Revista ARACÊ
ISSN: 2358-2472

THE CO-MANAGEMENT OF NATURAL RESOURCES IN INTERNATIONAL STUDIES BETWEEN 2012 AND 2021 WITH A FOCUS ON THE LEGAL AMAZON

https://doi.org/10.56238/arev7n4-037

Submitted on: 03/06/2025 **Publication date:** 04/06/2025

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ABSTRACT

This article aims to map publications on high-impact international studies in the area of public management of natural resources, enabling the analysis of trends in scientific production in the period from 2012 to 2021. This international study highlights the publications of environmental studies in five countries with the greatest impact: the United States of America, Canada, the United Kingdom, Australia and Brazil. The qualitative method was adopted with a bibliographic approach and bibliometric procedure. The results show environmental sciences as the largest area in terms of the number of scientific publications. Publications in the environmental area represent 25.8% of scientific works with international reach. Other areas of emphasis are social sciences (19%), agriculture and biology (17.4%), as well as medicine (10.5%), among others. Supplementary research in the context of Brazil and particularly in the Amazon shows that the relaxation of the Forest Code has had negative consequences on the environment.

Keywords: Natural resources. Environmental area. Co-management. Climate warming. Amazon.

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ISSN: 2358-2472

INTRODUCTION

The first half of the 21st century has not yet come to an end, but the world has already suffered numerous natural disasters, causing climate crises. Examples of this are the wildfires in Canada, which destroyed an entire city, and the historic floods in the United States, which isolated communities and caused deaths in submerged basements (CNN BRASIL, 2021).

Climate change intensifies debates on environmental issues at the global level. In Brazil, in general, and in the Amazon, in particular, during the year 2021, not a month went by without notifications of fires in Brazilian forests. MAPBIOMAS BRASIL (2022) states that, in the first ten months of 2021, the Amazon concentrated 85% of forest fires in the country, resulting in the burning of almost two million hectares.

Given this scenario, it is essential to map high-impact international publications related to the public management of natural resources. This study seeks to analyze the trends in scientific production between 2012 and 2021, contributing to a broader understanding of the evolution of environmental research.

Co-management is a shared management model that involves the joint participation of different stakeholders in the decision-making and governance of an organization or resources. This model seeks to balance power among the various participants, promoting collaboration, shared responsibility, and equity. Faria (2009) classifies co-management as one of the five forms of management, along with heteromanagement, participatory management, cooperative management and self-management. Co-management stands out for its characteristic of joint management or partnership, promoting a collaborative and democratic environment.

In co-determination, the principle of equal rights is fundamental. Mihály (2022) emphasizes the importance of the participation of all employees of the same level in meetings, as a way to express this equality within the organization. In companies managed by co-management, there is equality between capital and labour, essential elements for the organisational mission, which include participation (mitbestimmen) and co-determination (mitbestimmung) (Lasserre, 1994).

In addition, co-management values workers, encouraging their participation in society's initiatives and recognizing their creativity (Faria, 1982). Workers' representatives defend their interests on the company's boards of management (Lasserre, 1994). Motta

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(1983) highlights the legitimacy of representatives, who must be elected by the governed and controlled in their exercise of power.

Co-management, in addition to being applied in the corporate context, plays an essential role in the management of natural resources. In the environmental field, this model involves the participation of multiple actors, such as the State, civil society and local communities, promoting a shared and participatory management of natural resources. This approach promotes the integration of the local community in the definition and decision-making of policies for the conservation and protection of protected areas, encouraging the sustainable use of scarce natural resources.

The practice of environmental co-management allows for the sharing of responsibilities, power, and governance among different stakeholders, creating an environment of cooperation and trust. This practice is fundamental for community cohesion and the formation of cooperative social bonds (Alexander, Bodin and Barnes, 2018). All participants in co-determination have equal rights to deliberative voting, ensuring fairness in the decision-making process.

Berkes, F., George, P. and Preston, R. J. (1991), describe co-management as the sharing of power and responsibility between the government and local users of resources. Jentoft (2003) reinforces that co-management is a collaborative and participatory process in making normative and regulatory decisions about natural resources, including fishing, forestry activities and wildlife management. Araújo and Campos (2014) observe that co-management has been applied to a wide range of natural resources globally, such as fishing, forestry, wildlife management, protected area management, and tourism (Borrini-Feyerabend, 2004; Plummer, 2009).

International studies on the co-management of natural resources, carried out between 2012 and 2021, show a significant growth in publications in the environmental area. This area stands out for the relevance of current discussions on the environment and climate issues, representing 25.8% of studies on co-management (SCOPUS, 2022). Among the countries with the highest volume of publications on the subject are the United States, Canada, Australia, the United Kingdom, and Brazil (SCOPUS, 2022). The debate on the environment at UN Assemblies and the fight against global warming drive efforts to understand and mitigate climate change, as noted by Silva and Colombo (2018).

In addition to the negative impacts on environmental areas, climate change directly affects human life and social relations, especially in developing countries, where

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infrastructure and essential services are often inadequate (Silva and Colombo, 2018). Co-management in environmental science brings important contributions to facing crises such as global warming, forest fires, and deforestation, as highlighted by the IPCC (2019).

In this context, co-management presents itself as an effective approach to solving complex environmental problems and promoting sustainability. The adoption of public policies that protect and preserve the environment, along with practices that strengthen environmental education and ensure the livelihood of communities dependent on natural resources, is essential. Thus, co-management offers an innovative and necessary model to face contemporary challenges in the management and preservation of environmental resources.

Thus, this article aims to analyze the results of studies on co-management in the area of environmental sciences, based on the premise of international publications in the five countries that stood out for their work. From the qualitative methodological procedure and with the bibliometric approach, international publications from the last decade (2012-2021) will be analyzed.

THEORETICAL FRAMEWORK

The historical bases of the concept of co-management are situated in West Germany, and co-management would never have been possible without the consent of the working class. It is the result of various interest groups, among which the bourgeoisie, the bureaucracy and the working class stand out (Motta, 1983). The German co-management model has its roots in the end of the second half of the nineteenth century, a period in which Germany experimented with political democracy and tried to put social democracy into practice (Lasserre, 1994).

Co-management was defined in several ways. Armitage (2007) states that there is no universally accepted definition. According to Berkes (2009), the concept of co-management refers to a series of arrangements characterized by different degrees of power for joint decision-making by the state and communities and other stakeholders over certain natural resources and/or clearly defined areas.

Entities such as the World Bank and authors such as Berkes (2009), Borrini-Feyerabend (2000), Berkes, Plummer and Fitzgibbon (2004) define co-management as the sharing of responsibilities and rights between the main actors, especially local communities and the State.

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According to Berkes (2009), co-management is the sharing of power and responsibility between governments, communities and partners involved. This definition demonstrates the involvement of several actors who interact and who, according to Borrini-Feyerabend and Borrini (2000), express themselves and reassure themselves during the equitable management of functions, rights and responsibilities in certain resources.

For Plummer and Fitzgibbon (2004), the characteristics of co-management that differentiate it from other models of natural resource management (Plummer and Fitzgibbon, 2004) stand out, which include pluralism, communication and negotiation, decision-making, social learning and shared action/commitment. These common characteristics are considered by pluralist authors as important elements associated with the multiple characteristics of co-management.

Co-management, especially in the environmental area, is a management model that promotes the active participation of various actors, including local communities and governments, in decision-making about natural resources. From this perspective, Ferreira, Vasconcellos and Vasconcellos (2017) state that the management of extractive reserves assumes assumptions of shared management of common resources by various social actors, whose interests converge and/or diverge; thus, the work developed assumes the concept of co-management in extractive reserves in the Amazon. Environmental management is based on the principles of democratization, plurality and sharing of responsibilities, providing a path to sustainability and equity in the management of natural resources.

The idea of participation and decision brings social groups (stakeholders) to the center of managerial action and social innovation. Ferreira, Vasconcellos and Vasconcellos (2017) also in their studies state that the interests of the actors can conflict when it comes to the management of common resources by various social actors, whose interests converge and/or diverge.

Thus, the work developed assumes the concept of co-management in extractive reserves in the Amazon. In this study, the research assumes that the participation of civil society in environmental management brought to the center of the debate the importance of the participation of traditional communities for the management of the RESEX, assuming the role of co-managers. This statement is shared by authors who discuss the public management of extractive reserves in the Amazon, such as Ferreira; Vasconcellos; Vasconcellos, (2017, p. 95), among others.

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In Brazil, public policies on the environment are regulated by several laws and ordinances that establish guidelines for environmental protection and education. Article 225 of the Federal Constitution of 1988, for example, determines that everyone has the right to an ecologically balanced environment, a good for the common use of the people and essential to a healthy quality of life, imposing on the Government and the community the duty to defend and preserve it for present and future generations.

Studies on co-management, as pointed out by Plummer and Fitzgibbon (2004, p. 876-877), consider the growing interest in the co-management of natural resources as a mixture of practices and theories. The authors state that the implementation of co-management presents itself as an innovation in the face of practical challenges and theoretical advances. The theoretical foundation brought an organized literature, allowing the conceptualization of co-management from international and national studies for the application of the concept in the local reality of the Brazilian Amazon.

Table 1 - Legal Framework for Co-management in Environmental Policy

Area	Law / Regulation	Main provisions
Environmental	Federal Constitution 1988 (Art. 225)	Everyone has the right to an ecologically balanced environment, a good for the common use of the people and essential to a healthy quality of life, imposing on the Government and the community the duty to defend and preserve it for the present and future generations.
	Law 6938/1981 (PNMA)	Provides for the National Environmental Policy, its purposes and mechanisms for formulation and application, and provides for other provisions. •Environmental co-management is established as one of the principles of the national environmental policy; •It defines co-management as the participation of public agencies, civil society entities and private individuals in the environmental management process, with joint actions for the preservation and recovery of the environment.
	CONAMA Resolution No. 237/1997	Provides for co-management as a principle of environmental management.
	Law No. 9,795/1999	Provides for the National Policy for Environmental Education (PNEA). • It establishes that environmental education must be carried out in a participatory and democratic, with the promotion of environmental co-management and dialogue between the different sectors of society.
	Law No 9.985/2000	The law establishes the National System of Nature Conservation Units (SNUC). •The law establishes co-management as one of the forms of management of conservation units, in which the government and the community share responsibilities for the management and protection of the unit. •It establishes that co-management must be exercised through an advisory council, with representatives of the government, civil society and owners of properties located in the conservation unit.

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		•Defines the duties of the advisory board, which include approving management plans and the inspection of the activities developed in the conservation unit.
	Law No. 12,305/2010	The law establishes the National Solid Waste Policy; amends Law No. 9,605, of February 12, 1998. •It provides for the adoption of co-management as a form of solid waste management, with the participation of the government, civil society and the business sector. •It establishes that co-management must be implemented through the creation of public consortia, associations of municipalities and other forms of intermunicipal cooperation.
	Law No. 14,026/2020	Updates the legal framework for basic sanitation. It establishes the new regulatory framework for basic sanitation, in which co-management is one of the forms of providing sanitation services, in which the provision of the service is shared between the government and private companies or civil society organizations. Co-management is regulated through program contracts, in which municipalities can delegate the provision of services to the delegate entity, which can be a public company, a municipality or a civil society organization.
	Law No. 14,119/2021	The law institutes the National Policy for Payment for Environmental Services. •It regulates basic sanitation in Brazil, establishing that co-management is one of the forms of management of sanitation services, in which the provision of the service is shared between the government and private companies or civil society organizations.

Source: Prepared by the authors based in Brazil, 1981-2021.

The Brazilian legal framework has made it possible to address the feasibility of co-management according to the laws that regulate environmental areas. CF/88, regulated by laws related to environmental protection and education, provides instruments for the application of co-management in natural resources and extractive reserves.

METHODOLOGICAL PATH

The method used to carry out this article is qualitative, with a bibliographic approach and bibliometric procedure. This method is chosen according to the objective of the article. According to Martins (2004), the qualitative method favors the analysis of micro processes, through the study of individual and group social actions. It is a method that allows for an examination in breadth and depth, treating the units investigated as totalities.

The bibliographic approach allows the ordering of the set of documents in the procedure of searching for solutions and attentive to the object of study, for this reason, it cannot be random (Sasso de Lima, Mioto, 2007, p. 38). This approach allows for a wide range of information, in addition to allowing the use of data dispersed in numerous

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publications, also helping to build the best definition of the conceptual framework that involves the proposed object of study.

The bibliometrics procedure is a technique for measuring the indices of production and dissemination of scientific knowledge, allowing the obtaining of information in an academic area and serves, among other functions, to demonstrate the characteristics related to the scientific production of that area (Oliveira, Boldorini, Martins and Dias, 2016).

COLLECTION AND ORGANIZATION OF DOCUMENTS

The choice of the descriptor *co-management* allowed the collection of documents from the bibliographic approach with the help of the measurement of knowledge production and following methodological procedures and focusing on the search for publications in the environmental area in the period from 2012 to 2021 in the five countries with the highest number of publications (SCOPUS, 2022).

The search for articles in a digital database carried out from the second week of March 2022 to June of the same year. The bibliometric procedure allowed the selection, in the SCOPUS digital database, from the descriptor "co-management".

The selection of documents was carried out in stages: general selection of all areas and longer period, limitation of research to the environmental area, time cut between 2012 and 2021, selection only of academic articles from Qualis A1 and A2. The bibliometric research made it possible to choose the documents in relation to co-management.

The Scopus digital database brings together the publications of international scientific articles produced in several countries around the world, with open and/or restricted access with high relevance of scientific productivity achieved in the result of the publications of the H index and considering only the articles of the Qualis A1 and A2 journals of Capes.

The Capes Journal Portal offers access to full texts available in more than 45 thousand publications of international and national journals, and to several databases that bring together references and abstracts of academic and scientific works to technical standards, patents, theses and dissertations, among other types of materials, covering all areas of knowledge. It also includes a selection of important sources of scientific and technological information that are freely accessible on the *web* (CAPES, 2022).

With a multidisciplinary reach, in 2022, *Scopus* had a very broad database. The web search shows that "*Scopus* had more than 22,000 titles from more than 5,000 publishers

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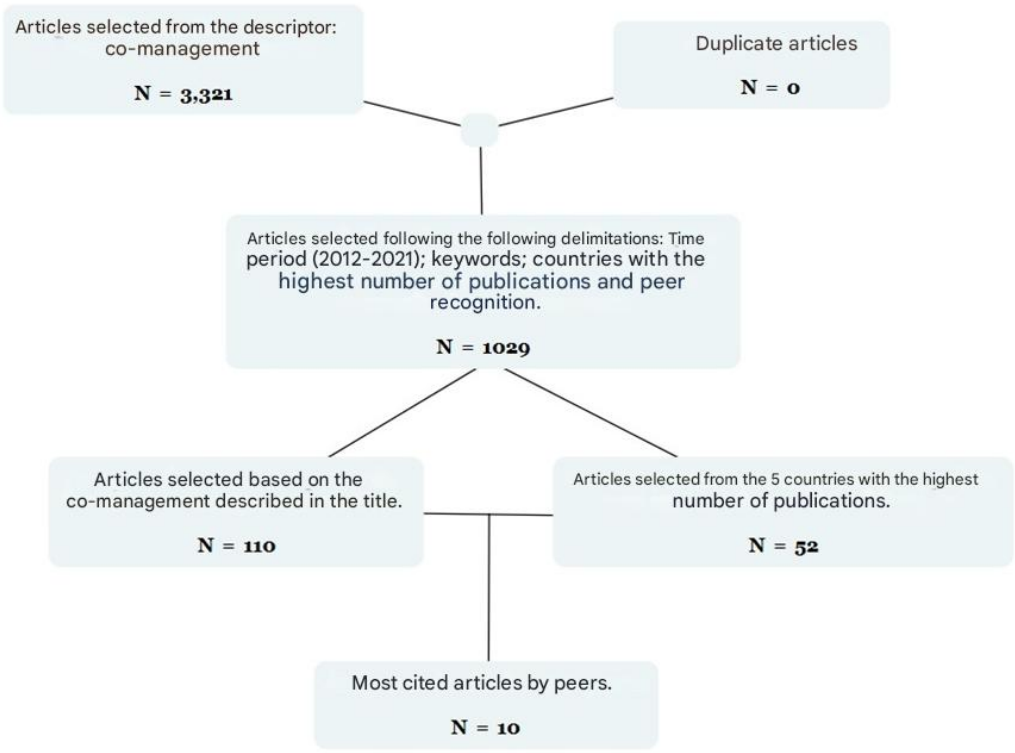
worldwide, covering the areas of science, technology, medicine, social sciences, arts and humanities. In addition, it contains more than 55 million records dating back to 1823, of which 84% have references dating back to 1996." (SCOPUS, 2022).

Image 1- Flowchart of the articles – selection



Source: Prepared by the authors themselves, 2025.

The figure above illustrates the process of exclusion and inclusion of documents in the bibliographic search, an important step for the search in the database. To have a more comprehensive look, the preliminary selection, before filtering the documents according to the established criteria, presented the initial data of 3,321 documents based on the keyword *"co-management*" between the years 1940 and the beginning of 2023. Duplicate articles were not identified.

The selection of inclusion and exclusion from time (2012 – 2021) presented a total of 1029 articles. When the search included the descriptor "*co-management*" in the titles of the articles, 110 articles were identified. The inclusion and exclusion criterion, based on the countries with the highest number of publications, 50 articles were identified. Finally, the selection was carried out from the most cited peer articles, in this last phase 10 articles were identified that served for the preparation of the article.

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The articles extracted from the database were exported to Excel. The titles of the articles and their abstracts and the keywords were read to identify those that are aligned with the research theme. This process resulted in the consolidation of the articles published in the environmental area presented in the following results.

RESULTS AND DISCUSSION

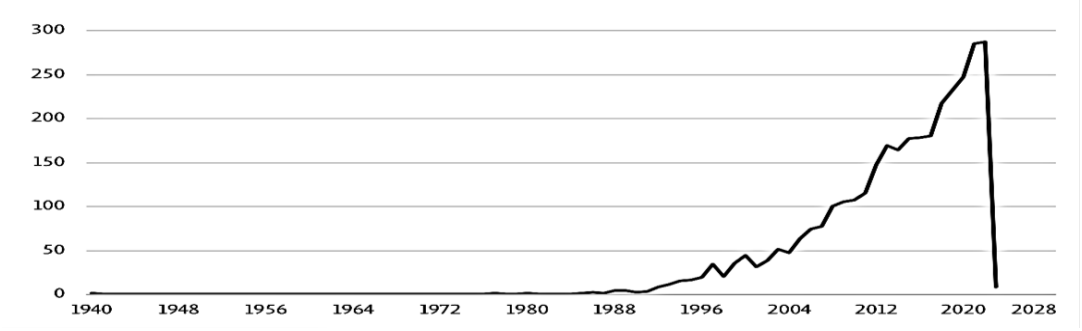
The scientific articles published on the co-management of natural resources available in the Scopus directory present the work since the 1940s. The environmental area is highlighted, representing more than 25% of the publications. Five countries lead these studies on co-management of natural resources: the United States, Canada, Australia, the United Kingdom and Brazil.

The results present, in the context of Brazil, an expanded picture of publications on extractive reserves and areas of environmental protection and artisanal fishing of communities that live depending on natural resources that are scarce. The following are the results of existing studies in the environmental area.

Graph 1 indicates that the variation in publications remains constant over time, with no increase in the number of scientific production until 1988, the year of the promulgation of the Federal Constitution. From the 1990s onwards, there has been a constant growth trend. This is a sign that the theme of co-management of the environment is beginning to interest researchers, since the Magna Carta, in article 225, already recognizes the protection of environmental areas.

The period after the 90s is characterized by widespread interest in the theme of co-management in several countries and in several areas, with the environmental, social, agriculture and health areas being the ones that stand out the most. The following graph shows the evolution of studies on the topic of co-management.

Graph 1 - General results of documents on the theme of co-management of natural resources, with *Scopus database*



Source: Survey data (2022, 2023)

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The result of graph 1 shows the thematic evolution of co-management with the volume of constant publications, that is, without an increase between the years 1940 and 1990. From the 90s onwards, the work gathered on environmental studies with a focus on co-management began to increase. The number of scientific publications in *high-impact journals* with a high H index demonstrates the interest of researchers interested in the topic of co-management.

The analysis of publications on the subject of co-management began to take a leap in the 90s. The scientific consequences In the 1980s, scientific evidence of the consequences of "greenhouse gas" emissions, resulting from human activities, on global climate change inspired a series of international conferences that made evident the urgency of a global Convention or Treaty to address the problem (Goldemberg, 2023, p. 277).

The interest of researchers in environmental issues began to occupy a preponderant place in the research agendas from the discussions on climate change in the period in which the United Nations General Assembly established the Intergovernmental Negotiating Committee for the Climate Convention. The historic milestone is the year 1992, marked by the meeting of the heads of state of the 154 countries in Rio de Janeiro to sign the climate convention that came into force in 1994 and followed by the first COP – Conference of the Parties in 1995 in Berlin.

CO-MANAGEMENT RESULTS FROM THE DECADE 2012 TO 2021

The results found through documentary research on co-management studies allowed us to perceive the advances made in research focused on co-management and to extract pertinent information about the researchers' agenda on current issues in the area of environmental management. The readings of debates on the subject led to the deepening of this debate, following the timeline of the last decade.

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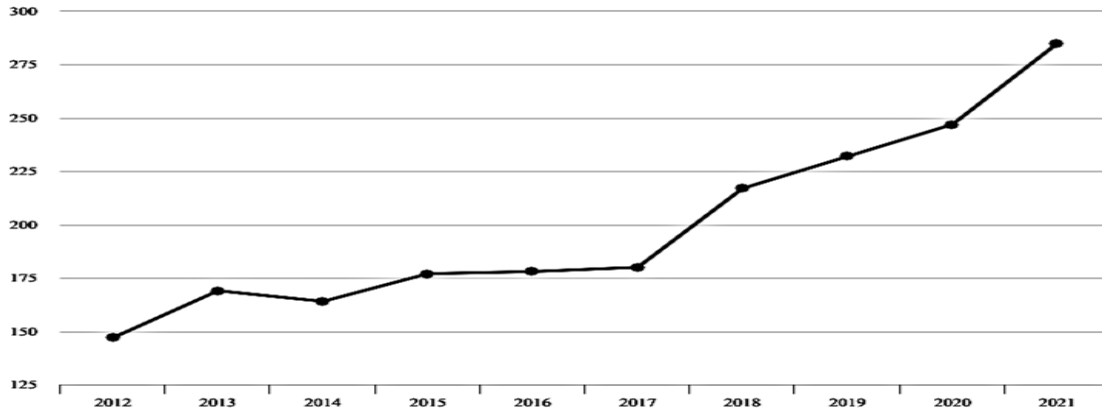
Figure 2 - General results of documents on the topic of co-management between 2012 and 2021



Source: Survey data (2022)

The graph shows the general results of the last 10 years of research on the co-management of natural resources and demonstrates a progressive increase in the number of publications of scientific articles. The works published between 2012 and 2021 follow the ascending order: in 2012, 147 documents were published; in 2013, they published 169 documents; in 2014, there were 164; in 2015, 177 documents were produced; in 2016, they produced 178. In 2017, there were 180 documents published.

In 2018, the number of publications rose to 217 documents; in 2019, they reached 232 documents; in 2020, 247 were reached. The period examined closes in 2021, with 285 documents published. These publications, in significant numbers, manifest the authors' ever-growing interest in investigating the theme of co-management in the environmental area and the efforts of governments to implement environmental public policies.

The interest in climate issues shown by the Parties (governments) in international events such as COP 27 held in Egypt, for example, with the presence of about 40 thousand people, of which about 5000 government agents, manifests the relevance of discussions on the environmental problem that reflects in the increase in scientific publications (Goldemberg, 2023).

RESULTS OF COUNTRIES THAT STAND OUT IN THE CO-MANAGEMENT STUDY

Countries are highlighted by the number of publications in the area of environmental co-management. Five countries stood out for their numbers of scientific articles published during the period under study. The United States of America occupies the first position, with 376 articles; followed by Canada, with 189 articles, and Australia, with 180 articles. In fourth position is the United Kingdom with 144 articles and Brazil in fifth position with 119

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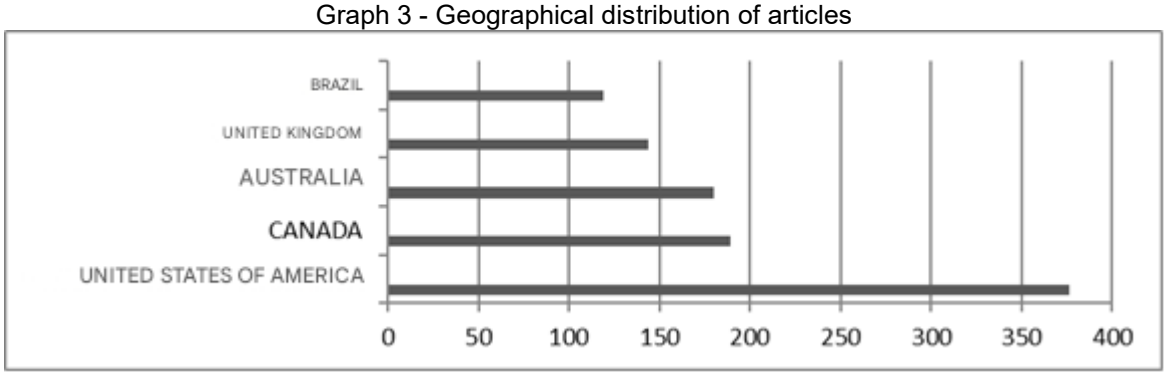
articles. Graph 3 below shows the five countries that have the highest number of publications on co-determination.

Graph 3 - Geographical distribution of articles



Source: Survey data (2022)

The graphic representation reveals the international dimension of environmental co-management work in the decade 2012 to 2021. Five countries stood out due to the volume of scientific production in the area. The graph shows a continental representativeness, except for the countries of Africa and Asia, which are not represented. The three continents included are: America, Europe and Oceania. Environmental co-management studies have the particularity of having greater scope.

The works produced in environmental co-management demonstrate the interest of researchers through the publications in increasing numbers in environmental studies. The period studied will represent a continuous increase in the number of publications compared to previous years. The Conference of the Parties has become an event of great importance in environmental education. The Convention states in the third article that Parties shall protect the climate system for the benefit of present and future generations of humanity on the basis of equity and in accordance with their common but differentiated responsibilities and respective capacities (Goldemberg, 2023).

The results of the environmental area in the United States of America demonstrate the interest that North American researchers have in environmental management. They occupy the first place in the order of the largest publications. They published 195 papers. In 2012, they published 20 articles; in 2013, there were 11; in 2014, there were 16 publications; in 2015, they published 23; in 2016, they published 18 articles. In 2017, there were 11 publications; In 2018, there were 20 articles published and in 2019, there were 24 articles. In 2020, they published 20 articles, and in 2021, they published 32 articles. Graph 4 below shows the variation curve of publications.

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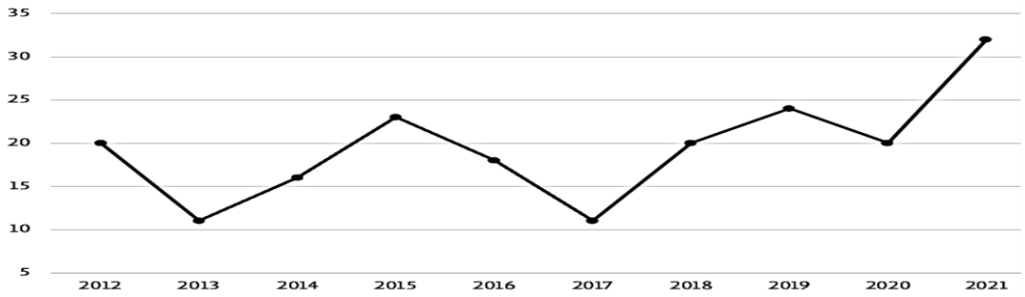
Graph 4 - Environmental results in the United States from 2012 to 2021



Source: Survey data (2022)

Graph 4 represents the results of studies on co-management in the environmental area in the United States in the period from 2012 to 2021. The graph shows a trend of growth in publications in the last five years compared to the previous five. There was an oscillation between 2016 and 2018, years marked by the anti-climatic discourse that characterized the US government and which finally withdrew from the Paris agreements in June 2017.

The United States, with its climate policies, has exercised a leadership in climate discussions as well as in financing the environmental policies of developing countries, but with the advent of Trump to the presidency, all efforts to reduce gas emissions have been abandoned. In the same period, the discourses against the protection of the environment were intensified.

Canada is the second country with the highest number of publications. He is responsible for 117 articles published in the period from 2012 to 2021. In 2012, there were 4 articles. In 2013, they published 7. In 2014, there were 7 publications. In 2015, this number rose to 12 publications. In 2016, there were 15 articles published. In 2017, the number of publications dropped to 6 articles, and then doubled in 2018, when 12 articles were published. In 2019, the number rose to 19 publications and, in 2020, there were 20 publications. In 2021, there were 15 publications.

Canada's National Report on the implementation of the commitments emanating from the Fifth Summit of the Americas demonstrates the country's commitment and rigor in relation to environmental public policies. For example, before releasing any permits, projects involving resources must undergo a thorough environmental and strict regulatory review, where all issues must be addressed prior to permits, in addition, governments also require extensive environmental monitoring and reporting (CANADA, 2009-2010).

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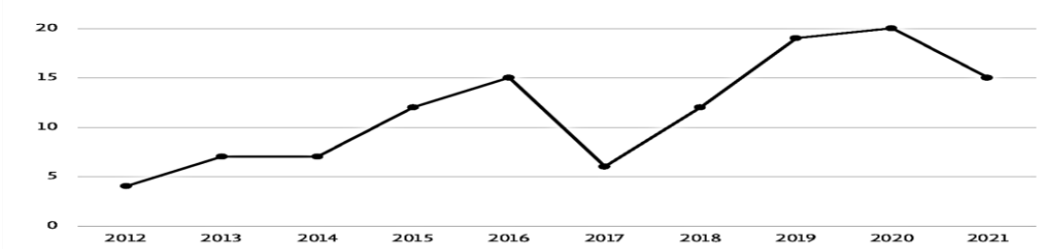
The interest of the State, which promotes and supports public policies, may be one of the reasons for researchers to have an agenda focused on environmental discussions. Environmental licensing, for example, follows strict control by Canadian state institutions.

Graph 5 - Results of Canada's environmental area in the period 2012-2021



Source: Survey data (2022)

Graph 5 represents the results of the environmental area of Canadian publications on the theme of co-management of natural resources. The publications cover the period from 2012 to 2021. The results made Canada the second country with the highest number of studies on environmental co-management. But the graphic representation shows that the year 2017 was characterized by the lowest performance in the production of scientific articles. The year 2021 also saw a drop in the volume of publications on co-management in Canada.

Australia is the third country that has worked a lot on environmental co-management. She is responsible for 116 publications. In 2012, she published 14 articles on co-management in the environmental area, the following year, she published 15 articles. In 2014, the number dropped to 12 published articles. In 2015, there were 13 articles published. In 2016, the number dropped again, 11 articles were published. And, in 2017, the drop was even greater when the number of publications dropped to four articles. In 2018, Australia again published 10 papers, and the following year (2019), it published 18 papers, the highest number of publications achieved. In 2020, 5 articles were published and, in 2021, 14 articles were published. Below is the graph of the results of the publications.

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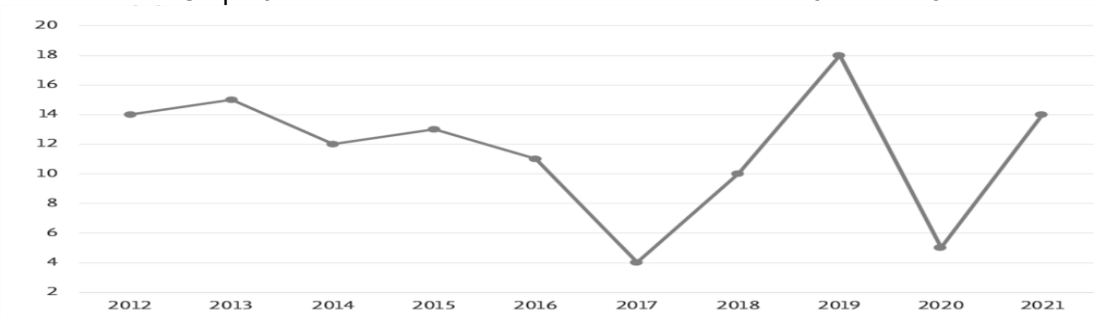
Graph 6 - Australia's environmental results between 2012 and 2021



Source: Survey data (2022)

Graph 6 represents the volume of publications of Australian studies on environmental co-management. This representation shows the oscillation of the results of the research that was developed on the topic of co-management in ten years (2012-2021) in Australia. The first five years were marked by a decrease in the number of publications.

Australia has adapted environmental policies with the adoption of stricter laws, having many instruments, such as environmental protection codes, for example (Dovers, 2013). The advances observed in Australian environmental policies are threatened by the changes that have occurred in recent years (Evans, 2016). The study by Evans (2016) warns that the accumulated gains in terms of laws against deforestation may suffer setbacks due to changes in Australian environmental policies that may lead the country to suffer again from large-scale deforestation at a global level. The graph of the publications highlights the oscillations in the number of publications that may be reflected in anti-environmental policies.

The United Kingdom ranks fourth among the most productive countries in the area of environmental co-management. This country published 106 articles on co-management in the period from 2012 to 2021. In 2012, 4 articles were published. In 2013, there were 10 publications. In 2014, 8 articles were published.

In 2015, the number of publications was 10 articles. In 2016, there were 9 articles published. In 2017, there were 11 articles and, in 2018, 11 articles were also published. In 2019, there were 14 articles published and, in 2020, there were 13 publications. In 2021, there were 16 publications. The following graph shows the results of the publication of the articles.

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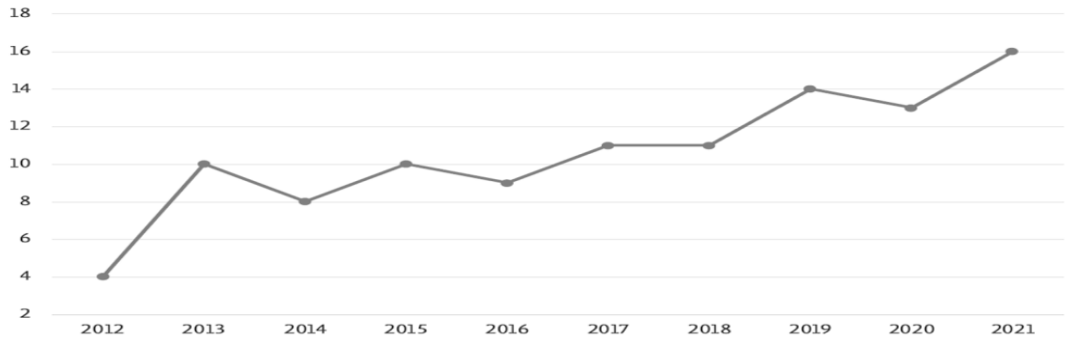
Graph 7 - Results of the United Kingdom's environmental area between 2012 and 2021



Source: Survey data (2022; 2023)

Figure 7 shows publications on environmental co-management in the United Kingdom in the years 2012-2021. This chart demonstrates steady growth in the UK's results. Researchers show an ever-growing interest in co-management in the environmental area. The results show that, after 2017, all publications were above 10 articles per year, this result reflects the dedication of the researchers and their interest in the topic of co-management.

The behavior of the progression of scientific publications reflects the commitment that the British government demonstrates to environmental issues. The results presented at the Conference of the Parties (COP-26), which took place in Glasgow, United Kingdom, in November 2021, focused on the Glasgow Climate Pact. Developed countries are committed to supporting developing countries in various aspects (financial, technological, ...) in tackling climate problems and implementing the Paris agreements to reduce global warming.

Brazil is the fifth country that presented the good performance in publications on environmental co-management. He was responsible for 55 articles published between 2012 and 2021. The annual performance is presented in such a way that, in 2012, an article was published. The following year, they published 3 articles. In 2014, the number of publications reached 7 articles. And, in 2015, 6 articles were published. In 2016, the number of publications dropped, only one article was published. After that year, the publications began to increase. In 2017, there were 3 articles published. In 2018, there were 8 articles; in 2019, they published 5; in 2020, they published 9 and, in 2021, there were 12 publications. The following graph shows the variations in publications on co-management in the environmental area in Brazil.

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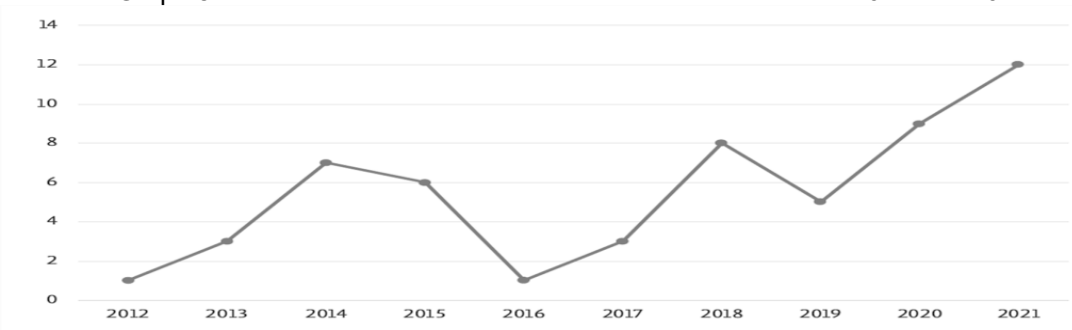
Graph 8 - Results of the environmental area in Brazil between 2012 and 2021



Source: Survey data (2022)

Graph 8 represents the results of co-management in the environmental area in Brazil, considering the decade from 2012 to 2021. The graph shows a drop in production between 2014 and 2016. From 2017 onwards, the numbers began to rise until reaching 12 scientific articles published in 2021.

Environmental Public Policies in Brazil were strongly impacted by the political-administrative crises, which culminated in the *impeachment* of President Dilma Rousseff in 2014 (Garcia *et al.*, 2020). The new management established established a political-institutional change in the Executive Branch, which had repercussions on the Education and Environment Portfolios.

It is emphasized in the supplementary research that Brazil has an environmental legal framework and instruments that allow environmental protection. The Federal Constitution of 1988 enshrines environmental protection, as well as successive environmental laws. The Water Code (Decree 24.643/1934) and the Forest Code (Decree 23.793/1934), instituted in 1934, demonstrate this interest in caring for and protecting the environment.

The results of publications in Brazil in the decade from 2012 to 2021 occupy the fifth and last position among the countries analyzed. The small number of publications in the environmental area demonstrates the crisis that exists in government environmental protection programs. The headline of ZEROHORA, for example, reported in 2019: "Bolsonaro government promotes shift in environmental policy and expands space for agribusiness" (Ferras, 2019). The environmental area was weakened with the change in inspection mechanisms and the application of fines for environmental crimes.

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A LOOK AT THE ENVIRONMENTAL CRISIS IN THE BRAZILIAN AMAZON

Article 03 of the new Forest Code delimits the territory of the legal Amazon to the "States of Acre, Pará, Amazonas, Roraima, Rondônia, Amapá and Mato Grosso and the regions located north of the parallel 13° S, in the States of Tocantins and Goiás, and west of the meridian of 44° W, in the State of Maranhão" (Brasil, 2012).

The territory thus delimited and legally named as the Legal Amazon has been facing numerous environmental crises such as illegal deforestation, illegal mining, among others. Silva *et al* (2019, pp. 604-605), in their study "From the global to the national context: evolution of Brazilian environmental policy", present in table 03 the government actions under the guidance of the new environmental policy. Such actions aim to dismantle environmental public policies, with the main point being "the weakening of the Ministry of the Environment from measures that led to the reduction of the portfolio" (Silva, 2019, p. 605).

Among other reasons for this crisis, the conflict of economic and environmental interests that lead actors to attack the existing legal framework for environmental protection can be highlighted. It is noted that in Brazil, for example, environmental policies have been attacked by governments that have started to prioritize economic issues without measuring environmental impacts and environmental consequences.

Between 2012 and 2017, environmental co-management studies fell. This period coincides with the discussions of the reformulation of the Forest Code that originated a new Forest Code (Law 12.651/2012). The new code was considered a setback in environmental protection laws, as it reduced the areas of permanent preservation and the possibility of granting amnesty to those who deforested.

Articles 3 and 59 of this new code (BRASIL, 2012) are an example of what can be considered a setback in environmental law. The Brazilian Amazon region suffers the greatest consequences of the relaxation of the new Forest Code with ever-increasing deforestation and illegal mining activity. The following table shows the advance of deforestation in the Amazon.

Table 2 - Number of alerts and deforested area per year in the legal Amazon

Legal Amazon	Number of alerts	Deforested area (ha)
2019	51.154	989.358
2020	73.668	1.188.522
2021	61.257	1.315.797
Total	186.079	3.493.677

Source: Extracted from the Annual Deforestation Report – RAD (2023).

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The effects of the new forest code may be reflected in the Annual Deforestation Report (RAD), which shows the advance of deforestation between the years 2019 and 2022. This period was marked by changes in environmental legislation, crises and conflicts related to the environment and the reduction of resources allocated to the environmental area. This situation has worsened due to the actions of the government, which has not prioritized the environment and has focused its greatest efforts on heating up the economy.

Finally, the results found on co-management in the environmental area in the five countries show a progressive evolution in the decades from 2012 to 2021. This evolution has faced many obstacles in the United States of America, as well as in Brazil due to the political and institutional changes that countries have adopted against environmental policies. The variations observed in the graphs highlight the good performance of countries that have promoted environmental public policies in the fight against the climate crisis. The constancy and/or evolution of publications in the environmental area reinforce the efficiency of the environmental policies of the countries that promoted the preservation and financing of environmental programs.

FINAL CONSIDERATIONS

The results presented from the publications of scientific articles in the area of environmental co-management represent the largest volume of scientific work productions compared to other areas. Environmental sciences are responsible for 25.8% of all publications in the last decade. Other areas, such as social sciences, agriculture, biology, and medicine, stand out as the top four areas that occupy the researchers' agenda.

Global climate change brings together environmental researchers in the same direction to produce studies that can support decision-makers, that is, stakeholders to support their measures to fight climate warming and deforestation of forests. Based on scientific evidence, the heads of governments met in the early 90s to discuss the climate crises. Scientific evidence on the global climate crisis led the UN summit to create the Conference of the Parties – COP in 1992.

The interest of researchers in the environmental area is justified by the importance of emerging environmental issues that have gained a lot of prominence since the 90s, a period marked by the first Conference of the Parties – COP in 1995 in Berlin. The United Nations – UN has given a preponderant place to environmental issues. Climate warming and the impacts of deforestation of forests in various regions of the world have aroused the

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concern of many leaders; they have adopted measures to reduce the risks of CO2 in the atmosphere. The Sustainable Development Goals outlined by the UN agenda for 2030 clearly manifest the UN's commitment to strengthening the fight against climate warming.

The results obtained from publications in the environmental area demonstrate an oscillation in the production of academic works in some countries, such as Brazil, for example. This fact is explained by the behavior adopted by some government leaders who ignored the current climate threats and problems. In Brazil, the head of government has belittled the problems of the environment with economic policies that boost agribusiness to the detriment of the environment, thus causing accelerated deforestation. In the United States of America, in 2017, the president withdrew the country from the Paris agreement.

Other practices against the environment were the combat and rejection by denialist leaders of the data of research entities, such as the National Institute for Space Research - INPE, for example, whose data were contested by the Brazilian government in 2019.

Contrary to this objective of combating the climate crisis, populist leaders have developed actions to attack the environment. This is one of the hypotheses that justifies the drop in publications in the environmental area. Future research should investigate whether there is a direct relationship between combating the crisis and the policies adopted by anti-climate leaders.

ACKNOWLEDGMENT

The authors thank CAPES for the financial support through scholarships, which are fundamental for the development of this research and for academic training.

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