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Where Are We with Respect to Research in Support of Sustainable Development Goal 13? Bibliometric Analysis

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ABSTRACT

Climate change is one of the main global challenges, addressed in the United Nations Sustainable Development Goal (SDG) 13, which seeks to "take urgent action to combat climate change and its impacts". The objective of the research was to analyze scientific articles that directly relate to SDG 13 through a bibliometric analysis for the period 2015 to 2024 of the Scopus database using the search term "SDG 13" OR "Sustainable Development Goal 13". The research identified prolific authors, articles, sources with the highest impact in the area of study, leading institutions and countries in publications along with a detailed keyword analysis. The results show that interest in the study of SDG 13 has grown significantly with a focus on areas such as mitigation and adaptation, low carbon economy and public policy. This analysis provides an overview of advances in SDG 13 research, helps to identify knowledge gaps and emerging areas, and contributes to the formulation of effective policies and the drive for global climate action.

1. INTRODUCTION

The United Nations 2030 Agenda for Sustainable Development outlines a comprehensive policy framework with the goal of ensuring that, by 2030, all nations achieve economic prosperity, social inclusion, environmental sustainability and effective governance. Among the 17 Sustainable Development Goals (SDGs) and 169 targets that make up this agenda, goals 13 ("Take urgent action on climate change and its impacts"), 14 ("Protect and sustainably use the oceans, seas and marine resources for sustainable development") and 15 ("Conserve, Conserve, restore and promote the sustainable use of terrestrial ecosystems, responsibly manage forests, combat desertification, reverse land degradation and halt biodiversity loss") focus on the environmental dimension, providing key indicators to address climate change and preserve life [1].

Sustainable Development Goal 13 (SDG 13) focuses on addressing climate change by promoting a framework for collaboration among various actors to achieve this goal. It also seeks to strengthen the capacity of developing countries to adapt and respond to climate challenges. The adoption of this SDG implies the incorporation of indicators related to action, adaptation, impact mitigation and early warning systems in government policies and plans, promoting awareness and individual responsibility [2]. Five main targets were defined for its fulfillment: Target 13.1 (Strengthen resilience and adaptive capacity to climate risks and natural disasters in all countries), 13.2 (Incorporate climate change-related measures into national policies, strategies and plans), 13.3 (Improve

education, awareness, and institutional and human capacity for climate change mitigation, adaptation, impact reduction and early warning), 13.4 (Improve the capacity of national governments and other stakeholders to address climate change), 13. a (Mobilize US$100 billion per year, a commitment made by developed countries to support developing nations from 2020) and 13. b (Promote mechanisms to strengthen climate change planning and management in least developed countries and small island developing states, with an emphasis on women, youth, and local and marginalized communities) [3].

With only six years left to achieve the goals of the 2030 Agenda, the urgency of transformations that accelerate the implementation of the SDGs has been raised, with a view to both 2030 and their future sustainability [4]. Six essential transformations have been identified that could facilitate the achievement of the SDGs and their maintenance until 2050 [5]. In this framework, science and research-based approaches play a decisive role in driving the implementation of SDGs [5, 6]. The scientific community plays a key role in the creation of sustainable indicators and methodologies that promote effective collaboration between various acceptable parties, enabling progress towards sustainability in the short, medium and long term. It is also a priority that scientific knowledge is translated into effective public policies [4, 5]. However, despite the acknowledged importance of science, the incorporation of research and evidence-based approaches to accelerate and implement the SDGs remains insufficient [6].

Climate change proves to be one of the most critical challenges to global sustainability, driving the adoption of policies and actions under SDG 13, which calls for urgent action to combat climate change and its effects. The purpose of this study was to map the global scientific output related to SDG 13, showing research trends, influential authors, and emerging themes in this area. The identification and analysis of SDG 13 research will enable researchers and policy makers to assess progress in key areas such as emissions mitigation and climate change adaptation. In addition, this study responds to the growing need to strengthen the integration between science and public policy in order to transform scientific knowledge into effective policy decisions. This effort also contributes to the reduction of collaboration gaps, especially between developed and developing countries, and promotes a clearer understanding of how the scientific effort can support the implementation of SDG 13 indicators and targets.

This bibliometric analysis brings practical and strategic benefits to climate change practitioners and researchers. It identifies key journals, authors and publications that can serve as a guide for designing future research and policy strategies. For researchers, it highlights relevant and growing thematic areas, promoting greater alignment with climate objectives and fostering international cooperation. These findings are critical for directing resources towards high-impact research and supporting the implementation of sustainable practices and policies aligned with SDG 2030.

2. MATERIALS AND METHODS

2.1 Search strategy

A bibliometric analysis was performed following the PRISMA methodology [7], designed to improve the rigor of such studies by using a structured checklist. Data were obtained from the Scopus database, a highly prestigious repository within the ScienceDirect platform, managed by Elsevier, which hosts a vast collection of high-impact scientific publications [4, 8]. The analysis covered the period from 2015, which marks the adoption of the SDG (2015), to October 10, 2024, the date of data extraction. The search used the terms “SDG 13” and “Sustainable Development Goal 13” for the data extraction.

This search strategy allowed the identification of research areas explicitly associated with SDG 13. Boolean operators were applied to refine the dataset and exclude irrelevant papers. Despite this, it is recognized that other significant contributions to SDG 13 may exist, but were not included if the search terms were not explicitly mentioned. Exclusion criteria were: 1. Language other than English, 2. Review of conferences, editorials, errata, short survey and 3. Conference papers (Figure 1).

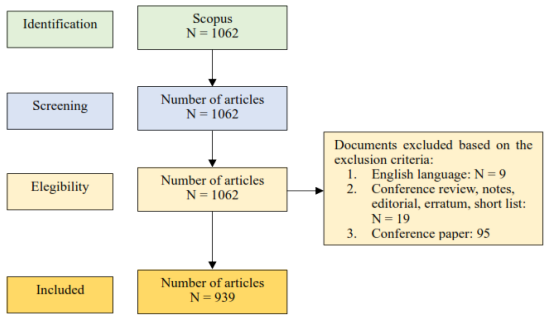

Figure 1. PRISMA flow chart

2.2 Data analysis

VOSviewer and Biblioshiny (R Studio) were used for bibliometric analysis, the former is a statistical bibliometric tool, used to build and view bibliometric maps, e.g.; is used in the construction of bibliometric networks of authors, journals and organizations through analysis methods such as co-authorship, co-occurrence, co-citations and bibliometric coupling [9], while Biblioshiny is the tool used in scientometrics and bibliometrics which contains different methods to import bibliographic data from “SCOPUS” [10].

A scientific mapping was carried out with the purpose of analyzing the connections between the different research elements and revealing both the structure and dynamics of existing knowledge related to SDG 13. For this purpose, techniques such as co-authorship, co-citation and co-occurrence analysis were employed using VOSviewer software. In addition, Biblioshiny was used to examine annual scientific production, identify the most prominent journals, institutions and authors, and explore research trends linked to SDG 13 [10].

3. RESULTS

3.1 General analysis of SDG 13

For the study period (2015 - 2024) showed a total number of published scientific articles equal to 939. In recent years, an accelerated increase of articles related to SDG 13 was observed; thus, in 2022, 2023 and 2024, 211, 280 and 307 articles were published respectively, and it should be noted that there is 1 article to be published in 2025 (Figure 2).

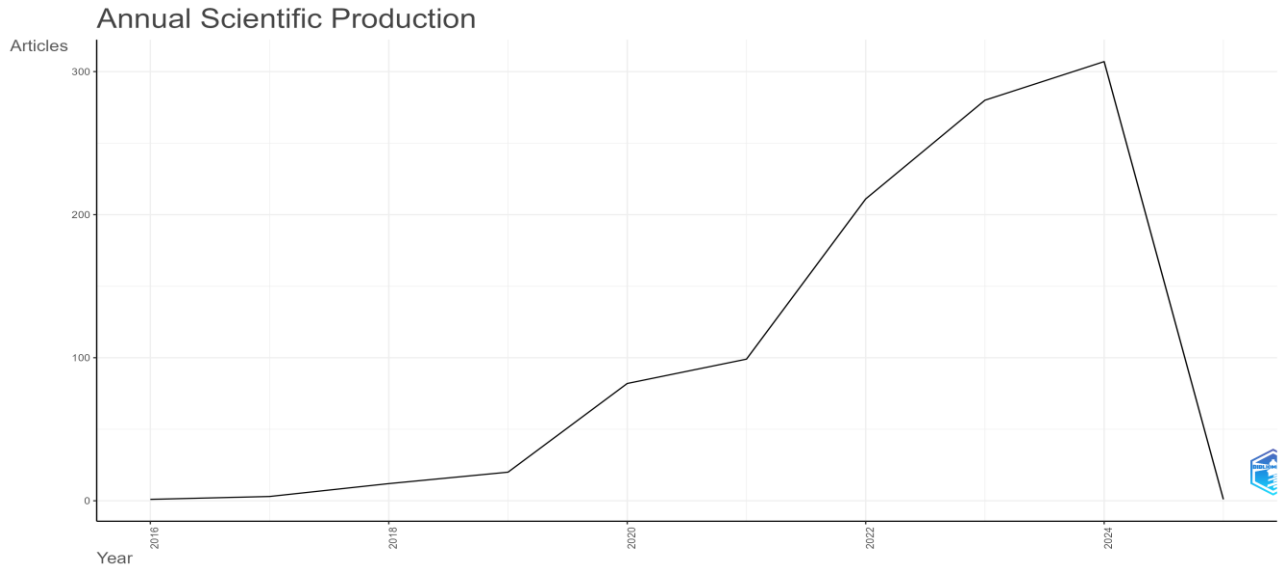

Figure 2. Annual evolution of scientific production related to SDG 13

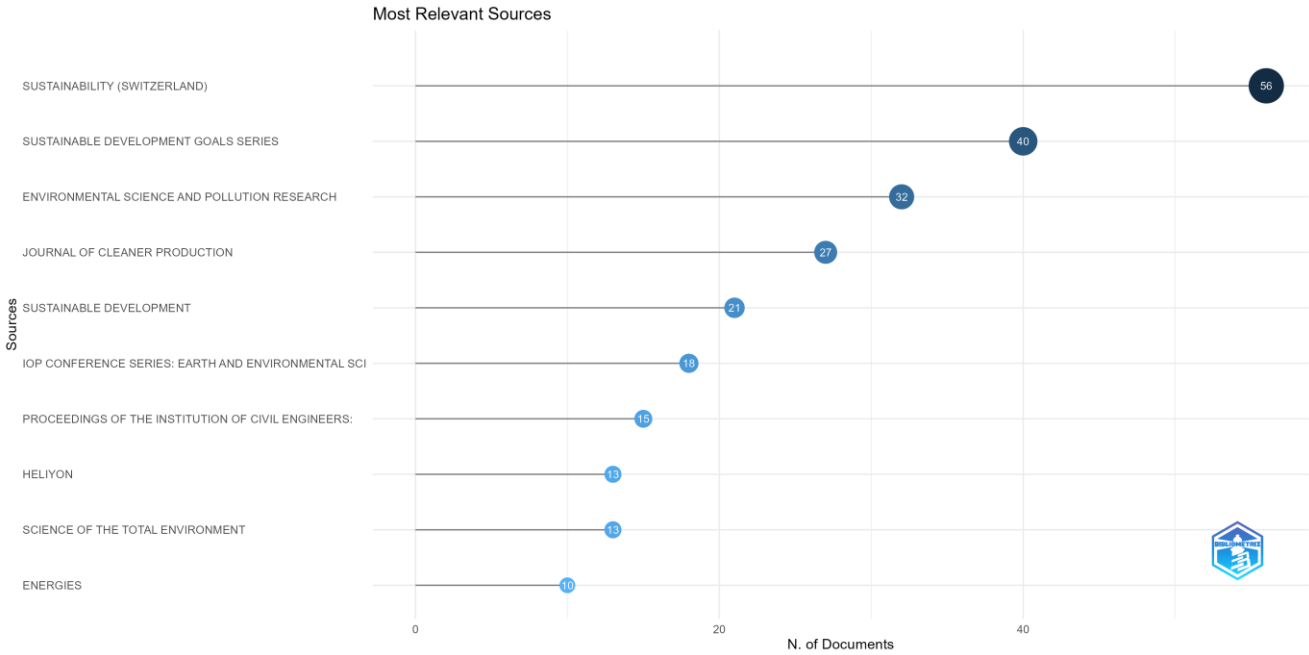

Figure 3. Journals with the highest scientific production related to SDG 13

Of the 939 articles, 6% were published in the journal Sustainability (Switzerland) [11] followed by Sustainable Development Goals Series [12], Environmental Science and Pollution Research [13], Journal of Cleaner Production [14], Sustainable Development [15], IOP Conference Series: Earth and Environmental Science [16], Proceedings of The Institution of Civil Engineers: Civil Engineering [17], Heliyon [18], Science of The Total Environment [19] and Energies [20] with 3%, 3%, 2%, 2%, 1%, 1% and 1% respectively, in total, 23% of all manuscripts related to SDG 13 were published in these ten journals. In this context, it is clear that the most significant contributions to SDG 13 transcend the publications focused exclusively on climate change (Figure 3).

Table 1 shows that the 10 most cited articles were published between 2020 and 2022, reflecting that they are recent research with considerable impact on the academic community. The most cited article is from 2021, with 388 citations, indicating that it is an influential paper in the discussion on the circular economy and the SDGs. Other papers close in number of citations were published in 2020, suggesting a growing interest in these topics as they become more relevant in the global context. Regarding research trends, it can be seen that several recent papers focus on green technological innovation and its relationship with CO_2 emissions. Clear examples are studies on carbon sequestration (with 249 citations) and the impact of environmental technologies and policies in G7 countries (with 194 and 248 citations, respectively). This emphasis on CO_2 reduction is consistent with the climate goals set out in the SDGs.

Most of the papers published in 2022 are rapidly gaining traction. For example, assessing the role of wastewater treatment in the SDGs (207 citations) and the role of green technology in CO_2 emissions in G7 countries (194 citations) are indicative of new emerging research areas that are rapidly gaining traction.

Table 1. Most cited articles

Year	Title	Number of Citations	References
2021	How the combination of Circular Economy and Industry 4.0 can contribute towards achieving the Sustainable Development Goals	388	[21]
2020	Industry 4.0 based sustainable circular economy approach for smart waste management system to achieve sustainable development goals: A case study of Indonesia	375	[22]
2020	Interplay between technological innovation and environmental quality: Formulating the SDG policies for next 11 economies	330	[23]
2022	Assessment of the pre-combustion carbon capture contribution to sustainable development goals SDGs using novel indicators	249	[24]
2022	How environmental taxes and carbon emissions are related in the G7 economies?	248	[25]
2022	The nexus between urbanization, renewable energy consumption, financial development, and CO_2 emissions: evidence from selected Asian countries	226	[26]
2022	The role of wastewater treatment in achieving sustainable development goals (SDGs) and sustainability guideline	207	[27]
2022	Nexus between green technology innovation, green financing, and CO_2 emissions in the G7 countries: The moderating role of social globalisation	194	[28]
2020	A conceptual framework for understanding the contribution of building materials in the achievement of Sustainable Development Goals (SDGs)	184	[29]

3.2 Keyword co-occurrence analysis and co-citation of journals

The map shows five clusters, the blue cluster (Climate Change and Sustainable Development) is one of the largest clusters and is centered on terms such as “climate change”, “sustainable development” and “sustainable development goals”. These key terms suggest that much of the research is related to the integration of climate change and development strategies, the Red cluster (Energy and Economy), located on the right hand side of the map is a cluster dominated by terms related to energy, economic growth and carbon and the Green cluster (Agriculture, Food Security and IA), this cluster is dominated by terms related to energy, economic growth and carbon, Food Security and AI), this cluster is composed of terms related to food security, the use of artificial intelligence and agriculture, the Yellow and Purple cluster (Emission Control and Clean Energy), terms related to emission control policies and clean energy are identified (Figure 4).

The journal co-citation analysis shows different clusters, among them, the blue cluster (Environmental Science and Sustainability) which contains journals such as Environmental Science & Pollution Research, Journal of Cleaner Production and Renewable Energy. These journals are fundamental in research related to sustainability, environmental pollution and renewable energy. The blue cluster represents a focus on environmental sustainability and clean energy production, in which journals such as Environmental Science & Pollution Research are widely cited in studies that focus on environmental pollution and mitigation of its effects, while journals such as Journal of Cleaner Production and Renewable Energy are fundamental for topics related to sustainable production and renewable energy technologies. The red cluster focuses on journals such as Journal of Cleaner Production, Renewable Energy and Renewable & Sustainable Energy Reviews, this cluster is clearly oriented towards research in renewable energy and clean production, highlighting journals that deal with technological innovations and materials used for the transition to a more sustainable economy.

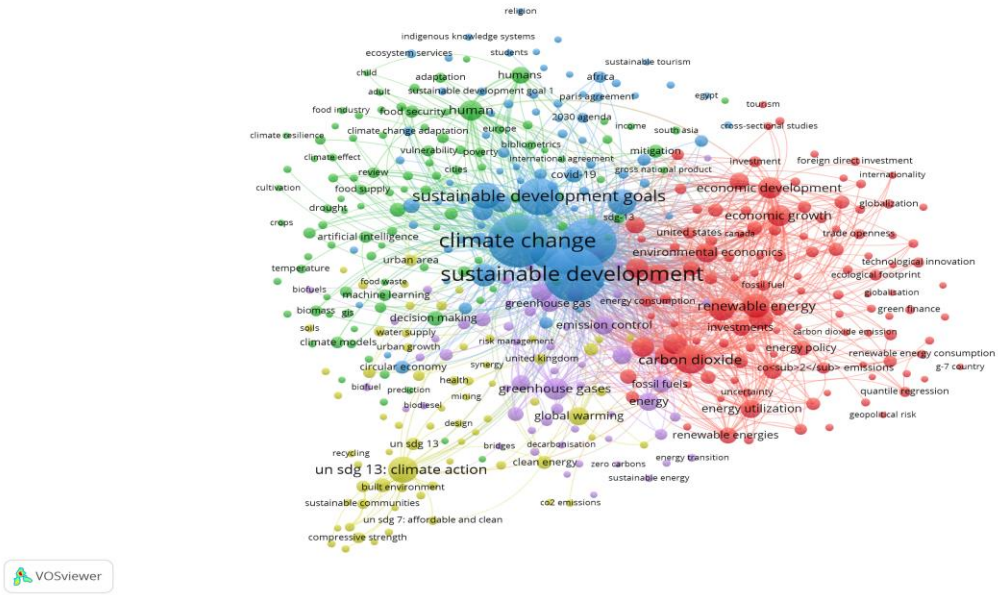

Figure 4. Co-occurrence of keywords

The cluster is highlighted by journals such as Sustainability and Energy Policy, which suggests a broader focus on energy policies and their relationship to sustainability. The Yellow cluster includes journals such as International Journal of Hydrogen Energy and Environmental Science and Pollution Control, this cluster is focused on hydrogen energy and pollutant emission control technologies. The Purple cluster includes journals such as International Journal of Hydrogen Energy and Energy Conversion and Management, these journals analyze from a more technical point of view how different forms of energy are managed and converted, with a particular focus on alternative and renewable fuels, including hydrogen energy. There is a strong connection between journals related to environmental sustainability and cleaner production (blue and red clusters), reflecting the interrelated nature of these disciplines. Sustainability research frequently cites papers on clean production technologies, suggesting a synergy between these two fields in terms of mitigating the effects of climate change (Figure 5).

3.3 Affiliations and authors with major publications

Figure 6 reflects the most relevant affiliations in terms of number of scientific publications, showing institutions that have contributed significantly to the study of SDG 13; this figure reveals a notable participation of universities from Asia, Africa and the Middle East. In Asia, as the epicenter of technological and environmental research, universities from countries such as China and India stand out, represented by Jiangsu University and Amrita School of Business; in Africa and the Middle East, which are new key players in scientific production, the University of Sharjahes, University of South Africa (UNISA), and emerging universities such as Amrita School of Business and Wuhan University stand out.

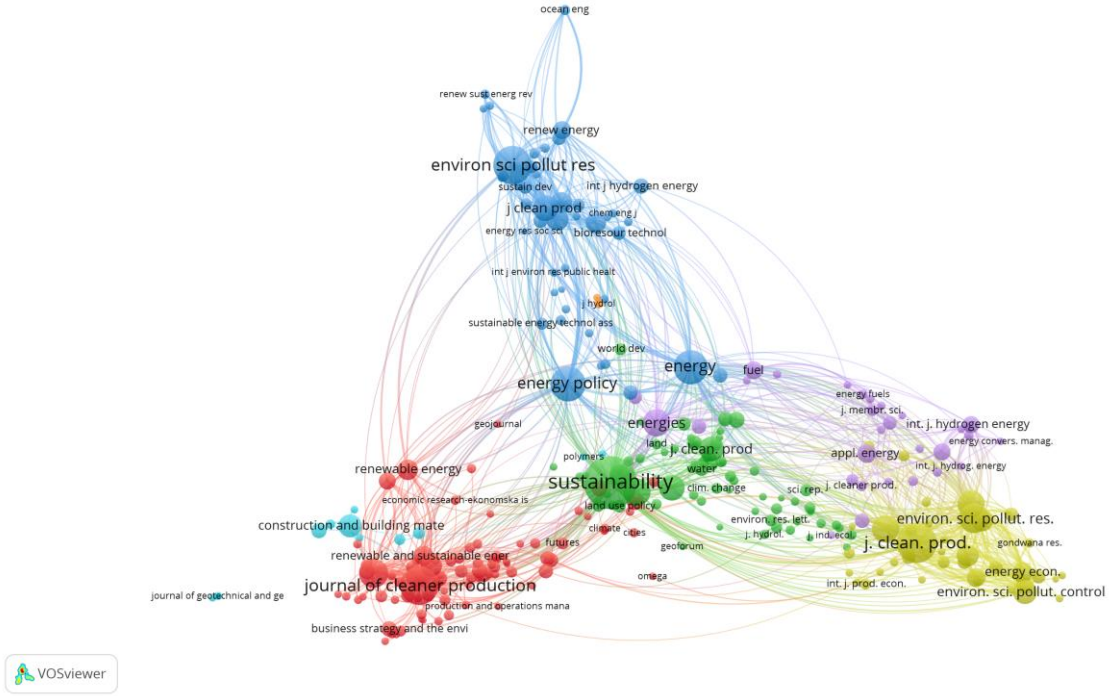

Figure 5. Journal citation network

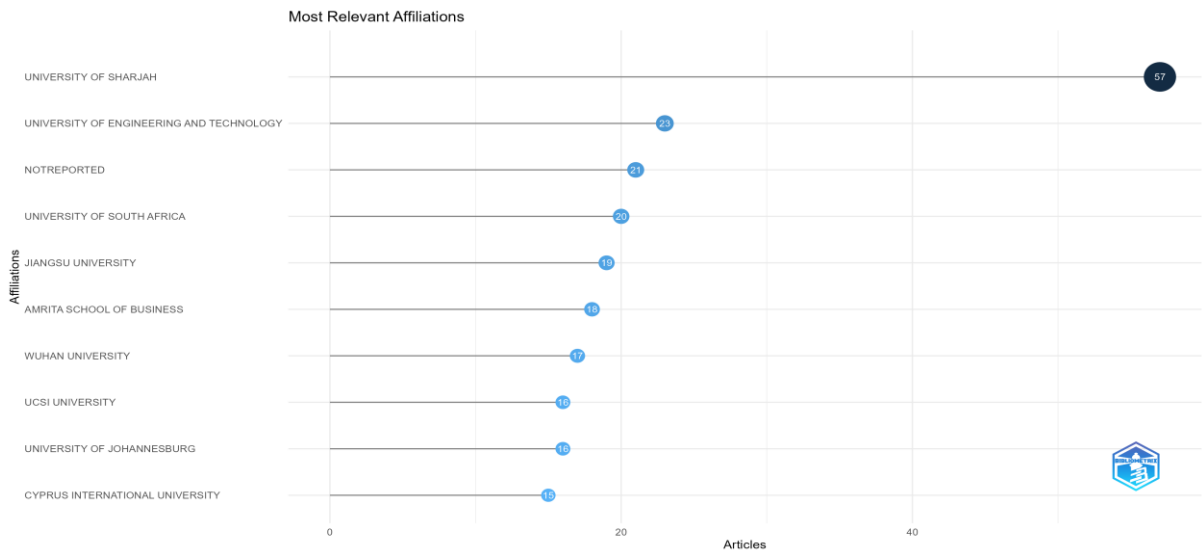

Figure 6. Affiliations with the highest number of publications

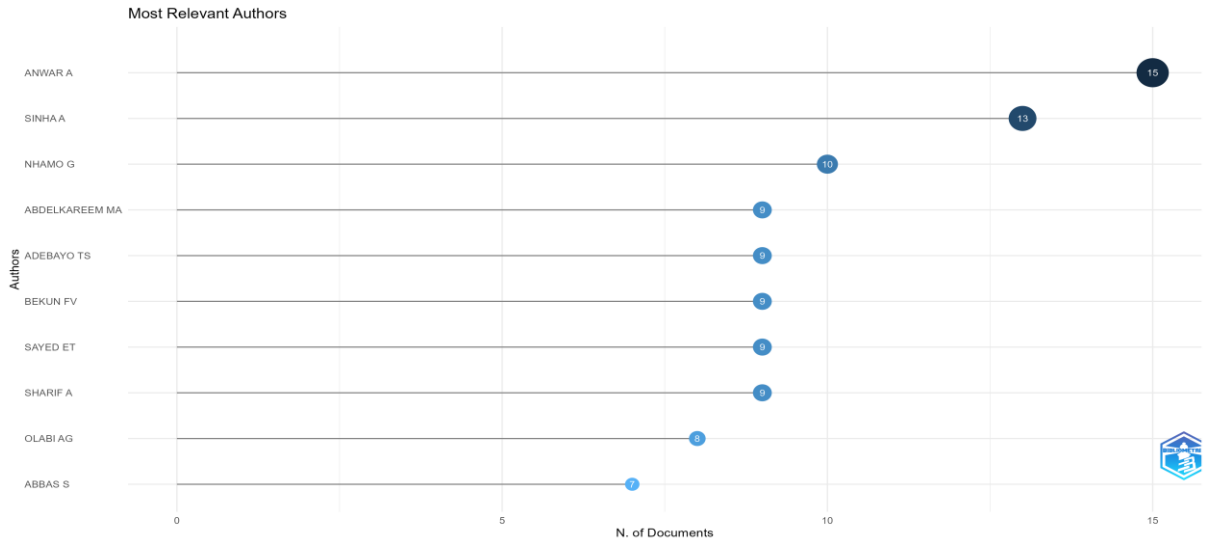

Figure 7. Authors with the highest number of publications

Figure 7 highlights the most relevant authors according to the number of papers associated with each one. The most relevant authors are Anwar et al. [30], with 15 papers, Sinha et al. [31] rank second with 13 papers, Nhamo et al. [32] follow with 10 papers, then, there is a group of authors with 9 papers each: Hai Alami et al. [33], Adebayo et al. [34], Bekun et al. [35], Sayed et al. [36] and Sharif et al. [28], Olabi et al. [19] have 8 papers and Abbas et al. [37] have 7 papers, being the author with the lowest number in this group.

3.4 Co-authorship analysis between countries

The results of the bibliographic linkage of at least 10 articles per country can be seen in Figure 8. It can be seen that, India; China and the United Kingdom are the countries with more than 100 articles related to SDG 13. Collaboration was also evident among developing countries such as Nigeria, South Africa, Turkey and Malaysia; however, research partnerships are weaker than among industrialized countries. This suggests that, in order to achieve the implementation of SDG 13, increased research collaboration and knowledge transfer among all countries is needed.

3.5 Trends and suggestions for future research on SDG 13

Most terms related to the Sustainable Development Goals (SDGs) and climate change have gained relevance in recent years, especially in 2023 and 2024. The most frequently mentioned topics, such as Climate Change, Sustainable Development Goals, and Circular Economy, are indicative of current global environmental concerns, while terms such as Waste Management and Adaptive Capacity, although important, seem to have decreased in relevance in recent years. Terms that align with international policies, such as Paris Agreement, remain relevant, although not as prominent as more recent global initiatives, such as climate action under SDG 13 (Figure 9).

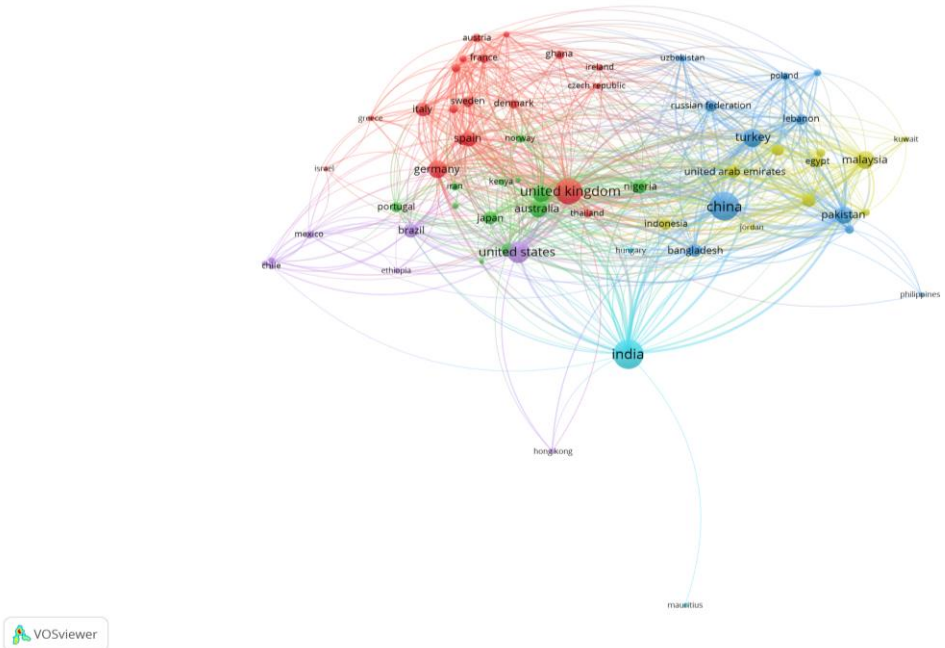

Figure 8. Map of international research collaboration aligned with SDG 13

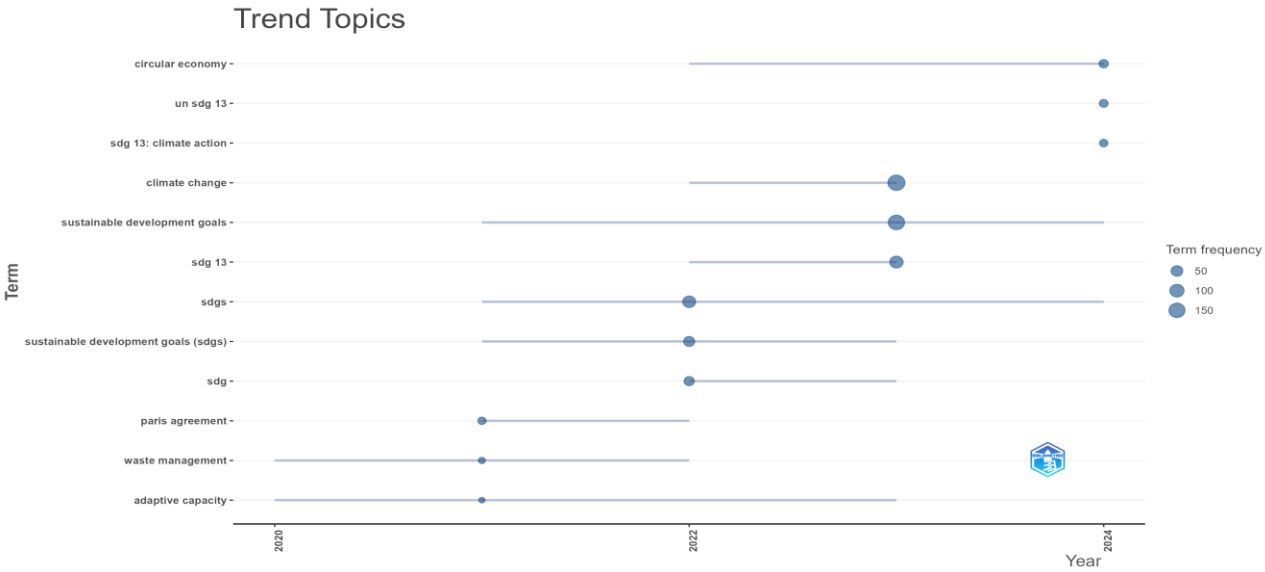

Figure 9. Trend topics regarding the study of ODS 13

4. DISCUSSION

A significant increase in publications related to SDG13 is evident between 2015 and 2024 (October 09, 2024). Despite the growth trend in the topic, it is important to continue research with an approach based on the integration and fulfillment of SDG 13 indicators and targets.

After completing the selection process, 939 articles were identified as suitable for bibliometric analysis. The most outstanding scientific publications in research related to SDG 13 are located in the Q1 quartile, which reflects a marked tendency to publish these papers in high-impact journals. Among the most cited are open access journals such as Sustainability and Journal of Cleaner Production [5].

With respect to the most cited manuscripts (Table 1), there is evidence of a significant focus on topics related to the circular economy, green technology and policies focused on reducing CO_2 emissions. These topics show an emerging attention towards both technological and economic solution mechanisms that can have a direct influence on climate change mitigation and the fulfillment of SDG 13. One possible reason for this trend is the growing recognition that the transition to a sustainable economy requires innovations that integrate industrial practices with low environmental impact while promoting efficient use of resources. In addition, the high number of citations in these articles suggests that they are having a considerable impact on the scientific community and, possibly, on environmental policy-making in different countries.

It was observed that different researchers from different countries and with common research experience generated synergies and have contributed significantly to research related to SDG 13. The results showed that developing countries such as South Africa, Turkey, Pakistan and Nigeria contributed significantly to SDG 13 research, so it is necessary to promote mechanisms for SDGs to embrace all populations (vulnerable and not) in order to avoid obstacles in the progress of SDG 13. These results are also shown in other studies, for example [5, 22, 38], thus corroborating the need for scientific research in these regions and using scientific findings to design technological and innovative solutions to achieve SDG 13 and advance all SDGs.

Regarding keywords, an accelerated growth of scientific publications regarding SDG 13 was observed. The first-time span (2015-2019), only 30 manuscripts connecting their research to SDG 13 were reported. It is noticeable that the articles published at this stage focus on three main axes on SDGs, first, publications whose focus is the dissemination and commitment to the SDGs [39-43] are appreciated, which is to be understood in this phase since after the publication of the SDGs, the adoption of commitments by the different actors is sought and is coupled to target 13., a second axis talks about sustainable development and the implementation of the SDGs [44-47] and the third addresses issues of climate change and its impact on smallholder agriculture [48-50]. This axis is very important, as it addresses the vulnerability of smallholder farmers to climate change and how they can adapt, and is directly related to target 13.1 and target 13.b. For the second period (2020-2024), a greater number of manuscripts were published (909) and therefore a broader horizon in the published subject matter was observed, for example, the importance of the economic aspect in the fulfillment of the SDGs was addressed, which is related to target 13.a., new trends in energy use were also studied, focusing mainly on clean energy in order to comply with SDG 13 and finally the contribution of carbon dioxide on climate change, which is related to target 13.2. Although, the keywords did not explicitly mention the different targets related to SDG 13, mentioning them will make them more visible and it will be much easier to implement them for science, technology and innovation, this would help the fulfillment of the SDGs [1, 5].

Figure 8 highlights issues such as climate change adaptation, circular economy and mitigation capacities, which have gained prominence in recent years. These emerging themes show an evolution in the focus of research from an emphasis on identifying problems to exploring practical and adaptive solutions to climate change. The popularity of these themes suggests that researchers and practitioners alike are seeking strategies that go beyond emissions reductions and address issues such as resilience and long-term sustainability, especially in vulnerable communities and developing countries.

The limitations found in the research are mainly related to the methodology used. Only the Scopus database was used;

therefore, a lower number of retrieved publications is to be expected. Another limitation is related to the type of literature used; only peer-reviewed literature was considered and government reports and/or policy briefs were excluded. Finally, this research did not differentiate between research that focuses on SDG 13 from those that only mention this term. Nevertheless, this study shows an overview of existing scientific research on SDG 13.

5. CONCLUSIONS

This study conducted a detailed bibliometric analysis of scientific production related to SDG 13, highlighting significant trends and patterns of collaboration. The results show a significant growth in scientific publications on topics such as circular economy, green technology and emission reduction policies, areas that have proven to be essential for the fulfillment of SDG 13. The manuscripts with the highest number of citations and the emerging themes identified show a transition towards practical solutions for mitigation and adaptation to climate change, with special attention in the context of developing economies. The main contributions of this research are:

1. It shows topics and areas with major influence in the field of climate change, which will guide future research related to SDG 13.
2. There is considerable evidence of collaboration on climate research issues among developed countries, but there is little collaboration with developing countries, which suggests an opportunity to foster inclusive and global partnerships.
3. 43% of the articles are in open access, this highlights the importance of open dissemination in broadening access to knowledge on climate change.

For the development of future research, it is recommended that:

1. Foster collaboration between developed and developing countries in order to accelerate the fulfillment of SDG 13.
2. To study in depth the application of the circular economy and green technologies in different socioeconomic and geographic realities.
3. Research related to SDG 13 should be explicitly incorporated into the established indicators and targets in order to facilitate the monitoring of the impact of science on public policies.
4. Since there is a high percentage of publications on climate change in open access journals, it is necessary that institutions continue to promote this practice in order to maximize the reach and accessibility of scientific results.

Finally, future research should focus not only on the study of new climate change issues, but also on analyzing how knowledge translates into effective policies and local solutions, which will allow policy makers and actors involved in SDG 13 to make evidence-based decisions, thus optimizing resources for effective climate action.

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