Journal of Advanced Research in Library and Information Science
Volume 11, Issue 2 - 2024, Pg. No. 6-13
Peer Reviewed Journal

Research Article

Mapping Global Biodiversity Research: A Web of Science-Based Bibliometric Analysis (2019–2023)

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How to cite this article:
Zaidi T, Ansari M A. Mapping Global Biodiversity Research: A Web of Science-Based Bibliometric Analysis (2019–2023). *J Adv Res Lib Inform Sci* 2024; 11(2): 6-13.

Date of Submission: 2024-08-07
Date of Acceptance: 2024-10-13

A B S T R A C T

Biodiversity is the collection of living creatures on the earth. All the essential functions of the environment are carried out by biodiversity. Human beings keep destroying nature and wildlife and their actions result in a loss of biodiversity. The present study is a bibliometric study, and the main objective is to find out the scholarly publications and citation trends on biodiversity literature from 2019 to 2023. The data was retrieved from the Web of Science database, and analysis was done with the help of Excel and Biblioshiny Software. The results show that fluctuation occurs in biodiversity literature production every year. The study also identified significant contributors such as countries, authors, institutions, and journals. Collaborative authorship is becoming increasingly common as a prominent trend, indicating the collective endeavour to advance biodiversity study. The study is important for scholars, researchers, policymakers, and organisations that are involved in the advancement and implications of biodiversity studies. It not only draws attention to recent developments in the discipline, but it also lays a foundation for further research

Keywords: Bibliometrics, Biodiversity, Biblioshiny, Database, Environment, Publication, Software, Web of Science, Wildlife

Introduction

Biodiversity is the variety of living beings on the planet Earth. Humans, animals, and plants, all together constitute biodiversity. It even includes genomic information and ecological information about living beings. Tons of species exist on the earth, As Mora said "over 1.2 million species already catalogued"[1] and all these species are getting benefit from biodiversity in multiple ways such as environment control, biogeochemical cycling, procreation of crops, hygienic air, and water. Therefore, one can assert that Biodiversity is a crucial component of living creatures lives.

Biodiversity helps humankind live its life properly, but the existing human species is the worst enemy. Anthropogenic activities damage biological resources and make them worse every day. Mankind is losing biodiversity at an extremely fast rate. Biodiversity loss is a condition in which the earth loses a species and usually biodiversity loss is permanent. Biological diversity is reducing day by day. Rawat says "The loss of biodiversity and the related changes in the environment are now faster than ever before in human history and there is no sign of this process slowing down".[2]

Factors associated with human interaction are causing the deterioration of biodiversity. Overpopulation, habitat reduction, climate change, pollution (air, water, land), deforestation, invasive species, over-exploitation, and even illegal wildlife trade are all together contributing to the loss of biodiversity.Now the time has come when humans must think about a healthy outlook showing sympathy towards nature and take steps for its progress and for future generations. Ecologists, experts, and social workers

do their best to conserve natural resources or biodiversity. They are the real heroes of nature. They are promoting activities like environment restoration, balanced use of natural resources, preserving vulnerable species, promoting awareness in society, and educating people. Nature is God-gifted hence, it has become our duty to protect it, conserve it, and most important respect it.

At the global level, governments and NGOs are creating, implementing, and monitoring the different acts and policies related to the conservation of biodiversity. We celebrate World Environment Day on the fifth of June every year, the third of March is celebrated as World Wildlife Day, and these types of events are great means to promote biodiversity, sustainability, and nature conservation.

Review of Literature

Bibliometrics studies have been conducted in biodiversity literature from various angles; some of the current ones are mentioned below to have a better understanding of the topic. Recently and most relevant study is conducted by Simion.[3] They studied using Scopus and Science Direct databases; the authors discussed the use of bibliometric methods for the scientific production of biodiversity. The findings of this study conducted from 2012 to 2022 indicated that during 2013 and 2015 a large amount of information was published and the lowest citation received in 2022. The analysis of their study indicated that there is a fluctuation of growth of articles per year. The author also highlighted that "Biological Conservation", and "Science of Total Environment" were the most specialised source or journals. Another study conducted by Maione indicated that 525 records were published from 2001 to 2021.[4] It reported that out of 1309, authors only 107 were single authors and the rest were collaborative authors. The US and UK were the most productive countries. "Ecological Economics" was the most influential journal and "Thomas Cuckston" was identified as the most prolific author.

Tan assessed the ongoing trends that are responsible for the loss of biodiversity in and around the world.[5] Their analysis notes down 6599 publications and identified that the USA was the most productive country, the most influential journal was "Biological Conservation", and the most prolific author was "Eisenhauer, N". In 2022 some more studies conducted by different authors in the field of biodiversity such as Abdullah, examined the management of biodiversity with the help of the Scopus database.[6] The interpretation of their data shows that conservation and biodiversity management have a stronger link, with biodiversity management directly tied to conservation; their work revealed that in 2021 about sixty-eight articles were published. In the Scopus Database USA was found to be the most productive country. "Biological Conservation" was the most influential source of information, and it mentioned that "de Boef, W.S." was the most prolific author. In 2021, studies have been conducted to explore more about the biodiversity research based on bibliometric analysis as well as scientometric analysis such as Sivasami used around 11902 records from the Web of Science Database, revealing an abundant growth in biodiversity research from 2011 to 2020.[7] The study indicated that using a document type filter 9102 records were the articles. "Schmidt B" was identified as the most productive author and collaboration among the authors was found to be 97.46% which means single-authored work was much less in comparison to multiple-authored work.

Houlden jointly worked on a bibliometric analysis of the effect of exposure to biodiversity on health and well-being and they found 1758 records.[8] They had mentioned that since 2019 there were over 250 new articles published which indicates that more research work conducted in the biodiversity field. The USA and UK were found to be the most productive countries.

Subiza conducted a study related to the nation's development and biodiversity state impacting the number of articles published in scientific journals; researchers also investigated these factors.[9] They have studied 37000 records ranging from the year 2010 to 2019 using the Web of Science Database. It was revealed in their study that 20% of articles were on freshwater biodiversity. Liu used the Web of Science database (WoS) as well as the Scopus database and bibliometric techniques utilised to analyse articles published between 2008 and 2017.[10] Nearly 3573 records were examined for their study. The findings indicated that after 2011 in the WoS database, 4932 papers increased, whereas Scopus records were 3252 in 2018. According to WoS, the most productive country was China, and the Scopus database shows the USA as the leading country. WoS revealed that the Cochrane Database of Systematic Reviews is the most influential source, whereas according to Scopus, PLoS is the most productive journal or source of information.

Objectives

The objectives of the study are mentioned below:

- To examine the annual scientific production and citation trends in biodiversity literature
- To find out the most productive country, authors, and institutions in biodiversity literature
- To determine the core journal in the field of biodiversity
- To examine the author's collaboration pattern in biodiversity literature

Methodology

For the present study, the data on Biodiversity literature was retrieved from the Web of Science (WoS) database. WoS is one of the most comprehensive research and citation databases.

The study was limited to biodiversity-related research that was published globally between the years 2019 to 2023. The topic "biodiversity" was searched and in 195548 results were retrieved. However, after applying the filters like Social Sciences Citation Index (SSCI), articles in document types, and publications years from 2019 to 2023. The final number of records obtained was 10879. Excel and Biblioshiny software were used for data analysis.

Analysis and Results

Annual Scientific Production and Citation Trend

The total number of articles published over the past five years (2019-2023) is 10879 and there is a notable variation in the number of publications each year. Maximum number of articles published in the year 2021 with 2816 articles. This was followed by the year 2020 with 2358. In the year 2022 number of articles published was 2100. During 2019 and 2023 number of articles published was 2091 and 1514, respectively.

The analysis revealed that fluctuation occurs in biodiversity literature production every year. The number of articles increased from the year 2019 to 2021, followed by a decrease in the year 2022 and 2023 (Figure 1).

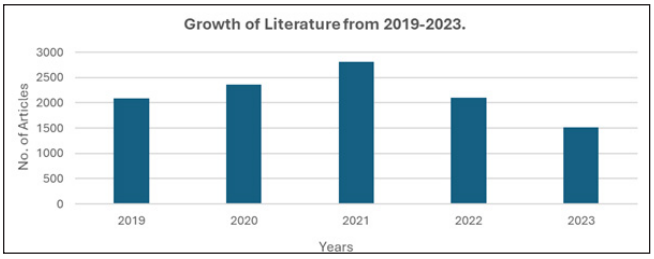

Figure 1.Growth of Literature from 2019 to 2023

Table 1 demonstrates an observable pattern in the number of articles published annually, with mean total citation per article per year. The highest mean total citations (TC = 23.87) per year were received in 2019, followed by the year 2020 with a mean of 20.9 per year and 2021 with a mean of 6.88 per year. The lowest mean (TC = 2) per year was collected in 2023.

Most Productive Country and Citation Trend

It was found that more than 160 countries are contributing to biodiversity publications. Among them, the USA contributed the highest number of articles which is 1477. China stands at second position with 1314 articles and after that UK is on the list with 902 articles. India secures the seventeenth position with 157 articles.

The top ten countries in terms of number of articles and number of citations are listed in Tables 2 and 3, respectively.

According to the analysis of Table 3, China has obtained the highest number of citations which is 21595 and 16.4 is the average article citation. USA stands at second position with 21450 citations and the average article citation is 14.50. The United Kingdom is in third position with 16151 citations and 17.90 is the average article citation.

Most Prolific Author and Citation Trend

The total number of authors contributing to biodiversity literature is 39242. These authors collectively contributed 10879 articles. The most prolific author in terms of highest number of articles is Wang Yao from China geological survey, China. He contributed 31 articles (5.80%). This was followed by Milner-Gulland, E.J. University of Oxford, England, with 28 publications (5.12%). At the third position is Wang Jun from Huazhong Agricultural University Chinese Academy of Sciences Yunnan University, China with 25 articles (5.15%). The next position was secured by Liu Yx with 24 articles (4.1%). Table 4 is given below showing the top ten prolific authors in terms of the number of articles.

Table 5 demonstrates the top ten prolific authors in terms of citations they obtained over the time of past five years (2019 to 2023).

According to the analysis, Watson Jem obtained the maximum number of citations which is 1562 and he also received the highest citations (910) in the year 2020. The second position is occupied by Wang J, with 1158 total citations and the maximum citations (895) he received in the year 2020. Liu Yx has secured the third rank with 1093 total citations and the maximum number of citations (516) he received in the year 2019. It is important to note that from the above analysis, 2019 and 2020 were the years during which maximum citations were received.

Most Productive Institution

A total of 9372 Institutions are contributing towards the enhancement of biodiversity publications. The topmost productive institution is Centre National De La Recherche Scientifique (CNRS) with 499 articles. According to the analysis of Table 6, the second most contributed institution is the Chinese Academy of Sciences with 422 articles. NRAE and the University of California System placed in third and fourth position with 322 and 290 articles, respectively.

The third position is occupied by the INRAE with 322 articles. The University of California System and Wageningen University and Research placed at the fourth and fourth position with 290 and 247 articles, respectively.

Most Productive Journal and Citation Trend

The total number of journals contributing to biodiversity literature is 1129. Using Bradford's law to find out the topmost journals. The first rank was occupied by the journal named "Sustainability" with 1448 articles. Next is "Land" with 622 articles. Table 7 shows a list of the top ten journals using Bradford's law.

The third position is occupied by "Land Use Policy" with 360 number of articles. Next are "Urban Forestry," Urban Greening" and "Ecosystem Services" with 327 and 258 articles, respectively.

Table 8 shows a list of core journals that received the highest number of citations. According to the analysis, the topmost rank was achieved by the journal "Sustainability" with 9943 total number of citations. The second position occupied is by a journal named "Land Use Policy" with 5509 total citations. "Science of The Total Environment" achieved third position with 5439 total citations. Whereas fourth and fifth positions were secured by "Nature Sustainability" and "Ecosystem Services" with 44518 and 4448 total citations, respectively.

Author Collaboration Pattern and Citation Trend

The analysis provided a connection to the collaboration patterns among the authors. Analysis of collaboration of authors has been studied and the results indicate that the number of articles credited to single authors is 917 with 72431 citations. Work done by collaboration among three authors has the highest number of articles with a total of 2014 as well as the highest number of citations 154446. This was followed by works having two authors adding up to 1547 articles and works with four authors adding up to 1766 articles with citations 119513 and 27411 respectively. Table 9 shows the top ten authors who have collaboratively written 165 articles with 12122 total citations.

The analysis reveals that the numbers of articles and citations vary across authors. As we move down the list there is a steady drop in the number of articles as well as in the number of citations, this indicates that productivity among authors is dropping. However, it is important to note here that, globally authors are collaborating with each other to foster expertise and innovations in research. Hence, we conclude that collaborative authorship dominates over single authorship.

Table 1.Mean Total Citations Per Article and Year of Articles

S. No.	Year	Mean Total Citations per Article	Number of Articles	Mean Total Citation per Year
1	2019	23.87	2,091.00	3.98
2	2020	20.90	2,358.00	4.18
3	2021	14.49	2,816.00	3.62
4	2022	6.88	2,100.00	2.29
5	2023	2.00	1,514.00	1.00

Table 2.Top Ten Countries and Number of Articles

S. No.	Country	Articles	SCP	MCP	Freq	MCP Ratio
1	USA	1477	944	533	0.134	0.361
2	China	1314	904	410	0.119	0.312
3	United Kingdom	902	441	461	0.082	0.511
4	Germany	700	393	307	0.064	0.439
5	Australia	615	343	272	0.056	0.442
6	Italy	456	306	150	0.041	0.329
7	France	419	236	183	0.038	0.437
8	Brazil	408	226	182	0.037	0.446
9	Spain	407	249	158	0.037	0.388
	Canada	381	222	159	0.035	0.417

SCP: Single Country Publication; MCP: Multiple Country Publication

Table 3.Top Ten Countries with Number of Citations

S. No.	Country	Total Citations	Average Article Citations
1	China	21595	16.40
2	USA	21450	14.50
3	United Kingdom	16151	17.90
4	Germany	10498	15.00
5	Australia	10148	16.50

6	Italy	5945	13.00
7	France	5699	13.60
8	Canada	5478	14.40
9	Brazil	5300	13.00
10	Spain	4959	12.20

Table 4.Top Ten Authors and Number of Articles

S. No.	Authors	Articles	Articles Fractionalised
1	Wang Yao	31	5.80357143
2	Milner-Gulland Ej	28	5.12291549
3	Wang Jun	25	5.15467262
4	Kowarik I	24	7.87171220
5	Liu Yx	24	4.19365079
6	Possingham Hp	24	3.66517061
7	Watson Jem	24	3.19395813
8	Zhang Y	24	3.47384560
9	Angelstam P	21	3.35889742
10	Verburg Ph	19	3.18297988

Table 5.Top Ten Authors in Terms of Citations Over Time

S. No.	Author	Year	Frequency	Total Citation	Total Citations Per Year
1	Watson Jem	2019	5	192	32.000
	Watson Jem	2020	9	910	182.000
	Watson Jem	2021	4	401	100.250
	Watson Jem	2022	3	33	11.000
	Watson Jem	2023	3	26	13.000
				Total = 1562	Total = 338.250
2	Wang J	2019	5	88	14.667
	Wang J	2020	6	895	179.000
	Wang J	2021	9	140	35.000
	Wang J	2022	4	34	11.333
	Wang J	2023	1	1	0.500
				Total = 1158	Total = 240.5000
3	Liu YX	2019	6	516	86.000
	Liu YX	2020	9	391	78.200
	Liu YX	2021	2	61	15.250
	Liu YX	2022	3	120	40.000
	Liu YX	2023	3	5	2.5000
				Total = 1093	Total = 221.950
4	Milner-Gulland EJ	2019	8	164	27.333
	Milner-Gulland EJ	2020	8	406	81.200
	Milner-Gulland EJ	2021	8	98	24.500
	Milner-Gulland EJ	2022	3	11	3.667
	Milner-Gulland EJ	2023	1	6	3.000
				Total = 685	Total = 139.700

5	Wang Y	2019	2	51	8.500
	Wang Y	2020	5	115	23.000
	Wang Y	2021	6	376	94.000
	Wang Y	2022	13	103	34.333
	Wang Y	2023	5	32	16.000
				Total = 677	Total = 175.88
6	Verburg PH	2019	6	332	55.333
	Verburg PH	2020	4	79	15.800
	Verburg PH	2021	2	28	7.000
	Verburg PH	2022	4	200	66.667
	Verburg PH	2023	3	2	1.000
				Total = 641	Total = 145.8
7	Zhang Y	2019	2	44	7.333
	Zhang Y	2020	5	269	53.800
	Zhang Y	2021	5	215	53.750
	Zhang Y	2022	8	61	20.333
	Zhang Y	2023	4	5	2.500
				Total = 594	Total = 137.710
8	Kowarik I	2019	7	276	46.000
	Kowarik I	2020	7	148	29.600
	Kowarik I	2021	6	87	21.750
	Kowarik I	2022	3	16	5.333
	Kowarik I	2023	1	2	1.000
				Total = 529	Total = 103.680
9	Possingham HP	2019	7	268	44.667
	Possingham HP	2020	5	82	16.400
	Possingham HP	2021	4	83	20.750
	Possingham HP	2022	5	51	17.000
	Possingham HP	2023	3	3	1.500
				Total = 487	Total = 100.310
10	Angelstam P	2019	5	136	22.667
	Angelstam P	2020	3	86	17.200
	Angelstam P	2021	5	84	21.000
	Angelstam P	2022	5	24	8.000
	Angelstam P	2023	3	3	1.500
				Total = 333	Total = 71.367

Table 6.Top Ten Institutions with Number of Articles

S. No.	Institution	Articles
1	Centre National De La Recherche Scientifique (CNRS)	499
2	Chinese Academy of Sciences	422
3	INRAE	322
4	University Of California System	290
5	Wageningen University and Research	247
6	University Of Queensland	238
7	Universite De Montpellier	211
8	Swedish University of Agricultural Sciences	183

9	Cirad	178
10	State University System of Florida	178

Table 7.Top Ten Journals in Biodiversity Literature

S. No.	Journals	Rank	Freq	Cumulative Freq	Zone
1	Sustainability	1	1448	1448	Zone 1
2	Land	2	622	2070	Zone 1
3	Land Use Policy	3	360	2430	Zone 1
4	Urban Forestry & Urban Greening	4	327	2757	Zone 1
5	Ecosystem Services	5	258	3015	Zone 1
6	Marine Policy	6	237	3252	Zone 1
7	Landscape and Urban Planning	7	232	3484	Zone 1
8	International Journal of Environmental Research and Public Health	8	196	3680	Zone 1
9	Science of the Total Environment	9	185	3865	Zone 2
10	Ecological Economics	10	167	4032	Zone 2

Table 8.Top Ten Journals and Number of Citations

S. No.	Journals	H Index	G Index	M Index	Total Citation
1	Sustainability	33	44	5.5	9943
2	Land Use Policy	36	54	6	5509
3	Science of the Total Environment	39	59	6.5	5439
4	Nature Sustainability	42	63	7	4518
5	Ecosystem Services	33	48	5.5	4448
6	Ecological Indicators	36	54	6	3988
7	Landscape And Urban Planning	35	47	5.833	3784
8	Urban Forestry & Urban Greening	29	40	4.833	3721
9	Land	24	34	4	3669
10	Nature Climate Change	28	52	4.667	3268

*H Index (Hirsch Index) *G Index (M Quotient) *M Index (Gini Index)

Table 9.Collaboration among the Authors with Number of Citations

S. No.	Authors	Articles	Citations
1	1	917	72431
2	2	1547	119513
3	3	2014	154446
4	4	1766	127411
5	5	1341	104716
6	6	983	76143
7	7	608	46642
8	8	437	33316
9	9	298	22980
10	10	202	15060

Discussion

Due to any cause, often fluctuations occur in the growth of literature. The present study result also indicates fluctuation. The analysis reveals that the year 2021 was the most productive year. The growth is notable with the number of articles increasing from 2091 in 2019 to 2816 in 2021 then suddenly the number drops to 2100 in 2022 and further decreases to 1514 in 2023. One of the studies conducted by Simion et al. (2023), also shows fluctuation in publication. They studied records from 2012 to 2021 and found that 2013 and 2015 were the most productive years.

Academic journals are secondary sources of information. Journals related to the content of Biodiversity publish articles covering topics like nature, ecosystems, and protections. According to the result of the present study, the most influential journal is "Sustainability" with 1448 numbers of articles. However, previous studies results are contradictory. Studies conducted by Simion et al. (2023), Maione et al., (2023), and Ling Tan et al. (2022) have found that "Biological Conservation" was the most influential journal.

Developed countries are producing more amount of literature on biodiversity. The present analysis shows that the USA and China are the most productive countries in terms of the production of articles and receiving the highest number of citations, respectively. This finding is in line with the findings of earlier studies. Studies conducted by Maione et al., (2023), Ling Tan et al. (2022), Abdullah et al. (2022), Houlden, Jani, and Hong (2021), and Liu et al. (2019) all have found that the US and UK are the most productive countries.

In this era, collaboration is essential for research work. Authors are collaborating with each other to bring expertise and evolving innovative ideas and insights to the area of the study. The present study examined that only 917 articles were written by a single author whereas collaborative work is much higher, the highest collaboration is among three authors with a 2014 number of articles. The result is consistent with other research findings. A study conducted by Sivasami (2021) found that 97.46% of work is done through collaboration.

Conclusion

The vast scientific output and international research initiatives that highlight both the ecological and socioeconomic aspects of biodiversity demonstrate the significance of biodiversity literature. Concisely it can be said that the literature on biodiversity over the post-five years indicates flux in terms of its annual growth although 2021 is the most productive year. The journal named "Sustainability" is the most dynamic journal and the most prolific author is Wang Yao from China. The most productive institution is the Centre National De La Recherche Scientifique (CNRS). China and the USA were to be among the most influential countries in terms of number of citations and number of articles, respectively. Collaborative authorship pattern is higher in comparison to single authorship. The study holds importance for scholars, researchers, policymakers, and organisations that are involved in the advancement and implications of biodiversity studies. It not only draws attention to recent developments in the discipline, but it also lays a foundation for further research.

Source of Funding: None

Conflict of Interest: None

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