Environ Res Tec, Vol. 7, Issue. 4, pp. 502–511, December 2024

Environmental Research and Technology
https://ert.yildiz.edu.tr - https://dergipark.org.tr/tr/pub/ert
DOI: https://10.35208/ert.1366472

Research Article

Bibliometric profile of research on ecological footprint

Figen DURKAYA*[1], Mustafa KAYA[2]

[1]*Department of Mathematics and Science Education, Kırıkkale University Faculty of Education, Kırıkkale, Türkiye*
[2]*Department of Healty Management, Kırıkkale University Vocational School of Healty Science, Kırıkkale, Türkiye*

ARTICLE INFO

Article history
Received: 26 September 2023
Revised: 05 March 2024
Accepted: 02 May 2024

Key words:
Bibliometric analysis; Ecological footprint; Environmental problems

ABSTRACT

The ecological footprint is an indicator of environmental impact and has become a significant research topic in recent years. It plays an important role in raising awareness about minimizing environmental problems by determining the extent of damage to the ecosystem. The ecological footprint is a valuable tool for researchers to assess the level of environmental damage and identify its causes, with the ultimate goal of promoting sustainability. This study aims to conduct a bibliometric analysis of scientific publications on the ecological footprint in the international arena. The study is descriptive and employs the scanning method. The researchers searched for studies published between 2010 and 2021 using the key concept of 'Ecological footprint' in the database. The bibliometric characteristics of 2748 publications scanned in the Web of Science database were determined. The research data were analyzed based on the number of publications per year and country, the most productive authors and journals, authors' h-indexes, most cited authors and journals, distributions by most cited references, and some relationships between these variables. The data reveal the interdisciplinary importance of the subject.

Cite this article as: Durkaya F, Kaya M. Bibliometric profile of research on ecological footprint. Environ Res Tec 2024;7(4)502–511.

INTRODUCTION

Due to population growth and rapid economic development, natural resource consumption is increasing, disrupting the balance of ecosystem capacity and causing environmental problems [1, 2]. Additionally, it is evident that the consumption of significant quantities of natural resources through agriculture, industrialization, deforestation, and mining has a detrimental impact on the environment [1]. Environmental issues, such as global warming, ozone depletion, and the greenhouse effect, are examples of negative effects. Factors that harm the environment, such as soil and water pollution, and destruction of ecosystems, should not be overlooked [2]. Raising awareness about the growing environmental problems and explaining them with measurable magnitudes is crucial. The concept of 'ecological footprint,' introduced by Rees in 1992, provides a way to quantify environmental issues. Its purpose is to ensure a protected environment for future generations and promote sustainability. Durkaya [3] stated that to keep environmental sustainability in the ecosystem under control, attention should be paid to environmental problems. Recent studies have highlighted the ecological footprint as an indicator of environmental degradation [4, 5]. Additionally, the studies include the most significant factors that determine the ecological footprint.

The use of unsustainable natural resources can negatively impact a country's biological capacity. When humans exceed the biological capacity of nature and consume more resources than can be replenished, it can lead to ecological vulnerability [4]. Countries have a global impact on the

***Corresponding author.**
*E-mail address: figendurkaya@kku.edu.tr

ecosystem, but this impact may not be immediately apparent. The degradation of the environment is influenced by higher population density, increasing energy demand, urbanization, and rapid industrial development over time. Economic growth leads to increased use of natural resources, causing pollution that poses a significant threat to the environment. Therefore, the ecological footprint helps countries evaluate their ecological resources [6]. An ecological footprint is a tool used to measure the impact of human activities on the environment. No changes in content were made. It calculates the amount of natural resources used based on global, regional, local, and personal supply and demand [7]. Therefore, the area of the ecological footprint, which is a calculable size; It is a quantity that depends on population size, material living standards, the technology used, and ecological productivity [8]. Ecological footprint calculations consider six types of land use for consumption distribution: agricultural lands, pastures, forests used for fuel and consumption, fishing areas, construction areas, and forest areas required for carbon emission capture. Durkaya [3] stated that when all the countries of the world care about the six components of the ecological footprint separately, they can secure their future by using all the resources in the ecological system more accurately. Furthermore, taking into account the ecological footprint as a whole is predicted to mitigate the risks associated with ecological deficits. The literature contains various bibliometric studies on the ecological footprint. Yang and Meng [9] compared the hotspots and boundaries of articles on the topic of ecological footprints in China and internationally from 2000 to 2017. A total of 2322 articles were found in the English literature using the WoS database, while 1925 articles were accessed in the Chinese literature through the Chinese national information infrastructure database. Ulucak and Erdoğan [10] conducted a bibliometric analysis of 2582 articles on ecological footprint in the Web of Science database. The analysis revealed that there were no limitations on the specific area or period of the articles.

In their research on the environmental footprint family, Wang et al. [11] conducted a comparative bibliometric analysis of Chinese and foreign articles. The study compared and analyzed two data sets covering 1103 Chinese and 6011 foreign articles on environmental footprints and footprint families between 1996 and 2019 using bibliometric analysis. Xie et al. [12], used various footprint indicators to investigate the environmental footprint family domain's overall appearance through bibliometric analysis. They reviewed all 6680 articles from the Web of Science Core Collection database between 1996 and 2018 and examined research topics in the field of environmental footprint family. The study employed bibliometric analysis to identify the top 16 journals, 15 academicians, 19 most productive institutions, and 15 influential countries/regions.

Ecological footprint calculations are crucial for a country's development and require economic and ecological sustainability. An ecological footprint measures human consumption of natural resources and their impact on the ecosystem. It provides concrete data for analysis. Calculating ecological footprints is essential for obtaining information to ensure sustainability. Therefore, the ecological footprint has become a popular research topic in recent years. Studies are conducted in the fields of education, engineering, and economy to measure the impact of human activities on the environment. The ecological footprint is an important concept that draws attention to the increasing environmental problems and provides a measurable way to express them. However, no bibliometric analysis has been found in the eleven-year period regarding the ecological footprint, which is an important issue in the literature. Therefore, we determined the bibliometric properties of publications related to this subject in the Web of Science database. The objective of this study is to comprehensively examine the results of all published studies on ecological footprint. The study analyzes the relationships between the number of publications of studies on ecological footprint by year, the number of publications by country, the most productive authors and journals, h-indexes of authors, the most cited authors and journals, and their distribution according to the most cited sources. The bibliometric analysis of research on ecological footprint provides a situational assessment for new researchers interested in this subject. Therefore, researchers who wish to highlight the issue of ecological footprint should address the deficiencies or explore different aspects of the subject, rather than repeating similar research on the topic.

This study conducted a bibliometric analysis of ecological footprint studies published in the Web of Science database between 2010 and 2021. The research aimed to answer the following questions:

1- What are the Characteristic Features of the Selected Publications?

2- What are the Characteristics of the Selected Authors?

MATERIALS AND METHODS

The study employed bibliometric analysis, a quantitative research method. The bibliometric methodology involves using quantitative methods on bibliometric data [13]. The bibliometric method is a quantitative analysis of publication characteristics, including subject, author, publication information, and cited sources, produced by individuals or institutions in a specific period and region within a particular field [14–17]. Bibliometric analysis is a rigorous and popular method for researching and analyzing large volumes of scientific data. It is used to decipher and map the developmental details of cumulative scientific knowledge by meticulously making sense of large volumes of unstructured data [18]. The main purpose of the bibliometric analysis is to reveal the general trends, scientific progress, and the current situation of publications in a particular field. Two important features of bibliometric analysis are performance analysis and scientific mapping of publications in a specific field [19].

Table 1. Data collection criteria

Criterias	Data	
Database	Web of Science Core Collection	
Keywords	"Ecological footprint"	
Publication date	2010–2021	
Language	English	2628
	Spanish	51
	Portuguese	18
	Chinese	16
	Others	35
Document type	All types	
Access type	All types	

Table 2. Descriptive characteristics of publications by country

No	Country	Citation (n)	Average citation per publication ($\bar{x}$)	h-index
1	China	13503	17.87	55
2	USA	9704	33.62	53
3	Türkiye	7015	35.92	46
4	Australia	4899	46.58	32
5	Pakistan	3730	30.89	35
6	England	3690	30.54	32
7	Netherlands	3447	45.22	31
8	Spain	3425	19.29	31
9	Italy	2691	19.72	32
10	Germany	2608	24.71	27

Bibliometric analysis was utilized to examine publications on the ecological footprint. The research data were obtained from the Web of Science database on June 3, 2022. A total of 2,748 publications between 2010 and 2021 were analyzed using the Web of Science database. The dataset was created by searching the Web of Science database using the keyword 'ecological footprint'. The purpose of utilizing a broad term like 'ecological footprint' is to access all published research across various disciplines.

The bibliometric analysis utilized various variables such as the distribution of publications by year and country, the most published authors, the h-index, citation density, best journal, and keywords. This analysis serves as a guide for field experts and researchers in a particular subject area. The study examined publications related to the ecological footprint using the Web of Science (WoS) database as the main source for publication searches. This database is preferred because it provides easy access to higher education institutions, a wide variety of data options, and includes top-level articles from respected journals. The Web of Science (WoS) database includes over 21,100 peer-reviewed scientific journals published worldwide in over 250 disciplines of science, social sciences, arts, and humanities. The database includes the Science Citation Index Expanded, the Social Sciences Citation Index, the Arts & Humanities Citation Index, and the Emerging Sources Citation Indexes [20]. After establishing the criteria for data collection in the bibliometric analysis, the results are presented in Table 1. Table 1 shows that between 2010 and 2021, 2628 publications were in English, making it the most commonly used language. A bibliometric analysis was conducted on all document and access types.

The research data were collected from the WoS database based on predetermined criteria. The data was then formatted and analyzed using Microsoft Excel and VOSviewer. Microsoft Excel was used to encode, edit, and analyze data, including publication number, author, journal, keywords, number of referenced references, and number of citations. This process was completed independently by two authors, and any differences identified in the dataset were discussed until a consensus was reached. VOSviewer is a Java-based program that creates maps using bibliographic data and allows for their visualization and exploration [21]. This research utilized VOSviewer to analyze and visualize bibliographic data, including publications, co-authorship between countries, co-citation, and keyword reproducibility. Microsoft Office Excel is a program used for mapping and analyzing geographic data from publications around the world. The WoS database also utilizes it to obtain additional information about publications, such as the h-index and the journal's impact factors.

RESULTS AND DISCUSSION

The ecological footprint is an important factor in addressing environmental issues. Numerous scientific studies on the ecological footprint have been conducted and can be found in the Web of Science database. Most of these studies focus on the impact of the ecological footprint on sustainability and the calculation of the environmental Kuznets curve using the ecological footprint. This section presents an analysis of publications on ecological footprint between 2010 and 2021. The WoS database research revealed a total of 2,748 publications by 6,944 authors published in 351 publishing houses. The relevant publications obtained from the WoS database are discussed below.

The Analysis Of Publications And Authors On Ecological Footprint

Characteristic Features of the Selected Publications

The distribution of publications by country was evaluated. It was found that research on ecological footprint has been carried out in China with a maximum of 786 publications. The highest number of publications was found in the USA (305) and Türkiye (196). Figure 1 shows the countries with more than 20 publications between 2010 and 2021.

Figure 2 evaluates the distribution of the number of publications and citations by year. The data obtained from the WoS database shows a stable increase in the number of publications related to the ecological footprint until 2018, with no significant increase. However, after 2018, there has been

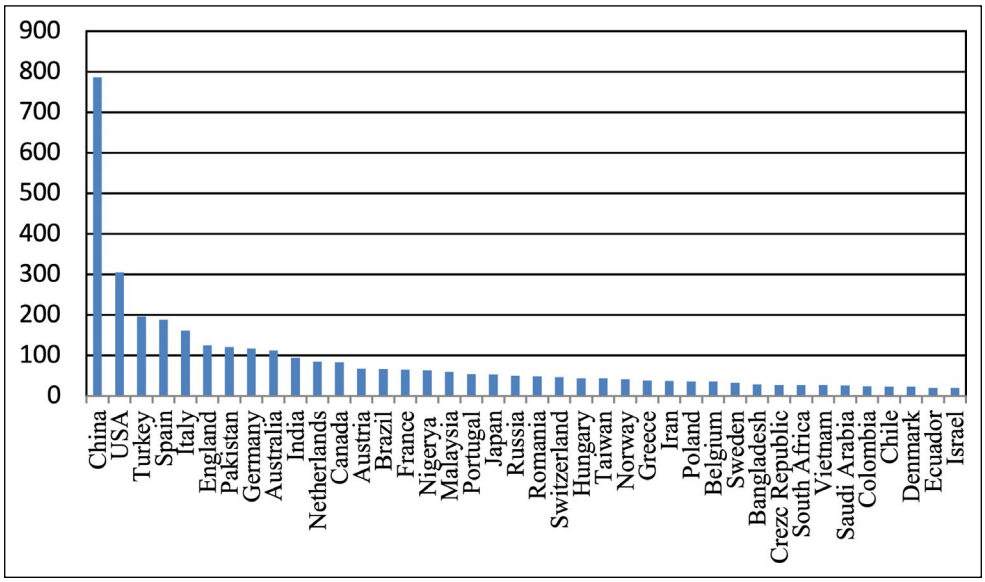

Figure 1. Distribution of publications by country.

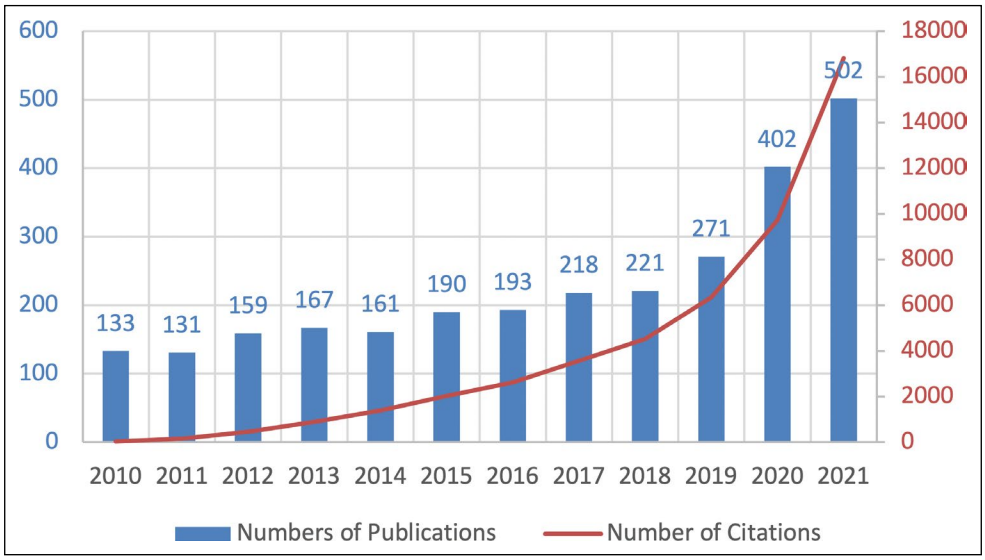

Figure 2. Distribution of publications and citations by year.

a linear increase in the number of publications related to the ecological footprint. The chart shows a 48% increase in publications on the subject between 2019 and 2020, and a 24% increase between 2020 and 2021. The reason for the increase in the number of publications on the topic of ecological footprint between 2019 and 2020 can be attributed to environmental problems and global climate change.

Figure 2 shows a parabolic graph of the increasing number of citations of the publications between 2010 and 2021. During this period, the number of citations to publications has consistently increased. In publications focused on the ecological footprint, the number of citations in 2021 was the highest at 16,817.

Table 2 presents the descriptive characteristics of publications, including the number of citations, average citations per publication, and h-index, analyzed by country. The countries with the highest number of citations are China (13503), the USA (9704), and Türkiye (7015), respectively. China, the USA, and Türkiye have the highest number of citations with 13503, 9704, and 7015 respectively. Meanwhile, Australia and the Netherlands have the highest average number of citations per publication with $\bar{x}$=46.58 and $\bar{x}$=45.22 respectively, followed by Türkiye with $\bar{x}$=35.92. China, America, and Türkiye have the highest h-index scores of 55, 53, and 46, respectively. According to Kızılöz [22], the number of citations received by scientific articles is an indicator of how much attention an article has received from other articles. The number of citations received by scientific articles is an indicator of how much attention an article has received from other articles. High citation numbers are expected to reflect a greater level of attention. According to Yang ve Meng [9], the number of citations an author receives from their articles is a key factor in determining their influence. Citation analysis is crucial for bibliometric applications as it indicates an author's academic influence in the field.

Table 3. Performance of the 10 most productive journals

No	The international journal	TP[a]	IF[b]	PP[c]
1	Environmental Science and Pollution Research	198	4.223	0.0720
2	Journal of Cleaner Production	163	9.297	0.0574
3	Ecological Indicators	158	4.958	0.0575
4	Sustainability	155	3.251	0.0564
5	Science of The Total Environment	55	7.963	0.0200
6	Journal of Environmental Management	40	6.789	0.0145
7	Advanced Materials Research	38	30.849	0.0138
8	Ecological Economics	37	5.389	0.0134
9	Environment Development And Sustainability	31	3.219	0.0112
10	Sustainable Cities and Society	26	7.587	0.0094

a: The total publications of the journal during 2010–2021 period; b: The international journal's impact factor is from the respective official website in 2020; c: Percent point.

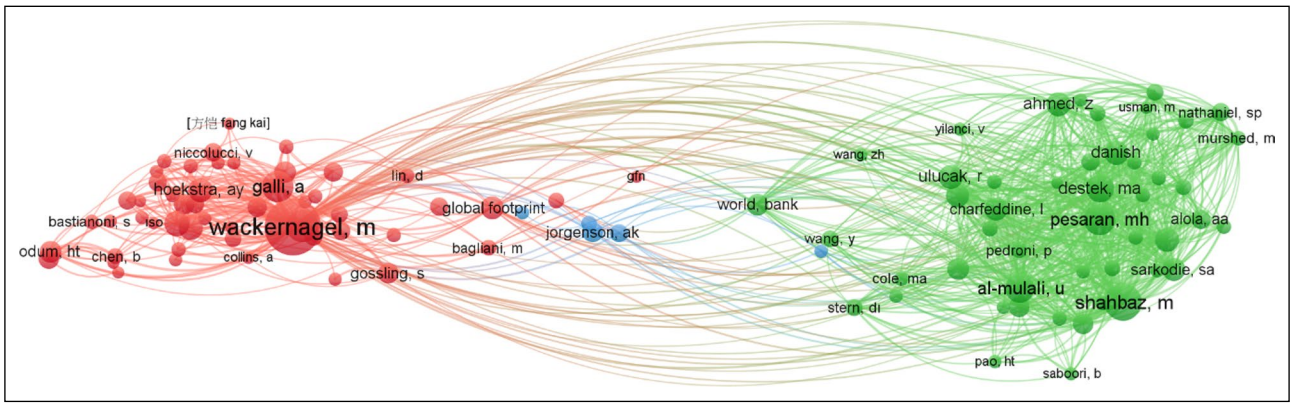

Figure 3. Map of common citations of references used in the research of ecological footprints (authors with more than 100 citations).

Table 3 displays the top 10 journals that have published the most articles on the ecological footprint internationally from 2010 to 2021. One of the main journals that includes studies in all areas of environmental science with an interdisciplinary perspective is 'Environmental Science and Pollution Research.' Its impact factor is 4.223, which is lower than the impact factor of other journals in the top three rankings. Therefore, the journal is preferred and has the highest total number of publications between 2010 and 2021. Furthermore, the journal's open access policy and prompt response to researchers during the publication process may also contribute to its popularity. The research articles on ecological footprint in the Web of Science database are ranked based on their impact factor as follows: Based on the impact factor, 'Advanced Materials Research' is ranked first with 30,849, followed by 'Journal of Cleaner Production' in second place with 9,297, and 'Science of the Total Environment' in third place with 7,963. A journal's impact factor is the average number of citations that papers published in the previous two years received in the current year. The impact factor of each international journal was obtained from the relevant official website in 2020. 'Advanced Materials Research' is a comprehensive periodical that covers both theoretical and practical research in materials engineering. This journal accepts publications from various disciplines to explore the technical aspects of the ecological footprint issue within the context of sustainable development, natural resources, and renewable energy resources.

The remaining journals listed in Table 3 are international, interdisciplinary publications with a citation index of 3.219. These journals cover topics related to environmental and sustainability research and practices on a global scale.

Table 4 presents the 10 most cited publications on ecological footprint. The top three, published in 'Science', 'Journal of Cleaner Production', and 'Annals of Tourism Research', respectively, received the most citations. Additionally, 3 of the 10 most cited studies related to the subject were published in 'Ecological Indicators', indicating the journal's effectiveness in this field.

Figure 3 shows the bibliometric map view of the common citations of the references used in the Ecological Footprint publications. Bibliometric mapping is a recent method in bibliometric analysis that visually represents the relationship between different disciplines, specialties, documents, and authors [33]. Similarly, analyzing commonly cited references is frequently utilized in bibliometrics [34].

Table 4. The 10 most cited publications on the research of ecological footprints

No	Title	Authors	Journal	Wos citation count (n)
1	Humanity's unsustainable environmental footprint	Hoekstra and Wiedmann [23]	Science	518
2	A Review of footprint analysis tools for monitoring impacts on sustainability	Cucek, Klemes and Kravanja [24]	Journal of Cleaner Production	490
3	Sustaınable tourism: Research and reality	Buckley [25]	Annals of Tourism Research	469
4	Integrating ecological, carbon and water footprint into a "footprint family" of indicators: Definition and role in tracking human pressure on the planet	Galli et al. [26]	Ecological Indicators	458
5	Urban ecology and sustainability: The state-of-the-science and future directions	Wu [27]	Landscape and Urban Planning	425
6	Investigation of environmental Kuznets curve for ecological footprint: The role of energy and financial development	Destek and Sarkodie [28]	Science of the Total Environment	395
7	Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI)	Mori and Christodoulou [29]	Environmental Impact Assessment Review	379
8	Affluence drives the global displacement of land use	Weinzettel et al. [30]	Global Environmental Change-Human and Policy Dimensions	373
9	Accounting for demand and supply of the biosphere's regenerative capacity: The National Footprint Accounts' underlying methodology and framework	Borucke et al. [31]	Ecological Indicators	352
10	Investigating the environmental Kuznets curve (EKC) hypothesis by utilizing the ecological footprint as an indicator of environmental degradation	Al-Mulali et al. [32]	Ecological Indicators	349

The bibliometric mapping method employs circles of different colors to represent clusters. The size of each circle corresponds to the citation frequency of the reference, with larger circles indicating higher citation frequency. Lines are used to show the relationship or connection between circles and clusters, with closer proximity indicating a stronger relationship between the two articles. The line connecting the two circles indicates that both articles were cited in one publication. The length of the line indicates the strength of the connection between the two articles [21, 35].

Figure 3 displays a map of common citations among authors with more than 100 citations. The red, blue, and green color clusters indicate that the references used in the ecological footprint study are grouped into three categories. The common citation density among the authors is primarily in the red and green color clusters. Figure 3 shows Wackernagel in the foreground of the red cluster and Shahbaz in the foreground of the green cluster. In the blue color set, although the authors have a low common citation density, there is a relationship between them in terms of common citation links. Jorgenson is in the foreground in the blue cluster.

Figure 4 displays the hotspot networks of keywords in publications related to the ecological footprint in the Wos database. The analysis reveals that 'ecological footprint' is the most frequently used keyword in all publications. Additionally, the network of keywords includes terms such as 'water footprint', 'ecological capacity', 'municipal solid waste', 'ecological deficit', 'global warming', 'emergency', and 'greenhouse gases'. Upon analyzing the distribution of keywords by year, it is evident that the words have become more diverse and the relationship network has expanded.

The research articles in the Web of Science database on ecological footprint were analyzed to determine the most frequently used keywords. Table 5 displays the keywords that were used in publications 50 or more times, along with their frequency of use.

Electronic databases and search engines in journals use keywords to locate articles on specific subjects. Therefore, it is crucial to select effective keywords that accurately reflect the research topic of the article. Keywords should be commonly used terms in the research field that are specific to the article. Additionally, it is important to select appro-

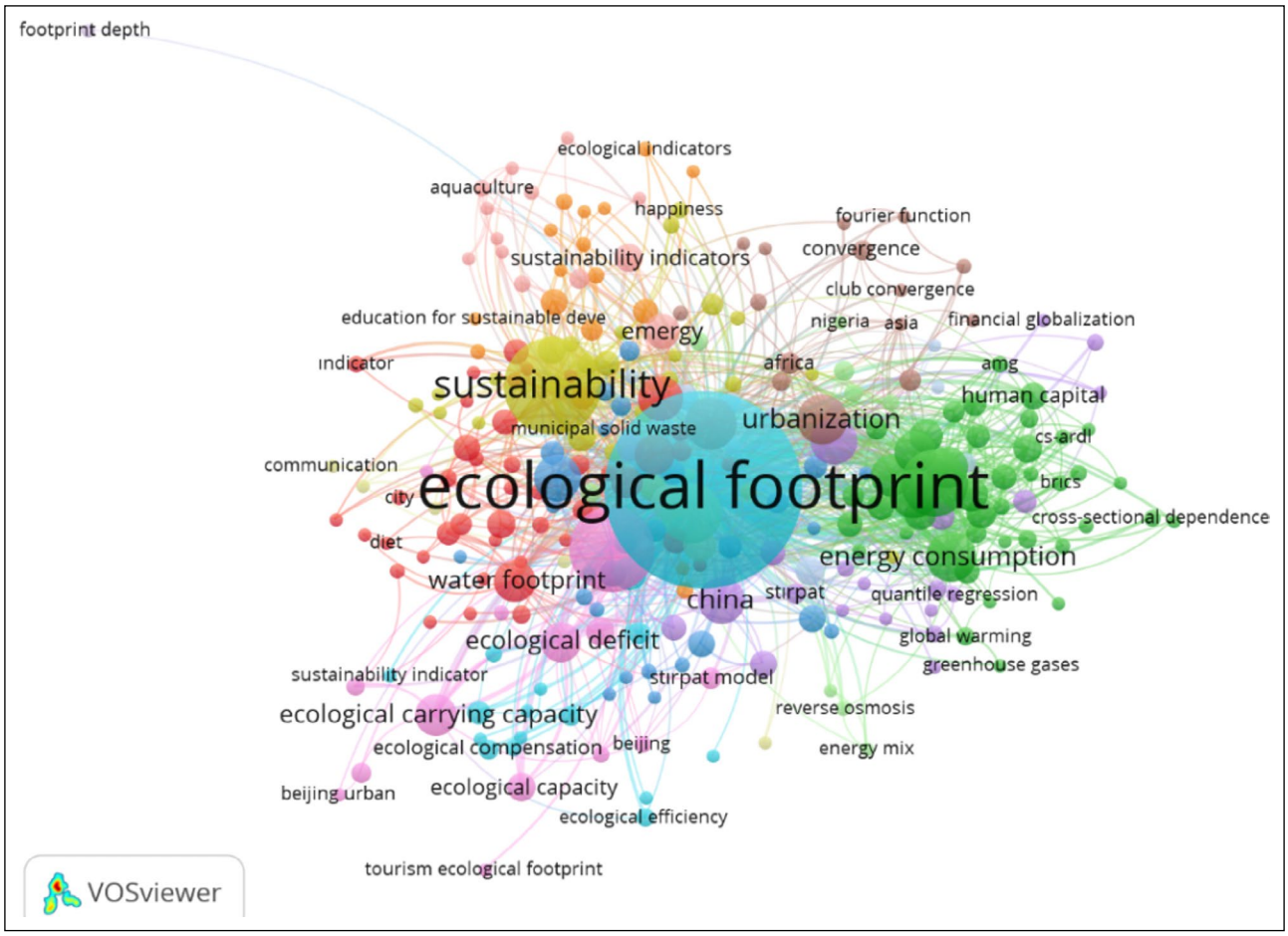

Figure 4. Bibliometric network analysis of keywords used in scientific publications on ecological footprint between 2010–2021.

Table 5. Information on keywords between 2010 and 2021 (50 or more repeats)

No	Keywords	Frequency	Total link strength
1	Ecological footprint	1061	612
2	Sustainability	253	178
3	Sustainable development	201	157
4	Economic	124	133
5	Carbon footprint	99	101
6	Biocapacity	73	95
7	Urbanization	68	87
8	Energy consumption	68	79
9	Renewable energy	67	72
10	Life cycle assessment	61	43
11	Environmental sustainability	60	58
12	China	60	52
13	Environment	56	45
14	Ecological carrying capacity	50	58

priate keywords to assist researchers in locating relevant information on the topic [36]. Table 5 shows that the most commonly used keywords are 'ecological footprint', 'sustainability', and 'sustainable development'.

Characteristics of Selected Authors

In scientific research, the productivity of authors can be analyzed by examining the number of publications they have produced. When conducting a bibliometric analysis on ecological footprint, the study determined the number of publications by the 10 most productive authors, the average number of citations per publication, the h-index, and research areas (Table 6). Out of the 2748 publications in the WoS database, Galli and Alessandro were identified as the most productive authors with 35 publications. These authors also have the highest average citations per publication. The research areas of the most productive authors were found to be Environmental Science and Ecology. The top ten authors ranked by average number of citations per publication are Galli and Alessandro in first place with 77.57, followed by Ahmed and Zahoor with 58.65, Wackernagel and Mathis with 52.5 in third place, and Lin and David with 43.84 in fourth place. The authors with the highest h-index in the top ten are Galli and Alessandro with 23 and Wackernagel and Mathis with 15.

CONCLUSION

Bibliometrics is the study of objectively derived and quantitatively categorized research topics in published studies across different disciplines. It involves examining, rearranging, and creating patterns from a scientific perspective. In

Table 6. The Top 10 Most productive authors

No	Authors	Publication (n)	Average citation per publication ($\bar{x}$)	h-index	Research area
1	Galli, Alessandro	35	77,57	23	Environmental Sciences Ecology
2	Li, Ying	25	8,8	7	Civil Engineering & Architecture
3	Wackernagel, Mathis	24	52,5	15	Sustainability
4	Marrero, Madelyn	21	20,43	10	Building Construction
5	Lin, David	19	43,84	14	Sustainability
6	Yang Yi	19	15,32	11	Econ & Management
7	Alola, Andrew Adewale	18	35,22	12	Accounting & Finance
8	Narodoslawsky, Michael	18	17,33	10	Sustainability
9	Ahmet, Zahoor	17	58,65	14	Econ & Management
10	Bekun, Festus Victor	17	38,18	11	Logistics Management

recent years, the use of bibliometric analysis has become increasingly prevalent in all fields of science. This study examines the issue of ecological footprint, a measurable indicator of environmental problems, using bibliometric analysis. Ecological footprint represents the use of the environment and natural resources to ensure economic and ecological sustainability, making it a crucial research topic today. Ulucak and Erdem [37] state that environmental factors play a crucial role in the growth process of developing countries. In other words, a country's development level is influenced by its ecological footprint. Tosunoğlu [38] states that ecological footprints vary due to differences in populations and consumption habits among countries. Given that environmental problems are multidimensional and irreversible, international efforts should be increased.

Nations have recognized the need for increased international cooperation to address environmental problems with a holistic approach in order to reduce the Ecological Footprint. Therefore, ecological footprint research is crucial to draw attention to the growing environmental problems and express them with measurable sizes. The bibliometric analysis method was used to analyze studies on ecological footprint between 2010 and 2021, utilizing the WoS database on an international platform. [39] The purpose of this study is to analyze the scientific cooperation structure of publications on ecological footprint using bibliometric analysis. A total of 2748 publications were analyzed by scanning the Web of Science database, and trends over the past 11 years were identified. According to the findings obtained as a result of the examinations, the distribution of the number of publications in the WoS database on ecological footprint by country is as follows. China ranks first with 786 publications, followed by the USA with 305 publications, and Türkiye in third place with 196 publications. It is worth noting that Türkiye is included in the ranking.

Upon examining the distribution of publications by year, it was found that there was a maximum increase of 48% between 2019 and 2020, while there were no significant increases in the number of publications prior to 2018. On the other hand, the distribution of the number of citations by year shows a constant increase in a parabolic manner. Additionally, it is observed that the highest number of citations received in publications on the subject of ecological footprint was in 2021, with a value of 16817. Australia has the highest average number of citations per publication, while China has the highest H-index.

Environmental Science and Pollution Research is the top journal in terms of the number of articles published on the international platform between 2010 and 2021, with a total of 198 publications. However, its impact factor is 4.223. The impact factor of this journal is lower than that of other journals in the top three rankings. However, it is preferred due to its complete open access policy and quick turnaround time for research publication. Among the top 10 journals, the 'Advanced Materials Research' journal has the highest number of published articles on the topic of ecological footprint.

The top three most cited publications on the ecological footprint in the WoS database are 'Science', 'Journal of Cleaner Production', and 'Annals of Tourism Research'. Additionally, three of the top ten most cited studies on the subject were published in the Ecological Indicators Journal. The data suggests that the journal is effective in this field. The reason for the high number of citations may be attributed to the impact of ecological footprints on sustainability. Furthermore, the top 10 most cited publications cover various determinants of water, carbon, and other environmental components related to the ecological footprint.

The authors who received more than 100 citations related to the ecological footprint in the WoS database are linked through common citations, which are grouped into three clusters: red, blue, and green. The authors' common citation density is highest in the red and green color clusters, while it is low in the blue color cluster. This suggests that the authors in the blue color cluster are less connected in terms of common citation links.

Upon analyzing the hotspot networks of keywords in publications related to ecological footprints in the WoS database, it was found that the term 'ecological footprint' was the most frequently used keyword in all publications. Furthermore, Figure 4 illustrates the utilization of keywords in the

time zone view of the keyword network, including water footprint, ecological capacity, municipal solid waste, ecological deficit, global warming, emergency, and greenhouse gases. The publications' keywords have diversified, and the network of relations has expanded up to the present day. The three most frequently used keywords in publications in the WoS database are ecological footprint, sustainability, and sustainable development.

This study found that numerous authors from various disciplines have published works on the ecological footprint, which is a measure of environmental impact. Based on the bibliometric analysis, it is evident that China has the highest number of publications and citations on this subject. This bibliometric analysis study has several limitations. Firstly, the inclusion criteria have been rigorously determined. Although the WoS database is extensive, there is a possibility that some publications may have been overlooked.

DATA AVAILABILITY STATEMENT

The author confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

USE OF AI FOR WRITING ASSISTANCE

Not declared.

ETHICS

There are no ethical issues with the publication of this manuscript.

REFERENCES

[1] Danish, and Z. Wang. "Investigation of the ecological footprint's driving factors: What we learn from the experience of emerging economies," Sustainable Cities and Society. Vol. 49, Article 101626, 2019. [CrossRef]

[2] K. Arrow, B. Bolin, R. Costanza, P. Dasgupta, C. Folke, C. S. Holling…, and D. Pimentel. "Economic growth, carrying capacity, and the environment," Ecological Economics, Vol. 15(2), pp. 91–95, 1995. [CrossRef]

[3] F. Durkaya, "analysis of graduate theses on the topic of ecological footprint," Journal of Science Mathematics Entrepreneurship and Technology Education, Vol. 5(2), pp. 166–184, 2022.

[4] Danish, R. Ulucak, and S. Khan, "Determinants of the ecological footprint: Role of renewable energy, natural resources, and urbanization," Sustainable Cities and Society, Vol. 54. Article 101996, 2020. [CrossRef]

[5] S. A. Solarin, "Convergence in CO2 emissions, carbon footprint and ecological footprint: evidence from OECD countries." Environmental Science and Pollution Research, Vol. 26, pp. 6167–6181, 2019. [CrossRef]

[6] S. A. Solarin, A.K. Tiwari, and M.O. Bello, "A multi-country convergence analysis of ecological footprint and its components," Sustainable Cities and Society, Vol. 46, Article 101422, 2019. [CrossRef]

[7] M. Wackernagel, L. Onisto, A. C. Linares, I. S. L. Falfán, J. M. Garcia, and A. I. S. Guerrero, "Ecological footprints of nations," https://www.footprintnetwork.org/content/uploads/2021/03/ecological-footprints-nations-1997.pdf Accessed Sept 10, 2024.

[8] E. T. Mızık, and Z. Y. Avdan, "The cornerstone of sustainability: Ecological footprint." Journal of Natural Disasters and Environment, Vol. 6(2), pp. 451–467, 2020. [CrossRef]

[9] Y. Yang, and G. Meng. "A bibliometric analysis of comparative research on the evolution of international and Chinese ecological footprint research hotspots and frontiers since 2000," Ecological Indicators, Vol. 102, pp. 650–665, 2019. [CrossRef]

[10] R. Ulucak, and S. Erdoğan, "Bibliometric analysis of ecological footprint studies," https://www.enscon.org/pdf/14-15%20Kas%C4%B1m%202020%20ENSCON%20Tam%20Metin%20Bildiriler%20Kitab%C4%B1.pdf Accessed Sept 10, 2024.

[11] Y. Wang, Y. Xie, R. Zhou, X. Hu, and X. Li, "A comparative bibliometric analysis of Chinese and foreign articles in environmental footprint family (EFF) research," Environmental Science and Pollution Research, Vol. 28, pp. 26280–26293, 2021. [CrossRef]

[12] Y. Xie, X. Li, and X. Hu, "The landscape of academic articles in environmental footprint family research: A bibliometric analysis during 1996–2018," Ecological Indicators, Vol. 118, Article 106733, 2020.

[13] R. N. Broadus, "Toward a definition of 'bibliometrics'," Scientometrics, Vol. 12, pp. 373–379, 1987. [CrossRef]

[14] M. Zitt, S. Ramanana-Rahary, and E. Bassecoulard. "Relativity of citation performance and excellence measures: from crossfeld to cross-scale efects of feld-normalisation," Scientometrics, Vol. 63(2), pp. 373–401, 2005. [CrossRef]

[15] L. L. Li, G. Ding, N. Feng, M. M. Wang, and Y. S. Ho, "Global stem cell research trend: Bibliometric analysis as a tool for mapping of trends from 1991 to 2006," Scientometrics, Vol. 80, pp. 39–58, 2009. [CrossRef]

[16] N. Ale Ebrahim, H. Salehi, M.A. Embi, F. Habibi, H. Gholizadeh, and S.M. Motahar. "Visibility and citation impact," International Education Studies, Vol. 7(4), pp. 120–125, 2014. [CrossRef]

[17] A. Kalantari, A. Kamsin, and H.S. Kamaruddin, "A bibliometric approach to tracking big data research trends," Journal of Big Data, Vol. 4, Article 30, 2017. [CrossRef]

[18] N. Donthu, S. Kumar, D. Mukherjee, N. Pandey, and W.M. Lim, "How to conduct a bibliometric analysis: An overview and guidelines," Journal of Business Research, Vol. 133, pp. 285–296, 2021. [CrossRef]

[19] E. C. M. Noyons, H. F. Moed, and M. Luwel, "Combining mapping and citation analysis for evaluative bibliometric purposes: a bibliometric study," Journal of American Society for Information Science and Technology, Vol. 50(2), pp. 115–131, 1999. [CrossRef]

[20] M. Kaya, and E. Erbay, "Global trends of the researches on COVID-19: A bibliometric analysis via VOSviewer," Journal of Ankara Health Sciences, Vol. 9(2), pp. 201–216, 2020. [CrossRef]

[21] N. J. van Eck, and L. Waltman, "VOSviewer manual - Version 1.6. 8.," https://www.vosviewer.com/documentation/Manual_VOSviewer_1.6.18.pdf Accessed Sept 10, 2024.

[22] H. E. Kızılöz, "Citation count prediction of academic papers," European Journal of Science and Technology, Special Issue, pp. 370–375, 2020.

[23] A. Y. Hoekstra, and T. O. Wiedmann, "Humanity's unsustainable environmental footprint," Science, Vol. 344(6188), pp. 1114–1117, 2014. [CrossRef]

[24] L. Čuček, J. J. Klemeš, and Z. Kravanja, "A review of footprint analysis tools for monitoring impacts on sustainability," Journal of Cleaner Production, Vol. 34, pp. 9–20, 2012. [CrossRef]

[25] R. Buckley, "Sustaınable tourısm: Research and reality," Annals Of Tourism Research, Vol. 39(2), pp. 528–546, 2012. [CrossRef]

[26] A. Galli, T. Wiedmann, E. Ercin, D. Knoblauch, B. Ewing, and S. Giljum. "Integrating ecological, carbon and water footprint into a 'footprint family' of indicators: definition and role in tracking human pressure on the planet," Ecological Indicators, Vol. 16, pp. 100–112, 2012. [CrossRef]

[27] J. Wu, "Urban ecology and sustainability: The state-of-the-science and future directions, "Landscape And Urban Planning, Vol. 125, pp. 209–221, 2014. [CrossRef]

[28] M. A. Destek, and S. A. Sarkodie, "Investigation of environmental Kuznets curve for ecological footprint: The role of energy and financial development," Science Of The Total Environment, Vol. 650(2), pp. 2483–2489, 2022. [CrossRef]

[29] K. Mori, and A. Christodoulou, "Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI)" Environmental Impact Assessment Review, Vol. 32(1), pp. 94–106, 2012. [CrossRef]

[30] J. Weinzettel, E. G. Hertwich, G. P. Peters, Kjartan Steen-Olsen, and A. Galli, "Affluence drives the global displacement of land use," Global Environmental Change-Human And Policy Dimensions, Vol. 23(2), pp. 433–438, 2013. [CrossRef]

[31] M. Borucke, D. Moore, G. Cranston, K. Gracey, K. Iha, J. Larson, E…, and A. Galli, "Accounting for demand and supply of the biosphere's regenerative capacity: The National Footprint Accounts' underlying methodology and framework," Ecological Indicators, Vol. 24, pp. 518–533, 2013. [CrossRef]

[32] U. Al-Mulali, C. Weng-Wai, D. Sheau-Ting, and A. H. Muhammed, "Investigating the environmental Kuznets curve (EKC) hypothesis by utilizing the ecological footprint as an indicator of environmental degradation," Ecological Indicators, Vol. 48, pp. 315–323, 2015. [CrossRef]

[33] M. J. Cobo, A. G. López-Herrera, and E. Herrera-Viedma, "Science mapping software tools: Review, analysis, and cooperative study among tools," Journal of the American Society for Information Science and Technology, Vol. 62, pp. 1382–1402, 2011. [CrossRef]

[34] A. Andres, "Measuring academic research: How to undertake a bibliometric study," Chandos Publishing, 2009.

[35] N. J. Van Eck, and L. Waltman, "Visualizing bibliometric networks.," In: Y. Ding, Rousseau R, D. Wolfram (Eds.), Measuring scholarly impact. Springer. pp. 285–320, 2014. [CrossRef]

[36] A. Turan, and G. Dolgun. "Software for title, abstract, keywords and author ınformation in scientific research articles," Journal of Education and Research in Nursing, Vol. 18(1), pp. 77–82, 2021. [CrossRef]

[37] R. Ulucak, and E. Erdem, "Environment in economic growth models: An application based on the ecological footprint," Hacettepe University Journal of the Faculty of Economics and Administrative Sciences, Vol. 35(4), pp. 115–147. 2017. [CrossRef]

[38] B. Tosunoğlu, "Ecological footprint as an indicator of sustainable global prosperity. International Journal of Labor and Society," Vol. 3(5), pp. 132–149, 2014.

[39] Web of Science, "Web of Science core collection," https://clarivate.com/products/scientific-and-academic-research/research-discovery-and-workflow-solutions/webofscience-platform/web-of-science-core-collection/ Accessed Sept 10, 2024.