

Global Boundaries: Mapping the Evolution of Green Product Exports through Bibliometric Analysis

Ashok Garg^{1*} and Sunil K Roy²

^{1*}Research Scholar, Manav Rachna University, Faridabad

²Professor, (Supervisor) Manav Rachna University, Faridabad

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ABSTRACT

Purpose

This study investigates the global evolution of green product exports through bibliometric analysis, mapping trends and contributions from various research institutions worldwide. It has focused on identifying the growth, key innovation drivers, and sustainability impacts of green exports worldwide.

Research Methodology

A large-scale dataset, including 723 documents, from 1978 to 2024, was analysed using bibliometric techniques. Data is collected from the Scopus database, focusing on important indicators such as citations, document growth, and collaboration networks. Tools such as 'Biblioshiny R Studio' view tabulations and visualisations.

Findings

The study showed that research on green product exports has grown significantly, especially since 2000. China and the USA dominate research outputs, but they display different citation effects. Sustainability practices, environmental policies and technological innovation were identified as the key drivers of research in this area. Collaboration networks highlight the global nature of green product export research, with major contributions from regions such as Europe and Asia.

Originality/Value

This research presents a new perspective on the evolution of green product exports using bibliometric analysis. It identifies the key themes, collaborations and influential sources shaping this growing field of study. The findings provide valuable insights for policymakers, researchers and industry leaders by highlighting the links between sustainability and international trade. The study also provides a basis for future research on the dynamics of green product exports and their role in promoting sustainable economic practices.

Keywords: Green Product Exports, Bibliometric Analysis, Sustainability, Technological Innovation, Global Trade Trends

Introduction

In recent decades, world trade has undergone profound changes, and green products have great power in the international market. Being driven by climate change and resource scarcity, environmental issues are well-known, so the state quickly gains the importance of sustainable practice in economic strategies. Export of green products including a wide range of products aimed at reducing the impact on the environment is essential to this paradigm, which reflects social responsibility and environmental integrity commitment. Various factors including technological advances, market demand and policy structure influence this development in green products. The introduction of new methods such as renewable energy sources, environmentally-friendly production processes, sustainable agricultural practices, etc. is intensifying competition with green products on global platforms. A country that invests in these methods not only enhances export capabilities but also grows to be a leader in the green growth economy. In addition, consumers' behaviour changes quickly, and population growth prefers sustainability of purchase decisions.

This change has increased the demand for environmentally friendly products. In other words, manufacturers and exporters are motivated to adapt their strategies accordingly. Businesses, which adopt green principles, not only meet market requirements but also rapidly gain competitive leaders in markets. Politics plays an important role in training the dynamics for exporting green products. Governments around the world have generally introduced structures and incentives to promote sustainable practices in their industries. Measures such as renewable energy subsidies, green technology rebates, strict environmental standards and other measures encourage companies to innovate and transition to green production methods. These politicians not only improve the quality and attractiveness of green products but also create a preferred environment for international business. The interplay between these factors - technological innovation, priority of consumers and development of tributaries - emphasizes the complexity and importance of product exports in modern economic scenarios. By understanding this development, stakeholders can better understand the issues and opportunities represented by the green economy.

Research Objective

The objective of this study is to analyze publication trends in green product exports from 1978 to 2024, identifying shifts in research focus and key contributors, including authors, institutions, and countries. It will explore collaborative networks and assess the thematic evolution of literature, particularly concerning sustainability and technological innovation. Additionally, the research will evaluate the citation impact of significant publications to highlight influential works. By mapping the global research landscape, the study seeks to identify regional contributions and gaps in existing literature, ultimately providing insights for policymakers and industry leaders on trends and best practices in green product exports

Review of Literature

The evolution of green product exports has been shaped by a complex interplay of agricultural advancements, market strategies, and sustainability concerns. Early research, such as Gahukar (1992), emphasized the contribution of the Green Revolution to India's food production and export economy, noting that while it boosted grain yields, it also led to socio-economic disparities and regional imbalances. Similarly, Quddus et al. (1997) examined the interconnectedness of Pakistan's livestock and crop sectors, showing how trade policies influenced the availability of green forage and livestock feed. Abdullah and Mursalim (1997) contributed to the field by investigating renewable energy applications for sustainable agriculture, particularly through greenhouse-effect solar dryers for vanilla production. These agricultural innovations laid a foundation for later advancements in green exports, supported by technologies and sustainability practices. Technological innovation has played a key role in the shift towards green product exports. For example, He et al. (2024) explored how technological similarities and complementarity in environmental goods trade among 176 countries have driven exports, particularly in high-complexity products from Northern countries. Their findings suggest that green exports depend on not only economic policies but also technological collaboration. Additionally, Shen et al. (2024) highlighted the importance of consumption-based carbon accounting in understanding global emissions patterns, with their findings revealing a decrease in consumption-based emissions in developed countries and a rise in China's green product exports. Other studies have examined the impact of regulatory frameworks on green exports. Liu and Qiu (2024) analyzed the effect of Sanitary and Phytosanitary (SPS) measures on the quality upgrading of agri-products, demonstrating that heterogeneous measures can inhibit environmental protection and quality improvements in export goods. Meanwhile, Yingkamhaeng and Vanichsriratana (2024) discussed Thailand's sugarcane sector, illustrating how the adoption of precision agriculture and the Bio-Circular-Green model has allowed for more sustainable agricultural practices and enhanced export growth. Similarly, Ahmed and Khan (2024) stressed the need for stricter environmental regulations in China's post-pandemic energy rebound, showing how such measures contribute to both economic growth and environmental sustainability through green innovation. Beyond agriculture, green product exports have expanded into other sectors. For instance, Wang et al. (2023) analyzed the potential impact of the EU's Carbon Border Adjustment Mechanism on China's carbon neutrality goals, demonstrating how policy shifts can influence global trade and sustainability goals. Arletti et al. (2023) took a different approach by investigating how industrial waste can be recycled into eco-friendly materials like stoneware tiles, highlighting innovation in resource efficiency. This is echoed in the renewable energy sector, where Ya'Acob et al. (2022) examined solar energy projects in Malaysia,

demonstrating how the integration of rainwater harvesting in solar infrastructure supports green jobs and environmental sustainability. The marketing strategies for green products have also evolved alongside technological and policy shifts. Anbarasi and Kumar (2019) explored the challenges and opportunities of online marketing strategies for organic products in the pharmaceutical sector, particularly regarding certification and quality standards. Klarić and Obućina (2020) highlighted the increasing global demand for environmentally friendly wood technologies, noting that innovations in engineered wood products (EWPs) have driven export markets, particularly in regions like Bosnia and Herzegovina. Finally, Xu et al. (2021) examined China's green tea production, contrasting the benefits of local versus export markets while emphasizing the environmental sustainability challenges associated with both. Collectively, these studies underscore the evolving landscape of green product exports, driven by a combination of agricultural advancements, technological innovation, regulatory frameworks, and market strategies. The ongoing shift towards sustainable development and environmental cooperation in global trade highlights the importance of optimizing production methods to align economic growth with environmental preservation (Nițescu & Murgu, 2022). Together, these insights provide valuable guidance for policymakers and industries aiming to balance the economic and environmental objectives of green exports.

Research Methodology

This study employs a bibliometric analysis to examine the evolution of green product exports, identifying key trends and influential publications in the field. Data for the analysis was sourced from Scopus, covering publications from 1978 to 2024, using search terms such as "green products," "sustainable exports," and "green economy." A total of 723 documents were selected, including articles, book chapters, and conference papers. After data cleaning, bibliometric indicators like citations, keywords, and authors' affiliations were examined. The Biblioshiny R Studio tools a used for the analysis, enabling the visualization of bibliometric analysis.

Framework

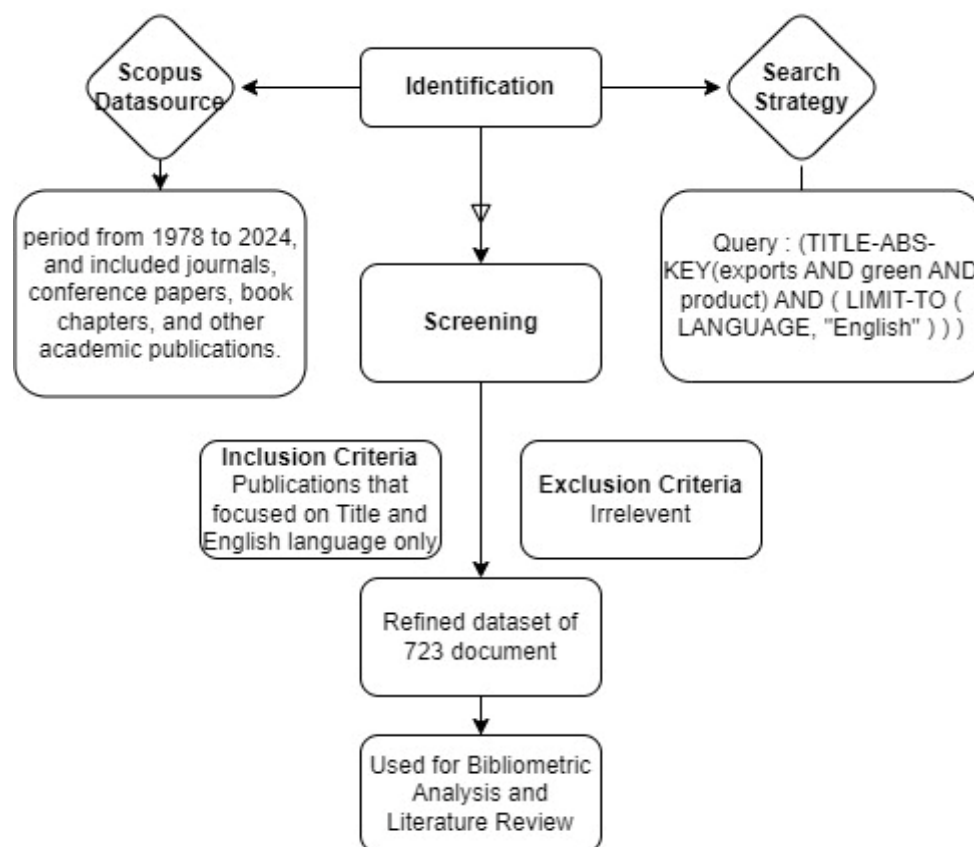


Figure 1 Author's work

DESCRIPTION	RESULTS
Main Information About Data	
Timespan	1978:2024
Sources (Journals, Books, Etc)	485
Documents	723
Annual Growth Rate %	9.42
Document Average Age	8.45
Average Citations Per Doc	29.01
References	30609
Document Contents	
Keywords Plus (Id)	5412
Author's Keywords (De)	2303
Authors	
Authors	2314
Authors Of Single-Authored Docs	107
Authors Collaboration	
Single-Authored Docs	115
Co-Authors Per Doc	3.55
International Co-Authorships %	22.96
Document Types	
Article	533
Book	3
Book Chapter	66
Conference Paper	83
Conference Review	2
Editorial	1
Erratum	2
Note	4
Retracted	1
Review	24
Short Survey	4

Table 1

Findings and discussions

Annual scientific production

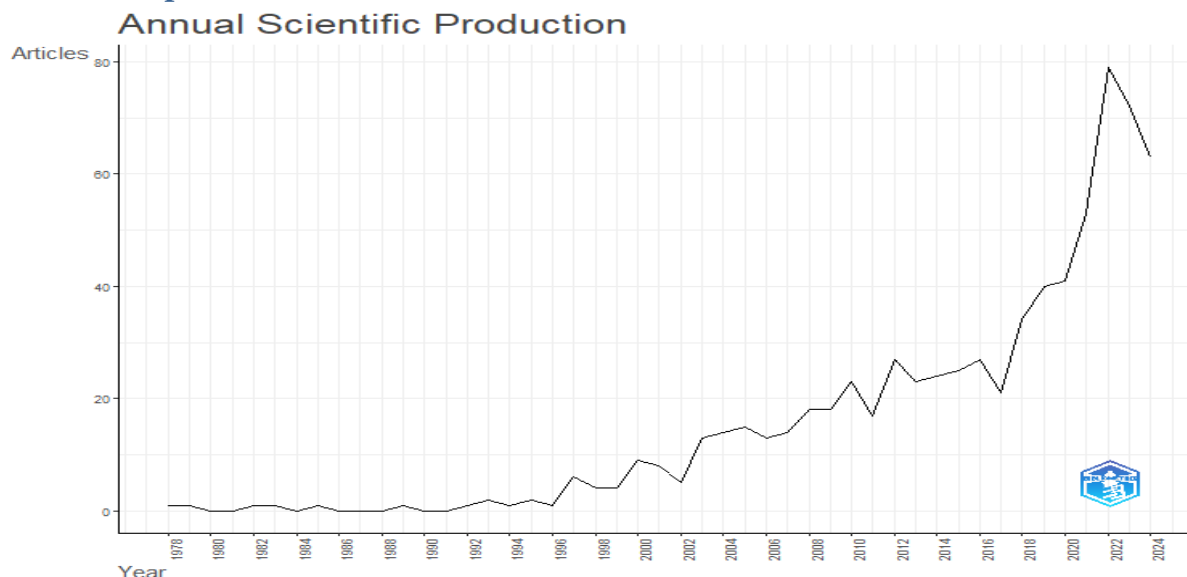


Figure 2

The data indicates that the number of published articles has been increasing steadily over time, especially since 2000. In the first years (1978-1999), it contributed sporadically, but since 2000, research results have increased regularly in 2018 (an increase of 34 articles), 2020 (41 articles) and 2022 (79 articles). This trend reflects the interest and expansion in this field, which is declining slightly in 2023 and 2024, and in general, the research department has reached a considerable pace, especially in the last 20 years.

Average Citations per year

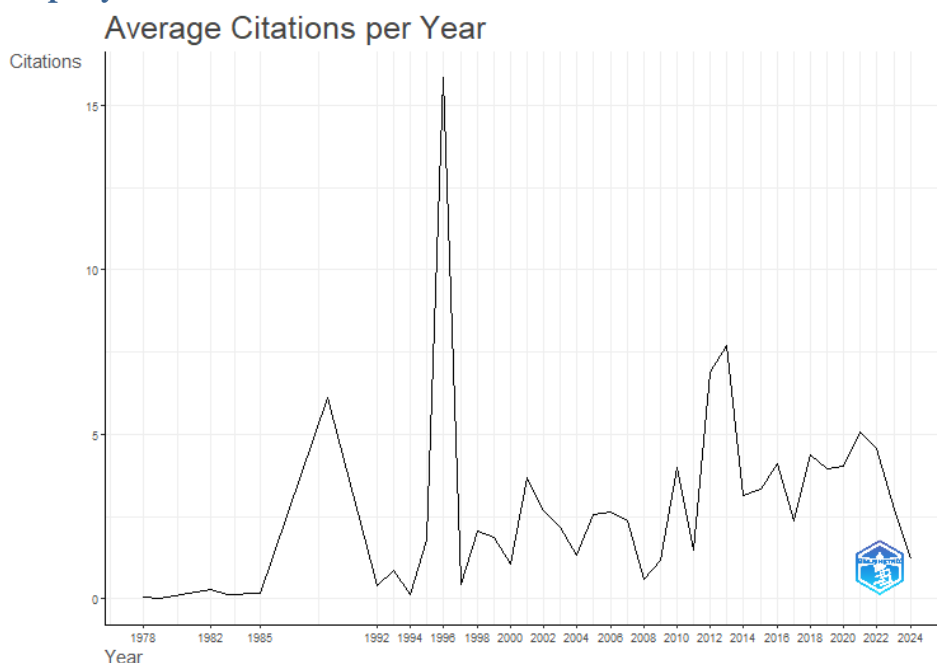


Figure 3

Figure 3 highlights the impact of citing articles over time. In the early years (1978 to 1996), it was sporadic, but in 1989 and 1996, high publications were affected by an average of 220 and 459 citations. Since 2000, the number of articles has increased, but citations were average. In key years such as 2012 and 2013, citations increased significantly (89.74 and 92.57), reflecting influential characteristics. The total number of articles has grown steadily, but according to the article, the average cited mark has decreased until 2021, but this may show a broader but more influential direction of research.

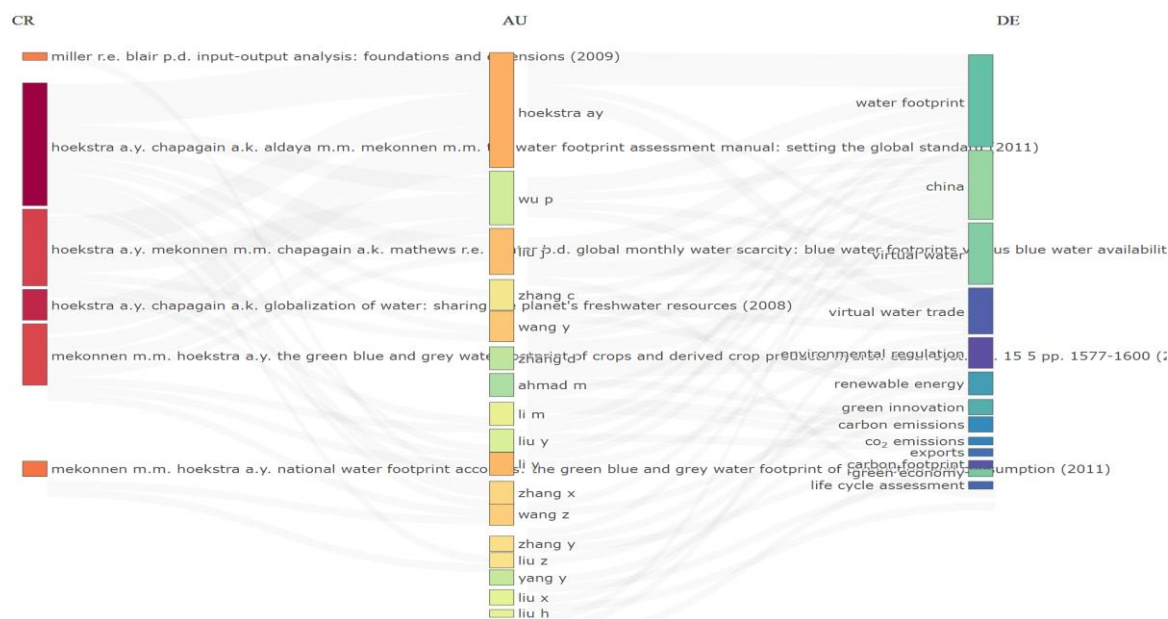


Figure 4

Most Relevant Sources

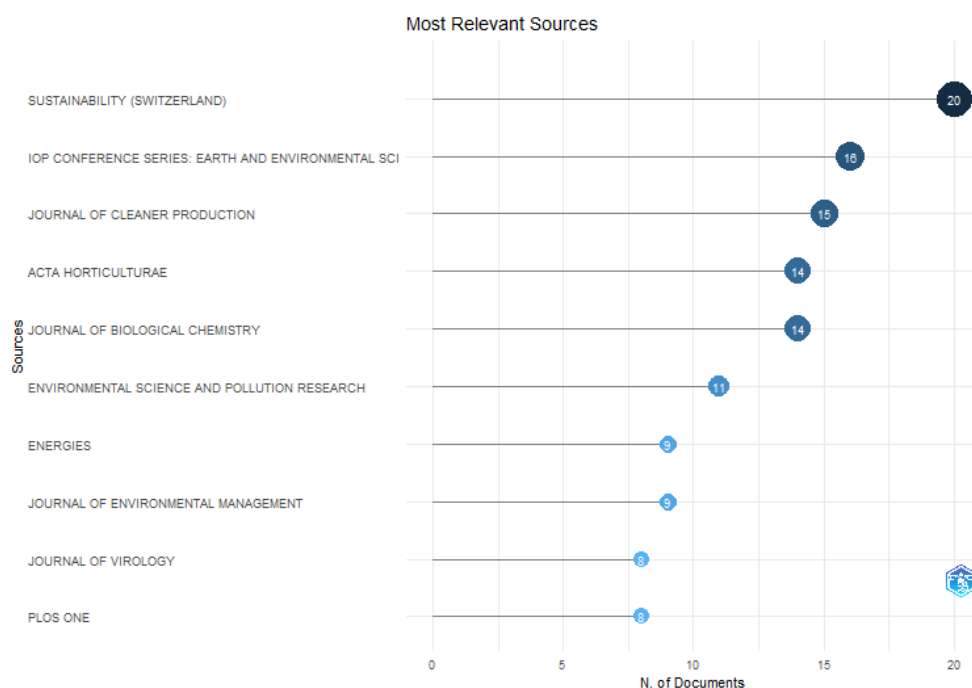
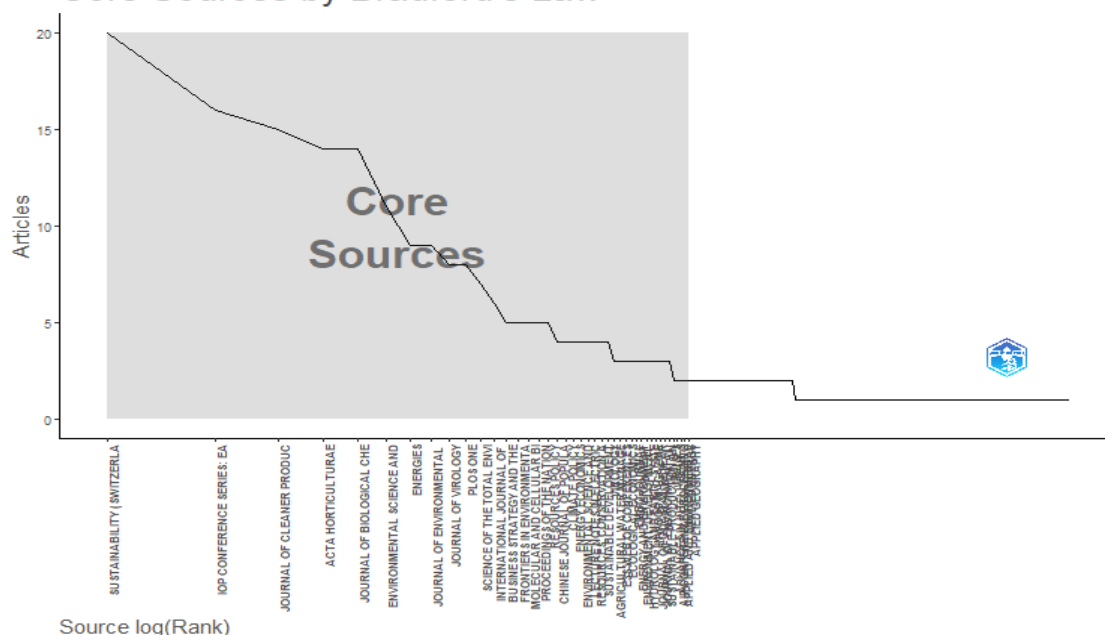


Figure 5

Core Sources by Bradford's Law



Bradford's law figure shows the main sources that contribute to his book list data. The "Main Sources" area shows some important journals in which "Sustainability (Switzerland)" leads with the most articles, followed by "IOP Conference Series: Earth and Environmental Sciences" and "Journal of Cleaner Productions". These main sources play an important role in the publication of literature about their research focus, reflecting important branches for work in sustainability and environmental science. Apart from this main source, the contribution of other journals shows that the distribution in the book list matches Bradford's rule.

Sources' Local Impact by H Index

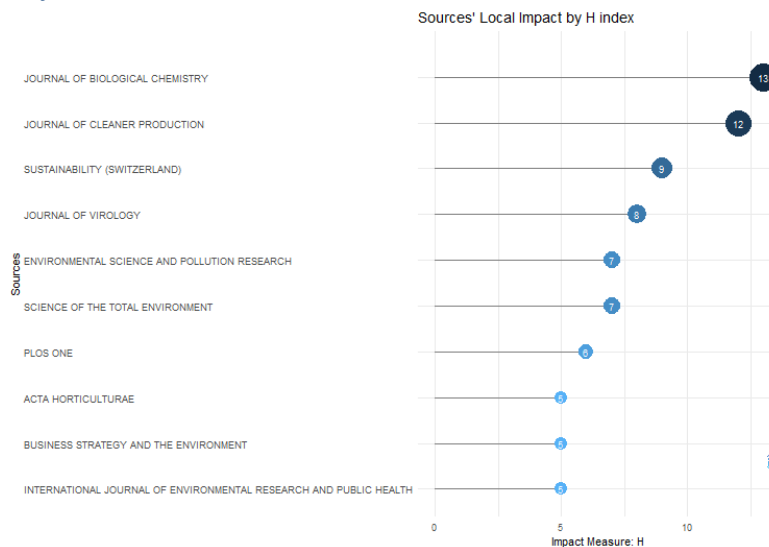


Figure 7

Figure 7 shows the most influential sources by h-index, with the Journal of Physical Chemistry ranked 13th, followed by the Journal of Cleaner Production at 12th. Other influential sources include Sustainability (Switzerland) and the Journal of Ecology, with h-index values of 9 and 8, respectively. Larger bubble sizes correspond to higher h-index values, indicating greater productivity and better citation impact in these journals, highlighting their importance in your research field.

Sources' Production over time

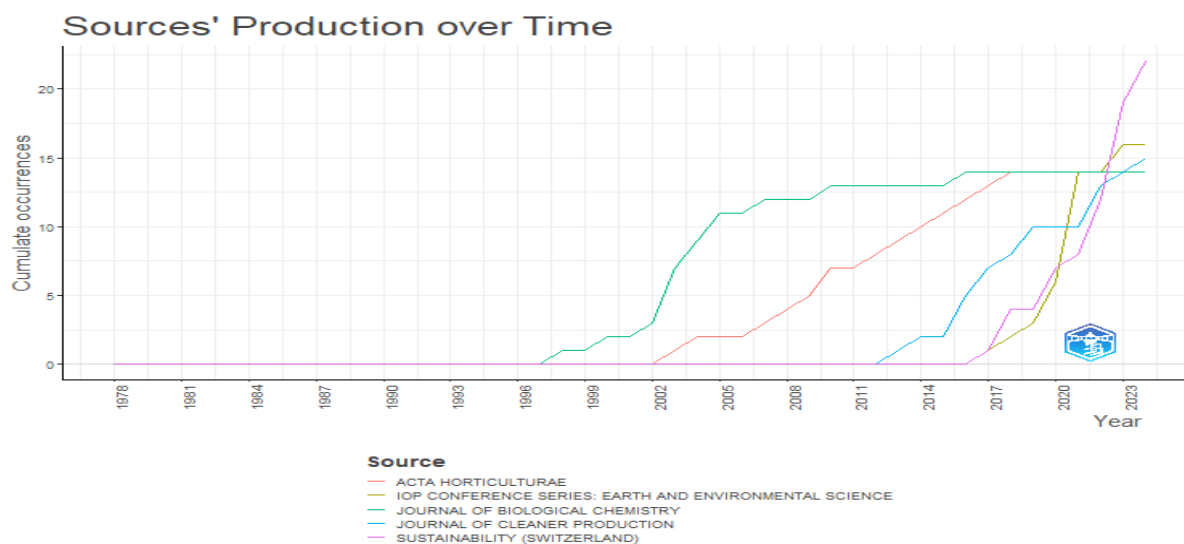


Figure 8

Figure 8 shows the publication trend of five journals from 1978 to 2024. In particular, Sustainability (Switzerland) recorded a significant increase in publications since 2017, reaching 22 articles in 2024. The IOP Series of Conferences: Earth and Environmental Sciences shows a regular increase compared to 2017, which will reach a peak of 16 articles by 2024. The Journal of Clean Plus Productions shows a regular increase since 1998, reaching 15 articles in 2024.

Most Relevant Sources

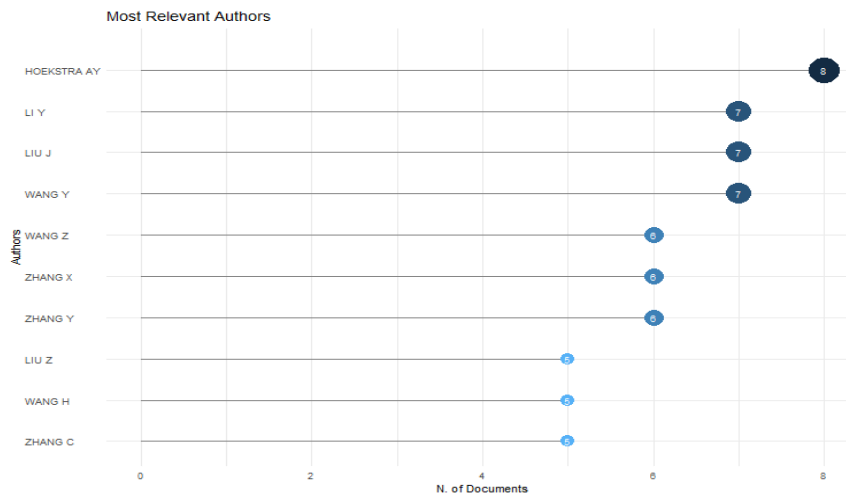


Figure 9

The figure shows the most relevant authors in the analysis according to the number of documents they have contributed. Author KolkaA is ranked highest with 8 documents, followed by LiY, LiuJ and WangY with 7 documents each. Several other authors have contributed 6 documents each, including ZengSX and ZhouZhou. This distribution indicates a significant concentration of research contributions by these authors, reflecting their influences on the research being conducted and their impact on the field. The classification is determined by the contribution of each author's contributions to the literature.

Authors Production Over Time

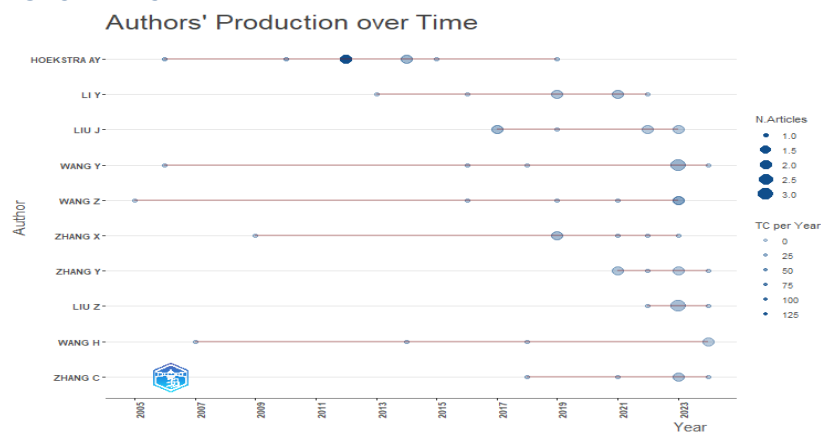


Figure 10

Figure 10 highlights important research on sustainability, water footprint and green finance, particularly in China. Hoekstra AY's work is notable for its numerous citations, demonstrating its strong influence on these areas. Recent research in 2023 and 2024 examines the impact of digital transformation and environmental policies on export quality and emissions, reflecting the growing interest in integrating environmental management into business practices.

Author's Local Impact by H index

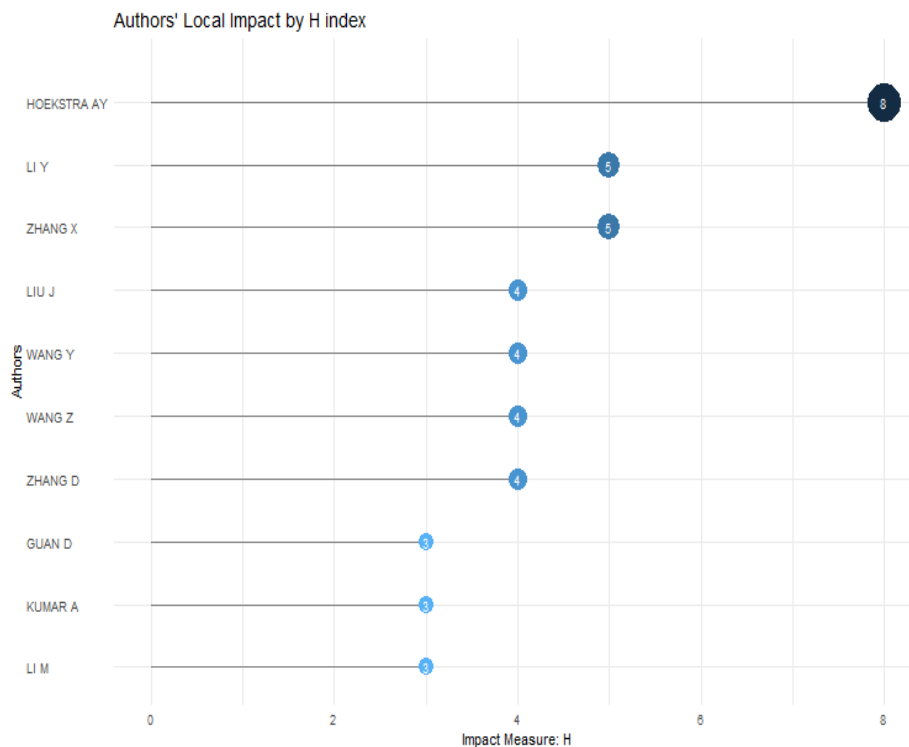


Figure 11

Figure 11 indicates the impact of authors based on their H-index, which reflects both productivity and citation impact. Kolk A stands out with the highest H-index of 8, indicating substantial influence in the research field. Following this, Li Y and Zeng S.X have an H-index of 5, showcasing moderate influence. Several authors, including Liu J, Wang Y, and Zhou Z.H, hold an H-index of 4, suggesting consistent contributions. The chart highlights the varying levels of research impact among these authors, with Kolk A being particularly prominent.

Most Relevant Affiliations

AFFILIATION	ARTICLES
SICHUAN AGRICULTURAL UNIVERSITY	20
BEIJING FORESTRY UNIVERSITY	18
NORTHWEST A AND F UNIVERSITY	18
NOTREPORTED	18
TSINGHUA UNIVERSITY	13
THE B.J. HABIBIE SCIENCE AND TECHNOLOGY AREA (KST)	12
UNIVERSITY OF CALIFORNIA	12
UNIVERSITY OF TWENTE	12
CORNELL UNIVERSITY	11
HOHAI UNIVERSITY	11

Table 2

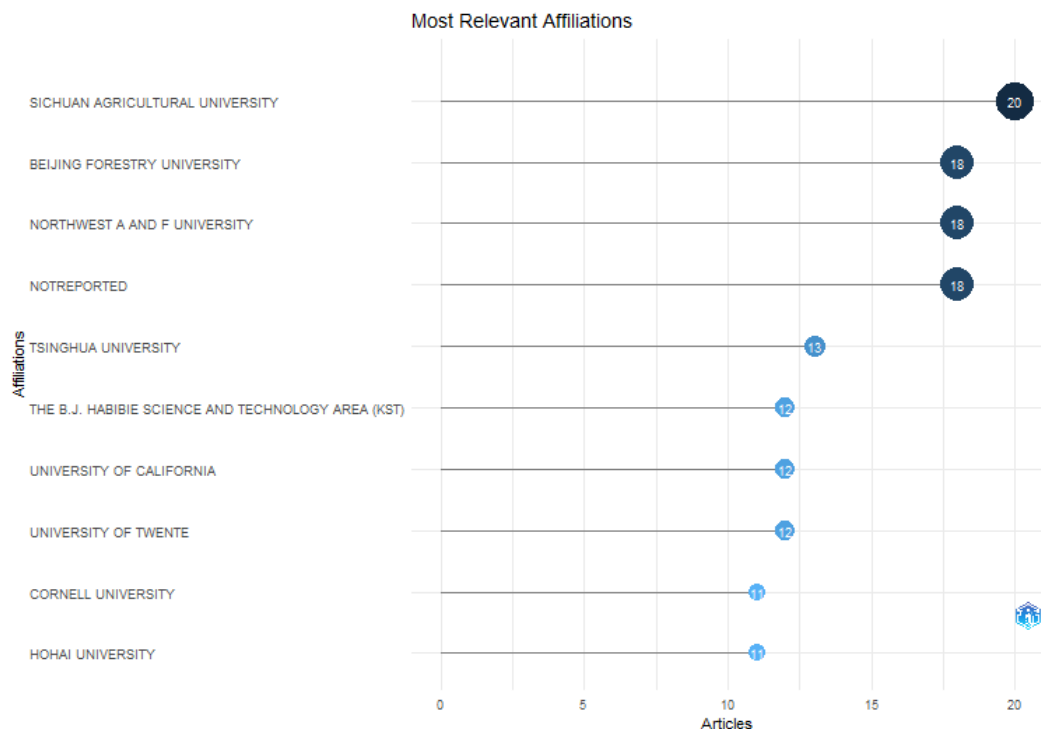


Figure 12

Affiliation data show that leading institutions in the field of sustainable development and environmental research: Sichuan Agricultural University, Beijing Forestry University and Northwestern A and F Universities published the largest number of articles (20, 18 and 18, respectively). Notably, several other leading universities, such as Tsinghua University and Cornell University, are also making significant contributions, indicating a strong network of research focusing on these important issues in various geographical locations.

Affiliations' Production over Time

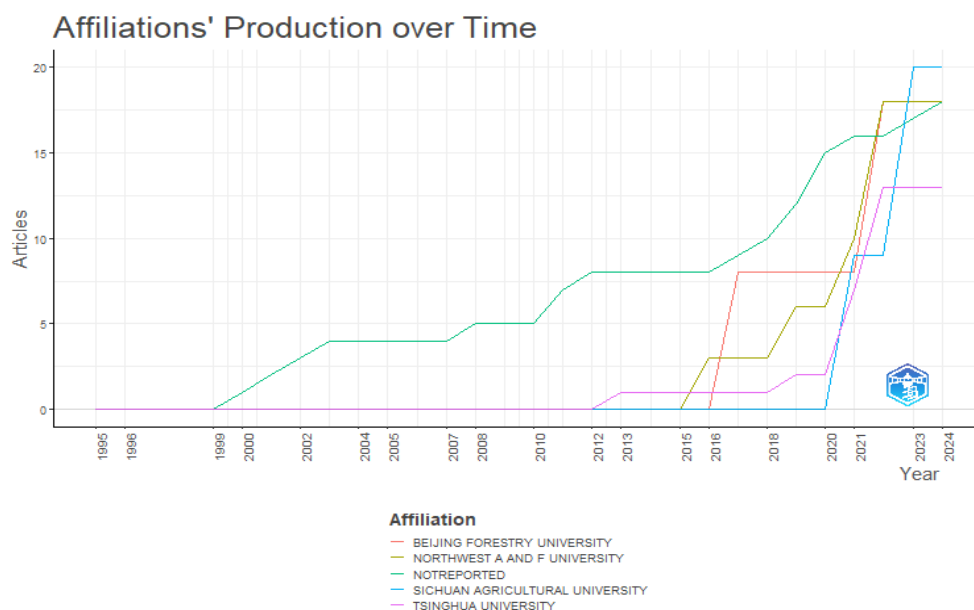


Figure 13

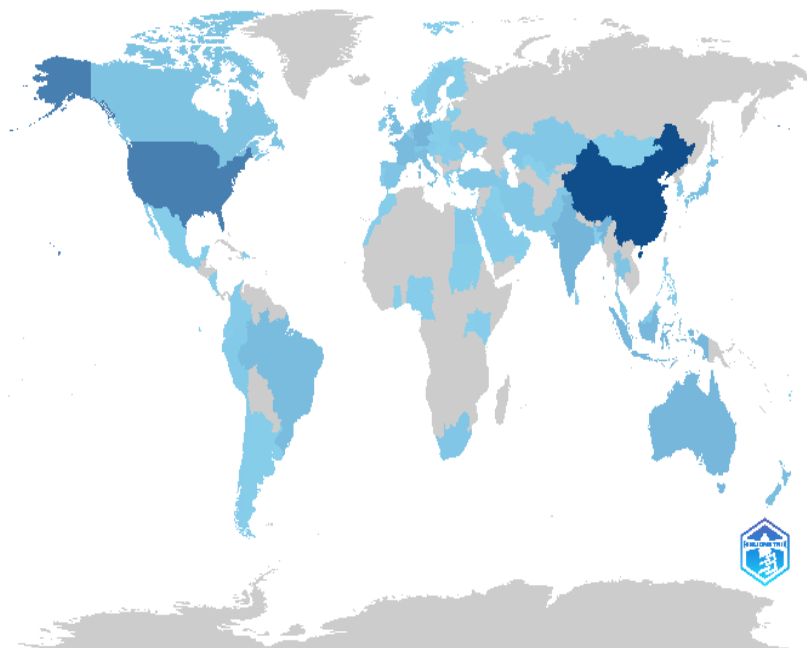
The trends of various universities reflect a significant increase in research output, especially in the "unpaid" range of 18 articles in 2024. Tsinghua University has shown a gradual increase in articles from 2013 to 13 in 2013. In 2024, it reflects an increase in attention to sustainability research. Similarly, A&F Agricultural University and Sichuan Agricultural University have experienced reasonable growth, and Sichuan Agricultural University won 20 articles in 2023 and 2024. In contrast, forestry is held by other institutions such as Forest University. A stable output volume of 18 articles from 2022 to 2024 contributed to a certain contribution. Generally, the data, especially in recent years, has shown an increase in research in this field.

Country Scientific Production

REGION	FREQ	REGION	FREQ
CHINA	547	ECUADOR	9
USA	325	PORTUGAL	8
GERMANY	103	ROMANIA	8
INDIA	100	CHILE	7
AUSTRALIA	91	SERBIA	7
INDONESIA	91	ARGENTINA	5
FRANCE	77	CYPRUS	5
BRAZIL	72	LEBANON	4
UK	69	MOROCCO	4
ITALY	67	NICARAGUA	4
NEW ZEALAND	62	NORWAY	4
JAPAN	53	OMAN	4
CANADA	45	SLOVAKIA	4
NETHERLANDS	44	SUDAN	4
SPAIN	42	UNITED ARAB EMIRATES	4
THAILAND	40	AZERBAIJAN	3
TURKEY	33	BANGLADESH	3
SOUTH AFRICA	31	CAMEROON	3
SWITZERLAND	31	COSTA RICA	3
PAKISTAN	30	DOMINICAN REPUBLIC	3
IRAN	26	KENYA	3
KAZAKHSTAN	26	MONACO	3
SWEDEN	24	NIGERIA	3
SOUTH KOREA	22	SINGAPORE	3
DENMARK	21	SLOVENIA	3
MALAYSIA	21	CZECH REPUBLIC	2
UKRAINE	21	GHANA	2
AUSTRIA	20	IRAQ	2
PERU	20	LATVIA	2
EGYPT	18	UGANDA	2
BELGIUM	14	UZBEKISTAN	2
COLOMBIA	13	FIJI	1
IRELAND	12	HUNGARY	1
ISRAEL	12	MONGOLIA	1
PHILIPPINES	12	QATAR	1
SRI LANKA	12	RWANDA	1
FINLAND	10	URUGUAY	1
POLAND	10		

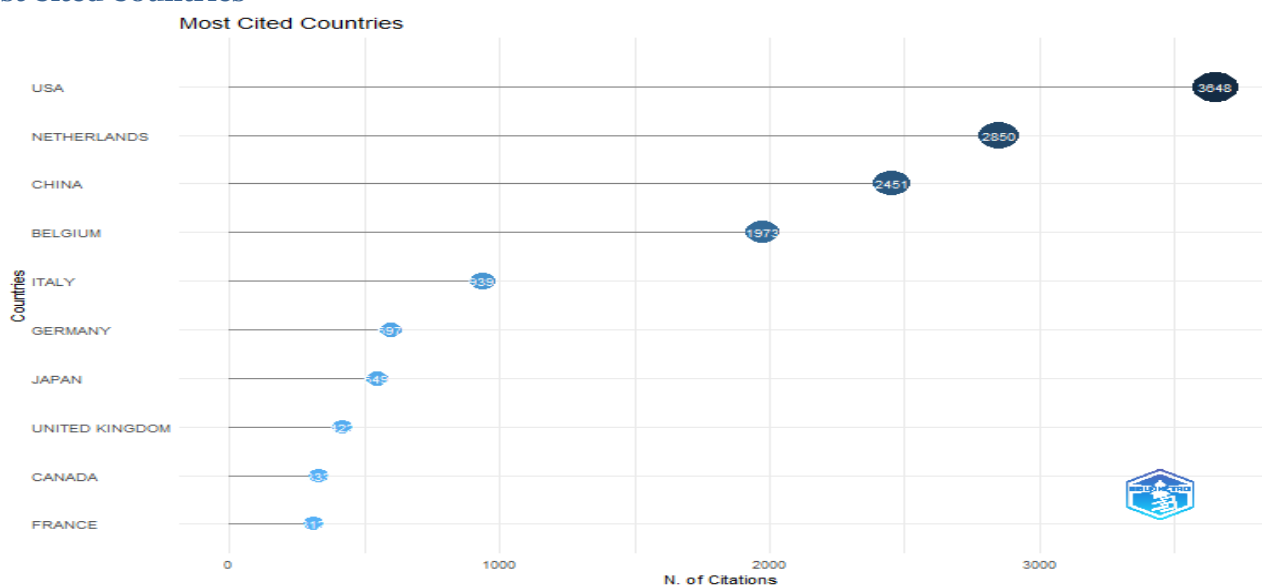
Table 3

Country Scientific Production

**Figure 14**

The regional distribution of research results indicates that China has received the largest contribution, 547 articles, followed by the United States with 325 articles. Germany (103) and India (100) also showed significant participation in this field, and Australia and Indonesia have offered 91 articles each. European countries such as France, the United Kingdom and Italy are 77, 69 and 67, each of them. In Asia, Japan (53), South Korea (22) and Malaysia (21) provide great research activities. This data is attracting attention in China and the United States, but many other countries have contributed to the global scene reflecting the varied international participation on this topic.

Most Cited Countries

**Figure 15**

Analysis of citations shows that the United States leads the list with 3,648 total citations (59.8 citations per article), followed by the Netherlands, which has a high average of 237.5 citations despite 2,850 total citations. Belgium has the highest average with 394.6 citations on 1,973 total citations. China, on the other hand, has a lower average of 17.1 citations, with 2,451 articles, indicating high production but low impact by article. This highlights the impact of citations and important variations in the recognition of research between countries.

Reference Publication Year Spectroscopy

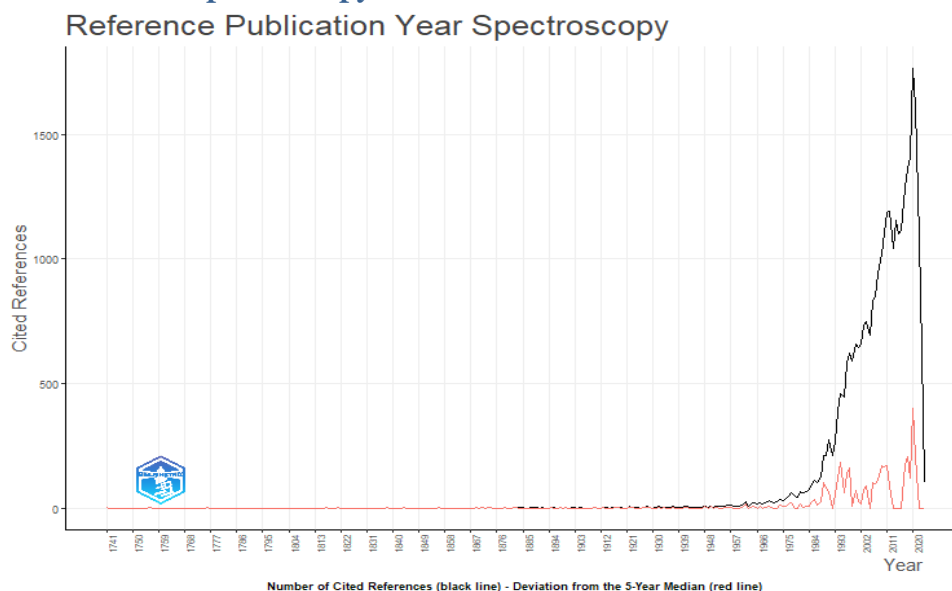


Figure 17

This chart presents a Reference Publication Year Spectroscopy (RPYS) analysis for spectroscopy-related works. The black line shows the number of cited links over time, showing a significant increase in citations starting in the mid-20th century, with a sharp increase in the 1990s and a peak around 2020. The red line shows deviations for 5 years, particularly from the late 2000s to the early 2010s, highlighting specific provisions of notable citations of publications or bursts of influential publications during these years. The general trend reflects the growing influence and research interest in spectroscopy.

Most Relevant Words

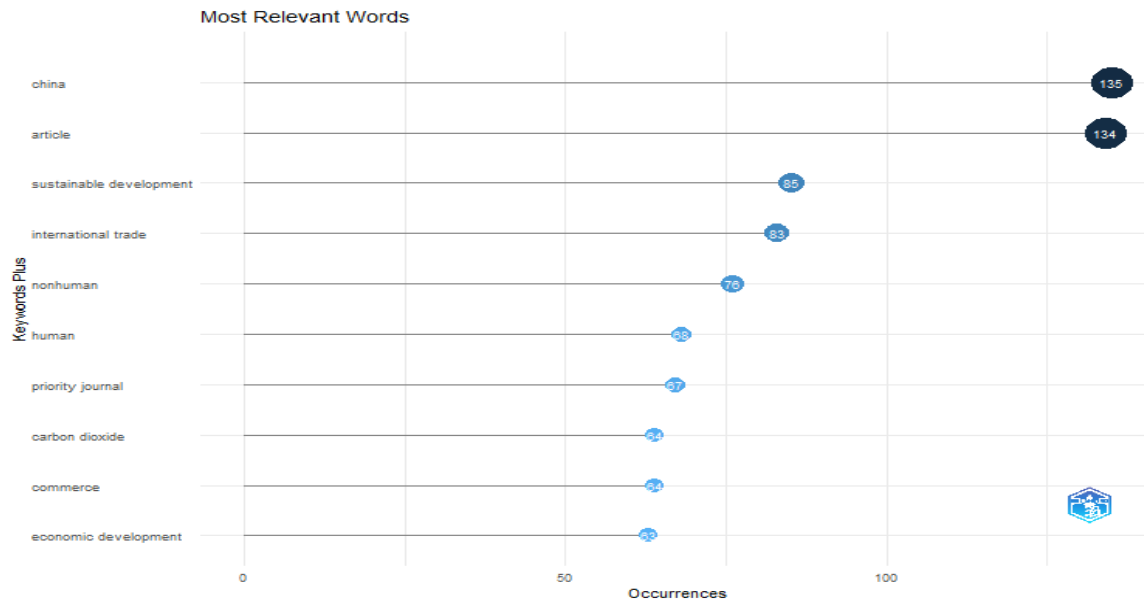


Figure 18

Analysis highlights key themes in the literature, with the most frequently mentioned terms being "China" and "articles", indicating a significant focus on Chinese contributions to research. "Sustainable development" and "international trade" reflect the importance of these concepts in current discussion, while the terms "non-human" and "human" suggest discussions on environmental and social impacts. The presence of "priority journals" indicates a concentration on high-quality publications and "commerce" along with "carbon dioxide" underline environmental issues in the context of research.

Word Cloud



Figure 19

Tree Map

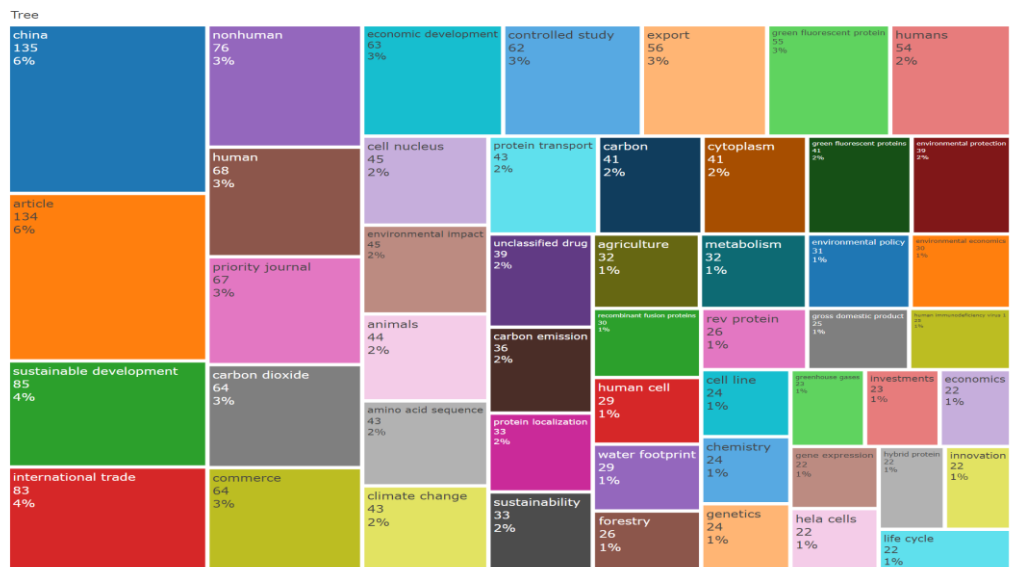


Figure 20

Words' Frequency over Time

Words' Frequency over Time

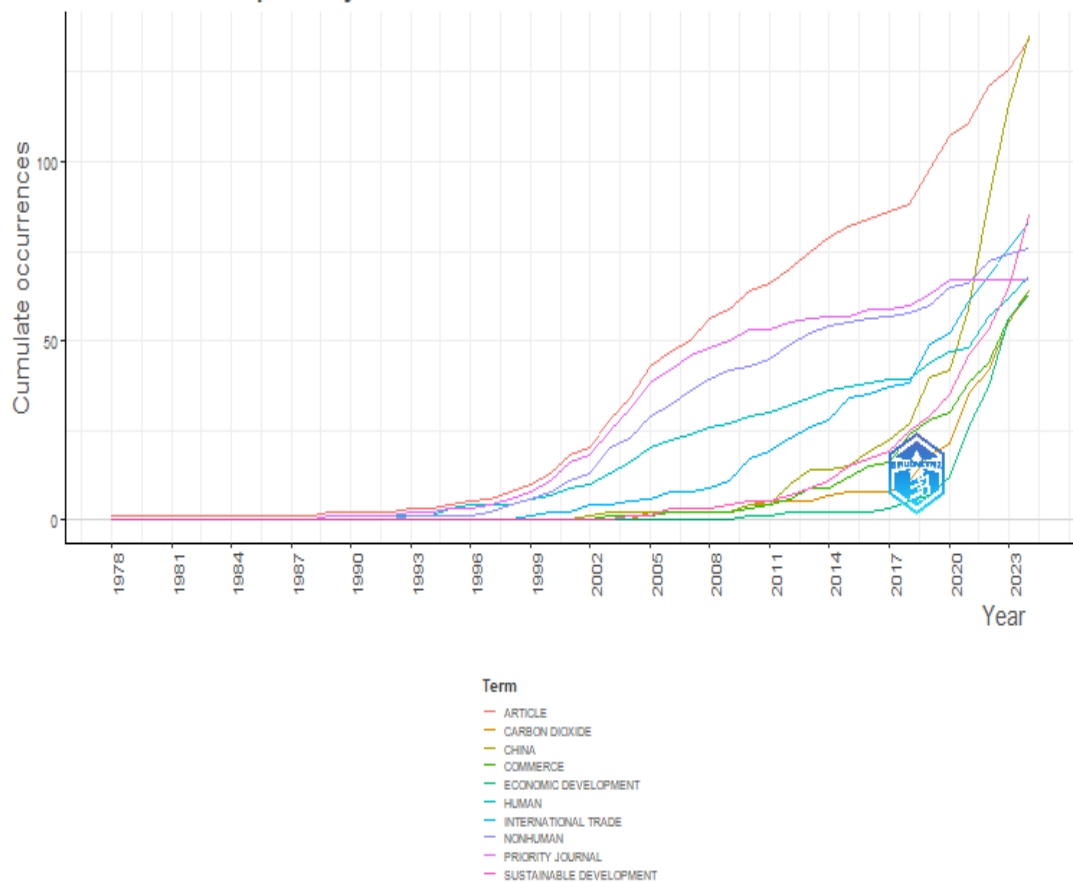


Figure 21

Annual data, especially the annual data since 2000, show a significant increase in research results. The number of articles related to China has increased markedly, reaching 135 in 2024. This reflects the increase in accents in China's research in various fields. "Sustainable development" and "international trade" have also shown significant growth in recent years. Terms such as "carbon dioxide" and "trade" emphasize growing environmental knowledge and economic relations. The priority has led to continuous improvement in the quality and impact of research in the field of publications. Generally, the data show a dynamic research environment with great attention to China and China-related economic development.

Trend Topics

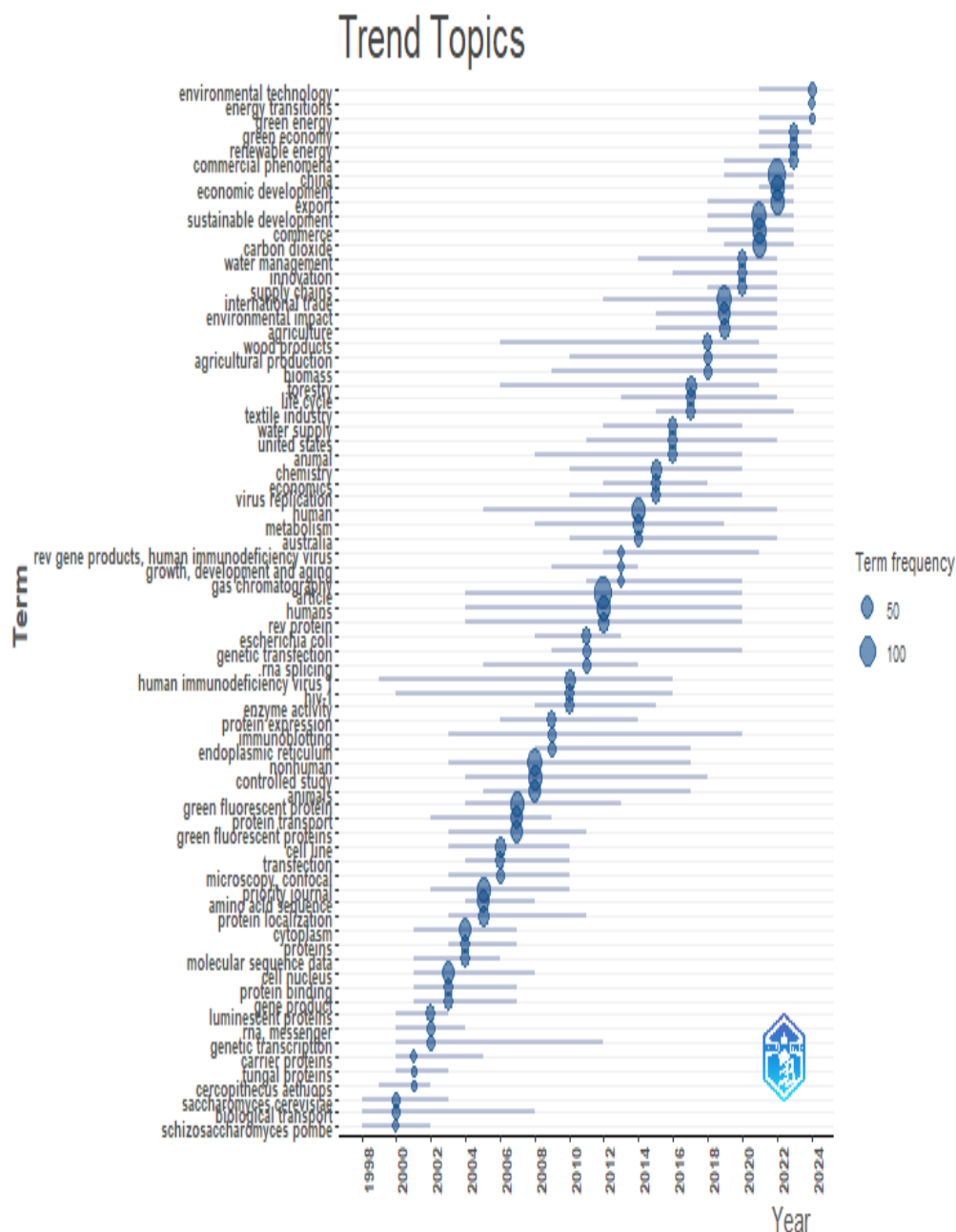


Figure 22

Term frequency analysis shows significant emphasis on terms such as "sustainable development," "carbon dioxide," and "international trade," particularly since 2018, indicating a shift toward sustainability and molecular biology.

Provided. The strong presence of priority journals focused on high-impact research, and the increased mention of 'China' since 2019 highlight the journal's growing importance in these discussions. Overall, the data demonstrate an evolving research environment that integrates environmental, economic, and biological fields.

Collaborative Word Network

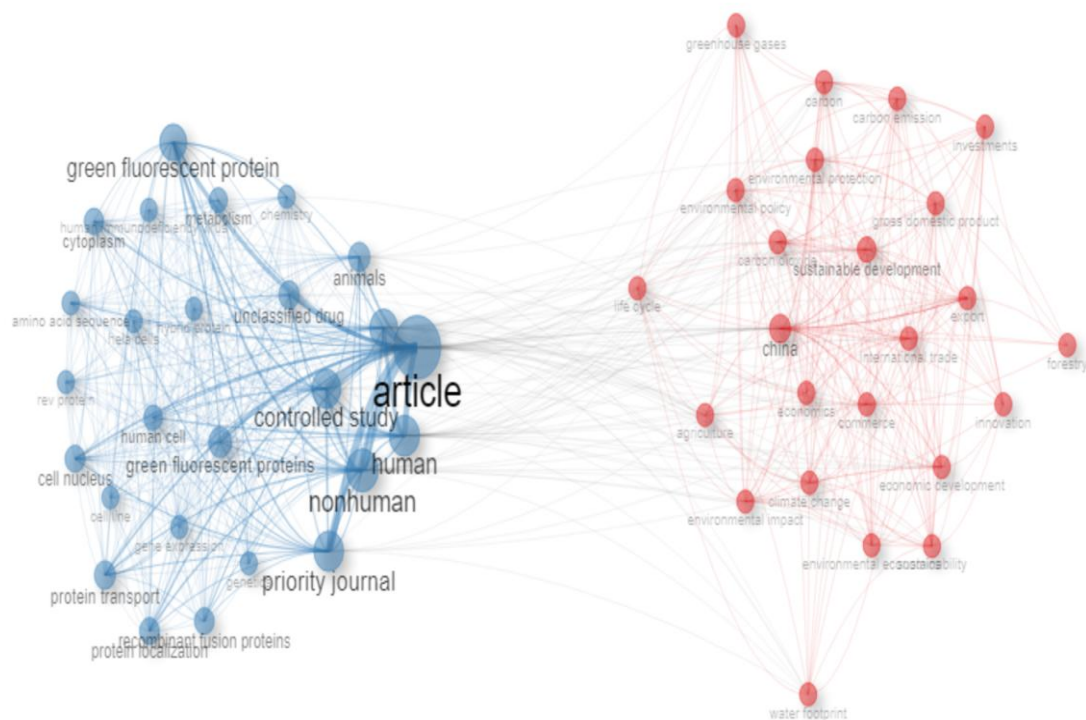
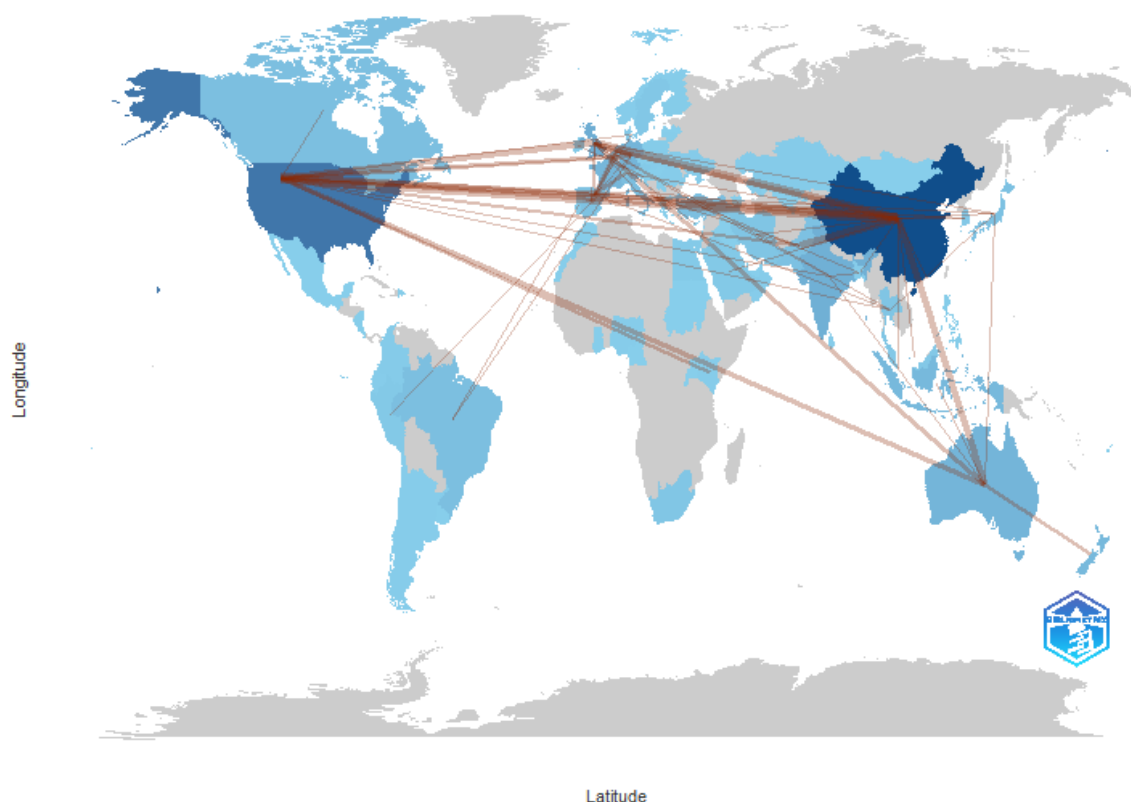


Figure 23

Network analysis highlights key nodes in the research, which display “China”, “continues” and “international trade” scores and Pagenk scores, showing their central role in academic discussion. Words such as “carbon dioxide” and “trade” put more emphasis on the integration of environmental and economic issues. In addition, “article” and “humans” serve as important connections across different disciplines, while “priority journal” and “controlled studies” focus on quality research methods, focusing on methods, quality research, performance consistency, environmental impact and structure of interconnected biological studies.

Collab World Map



The frequency data indicates connectivity between countries in various research collaborations, with China emerging as a major partner, most notably the United States (15) and the United Kingdom (10). Australia also shows significant collaborations, particularly with New Zealand (3) and the United Kingdom (4). Other notable connections include Brazil with Portugal (2) and Turkey with Bangladesh (2). The data reflect the worldwide nature of research networks across different disciplines, particularly in areas such as environmental studies, economics and international relations.

Opportunities and challenges

Export opportunities for green products are growing rapidly due to rising global awareness of sustainability and increased demand for ecological products across various sectors. Countries and companies that invest in green technologies and sustainable practices are gaining new markets, which are gaining strength due to government incentives, consumer agreements such as the Paris Agreement and consumer preferences for low-carbon products and efficiency from an energy point of view. Carbon footprints regulatory structures and emission policies also provide new roads for competitive advantages. In addition, advancements in technology such as renewable energy and waste recycling provide exporters with an opportunity to innovate and diversify their wallets. However, this growing market also offers many challenges. The costs associated with the use of green production methods and obtaining certifications such as ISO 14000 can be quite high, especially for small and medium-sized enterprises. Navigating through different regulatory standards and sometimes inconsistent ones across different sectors adds complexity for exporters who wish to enter global markets. In addition, greenwashing—in which companies promote products as an ecological scapegoat among consumers—makes it difficult for exporters to maintain transparency and build trust through continuous verification. Finally, while demand for ecological products is growing, the cost rewards for these goods are low, which may limit their competitiveness compared to economical and non-ecological alternatives in some markets. Long-term success in the green products export sector requires balancing these opportunities and challenges.

Conclusion

In conclusion, this analysis of green products from 1978 to 2024 reflects business sustainability and extends research results that support the increasing global emphasis on environmental considerations. The conclusion is that China and the United States are the main participants in the literature, but related efforts between institutions and countries are important in promoting knowledge in this field. In particular, the main theme concerns the interaction between technological innovation and the practice of sustainability. In addition, this study emphasizes the impact of influential publications, which shows the need for continued research to eliminate existing gaps in the literature. This study, which provides a complete monitoring of the research landscape, provides valuable information that can inform politicians and industry leaders about effective strategies to enhance green products. Finally, the results are the basis for future research that contributes to a deeper understanding of the important relationship between sustainable practices and international business.

Limitation and Future Research Scope

This analysis has several restrictions, most notably in the reliance on available data that may not include any relevant literature, especially from non-English-speaking sources or new journals. Furthermore, focusing on quantitative indicators may overshadow qualitative contributions, such as theoretical understanding and practical results. Future studies should take into account the mixed method in which qualitative studies should be integrated into the text analysis to ensure a more complete understanding of the export of green products. Exploring the impact of digital innovations on a specific policy, market conditions and sustainability can identify trends and best practices. Long-term changes that govern changes in time can further understand this new field, which can help develop effective strategies for sustainable business practices.

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