Continent-wise Analysis of Research Productivity in Limnology with Activity and Priority Index : a scientometric study

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Abstract

The Activity Index (AI) and Priority Index (PI) values for the six continents are examined in this study. There are seven continents, but we have only included six continents here because the remaining continent, Antarctica, hasn't contributed anything to this area's publications. This study looks at the AI and PI value of Limnology research publications at the continental level. The continents like North America, Europe, and Africa, which produce the majority of the year's output, have a higher AI and PI value. The Oceania continent had a higher AI and PI value for sixteen years, while the remaining sixteen years had a lower index value. The South American and Asian continents, which produced the majority of the year's output, have lower AI and PI values.

Keywords: Activity Index, Limnology, Priority Index, Scientometrics

1. Introduction

Scientometrics is the quantitative and qualitative examination of a subject. It is a valuable tool for assessing the research productivity of a country, institution, author, journal evaluation, collaboration trends, and so on. It is used to investigate the evolution of a subject field, assess the impact of a study through citation analysis, and the mapping of knowledge. Scientometricsis important in measuring and evaluating research performance. Scientometric analysis is used in a variety of contexts.

Limnology is the study of fresh or saline waters contained boundaries. Limnology and the closely related science of oceanography together cover all aquatic ecosystems. Although many limnologists are freshwater ecologists, physical, chemical, and engineering limnologists all participate in this branch of science. Limnology covers lakes, ponds, reservoirs, streams, rivers, wetlands, and estuaries, while oceanography covers the open sea. Limnology evolved into a distinct science only in the past two centuries, when improvements in microscopes, the invention of the silk plankton net, and improvements in the thermometer combined to show that lakes are complex ecological systems with distinct structures (Horne and Goldman1994).

2. Review of literature

Abhilash and Asha (2021) analyzed the growth and development of library trends research at a continental level, as reflected in publication output covered by the Web of Science online database during 1989-2019.

Gupta and Dhawan (2018) carried out a multi-angle assessment of artificial intelligence research by the topmost countries, international collaboration in Indian research output, most productive Indian organizations, and highly cited papers. Pranali and Vaishali (2016) explored the periodicals of mathematics at the continental with the country-wise distribution of publications. The work also gave existing subjective and evaluative literature reviews on present research. Dutt and Nikam (2015) suggested collaborative aspects of research publications about global solar cell research as in Science Citation Index-Expanded (SCI-E) have been studied. Dwivedi, Kumar, and Garg (2015) analyzed 17, 344 papers published by Indian scientists and indexed by the Web of Science in the discipline of organic chemistry and its sub-disciplines during 2014-2013 indicating that the Indian output has increased significantly in the later period. Jeyshankar, Nageswara Rao and Arivunithi (2012) described the scientometric study of literature on neutrino research published in India. The article in the Scopus database covering the period 1966-2011 has been considered for this study. Konur (2012) explored the characteristics of the literature on biodiesel published during the last three decades based on the Science Citation Index Expanded (SCI-E) and Social Sciences Citation Index (SSCI) and its implications using the scientometric techniques. Surulinathi, Balasubramani and Kalisdha (2013) examined the growth and research productivity of Green Computing research at the continental level with a country-wise distribution of publications from 1956-2011.

The studied literature has identified that there are different scientometrics studies on bio-science but an in-depth scientometrics study on Limnology has not been done so far.

3. Objectives

- To determine the year-by-year distribution of Limnology research output
- To identify the continent-wise research productivity in Limnology
- To identify the pattern of the Activity Index and Priority Index

4. Methodology

The data for this study was obtained from the Web of Science database from1989 to 2020. The researcher used the search string "Limnology" to get data from the Web of Science database, including the Science Citation Index (SCI). The data is downloaded in plain text format and extracted using Hist Cite software. Further analysis is carried out using Microsoft Excel and Word software.

4.1 *Activity Index (AI)*

Activity Index is used to measure the production of individual continents' and countries' research output concerning the world contribution in the field of Limnology in Scientometrics.

4.2 *Priority Index (PI)*

The priority index indicates the research priority of a country for a given subfield that corresponds precisely to the average of all countries.

5. Data analysis

5.1 *Year-wise distribution of publications*

Table 1: Year-wise distribution of publication

S. No	Publication Year	Articles	%	TLCS	TGCS
1	1989	11	0.7	8	205
2	1990	15	1	44	512
3	1991	28	1.9	32	598
4	1992	27	1.8	48	891
5	1993	26	1.7	48	779
6	1994	35	2.3	50	406
7	1995	32	2.1	29	479
8	1996	27	1.8	48	886
9	1997	34	2.3	227	2076
10	1998	39	2.6	82	544
11	1999	31	2.1	51	1098
12	2000	31	2.1	59	808
13	2001	44	2.9	166	1362
14	2002	29	1.9	103	1423
15	2003	43	2.9	170	2989
16	2004	44	2.9	94	1786
17	2005	46	3.1	109	1468
18	2006	53	3.5	49	2255
19	2007	60	4	119	2288
20	2008	66	4.4	54	2843
21	2009	62	4.1	83	1995
22	2010	50	3.3	73	2510
23	2011	53	3.5	27	856
24	2012	54	3.6	84	1287
25	2013	51	3.4	31	742
26	2014	77	5.1	56	1508
27	2015	58	3.9	42	1155
28	2016	70	4.7	33	1016
29	2017	67	4.5	36	1011
30	2018	65	4.3	11	489
31	2019	78	5.2	15	731
32	2020	93	6.2	0	341
	Total	1499	99.8	2081	39337

(TLCS =Total Local Citation Score , TGCS =Total Global Citation Score)

The data has been shown in the table to assess the year-by-year publishing of research on Limnology. The global research output is depicted in the table. It is obvious from the table below, that between 1989 and 2020, a total of 1499 publications were produced. The research output on Limnology publications is used as a method to evaluate performance at various levels in this study. The highest publication is 93 in 2020 with 341 citations, followed by 78 in 2019 with 731 citations, respectively. The survey also discovered that all of these 1499 articles have 39337 cited references, indicating that there is a strong trend in citing among scientists in the "Limnology" field.

5.2 *Continent-wise distribution of limnology research output*

Table 2: Continent wise research output of limnology

S. No	Continents	No. of Publication	%	Rank	TCS
1	North America	627	41.83	1	27392
2	Europe	477	31.82	2	24621
3	South America	149	9.94	3	3030
4	Asia	140	9.34	4	3455
5	Australia/Oceania	67	4.47	5	2391
6	Africa	39	2.60	6	626
TOTAL		**1499**	**100**		**61515**

(TCS = Total Citation Score)

This study analysis covers the scientific research output on Limnology research publications at the continental level. There are seven continents, but here the researcher has taken only six continents because the last continent, Antarctica, does not have any contribution to the publications in this area. So for this part of the analysis, researcher has selected the continents of North America, Europe, South America, Asia, Oceania, and Africa. The data was analysed using descriptive statistics.

5.3 *Activity and Priority Index of North American continent research output*

Table 3: Activity and Priority Index of North American continent research output

Year	R.O/P of North America Continent	COP = A	W. O/P	WOP = B	A/B = AI Value	PI Value
1989	4	0.64	11	0.7	0.91	91.14
1990	8	1.28	15	1	1.28	127.59
1991	15	2.39	28	1.9	1.26	125.91
1992	13	2.07	27	1.8	1.15	115.19
1993	15	2.39	26	1.7	1.41	140.73
1994	12	1.91	35	2.3	0.83	83.21
1995	11	1.75	32	2.1	0.84	83.54
1996	13	2.07	27	1.8	1.15	115.19
1997	19	3.03	34	2.3	1.32	131.75
1998	16	2.55	39	2.6	0.98	98.15
1999	13	2.07	31	2.1	0.99	98.73
2000	14	2.23	31	2.1	1.06	106.33
2001	15	2.39	44	2.9	0.82	82.49
2002	15	2.39	29	1.9	1.26	125.91
2003	19	3.03	43	2.9	1.04	104.49
2004	17	2.71	44	2.9	0.93	93.49
2005	24	3.83	46	3.1	1.23	123.48
2006	20	3.19	53	3.5	0.91	91.14
2007	24	3.83	60	4	0.96	95.69
2008	34	5.42	66	4.4	1.23	123.24
2009	28	4.47	62	4.1	1.09	108.92
2010	19	3.03	50	3.3	0.92	91.83
2011	11	1.75	53	3.5	0.50	50.13
2012	22	3.51	54	3.6	0.97	97.47
2013	13	2.07	51	3.4	0.61	60.98
2014	31	4.94	77	5.1	0.97	96.94
2015	29	4.63	58	3.9	1.19	118.59
2016	25	3.99	70	4.7	0.85	84.83
2017	29	4.63	67	4.5	1.03	102.78
2018	24	3.83	65	4.3	0.89	89.02
2019	35	5.58	78	5.2	1.07	107.35
2020	40	6.38	93	6.2	1.03	102.90
Total	**627**	**100**	**1499**	**100**		

(R.O/P = Research Output, COP = Country Output, WOP = World Output,
AI = Activity Index, PI = Priority Index)

Table 3 shows the results of the North American continent's AI and PI. It was found that the result of the AI formula table for the overall study period saw higher activity in 1993 and lower activity in 2011. The year 1993 has a very high PI, while the year 2011 has a very low PI.

5.4 *Activity and Priority Index of European research output*

Table 4: Activity and Priority Index of European continent research output

Year	R.O/P of Europe Continent	COP = A	W. O/P	WOP = B	A/B = AI Value	PI Value
1989	1	0.21	11	0.7	0.30	29.95
1990	2	0.42	15	1	0.42	41.93
1991	5	1.05	28	1.9	0.55	55.17
1992	8	1.68	27	1.8	0.93	93.17
1993	4	0.84	26	1.7	0.49	49.33
1994	11	2.31	35	2.3	1.00	100.26
1995	16	3.35	32	2.1	1.60	159.73
1996	9	1.89	27	1.8	1.05	104.82
1997	10	2.10	34	2.3	0.91	91.15
1998	15	3.14	39	2.6	1.21	120.95
1999	12	2.52	31	2.1	1.20	119.80
2000	4	0.84	31	2.1	0.40	39.93
2001	15	3.14	44	2.9	1.08	108.44
2002	9	1.89	29	1.9	0.99	99.30
2003	10	2.10	43	2.9	0.72	72.29
2004	24	5.03	44	2.9	1.73	173.50
2005	12	2.52	46	3.1	0.81	81.15
2006	16	3.35	53	3.5	0.96	95.84
2007	19	3.98	60	4	1.00	99.58
2008	16	3.35	66	4.4	0.76	76.23
2009	23	4.82	62	4.1	1.18	117.60
2010	18	3.77	50	3.3	1.14	114.35
2011	19	3.98	53	3.5	1.14	113.81
2012	16	3.35	54	3.6	0.93	93.17
2013	21	4.40	51	3.4	1.29	129.49
2014	28	5.87	77	5.1	1.15	115.10
2015	12	2.52	58	3.9	0.65	64.51
2016	24	5.03	70	4.7	1.07	107.05
2017	17	3.56	67	4.5	0.79	79.20
2018	22	4.61	65	4.3	1.07	107.26
2019	26	5.45	78	5.2	1.05	104.82
2020	33	6.92	93	6.2	1.12	111.58
Total	**477**	**100**	**1499**	**100**		

Table 4 summarises the AI and PI values for the European continent. Based on the results of the AI formula table, it can be seen that the overall study period's activity was higher in 2004 than in 1989, based on the results of the AI formula table. According to the table, the overall study period witnessed a higher PI value in 1995 and a lower PI value in 1989.

5.5 *Activity and Priority Index of South American continent research output*

Table 5: Activity and Priority Index of South American continent research output

Year	R.O/P of South America Continent	COP = A	W. O/P	WOP = B	A/B = AI Value	PI Value
1989	0	0	11	0.7	0.00	0.00
1990	1	0.67	15	1	0.67	67.11
1991	1	0.67	28	1.9	0.35	35.32
1992	1	0.67	27	1.8	0.37	37.29
1993	2	1.34	26	1.7	0.79	78.96
1994	3	2.01	35	2.3	0.88	87.54
1995	1	0.67	32	2.1	0.32	31.96
1996	1	0.67	27	1.8	0.37	37.29
1997	1	0.67	34	2.3	0.29	29.18
1998	2	1.34	39	2.6	0.52	51.63
1999	0	0	31	2.1	0.00	0.00
2000	5	3.36	31	2.1	1.60	159.80
2001	3	2.01	44	2.9	0.69	69.43
2002	2	1.34	29	1.9	0.71	70.65
2003	4	2.68	43	2.9	0.93	92.57
2004	1	0.67	44	2.9	0.23	23.14
2005	4	2.68	46	3.1	0.87	86.60
2006	2	1.34	53	3.5	0.38	38.35
2007	5	3.36	60	4	0.84	83.89
2008	9	6.04	66	4.4	1.37	137.28
2009	7	4.70	62	4.1	1.15	114.59
2010	6	4.03	50	3.3	1.22	122.03
2011	9	6.04	53	3.5	1.73	172.58
2012	7	4.70	54	3.6	1.30	130.50
2013	7	4.70	51	3.4	1.38	138.18
2014	10	6.71	77	5.1	1.32	131.60
2015	13	8.72	58	3.9	2.24	223.71
2016	9	6.04	70	4.7	1.29	128.52
2017	8	5.37	67	4.5	1.19	119.31
2018	14	9.40	65	4.3	2.19	218.51
2019	4	2.68	78	5.2	0.52	51.63
2020	7	4.70	93	6.2	0.76	75.77
Total	**149**	**100**	**1499**	**100**		

The results of the Activity and Priority Index values are given in table 5. It could be found that the result of the AI applied in the formula is calculated for the South American continent.

5.6 *Activity and Priority Index of Asian continent research output*

Table 6: Activity and Priority Index of Asian continent research output

Year	R.O/P of Asian Continent	COP = A	W. O/P	WOP = B	A/B = AI Value	PI Value
1989	3	2.14	11	0.7	3.06	306.12
1990	1	0.71	15	1	0.71	71.43
1991	4	2.86	28	1.9	1.50	150.38
1992	0	0	27	1.8	0.00	0.00
1993	2	1.43	26	1.7	0.84	84.03
1994	5	3.57	35	2.3	1.55	155.28
1995	1	0.71	32	2.1	0.34	34.01
1996	1	0.71	27	1.8	0.40	39.68
1997	2	1.43	34	2.3	0.62	62.11
1998	3	2.14	39	2.6	0.82	82.42
1999	2	1.43	31	2.1	0.68	68.03
2000	5	3.57	31	2.1	1.70	170.07
2001	3	2.14	44	2.9	0.74	73.89
2002	1	0.71	29	1.9	0.38	37.59
2003	6	4.29	43	2.9	1.48	147.78
2004	1	0.71	44	2.9	0.25	24.63
2005	3	2.14	46	3.1	0.69	69.12
2006	9	6.43	53	3.5	1.84	183.67
2007	7	5.00	60	4	1.25	125.00
2008	3	2.14	66	4.4	0.49	48.70
2009	3	2.14	62	4.1	0.52	52.26
2010	4	2.86	50	3.3	0.87	86.58
2011	10	7.14	53	3.5	2.04	204.08
2012	6	4.29	54	3.6	1.19	119.05
2013	7	5.00	51	3.4	1.47	147.06
2014	4	2.86	77	5.1	0.56	56.02
2015	4	2.86	58	3.9	0.73	73.26
2016	10	7.14	70	4.7	1.52	151.98
2017	7	5.00	67	4.5	1.11	111.11
2018	3	2.14	65	4.3	0.50	49.83
2019	10	7.14	78	5.2	1.37	137.36
2020	10	7.14	93	6.2	1.15	115.21
Total	**140**	**100**	**1499**	**100**		

Table 6 shows the results of the Activity and Priority Index for the Asian continent. It is noticeable other than higher and lower priority the year 1989 has a far higher priority than the year 2004, which has a much lower priority. The year 1992 had no research productivity in terms of Limnology publications.

4.7 *Activity and Priority Index of Oceania continent research output*

Table 7: Activity and Priority Index of Oceania continent research output

Year	R.O/P of Oceania Continent	COP = A	W. O/P	WOP = B	A/B = AI Value	PI Value
1989	3	4.48	11	0.7	6.40	639.66
1990	2	2.99	15	1	2.99	298.51
1991	3	4.48	28	1.9	2.36	235.66
1992	3	4.48	27	1.8	2.49	248.76
1993	2	2.99	26	1.7	1.76	175.59
1994	1	1.49	35	2.3	0.65	64.89
1995	3	4.48	32	2.1	2.13	213.22
1996	3	4.48	27	1.8	2.49	248.76
1997	1	1.49	34	2.3	0.65	64.89
1998	2	2.99	39	2.6	1.15	114.81
1999	3	4.48	31	2.1	2.13	213.22
2000	3	4.48	31	2.1	2.13	213.22
2001	5	7.46	44	2.9	2.57	257.33
2002	2	2.99	29	1.9	1.57	157.11
2003	3	4.48	43	2.9	1.54	154.40
2004	0	0.00	44	2.9	0.00	0.00
2005	3	4.48	46	3.1	1.44	144.44
2006	4	5.97	53	3.5	1.71	170.58
2007	4	5.97	60	4	1.49	149.25
2008	2	2.99	66	4.4	0.68	67.84
2009	1	1.49	62	4.1	0.36	36.40
2010	0	0.00	50	3.3	0.00	0.00
2011	2	2.99	53	3.5	0.85	85.29
2012	2	2.99	54	3.6	0.83	82.92
2013	1	1.49	51	3.4	0.44	43.90
2014	1	1.49	77	5.1	0.29	29.27
2015	0	0.00	58	3.9	0.00	0.00
2016	2	2.99	70	4.7	0.64	63.51
2017	2	2.99	67	4.5	0.66	66.33
2018	2	2.99	65	4.3	0.69	69.42
2019	0	0.00	78	5.2	0.00	0.00
2020	2	2.99	93	6.2	0.48	48.15
Total	**140**	**100**	**1499**	**100**		

Table 7 shows the results of the AI and PI of the Oceania continent. It can be found that the results applied from the activity index formula table to the overall study periods witnessed a higher activity in the year 1989 and a lower activity in the year 2014. Figure 1 clearly presents a graphical outlook of the concerned matter.

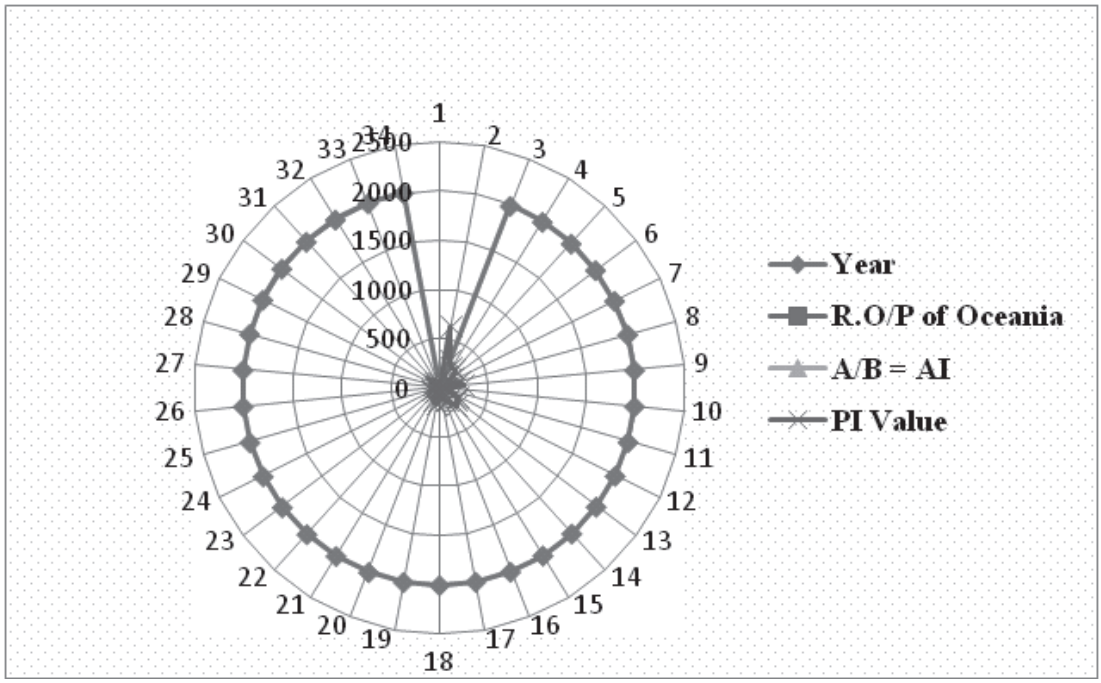

Figure 1: Research Output of Activity and Priority Index of Oceania continent

5.8 *Activity and Priority Index of African continent research output*

Table 8: Activity and Priority Index of African continent research output

Year	R.O/P of Africa Continent	COP = A	W. O/P	WOP = B	A/B = AI Value	PI Value
1989	0	0	11	0.7	0.00	0.00
1990	1	2.56	15	1	2.56	256.41
1991	0	0	28	1.9	0.00	0.00
1992	2	5.13	27	1.8	2.85	284.90
1993	1	2.56	26	1.7	1.51	150.83
1994	3	7.69	35	2.3	3.34	334.45
1995	0	0	32	2.1	0.00	0.00
1996	0	0	27	1.8	0.00	0.00
1997	1	2.56	34	2.3	1.11	111.48
1998	0	0	39	2.6	0.00	0.00
1999	1	2.56	31	2.1	1.22	122.10
2000	0	0	31	2.1	0.00	0.00
2001	3	7.69	44	2.9	2.65	265.25
2002	0	0	29	1.9	0.00	0.00
2003	1	2.56	43	2.9	0.88	88.42
2004	1	2.56	44	2.9	0.88	88.42
2005	0	0	46	3.1	0.00	0.00
2006	2	5.13	53	3.5	1.47	146.52
2007	1	2.56	60	4	0.64	64.10
2008	2	5.13	66	4.4	1.17	116.55
2009	0	0	62	4.1	0.00	0.00
2010	3	7.69	50	3.3	2.33	233.10
2011	3	7.69	53	3.5	2.20	219.78
2012	0	0	54	3.6	0.00	0.00
2013	2	5.13	51	3.4	1.51	150.83
2014	3	7.69	77	5.1	1.51	150.83
2015	0	0	58	3.9	0.00	0.00
2016	0	0	70	4.7	0.00	0.00
2017	4	10.26	67	4.5	2.28	227.92
2018	1	2.56	65	4.3	0.60	59.63
2019	2	5.13	78	5.2	0.99	98.62
2020	2	5.13	93	6.2	0.83	82.71
Total	**39**	**100**	**1499**	**100**		

Table 8 shows the results of the activity and priority index of the African continent. It can be found that the results applied from the activity index formula table to the overall study periods witnessed a lower activity in 2018 and a higher activity in the year 1994. The trend has been shown graphically in figure 2.

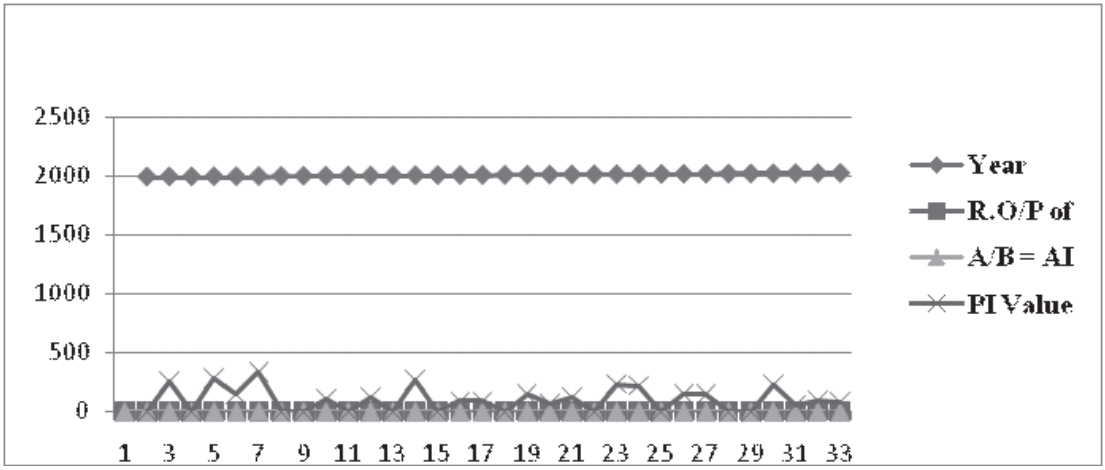

Figure 2: Research Output of Activity and Priority Index of African continent

6. Major findings

i. The finding of the highest publication is 93 in 2020 with 341 citations, followed by 78 in 2019 with 731 citations, respectively.

ii. The overall study period saw higher activity in 1993 and lower activity in 2011. The year 1993 has a very high PI, while the year 2011 has a very low PI.

iii. The AI and PI values for the European continent. It can be seen that the overall study period activity was higher in 2004 and lower in 1989, with a higher PI value in 1995and a lower PI value in 1989.

iv. It could be found that the result of the AI applied in the formula is calculated for the South American continent. The overall study period has witnessed higher activity in the year 2015 and lower activity in the year 2004.The year 2015 has a higher PI value and a lower Priority than the year 2004. The years 1989 and 1999 had no research productivity in terms of limnology publications.

v. The results of the AI and PIfor theAsian continent show higher activity in the year of 1989 and lower activity in the year 2004. The year 1989 has a far higher priority than the year 2004, which has a much lower priority. The year 1992 had no research productivity in terms of Limnology publications.

vi. From the results of the AI and PI of the Oceania continent, it can be found that the results applied from the AI formula table to the overall

study periods witnessed higher activity in the year 1989 and lower activity in the year 2014. As a result of the mentioned years, sixteen years have a higher activity and PI, and the remaining sixteen years have a lower index. The years 2004, 2010, 2015, and 2019 do not have research productivity regarding Limnology publications.

vii. On the African continent, it can be found that the result applied from the AI formula table to the overall study periods witnessed lower activity in 2018 and higher activity in the year 1994.

7. Conclusion

The paradigm shift over the period is a gradual increase in the study period. This study highlighted the contributions made by the researchers during the period 1989-2020 based on the Web of Science database and the literature on continent-wise analysis of research productivity in Limnology with AI and PI. The comparison of North American research output with the continent's output could facilitate an understanding of the contribution at a very high level. According to the analysis, the majority of years' output has a higher AI and PI in every continent. Though the publications available in the Web of Science database show some variation, it is important to note that the Web of Science database only covers peer-reviewed journals.

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