RESEARCH ARTICLE   **OPEN ACCESS**

ECONOMY AND SUSTAINABLE DEVELOPMENT GOALS: MAPPING OF INTERNATIONAL SCIENTIFIC PRODUCTION

Lucia Silva Albuquerque de Melo, Msc., Jandmara de Oliveira Lima Lira Msc. and Isabel Lausanne Fontgalland*, PhD.

Center for Technology and Natural Resources-CTRN-PPGRN, Federal University of Campina Grande –UFCG-Brazil

ARTICLE INFO

ABSTRACT

In 2015 representatives from 193 countries, member states of the United Nations, met in New York, United States. The event culminated in the 2030 Agenda, so called New Urban Agenda, through which a set of commitments was established to promote sustainable development. The growing awareness with development, based on the tripod economy, environment, and society, has aroused many researchers' interest. The objective of mapping how the international scientific production on the Sustainable Development Goals - SDG, within the perspective of the Economy, has been considered and proposed by the literature in the period from 2015 to 2020. The Web of Science database and VOSviewer, andCitNetExplorersoftware was used to achieve this goal. We chose to restrict the Economy's analysis due to the apparent predominance of policies published towards economic growth. As a result of this work, it was found that the most cited articles are related to sustainable development, carbon emission reductions, clean energy services, national contexts to foster innovation and the adoption of technology, application of circular economy techniques, governance model, and combating climate change and the implications of climate change policy in the paths of sustainable development.

INTRODUCTION

The negative impacts caused by the Industrial Revolution and rampant consumption became the target of reflection and debate due to environmental depredation and possible scarcity of natural resources. As man advances in his announced goal of conquering nature, he has been writing a depressing sequence of destruction (Carson, 1969). With these words, Rachel Carson begins the chapter of the book Silent Spring, entitled "Unnecessary Devastation". She, like Kenneth Boulding in the 1960s, contributed to the emergence of a more sustainable economy. The old economic model had become inappropriate to the limitations of planet Earth and its capacity for regeneration. The exhaustion of natural resources represents the same problem for different dimensions. In the current scenario in which we find ourselves, the world faces various types of threats, not only environmental but also economic and social, that can interact catastrophically unless they are treated urgently and in an integrated way to enable more sustainable development. Not only would environmental disasters need to be contained, but aspects such as increased poverty began to require greater attention (Munasinghe, 2011). To align the Economy and the environment, the environmental Economy and ecological Economy also emerged in the

a commitment to a new world. They set out an action plan based on the 17 Sustainable Development Goals and their 169 goals. Since then, interest in the theme has grown over the years in the political and academic spheres and civil society. Given the above, the research's objective is to map how the international scientific production of the Sustainable Development Goals - SDDS, within the perspective of the Economy, have been considered and proposed by the literature in the period from 2015 to 2020.

METHODOLOGY

Considering that the research objective is to map how the international scientific production of the Sustainable Development Goals - SDDS, within the perspective of the Economy, have been considered and proposed by the literature in the period from 2015 to 2020. The study had an exploratory-descriptive character, and bibliometrics was the method chosen to carry out this research, which allowed the mapping of the primary scientific studies conducted in a given area, which encompasses the themes of economics and objectives of sustainable development. The bibliometrics study allows verifying the research conducted over the years and identifying the

main characteristics of this production, allowing to demonstrate outstanding aspects in the field, such as authors, journals, keywords, topics discussed, and potential research gaps. Bibliometrics is a tool to analyze how areas evolve from the intellectual structure, social structure, and conceptual structure (Zupic & ater, 2015). It is an approach to analyze and monitor certain areas' development through the selection of data, including citations, author affiliations, keywords, topics discussed, and methods used for published studies (Koseoglu, Rahimi, Okumus & Liu, 2016). Figure 1 presents the steps followed to achieve bibliographic mapping:
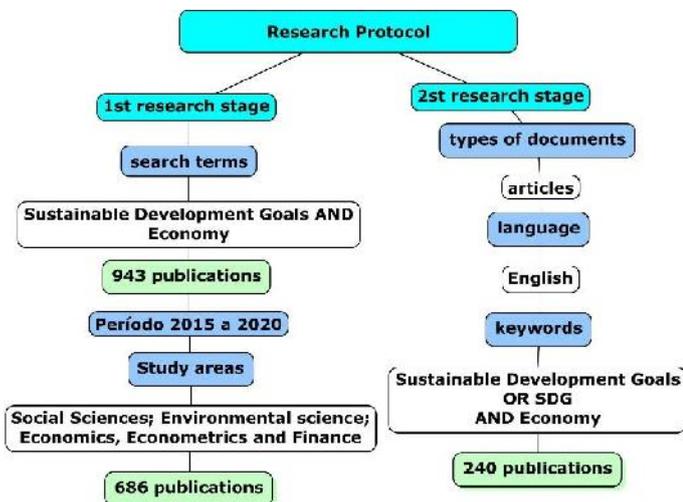

Source: Writing of authors, 2020

Figure 1. Research steps

In this research, the database used was the Web of Science (WoS), the main collection. The journals classified in the indexes were selected: Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), and Emerging Sources Citation Index (ESCI). WoS enables researchers to access publications from all areas of activity, providing information on results, dissemination, collaboration, and research impact (Albort-Morant & Ribeiro-Soriano, 2016). The search in the WoS database was conducted on September 22, 2020, at 21:50 h. The search protocol took advanced search targeting, in the first filter, the keywords" Sustainable Development Goals" AND "Economy". The period was used for the years 2015 to 2020, resulting in a total of 467 articles located. Given that the Sustainable Development Goals are the result of the United Nations Meeting in 2015 and culminated in the 2030 Agenda, it is justified that the period used for research should comprise the years 2015 to 2020. The second filter consisted of the inclusion of articles as a type of document, as language to English language and in the Web of Science categories were selected the areas of Environmental Sciences and Economics finalizing the search protocol with 217 publications. In the sequence, seeking the use of VOSviewer and CitNetExplorer software, the search protocol results in the WoS database was exported and recorded the content (complete record and cited references) in a file format separated by win tabs for use in the bibliometrics analysis of the collected data. For analysis, the results of the study were separated into three stages. The first consists of an evaluation related to the number of citations and publications per year, journals and more relevant countries. In the second stage, bibliometrics maps were elaborated, using the VOSviewer software version 1.6.12, with co-authorship clusters and the networks of keyword co-occurrences with greater relation and frequency in publications about the area researched. Finally, in the third stage, with the use of CitNetExplorersoftware, it was possible to elaborate the network of citations of the field of study and highlight the main networks (clusters) and the publications of impact on each network.

RESULTS AND DISCUSSIONS

The study identified 217 publications indexed in the Web of Science (WoS) database, with WoS database as the consultation date on

September 22, 2020. The citation report showed that the number of citations was 1,377, an average of 6.35 citations per publication. Figure 3 shows the evolution of citations each year, in the period studied, evidencing an area on the rise. The result is also corroborated by the number of publications, as shown in Figure 2.
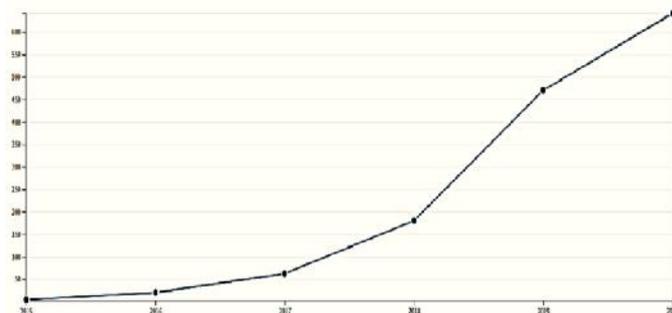
Source: Web of Science (2020)

Figure 2. Number of citations per year

Regarding the number of publications per year, the interest around the researched area was observed, implemented in many publications from 2015 to 2020. As previously reported, the choice of the year 2015, as the initial year of study, is based on the implementation of the 2030 Agenda with the SDGs having occurred in September 2015. This also explains the existence of only one article published that year. However, from 2016, interest in the theme increases, and publications are accentuated, signaling a trend of growth and development. Figure 4 shows the growth and evolution in the number of publications per year. Accurately, one publication was detected in 2015, 8 in 2016, 17 in 2017, 37 in 2018, 77 in 2019, and 77 in 2020. It is noteworthy that the final number of publications in 2020 should still be higher than that mentioned, given that the study was conducted in September 2020, and new publications could still be included in the WoS database.
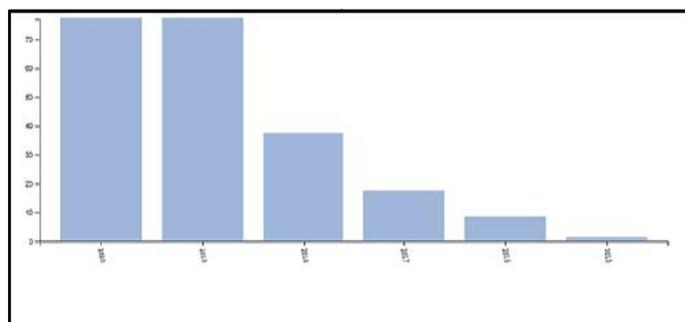

Source: Web of Science (2020)

Figure 3. Number of publications per year

Regarding the journals investigated, a total of 37 journals were identified among the 217 publications. The most relevant journals in terms of publication numbers were Sustainability with 75 publications, representing 34% of the sample surveyed, followed by the Journal of Cleaner Production with 21 (9.6 %) publications and Resources Conservation and Recycling with 11 (5%) Articles. Others worth mentioning are World Development, Ecological Economics, European Journal Of Sustainable Development, Energy Policy, Journal of Environmental Management and Environment Development and Sustainability. The study located 38 countries that developed some study related to the SDGs and the economy regarding country publications. Among the ten countries with the highest number of publications, Spain is the country with the highest number of works with 31 (14.2%), following we have England with 30 (13.8%), China 29 (13.3 %), Germany 25 (11.5%), Australia 17 (7.8%), Austria 13 (5.9%), Italy 13 (5.9%), Netherlands 9 (4.1%), France 8 (3.6%) and Japan 8 (3.6%). The ten countries together represent more than 83% of all publications on the theme surveyed.

Analysis of Co-authoring Networks and Keyword Co-occurrences: The co-authorship network is used to demonstrate the relationships between the most cited authors and their relationship based on the publications produced, with the purpose that the more cited the author is, the larger he is represented, becoming relevant in the cluster. It's grouping, clustering, occurs by uniting the publications that refer to each other, presenting clusters based on related themes of publication that produce works on the theme and co citation among them (Melo & Barbosa, 2020). Figure 5 presents the bibliometrics map of co-authorship by authors. Due to this study's exploratory nature, all authors were included with some publication in the scope of the research. The entire co-authorship network shows a total of 790 authors. In the bibliometrics map analysis, it is observed that the co-authorship network is extensive with 189 clusters but also very dispersed because of the 790 authors in the network, only 55 authors are connected.
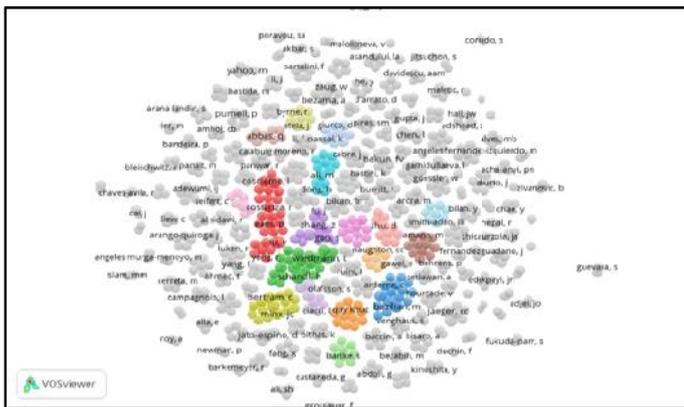
Source: Prepared by the authors, 2020.

Figure 4. Bibliometrics map of co-authorship, by authors

A total of 1,727 links were identified between authors of the network, with four (4) main clusters of cooperation. The association force method was used to normalize the strength of the links between the authors (items), which will be higher the frequency of publications produced by a group of authors (Lima &Leocádio, 2018).
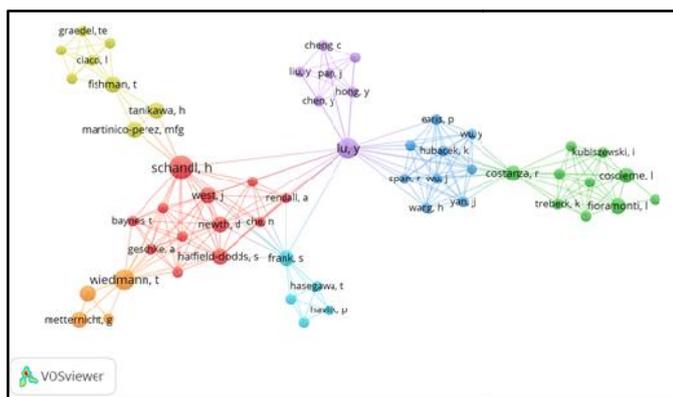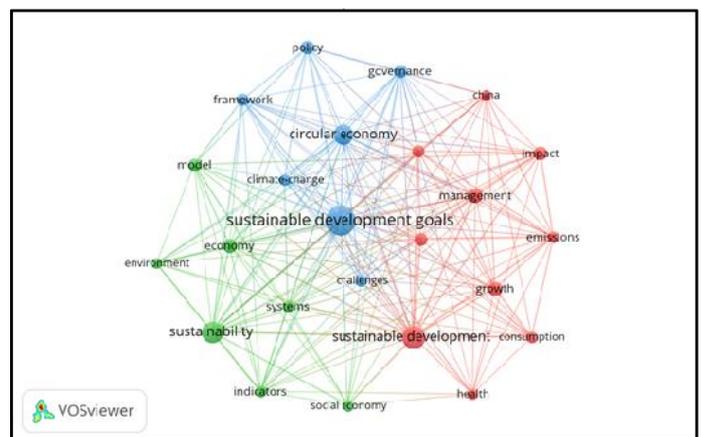

Source: Prepared by the authors, 2020.

Figure 5. Bibliometrics map of co-authorship, by interconnected authors

The central cluster, with more nodes, consequently, with more authors collaborating, in the red color in Figure 5, is composed of 26 authors, with Lu, Y as the principal author in the cluster with three publications, four citations, and a strength ratio size 24, followed by Costanza, R (11 citations) with two publications and size 18 strength ratio. The second cluster (in green on the network) consists of 21 authors. Cluster 2 has centrality in Schandl, H with 195 citations, four publications, and a strength ratio of 22. The authors also featured Hatfield-dodds, S; West, J and Newth, D, with two publications, 172 citations, and a 17 strength ratio in the co-authorship network. In the third cluster, in blue, three relevant authors were identified in the co-authorship network: Bazilian, M; Howells, M and Korkovellos, A.

They presented on the co-authorship map two publications, 46 citations and a strength ratio of 17 each. The fourth cluster, in yellow, has Bertram, C, Luderer, G, and Minx, JC as the prominent authors in the cluster, both of which showed 68 citations, two publications, and a strength ratio of 16. To deepen the analysis of co-authoring networks, a new execution of the bibliometrics map of co-authorship was carried out using only the authors connected to the network. Figure 6 presents the bibliometrics map of co-authorship by interconnected authors, in which 55 authors distributed in seven clusters are listed.

Authors with at least one publication in the sample were considered, and as the Sustainable Development Goals were implemented in 2015, we did not put several citations to their respective works. The size of the circles indicates the number of publications by each author in the sample search. The first cluster, in red, consists of twelve authors, besides presenting as a highlight the authors Schandl, H and West, J, the map of co-authorship by interconnected authors shows as relevant authors in the Hatfield-Dodds, S, and Newth network, D, both with 199 citations, two publications and a strength ratio 17. In cluster number two, in green color, the principal author is Costanza, R (11 citations) with two publications and a strength ratio in the co-authorship network of 18. The third Cluster, in blue, is made up around the Authors Chou. S.K., Earis.P. K, Wu.J. Span. R, Li. B.L, Wang. R, Yan. J.J., Wu.Y. The fourth cluster, in yellow, is made up around the Fishman author. T with the most robust collaboration with Tanikawa. H and Martinico-Perez.M.F.G. Cluster five, in purple, has centrality in Lu. Y and deserves the author's Hong. Y and Chey. Y. Frank.S is the author who polarizes cluster 6, in light blue, with a more intense partnership with Valin. H and Hasegawa. T. The seventh and last cluster, in orange color, has four authors, having Wiedman. T is the most relevant and central author of the cluster with 257 citations, three publications, and several links (strength ratio 14). The relationship of co-occurrences between two keywords is established by the number of posts in which the two keywords occur together in the title, abstract, or keyword list (Van Eck & Waltman, 2014). It is possible to map likely research themes in the searched area by analyzing the keyword co-occurrence network. In the study, 1,453 keywords were identified from the 217 publications in the sample surveyed. To demonstrate the terms with the highest occurrence, we opted for the criterion of at least ten occurrences in the text.
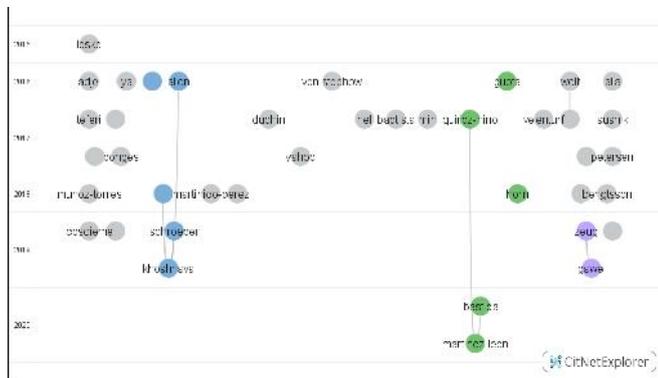

Source: Prepared by the authors, 2020.

Figure 6. Network of keyword co-occurrences

Figure 6 shows the formation of three clusters with 24 terms, in which the keyword Sustainable Development Goals is in the centrality of the co-occurrence map; that is, it has a more significant number of links with the other terms well as the largest number of occurrences. According to Lima and Leocádio (2018) the node size demonstrates the frequency of occurrence of a keyword, and the relationship between nodes is as strong as the closer proximity between them. In the red cluster, containing ten terms (nodes), it is verified that those with the highest frequency of occurrence, in this order, are Sustainable development, management, innovation, impact, emissions, energy, growth, consumption, China, and health. This set suggests research addressing global perspectives on sustainable

development, carbon emission reductions, clean energy services, national contexts to foster innovation and technology adoption. The Green Cluster has seven terms, highlighting, respectively, Sustainability, Economy, model, indicators, social Economy, systems, and environment. Such occurrences allow us to signal a research trial addressing digital business models, Social and Solidarity Economy policies, and a set of indicators that guide decision-making and facilitate accountability to citizens. In blue, the third cluster gathered seven keywords, in this order, the expression Sustainable Development Goals itself as central in the cluster, having as the most frequent circular Economy, policy, governance, framework, climate change, and challenges. The research line that these words suggest is focused on applying circular economy techniques, governance model, and combating climate change and the implications of climate change policy in the paths of sustainable development.

Analysis of Citation Networks: The analysis of citation of the documents obtained through research in the Web Of Science database was performed from the use of the CitNetExplorer software. Once the graph of the citation network was generated (minimum number of 10 citations), the main publications were identified. From this analysis parameter, 31 network publications were identified.

Source: Prepared by the authors, 2020.

Figure 7. Quote Network Map

Figure 7 shows the network obtained from 217 documents, belonging to the period 2015 to 2020, where 42 have citation links with other documents. The lines represent the relationships between publications. Each circle corresponds to a publication and describes the surname of the first author. For network configuration in CitNetExplorer, the criterion was the resolution of 0.40 and minimum size 5. As a result, the citation network presented has three clusters. The first and second clusters are represented by blue and green, respectively, both with 13 publications. In lilac color, the third cluster has five publications. It should be noted that 186 publications do not belong to any cluster. The primary source of publication was the journal "Sustainability" (ISSN 2071-1050). Of the 42 articles belonging to the network, 20 were published in this international and open-access journal. For individual analysis of each cluster, the parameter "Based on groups" and the function "Drill down" were selected, as shown in figures 8, 9, and 10.
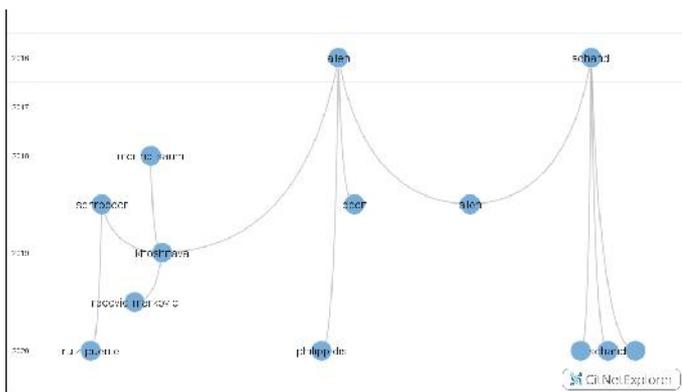
Source: Prepared by the authors, 2020.

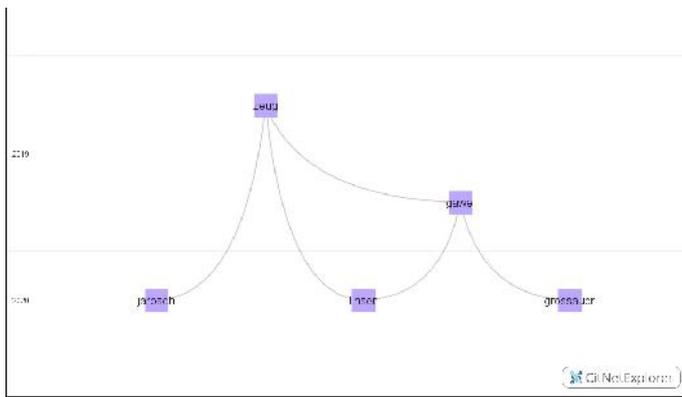**Figure 8. Expanded Cluster 01**

Figure 8 corresponds to the first cluster, with 12 citation links, from 2016 to 2020. The themes' main themes are modeling, tools, methodological approaches, and indicators that help planning and evaluation for sustainable development. Allen and Schandl are the principal authors of the network, with two publications each. The first, from Allen, C; Metternicht, G and Wiedmann, T.is titled "National pathways to the sustainable development goals (SDGS): a comparative review of scenario modeling tools," with citation score 4, written in 2016 and where it seeks to analyze and evaluate "a wide range of different quantitative models that have the potential to support national development planning for the SDGs from this first analysis, the authors develop a typology and inventory with 80 different models. The second article, also with citation score 4, was published in 2016 and written by Schandl, H; Hatfield-Dodds, S; Wiedmann, T; Geschke, A; Fall, Yy; for the J; Newth, D; Baynes, T; Lenzen, M, and Owen, A. It is titled "Decoupling global environmental pressure and economic growth: scenarios for energy use, materials use and carbon emissions." Its central question is "whether well-designed policies can reduce global use of materials and energy and carbon emissions, with only minimal impacts on improvements in living standards." The authors use a combined economic and environmental modeling approach to assess the decoupling potential of environmental pressure and economic growth in 13 global regions. Cluster 2 is represented in Figure 10. Also composed of 13 publications, where Bastida, Gupta, and Quiroz-nino head the most relevant documents, as can be seen below:
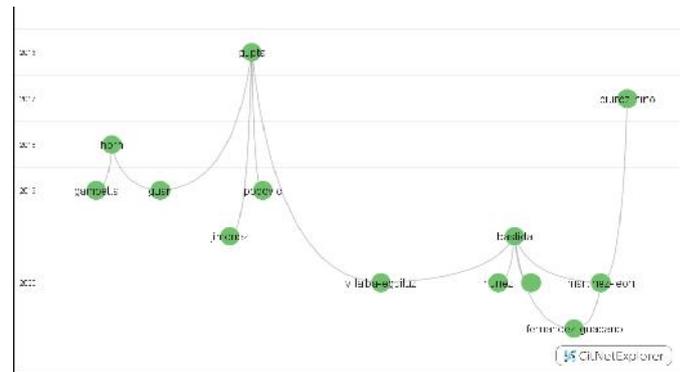
Source: Prepared by the authors, 2020.

Figure 9. Expanded Cluster 02

The second cluster groups 13 publications focusing on the social dimension of sustainable development. It addresses topics such as Social and Solidarity Economy, awareness of society, gender equality, reduction of social inequalities, and contribution of cooperatives in the SDGs' reach. The most relevant document within the cluster was published on January 3 of this year (2020), written by Bastida, M; Garcia, Av; Marquez, Mc and Blanco, A and the title "Fostering the sustainable development goals from an ecosystem conducive to these: the Galician's case." Although it is still recent, not only in the second cluster but also in the primary network of citation, the publication has a citation score of 5, the largest in the network. Its central theme is the Social Economy and its alignment with the SDGs. This is a case study that explains the promotion strategy established in Galicia, which resulted in an ecosystem favorable to the development and consolidation of the Social Economy of this region, " from a combination of public policies with synergistic effects". With citation score 4, published in 2016, the second most important document in this second cluster received the following title: "Sustainable development goals and inclusive development". Its authors are Gupta, J; Vegelin, C. Addresses the theme of inclusive development, seeking to understand the extent to which it is taken into account in the SDGs framework. The third clusterhas only five documents, containing five citation links and published in 2019 and 2020. The main theme of the cluster isBioeconomy and its relationship with the Sustainable Development Goals achievement. It addresses aspects such as strategies, monitoring, and social impact. As can be seen in Figure 11, the most relevant work is first-authored by Zeug.

Source: Prepared by the authors, 2020.

Figure 10. Expanded Cluster03

Zeug, W; Bezama, A; Moesenfechtel, U; Jahkel, A and Thran, D published in 2019 the article entitled "Stakeholders' interests and perceptions of bioeconomy monitoring using a sustainable development goal framework". In it, the authors defend the importance of adequate and systematized monitoring and seek to evaluate the relevance of the SDGs to the Bioeconomy.

CONCLUSION

This research was restricted to data from the Web of Science database, complete collection, which cannot be characterized as a limitation because the choice of said database happens because of its compatibility with citNetExplorer software. However, as a suggestion for future research, it is guided by other databases, such as Scopus, Science Direct, EBSCO, and Scielo, and other software such as Iramuteq.

REFERENCES

Albort-Morant, G., & Ribeiro-Soriano, D. (2016). A bibliometrics analysis of the international impact of business incubators. *Journal of Business Research*, 69(5), 1775–1779. https://doi.org/10.1016/j.jbusres.2015.10.054

Allen, C., Metternicht, G., &Wiedmann, T. (2016). National pathways to the Sustainable Development Goals (SDGs): A comparative review of scenario modelling tools. *Environmental Science and Policy*, 66, 199–207. https://doi.org/10.1016/j.envsci.2016.09.008

Bastida, M., García, A. V., Márquez, M.C., & Blanco, A. O. (2020). Fostering the sustainable development goals from an ecosystem conducive to the SE: The Galician's case. *Sustainability*, 12(2), 1–17. https://doi.org/10.3390/su12020500

Boulding, K. E. (1966). The Economics of the Coming Spaceship Earth. The Earthscan Reader in Environmental Economics,27–35. https://doi.org/10.4324/9781315064147

Brundtland, G. H. (1987). Brundtland Report: Our Common Future. In the United Nations.

Carson, R. (1969). Silent Spring. (1a. Ed.; C.S. Martins, trad). São Paulo: Gaia.

Costanza, R. (2020). Ecological economics in 2049: Getting beyond the argument culture to the world we all want. *Ecological Economics*, 168 (June 2019), 106484. https://doi.org/10.1016/j.ecolecon.2019.106484

Koseoglu, M. A., Rahimi, R., Okumus, F., & Liu, J. (2016). Bibliometrics studies in tourism. *Annals of Tourism Research*, 61, 180–198. https://doi.org/10.1016/j.annals.2016.10.006

Lima, O. S. H. de O., & Leocádio, A. L. (2018). Mapping the International Scientific Production on Open Innovation. Brazilian *Journal of Management and Innovation*, 5(2), 181–208. https://doi.org/10.18226/23190639.v5n2.08 .

Melo, L. S. A. de, & Barbosa, M. D. F. N. (2020). Sustainable tourism and sustainable development goals: evaluative and relational bibliometrics perspective in the period 2015-2020. *Ibero-American Journal of Environmental Sciences*, 11(4), 371–385. https://doi.org/10.6008/cbpc2179-6858.2020.004.0030

Munasinghe, M. (2011). Addressing sustainable development and climate change together using sustainomics. *Wiley Interdisciplinary Reviews: Climate Change*, 2(1), 7–18. https://doi.org/10.1002/wcc.86 .

Pearce, D. (2002). An intellectual history of environmental economics. *Annual Review of Energy and the Environment*, 27(1), 57–81. https://doi.org/10.1146/annurev.energy.27.122001.083429

Rossi, V., &Litre, G. (2020). Achieving the Sustainable Development Goals through good enough governance Alcanzar los Objetivos de Desarrollo Sostenible a través de la gobernanza sufficiently buenaLecciones de municipalities argentinas y Achieving the Development Goals. *Agro Sciences Uruguay,* 24(2). https://doi.org/10.31285/AGRO.24.139

Van Eck, N.J., & Waltman, L. (2014). Visualizing bibliometrics networks. In Y. Ding, R. Rousseau, & D. Wolfram (Eds.), Measuring scholarly impact: Methods and practice 285–320. Mr. Springer.

Zupic, I., & ater, T. (2015). Bibliometrics Methods in Management and Organization. *Organizational Research Methods*, 18(3), 429–472. https://doi.org/10.1177/1094428114562629

****