University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Library Philosophy and Practice (e-journal) | Libraries at University of Nebraska-Lincoln

December 2018

Mapping of Bioremediation Research Output in India: A Scientometric Study

Saravanan S, Research Scholar Alagappa University, Tamil Nadu. India
Librarian, Government Arts College, Ariyalur, India, libsaraman@gmail.com

Baskaran C. - -
Librarian & Research Supervisor, Alagappa University, Karaikkudi-3, Tamilnadu, India

Follow this and additional works at: http://digitalcommons.unl.edu/libphilprac

 Part of the Library and Information Science Commons

S,, Saravanan Research Scholar Alagappa University, Tamil Nadu. India and -, Baskaran C. -, "Mapping of Bioremediation Research Output in India: A Scientometric Study" (2018). *Library Philosophy and Practice (e-journal)*. 2038.
http://digitalcommons.unl.edu/libphilprac/2038

Mapping of Bioremediation Research Output in India: A Scientometric Study

S.Saravanan[1], Dr.C.Baskaran[2]

1. Research Scholar, Alagappa University, Karaikudi.India.

2. Librarian & Research Supervisor, Alagappa University, Karaikudi.India.

Abstract

An analysis of 1981 publications published by Indian scientists during 1994 to 2018 indexed by Web of Science online Database indicates the Bioremediation Research Publication. This study tries to map the number of publications, growth rate and doubling time, scattering of publication over journals, and its impact on publication output, authorship patterns and Global citation score of bioremediation research publication in India using the HistCite, VOSviewer software. Indian Institute of technology, Baba atomic research centre and CSIR are the major producers of research output in the area of bioremediation.

Keywords: Scientometric, Bioremediation, Global Citation Score, the degree of collaboration, authorship pattern

INTRODUCTION

Bioremediation is a procedure used to treat contaminated media, including water, soil and subsurface material, by modifying natural conditions to invigorate development of microorganisms and corrupt the objective toxins. Much of the time, bioremediation is more affordable and more economical than other remediation choices. Natural treatment is a comparable approach used to treat wastewater, modern waste and strong waste. Most bioremediation forms include oxidation-reduction where either an electron acceptor (regularly oxygen) is added to invigorate oxidation of a lessened contamination (e.g. hydrocarbons) or an electron contributor (normally a natural substrate) is added to lessen oxidized toxins (nitrate, perchlorate, oxidized metals, chlorinated solvents, explosives and propellants). In both these methodologies, extra supplements, vitamins, minerals, and pH cushions might be added to

upgrade conditions for the microorganisms. At times, particular microbial societies are included (bioaugmentation) to additionally upgrade biodegradation. A few cases of bioremediation related innovations are phytoremediation, mycoremediation, bioventing, bioleaching, landfarming, bioreactor, treating the soil, bioaugmentation, rhizofiltration, and biostimulation.

OBJECTIVES

The main objective of this study was to use Scientometric mapping and analyze the key features of Bioremediation research activities at Indian level such as : the rate of growth and doubling time on bioremediation research, to identify document wise distribution of publications, to analyze the authorship pattern and examine the extent of research collaboration, to identify the ranking of authors based on publications, to identify journal wise distribution of publications and to assess the Institution wise research concentration and Global citation score of the publications.

METHODOLOGY

The research publications were retrieved from the Web of Science core collections database on the topic Bioremediation, which is scattered over the period from 1994 to 2018. The data was collected during the first week of July 2018. The search was carried out using the keyword Bioremediation in the 'topic field' and refined to the Country "India". A total of 1981 publications were downloaded and the same was analyzed using the software HistCite, VoSviewer and Microsoft Excel as per the objectives of the study.

ANALYSIS AND INTERPRETATION

Relative Growth rate and Doubling Time

To analyze the year wise publication of research on Bioremediation, the data has been presented in Table 1. The research output on Bioremediation publication is taken as a tool to evaluate the performance at various levels. It also shows that chronological histogram of citations, demonstrating that citation frequency grew steadily from 1994; it reached a maximum TGCS of 3479 and TLCS of 323 in the same year 2011.

Table 1 could clearly see that during the period 1994 to 2018 a total of 1981 publications were published at India level. The highest publication is 238 in the year 2016 and 2017 with 1101 and 381 TGCS followed by 200 papers in 2015 with 1363 TGCS and 196 papers in 2014 with 2104 TGCS. The lowest publication is 2 in 1994 with 28 TGCS. Table 1 shows that even minimum numbers of records were scored higher global citations, such as in the year 1997 and 2000 has produced only 7 and 9 papers respectively, but it has received as TGCS of 1517 and 1619. The study also reveals all these 1981 publications have 37149 TGSC, it shows that there is a healthy trend in citation found in bioremediation research output.

It is observed that its relative growth rates have decreased gradually from 1.26 in 1994 to 0.13 in 2017. The whole study period records the mean relative growth rate of 0.276. Contrarily, the doubling time for publication of all sources of output has increased from 0.55 in 1994 to 11.5 in 2018. The doubling time for publications at the aggregate level has been computed as 3.11 years.

Table 1: Shows relative growth and doubling time of Bioremediation Publications

S.No	Year	Records	Cumu-lative	Per cent %	W1	W2	R (a) (W2-W1)	Dt	TLCS	TGCS
1	1994	2	2	0.1	-	0.69	-	-	1	28
2	1995	5	7	0.3	0.69	1.95	1.26	0.55	11	79
3	1996	5	12	0.3	1.95	2.48	0.53	1.31	16	64
4	1997	7	19	0.4	2.48	2.94	0.46	1.51	101	1517
5	1998	8	27	0.4	2.94	3.30	0.36	1.93	25	372
6	1999	8	35	0.4	3.30	3.56	0.26	2.67	10	254
7	2000	9	44	0.5	3.56	3.78	0.22	3.15	78	1619
8	2001	14	58	0.7	3.78	4.06	0.28	2.48	93	666
9	2002	24	82	1.2	4.06	4.41	0.35	1.98	133	2276
10	2003	18	100	0.9	4.41	4.61	0.20	3.47	25	1063
11	2004	22	122	1.1	4.61	4.80	0.19	3.65	90	951
12	2005	37	159	1.9	4.80	5.07	0.27	2.57	152	2543
13	2006	62	221	3.1	5.07	5.40	0.33	2.1	244	2499
14	2007	57	278	2.9	5.40	5.63	0.23	3.01	252	2067
15	2008	89	367	4.5	5.63	5.91	0.28	2.48	287	3401
16	2009	98	465	4.9	5.91	6.14	0.23	3.01	240	3025
17	2010	97	562	4.9	6.14	6.33	0.19	3.65	243	1983
18	2011	144	706	7.3	6.33	6.55	0.22	3.15	323	3479
19	2012	133	839	6.7	6.55	6.73	0.18	3.85	274	2137
20	2013	158	997	8	6.73	6.90	0.17	4.08	239	2239

21	2014	196	1193	9.9	6.90	7.08	0.18	3.85	239	2104
22	2015	200	1393	10.1	7.08	7.24	0.16	4.33	148	1363
23	2016	238	1631	12	7.24	7.40	0.16	4.33	88	1011
24	2017	238	1869	12	7.40	7.53	0.13	5.33	50	381
25	2018	112	1981	5.7	7.53	7.59	0.06	11.55	0	28
Total		**1981**		**100**			**6.9 (0.276)**	**79.99 (3.11)**	**3362**	**37149**

Types of Document and its Citations

The study reveals that the major source of publications covered by a web of science on bioremediation research in journal articles (82.5%), while review comprises (13.3%) and conference proceedings with (2.3%) literature and remaining are meeting abstract, editorial materials and correction and so on. It is found from the table 2 that, the journal's articles were contributed to a most noteworthy number of distributions and most noteworthy number of TLCS and TGCS in bioremediation. The articles from reviews and proceeding papers were additionally having the most noteworthy citation scores.

Table 2 shows the document wise distribution of Publications

S.No	Document Type	Records	Percentage	TLCS	TGCS
1	Article	1638	82.5	2568	21200
2	Review	264	13.3	690	14055
3	Article; Proceedings Paper	46	2.3	63	1054
4	Meeting Abstract	9	0.5	1	1
5	Editorial Material	7	0.4	13	127
6	Review; Book Chapter	6	0.3	17	305
7	Article; Book Chapter	5	0.3	5	100
8	Correction	2	0.1	1	1
9	Letter	2	0.1	1	2
10	Article; Early Access	1	0.1	0	0
11	Review; Retracted Publication	1	0.1	3	304
Total		**1981**	**100**	**3362**	**37149**

Ranking of Highly Productive authors

Table 3 shows ranking of highly productive authors by number of research productivity, "Kumar A" contributed most number of articles for the investigated time frame with 36 records, next two

authors “Das S” and “Jain RK” contributed next most number of articles for the time frame with 34 and 33 records each, and author “Kumar M” and “Kumar S” ranked eleventh with the publication of 19 articles each. In this way, the TGSC distinguished from the most-published ones.

Table 3: Top 15 Highly productive Authors

S.No	Author	Records	Per cent	TLCS	TGCS
1	Kumar A	36	1.8	54	497
2	Das S	34	1.7	104	548
3	Jain R	33	1.7	169	1955
4	Kumar R	32	1.6	56	356
5	Kumar V	28	1.4	49	306
6	Singh S	23	1.2	22	173
7	Madamwar D	22	1.1	113	741
8	Purohit HJ	21	1.1	38	216
9	Singh R	21	1.1	47	462
10	Mohan SV	20	1	42	436
11	Sar P	20	1	85	528
12	Singh N	20	1	35	205
13	Srivastava S	20	1	41	242
14	Kumar M	19	1	38	251
15	Kumar S	19	1	17	160

Authorship Pattern

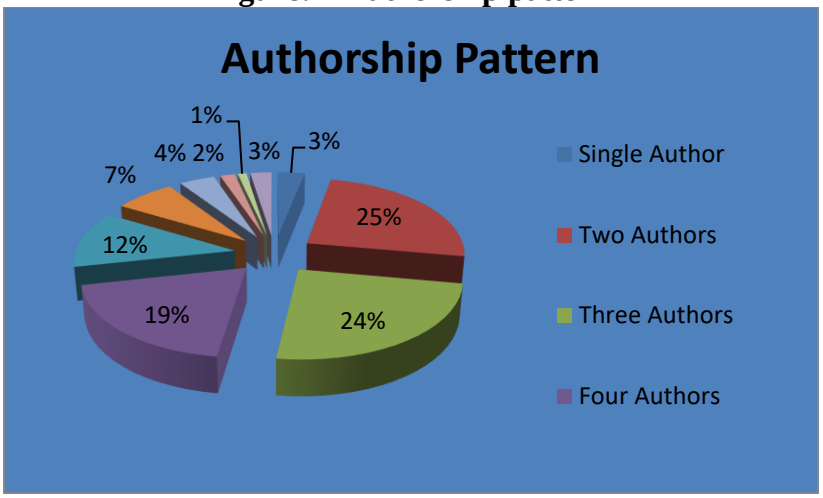
Table 4 shows the authorship patterns of research publications. It could be noted that two authored papers rank first in order sharing 24.68%. The next place is recorded by three authored papers sharing 24.38% of the total research contributions. Four authored contributions take that third position in order occupying 19.38% of the total research output during the study period followed by between Five and six authored 19.07 %. The least percentage was recorded by eight authored publications with 1.71%. It is inferred from the table - 4 that at the aggregate level, the degree of collaboration is of 0.79. This brings out clearly the high level of collaborative research in Bioremediation

Table 4: Authorship Pattern

Authorship	Publications	Cumulative	Percentage

Pattern			
Single Atuthor	62	62	3.12
Two Authors	489	551	24.68
Three Authors	483	1034	24.38
Four Authors	384	1418	19.38
Five Authors	238	1656	12.01
Six Authors	140	1796	7.06
Seven Authors	82	1878	4.13
Eight Authors	34	1912	1.71
Nine Authors	20	1932	2.03
Ten and More Than Ten Authors	49	1981	2.47

Figure: 1 Authorship pattern



Journal wise Distribution of Publications

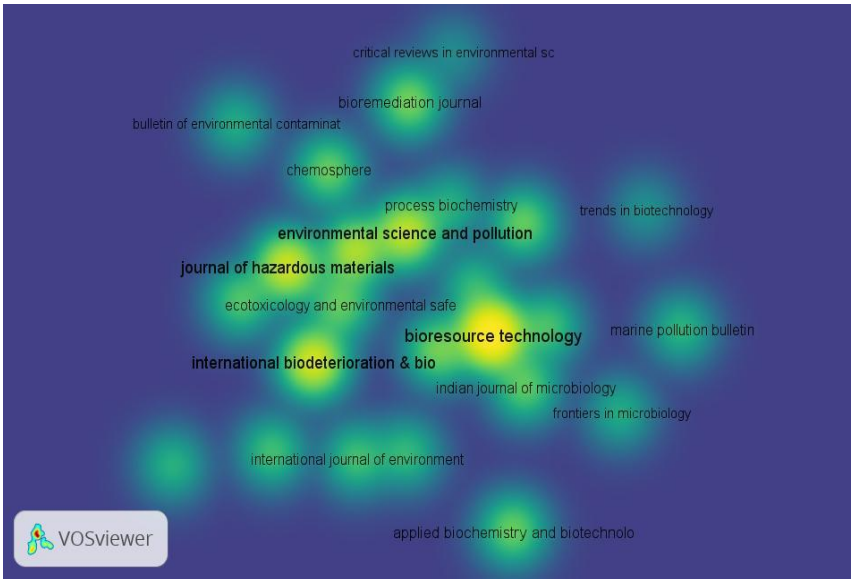
The study found that the total research output of the bioremediation for the study period (1994 – 2018) published in 411 journals. In Table 5 The journal "Bioresource Technology" topped with 113 publications with the Global Citation Score of 3331, next "International biodeterioration and biodegradation" with 68 publications with the Global Citation Score of 1141 and third position by "Journals of Hazardous materials with 64 publications with the Global Citation Score of 2305 respectively. "Applied microbiology and biotechnology" placed in ninth position got second highest global citation score of 2424 with just 31 records.

Table 5: Distribution of Bioremediation research in Journals Publications

S.No	Journal	Records	Percentage	TLCS	TGCS	TLCR
1	Bioresource Technology	113	5.7	351	3331	191
2	International Biodeterioration &	68	3.4	174	1141	126

	Biodegradation					
3	Journal of Hazardous materials	64	3.2	219	2305	111
4	Environmental Science and Pollution Research	58	2.9	115	518	164
5	3 BioTech	50	2.5	7	104	93
6	Bioremediation Journal	35	1.8	15	126	65
7	World Journal of Microbiology & Biotechnology	34	1.7	87	576	48
8	Applied Biochemistry and Biotechnology	32	1.6	30	448	44
9	Applied microbiology and biotechnology	31	1.6	203	2424	100
10	Chemosphere	31	1.6	70	596	77

Figure: 2: VoSviewer view on Distribution of Journals in bioremediation Research



Institution wise Distribution of Publications

The below table 6 analysis indicates Institution-wise research productivity. It is noted that Indian Institute of technology contributed the highest number of research publications (124, 6.3%) and ranked first in publications and also in terms of Total Global Citation Score of 3573.

Table 6: Institution wise Distribution of Publications (Top 10)

S.No	Institution	Records	%	TLCS	TGCS
1	Indian Institute Technology	124	6.3	280	3573
2	Bhabha Atomic Research Centre	64	3.2	113	1010
3	CSIR	58	2.9	100	1881

4	University of Calcutta	48	2.4	113	698
5	Institute of Microbial Technology	47	2.4	250	3502
6	Banaras Hindu University	46	2.3	118	904
7	National institute of Technology	44	2.2	95	380
8	VIT University	44	2.2	33	270
9	University of Delhi	43	2.2	163	1342
10	National Environment Engineering Research Institute	41	2.1	94	763

Top 10 Global Citation

The top 10 Global Citation Scores papers the most cited research papers span the period from 1997 to 2015 with one major network. There are only 81 links with GCS ranging between maximum 1281 and minimum. Figure 3: shows the interlinks of 100 GSC citation publication, which shows the healthy citation practices and development of the research in the area of bioremediation

Table 6: Global citation of Top Ten Publications

S.No	Node	Author/Year/Journal	LSC	GCS
1.	17	Desai JD, 1997, MICROBIOL MOL BIOL R, V61, P47	66	1281
2.	37	Banat IM, 2000, APPL MICROBIOL BIOT, V53, P495	40	830
3.	40	Pandey A, 2000, PROCESS BIOCHEM, V35, P1153	3	564
4.	66	Samanta SK, 2002, TRENDS BIOTECHNOL, V20, P243	0	499
5.	76	Banerjee A, 2002, APPL MICROBIOL BIOT, V60, P33	3	304
6.	91	Pandey A, 2003, BIOCHEM ENG J, V13, P81	0	485
7.	145	Shanker AK, 2005, ENVIRON INT, V31, P739	11	756
8.	217	Mukherjee S, 2006, TRENDS BIOTECHNOL, V24, P509	15	351
9.	289	Kotay SM, 2008, INT J HYDROGEN ENERG, V33, P258	0	295
10.	601	Ma Y, 2011, BIOTECHNOL ADV, V29, P248	11	288

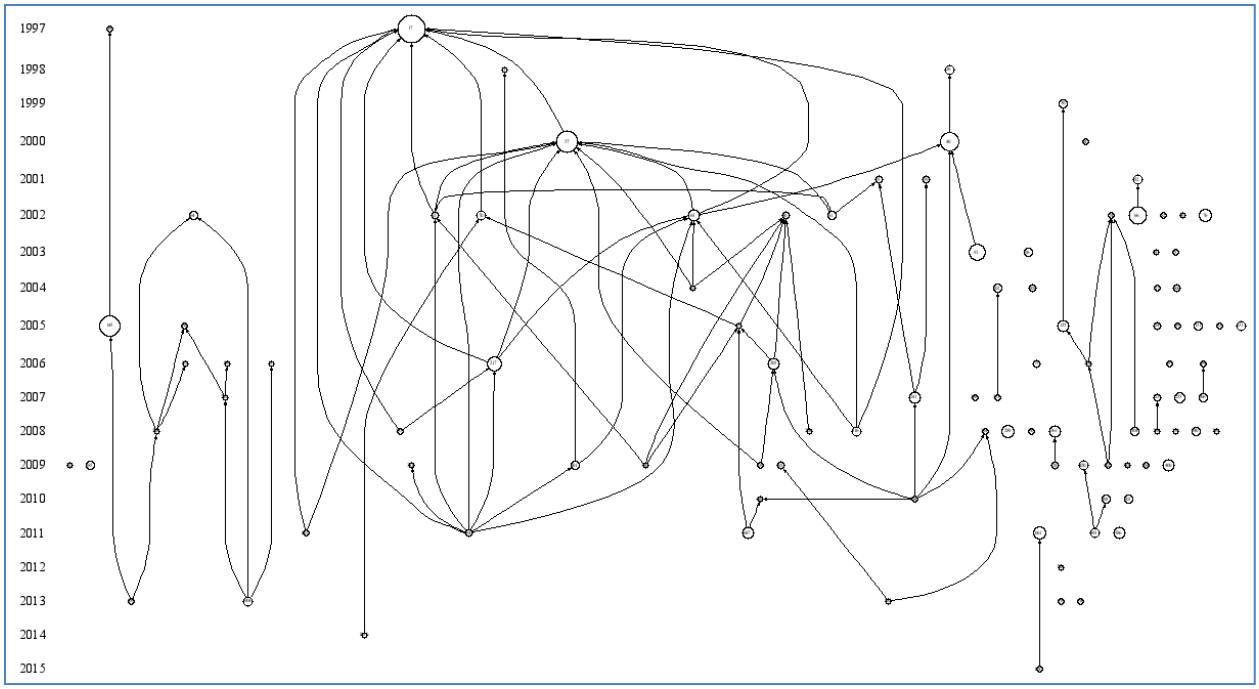


Figure:3: Shows Bioremediation Research - Historiograph by top 100 GCS Nodes: 100, Links: 81, GCS, top 100; Min: 17, Max: 1281 (GCS scaled)

Conclusion

Bioremediation research in India has been promising and need of the hour, its research development, has been studied using scientometric methods. The overall increase in the publication and citation in this field reveals that the impact of the bioremediation and is possibly going to outperform in the area of environmental studies in the coming years. The average number of publications produced per year was 79.24%. The highest number of publications produced in 2016 and 2017 was 238. It can be clearly visualized from Table 1 that the growth of the literature was very less during 1994 to 2009 and thereafter literature grows in consistent pace over the years, reaching the highest numbers 238 during the year 2017.

The most productive author is Kumar A with 36 papers dealing with bioremediation with GCS of 497 and third author with highest GSC of 1955 with only 33 publications. It has been observed that (1638) 82.5 % per cent of the article has been published in Article followed by (264)13.3% per cent in Review. It is found that collaborative authorship is prevailing in the authorship trends.

Among the top 10 most productive research Institutions, Indian Institute of technology (164) topped the study, followed by Bhabha atomic research centre (64) and next CSIR with 58 Publications. In this study , the key journals in bioremediation research has been identifies and represented using VoSviewer software and the major journals Bioresource Technology with 113 publications, followed by International Biodeterioration & Biodegradation with 68 publications

Reference :

Green Remediation Best Management Practices: Sites with Leaking Underground Storage Tank Systems. EPA 542-F-11-008" (PDF). EPA. June 2011.

Introduction to In Situ Bioremediation of Groundwater (PDF). US Environmental Protection Agency. 2013. p. 30.

C.Baskaran, (2014) "Citations Analysis on Library and Information Science Research: The Quantitative approach from Web of Science", SRELS Journal of Information Management, 51(3).

Mishra, A.K and Balhara, Y.P.S (2013). "Statistical Methodology for the Scientometric Study of the Growth of Medical Science in India", Current Science, Vol.105 (6), Sep. 25.

C. Baskaran, (2016) "A Scientometric study on Bioinformatics Literature during 1999-2013", International Journal of Library Science and Information Management (IJLSIM), 2(4), 62-79

C.Baskaran, (2013) "Research growth trend and author collaboration of Alagappa University in India during 1999-2011, International Journal of Library and Information Studies", 3(1), 57-64.

C.Baskaran, (2015) "Research productivity of enzymes Literature: A Scientometric Study", International Journal of Library Science and Information Management (IJLSIM), 1(2), 17-25.