Priority areas in the implementation of Payment for Environmental Services schemes: A scientometric analysis

Luana Pessoa Genuino
Master's student in Environmental Management, IFPE, Brasil.
lpg@discente.ifpe.edu.br

Sofia Suely Ferreira Brandão Rodrigues
PhD Teacher, IFPE, Brasil.
sofiabrandao@recife.ifpe.edu.br

Ioná Maria Beltrão Rameh Barbosa
PhD Teacher, IFPE, Brasil
ionarameh@recife.ifpe.edu.br

Vania Soares Carvalho
PhD Teacher, IFPE, Brasil
vaniacarvalho@recife.ifpe.edu.br

ABSTRACT

Payment for Environmental Services schemes and programs emerge as economic instruments that aim to complement command and control instruments in environmental management. Due to their relevance and the need for allocation in places that can have the best performance, because they have a counterpart in financial resources, which are also scarce, research for the selection of priority areas is extremely important. To support researchers who aim to explore the line of research related to payment for environmental services, scientometric analysis presents the state of research in the area with measurement and quantitative analysis of bibliometric data, guiding the main sources and authors of reference and geolocating the scientific productions related to the subject. In the present research, a scientometric analysis and literature review was carried out with data from the Scopus and Web of Science databases, unifying the databases and analyzing the bibliometric information through the R-bilbiometrix interface, resulting in images, graphs, tables and maps that allowed an analysis of the state of the art and scientific research on the proposed theme. With the results, it was possible to observe the need for further studies on methodologies for selecting priority areas for PES schemes, as it is a fundamental tool for sustainable development

PALAVRAS-CHAVE: Scientometrics. Bibliometrix. Payment for environmental services. Mathematical analysis. Literature review.

1 INTRODUCTION

Interest in the protection of ecosystems and the benefits obtained from them has been increasing since the Millennium Ecosystem Assessment, which provided scientific information on changes in ecosystems and their influence on human well-being (COELHO et al., 2021a). According to the Millennium Ecosystem Assessment (MEA) (2005), approximately 60% (15 out of 24) of the ecosystem services examined are being degraded or used in an unsustainable manner, as human activities are depleting the Earth's natural functions, leaving the sustainability of future generations uncertain. The total costs of the loss and degradation of these ecosystem services are difficult to measure, but the available evidence demonstrates that they are substantial and increasing (MEA, 2005).

Faced with the enormous challenge of recovering ecosystem services, the Payment for Environmental Services (PES) programs have been highlighted as an alternative political strategy for the management and management of natural resources, which aims to ensure the provision of environmental services through monetary remuneration to those who work in environmental preservation (FIDALGO et al., 2017; LOMBARDI, 2013). PES is characterized by being an economic instrument that has been recognized as innovative due to its character as a financial incentive related mainly to the remuneration of those individuals who produce positive externalities and adopt good environmental management practices.

As it is considered an important economic instrument for environmental management, Law No. 14,119, of January 13th, 2021, was instituted at the Federal level, defining concepts, objectives, guidelines, actions, and implementation criteria related to PES and has currently been on the agenda of working groups, according to Ordinance GM/MMA No. 778, of October 5th, 2023, in order to better direct the use of the PES instrument in the maintenance, recovery or improvement of ecosystem services throughout the national territory (BRASIL, 2021; BRASIL, 2023).

However, for the purpose of using the PES economic instrument, several steps are essential, such as choosing priority areas for the implementation of PES schemes (GJORUP et al., 2016; CAMPANHÃO, 2017; PICHARILLO; RANIERI, 2019). Wang et al. (2022) point out that the effectiveness of PES regimens is currently low. Research on the prioritization stage of PES areas is scattered, fragmented, with methodological inconsistencies and a lack of systematization of implementation methodologies (GJORUP et al., 2016; TESSITORE et al., 2022), so that there is a need to collect and map scientific information, at the national and international levels, that address the priority areas in PES schemes and the advancement in the scientific environment in order to subsidize projects that aim to implement PES in order to obtain maximum additionality in relation to the results and point out paths for improvement subsidizing new studies.

A tool for the purpose of data analysis in the scientific field is scientometrics, which brings to light the state of the art of a given theme, being an effective tool that seeks, from a bibliographic survey, the construction and analysis of the quantitative aspects of science (CAMARGO; BARBOSA, 2018). Thus, it is conceptualized in the field of Information Sciences as a way to understand and measure scientific progress with an analysis of the whole and based on bibliometric indicators (PARRA et al., 2019). Thus, in order to understand the current situation of scientific research related to the theme "priority areas in the implementation of payments for environmental services", the present work presents a scientometric survey and literature review, aiming to observe the reality of the research, visualization of gaps and, in the end, indicate trends and need for more related research.

2 METHODOLOGICAL PROCEDURES

The methodology described and used in the present study was based on a scientometric analysis. The databases used to capture scientific documents were Scopus and Web of Science (WoS), as they are databases with wide coverage in the availability of scientific documents, reliability in the academic environment and reliable available metrics. Table 1 show the results of the searches in the Scopus and Web of Science databases.

Table 1 - Results of searches in the Scopus and Web of Science databases.

Database	Keywords	Documents returned
Scopus	(TITLE-ABS-KEY (*"Payment for environment* service*"*) OR TITLE-ABS-KEY (*"Payment for ecosyst* service*"*) AND TITLE-ABS-KEY (*"priorit* area* "*)	33
Web of Science	"Payment for environment* service*" (Topic) OR "Payment for ecosyst* service*" (Topic) AND "priorit* area* " (Topic)	340

Source: Prepared by the authors.

The words used in the search were refined to search in the title, keywords and in the abstract of the publications, aiming to search for documents in which the main focus of the

research was the theme of Payment for Environmental Services, addressing the priority areas for its implementation. There was no refinement in relation to the other parameters returned in the survey. The documents found date from the year 2000 to the year 2022, totaling, in both databases, 365 documents. Data collection was carried out in September 2022, and the final search was carried out on September 23rd, 2022.

With the result of the search, all the returned documents were selected and exported to the BibTex format, selecting all the available data for export purposes.

The results of the research were imported and processed by the Bibliometrix tool, a package for the R programming language, used for scientometric analysis and generation of quantitative data and statistical analyses and analyses to be presented in the results of the research.

To access Biblioshiny®, contained in the bibliometric tool Bibliometrix (ARIA; CUCCURULLO, 2017) the R and RStudio software were used, installed according to the orientation of the Bibliometrix website. The files from Scopus and Web of Science were compiled into a single file, the duplicate documents deleted, resulting in a unified database to be analyzed in Biblioshiny®.

Data analysis was supported by a literature review on the importance of the indices and the relevance of the researched theme.

3 RESULTS

The methodological flowchart with the steps developed are presented in Figure 1.

Figure 1 - Flowchart of the applied methodology.
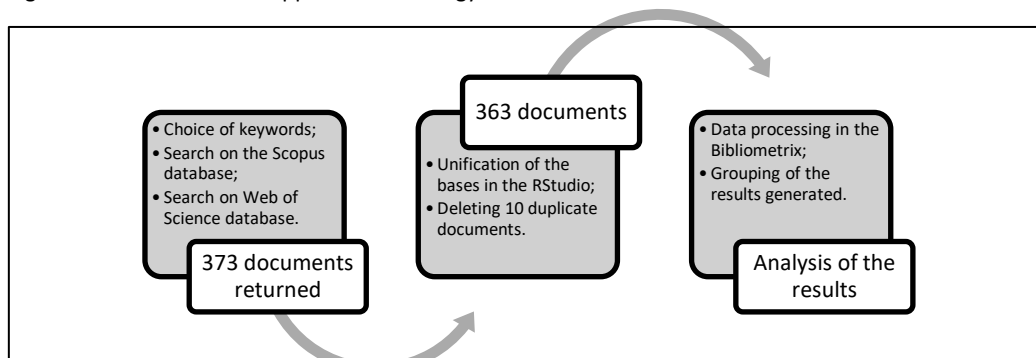
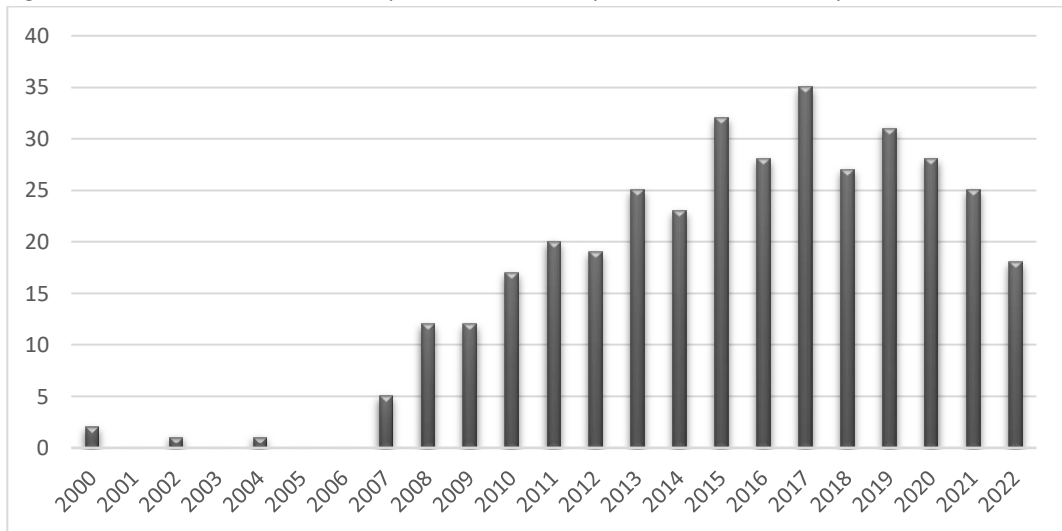Source: Prepared by the authors, 2022.

The scientometric characterization of the 363 documents found according to the methodological parameters adopted reflects that 328 (90.35%) documents are scientific articles, 1 (0.27%) is a book chapter, 3 (0.82%) are editorial materials, 15 (4.13%) are procedural papers, and 16 (4.40%) are book and article reviews. Most of the documents were published in English, representing 316 (87.05%), followed by 26 (7.16%) in Portuguese, 17 (4.16%) in Spanish, 2 (0.55%) in French, 1 (0.27%) document had versions in Portuguese and English and 1 (0.27) in Spanish and English. The returned publications date from the year 2000 to September 2022, with

an average citation per document of 27.4 per year. The analyses were made based on the results processed by Bibliometrix, which were ordered and grouped according to topics and related information for a better global analysis of the state of the art of the theme.

Figure 2 show the annual scientific production since the first records found in the databases. Regarding the production of the year 2022, it is considered only demonstrative, since at the time of data collection more documents may be published in relation to the researched theme in the subsequent months.

Figure 3 show, in a single graph, the year of publications associated with the authors and the most used keywords in the documents whose theme addresses priority areas for payments for environmental services.

Figure 2 - Evolution of annual scientific production from the year 2000 to the current year 2022.

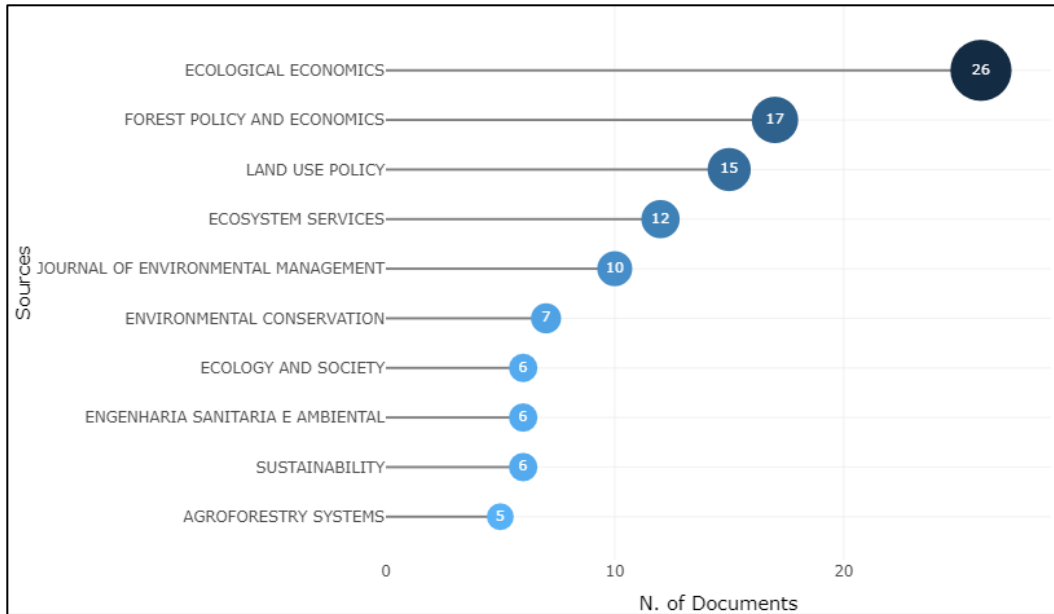Source: Prepared by the authors, 2022.

Figure 3 - Graph of three fields showing cited references (CR), authors (AU) and authors' keywords (DE).
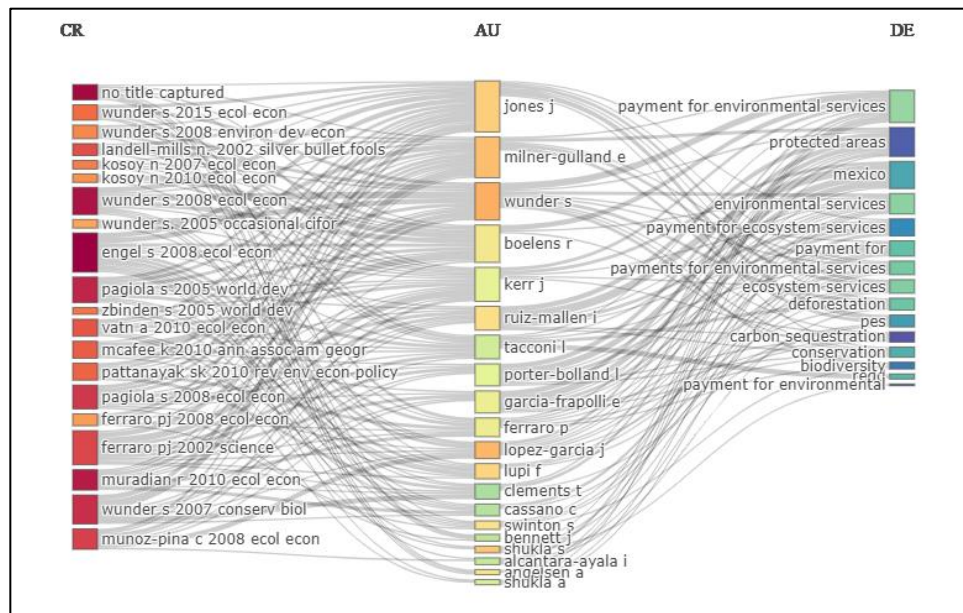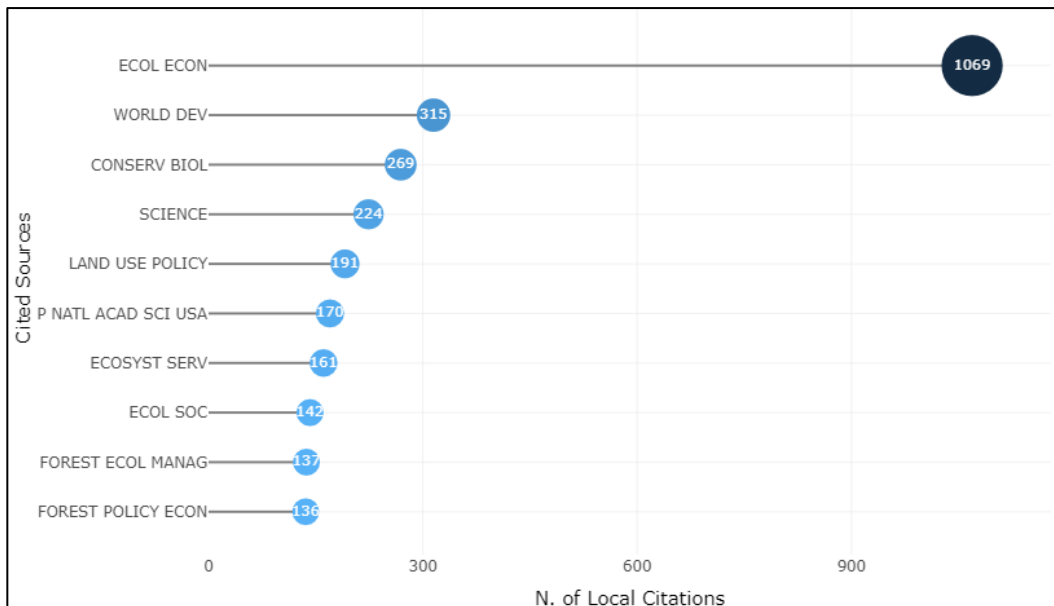
Source: Prepared by the authors, 2022.

Figures 4 and 5 shows the 10 most relevant sources of publication on the proposed theme and the number of citations of the documents returned from each magazine, noting that they are not the same in the two Figures, which will be discussed in this article.

Figure 4 - Most relevant sources of publication on the subject and number of documents published.

Source: Prepared by the authors, 2022.

Figure 5 - Most cited sources and quantification of citations.

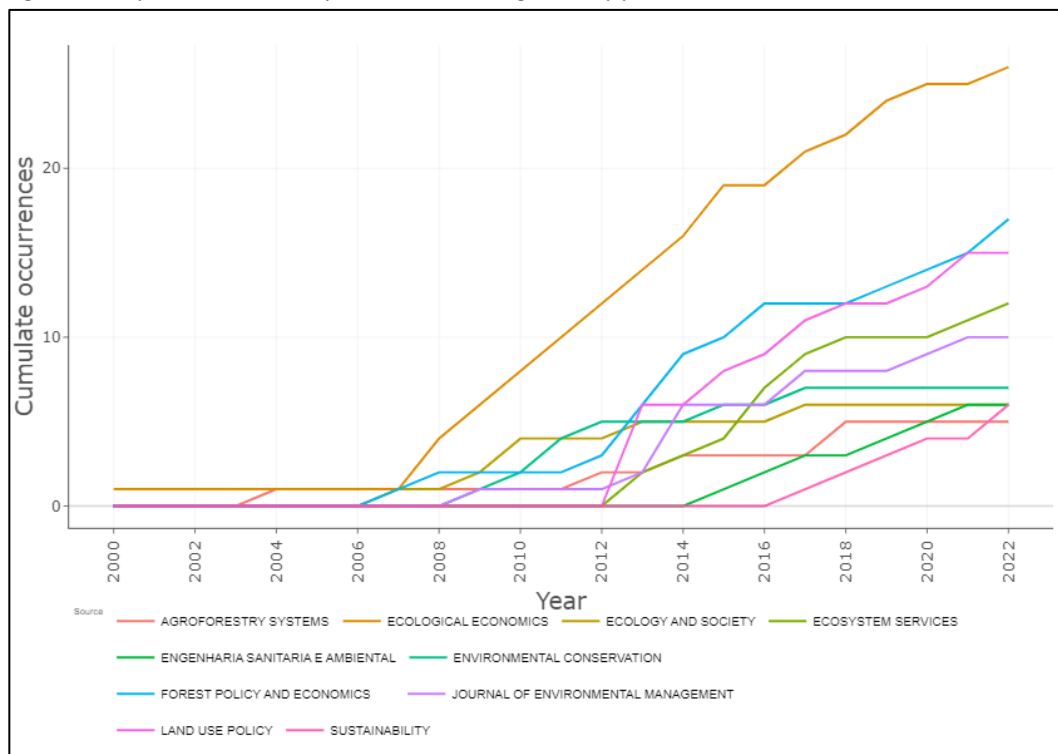Source: Prepared by the authors, 2022.

Figure 6 presents a representative graph of the 10 sources that have the greatest impact through the measurement of the H Index and Figure 7 show the citation dynamics of the 10 sources that grew the most cumulatively between the years 2000 and 2022.

Figure 6 - Source Impact by H Index.

Source: Prepared by the authors, 2022.

Figure 7 - Graph of the citation dynamics of each magazines by year.

Source: Prepared by the authors, 2022.

Figures 8, 9 and 10 shows the 10 most relevant authors from the perspective of measuring the highest number of productions per author, most cited documents per author and author impact measured by the H Index.

Figure 8 - Authors most relevant to the researched theme.
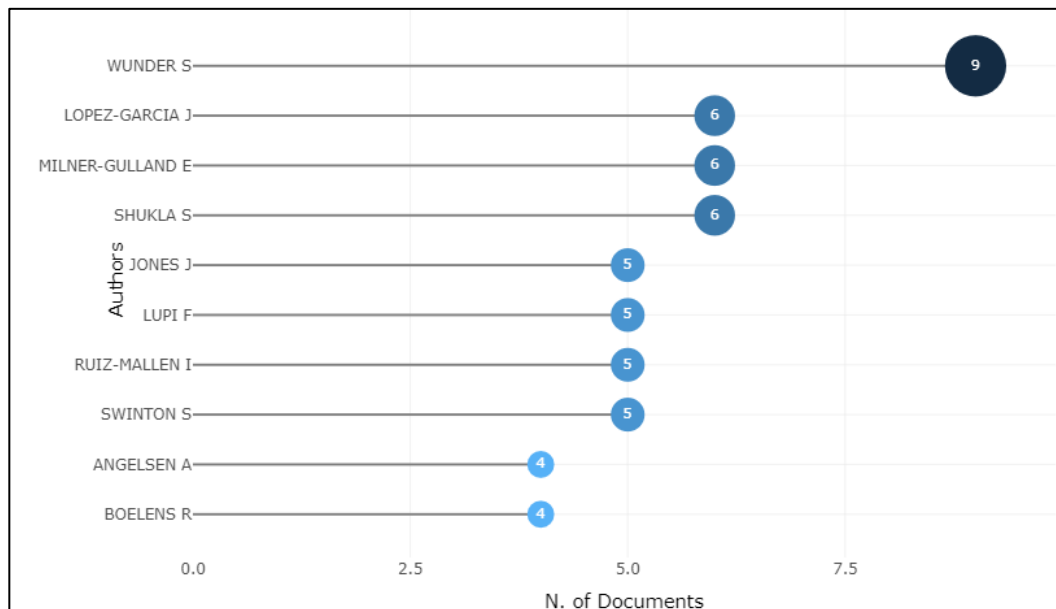
Source: Prepared by the authors, 2022.

Figure 9 - Most cited documents by author.

Source: Prepared by the authors, 2022.

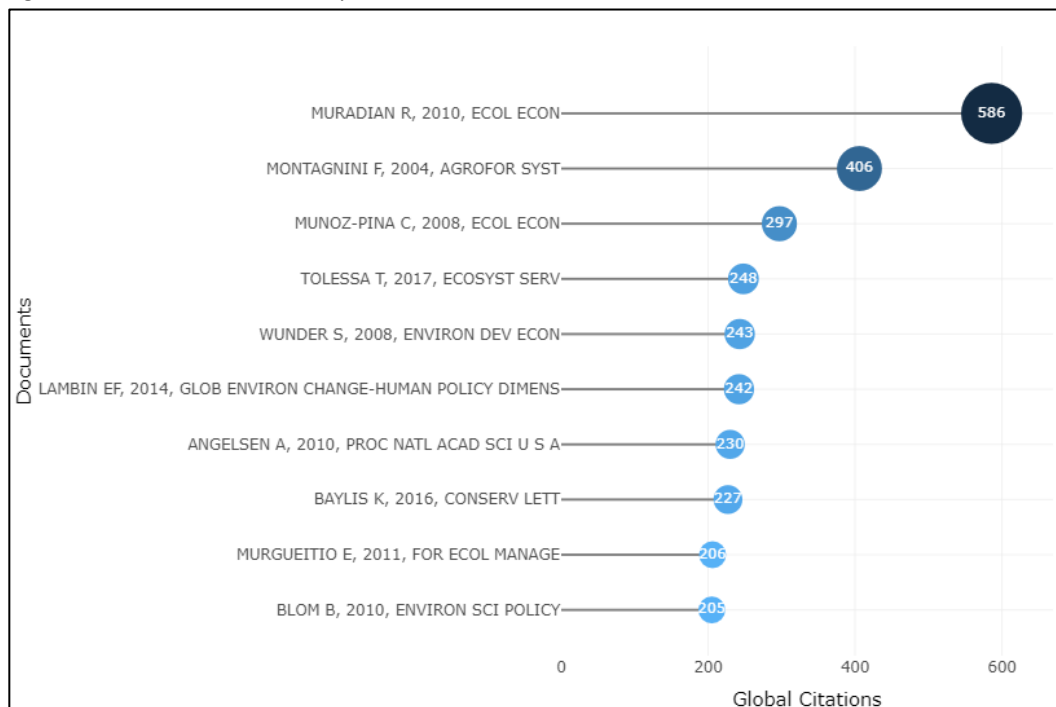Figure 10 - Impact of authors by the H Index in 2022.
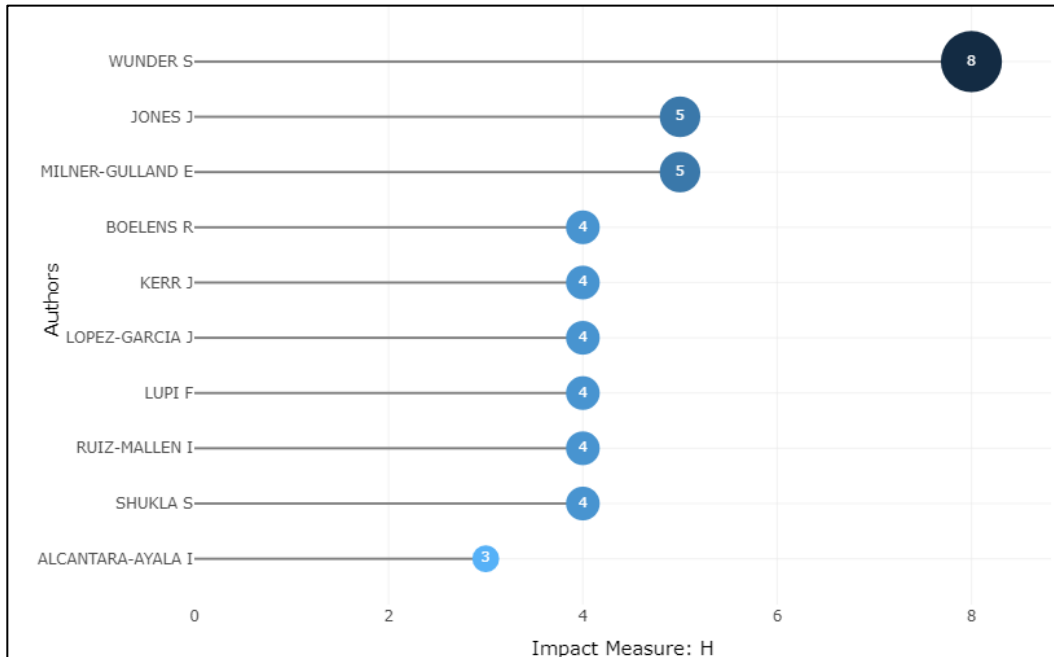
Source: Prepared by the authors, 2022.

Figure 11 show the 10 institutions with the highest number of publications by affiliated authors, such as universities, research institutions where the authors report the sources of publication.

Figure 11 - Most important affiliations.

Source: Prepared by the authors, 2022.

Figure 12 graphically presents, in map format, the collaboration networks between the countries related to the publication of the proposed theme. In Figure 13, the word cloud represents the most commonly used terms in publications, and the larger the word, the more often it is found.

Figure 12 - World map with the countries that publish the most and their collaboration networks.

Source: Prepared by the authors, 2022.

Figure 13 - Word cloud.

Source: Prepared by the authors, 2022.

4 DISCUSSION

In Brazil, although many of the payment projects for environmental services have been implemented in recent decades, there is still a gap in relation to the methodologies for the selection and implementation of priority areas, with a lack of information on the subject (TESSITORE et al., 2022).

Figure 2 show a more significant growth in research related to PES priority areas from 2007 onwards, following the implementation of schemes in Mexico in 2003 (RODRIGUES-ROBAYO et al., 2016), Costa Rica (SÁNCHEZ-AZOFEIFA et al., 2007), Brazil (JARDIM; BURSZTYN; 2015), among other countries. The analysis of the growth of publications reflects both an increase in the implementation of PES schemes in the world, as well as the need to understand methodologies in the choice of areas for implementation of PES schemes, since it is not only a promoter of improvement in the provision of environmental services, but also an economic instrument of environmental management that promotes economic and social improvement in the contemplated area with a focus on sustainable development (TÁVORA et al., 2018).

Figure 3 show the keywords most used to portray the theme in descending order of frequency: a) payment for environmental services, b) protected areas, c) Mexico, d) environmental services, among others in less frequency, such as carbon sequestration and conservation, allowing us to observe the authors of the authors' reference of the initial publications on the subject.

Figure 4 presents a source of analysis of the 10 main magazines that publish the theme, highlighting two magazines "Ecological Economics" and "Forest Policy and Economics", which publish environmental themes in the light of economics, with strong adherence to PES, since it is an economic instrument that seeks to assist the command and control instruments already known in the protection of the environment. Figures 5 and 6 presents the 10 most relevant sources of publications under different information science metrics, the first the number of citations of articles published by the magazine and the second through the H Index, which measures the impact and relevance of the publication source or author (CANDELA-SOTO, 2021). The magazine "Ecological Economics" appears as the reference magazine in all analyses related to source metrics, showing an increase in PES publications over the years (Figure 7), while other magazines shows oscillations in relation to the position of relevance in the analyses of data origin, hence the need for analysis in conjunction with the H Index and number of citations, because a large number of publications does not necessarily result in the quality and importance of the content worked on (SILVA E BIANCHI, 2001; CAMARGO E BARBOSA, 2018).

Still focusing on productivity, scientometrics, in addition to measuring and analyzing the productivity and impact metrics of magazines, brings to light the importance of the most relevant authors in a given area of research, calculating representativeness in terms of scientific performance and impact on the academic community. Figures 8, 9 and 10 shows that the most cited author is not always the most relevant in the proposed area, the work by Muradian et al. (2010) published in the magazine "Ecological Economics" presents a large number of citations in other scientific works due to its basic article content for understanding the concepts of PES, however, "Wunder" results as the author of greater relevance when analyzed together with other metrics, the largest number of published documents and the H Index, both are references

when it comes to seminal articles in PES studies, presenting key concepts for the understanding of the subjects.

Another important aspect of scientometric analyses is the identification of the affiliations and institutions to which the authors belong, which characterizes a nucleus of studies of a given theme, such information is a facilitator for researchers interested in getting in touch with the research groups and becoming aware of the progress of the research developed. Figure 11 show the 10 institutions with the highest number of published studies in which the authors are linked. Figure 12 represents the main countries with publications in the area of PES according to color intensity, with emphasis on South America and North America, and their research collaboration networks, which is extremely important, as it means that research groups collaborate with each other at a global level and engage in the improvement of research related to the theme of priority areas of PES.

Figure 13 is a representation of the keywords related to the publications returned in the scientometric search. The larger the word in the word cloud, the higher the frequency in searches and the greater the importance of the topic. In the search for priority areas of PES, the most common word is "conservation", since conservation is really the strongest objective of the implementation of PES in environmental management, through payments to environmental service providers, promoting actions that preserve biodiversity in forests with the reduction of deforestation. Thus, the word cloud reflects the objectives, location, practices and essence of the subjects studied through the words arranged, complementing the other metric analyses that are important to the global understanding of the research theme and objectively results in the understanding of the importance of scientometric analyses as a subsidy for new research and development of public policies.

5 CONCLUSION

Although methodological research aimed at selecting priority areas for the implementation of PES schemes is extremely important, the theme is still little explored, given its importance in environmental management and environmental services. It is necessary that more research on the subject of payment schemes for environmental services be developed in relation to the most important stage of a PES project, the stage of selection of priority areas, since it is what will define the success or failure of the scheme.

Although the data found were sufficient for scientometric analyses and conclusions about the path to be taken in the development of research, articles still address themes about the need for further studies, PES concepts, and planning and implementation stages.

The data presented two moments of PES research, from the year 2000 to the year 2006, when the first PES schemes were being implemented and tested, emerging to visibility, and from the year 2007 to the year 2022, when the greater importance of ecosystem services and the need for maintenance around the world is perceived. Thus, with the realization of the great importance of PES schemes for the purpose of achieving global environmental goals, such as the SDGs of the 2030 Agenda, for example, more studies on priority areas should be conducted in order to allocate financial resources in order to maximize positive environmental results.

In Brazil, as a potential example for such studies, with the institution of the Payment for Environmental Services law, a range of possibilities and the need for further studies in the various biomes and for the conservation of the most diverse ecosystem services is opened, since the methodologies must be in accordance with the needs of the place and using criteria specific to the proposed objective.

6 REFERENCES

ARIA, M., CUCCURULLO, C. Bibliometrix: An R-tool for comprehensive science mapping analysis. **Journal of Informetrics**, v. 11, n. 4, p. 959-975, 2017.

BRASIL. Lei nº 14.119, de 13 de janeiro de 2021. Institui a Política Nacional de Pagamento Por Serviços Ambientais; e altera as Leis nº 8.212, de 24 de julho de 1991, 8.629, de 25 de fevereiro de 1993, e 6.015, de 31 de dezembro de 1973, para adequá-las à nova política. **Diário Oficial da União**: seção 1, Brasília, DF, 13 jan. 2021. Disponível em: https://www.in.gov.br/en/web/dou/-/lei-n-14.119-de-13-de-janeiro-de-2021-298899394. Acesso em: 16 set. 2022.

BRASIL. Portaria nº PORTARIA GM/MMA Nº 778, de 5 de outubro de 2023. Órgão: Ministério do Meio Ambiente e Mudança do Clima/Gabinete da Ministra. Institui Grupo de Trabalho - GT PSA para elaborar proposta de Decreto para regulamentação da Lei nº 14.119, de 13 de janeiro de 2021. PORTARIA GM/MMA Nº 778, DE 5 DE OUTUBRO DE 2023, Brasília: **Diário Oficial Da União**, ano 2023, 5 out. 2023. Disponível em: https://www.in.gov.br/en/web/dou/-/portaria-gm/mma-n-778-de-5-de-outubro-de-2023-515384533. Acesso em: 12 out. 2023.

CAMARGO, L. S.; BARBOSA, R. R. Bibliometria, cienciometria e um possível caminho para a construção de indicadores e mapas da produção científica. **Ponto de Acesso**, v. 12, n. 3, p. 109-125, 2018. DOI: 10.9771/rpa.v12i3.28408 Acesso em: 16 set. 2022.

CAMPANHÃO, Ligia Maria Barrios. **Identificação de áreas prioritárias para a implantação de esquemas de Pagamento por Serviços Ambientais hidrológicos**: uma proposta metodológica. 2017. 331 p. Dissertação (Mestrado) - Escola de Engenharia de São Carlos, [S. l.], 2017.

CANDELA-SOTO, A. Influencia del Índice H en la medición de investigadores y revistas. **ITECKNE**, v. 18, n. 2. p. 97, 2021.

COELHO, N. R.; GOMES, A. S.; CASSANO, C. R. Como se paga pelo serviço ambiental hídrico? Uma revisão das experiências brasileiras. **Desenvolvimento e Meio Ambiente**, v. 56, p. 139-157, 2021.

FIDALGO, E. C. C.; PRADO, R. B.; TURETTA, A.P.D.; SCHULER, A. E. **Manual para pagamento por serviços ambientais hídricos: seleção de áreas e monitoramento.** 1. ed. Brasília, DF: Embrapa, 2017. p. 30-49.

GJORUP, A. F.; FIDALGO, E. C. C.; PRADO, R. B.; SCHULER, A. E. Análise de procedimentos para seleção de áreas prioritárias em programas de pagamento por serviços ambientais hídricos. **Revista Ambiente & Água**, v. 11, n. 1, p. 225, 2016.

JARDIM, M. H.; BURSZTYN, M. A. Pagamento por serviços ambientais na gestão de recursos hídricos: o caso de Extrema (MG). **Engenharia Sanitária e Ambiental** [online]. 2015, v. 20, n. 03 [Acessado: 1 outubro 2022], pp. 353-360. Disponível em: <https://doi.org/10.1590/S1413-41522015020000106299>.

LOMBARDI, Daniela. **Pagamento por Serviços Ambientais pelo custo de oportunidade da terra utilizando o Sistema de Informações Geográficas**. 2013. 189 f. Dissertação (Mestrado em Engenharia Civil) - Universidade Federal de Santa Catarina, Florianópolis, 2013. Disponível em:

https://repositorio.ufsc.br/handle/123456789/122671. Acesso em: 20 abr. 2022.

MILLENNIUM ECOSYSTEM ASSESSMENT (MEA). **Ecosystems and Human Being – Synthesis**. Washington: Island Press; 2005.

MURADIAN, R., CORBERA, E., PASCUAL U., KOSOY N., MAY P. H. Reconciling theory and practice: an alternative conceptual framework for understanding payments for environmental services. **Ecological Economics**. v. 69, n. 6, p. 1202-1208, 2010.

PARRA, M. R.; COUTINHO, R. X.; PESSANO, E. F. C. Um Breve Olhar Sobre a Cienciometria: Origem, Evolução, Tendências e sua Contribuição para o Ensino de Ciências**. Revista Contexto & Educação** [S. l.], v. 34, n. 107, p. 126–141, 2019. DOI: 10.21527/2179-1309.2019.107.126-141. Disponível em: https://www.revistas.unijui.edu.br/index.php/contextoeducacao/article/view/7267. Acesso em: 4 nov. 2022.

PICHARILLO, C.; RANIERI, V. E. L. Payment For Environmental Services: Guidelines For Identifying Priority Areas Focusing On Biodiversity*. **Ambiente & Sociedade** (ONLINE), v. 22, p. 1-18, 2019.

RODRÍGUEZ-ROBAYO, K., ÁVILA-FOUCAT, V.; MALDONADO, J. Indigenous communities' perception regarding payments for environmental services programme in Oaxaca Mexico. **Ecosystem Services**, n. 17, 163-171, 2016.

SÁNCHEZ-AZOFEIFA, G., PFAFF, A., ROBALINO, J.; BOOMHOWER, J. Costa Rica's Payment for Environmental Services Program: Intention, Implementation, and Impact. **Conservation Biology**, v. 21, n. 5, p. 1165-1173, 2007.

SILVA, J. A.; BIANCHI, M. L. P. Cientometria: a métrica da ciência. **Paidéia (Ribeirão Preto)**, Ribeirão Preto, v. 11, n. 21, p. 5-10, 2001.

TAVORA, G. S. G.; SILVA, A. S.; TURETTA, A. P. D. Análise da Política por Pagamento por Serviços Ambientais como um instrumento para sustentabilidade socioambiental. **Revista GEOSUL** (UFSC), v. 33, p. 29-47, 2018.

TESSITORE, R. F.; OLIVEIRA, A. H.; CARDOSO, D. C.; BORGES, C. P.; OLIVEIRA, M. H. A pesquisa científica brasileira em Pagamento por Serviços Ambientais. **REVISTA ORBIS LATINA**, v. 12, p. 95, 2022.

WANG, J., WANG, J., ZHANG, M., ZHANG, Y., WANG, J., ZHU, Q., LI, S. The payment scheme for ecosystem services in the coastal city based on the ecosystem services value and current payment efficiency: A case study in Jimo of Qingdao city, China. **Environmental Science and Pollution Research International,** v. 29, n. 32, p. 49179-49193, 2022.