

A Scientometric Analysis of Research Productivity: A Case Study of National Institute of Ocean Technology, Tamil Nadu

N. Senthil Kumar

Librarian cum Information Assistant
Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR)
Bangalore
e-mail: senthilneelamegam@gmail.com

P. Prabahar

Assistant Librarian
Indian Institute of Astrophysics (IIAP)
Bangalore

Abstract - *The present study demonstrates a 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 have been downloaded and analyzed. Maximum 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 top collaborate institute.*

Keywords: *Bibliometrics, Web of Science, Scientometrics, Authorship pattern, NIOT publications, Library science, Citations*

Introduction

National Institute of Ocean Technology (NIOT), Chennai was established by Ministry of Earth Sciences, Government of India on 1993. The primary objectives of this institute are to develop reliable indigenous technology to solve the various engineering problems associated with harvesting of living and non-living resources. This study presents to the research output of NIOT during the period 1997-2017. There is a continuous or noticeable increase in research publications during the last decades, several scientific methods to justify the growth and development of concern organization. The scientometric study is one of the techniques to examine the research output qualitatively as well as quantitatively; analyzing the citations, authorship patterns; degrees of collaboration, collaboration index, author productivity, impact factor of distributed journals, etc. will support to identify the research productivity of NIOT during the study period.

Review of Literature

Velmurugan, C. and Radhakrishnan N. (2016) were analyzed the publications of Malaysian Journal of Library and Information Science between 2008 and 2014. Authors have used various methods such as authorship pattern, annual growth rate (AGR), degrees of collaboration, collaborative index, institute wise distributions, contributions of citations, etc. Highest productivity in 2011 with 19.71% records and lowest productivity noted in 2014 with 9.86%. Average author productivity per year was 0.42; a degree of collaboration of Malaysian Journal of Library and Information Science during the study period was 0.75.

Nagesh Hamimani, Mulla, K.R. and Senthil Kumar, N. (2015) have revealed the cancer research publications in India during 2003-2013. There were 15794 articles published during the study period. Authors have analyzed year-wise distributions, highly preferred journals, author productivity, most prolific authors and global publications share, etc. Maximum numbers of articles published in 2013 with 2996 records and less number of publications noted in 2003 with 440 records. Average output per year is 21.7; the authors further identified that Asian Pacific Journal of Cancer Prevention is the most favored journal and Kumar A. is a most prolific author during the study period.

Jiban Pal, K. (2015) examined the cryptographic research publications for the period of 2001-2010. The author analyzed the publication's growth, authorship pattern, collaborative trends, prolific researchers, productive institutions, Lotka's law of scientific productivity, etc. Average output per author per paper is 2.4; the degree of collaboration during the study period is 0.74. Researchers' prefers co-authorship pattern to publish more articles than solo-authorship, and USA researchers contributed more in cryptographic research productivity in the concerned period.

Chanda Arya (2013) revealed the publications of Sadhana journal between 2005 and 2009. The author has selected five volume articles to identify the volume and issue-wise contributions, authorship patterns, institute-wise contributions, global researcher contributions, citation pattern, etc. There were 253 papers published during the study period; highest records in 2009 with 60; maximum articles written by two authors; average references per article and volume are 23.72 and 200.602 respectively. Karnataka state authors have published more documents 56 (34.15%) followed by Tamil Nadu researchers with 19 (11.58%) and globally top three contributors are from India, Turkey, and the USA.

Radhakrishnan, N. and Velmurugan C. (2015) analyzed the faculty publications of Periyar University, Tamil Nadu for a period of 1998-2014, and the data retrieved from the web of science. Authorship pattern, documents type, the degree of collaboration, geographical distributions, TLCS, TGCS, TLCR, etc. were analyzed. 703 papers were published by Periyar University researchers during the study period, maximum in 2014 with 148. Single author contributions are very less as 5, and multi-author records were 698. Krishnakumar V. is the most prolific author with 111 publications, and more articles were published in Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy journal with 98 (13.9%). 48 records published with the collaboration of South Korean researchers which is 5.17% of total publications.

Objectives of the study

1. To identify the annual distribution of NIOT publications.
2. To study the document type wise distributions.
3. To reveal the subject wise publications.
4. To identify the journal wise distribution.
5. To exhibit the authorship pattern of NIOT publications.
6. To explore the collaborative institutes of NIOT.
7. To know the most prolific authors of NIOT.
8. To know the highly cited articles.

Methodology

This study aims to analyze the research output of National Institute of Ocean Technology (NIOT), Tamil Nadu during 1997-2017. Data retrieved from the web of science core collection database on 30th January 2018. Organization name selected through 'Organization Enhanced' and period '1997-2017' are used to retrieve the data. The data analyzed by different techniques to identify annual distribution, document-wise distribution, subject wise distribution, journal wise distribution, authorship pattern, collaborative institutes, most prolific authors and highly cited articles, etc.

ANALYSIS

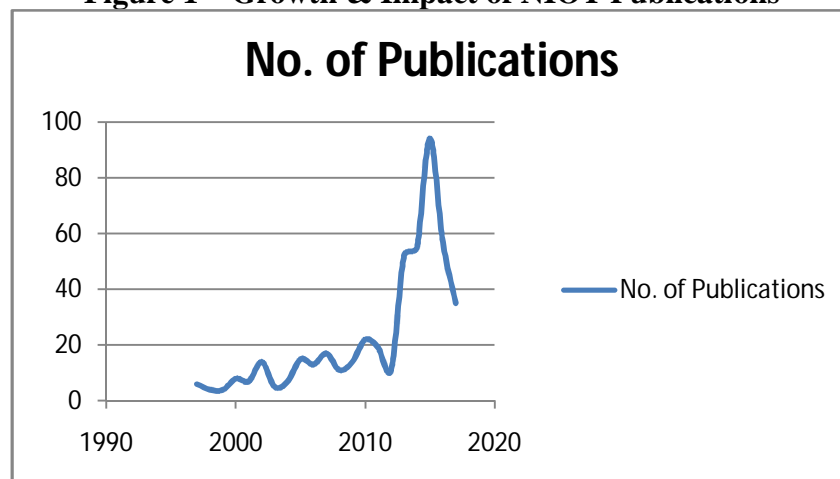
Growth & Impact of NIOT Publications:

Table 1 show that growth and impact of NIOT publications during the study period of 1997 – 2017. More articles have published in the years of 2014, 2015 and 2016 as 55, 94 and 57 respectively. Fewer articles noted in 1998 and 1999 equally with 4. Citation wise, 2010 publications were cited maximum as 617 times with 28.05 % followed by 2001 articles cited 334 times (47.71%); Minimum citations noted in 2003 and 2017 as 11 (2.2%) and 5 (0.14%) respectively. Totally 470 publications cited 3465 times; average research output per year is 22.38 and average citation per year is 11.82.

Table 1 – Growth & Impact of NIOT Publications

Years	No. of Records	Total Citations	Average Citation Per Paper
1997	6	31	5.16
1998	4	65	16.25
1999	4	31	7.75
2000	8	187	23.38
2001	7	334	47.71
2002	14	93	6.64
2003	5	11	2.2
2004	7	150	21.43
2005	15	198	13.2
2006	13	96	7.38
2007	17	167	9.82
2008	11	154	14
2009	14	155	11.07
2010	22	617	28.05
2011	19	252	13.26
2012	11	77	7
2013	52	311	5.98
2014	55	219	3.98
2015	94	235	2.5
2016	57	77	1.35
2017	35	5	0.14
Total	470	3465	248.25
Average research output per year 22.38			
Average citation per year 11.82			

Figure 1 – Growth & Impact of NIOT Publications



Subject-wise Distributions:

Table 2 describes the top 20 subjects wise distribution of NIOT research output during the study period. Maximum output in oceanography with 115 (24.47%) followed by ocean engineering with 76 (16.17%) and marine engineering is in the third position with 55 (11.70%); minimum outputs noted in mechanical engineering and meteorology atmospheric sciences; both the subjects having equal papers as 12 (2.55%) and placed in the fifteenth position.

Table 2 - Top 20 Subject-wise Distributions

Categories	No. of Publications	Percentage of Records	Rank
Oceanography	115	24.47	1
Ocean Engineering	76	16.17	2
Marine Engineering	55	11.70	3
Electrical Electronic Engineering	51	10.85	4
Environmental Sciences	40	8.51	5
Multidisciplinary Sciences	38	8.09	6
Marine Freshwater Biology	31	6.60	7
Water Resources	28	5.96	8
Biotechnology Applied Microbiology	25	5.32	9
Chemical Engineering	22	4.68	10
Fisheries	20	4.26	11
Geosciences Multidisciplinary	20	4.26	11
Materials Science Multidisciplinary	15	3.19	12
Biochemistry Molecular Biology	14	2.98	13
Physical Chemistry	14	2.98	13
Energy Fuels	14	2.98	13
Acoustics	13	2.77	14
Civil Engineering	13	2.77	14
Mechanical Engineering	12	2.55	15
Meteorology Atmospheric Sciences	12	2.55	15

Authorship Pattern:

Table 3 presents the solo and co-authorship pattern of NIOT research productivity between 1997 and 2017. Out of 470 publications, nine only single author records, rest of 461 are joint authorship records. 2011 and 2013 were maximum as well as equally single author papers (3); single article only published in the years of 1997, 2002 and 2016. The highest number of joint author records in 2015 with 94 followed by 56 in 2016 and 55 records in 2014. Less number of joint authorship papers published in 1997 as five followed by 1998 and 1999 are equally with four papers.

Table 3 - Solo and Co-authorship

Year	Single Author Articles	Joint Authors Articles	Total	Percentage
1997	1	5	6	1.28
1998		4	4	0.85
1999		4	4	0.85
2000		8	8	1.7
2001		7	7	1.49
2002	1	13	14	2.98
2003		5	5	1.06
2004		7	7	1.49
2005		15	15	3.19
2006		13	13	2.77
2007		17	17	3.62
2008		11	11	2.34
2009		14	14	2.98
2010		22	22	4.68
2011	3	16	19	4.04
2012		11	11	2.34
2013	3	49	52	11.06
2014		55	55	11.7
2015		94	94	20
2016	1	56	57	12.13
2017		35	35	7.45
Total	9	461	470	100

Author Productivity:

Table 4 describes the author productivity of NIOT publications, formulas used to calculate the average authors per paper (AAPP) and productivity per year (PPY) given below. 2403 authors contributed in 470 publications; the maximum number of records published in 2015 as 94. 518 researchers contributed to publishing these 94 papers; followed by 2016 with 57 articles delivered by 343 researchers. AAPP is 4.74, and average author productivity per paper (AAPPY) is 0.22 during the study period.

AAPP = Number of Authors / Number of Papers

Productivity per Year = Number of Papers / Number of Authors

Table 4 – Year wise Author Productivity

Year	No. of Articles	No. of Authors	AAPP	Productivity per Year
1997	6	15	2.50	0.40
1998	4	11	2.75	0.36
1999	4	21	5.25	0.19
2000	8	32	4.00	0.25
2001	7	42	6.00	0.17
2002	14	50	3.57	0.28
2003	5	21	4.20	0.24
2004	7	27	3.86	0.26
2005	15	91	6.07	0.16
2006	13	62	4.77	0.21
2007	17	92	5.41	0.18
2008	11	53	4.82	0.21
2009	14	80	5.71	0.18
2010	22	113	5.14	0.19
2011	19	80	4.21	0.24
2012	11	56	5.09	0.20
2013	52	255	4.90	0.20
2014	55	266	4.84	0.21
2015	94	518	5.51	0.18
2016	57	343	6.02	0.17
2017	35	175	5.00	0.20
Total	470	2403	99.61	4.68
Average author productivity per paper 4.74				
Average author productivity per paper 0.22				

Degrees of Collaboration:

Table 5 represents the degrees of the collaboration of NIOT publications during the study period. The formula which is applied to identify the degrees of collaboration is below mentioned. Maximum of degrees of the collaboration noted in the years of 1998-2001, 2003-2010, 2012, 2014, 2015 and 2017 as 1. Minimum degrees of collaboration identified in 1997 as 0.83. A total degree of collaboration between study periods is 20.52 and average is 0.98.

Degrees of Collaboration (DC) = $N_m / N_m + N_s$

Where,

DC = Degrees of Collaboration

N_m = Number of multiple authors

N_s = Number of single authors

$$DC = 461/461+9$$

$$= 461/470$$

$$DC = 0.98$$

Table 5 - Degrees of Collaboration

Year	Single Authored Articles	Multi-authored Articles	Total Articles	Degrees of Collaboration
1997	1	5	6	0.83
1998		4	4	1
1999		4	4	1
2000		8	8	1
2001		7	7	1
2002	1	13	14	0.93
2003		5	5	1
2004		7	7	1
2005		15	15	1
2006		13	13	1
2007		17	17	1
2008		11	11	1
2009		14	14	1
2010		22	22	1
2011	3	16	19	0.84
2012		11	11	1
2013	3	49	52	0.94
2014		55	55	1
2015		94	94	1
2016	1	56	57	0.98
2017		35	35	1
Total	9	461	470	20.52
Average degrees of collaboration 0.98				

Collaboration Index (CI):

Table 6 explains the collaboration index of NIOT publications, the formula used to measure the collaboration index is given below. 2394 researchers contributed to delivering 461 multi-authored papers. Highest collaboration index noted in the year of 2016 as 6.11 followed by 2005 with 6.07 and lowest collaboration index noted in 1998 as 2.75. Average collaboration index during the study period is 4.81.

CI = Total authors of multi-authored papers during a year / Multi-authored papers during a year

Table 6 – Collaborative Index

Year	Multi-authored Papers	Total authors of multi-authored papers	Collaboration Index (CI)
1997	5	14	2.80
1998	4	11	2.75
1999	4	21	5.25
2000	8	32	4.00
2001	7	42	6.00
2002	13	49	3.77
2003	5	21	4.20

2004	7	27	3.86
2005	15	91	6.07
2006	13	62	4.77
2007	17	92	5.41
2008	11	53	4.82
2009	14	80	5.71
2010	22	113	5.14
2011	16	77	4.81
2012	11	56	5.09
2013	49	252	5.14
2014	55	266	4.84
2015	94	518	5.51
2016	56	342	6.11
2017	35	175	5.00
Total	461	2394	101.04
Average collaboration index 4.81			

Most Favored Journals:

Table 7 shows the top 15 most favored journals of NIOT researchers with its impact factors. Journals arranged according to its impact factor (IF) value taken from JCR 2017. JCR offered by International Scientific Institute (ISI), the United States which is one of the world’s leading sources offering indexing services of journals and research conferences. ISI evaluates the leading journals systematically to identify its impact factor. Colloids and surfaces B: Biointerfaces having more impact factor as 3.887, nine articles published in this journal. Marine pollution bulletin is being in the second position with 3.146 followed by International biodeterioration & biodegradation with 2.962. More research papers (168) presented in five conferences since 2013, but these don't have the impact factor hence placed in the eleventh position.

Table 7 - Top 15 Most Favored Journals

Journal Name	Total	IF 2017	CIF	Rank
Colloids and Surfaces B : Biointerfaces	9	3.887	34.983	1
Marine Pollution Bulletin	9	3.146	28.314	2
International Biodeterioration & Biodegradation	7	2.962	20.734	3
Applied Acoustics	5	1.921	9.605	4
Desalination and Water Treatment	8	1.631	13.048	5
Applied Ocean Research	5	1.596	7.98	6
Current Science	35	0.843	29.505	7
Marine Technology Society Journal	23	0.727	16.721	8
Indian Journal of Marine Sciences	6	0.316	1.896	9
Indian Journal of Geo-Marine Sciences	39	0.172	6.708	10
2015 IEEE Underwater Technology Symposium UT	23	0	0	11
Ocean Electronics	18	0	0	11
2013 Ocean Electronics Symposium	13	0	0	11
IEEE Oceans Conference	9	0	0	11
2015 International Symposium on Ocean Electronics Symposium	5	0	0	11

IF - Impact Factor as per JCR 2017

CIF – Cumulative Impact Factor

Rank – Global Ranking of the Journals as per JCR 2017

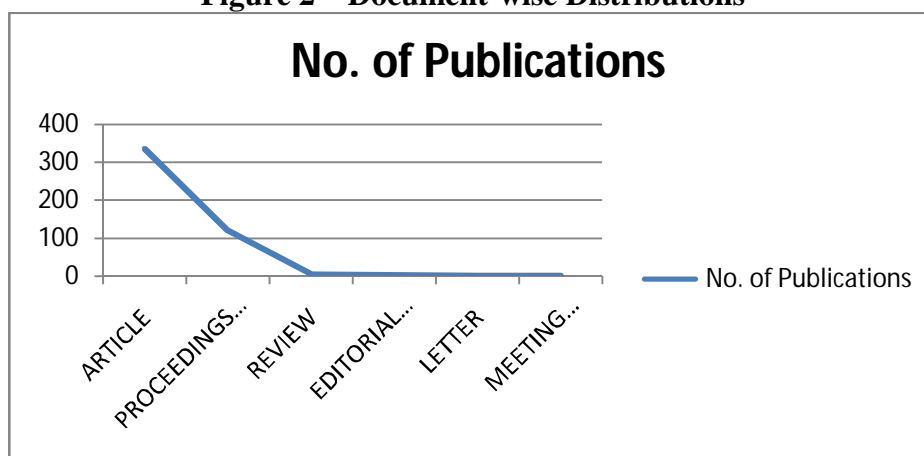
Ranking of Documents:

Table 8 shows the bibliographic form wise distribution of NIOT records during study period. Maximum records were published as articles with 336 (71.49%) followed by conference proceeding papers with 120 (25.53%) and reviews are 6 (1.28%). Editorial materials, letters and meeting abstracts are rest of the NIOT records as 4 (0.85%), 2 (0.43%) and 2 (0.43%) respectively.

Table 8 - Documents Type-wise Distribution

Rank	Bibliographic Form	No. of Records	Percentage	No. of Cumulative Records	Cumulative Percentage
1	Article	336	71.49	336	71.49
2	Proceedings Paper	120	25.53	456	97.02
3	Review	6	1.28	462	98.3
4	Editorial Material	4	0.85	466	99.15
5	Letter	2	0.43	468	99.58
6	Meeting Abstract	2	0.43	470	100.01
	Total	470	100.01		

Figure 2 – Document-wise Distributions



Institute wise Distribution:

This table explains the top 20 collaborative organizations associated with NIOT during the study period. NIOT researchers contributed in all the publications followed by Indian Institute of Technology (IIT) with 84 (17.87%) and third rank obtained by Anna University with 80 (17.02%). Among top 20 institutes, Bharathidasan University, Bose Institute, and ICAR Central Marine Fisheries Research Institute equally share 15th rank with 6 (1.28%) followed by Indian Institute of Tropical Meteorology (IITM) with 5 (1.06%) publications.

Table 9 - Top 20 Institute wise Distribution of Articles

Name of the Organizations	No. of Papers	Percentage	Rank
National Institute of Ocean Technology (NIOT)	470	100.00	1
Indian Institute of Technology (IIT)	84	17.87	2
Anna University	80	17.02	3
Council of Scientific Industrial Research (CSIR) India	46	9.79	4
Sathyabama University	28	5.96	5
University of Madras	19	4.04	6
Indian Institute of Science (IISc) Bangalore	18	3.83	7
National Institute of Oceanography India	15	3.19	8
Indian National Centre for Ocean Information Services	13	2.77	9
Central Leather Research Institute India (CLRI)	12	2.55	10
Berhampur University	11	2.34	11
Integrated Coastal Marine Area Management Project Directorate (ICMAM PD)	11	2.34	11
Annamalai University	10	2.13	12
Bhabha Atomic Research Center	10	2.13	12
Indira Gandhi Centre for Atomic Research	8	1.70	13
Indian Council of Agricultural Research (ICAR)	7	1.49	14
Bharathidasan University	6	1.28	15
Bose Institute	6	1.28	15
ICAR Central Marine Fisheries Research Institute	6	1.28	15
Indian Institute of Tropical Meteorology (IITM)	5	1.06	16

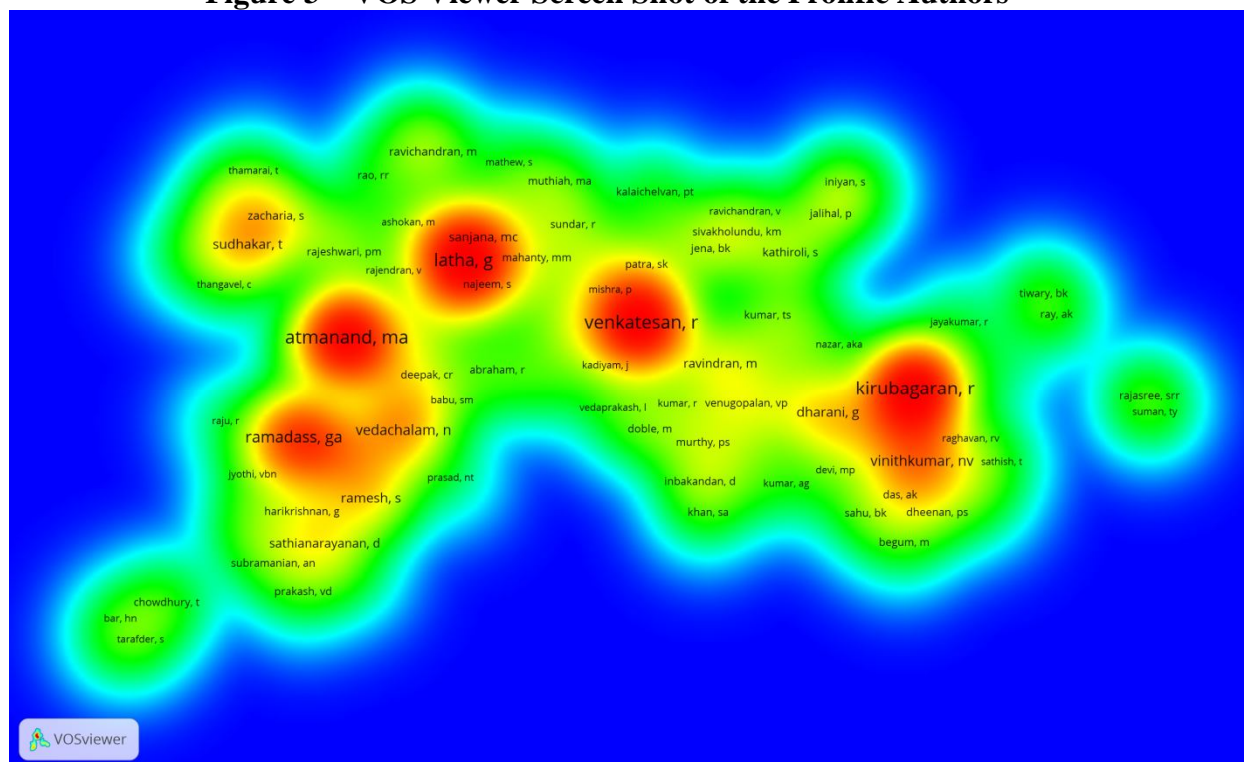
Most Prolific Author:

Table 10 presents the list of most prolific authors based on their H-index. Venkatesan is at first with more H-index as 17, he has published 78 papers during the study period followed by Kirubakaran, his H-index is 14 for 79 records. Researchers Atmanand and Latha having equal H-index as eight similarly Ramadass, Vedachalam and Vinithkumar also obtain an equal H-index value as 7; researcher Zacharia has less H-index as 2 for his 15 papers.

Table 10 - List of Top 15 Prolific Authors

S.No.	Authors	No. of Records	Total Citations	Average Citations per Paper	H-Index
1	Venkatesan R	78	908	11.64	17
2	Kirubakaran R	79	598	7.57	14
3	Atmanand M A	73	235	3.22	8
4	Latha G	63	232	3.68	8
5	Ramadass G A	49	171	3.49	7
6	Vedachalam N	31	128	4.13	7
7	Vinithkumar N V	29	173	5.95	7
8	Dharani G	22	102	4.64	6
9	Ravindran M	18	163	9.06	6
10	Ramesh R	24	76	3.17	5
11	Ramesh S	22	56	2.55	4
12	Sudhakar T	23	25	1.09	3
13	Sanjana M C	17	20	1.18	3
14	Sathianarayanan D	16	32	2	3
15	Zacharia S	15	8	0.53	2

Figure 3 – VOS Viewer Screen Shot of the Prolific Authors



Highly Cited Articles:

Table 11 - List of Top 15 Highly Cited Articles

S.N o.	Article Title & DOI	Journal Details	Times Cited	Average Citation Per Year
1	Biogenic synthesis of silver nanoparticles and their synergistic effect with antibiotics: a study against gram-positive and gram-negative bacteria DOI: 10.1016/j.nano.2009.04.006	Nanomedicine-Nanotechnology Biology and Medicine, 2010, 6(1), pp.103-109	367	40.78
2	BOBMEX: The Bay of Bengal Monsoon Experiment DOI: 10.1175/1520-0477(2001)082<2217:BTBOBM>2.3.CO;2	Bulletin of the American Meteorological Society, 2001, 82(10), pp.2217-2243	142	7.89
3	Oscillations of Bay of Bengal sea surface temperature during the 1998 summer monsoon DOI: 10.1029/2000GL012548	Geophysical Research Letters, 2001, 28(10), pp. 2033-2036	105	5.83
4	Carbon steel corrosion by iron oxidising and sulphate reducing bacteria in a freshwater cooling system DOI: 10.1016/S0010-938X(99)00141-9	Corrosion Science, 2000, 42(8), pp.1417-1431	80	4.21
5	Marine microbe-mediated biodegradation of low- and high-density polyethylenes DOI: 10.1016/j.ibiod.2007.07.011	International Biodeterioration & Biodegradation, 2008, 61(3), pp.203-213	72	6.55
6	First results from a new observational system over the Indian seas DOI: NA	Current Science, 2000, 78(3), pp.323-330	70	3.68
7	Biosynthesis, characterization and cytotoxic effect of plant-mediated silver nanoparticles using Morinda citrifolia root extract DOI: 10.1016/j.colsurfb.2013.01.037	Colloids and Surfaces B - Biointerfaces, 2013, 106, pp.74-78	69	11.5

8	The biology of triploid fish DOI: 10.1007/s11160-004-8361-8	Reviews in Fish Biology and Fisheries, 2004, 14(4), pp.391-402	68	4.53
9	Biofouling and stability of synthetic polymers in seawater DOI: 10.1016/j.ibiod.2009.03.003	International Biodeterioration & Biodegradation, 2009, 63(7), pp.884-890	60	6
10	Biofouling and biodegradation of polyolefins in ocean waters DOI: 10.1016/j.polymdegradstab.2007.03.029	Polymer Degradation and Stability, 2007, 92(9), pp.1743-1752	55	4.58
11	Biosynthesis of gold nanoparticles utilizing marine sponge <i>Acanthella elongata</i> (Dendy, 1905) DOI: 10.1016/j.colsurfb.2010.08.016	Colloids and Surfaces B - Biointerfaces, 2010, 81(2), pp.634-639	50	5.56
12	Mechanisms and control of vitellogenesis in crustaceans DOI: 10.1007/s12562-010-0301-z	Fisheries Science, 2011, 77(1), pp.1-21	47	5.88
13	The tsunami of the great Sumatra earthquake of M 9.0 on 26 December 2004 - Impact on the east coast of India DOI: NA	Current Science, 2005, 88(8), pp.1297-1301	47	3.36
14	Biosynthesis of silver and gold nanoparticles using thermophilic bacterium <i>Geobacillus stearothermophilus</i> DOI: 10.1016/j.procbio.2011.07.003	Process Biochemistry, 2011, 46(10), pp.1958-1962	46	5.75
15	Blue orange light emission from biogenic synthesized silver nanoparticles using <i>Trichoderma viride</i> DOI: 10.1016/j.colsurfb.2009.08.028	Colloids and Surfaces B - Biointerfaces, 2010, 75(1), pp.175-178	44	4.89

Conclusion:

NIOT researchers have published 470 research papers during the study period of 1997-2017. 71.49% of NIOT outputs are journaled articles (336). Oceanography subject records stood the first position with 115 (24.47%), more articles (35) published in Current Science journal which shows that NIOT researchers are more interested in publishing Indian journals. Average research output per year is 22.38 and average citation per year is 11.82. Among 470 papers, nine only single-author papers, rest of 461 are joint authorship records. 2394 researchers contributed to delivering 461 co-authorship records. Average author productivity per year is 4.74, and a degree of collaboration is 0.98. Average collaboration index is 4.81. IIT is collaborating more with NIOT, 84 records published with IIT collaboration which is 17.87% of total NIOT publications. Researcher Venkatesan is the most prolific author based on his H-index value as 17 followed by Kirbagaran with 14. Article published in Nanomedicine-Nanotechnology Biology and Medicine journal is the highly cited article during the study period which cited by 367 times and average citation per year of this article is 40.78.

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