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The relationship between innovation ecosystem and bioeconomy: A bibliometric review

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Abstract

Objective: the bioeconomy emerges as an innovative and sustainable approach to face the various global challenges related to food security, climate change and the use of natural resources. The Quintuple Helix model includes environmental concerns and emphasizes transforming society and the current economic system to become more sustainable. Therefore, this article aims to analyze how these themes are related in international literature.
Methodology: bibliometric research in the Scopus database that brought together 82 publications.
Originality/Relevance: identification of the relationship between concepts is essential, as innovation ecosystems play a crucial role in the promotion and development of the bioeconomy, by boosting research, development and adoption of innovative solutions that sustainably use available biological resources.
Main Results: as a result it was possible to identify the main keywords, being green economy; sustainability development; bioeconomy; innovation and sustainability. Furthermore, the most cited authors are Laurens Klerkx and David Rose and the countries with the highest number of publications are China, Germany and the United States. The results also indicate that there are several clusters in the world researching innovation ecosystems and relating this topic to the bioeconomy, whose content has a field of research that can be explored.
Technical/methodological contributions: the results obtained from the bibliometric review make it possible to analyze scientific productivity through the quantitative study of publications, providing an overview of current affairs and trends related to the topic of study.
Social/management contributions: synthesize and organize existing knowledge on the topics researched. In addition to identifying gaps in the literature, it also allows stimulating innovation, through access to information for researchers, professionals and interested parties in general.

Keywords: innovation ecosystem, green economy, sustainable development, bioeconomy

Resumo

A relação entre ecossistema de inovação e bioeconomia: Uma revisão bibliométrica

Objetivo: a bioeconomia emerge como uma abordagem inovadora e sustentável para enfrentar os vários desafios globais, relacionados à segurança alimentar, mudanças climáticas e uso de recursos naturais. O modelo de Hélice Quíntupla inclui preocupações ambientais e enfatiza a transformação da sociedade e do sistema econômico atual para tornarem-se mais sustentáveis. Assim, o presente artigo visa analisar como esses temas estão relacionados na literatura internacional.
Metodologia: pesquisa bibliométrica na base de dados da *Scopus* que reuniu 82 publicações.
Originalidade/Relevância: identificação da relação entre os conceitos é essencial, visto que os ecossistemas de inovação desempenham um papel crucial na promoção e no desenvolvimento da bioeconomia, ao impulsionar a pesquisa, o desenvolvimento e a adoção de soluções inovadoras que utilizam de forma sustentável os recursos biológicos disponíveis.
Principais Resultados: como resultado foi possível identificar as palavras-chave principais, sendo *green economy*; *susteinability development*; *bioeconomy*; *innovation* e *susteinability*. Além disso, os autores mais citados são Laurens Klerkx e David Rose e os países com maior número de publicações são a China, a Alemanha e os Estados Unidos. Os resultados também indicam que existe no mundo diversos *clusters* pesquisando sobre ecossistemas de inovação e relacionando esse tema com a bioeconomia, cujo conteúdo tem campo de pesquisa que pode ser explorado.
Contribuições técnicas/metodológicas: os resultados obtidos a partir da revisão bibliométrica permitem analisar a produtividade científica pelo estudo quantitativo das publicações, traçando um panorama da atualidade e tendências relacionadas ao tema de estudo.
Contribuições sociais/de gestão: sintetizar e organizar o conhecimento existente sobre os temas pesquisados. Além de identificar lacunas existente na literatura, permite ainda estimular a inovação, por meio de acesso à informação para pesquisadores, profissionais e interessados em geral.

Palavras-chave: ecossistema de inovação, economia verde, desenvolvimento sustentável, bioeconomia

Resumen

La relación entre ecosistema de innovación y bioeconomía: Una revisión bibliométrica

Objetivo: la bioeconomía surge como un enfoque innovador y sostenible para enfrentar los diversos desafíos globales relacionados con la seguridad alimentaria, el cambio climático y el uso de los recursos naturales. El modelo Quíntuple Hélice incluye preocupaciones ambientales y enfatiza la transformación de la sociedad y el sistema económico actual para que sean más sostenibles. Por lo tanto, este artículo tiene como objetivo analizar cómo se relacionan estos temas en la literatura internacional.
Metodología: investigación bibliométrica en la base de datos Scopus que reunió 82 publicaciones.
Originalidad/Relevancia: la identificación de la relación entre conceptos es esencial, ya que los ecosistemas de innovación juegan un papel crucial en la promoción y desarrollo de la bioeconomía, al impulsar la investigación, el desarrollo y la adopción de soluciones innovadoras que utilicen de manera sostenible los recursos biológicos disponibles.

Principales Resultados: como resultado se pudo identificar las principales palabras clave, siendo economía verde; desarrollo sustentable; bioeconomía; innovación y sostenibilidad. Además, los autores más citados son Laurens Klerkx y David Rose y los países con mayor número de publicaciones son China, Alemania y Estados Unidos. Los resultados también indican que existen varios clusters en el mundo que investigan ecosistemas de innovación y relacionan este tema con la bioeconomía, cuyo contenido tiene un campo de investigación que se puede explorar.
Aportes técnico/metodológicos: los resultados obtenidos de la revisión bibliométrica permiten analizar la productividad científica a través del estudio cuantitativo de las publicaciones, brindando una visión general de la actualidad y tendencias relacionadas con el tema de estudio.
Aportes sociales/de gestión: sintetizar y organizar el conocimiento existente sobre los temas investigados. Además de identificar vacíos en la literatura, también permite estimular la innovación, a través del acceso a la información para investigadores, profesionales e interesados en general.

Palabras clave: ecosistema de innovación, economía verde, desenvolvimiento sustentable, bioeconomía

Introduction

The need to develop a new economy, new political growth and new economic measurement is vital if economies are to achieve the Sustainable Development Goals (SDGs) set by the United Nations. The 2030 Agenda for Sustainable Development represents an action plan for economists, politicians, society and the planet, which seeks sustainable development in its three dimensions, economic, social and environmental (Khoshnava, Rostami, Zin, Štreimikiene, Yousefpour, Strielkowski, & Mardani, 2019).

It is a fact that governments need new ways to increase the resilience of economies and societies and sustain environmental quality. The "green" stimulus was one of several proposals for an alternative to the pandemic that helps the economy recover and facilitates its transition to a cleaner and more sustainable path (Chen, Marin, Popp, & Vona, 2020).

The United Nations Environment Program (UNEP) defines a green economy as "the one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcity. At its simplest, a green economy can be thought of as one that is low-carbon, resource-efficient and socially inclusive" (United Nations Environment Programme, 2011).

The relationship between the innovation ecosystem and the bioeconomy is close and synergistic, as both share the goal of promoting sustainable development and technological innovation, but focused on different aspects. The bioeconomy is a key element of the long-term transition to sustainability and is broadly conceived as one that involves cross-cutting innovation and adds value and, to this end, uses bio-based resources and processes in all economic sectors (International Advisory Council of the Global Bioeconomy Summit, 2018). It encompasses sectors such as agriculture, forestry, fisheries, biotechnology and industries based on bioproducts, with a focus on reducing environmental impact and the efficient use of natural resources.

Innovation, on the other hand, is a driving force behind economic development and the competitiveness of countries, sectors and companies (Schumpeter, 1934). Studies of innovations for sustainability often focus on transformative innovations that support the change of the economic (or social) system, for example towards a bioeconomy, where different understandings of sustainability or bioeconomy are observed (Bugge, Hansen, & Klitkou., 2016; Hausknost, Schriefl, Lauk, & Kalt, 2017).

The core elements of an innovation system or innovation ecosystem (Adner, 2006) are:

- companies and other economic actors;
- research and education organizations; and
- political-institutional actors, consolidated in the triple helix model (Leydesdorff & Etzkowitz, 1998) as industry, university and government.

Other approaches have explicitly added the users of innovative products and services, or society, as elements of similar importance, referred to as the quadruple helix (Carayannis et al., 2009) socio-technical systems (Geels, 2004; Rohracher, 2001), user-centered innovation, open innovation (Von Hippel, 2005), value-based approaches (Vargo & Lusch, 2004) or social innovation (Moulaert, MacCallum, Mehmood, & Hamdouch, 2013).

It can be seen that the concepts of bioeconomy and innovation ecosystem are focused on

different aspects. The bioeconomy depends on robust innovation ecosystems to develop new technologies and sustainable business models, while innovation ecosystems benefit from the bioeconomy as a strategic sector for green innovation and sustainable growth. The aim of the study

was to understand how authors have dealt with the relationship between the themes and how they are positioned in the literature.

To answer the research question, a bibliometric review was used to analyze scientific production in this field of knowledge, with a focus on quantifying and mapping trends. This type of research is based on the analysis of bibliometric indicators, such as the number of publications, citations, co-authorship, collaboration networks, as well as identifying the main authors, journals, institutions and countries working on the subject under study.

Data was collected and analyzed using VOSviewer software. To this end, The keywords "innovation ecosystem" and "bioeconomy" were selected to clearly define the field of study. Afterwards, metrics were analyzed, such as keywords; the evolution of search terms; analysis of authors; publication sources and analysis of the countries from which publications originated. Finally, graphs and network maps were generated to illustrate the connections between authors, themes and citations.

The results show that the bioeconomy and the innovation ecosystem are topics of common interest to most countries and have a field of research that can be explored.

Theoretical Framework

Innovation ecosystem

The concept of ecosystem was first defined in the field of biology, where the connection and interdependence between the elements of the system was demonstrated. This quickly became related to business management and was known as the business ecosystem approach. Subsequently, it was enshrined in the literature as an innovation and entrepreneurial ecosystem (Adner, 2006; Fleming, 2014; Amonarriz, Iturrioz, Narvaiza, & Parrilli, 2019).

Business stakeholders depend on each other to innovate, encouraging the alliance of the individual efforts of the ecosystem's stakeholders. Otherwise, the ecosystem could become weak and obsolete (Adner, 2006; Rabelo & Bernus, 2015). Therefore, once an ecosystem is established, it includes stakeholders who collaborate and contribute to the interaction in relationships and also to other intangible issues.

Thus, the literature on innovation systems (Freeman, 1987; Lundvall, 1992; Nelson, 1993) describes organizations and institutions in constant interaction, resulting in a dynamic and generative set of relationships through which the system fulfills functions in the innovation

process, e.g. providing information and incentives or coordinating the actors involved (Edquist, 1997).

The helical model, on the other hand, developed as a result of economic and social needs and progress, seeks to describe the dynamic relationship between the actors in a society, with the double helix model including a linear link between academia and entrepreneurs (Gibbons, Limoges, & Nowotny, 1994).

Next, the development of information and communication technologies leads to the need to add new helices that establish knowledge and innovation in society, namely the development of the triple helix model by the government. This model is a spiral model of innovation that explains the importance of innovation between the three strands and aligns the education system with the needs of the labor market (Etzkowitz & Leydesdorff, 2000).

The Quadruple Helix is introduced due to the rapid progress of the knowledge society. The fourth element added to the first three mentioned is the public based on media and culture (Carayannis & Campbell, 2009). Later on, significant challenges and crises in the world, especially pollution and environmental degradation, were the most important factors for the introduction of the Quintuple Helix model. The additional fifth dimension called environment highlights the sociological transformations and significance of the natural environment. The natural environment in the fivefold helix model aims to generate new green technologies as well as preserve humanity (Barcellos-Paula, La Vega, & Gil-Lafuente, 2021; Carayannis & Campbell, 2010; Franc & Karadžija, 2019).

Bioeconomy

Sustainable development is the common goal of humanity and is necessary to achieve human well-being. In the context of climate change, it is mandatory to make the production process and consumption patterns more sustainable, due to the increasing pressure on non-renewable resources. A shift towards more sustainable production and more efficient use and management of biological resources can help reduce waste, pollution, climate change and the use of fossil resources. This movement implies a series of changes in both primary production and industrial processes that are characterized as the bioeconomy (Haarich, 2017).

The definition of the bioeconomy varies in different parts of the world. In the European context, there is a greater focus on biomass and its waste streams as a resource in the transformation

towards a more sustainable society and a circular economy; in contrast, the Organization for Economic Cooperation and Development (OECD) and the United States of America (USA) do not have an explicit sustainability agenda and the concept is mainly used to describe the conversion of raw materials into products in biotechnology and the life sciences (Grundel & Dahlström 2015).

It has been argued that the bioeconomy is just another buzzword for sustainable development and a "greening of the economy" (Birch, Lewidow, & Papaioannou, 2010). In Europe, this can be seen as a result of the commodification and development of new products in food, animal feed, bio-based products and bioenergy (European Commission, 2012) to improve the competitiveness of the European Union.

The term green economy and its related concepts, such as green growth and sustainable development, have progressed since their appearance until now (Dogaru, 2021). The green economy is estimated to be a catalyst for this new economic program, as it aims to improve the efficiency of resource use, ensure ecosystem resilience and increase social equity (Brears, 2018).

Method

Bibliometrics is the study of the quantitative aspects of the production, dissemination, socialization and disclosure of recorded information (Macias-Chapula, 1998). Bibliometric analysis is a research technique that involves the quantitative analysis of bibliographic and citation data. It is used to evaluate scientific production, identify research trends, measure the impact of publications and authors, and understand the interconnection between different areas of knowledge.

In addition, bibliometric analysis can include metrics such as the number of citations, journal impact indexes, co-citations and collaboration networks between authors. The importance of bibliometrics lies in gaining analytical and in-depth knowledge of a particular area of scientific knowledge (Leite Filho, 2008).

It should be noted that for this research, the following keyword co-occurrence networks were analyzed: evolution of research fields, most cited authors, main articles, publication sources and country of origin of publications. The database used to retrieve the publications was *Scopus*. The terms were filtered for those occurring in the title, abstract or keywords.

The following terms were used to retrieve the papers: "Innovation ecosystem" and "bioeconomy" or "green economy" or "sustainable economy". The total number of papers retrieved

was 160. The terms were then filtered by document type (articles and reviews); language (English); access option (all open access) and 82 publications were retrieved. All the articles were analyzed. The search string was as follows: (ALL ("Innovation ecosystem*") AND TITLE-ABS-KEY ("bioeconomy") OR TITLE-ABS-KEY ("green economy") OR TITLE-ABS-KEY ("sustainable economy")) AND (LIMIT-TO (OA , "all")) AND (LIMIT TO (PUBSTAGE , "final")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re")). The survey was carried out on 06/04/2024. The software used to analyze the data extracted from the articles was VOSviewer, version 1.6.20. VOSviewer is a software tool for building and visualizing bibliometric networks (Matos, Souza e Teixeira, 2021)

Results And Discussion

Keyword analysis

By analyzing the keywords of the studies, it is possible to indicate trends and relationships between them. A total of 747 keywords were identified from the 82 publications retrieved. The keywords that occurred most in the publications were then selected and are shown in Table 1. As a result, it was possible to identify the keywords that occurred most in the studies, showing which subjects are most closely related to the two themes.

Table 1

Number of occurrences of keywords.

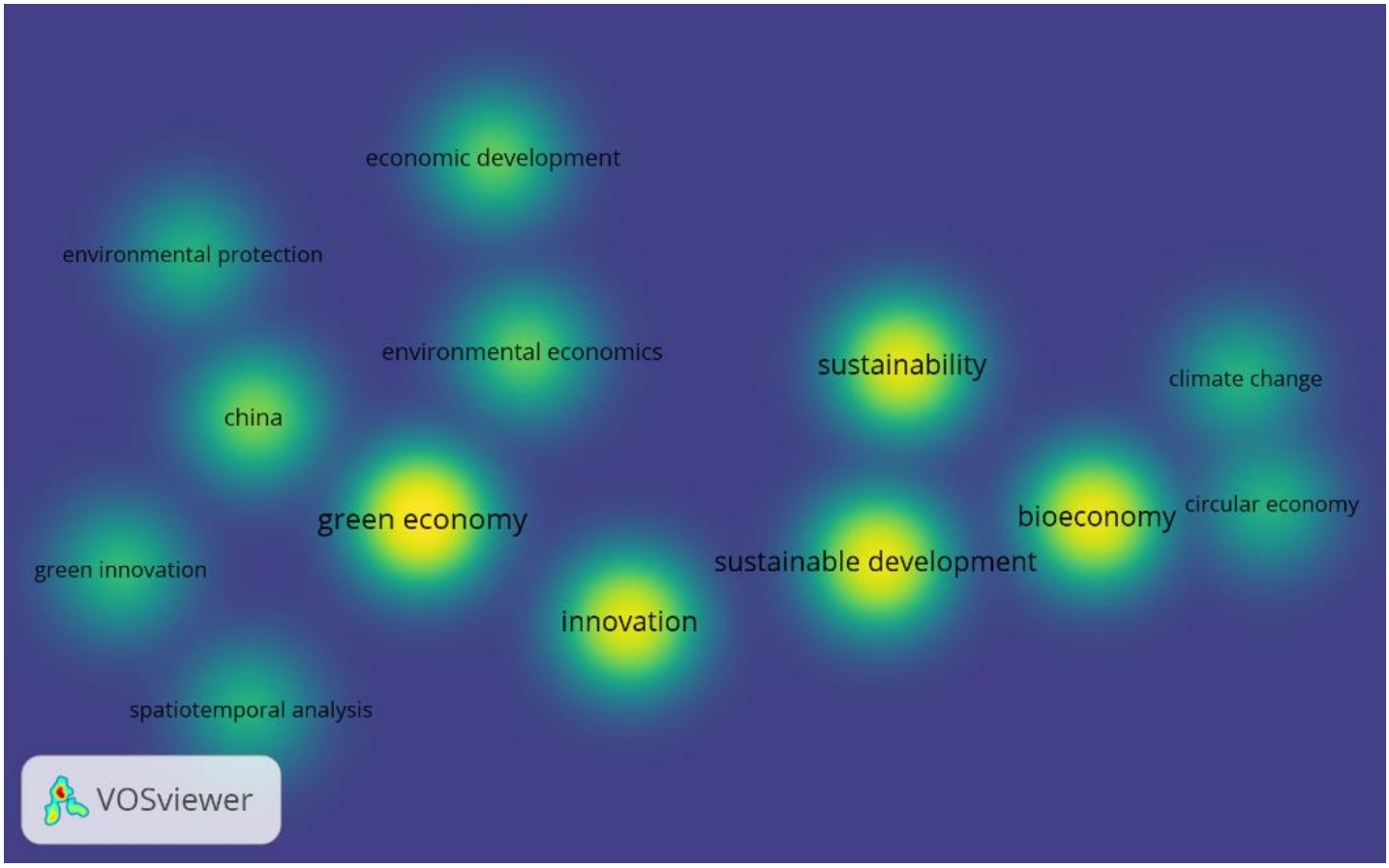
Keywords	Occurrences
Green economy	33
Susteinability development	25
Bioeconomy	25
Innovation	23
Susteinability	23

Source: prepared by the authors (2024)

To build the density and network of keyword occurrences, those with at least 4 occurrences were considered for better visualization of the networks. Figure 1 shows the terms the highest occurrence densit.

Figure 1

Density of occurrence of keywords



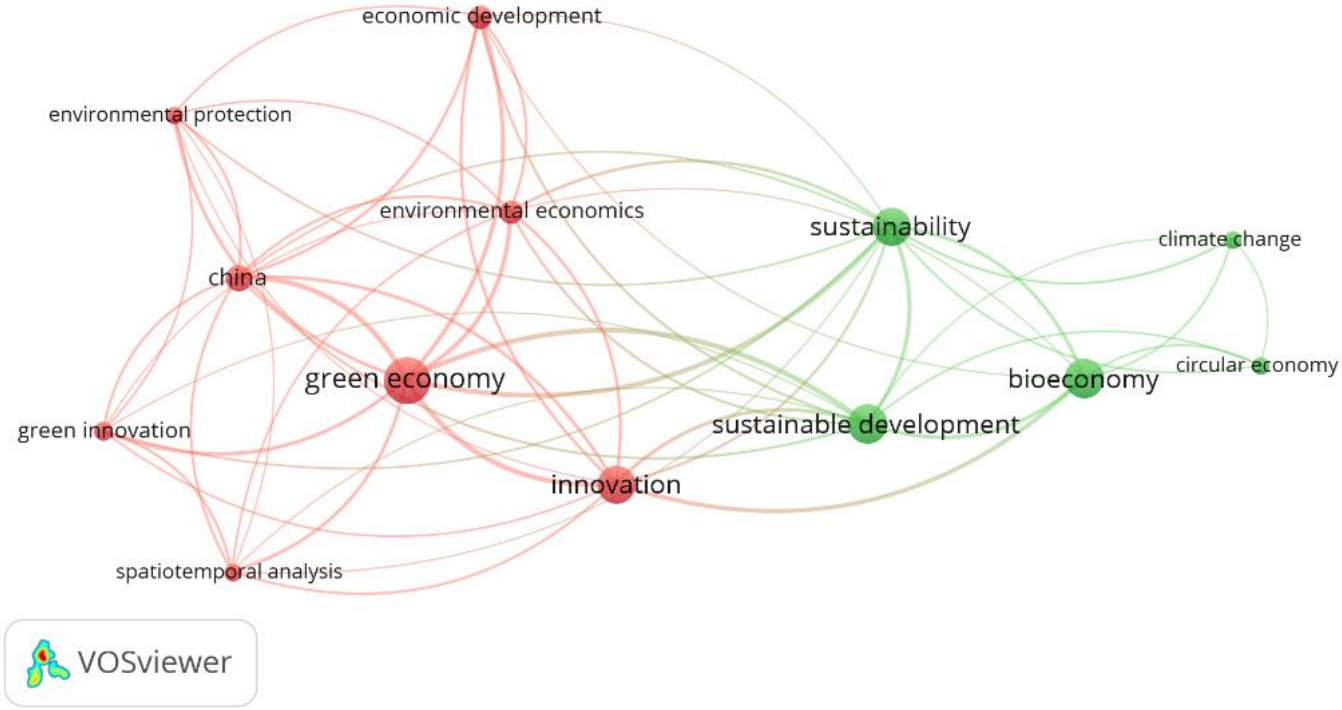
Source: prepared by the authors (2024).

The words green economy, innovation, sustainability development, sustainability and bioeconomy are highlighted. The literature has correlated the terms "Innovation" and "Sustainability", as Pedersen (2019) discusses when addressing how innovation ecosystems can be structured to support the transition to a bioeconomy, emphasizing collaboration between various stakeholders.

Figure 2 shows how the keywords are related and how they are grouped by clusters. The co-occurrence network shows the keywords that occur together, demonstrating which keywords are most closely related. Figure 2 shows the keyword network.

Figure 2

View of the keyword co-occurrence network.



Source: prepared by the authors (2024)

With regard to the co-occurrence of keywords, there are two clusters of related terms. The largest cluster is in red, where the word green economy is related to innovation, environmental economics, China, green innovation, spatiotemporal analysis, environmental protection and economic development. The green cluster is made up of sustainability, sustainable development, bioeconomy, climate change and circular economy.

The distance between two clusters roughly indicates their relationship in terms of citations. Clusters located close together tend to be strongly related in terms of citations. In other words, the cluster where the term green economy is present is closer to the innovation and environmental economics clusters. These keywords also have the highest number of publications, since the size of a cluster is determined by the number of publications belonging to the same group. It can be seen that there is a proximity of distinct concepts as seen by Iacob et al. (2021), when analyzing

how these concepts overlap in their objectives of promoting a more sustainable economy, but with distinct approaches

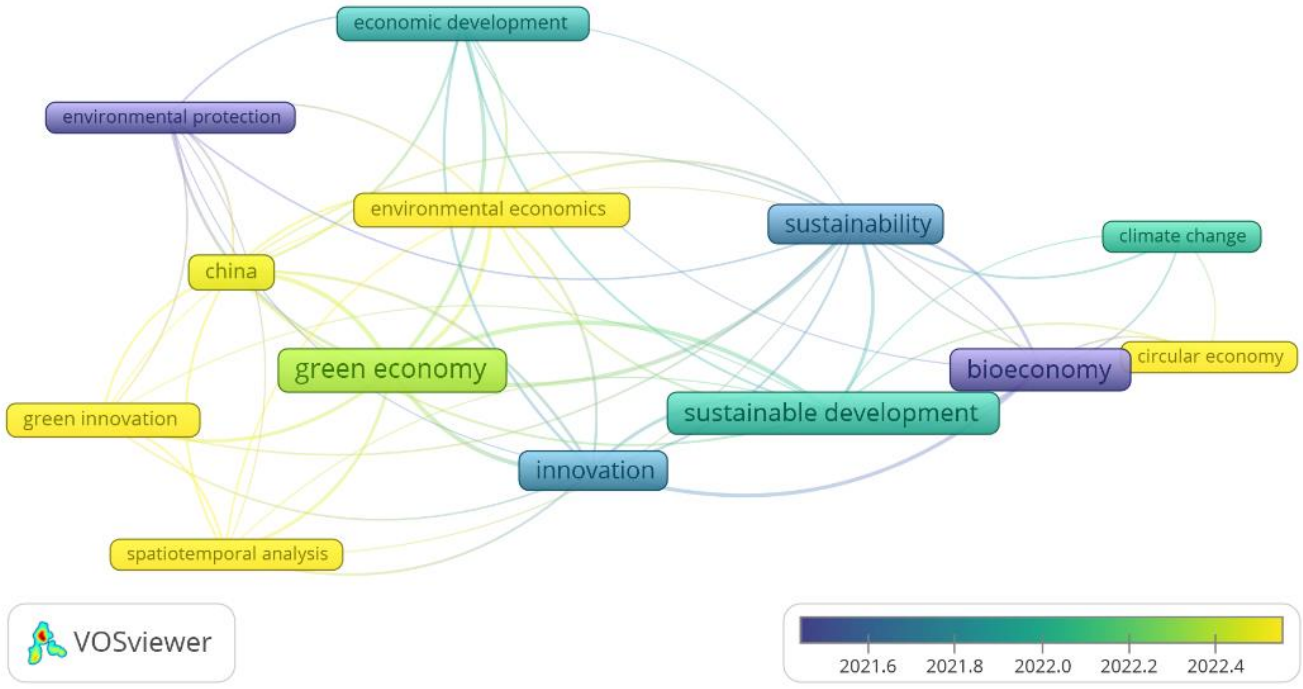
In the next section, an analysis of the evolution of search terms is presented.

Evolution of search terms

In order to analyze the evolution of the search terms, the most frequently occurring terms were identified. Figure 3 shows the evolution of the year of publication of the main keywords. It can be seen that the oldest terms (2021) are related to environmental protection and bioeconomy. Later, the keywords sustainable development, climate change, sustainability and innovation appear in an intermediate position. From 2022 onwards, the term green economy gained prominence. The most recent terms (2023) are: green innovation, environmental economics, China, spatiotemporal analysis and circular economy.

Figure 3

Year of publication of the terms



Source: prepared by the authors (2024)

Thus, there has been a specialization of terms, evolving from concepts already established in the literature, such as *bioeconomy*, *green economy* and *China*. The term circular *bioeconomy* is gaining interest in more recent publications.

Analysis of authors and publication sources

A total of 299 authors were identified who had published at least one piece of research on the subject. Of all the authors, only 8 have published twice on the subject. This shows that the topic is not addressed by a specific group of authors. Table 2 shows the authors with the most citations and the respective number of documents published.

Table 2

Authors, citations and published documents

Authors	Quotes	Documents	Authors	Quotes	Documents
Klerkx, Laurens	536	2	Dahlstrom, Margareta	101	2
Rose, David	286	1	Grundel, Ida	98	1
Hirckey, Gordon m.	250	1	Sotarauta, Markku	67	2
Pigford, Ashlee-ann e.	250	1	Suvinen, Nina	67	2

Source: prepared by the authors (2024).

The most cited authors are Laurens Klerkx with 536 citations, followed by David Rose with 286 citations. The article by Klerkx and Rose, entitled *Dealing with the game-changing technologies of Agriculture 4.0: How do we manage diversity and responsibility in food system transition pathways?*, published *by Global Food Security*, already has over 286 citations. The article argues that more attention needs to be paid to the inclusionary and exclusionary effects of Agriculture 4.0 technologies, and to reflecting on how they relate to various transition pathways towards sustainable agricultural and food systems, driven by mission-oriented innovation systems. Mazzucato (2018) argues that mission-driven innovations are key to solving major global challenges such as climate change and social inequality.

The article, *Beyond agricultural innovation systems? Exploring an agricultural innovation ecosystems approach for niche design and development in sustainability transitions*, by the authors Ashlee-Ann E. Pigforda, Gordon M. Hickeya and Laurens Klerkxb, and published by *Agricultural Systems*, has 250 citations. The article discusses existing agricultural innovation systems and how they can support the creation of innovation niches. They consider how innovation ecosystems can enhance efforts to create multi-actor, cross-sector innovation niches that are capable of supporting transitions to sustainable agricultural systems at multiple scales.

Ida Grundel and Margareta Dahlström are the authors of the article *A Quadruple and Quintuple Helix Approach to Regional Innovation Systems in the Transformation to a Forestry-Based Bioeconomy*, which has more than 98 citations and was published by the *Journal of the Knowledge Economy*. In this article, the aim was to discuss the possible preconditions for the transformation of a Regional Innovation System (RIS) into a quadruple and quintuple helix system, applied to the development of a sustainable forestry-based bioeconomy in Värmland, Sweden.

The research points to the need not only to continue to develop the current innovation systems to include more players than before, but also to consider concern for the environment as a way of achieving sustainability, in line with what Carayannis and Campbell (2010) advocated which broadened the traditional innovation model to include civil society and the environment, in addition to the already established players (academia, industry and government).

Table 3 shows the articles with the most citations, the year of publication, the authors, the source of publication and the number of citations for each article.

Table 3

Articles with the highest number of citations

Article	Authors	Source of Publication	Quotes
Dealing with the game-changing technologies of Agriculture 4.0: How do we manage diversity and responsibility in food system transition pathways?	Klerkx, L., Rose, D.	Global Food Security, 24, 100347	286
Beyond agricultural innovation systems? Exploring an agricultural innovation ecosystems approach for niche design and development in sustainability transitions	Pigford, A.-A.E., Hickey, G.M., Klerkx, L	Agricultural Systems, 164, pp. 116–121	250
A Quadruple and Quintuple Helix Approach to Regional Innovation Systems in the Transformation to a Forestry-Based Bioeconomy	Grundel, I., Dahlström, M.	Journal of the Knowledge Economy, 7(4), pp. 963–983	98
The role of green economy in sustainable development (Case study: The eu states)	Lavrinenko, O., Ignatjeva, S., Ohotina, A., Rybalkin, O., Lazdans, D.	Entrepreneurship and Sustainability Issues, 6(3), pp. 1113–1126	64
Global action on sdgs: Policy review and outlook in a post-pandemic era	Cheng, Y., Liu, H., Wang, S., Cui, X., Li, Q.	Sustainability (Switzerland), 13(11), 6461	50
Can corporate digitalization promote green innovation? The moderating roles of internal control and institutional ownership	Li, D., Shen, W.	Sustainability (Switzerland), 13(24), 13983	50

Source: prepared by the authors (2024).

Analysis of the countries of origin of the publications

Table 4 shows that the country with the highest number of publications is China, with 17 documents. Next comes Germany with 10. The United States has 8 publications. Then come the Netherlands and Sweden with 7 publications each. The United Kingdom, Finland, Italy and Brazil

have published 6 documents. Norway has 5 publications. In all, 49 countries have published on the subject.

Table 4

Publications by country

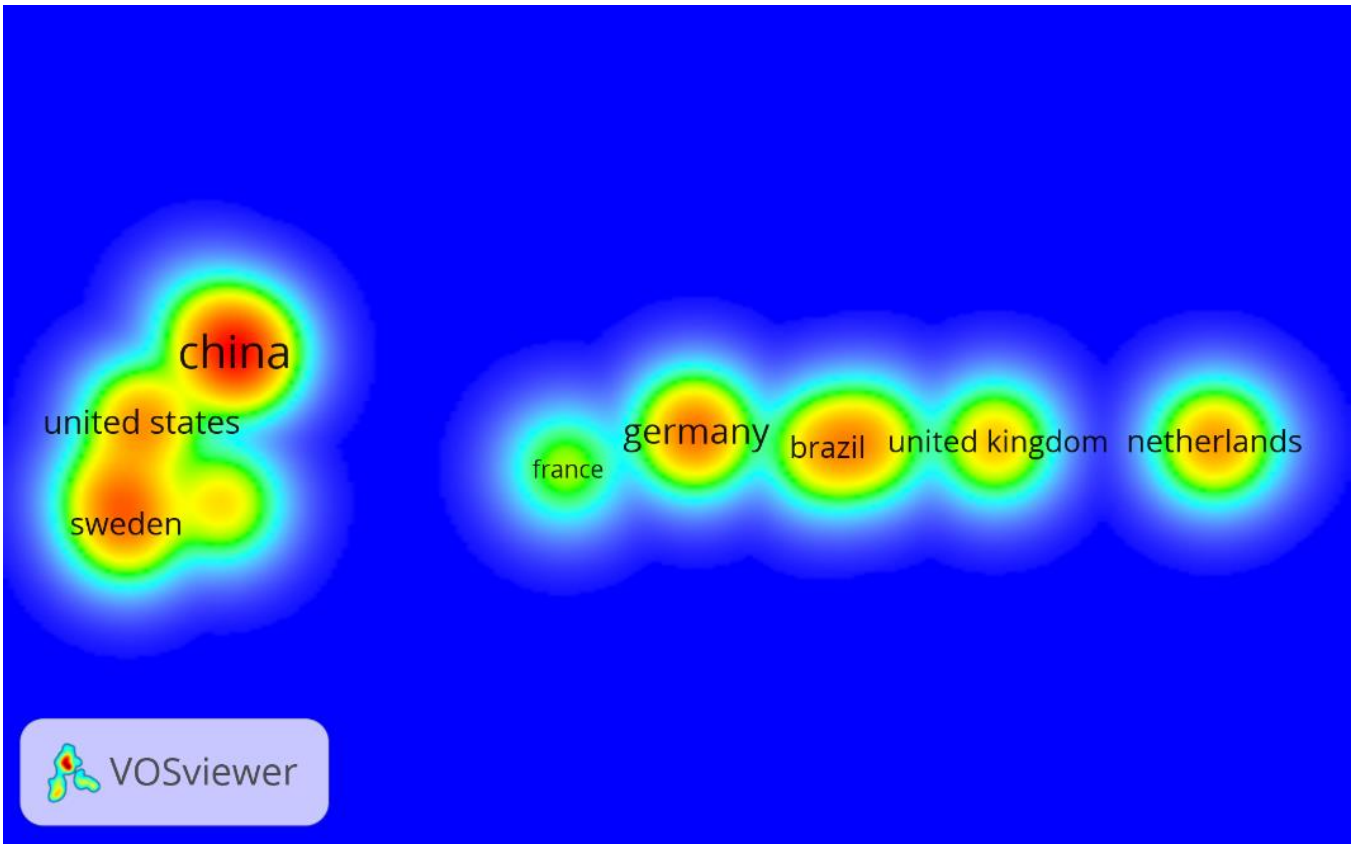
Country	Documents	Country	Documents
China	17	United Kingdom	6
Germany	10	Finland	6
United States	8	Italy	6
The Netherlands	7	Brazil	6
Sweden	7	Norway	5

Source: prepared by the authors (2024).

The countries with the most citations: Netherlands (552), United Kingdom (313), China (251), Canada (250), Sweden (154), United States (149), Germany (142), Finland (116), Norway (77), Latvia (64). It is possible to notice that Europe plays a central role in the development of studies and policies on these issues, as Birgit Dewick *et al.* (2020) point out, highlighting the European focus on sustainability and the bioeconomy, driven by investments in research and innovation.

Figure 5

Countries that have published the most



Source: elaborado pelo autor (2024).

It can be seen that publications have been published in countries on several continents. China, on the Asian continent, is the country with the largest number of publications. Europe stands out with publications from several countries, the main ones being: Germany, the Netherlands, Sweden, the United Kingdom, Finland and Norway. In the Americas, the highlights are the United States and Brazil. The African continent and Oceania have little representation in the set of publications. China's prominence in publications is well examined by Yan *et al.* (2021), who noted the rapid advance in research aimed at the bioeconomy, driven by its policy of innovation and sustainable development.

Conclusion

This article investigated how innovation ecosystems and the bioeconomy are related and positioned in international literature.

It is a fact that the survival and development of humanity requires a transition to the "green economy", which is a system of economic activities related to the production, distribution and consumption of goods and services that lead to an increase in human well being in the long term, but at the same time without exposing future generations to significant environmental risks or environmental deficits.

The strategies and policies used to transform current economies into a sustainable bioeconomy can be seen as a way of coordinating the transformation by protecting biodiversity, food quality and quantity, preserving biotopes and mitigating climate change.

Thus, the Quintuple Helix innovation system includes environmental concerns and emphasizes the transformation of society and the current economic system to become more sustainable. The proposed model is interesting from the point of view of the new environmental challenges and the transformation towards sustainability.

Therefore, from the research carried out, it can be concluded that both terms are well interlinked in the literature. The main keyword is green economy, followed by susteinability development; bioeconomy; innovation and susteinability, which are also strongly related in the formation of clusters. They also have the highest number of publications.

The oldest terms in recent years are environmental protection and bioeconomy. And, from 2022 onwards, the term green economy is gaining prominence. The most recent terms (2023) are: green innovation, environmental economics, China, spatiotemporal analysis and circular economy.

China stands out in terms of the number of publications on the Asian continent. However, European countries stand out in terms of citations and number of publications.

As a final definition, the results show that the bioeconomy and the innovation ecosystem are topics of common interest to most countries and have a field of research that can be explored.

The limitation of this study is the use of one database and the possibility of a wider selection of publications, with the recommendation that future research should explore the content of these publications, draw up a review of the main results found in each study and point out any gaps in knowledge that could still be explored.

Authors' contributions

Contribution	Felix Júnior, R. C.	Lima, C. P.	Viani, R. B.	Fonseca, A. S.
Conceptualization	X	X	-----	-----
Methodology	X	-----	-----	-----
Software	X	-----	-----	-----
Validation	X	X	X	X
Formal analysis	X	X	X	X
Investigation	X	-----	X	-----
Resources	X	-----	X	X
Data curation	X	-----	X	-----
Original	X	-----	X	X
Revision and editing	X	-----	X	X
Viewing	X	-----	X	X
Supervision	X	X	-----	-----
Project management	X	X	X	-----
Obtaining funding	X	X	X	X

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