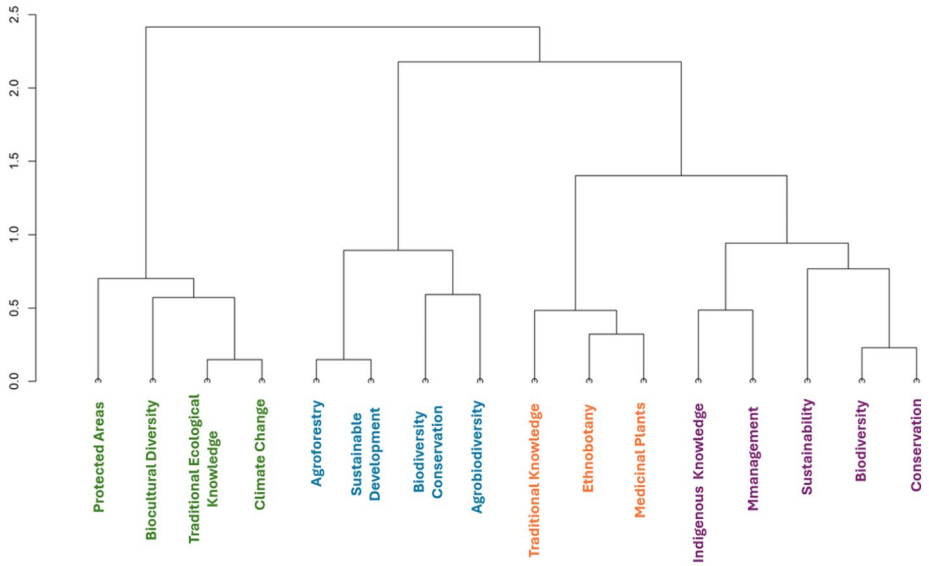


Fig. 8 Dendrogram showing the relationship between different themes related to traditional knowledge and biodiversity conservation. Databases used: Scopus and Web of Science

able initiatives (Maxwell et al. 2020; Guerrero-Moreno and Oliveira-Junior 2024b). Biocultural diversity, which encompasses the knowledge and practices of traditional communities, is crucial for sustainable management of protected areas and the protection of local flora and fauna (Gavin et al. 2018). Climate change poses a significant threat to protected areas and the biodiversity they harbor, exacerbating conservation challenges (Lovejoy and Nobre 2019). Additionally, traditional ecological knowledge can provide adaptive solutions to address the impacts of climate change, helping to maintain ecosystem resilience (Sterling et al. 2017; Hosen et al. 2020).

The second cluster, composed of *agroforestry*, *sustainable development*, *biodiversity*, and *biodiversity conservation*, shows the relationship between sustainable agricultural practices and biodiversity conservation. Agroforestry is a practice that combines tree cultivation and agricultural crops, promoting conservation and sustainable development (Jose 2009). Sustainable development aims to meet present needs without compromising the ability of future generations to meet their own needs (Henderson and Loreau 2023), and biodiversity is a key component in achieving this goal (Sekhar et al. 2024). Agroforestry not only promotes biodiversity but also enhances the resilience of agricultural systems (Rahman et al. 2023).

The third cluster consists of keywords such as *traditional knowledge*, *ethnobotany*, and *medicinal plants*, which is similar to the results of the word cloud (Fig. 6). Traditional knowledge includes practices and wisdom passed down through generations, which are fundamental for the sustainable discovery and use of medicinal plants (Altieri et al. 2015). Ethnobotany studies the interactions between people and plants, highlighting the importance of traditional knowledge in the conservation and sustainable use of plant resources (Woldearegay and Teso 2023). For example, traditional communities have used ethnobotanical knowledge for the conservation of medicinal plants and the promotion of health, while also preserving important endemic botanical species, demonstrating the relevance of these practices (Graham 2021).

The fourth cluster emphasizes the interconnection between *indigenous knowledge*, *management*, *sustainability*, *biodiversity*, and *conservation*. Indigenous knowledge is vital for the sustainable management of natural resources and for biodiversity conservation (Reyes-García et al. 2019). Sustainability involves practices that maintain ecosystem health over the long term, and effective resource management is essential for achieving biodiversity conservation (Díaz et al. 2019). Case studies show how indigenous knowledge has been fundamental to successful conservation projects, such as the management of indigenous lands in the Amazon (Sousa et al. 2024; Levis et al. 2024).

Overall, the dendrogram reveals the complex interconnections between different terms related to conservation and biodiversity, highlighting the importance of traditional and indigenous knowledge, the relevance of protected areas and biocultural diversity, and the need for sustainable agricultural practices and sustainable development. These interconnections underscore the need for integrative and inclusive approaches to biodiversity conservation, considering both ecological and socio-cultural aspects, as well as political and economic factors.

Study populations (Indigenous/Non-indigenous)

We observe a predominance of studies addressing indigenous knowledge (54.14%), suggesting that most research specifically focuses on indigenous communities (Fig. 9). This phenomenon can be attributed to the growing recognition of the crucial role that indigenous peoples play in biodiversity conservation (Sousa et al. 2024; Levis et al. 2024). Research indicates that indigenous lands often exhibit higher levels of biodiversity and are more effective in preventing deforestation compared to other protected areas (Berkes et al. 2000; Garnett et al. 2018; Fa et al. 2020; Sousa et al. 2024). In light of this, some authors raise concerns about the accuracy and reliability of the percentage of global biodiversity present in Indigenous territories. However, this does not diminish the essential and well-documented role that Indigenous peoples play in conserving the planet's biodiversity (Fernández-Llamazares et al. 2024). Studies such as Garnett et al. (2018) show that Indigenous peoples manage or hold tenure rights over approximately 38 million km² in 87 countries or politically distinct territories across all inhabited continents, covering more than a quarter of the global land surface and overlapping with around 40% of protected areas and ecologically intact landscapes, such as primary boreal and tropical forests, savannas, and wetlands. Additionally, thetraditional ecological knowledge of indigenous peoples is also a powerful tool in the sustainable management of natural resources (Ntoko and Schmidt 2021), being fundamental to conservation strategies (Rayne et al. 2020).

On the other hand, a significant percentage of publications focus on non-indigenous communities (45.47%), reflecting the diversity of groups that also contribute to biodiversity conservation (Ridwan et al. 2023; Levis et al. 2024). Afro-descendant, riparian, and other local traditional communities possess sustainable resource use practices that are vital for conservation (Berkes and Davidson-Hunt 2006; Silva 2019; Selemani 2020). These actions are often aligned with ecosystem preservation and biodiversity maintenance (Levis et al. 2024). Including these communities in conservation efforts is crucial for ensuring a comprehensive, holistic, and effective approach (Abayneh et al. 2017).

The analysis of works addressing both traditional knowledge groups (0.39%) reveals a gap in the literature, with few studies integrating the perspectives of both groups. However,

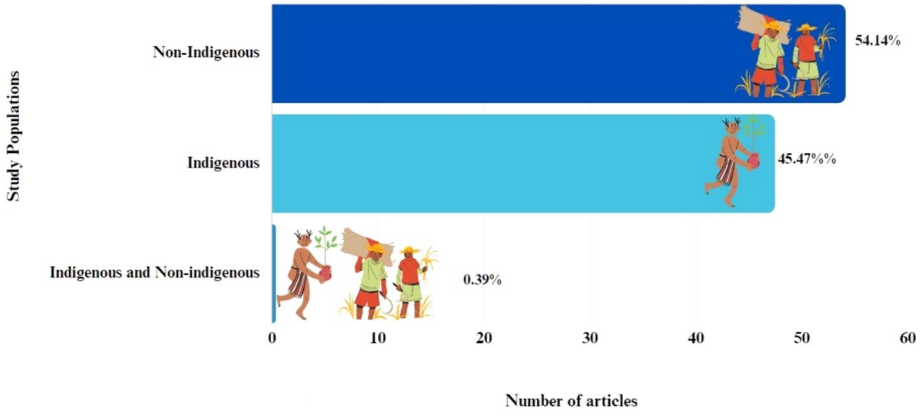


Fig. 9 Percentage of study populations divided into categories: Indigenous; Non-Indigenous; Indigenous and Non-Indigenous in scientific articles on the importance of traditional communities in biodiversity conservation. Databases used: Scopus and Web of Science

Fig. 10 Contributions of Traditional Communities to Biodiversity Conservation addressed in the analyzed articles. Databases used: Scopus and Web of Science

integrating the practices of both communities can be highly beneficial for creating more inclusive and sustainable conservation strategies (Salvaña and Arnibal 2019). Studies suggest that collaboration between different traditional communities can strengthen conservation efforts (Dawson et al. 2021), promoting an exchange of knowledge and sustainable practices (McCarthy et al. 2018).

Contributions of traditional communities to the conservation of biodiversity

The contributions of traditional communities to biodiversity conservation have been grouped into five main categories of analysis: Management and sustainable use of natural resources, cultural and traditional practices, environmental education and awareness, habitat conservation and restoration, and community monitoring and management (Fig. 10).

The most representative category was the management and sustainable use of natural resources ($n=370$; 71.29%). This highlights the importance of sustainable management as a central theme in the literature on biodiversity conservation (Doley and Barman 2023). Sustainable natural resource management practices are crucial for ensuring the continuity of ecosystems and biodiversity (Levis et al. 2024; Sousa et al. 2024). Studies show that community-based management practices can lead to more effective resource management, especially when integrated with traditional ecological knowledge (Tantoh et al. 2021). From the reviewed literature, it is observed that common practices are associated with the development of ecological agroforestry systems, sustainable fishing and hunting, along with other low-impact environmental strategies such as community-based ecotourism and family-based extraction (Guerrero-Moreno et al. 2024).

Cultural and traditional practices were also significant ($n=241$; 46.43%), possibly because they incorporate beliefs and detailed knowledge about local ecosystems and have proven essential in biodiversity conservation (Berkes et al. 1994; Haq et al. 2023). For example, limiting the consumption of certain species associated with community-specific taboos, creating rituals and ceremonies connecting with nature, using endemic medicinal plants, designating sacred animals such as large mammals, and selecting sacred forests that act as protected areas are important practices that significantly contribute to maintaining biodiversity (Berkes et al. 2000).

Environmental education and awareness also stand out ($n=150$; 28.90%), reflecting the growing importance of public awareness and education as tools for conservation. However, scientific information and its application is often a one-way transfer of knowledge and power from scientists to the community (Vierros 2017), overlooking that the values and worldviews of traditional communities, developed over centuries, focus on caring for and preserving nature. These principles are passed down through generations, fostering community-based environmental awareness and ethics from an ecocentric perspective, contrary to Western anthropocentrism (Berkes et al. 2000; Levis et al. 2024). Additionally, the use of new hybrid forms of knowledge for research, awareness, management, and protection of biodiversity—based on a combination of approaches from multiple knowledge systems—can lead to better outcomes in terms of biodiversity and livelihoods (Wensing 2012).

The category of habitat conservation and restoration ($n=91$; 17.53%) highlights the importance of recovering degraded ecosystems to reverse or mitigate biodiversity loss. Restoration projects that involve local communities and incorporate traditional knowledge are more likely to succeed and be sustainable in the long term (Haq et al. 2023). These practices include crop rotation, resource extraction area management, succession management, temporary harvest restrictions, and protection of vulnerable stages of plants and animals, both terrestrial and aquatic (Berkes et al. 2000).

Finally, the category of community monitoring and management is relevant among the contributions of traditional communities to biodiversity protection ($n=51$; 9.82%). Community monitoring involves the active participation of local communities in data collection and natural resource management (Danielsen et al. 2009). This approach can enhance data accuracy and strengthen community engagement in conservation (Rayne et al. 2020). Monitoring is a common practice among traditional communities, focusing on tracking the abundance and richness of resources, as well as identifying changes in ecosystems over time to develop mitigation strategies, such as temporary restrictions (Berkes et al. 2000).

Conclusions

This study confirms the important role that Indigenous and non-Indigenous traditional communities play in biodiversity conservation. Both hypotheses were supported: there is an increase in academic production on the role of traditional communities, and there is unequal academic growth, with greater output in Global North countries. The results highlight that despite growing scientific attention and widespread recognition of the value of traditional knowledge, there remains a lack of practical and specific approaches to effectively implement this knowledge in global conservation strategies.

Beyond mere rhetorical appreciation, it is essential to move toward operationalizing traditional knowledge in conservation policies and practices. This requires developing collaborative and co-management mechanisms that ensure the active participation of local communities in decision-making processes related to the management of their natural resources. The establishment of hybrid frameworks that combine scientific knowledge with cultural practices could represent a significant step in overcoming this discursive limitation.

Moreover, it is crucial to address the structural barriers that prevent the full and equitable integration of this knowledge, investigating the specific challenges faced by traditional communities in this process. The results emphasize the importance of a more proactive discussion that not only values traditional knowledge theoretically but also proposes concrete strategies for its effective application.

Current literature must strive to more meaningfully include the voices and perspectives of traditional communities, promoting more inclusive and less colonial narratives. This will not only enrich the theoretical base but also ensure that conservation practices are more equitable, adaptive, and effective. By giving a central role to this knowledge and empowering local communities, it will be possible to build truly sustainable conservation efforts in harmony with cultural practices, contributing to environmental management that addresses the complex socioecological realities of our time.

Limitations and future research

We employed a scientometric methodology to analyze a significant volume of information; however, it is necessary to acknowledge the limitations of this approach. One major limitation lies in the selection of the two main databases, Web of Science and Scopus. Although these databases are widely recognized and used globally for mapping scientific literature, it is possible that critical articles published in other sources, such as regional journals or less prominent databases, were excluded. This exclusion may result in a partial understanding of the full extent of research on the importance of traditional communities in biodiversity conservation. Additionally, excluding other types of texts, such as book chapters, reviews, reports, and conference proceedings, may have limited the scope of our findings, particularly in understanding the broader sociocultural context.

Another limitation pertains to the focus on scientific literature, which may not fully capture the cultural and contextual complexities related to the roles of traditional communities in biodiversity conservation. This could lead to an underrepresentation of the lived experiences and nuanced understandings these communities have of their environments.

Despite efforts to ensure data accuracy, the possibility of human error in data cleaning and consolidation cannot be completely dismissed. Similarly, the use of bibliometric metrics, while valuable for trend analysis, may not always reflect the true impact or quality of research contributions.

For future research, we recommend adopting a more inclusive approach that integrates traditional ecological knowledge with scientific research using other data sources. Future studies should aim to collaborate directly with traditional communities, ensuring their active participation and recognition in the research process. Exploring interdisciplinary frameworks that combine ecology, anthropology, sociology, and environmental policy could

provide a more holistic understanding of the contributions of traditional communities to biodiversity conservation.

Additionally, it is recommended that future studies evaluate the socioeconomic and cultural impacts of conservation policies on traditional communities, describing how these policies align with or disrupt local practices. Longitudinal studies could be particularly valuable for understanding the evolving relationship between traditional communities and biodiversity conservation over time. Finally, comparative studies across different geographic regions could highlight variations in traditional practices and inform the development of culturally sensitive and equitable conservation strategies. This would not only improve the effectiveness of biodiversity conservation but also promote social justice and the appropriate recognition of the roles and rights of traditional communities, as well as the development of contextually relevant public policies.

Acknowledgments E.C.S. thank the Programa de Pós-Graduação Ecologia (PPGECO/UFPA) and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the doctoral scholarship. M.A.G.-M. thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for the doctoral scholarship. M.A.G.-M. and J.M.B.O.-J. thank the Programa de Pós-Graduação em Sociedade, Natureza e Desenvolvimento (PPGSND/UFOPA) and Edital Nº 13/2020 CAPES (PDPG Amazônia Legal) for their academic support. F.G.C. thank the Amazonian BioTechQuilombo- CNPq/CONFAP nº 34/2023. We are grateful to Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for research productivity scholarships to L.J. (process 304710/2019 –9) and J.M.B.O.-J. (process 307808/2022 –0). We extend our gratitude to the whole team of Laboratório de Estudos de Impacto Ambiental (LEIA/UFOPA) that in some way provided support to this research. We are grateful for the support of the projects INCT Sínteses da Biodiversidade Amazônica (CNPq/MCTIC/INCT-2022 58/2022 process 406767/2022 –0) and the Propgrama de Pesquisa em Biodiversidade da Amazônia Oriental - PPBIO AmOr (CNPq/MCTI/FNDCT No. 07/2023 process 441257/2023 –2). We thank the anonymous reviewers and academic editors for their valuable contributions.

Author contributions Conceptualization, E. C. S., M. A. G.-M., and J. M. B. O.-J.; methodology, M. A. G.-M., F. A. O., L. J., and J. M. B. O.-J.; formal analysis, E. C. S., M. A. G.-M., L. J., and F. A. O.; investigation, E. C. S., M. A. G.-M., and L. J.; resources, L. J. and F. G. C.; data curation, E. C. S., M. A. G.-M., and F.A.O.; writing—original draft preparation, E. C. S. and M. A. G.-M.; writing—review and editing, L.J., F. G. C., and J. M. B. O.-J.; visualization, M. A. G.-M., F. A. O., and J. M. B. O.-J.; supervision, J. M. B. O.-J.; project administration, E. C. S. and J. M.B. O.-J.; funding acquisition, M. A.G.-M. All authors have read and agreed to the published version of the manuscript.

Funding This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the productivity grant (PQ) (process: 307808/2022-0; 304710/2019 –9). This project is supported by Edital Nº 13/2020 Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) (PDPG Amazônia Legal) - Project 88881.510170/2020-01-PDPG_AL_CAPES_Auxpe 0786/2020.

Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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