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Bibliometric Analysis of Water Pollution Research

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ABSTRACT
This paper discuss on Bibliometric analysis of water pollution research, the study aims to analysis, to find out year wise publications on water pollution research, to examine authorship pattern, to find out sources wise publications, to find out top twenty institutions, to identify top twenty countries contributed on water pollution research. The data have been collected from the Scopus database; time span field was select from 2006 to 2020. The study found that, the year-wise analysis shows on water pollution research an increasing and decreasing trend, articles are highly contributed with 69.75 percent publications, sources type wise research publications on water pollution Journal has contributed 77.38 percent papers, out of 4152 water pollution publications, first and second place occupies Chinese institutions. Countries wise contributed on water pollution research, China has first, United States America second place, India has third place.
Keywords: *Bibliometric, Water pollution, Water contamination, Potable water*

I. INTRODUCTION

Almost 71% of the earth's total surface is covered with water, only 2.5% of this amount can be considered as freshwater (Shiklomanov, 1993). Water resources are under threat from the pollution, chiefly generated by human factors. The agricultural sector, industrial production, mining, power generation, and other factors are some of the contributors to the pollution of water bodies, which will eventually affect humans in general (UN-Water, 2001). Water pollution is an international phenomenon and one of the fundamental issues in many developing nations. Many areas of groundwater and other sources of water are contaminated with heavy metals, chronic organic pollution, and waste materials that have a destructive effect on public health and the environment (Mridul Dharwal, et al., 2020). Diseases: cholera, diarrhea, dysentery, hepatitis A, etc. are directly linked to the unhygienic and contaminated potable water. It is estimated that each year more than 842,000 people die from diarrhea globally (WHO, 2017 a, b). Arsenic pollution is one of the major groundwater contaminations, and it affects nearly 70 million people worldwide (UNESCO, 2009). The Central Pollution Control Board (CPCB) in 2018 identified 351 polluted river stretches in India.

II. METHODOLOGY

In the present study, data are accessed from Scopus database; the search string was used 'Water pollution' in the Title search box, field was used, and the time span field was select from 2006 to 2020. A total of 4152 records were retrieved, the data downloaded and analyzed using MS office-Excel as per objectives of the present study.

Relative Growth Rate (RGT) and Doubling Time (DT)

The relative growth rate is the increase in the number of publications/pages per unit of time. Here, one year is taken as the unit of time. The mean relative growth rate R (1-2) over a specified period of interval can be calculated from the following equation suggested by Mahapatra (1985).

$$R(1-2) = \frac{W2 - W1}{T2 - T1}$$

Where,

R	=	Mean relative growth rate over the specific period of interval;
W1	=	log w1 (Natural log of initial number of publications/ pages);
W2	=	log w2 (Natural log of initial number of publications/pages);
T2-T1	=	Unit difference between the initial time and final time.

Therefore,

R (a)	=	Relative growth rate per unit of publications per unit of time (year)
R (p)	=	Relative growth rate per unit of pages per unit of time (year)

Doubling Time (DT)

A direct equivalence exists between the relative growth rate and doubling time. If the number of publications/pages of a subject doubles during a given period, then the difference between the logarithms of the numbers at the beginning and at the end of the period must be the logarithms of the number 2. This difference has a value of 0.693. Thus, the corresponding doubling time for publication and pages can be calculated by the following formula:

$$\text{Doubling time (Dt)} \frac{0.693}{R}$$

Therefore,

$$\text{Doubling time for publications Dt (a)} \frac{0.693}{R(a)}$$

Objectives

The following objectives are framed for the present study;

To find out year wise publications on water pollution research
To find out sources wise publications on water pollution research
To find out top ten authors on water pollution research
To examine authorship pattern
To find out top twenty institutions contributed on water pollution research
To find out top twenty sources contributions water pollution research
To find out top twenty countries contributed on water pollution research

ANALYSIS AND INTERPRETATION

Table 1 year wise publications on water pollution research

Sl. No.	Year	No. of Records	Percentages
1	2006	154	3.71
2	2007	161	3.88
3	2008	169	4.07
4	2009	195	4.70
5	2010	248	5.97
6	2011	286	6.89
7	2012	256	6.17
8	2013	239	5.76
9	2014	316	7.61
10	2015	244	5.88
11	2016	282	6.79
12	2017	276	6.65
13	2018	382	9.20
14	2019	435	10.48
15	2020	509	12.26
	Total	4152	100.00

Table 1 shows year wise publications on water pollution research, during the study period 4152 publications were published. In the year 2020; 12.26% papers were published, in 2019 have published 10.48% papers, in 2018 have published 9.20% papers, in 2014 have published 7.61% of papers, in 2011 have least published 6.89% papers, in 2016 have published 6.79% papers, in 2017 have published 6.65% papers, in 2012 have published 6.17% papers, in 2010 have published 5.97% papers, in 2015 have published 5.88% papers, in 2013 have published 5.76%, in 2009 have published 4.07% papers, in 2008 have published 4.07% papers, in 2007 have published 3.88% papers, in 2006 have published 3.71% papers, It found that, the year-wise analysis shows on water pollution research an increasing and decreasing trend.

Table 2 Relative Growth Rate and Doubling Time of water pollution research

Sl. No.	Publication Years	Record Count	Cumulative	W1	W2	W2 - W1(Ra)	Mean (Ra) W2-W1	Doubling Time	Mean Dt (a)
1	2006	154	154		5.03				
2	2007	161	315	5.03	5.08	0.05		13.86	
3	2008	169	484	5.08	5.13	0.05		13.86	
4	2009	195	679	5.13	5.27	0.14		4.95	
5	2010	248	927	5.27	5.51	0.24	0.12	2.89	8.89
6	2011	286	1213	5.51	5.65	0.14		4.95	
7	2012	256	1469	5.65	5.54	-0.11		-6.30	
8	2013	239	1708	5.54	5.47	-0.07		-9.90	
9	2014	316	2024	5.47	5.75	0.28		2.48	
10	2015	244	2268	5.75	5.49	-0.26	-0.004	-2.67	-2.29
11	2016	282	2550	5.49	5.64	0.15		4.62	
12	2017	276	2826	5.64	5.62	-0.02		-34.65	
13	2018	382	3208	5.62	5.94	0.32		2.17	
14	2019	435	3643	5.94	6.07	0.13		5.33	
15	2020	509	4152	6.07	6.23	0.16	0.14	4.33	-3.64
	Total	4152					0.08		0.98

Table 2 shows that, Relative Growth Rate and Doubling Time, during the study period publications Doubling Time mean value is -3.64. In 2006, the water pollution research publication was 154; gradually the research publications were raised to 509 in the year 2020, the relative growth rate mean value is 0.08. The water pollution research publications are increasing more than two times form starting year to end of the study period year.

Table 3 document type wise research publications on water pollution

Sl. No.	Document Type	No. of Records	Percentages
1	Article	2896	69.75
2	Conference Paper	701	16.88
3	Book Chapter	167	4.02
4	Review	153	3.68
5	Erratum	78	1.88
6	Note	45	1.08
7	Editorial	44	1.06
8	Book	22	0.53
9	Letter	17	0.41
10	Short Survey	10	0.24
11	Retracted	10	0.24
12	Conference Review	6	0.14
13	Data Paper	2	0.05
14	Undefined	1	0.02
	Total	4152	100.00

Table 3 shows that document types wise papers publications on water pollution research, totally fourteen document types are contributed in this research, Articles are highly contributed with 69.75% publications. Conference Papers are 16.88%, Book Chapter is 4.02% papers, Review is 3.68% papers, Erratum

is 1.88%, Note is 1.08%, Editorial are contributed 1.06% papers, Book are contributed 0.53% papers, Letters are contributed 0.41% papers, Short Survey and Retracted are contributed 0.24% papers respectively, Conference Review are contributed 0.14% papers, Data Papers are contributed 0.05% papers, only one document type are Undefined.

Table 4 sources type wise research publications on water pollution

Sl. No.	Source type	No. of Records	Percentages
1	Journal	3213	77.38
2	Conference Proceeding	556	13.39
3	Book Series	207	4.99
4	Book	142	3.42
5	Trade Journal	34	0.82
	Total	4152	100.00

Table 4 shows that sources type wise research publications on water pollution, five sources were contributed 4152 publications, journal is major sources for research publications, Journal has contributed 77.38% papers, Conference Proceedings contributed 13.39% papers, Book Series contributed 4.99% papers, Book contributed 3.42% papers, and Trade Journal has contributed 0.82% papers. Found that, Sources type wise research publications on water pollution, journal have contributed more than 75% publications.

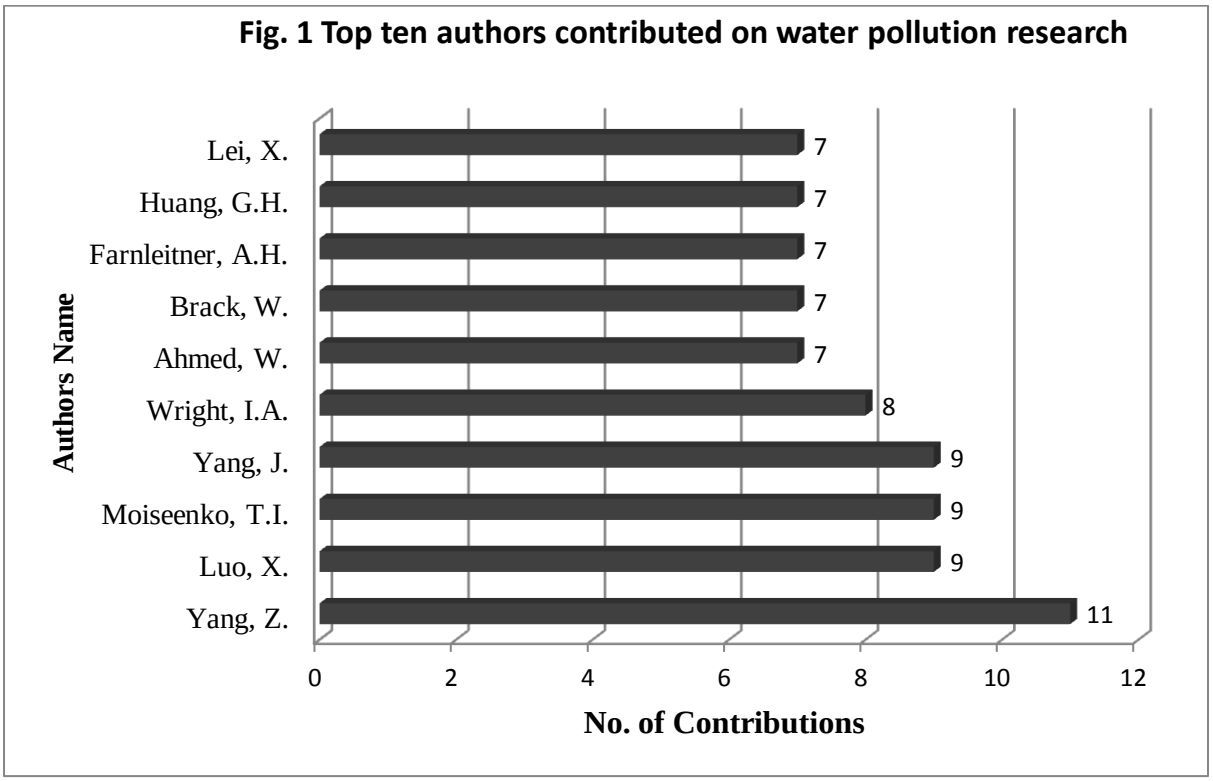

Figure 1 shows that, top ten authors contributed on water pollution research, among the top ten authors, Yang, Z. has first position with 11 contributions, followed by Luo, X. has second position, Moiseenko, T.I. has third position, Yang, J. has fourth position, Wright, I.A. has fifth position, Ahmed, W. has sixth position, Brack, W. has seventh position, Farnleitner, A.H. has ninth position, Huang, G.H. has ninth position, Lei, X. has tenth position.

Table 5 authorship pattern on water pollution research

Sl. No.	Authorship pattern	No. of papers	Percentages
1	Single	98	2.36
2	Double	254	6.12
3	Three	619	14.91
4	Four	806	19.41
5	Five	1021	24.59
6	Six and Above	1354	32.61
	Total	4152	100.00

Table 5 shows that authorship pattern on water pollution research, six and above authors were collaborative contributions are 32.61%, five authors collaborative contributions are 24.59%, four authors collaborative contributions are 19.41%, three authors collaborative contributions are 14.91% papers, double authors collaborative are 6.12%, and Single author contributions are 2.36% papers. The authorship pattern on water pollution research, the collaborative contributions high compare with single author contributions.

Table 6 language wise research performance on water pollution

Sl. No.	Languages	No. of Records	Percentages
1	English	3561	85.77
2	Chinese	398	9.59
3	Russian	40	0.96
4	French	38	0.92
5	German	37	0.89
6	Spanish	22	0.53
7	Polish	16	0.39
8	Turkish	9	0.22
9	Portuguese	7	0.17
10	Moldavian	4	0.10
11	Italian	3	0.07
12	Japanese	3	0.07
13	Persian	3	0.07
14	Croatian	2	0.05
15	Czech	2	0.05
16	Dutch	2	0.05
17	Romanian	2	0.05
18	Bosnian	1	0.02
19	Lithuanian	1	0.02
20	Slovenian	1	0.02
	Total	4152	100.00

Table 6 shows that the language wise research performance on water pollution, 4152 papers are contributed in twenty languages, 85.77% papers ware contributed in English language, 9.59% papers were contributed in Chinese language, in Russian 0.96% papers published, 0.92% contributions were contributed in French language, 0.89% papers are in German languages, 0.53% papers are in Spanish, 0.39% papers are in Polish languages, 0.22% contributions are in Turkish, 0.17% papers were contributed in Portuguese language, 0.10% contributions are Moldavian, 0.07% contributions in Italian, Japanese, and Persian respectively, 0.05% contributions are in Croatian, Czech, Dutch, and Romanian language respectively, Followed by, Bosnian, Lithuanian and Slovenian languages are contributed a single contributions respectively.

Table 7 top twenty institutions contributed on water pollution

Sl. No.	Institutions (Affiliations)	No. of Records	% of 4152
1	Chinese Academy of Sciences	190	4.58
2	Ministry of Education China	98	2.36
3	Beijing Normal University	68	1.64
4	Russian Academy of Sciences	64	1.54
5	University of Chinese Academy of Sciences	64	1.54
6	Hohai University	62	1.49
7	Chinese Research Academy of Environmental Sciences	54	1.30
8	Tsinghua University	49	1.18
9	Research Center for Eco-Environmental Sciences Chinese Academy of Sciences	40	0.96
10	Harbin Institute of Technology	38	0.92
11	Tianjin University	35	0.84
12	Zhejiang University	34	0.82
13	Nanjing University	34	0.82
14	Tongji University	30	0.72
15	China Institute of Water Resources and Hydropower Research	27	0.65
16	Institute of Geographical Sciences and Natural Resources Research Chinese Academy of Sciences	25	0.60
17	Ministry of Environmental Protection of People's Republic of China	25	0.60
18	Peking University	24	0.58
19	Xi'an University of Technology	23	0.55
20	Helmholtz Zentrum fÃ¼r Umweltforschung	22	0.53

Table 7 sows that the top twenty institutions contributed on water pollution research, out of 4152 water pollution publications, the Chinese Academy of Sciences has first place with 190 contribution, Ministry of Education China second place with 98 papers, Beijing Normal University has third place with 68 publications, Russian Academy of Sciences, and University of Chinese Academy of Sciences has fourth and fifth place with 64 papers, Hohai University has sixth place with 62 papers, Chinese Research Academy of Environmental Sciences has seventh place with 54 papers, Tsinghua University has eight place with 49 papers, Research Center for Eco-Environmental Sciences Chinese Academy of Sciences has ninth place with 40 papers, Harbin Institute of Technology has tenth place with 38 papers, Tianjin University has eleventh place with 35 papers, Zhejiang University and Nanjing University has twelfth and thirteenth place with 34 papers respectively, Tongji University has fourteenth place with 30 papers, China Institute of Water Resources and Hydropower Research has fifteenth place with 27 papers, Institute of Geographical Sciences and Natural Resources Research Chinese Academy of Sciences has and Ministry of Environmental Protection of People's Republic of China has sixteenth and seventh place with 25 papers respectively, Peking University has eighteenth place with 24 papers, Xi'an University of Technology has nineteenth place with 23 papers twentieth place with 22 papers.

Table 8 top twenty sources contributed on water pollution

Sl. No.	Source title	No. of Records	% of 4152
1	Environmental Science and Pollution Research	99	2.38
2	Science of the total Environment	95	2.29
3	IOP Conference Series Earth and Environmental Science	84	2.02
4	Water Air And Soil Pollution	68	1.64
5	Environmental Monitoring and Assessment	61	1.47
6	Advanced Materials Research	59	1.42

7	Huanjing Kexue Environmental Science	59	1.42
8	Marine Pollution Bulletin	44	1.06
9	Water Switzerland	43	1.04
10	Desalination and Water Treatment	42	1.01
11	Zhongguo Huanjing Kexue China Environmental Science	39	0.94
12	Applied Mechanics and Materials	38	0.92
13	Huanjing Kexue Xuebao Acta Scientiae Circumstantiae	36	0.87
14	Environmental Pollution	34	0.82
15	Journal of Environmental Management	32	0.77
16	Journal of Cleaner Production	30	0.72
17	Environmental Earth Sciences	29	0.70
18	Water Resources	29	0.70
19	Water Science and Technology	29	0.70
20	International Journal of Environmental Research and Public Health	28	0.67

Table 8 shows that top twenty sources contributed on water pollution research, out of 4152 papers, Environmental Science and Pollution Research have first place with 99 papers, Science of the total Environment have second place with 95 papers, IOP Conference Series Earth and Environmental Science has third place with 84 papers, Water Air And Soil Pollution have fourth place with 68 papers, Environmental Monitoring and Assessment have fifth place with 61 papers, Advanced Materials Research, Huanjing Kexue Environmental Science have sixth place and seventh place with 59 papers respectively, have eighth place with 44 papers, Water Switzerland have ninth place with 43 papers, Desalination and Water Treatment have tenth place with 42 papers, Zhongguo Huanjing Kexue China Environmental Science have eleventh place with 39 papers, Applied Mechanics and Materials have twelfth place with 38 papers, Huanjing Kexue Xuebao Acta Scientiae Circumstantiae have thirteenth place with 36 papers, Environmental Pollution have fourteenth place with 34 papers, Journal of Environmental Management have fifteenth place with 32 papers, Journal of Cleaner Production have sixteenth place with 30 papers, Environmental Earth Sciences, Water Resources, Water Science and Technology have seventeenth, eighteenth, nineteenth place with 84 papers respectively, International Journal of Environmental Research and Public Health has a twentieth place with 28 papers, these top twenty sources were published 23.55 publications on water pollution research.

Table 9 top twenty countries contributed on water pollution research

Sl. No.	Country	No. of Records	% of 4152
1	China	1386	33.38
2	United States America	381	9.18
3	India	334	8.04
4	United Kingdom	201	4.84
5	Russian Federation	172	4.14
6	Germany	120	2.89
7	Spain	110	2.65
8	France	108	2.60
9	Japan	99	2.38
10	Australia	97	2.34
11	Indonesia	97	2.34
12	Poland	90	2.17
13	Turkey	85	2.05
14	Italy	77	1.85
15	Canada	76	1.83

16	Iran	73	1.76
17	Romania	65	1.57
18	Egypt	63	1.52
19	Malaysia	63	1.52
20	Nigeria	55	1.32

Table 9 shows that the top twenty countries contributed to water pollution research, total of 122 countries have contributed to water pollution research from 2006 to 2020. Out of 4152 publications on water pollution research, China has first place with 33.38% publications, followed by United States America has second place with 9.18% , India has third place with 8.04%, United Kingdom fourth place, Russian Federation fifth place, Germany sixth place, Spain seventh place, France eighth place, Japan ninth place, Australia, Indonesia has tenth and eleventh place with 2.34% respectively, Poland twelfth place, Turkey thirteenth place, Italy fourteenth place, Canada fifteenth place, Iran sixteenth place, Romania seventeenth place, Egypt, Malaysia eighteenth and nineteenth place with 1.52% respectively, Nigeria has twentieth place with1.32% publication on water pollution research.

III. Conclusion

Conclude from the study, year wise analysis on water pollution shows on increasing and decreasing trend. The year wise publications on water pollution research, during the study period 4152 publications were published; in the year 2020 have published 12.26% in water pollution research, document types wise publications on water pollution research, totally fourteen document types are contributed in this research, articles are highly contributed with 69.75 percent publications, the sources wise publications, Journal has contributed more than 75 percent contributions, authors wise contributed on water pollution research Yang, Z. has first position, The authorship pattern on water pollution research, the collaborative contributions high compare with single author contributions, 85.77% contributions are in English language, the institutions contributed on water pollution research, out of 4152 water pollution publications, the Chinese institutions were occupies first, second, and third place respectively ,the countries contributed on water pollution research, total of 122 countries have contributed to water pollution research from 2006 to 2020, China has occupies first place, followed by United States America has second place, India has third place.

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