

Scientometric Dimension Of Authors Collaboration And Productivity Of Geoscience Research Output In Global Level

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Abstract

A bibliography record of global Geoscience research output for the period 1989-2020 covering 2825 research items evaluated year wise publication of research on Geoscience, author productivity distributions, journal distributions, keywords occurrence and tests the empirical laws. Eight thousand three hundred and forty six authors have contributed the total of 2825 research papers. This study identifies the most prolific authors, scattering of articles in different journals word frequency and citation analysis is also noted. The analysis also discovered that these 2825 papers have a total of 56075 referenced references. Author Wang, C topped the list with total 23 publications, Comptes Rendus Geoscience which comprises of 208 publications was dominated as most preferred Journal of Geoscience and high frequency keyword were "Geoscience" is used 864 times with 10114 citations also noted. Out of 2825 publications, only 734 publications single authored and other publications are multi authored with degree of collaboration 0.62. Pattern of co-authorship revealed that the improving the trend of co-authored publications. This study also verified price square root law.

Keywords: Scientometrics, Bibliometrics, Lotka's Law, Bradford's Law, Zipf's Law, Author Productivity.

1. INTRODUCTION

The study of the earth's seas, atmosphere, rivers and lakes, ice sheets and glaciers, soils, complex surface, rocky interior, and metallic core is referred to as geoscience. This covers a wide range of topics, including how living things, such as humans, interact with the environment. Geoscience has its own set of tools and techniques, yet it is inextricably tied to the biological, chemical, and physical sciences.

Scientometric studies are conducted in large numbers by analyzing various aspects of different subjects of publications. Scientometrics is the study of scientific research's quantitative features and characteristics. This research aims to evaluate the global Geoscience research output that is indexed in the Web of Science database. The use of Lotka's Inverse square law of author productivity, Bradford's law of Journal distribution, and Zipf's law of word occurrence is the study's main focus. . The study of authorship pattern and productivity of author research collaboration is important tool of researchers and scientists. It aims to examine the emergence of research areas of Geoscience, author productivity, single authored and multi authored with degree of collaboration, co-authorship index, authorship pattern, etc.

2. REVIEW OF THE LITERATURE

Alexander Maz-Machado et al., (2017) examined the bibliometric study on the fit of Lotka's law on Information Science & Library Science journals indexed in social science citation index of journal Citation Report from the period 1956-2014. The parameters of the Lotka's law model, c and α , were found using the linear least squares method and the Kolmogorov-Smirnov test was applied to estimate the kindness of adjustment of the results to the Lotka's distribution. It was found that the pattern of publication of the LIS category articles fits to Lotka's law.

Bebi and Shailendra kumar (2017) studied contribution of women faculty in the discipline of physics in select institutions of Delhi. The study covers a total 44 women faculties and their 802 publications during the period of 2011-2015 collected from various sources. The study focuses on authorship pattern, research interest areas, most productive authors, most used journals, etc. The study indicates that multi authored papers were dominated. Ratnamala Chatterjee from IIT Delhi found to be the most productive author and Journal of Applied Physics is the most preferred journal. CSIR-National Physical Laboratory was leading institution in publishing journal article (145). It was noticed that majority of women authors preferred to the second author while writing the paper jointly.

Senthilkumar, N & Prabahar, P (2018) demonstrated research output of National Institute of Ocean Technology (NIOT) Tamil Nadu between 1997 and 2017 as data retrieved from Web of Science core collection database. It examines the growth and development of NIOT during the study period. Totally 470 publications in the year of 2015 with 93 records; Subject wise oceanography articles are more as 115; joint authorship contributions are maximum with 461 publications, average degrees of collaboration during the study period is 0.98, and Indian Institute of Technology is a collaborate institute.

3. OBJECTIVES

-  To determine the distribution of Geoscience research output by year
-  To identify the author productivity

- ✚ To find out the Authorship pattern
- ✚ Degree of the collaboration in Geoscience research
- ✚ To identify the pattern of co-authorship index
- ✚ To investigate the use of the Scientific Author Productivity Inverse Square Law
- ✚ To verify the price square root law
- ✚ To examine the journal wise distribution of publications
- ✚ To test the Bradford's law of distribution
- ✚ To determine the word-by-word distribution of publications and to put Zipf's Law to the test.

3.1 METHODOLOGY

The data for the study accessed from Web of Science database during 1989-2020. The researcher has used the search string "Geoscience" for getting data from the Web of Science database which includes Science Citation Index (SCI). The researcher has downloaded the bibliographical data in the form of notepad files. Overall data retrieved by the researcher are 2825 records taken for analyzing the present study. The data has analyzed and classified into HistCite software.

4. ANALYSIS AND DISCUSSION

4.1 Year wise distribution of publications

The data has been shown in table-1 to assess the year-by-year publishing of research on Geoscience. The global research output is depicted in the table. It is obvious from the table below that between 1989 and 2020, a total of 2825 publications were produced. The research output on Geoscience publications is used as a method to evaluate performance at various levels in this study.

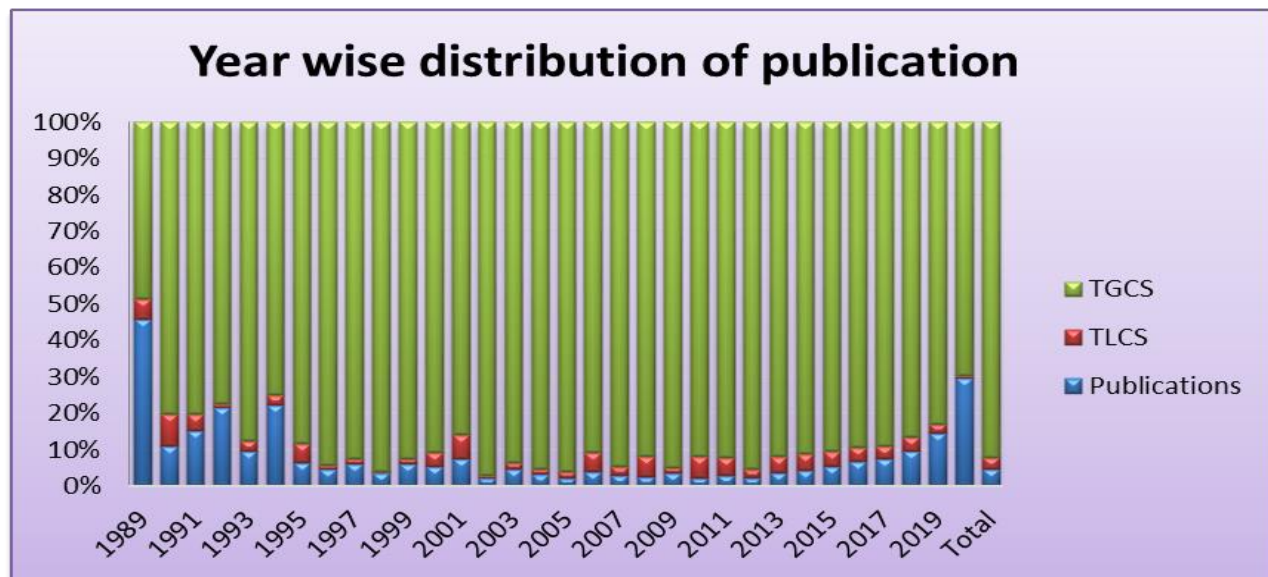
The highest publication is 247 in 2020 with 581 citations followed by 227 in 2019 with 1299 citations respectively. The survey also discovered that all of these 2825 articles have 56075 cited references, indicating that there is a strong trend in citing among global scientists in the "Geoscience" field.

Table -1: Year wise distribution of publication

S. No	Publication Year	Publications	TLCS	TGCS
1	1989	16	2	17
2	1990	21	17	155
3	1991	27	8	143
4	1992	23	1	82
5	1993	22	7	202
6	1994	24	3	80
7	1995	39	33	544
8	1996	41	10	858

9	1997	43	10	642
10	1998	49	7	1304
11	1999	58	13	859
12	2000	48	35	805
13	2001	36	31	409
14	2002	51	17	2401
15	2003	36	15	722
16	2004	92	39	2758
17	2005	85	73	3928
18	2006	56	78	1315
19	2007	96	74	2945
20	2008	121	271	4393
21	2009	182	83	4877
22	2010	94	240	3747
23	2011	89	147	2732
24	2012	102	101	4262
25	2013	129	148	3129
26	2014	129	139	2742
27	2015	154	115	2536
28	2016	160	94	2135
29	2017	177	85	2122
30	2018	151	62	1351
31	2019	227	42	1299
32	2020	247	6	581
	Total	2825	2006	56075

Fig -1: Year wise distribution of publication



4.2 Author Productivity

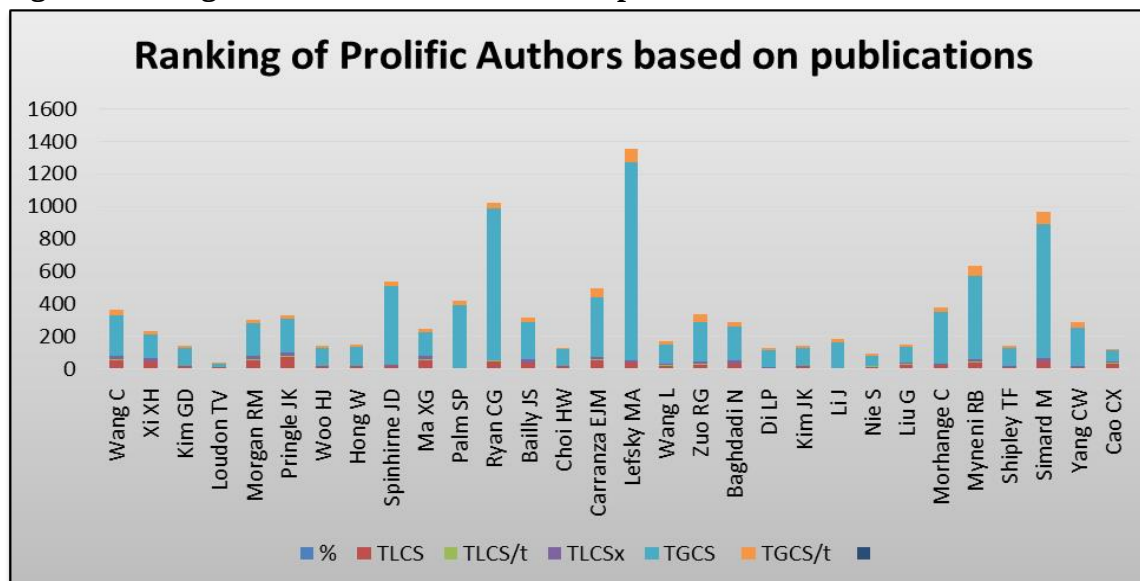
The author data of Geoscience research reveals that there were 8346 authors contributed with 2825 publications. As shown in Table 2, on the basis of number of publications, the most prolific author. Wang, C topped the list with total 23 publications, followed by Xi, XH has 16 publications. However, the result would be quite different, if the listing done by Total Citations received by authors. Lefsky, M.A., has 1217 citations followed by Ruyan C.G., has 937 citations.

Table -2: Ranking of Prolific Authors based on publications

S.No	Author	Publications	%	TLC S	TLCS /t	TL CS x	TGC S	TGCS /t
1	Wang C	23	0.8	48	6.78	24	248	34.99
2	Xi XH	16	0.6	41	5.70	19	143	22.03
3	Kim GD	15	0.5	16	1.26	0	111	9.55
4	Loudon TV	15	0.5	6	0.32	5	20	1.02
5	Morgan RM	15	0.5	52	5.67	17	208	20.58
6	Pringle JK	15	0.5	72	9.05	20	206	23.79
7	Woo HJ	15	0.5	16	1.26	0	111	9.55
8	Hong W	14	0.5	15	1.17	0	120	10.08
9	Spinhirne JD	14	0.5	15	0.79	8	483	28.31
10	Ma XG	13	0.5	52	8.10	20	143	22.89
11	Palm SP	13	0.5	3	0.21	1	388	23.98
12	Ryan CG	13	0.5	46	1.60	3	937	36.43
13	Bailly JS	12	0.4	35	4.48	20	225	29.94
14	Choi HW	12	0.4	15	1.17	0	101	8.61
15	Carranza	11	0.4	50	7.27	16	366	51.97

	EJM							
16	Lefsky MA	11	0.4	35	3.93	12	1217	87.95
17	Wang L	11	0.4	19	2.16	11	118	17.31
18	Zuo RG	11	0.4	25	5.59	11	243	51.98
19	Baghdadi N	10	0.4	29	3.66	16	211	27.99
20	Di LP	10	0.4	3	0.42	2	108	16.21
21	Kim JK	10	0.4	14	1.09	0	114	9.41
22	Li J	10	0.4	3	0.29	2	155	23.21
23	Nie S	10	0.4	12	2.47	4	59	12.46
24	Liu G	9	0.3	24	3.32	6	99	17.75
25	Morhange C	9	0.3	20	1.30	10	318	24.56
26	Myneni RB	9	0.3	39	4.68	15	515	59.46
27	Shipley TF	9	0.3	10	1.24	4	111	14.84
28	Simard M	9	0.3	41	4.32	17	829	77.87
29	Yang CW	9	0.3	10	1.34	5	235	37.34
30	Cao CX	8	0.3	31	3.76	7	71	9.64

Fig -2: Ranking of Prolific Authors based on publications



4.3 Lotka's Law of author Productivity

The logarithmic relationship between researchers and publication amounts is summarized by Lotka. It states that “the number of authors making n contribution is about $1/n^2$ of those making one publications and the proportion of all contributors that make a single contribution is about 60 percent” (Lotka 1926), as cited by Potter (1988).

The general formula is $XY = C$,

Where X is the number of publications

Y is the relative frequency of authors with X publications

C is constant

Tabel-3: Lotka's Law of Author Productivity

No. of Contributors X	No. of Contributors	Y	$\Sigma X = \log x$	$\Sigma Y = \log y$	$\Sigma X * \Sigma Y$	$\Sigma X * X$
1	7085	7085	0	8.865735	0	0
2	820	1640	0.693147	7.402452	5.130987	0.480453
3	251	753	1.098612	6.624065	7.277277	1.206948
4	68	272	1.386294	5.605802	7.77129	1.921811
5	24	120	1.609438	4.787492	7.705172	2.590291
6	35	210	1.791759	5.347108	9.580729	3.2104
7	22	154	1.94591	5.036953	9.801457	3.786566
8	11	88	2.079442	4.477337	9.310363	4.324079
9	6	54	2.197225	3.988984	8.764695	4.827798
10	5	50	2.302585	3.912023	9.007765	5.301898
11	4	44	2.397895	3.78419	9.07409	5.7499
12	2	24	2.484907	3.178054	7.897169	6.174763
13	3	39	2.564949	3.663562	9.39685	6.578963
14	2	28	2.639057	3.332205	8.793879	6.964622
15	5	75	2.70805	4.317488	11.69197	7.333535
16	1	16	2.772589	2.772589	7.68725	7.68725
23	1	23	3.135494	3.135494	9.831323	9.831323
66	1	66	4.189655	4.189655	17.55321	17.55321
Total	8346	10741	37.99701	84.42119	156.2755	95.52381

In summary, an author who publishes two pieces accounts for around a quarter of all publications. The authors who publish three articles account for approximately 1/9th of all publications, and so on. As a result, 60 percent of all publications come from authors who only publish one piece. That is, authors who publish n publications will account for $1 / n^2$ of the total number of publications. The Inverse Square Law is another name for this formula. (Tsay 2003).

The results of author productivity in terms of Lotka's law implications reveal the following facts, proving that Lotka's claims are invalidated by the studied data. The percentage of all contributors who make a single contribution is less than 60%, especially when considering the number of authors that contributed.

4.4 Authorship Pattern:

This table explicates the authorship pattern of contributions. Out of 2825 publications, single author has contributed 734 (25.98%) publications, 462 (16.35%) articles were published with two authors, 432(15.29%) publications were published by three authors, 359 (12.71%) publications were published by four authors, 274 (9.70%) publications were published by the five authors, 203 (7.19%) publications were published by six authors, 111 (3.93%) publications published by seven authors, 84 (2.97%) publications were published by eight authors, 50 (1.77%) publications were published by nine authors, and remaining 116 (4.11%) publications were published by ten and above authors.

Table -4: shows authorship pattern of Geoscience research

Year	Single	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten and above	Total
1989	11	4	1								16
1990	12	4	3	2							21
1991	17	4	3	2		1					27
1992	14	4	2	1	1					1	23
1993	14	4	1	1		1				1	22
1994	16	2	1	2	1			1		1	24
1995	22	6	2	1	4	2	1	1			39
1996	28	2	6	2		1	1	1			41
1997	25	8	4	3	2					1	43
1998	31	7	3	2	2	2		1	1		49
1999	30	13	8	1	1	1	2			2	58
2000	31	5	6	2	2			1		1	48
2001	17	7	3	6	1	1			1		36
2002	24	11	3	9	2				1	1	51
2003	14	11	6	1	2	1				1	36
2004	23	15	13	10	10	8	5	1	1	6	92
2005	16	12	11	10	7	20	4	4	1		85
2006	17	14	7	7	4		3	3		1	56
2007	25	20	17	7	10	9	3	1	1	3	96
2008	29	19	19	25	6	5	7	3	3	5	121

2009	39	24	41	25	18	6	10	8	3	8	182
2010	25	13	20	10	8	6	3	5		4	94
2011	15	20	18	17	12	7	1	6	2	1	99
2012	20	24	12	15	15	4	3	3	2	4	102
2013	24	22	24	20	12	9	4		2	2	119
2014	21	26	19	19	6	12	5	6	7	8	129
2015	29	28	22	17	18	14	10	8	2	6	154
2016	31	25	19	23	23	13	12	6	5	3	160
2017	26	27	30	22	24	21	7	6	5	9	177
2018	16	13	34	25	18	18	9	2	2	14	151
2019	40	32	27	36	33	18	12	6	8	15	227
2020	32	36	47	36	32	23	9	11	3	18	247
Total	734	462	432	359	274	203	111	84	50	116	2825
%	25.98	16.35	15.29	12.71	9.70	7.19	3.93	2.97	1.77	4.11	100

4.5 Degree of Collaboration

The author's degree of collaboration is one of the yardsticks to measure the productivity of authors. It is defined as the number of multi author publications in the discipline published during the period of year as against the total number of papers. (Multi author and the single author) published during a year. Subramaniam's formula for calculating in the degree of collaboration is followed.

$$C = \frac{NM}{NM+NS}$$

Here, NM = Number of multiple authors

NS = Number of Single authors

From this study the degree of collaborations in Geoscience research output during the period of the study is C= 0.62.i.e. 62 percent of collaboration of authors published articles during 1989-2020.

Table -5: Author's Degree of Collaboration

S.No	Year	Single Author	Multiple Authors	Degree of Collaboration	Mean
1	1989	11	5	0.31	0.44
2	1990	12	9	0.43	
3	1991	17	10	0.37	
4	1992	14	9	0.39	
5	1993	14	8	0.36	

6	1994	16	8	0.33	
7	1995	22	17	0.44	
8	1996	28	13	0.32	
9	1997	25	18	0.42	
10	1998	31	18	0.37	
11	1999	30	28	0.48	
12	2000	31	17	0.35	
13	2001	17	19	0.53	
14	2002	24	27	0.53	
15	2003	14	22	0.61	
16	2004	23	69	0.75	0.80
17	2005	16	69	0.81	
18	2006	17	39	0.70	
19	2007	25	71	0.74	
20	2008	29	92	0.76	
21	2009	39	143	0.79	
22	2010	25	69	0.73	
23	2011	15	74	0.83	
24	2012	20	82	0.80	
25	2013	24	105	0.81	
26	2014	21	108	0.84	
27	2015	29	125	0.81	
28	2016	31	129	0.81	
29	2017	26	151	0.85	
30	2018	16	135	0.89	
31	2019	40	187	0.82	
32	2020	32	215	0.87	
Total		734	2091		0.62

4.6 Pattern of co-authorship index

From table 6 indicates the pattern of co-authorship pattern of single authors and multiple authors. Co-authorship index for the single authors declined from 264.60 in the year of 1989 to 49.86 in the year 2020. Multiple authors enhanced from 42.22 in the year of 1989 to 117.60 in the year of 2020. From this result, the pattern of co-authorship index increasing among the contributions.

Table -6: Pattern of co-authorship index

Year	Single Authors		Multiple Authors		Total
	No. of Output	CAI	No. of Output	CAI	
1989	11	264.60	5	42.22	16
1990	12	219.93	9	57.90	21
1991	17	242.33	10	50.04	27
1992	14	234.27	9	52.87	23
1993	14	244.92	8	49.13	22
1994	16	256.58	8	45.03	24
1995	22	217.11	17	58.89	39
1996	28	262.84	13	42.84	41
1997	25	223.77	18	56.55	43
1998	31	243.49	18	49.63	49
1999	30	199.07	28	65.22	58
2000	31	248.57	17	47.85	48
2001	17	181.75	19	71.30	36
2002	24	181.12	27	71.53	51
2003	14	149.67	22	82.56	36
2004	23	96.22	69	101.33	92
2005	16	72.45	69	109.67	85
2006	17	116.84	39	94.09	56
2007	25	100.23	71	99.92	96
2008	29	92.24	92	102.72	121
2009	39	82.47	143	106.15	182
2010	25	102.36	69	99.17	94
2011	15	58.31	74	100.99	99
2012	20	75.47	82	108.61	102
2013	24	77.62	105	119.21	119
2014	21	62.65	108	113.11	129
2015	29	72.48	125	109.66	154
2016	31	74.57	129	108.93	160
2017	26	56.54	151	115.26	177
2018	16	40.78	135	120.79	151
2019	40	67.82	187	111.30	227
2020	32	49.86	215	117.60	247
	734		2091		2825

4.7 Price Square Root Law

Based on the Price Square Root Law of author productivity based on the calculation is

$$PSQ = \sqrt{N} = 103.30 \quad N = 10670$$

The square root value is just 0.70 % of publications. Most of the authors are contributed very less number of times in Geoscience research. The contribution percentage of 114 (nearly closed to the root value of 10670) contributors is located at 1.07 percent of publications. The value is very away from 50% of literature on the subject. Therefore this result is not fit for price square root law of contributors.

Table -7: Price's square root law of Geoscience research

No. of Contribution (A)	No. of Contributors (B)	A*B	% of A*B	% Cumulated value of A*B	Cumulated value of A*B
23	1	23	0.22	0.22	23
16	1	16	0.15	0.37	39
15	5	75	0.70	1.07	114
14	2	28	0.26	1.33	142
13	3	39	0.37	1.7	181
12	2	24	0.22	1.92	205
11	4	44	0.41	2.33	249
10	5	50	0.47	2.8	299
9	6	54	0.51	3.31	353
8	11	88	0.82	4.13	441
7	22	154	1.44	5.57	595
6	35	210	1.97	7.54	805
5	24	120	1.12	8.66	925
4	68	272	2.55	11.21	1197
3	251	753	7.06	18.27	1950
2	820	1640	15.37	33.64	3590
1	7080	7080	66.35	100	10670
		10670	100		

4.8 Most Preferred Journals:

During the study period, scientists contributed 2825 research publications to 708 journals, resulting in a total of 2825 articles. The journals are ranked according to the number of papers they have published. It displays its TLCS, TLCS/t, TGCS, TGCS/t, and TLCR citation scores.

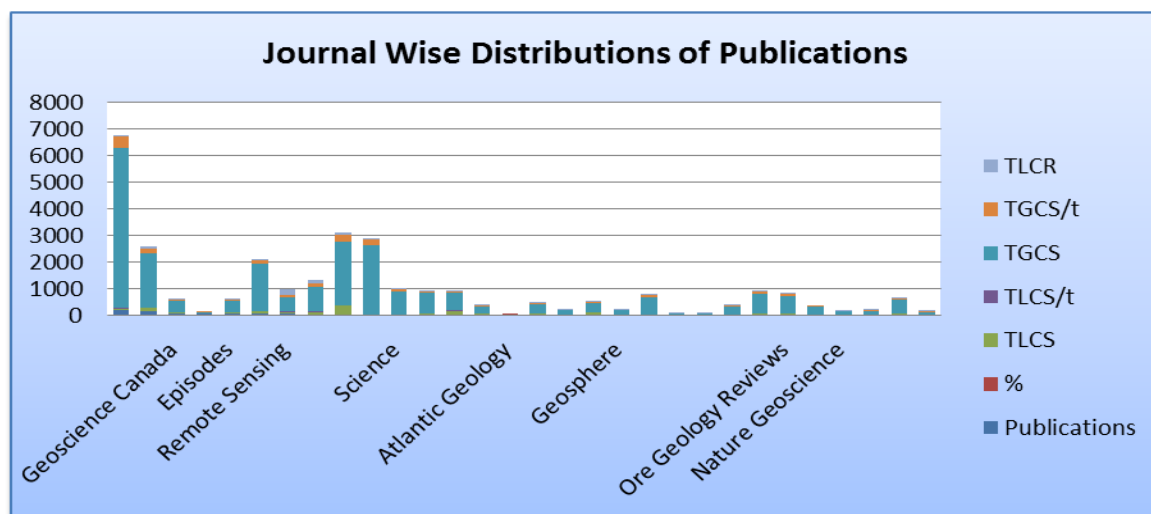
The most popular journal in geoscience research is Comptes Rendus Geoscience, with 208 publications, followed by Computers & Geosciences, with 143 articles and 2029 citations.

Table -8: Journal Wise Distributions of Publications

S.No	Journal	Publications	%	TLCS	TLCS /t	TGCS	TGCS /t	TL CR
1	Comptes Rendus Geoscience	208	7.3	47	3.06	6036	422.64	49
2	Computers & Geosciences	143	5.0	125	13.00	2029	188.99	71
3	Geoscience Canada	86	3.0	38	2.12	429	21.78	35
4	Geotimes	79	2.8	4	0.17	25	1.05	0
5	Episodes	75	2.6	25	2.58	451	43.84	15
6	IEEE Transactions on Geoscience and Remote Sensing	67	2.4	88	7.68	1782	141.25	36
7	Remote Sensing	52	1.8	73	9.12	533	102.26	226
8	IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing	44	1.5	82	11.79	917	147.36	132
9	Remote Sensing of Environment	35	1.2	319	29.73	2389	250.52	102
10	Geophysical Research Letters	33	1.2	6	1.20	2592	204.47	7
11	Science	32	1.1	5	0.65	854	70.49	4
12	Nuclear Instruments & Methods in Physics Research Section B-Beam Interactions with Materials and Atoms	29	1.0	53	1.95	777	33.52	46
13	International Journal of Remote Sensing	28	1.0	140	12.79	652	66.06	60
14	Geoheritage	27	0.9	21	3.04	278	44.96	32
15	Atlantic Geology	24	0.8	0	0.00	0	0.00	0
16	IEEE Geoscience and Remote Sensing Letters	24	0.8	40	4.51	338	46.82	34
17	Canadian Journal of Earth Sciences	23	0.8	6	0.47	166	10.33	2
18	Forensic Science International	22	0.8	85	7.51	341	32.96	55

19	Geosphere	20	0.7	18	2.98	147	25.65	19
20	IEEE Geoscience and Remote Sensing Magazine	20	0.7	0	0.00	657	73.72	8
21	Journal of the Geological Society of India	19	0.7	4	0.17	34	2.77	4
22	Acta Geologica Sinica-English Edition	18	0.6	1	0.06	44	4.30	2
23	Australian Journal of Earth Sciences	18	0.6	1	0.06	309	29.37	3
24	Earth-Science Reviews	18	0.6	62	7.52	720	87.13	30
25	Ore Geology Reviews	18	0.6	40	5.13	665	81.25	17
26	Environmental Geology	17	0.6	1	0.04	296	19.18	0
27	Nature Geoscience	17	0.6	13	1.62	110	16.63	2
28	Chinese Journal of Geophysics-Chinese Edition	15	0.5	4	0.22	152	10.75	4
29	International Journal of Applied Earth Observation and Geoinformation	15	0.5	46	5.03	512	65.18	50
30	ISPRS International Journal of Geo-Information	15	0.5	1	0.11	102	22.37	15

Fig -3: Journal Wise Distribution of Publications



4.9 Bradford's Law of scattering

Table 9 shows that the first 16 journals published more than a third of the total number of articles. The next 103 publications covered the remaining one-third of the articles. The remaining

571 journals published the final one-third of the articles. The relationship between the zones, according to Bradford's distribution, is 1:a:a², however the relationship in each zone of the current study is 16:103:571, which does not fit into Bradford's distribution. This demonstrates that just a few periodicals make significant contributions.

Table -9: Bradford's Law of scattering (690 journals) of Geoscience Research publications

S. No	No. of Journals	No. of Articles	Total no. of Articles	Cumulative No. of articles
1	1	208	208	208
2	1	143	143	351
3	1	86	86	437
4	1	79	79	516
5	1	75	75	591
6	1	67	67	658
7	1	52	52	710
8	1	44	44	754
9	1	35	35	789
10	1	33	33	822
11	1	32	32	854
12	1	29	29	883
13	1	28	28	911
14	1	27	27	938
15	2(16)	24	48	986 (948)
16	1	23	23	1009
17	1	22	22	1031
18	2	20	40	1071
19	1	19	19	1090
20	4	18	72	1162
21	2	17	34	1196
22	6	15	90	1286
23	4	14	56	1342
24	10	13	130	1472
25	2	12	24	1496
26	3	11	33	1529
27	3	10	30	1559
28	4	9	36	1595

29	2	8	16	1611
30	14	7	98	1709
31	19	6	114	1823
32	25(103)	5	125	1948(962)
33	33	4	132	2080
34	57	3	171	2251
35	93	2	186	2437
36	388(571)	1	388	2825
Total	690			

4.10 Zipf's Law of Word Occurrences:

The below mentioned table explains what are the find keywords and how many times it is used. "Geoscience" is used 864 times with 10114 citations followed by "Data" is used 330 times with 6751 citations and so on.

Zipf's Law of Word Occurrences states that, "in a long textual matter if words are arranged in their decreasing order of frequency, then the rank of any given word of the text will be inversely proportional to the frequency of occurrence of the word"

$rf = c$ (where, c is constant) Taking log on both the sides, $\log(f) + \log(r) = \log c$

To apply this law, the words (terms) were extracted from the titles of the articles and ordered in decreasing order based on their frequency of occurrence. Table-10 shows only the top thirty words with a frequency of up to 6217 items. Using this law, it was shown that when the log of frequency of occurrence of words is added to the log of their rank, the results are nearly same for each term.

Table -10: Zipf's Law of Word Occurrence

S.No	Word	Publications	%	TLCS	TGCS	Rank	Log F	Log R	Log C
1	Geoscience	864	30.4	462	10114	1	6.76	0	6.76
2	Data	330	11.6	571	6751	2	5.80	0.69	6.49
3	Using	255	9.0	543	5409	3	5.54	1.10	6.64
4	Based	146	5.1	134	1839	5	4.98	1.61	6.59
5	Analysis	132	4.6	115	1901	6	4.88	1.79	6.67
6	Earth	121	4.3	96	1648	7	4.80	1.95	6.74
7	Geological	113	4.0	83	1541	8	4.73	2.08	6.81
8	Remote	100	3.5	23	1041	9	4.61	2.20	6.80
9	New	97	3.4	78	1763	10	4.57	2.30	6.88
10	Icesat	96	3.4	395	4380	11	4.56	2.40	6.96
11	Sensing	96	3.4	22	1013	11	4.56	2.40	6.96
12	Glas	94	3.3	450	2610	13	4.54	2.56	7.11
13	System	93	3.3	62	2102	14	4.53	2.64	7.17

14	Forest	87	3.1	454	4576	15	4.47	2.71	7.17
15	Research	87	3.1	24	1067	15	4.47	2.71	7.17
16	China	86	3.0	106	1196	17	4.45	2.83	7.29
17	Model	86	3.0	73	1269	17	4.45	2.83	7.29
18	Mapping	85	3.0	105	2610	18	4.44	2.89	7.33
19	Education	82	2.9	41	380	19	4.41	2.94	7.35
20	Time	81	2.8	90	1711	20	4.39	3.00	7.39
21	Application	80	2.8	62	1656	21	4.38	3.04	7.43
22	High	80	2.8	35	1587	21	4.38	3.04	7.43
23	Science	79	2.8	71	1083	23	4.37	3.14	7.50
24	Applications	78	2.7	90	3351	24	4.36	3.18	7.53
25	Method	72	2.5	49	1178	25	4.28	3.22	7.50
26	International	70	2.5	11	52	26	4.25	3.26	7.51
27	Lidar	70	2.5	211	2284	26	4.25	3.26	7.51
28	Case	69	2.4	57	927	28	4.23	3.33	7.57
29	Global	69	2.4	31	1936	28	4.23	3.33	7.57
30	Models	69	2.4	39	2044	28	4.23	3.33	7.57

5. MAJOR FINDINGS:

1. The finding of the highest publication is 247 in 2020 with 581 citations followed by 227 in 2019 with 1299 citations respectively. The survey also discovered that all of these 2825 papers have 56075 cited references, indicating that there is a strong trend in citing among global scientists working in the field of "Geoscience" research.
2. The study found that author Wang, C topped the list with total 23 publications, followed by Xi, X.H., has 16 publications. However, the result would be quite different, if the listing done by Total Citations received by authors. Lefsky, M.A., has 1217 citations followed by Ruyan C.G., has 937 citations.
3. The findings of author productivity in terms of Lotka's law implications reveal the following facts, proving that Lotka's claims are invalidated by the studied data. The percentage of all contributors who make a single contribution is less than 60%, especially when considering the number of authors that contributed.
4. The authorship patterns reveal that single authors have the highest contribution with 734 research papers during the study period.
5. From this result, the pattern of co-authorship index increasing among the contributions.
6. From this study the degree of collaborations in Geoscience research output during the period of the study is $C = 0.62$. i.e. 62 percent of collaboration of authors published articles during 1989-2020.
7. It is found that most of the authors are contributed very less number of times in Geoscience research, so this study is not fit for price square root law of contributors.

8. In Journal wise distribution of publications, Comptes Rendus Geoscience which comprises of 208 publications was dominated as most preferred Journal of Geoscience research followed by Computers & Geosciences having 143 publications with 2029 citations respectively.
9. According to Bradford's distribution, the relationship between the zones is $1:a:a^2$, however the current study's relationship in each zone is 16:103:571, which does not fit into Bradford's distribution. This demonstrates that just a few periodicals make significant contributions.
10. The findings of high frequency keyword were "Geoscience" is used 864 times with 10114 citations followed by "Data" is used 330 times with 6751 citations respectively.
11. The formulated of the applicability of Zipf's Law is identified as validated.

References

1. **Alexander Maz-Machado et al. (2017).** Empirical examinations in Lotka's law for information science and library science. *Pakistan Journal of Information Management & Libraries*, 19, 37-51.
2. **Bebi, & Shailendra kumar. (2017).** Contributions by Women Faculties of Physics from Select Institutions of Delhi: A Scientometrics Study. *DESIDOC Journal of Library & Information Technology*, 37(6), 410-416. <https://doi.org/10.14429/djlit.37.11713>
3. **Senthil Kumar, N., & Prabahar, P. (2018).** A Scientometric Analysis of Research Productivity: A case Study of National Institute of Ocean Technology, Tamil Nadu. *International Journal of Library and Information Studies*, 8(3), 100-112.
4. **Farldeh Osareh, S., & Esmaeel Mostafavi, S. (2015).** Lotka's Law and authorship distribution in Computer Science using Web of Science (WOS) during 1986-2009. *Collnet Journal of Scientometrics and Information Management*, 5(2), 171-183.
5. **Garg, K. C., & Tripathi, H. K. (2018).** Bibliometrics and scientometrics in India: An overview of studies during 1995-2014 Part II: Content articles in terms of disciplines and their bibliometric aspects. *Annals of library and Information Studies*, 65, 7-42.
6. **Khanna, S. (2017).** Scientometric Analysis of the Research Output of Physics and Astronomy of Guru Nanak Dev University during 2006-15. *DESIDOC journal of Library and Information Technology*, 37(5), 337-345. DOI : 10.14429/djlit.37.10683
7. **Lotka, A. J. (1926).** The frequency distribution of scientific productivity, *Journal of the Washington Academy of Science*, 16 (12), 317-323.
8. **Mondal, et al. (2017).** Contribution by Indian Authors in foreign Origin Library and Information Science Journals during 2006-2015: A Scientometrics Study. *DESIDOC Journal of Library & Information Technology*, 37(6), 396-402.
9. **Patel, V., & Thakur, N. S. (2018).** Scientometric analysis of research productivity: A case study of National Environmental Engineering Research Institute, Nagpur. *International Journal of Library Information Network and Knowledge*, 3(1), 43-53.

10. **Ranganathan, C (2014).** Mapping of Oceanography Research Productivity in India: A Scientometric Analysis. Library Philosophy and Practice (e-Journal). Winter 12-23-2014. Paper 1205. Link: <http://digitalcommons.unl.edu/libphilprac/1205>
11. **Pillai Sudhir, K. G., & Raja, S. (2013).** Lotka's Law and Pattern of Author Productivity in the area of Physics Research. DESIDOC Journal of Library and Information Technology, 33(6), 457-464.
12. **Potter, W.G. (1981).** Lotka's Law revised. Library Trends, 30(1), 21-39.
13. **Ranganathan, C. (2015).** Scientometric analysis of authorship trends and collaborative research in horticulture. IJNGLT, 1(3), 1-11.
14. **Vijayakumar, M., & Kalle, S. R. (2017).** Indian Contribution in Information Science and Library Science Research during 1991-2015: A Bibliometric Analysis. DESIDOC Journal of Library & Information Technology, 37(6), 387-395. <https://doi.org/10.14429/djlit.37.11005>