Content available at: https://www.ipinnovative.com/open-access-journals

IP Indian Journal of Library Science and Information Technology

Journal homepage: https://www.ijlsit.org/

Original Research Article

Scientometric analysis of research progress on water pollution during 2012-2021

R. Santhakumar[1],*, S. Mahalakshmi[2]

[1] *Librarian, Arulmigu Kapaleeswarar Arts and Science College, Kolathur, Chennai, Tamil Nadu, India*
[2] *Librarian, C. Kandaswami Naidu College for Men, Annanagar, Chennai, Tamil Nadu, India*

ARTICLE INFO

Article history:
Received 19-06-2022
Accepted 10-08-2022
Available online 30-11-2022

Keywords:
Water pollution
Relative growth rate
Trend analysis and authorship pattern

ABSTRACT

This paper examines the scientometric analysis of 44172 global publications trends on water pollution using web of science database during the period 2012-2021. The average number of publications published per year was 4417.2. The highest number of publications (8079) was published in the year 2021. The relative growth rates (RGR) has decreased from 2013 (0.74) to 2021 (0.22) in the span of 10 years. The doubling time (DT) has gradually increased from 0.94 in 2013 to 3.15 in 2018. The exponential growth of publications was observed during the study period. Majority of publications were found in English language. The results showed that China is the major country that conducts research on water pollution and India stood 3^{rd} rank in terms of productivity in this period. A total of 23,519 different institutions were involved in publication of articles. Chinese Academic of Sciences, China topped the list with 3013 (6.82%) publications followed by University of Chinese Academic of Sciences, China with 1116 (2.53%) publications. The scientific literature on water pollution is spread over 2728 different web of science source journals. Environmental sciences ecology has highest number of articles with 24562 (55.60%) among subjects.

1. Introduction

Water is an important natural resource of all over the world. We live without food for few days but not without water. It is need for the survival of all organisms including human, food production and economic development. Two thirds of the earth surface is covered by water. Water is life for all but this water is polluting day by day in severe condition and our life is not safe now. We are living in crisis period. Water pollution is a major serious problem for all over the world and its affects drinking water, rivers, lakes and oceans all over the world. It consequently harms the health and wellbeing of human life and the natural environment.

Polluted water not only affects the life of present generation but it also affect the life of upcoming generations because its effect remains for long. If water is polluted in an area, then the all living creatures and people are faced to drink polluted water because they have no other option. It affects their bodies, skin, lungs, brain, liver and kidneys, caused cancers, birth defects and other diseases.[1] This is clear from the scientometric evidence from 2012 to 2021, that the number of publications in the Web of Science database was increased from 2302 to 8079. Therefore the present study has been undertaken to know the growth and development of publications in the field of water pollution.

2. Review of Literature

Sivasami analysed to year wise publications, authorship pattern, sources wise publications, top twenty institutions, top twenty countries contributed on water pollution research.[2] The data was collected from the Scopus database

* *Corresponding author.*
E-mail address: santham74@gmail.com (R. Santhakumar).

https://doi.org/10.18231/j.ijlsit.2022.016

from 2006 to 2020. The study found that, 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. Saraswathy Kasavan conducted to explore research trends regarding plastic pollution in the water ecosystem.[3] Data of publications output was identified based on the Web of Science (WoS) database's research articles from 2000 to 2020. This study used VOSviewer to analyse collaboration networks among authors, countries, institutions, and co-occurrence analysis of keywords in three defined periods. A total of 2182 papers in plastic pollution in water ecosystem research were identified.

Wang, Ming-Huang presented a detailed chronological survey of papers published in the journal titled Water Research which started publication since 1967. This current investigation reviews publication patterns between 1967 and 2008. An analysis of the research performance according to publication output, distribution of words in article title, author keywords, and keywords plus. Performances of countries, institutes, and authors, including total, single, collaborative, first author, and corresponding author publications were analyzed. Wang et al.,[4] identified certain characteristics of literature related to river water quality assessment and simulation and consequently to assist researchers to establish future research directions. There were 3701 articles pertinent to river assessment and simulation published by SCIE and SSCI databases from 2000 to 2014. Various publication characteristics were analyzed, such as countries, research organizations, subject categories, journals and keywords.

Enos wambu and Yuh-Shan Ho analysed a total of 1917 publications of drinking water research in Africa from 1991 to 2013 were identified from the data hosted in Web of Science, for bibliometric analysis.[5] The analysis included publication output, distribution of keywords, journals and subject areas, and performances of countries, institutions, and authors. Citation trends and highly-cited publications are also reported. Yaxing Zhou et al.[6,7], Analyzed the related papers on karst groundwater pollution in the core database of Web of Science, intending to sort out the research results in this field and explore potential research hotspots. Analysis results show that, In recent years, the number of publications and citations in this field has gradually increased, and there is a large space for research and development; The United States, China, Germany are the countries that have contributed the most in this field.

3. Objectives for the Study

The present study has been undertaken with the objectives of analysing the following aspects:

1. Year wise growth of publications
2. Language-wise distribution of publications
3. Most prolific authors
4. Highly productive countries
5. Highly productive institutes
6. Most preferred source titles for publication
7. High productive subject areas

4. Materials and Methods

The Web of Science database was used for retrieving data on water pollution in topic field. A total of 44172 publications were downloaded and analysed by using the Microsoft excels per the objectives of the study. The Web of Science database allows us to refine the results in terms of publication years, countries, institutes, authors, language, subjects and source titles.

5. Data analysis and Interpretations

5.1. Growth of publications

A total of 44172 water pollution publications were published during 2012-2021. The highest number of publications was 8079 (18.29%) published in 2021. The lowest publications 2302 (5.21%) were published in 2012. The average number of publications published per year was 4417.2. But it is seen that first five years in which the less than average papers (2913.4) were published i.e. 2012-2016. The more productive years with more than average papers were in 2017-2021. It is also found out that an increasing trend in quantum of publications during the study period.

5.1.1. Relative growth rate (RGR and doubling time

The Relative Growth Rate (RGR) is the increase in number of articles or pages per unit of time. The mean relative growth rate (R) over the specific period of interval can be calculated from the following equation.

Relative Growth Rate (RGR)

$1 - 2R_{=}\text{Log } W_2 - \text{Log } W_1 / T_2\text{-}T_1$

Doubling Time (DT) = 0.693/R

The year wise RGR is found to be in the range of 0.74 to 0.22. It has been observed from Table 1 and Figure 1 that RGR is downward trend from 2013 (0.74) to 2018 (0.22).

The Doubling Time (DT) has increased when calculated year wise. The Doubling Time increases from 0.94 in 2013 to 3.15 in 2018. In 2019 to 2021, the values are constant. Though the doubling time is increasing but it is not showing the exponential growth rate as seen in the annual growth rate analysis presented in the table.

5.1.2. Trend analysis –Method of least squares

This is the best method for obtaining the trend values. It provides a convenient basis for obtaining the line of best fit in a series.

Table 1: Relative growth rate (RGR) and doubling time (DT) of publications

Year	No. of Publications	Cumulative Total	W1	W2	RGR	DT
2012	2302	2302	-	7.74	-	-
2013	2525	4827	7.74	8.48	0.74	0.94
2014	2907	7734	8.48	8.95	0.47	1.47
2015	3088	10822	8.95	9.29	0.34	2.04
2016	3745	14567	9.29	9.59	0.30	2.31
2017	3953	18520	9.59	9.83	0.24	2.89
2018	4706	23226	9.83	10.05	0.22	3.15
2019	5731	28957	10.05	10.27	0.22	3.15
2020	7136	36093	10.27	10.49	0.22	3.15
2021	8079	44172	10.49	10.71	0.22	3.15

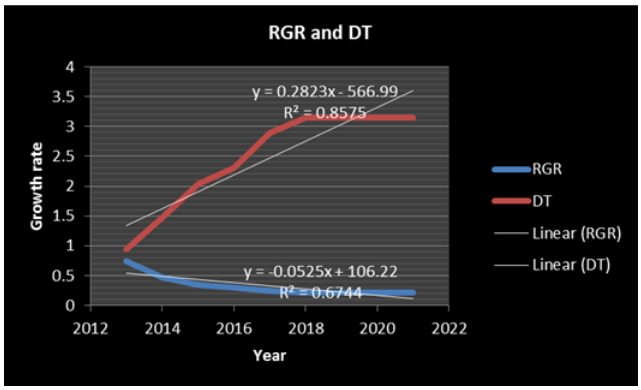

Fig. 1: Relative growth rate for research output

The straight line trend has an equation of the type: Y = a + bX,

Where, Y represents the estimated values of the trend, X represents the deviations in time period; 'a' and 'b' are constants.

The values of two constants 'a' and 'b' are estimated by solving the following two normal equations.

$\Sigma Y = Na + b\Sigma X$

$XY = a \Sigma X + b\Sigma X2$

Where N represents number of years for which data is given.

The equation of the straight line trend is Y= a + bX

Since $\sum X=0$, therefore

$$a = \frac{\sum X}{N} = \frac{44172}{10} = 4417.2$$

$$b = \frac{\sum XY}{\sum X^2} = \frac{170492}{450} = 378.87$$

Thus, substituting the value of 'a' and 'b' in the straight line of the trend, we get

Y= a + bX

Estimate of 2031 will be calculated on the basis of X= 31

$$Y_{2031} = 4417.2 + (378.87) \times 31 = 16162$$

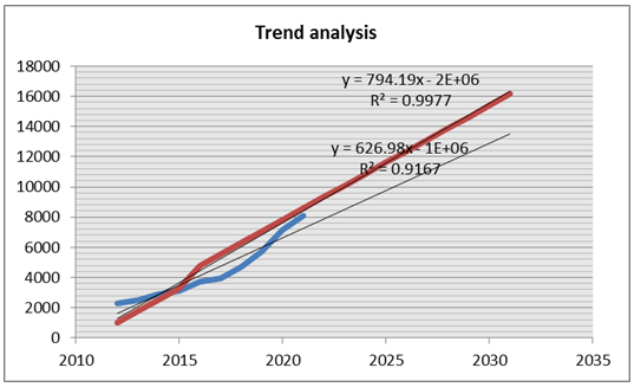

Fig. 2: Trend analysis

With the use of the trend analysis, the trend values are calculated up to 2031. The trend line and actual line are presented in the Figure 4. And, it is seen from the Table 2, that the actual trend was standard in the year 2012 since then there is an upward trend up to the year of 2021. The trend value has been increased from 1007 in 2012 to 16162 in 2031. It is interesting to note that there is an upward trend in the growth of the literature. From this it can be interpreted that the upward trend in the actual line reflects in the trend line also.

5.2. Language wise distributions

Publications on water pollution are spread over 13 languages. The study reveals that the maximum number of publications have been published in English language with 44018 (99.65%) publications, followed by Chinese with 44 (0.10%) publications, Spanish ranks third position with 30 (0.07%) publications, French with 30 (0.39%) publications, French with 19 (0.04%) publications and German with 18 (0.04%) publications. The most predominant language used for communication was English in every year in total productivity on the subject during the study period.

Table 2: Computation of straight line trend by the least squares method

Year	Actual value (Y)	Deviation	Multiply (X)	XY	X^2	Trend value
2012	2302	-4.5	-9	-20378	81	1007
2013	2525	-3.5	-7	-17675	49	1765
2014	2907	-2.5	-5	-14535	25	2523
2015	3088	-1.5	-3	-9264	9	3281
2016	3745	1	1	3745	1	4796
2017	3953	1.5	3	11859	9	5554
2018	4706	2.5	5	23530	25	6312
2019	5731	3.5	7	40117	49	7069
2020	7136	4.5	9	64224	81	7827
2021	8079	5.5	11	88869	121	8584
2022			13			9342
2023			15			10100
2024			17			10858
2025			19			11616
2026			21			12373
2027			23			13131
2028			25			13889
2029			27			14647
2030			29			15404
2031			31			16162
Total	44172			170492	450	176240

Table 3: Language wise distribution of publications

S. No.	Language	No. of Publications	S. No.	Language	No. of Publications
1	English	44018 (99.65%)	6	Polish	13 (0.03%)
2	Chinese	44 (0.10%)	7	Japanese	10 (0.02%)
3	Spanish	30 (0.07%)	8	Portuguese	10 (0.02%)
4	French	19 (0.04%)	9	Czech	4 (0.01%)
5	German	18 (0.04%)	10	Russian	3 (0.01%)

Table 4: Highly productive countries

S. No.	Country	Total Publications	Percentage
1	China	15938	36.08
2	USA	6385	14.45
3	India	2712	6.14
4	Spain	1926	4.36
5	England	1870	4.23
6	Germany	1849	4.19
7	Italy	1762	3.99
8	France	1663	3.76
9	Canada	1505	3.41
10	Australia	1436	3.25

Table 5: Most prolific authors

S. No.	Author	No. of publications	Percentage
1	Zhang Y	412	0.93
2	Liu Y	353	0.80
3	Wang Y	348	0.79
4	Li Y	329	0.74
5	Li J	319	0.72
6	Wang J	298	0.67
7	Zhang J	248	0.56
8	Zhang L	247	0.56
9	Wang L	228	0.52
10	Liu J	203	0.46

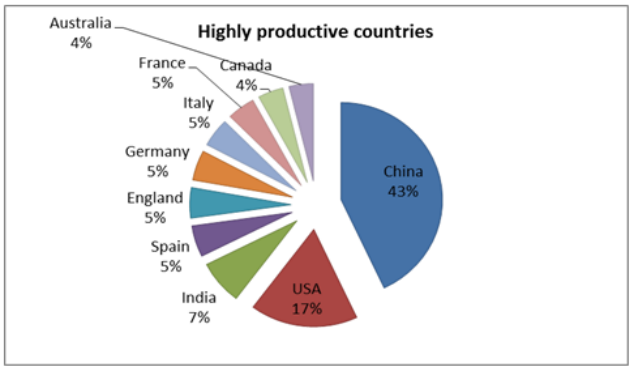

Fig. 3: Highly productive countries

5.3. *Highly productive countries*

In all, there were 191 countries involved in the research in water pollution field and which published at least one publication. The publications share of highly productive countries (≥1400 publications) in water pollution varies from 3.25% to 36.08r% as seen in the Table 4 and Figure 4. China topped the list with highest share 15938 (36.08%) of publications. USA ranked second with 6385 (14.45%) share of publications followed by India with 2712 (6.14%) share of publications, Spain with 1926 (4.36%) share of publications, England with 1870 (4.23%) share of publications, Germany with 1849 (4.19%) share of publications and the remaining countries are publishing less than 4% of the research output in this study period.

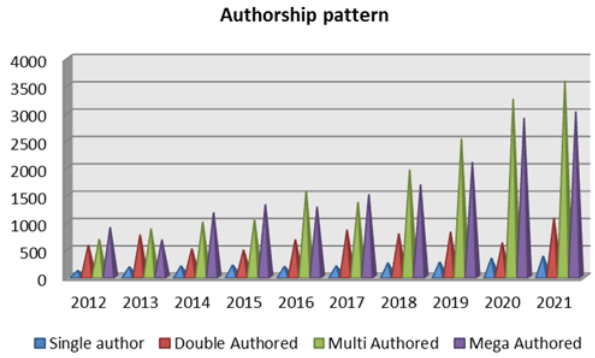

Fig. 4: Authorship pattern

5.4. *Most prolific authors*

The authors having 200 or more publications during 2012-2021 are given in Table 5. Zhang Y is the most productive author with 412 (0.93%) publications followed by Liu Y with 353 (0.80%) publications, Wang Y with 348 (0.79%) publications, Li Y with 329 (0.74%) publications, Li J with 319 (0.72) publications, Wang J with 298 (0.67%) publications, Zhang, J with 248 (0.56%) publications and Zhang L with 247 (0.56%) publications respectively. And a total of 1, 00,025 authors are contributed entire research output of the period under study.[4]

5.5. *Authorship pattern*

Authorship trend the whole publications were divided into the four categories (single, double, multi and mega-authored) are presented in table 6. Out of 44172 water pollution publications, 2383 (5.39%) were single authored papers, 7258 (16.43%) two authored papers, 17910 (40.55%) multi-authored papers and 16621 (37.63%) mega-authored papers. The authorship pattern clearly shows that 78.18% publications were contributed by multi and mega-authors while 21.82% of total publications were published by single and double-authors.

As per Degree of Collaboration of a discipline, must be between 0 and 1, hence the degree of collaboration of total publications of the water pollution is 0.94. The value of degree of collaboration brings out clearly the prevalence of team research in water pollution field. Out of the total publications, 94.61 % publications were collaborated by multi authors and 5.39 % of total contributions by single authors.

Analysis from the Table 6, Collaboration Index varies from 1.63 in 2021 and highest collaboration notices in 2013 i.e. 2.98. The average collaboration index is 2.42.

5.6. *Highly productive institutes*

Resents the top 10 institutes that have contributed 350 or more publications on water pollution during 2006-2015. A total of 23,519 institutions are contributed entire research output of the study. Chinese Academic of Sciences, China topped the list with 3013 (6.82%) publications followed by University of Chinese Academic of Sciences, China with 1116 (2.53%) publications, Beijing Normal University, China with 718 (1.63%) publications, Tsinghua University, China with 533 (1.21%) publications, Chinese Research Academy of Environmental Science, China with 440 (1.00%) publications and Nanjing University, China with 420 (0.952%) publications. It is interesting to note that the all top ten institutions are from China.

5.7. *Most preferred source titles*

Rovides the leading journals each with number of publications and impact factor. The scientific literature onwater pollution is spread over 2728 different web of science source journals. It reveals that Science of the Total Environment the list with the highest number of publications 2677 (6.06%) and the impact factor is 10.75, followed by Environmental Science and Pollution Research with a share of 2043 (4.62%) publications and the impact factor is 5.19. Marine Pollution Bulletin occupies the third position with 1148 (2.60%) publications and the impact factor is

Table 6: Authorship pattern

Year	Single author	Double Authored	Multi Authored	Mega Authored	Total Publications	Total Authors	CI	DC
2012	117	585	693	907	2302	5433	2.36	0.95
2013	186	773	885	681	2525	7537	2.98	0.93
2014	202	517	1007	1181	2907	8104	2.79	0.93
2015	218	497	1045	1328	3088	8763	2.84	0.93
2016	194	686	1579	1286	3745	9412	2.51	0.95
2017	203	867	1370	1513	3953	10105	2.56	0.95
2018	259	796	1962	1689	4706	12201	2.59	0.94
2019	273	827	2527	2104	5731	12939	2.26	0.95
2020	347	629	3255	2905	7136	12362	1.73	0.95
2021	384	1081	3587	3027	8079	13169	1.63	0.95
Total	2383	7258	17910	16621	44172	100025	2.42	0.94

DC – Degree of Collaboration, CI- Collaborative Index

Table 7: Highly productive institutes

S. No.	Institutions	Country	No. of Publications	Percentage
1	Chinese Academic of Sciences	China	3013	6.82%
2	University of Chinese Academic of Sciences	China	1116	2.53%
3	Beijing Normal University	China	718	1.63%
4	Tsinghua University	China	533	1.21%
5	Chinese Research Academy of Environmental Science	China	440	1.00%
6	Nanjing University	China	420	0.95%
7	Hohai University	China	397	0.90%
8	Zhejiang University	China	369	0.83%
9	Tongji University	China	358	0.81%
10	Peking University	China	352	0.80%

Table 8: Sourcetitle of publications

S. No.	Source Title	No. of Publications	Percentage	Impact Factor
1	Science of the Total Environment	2677	6.06	10.75
2	Environmental Science and Pollution Research	2043	4.62	5.19
3	Marine Pollution Bulletin	1148	2.60	5.553
4	Environmental Pollution	1098	2.49	8.071
5	Environmental Monitoring and Assessment	1083	2.45	2.513
6	Water	982	2.22	3.530
7	Chemosphere	922	2.09	7.086
8	Journal of Cleaner Production	857	1.94	9.297
9	Environmental Earth Sciences	798	1.81	2.18
10	Desalination and Water Treatment	692	1.57	1.254

Table 9: High productivity subject areas

S. No.	Subject	No. of Articles	Percentage
1	Environmental sciences ecology	24562	55.60
2	Engineering	8911	20.17
3	Energy fuels	3873	8.77
4	Physical sciences	3495	7.91
5	Chemistry	2931	6.63
6	Marine freshwater biology	2900	6.56
7	Materials science	1806	4.09
8	Physics	1489	3.37
9	Agriculture	1305	2.95
10	Pharmacology Pharmacy	1295	2.93

5.553. The fourth highest source title is Environmental Pollution with 1098 (2.49%) publications and the impact factor is 8.071, Environmental Monitoring and Assessment with 1083 (2.45%) publications and the impact factor is 2.513 and Water with 982 (2.22%) publications and the impact factor is 3.530.

5.8. High productivity subject areas

The scientific literature on water pollution is spread over 93 different subjects.Table 9 shows high productivity subjects which are contributing more than 300 articles. It is found that Environmental sciences ecology has highest number of articles with 24562 (55.60%) followed by Engineering contributing 8911 (20.17%) articles. Energy fuels occupy the third position with 3873 (8.77%) articles. The fourth highest articles belonged to the subject Physical sciences with 3495 (7.91%) articles, Chemistry with 2931 (6.63%) articles and Marine freshwater biology with 2900 (6.56%) articles respectively.

6. Conclusions

The present study attempted to highlight the growth and development of research publication on water pollution. A total of 44172 publications were published during 2012-2021 and the average number of publication per year was 4417.2. The exponential growth of publication was observed during the study period. Publications on water pollution are spread over 13 languages. Zhang Y is the most productive author with 412 (0.93%) publications followed by Liu Y with 353 (0.80%) publications and Wang Y with 348 (0.79%) publications and a total of 1,00,025 authors are contributed entire research output of the period under study. Degree of collaboration for total publications of the water pollution was 0.94. The value of degree of collaboration brings out clearly the prevalence of team research in water pollution which is evident, out of total publications, 94.61% were collaborated with multi authorship and 5.39% by single authors. The scientific literature on water pollution is spread over 2728 different web of science source titles.

7. Source of Funding

None.

8. Conflict of Interest

None.

References

1. Khatun S. Water Pollution: Causes, Consequences, Prevention Method and Role of WBPHED with Special Reference from Murshidabad District. *Int J Sci Res Publications*. 2017;7(8):269–77.
2. Bibliometric K. Analysis of Water Pollution Research. *Int J Res Eng Sci*. 2021;7:97–104.
3. Wang M, Huang Y, Ho TC, Shan Y. A bibliometric analysis of the performance of Water Research. *Scientometrics*. 2010;84(3):813–20.
4. Wang Y, Xiang C, Zhao P. A bibliometric analysis for the research on river water quality assessment and simulation during. *Scientometrics*. 2000;108(3):1333–46.
5. Kasavan SS. Plastic pollution in water ecosystems: A bibliometric analysis from. *J Cleaner Prod*. 2000;313:127946.
6. Enos W, Wambu YS. A bibliometric analysis of drinking water research in Africa. *Water SA*. 2016;42(4):612–20.
7. Zhou Y, Yang F, Wu X, Jia C, Liu S, Gao Y. Bibliometric analysis of research progress on karst groundwater pollution, 2nd Global Conference on Ecological Environment and Civil Engineering. *IOP Conf Series: Earth Environ Sci*. 2020;568:12040.

Author biography

R. Santhakumar, Librarian

S. Mahalakshmi, Librarian

Cite this article: Santhakumar R, Mahalakshmi S. Scientometric analysis of research progress on water pollution during 2012-2021. *IP Indian J Libr Sci Inf Technol* 2022;7(2):89-95.