PRODUCTIVITY ANALYSIS ON ECOLOGICAL RESEARCH OUTPUT IN INDIA

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The paper analyses the publishing pattern of ecology literature during 1964 - 2013. The Scopus database is used to retrieve the data in the field of Ecology in India and 1165 records were found during the study period. The literature growth is studied through relative growth rate and doubling time. Authorship pattern is identified as multiple authored contributions are gradually increasing after the year 1984 which is evidenced by the collaboration rate of authors in every decade.

Keywords: Ecology, India, Scientometrics, Author mapping, Author productivity.

INTRODUCTION

Ecology is defined as the scientific study of interactions of organisms with one another within the physical and chemical environment. It involves use of scientific methodology via lab experiments to understand how the different organisms grow, populate, how they interact with other organism, how the organisms die out as well as they either evolve or adopt to changing climate and environmental situations.

Studying ecology will enable the society in making informed decisions by exploring how the natural environment works. The world today is greatly concerned with environmental factors; ecological knowledge will continue to be in high demand to help the world in consuming the environment. Scientometric study will enable the policy makers, scientists, managers and general public to plan better strategy for ecological development. Scientometrics is one of the methodologies to assess the scientific productivity. The aim of scientometrics is to reveal the characteristics of scientometric phenomena and processes in scientific research for more efficient management of science. This study focuses the research performance in Ecology research in India.

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LITERATURE REVIEW

Review helps the researcher to identify the research areas covered, methodologies adopted and to spot the area in which research to be done. A study conducted by Liao *et al*. [1] gives stress to the fact that aquatic ecosystems are ecologically important, but continuously threatened by a growing number of human induced changes and evaluates the research trends of 'aquatic ecosystem' between 1992 and 2011 in journals of all subject categories of the science citation index and social sciences citation index. Various parameters such as publication output, cited publication,

document type, language, journal productivity, authorship and analysis of author keywords were analyzed and found that over the past two decades, there was a consistent growth in publication output with involvement of increasing number of countries and institutions, and North America was the leading region in the subject.

Saravanan [2] attempted to measure the publishing pattern, growth and development of ecology research output in journal "Frontiers in Ecology and the Environment". It revealed that growth rate was 1.2 and degree of collaboration was 0.33. Single authored contributions were found higher than the co-authored papers. During the second half period (i.e. 2008–2012), CAI > 100 revealed that the authors were interesting to work together as a team. Konur[3] evaluated the research output on algae and bio-energy based on the database SCIE and SSCI. The study revealed that the literature on algae and bio-energy has grown exponentially during this period. USA, China, Germany, and England are the four biggest contributing countries on the algae and bio-energy literature. The Chinese Academy of Sciences is the largest institutional contributor with 2.6% of the papers.

Neff [4] did a bibliometric analysis of the evolution of ecology research outcome from the year 1970 to 2005 using co-word analysis.

Lolis, *et al.* [5] investigated articles on Energetic Ecology of Aquatic Macrophytes and 189 articles related to the primary production of aquatic macrophytes were published by researchers from 13 nationalities during 1956 to 2006. The United States of America was the country with the highest contributions (37 articles); followed by Germany (9); and Spain (4 articles).

NEED FOR THE STUDY

Though ecology is a highly relevant field in the modern day life of climate change, environmental damages and epidemics, very little has been done to consolidate and analyze ecological publications. We understood that this gap in bibliometric studies, especially in India, in the field would be better addressed by choosing one well-read and high-impact journal that would overall reflect the research trends and directions in ecology. Thus, the present study will be carried out to understand the ecological research development in India.

OBJECTIVE OF THE STUDY

- To analyze the literature growth and future trend in ecology research in India.
- To identify the pattern of scatter of literature.
- To identify the publishing channels used by the ecological researchers in India.
- To identify the authors involved in ecological research in India.
- To test the fitness of Lotka's law for author productivity.
- To analyze the quality of publications on Ecology research in India.

METHODOLOGY

This study attempts to analyze the growth of literature by the researchers on Ecology in India based on Scopus database during the period of 1964 – 2013. Quantitative data on the literature growth, authorship pattern, collaboration, prolific journals, research quality and language distribution were calculated.

ANALYSIS AND INTERPRETATION

The bibliographical data of published documents during 1964-2013 are downloaded from Scopus database and analyzed. Bibliometric laws are applied to author productivity data, scattering of journals. Growth of literature, authorship pattern, forms of publications, author mapping, and partnering countries are analyzed.

Literature Growth

This study found that 1165 articles published during the period 1964 -2013 on ecology in India. The year is grouped as a block and measured the growth of literature, relative

growth rate and its' doubling time. Growth of literature shows an increasing trend and it's doubled in 5 - 6 years period except the period 1994 - 2003.

Authorship Pattern

The published records are taken for the study from the year 1964 – 2013. Single authored and two authored papers alone can be seen during the first decade of the study period. Contributions by more than two authors are started from the next decade and gradually this kind of contributions is increasing over the study period especially in the last decade. This can be evidenced with the increasing author collaboration rate in each decade. Degree of collaboration among the authors was 0.53 and average paper per year was 23.

Author Productivity

Lotka's law describes the frequency of contributions by the authors in a subject. Of the 720 unique author names, 550 (47.21%) produced one article, 38 (3.26%) produced two articles, and 78 (6.69%) produced three articles and so forth. The undefined authors have not been considered [6]. Using Least squares method, the values of n and critical value are found to be 0.342 and 0.048 respectively. As the formula of lotka's law is $y= c / x^n$ can be obtained as follows: $c = 1/ \sum 1/x^n$. The kolmogorov-Smirov test is applied to verify whether the observed data fit the theoretical distribution according to lotka's law. The highest Dmax value is higher than the critical value then it can be concluded that author productivity in this research area does not fit to lotka's law.

Table 1: Relative Growth Rate and Doubling Time

Year Block-Wise	No. of Papers	Cumulative Papers	Log 1	Log 2	RGR	Dt
1964 - 1973	11	11	-	2.40	0.240	2.89
1974 - 1983	36	47	2.40	3.58	0.119	5.85
1984 - 1993	115	162	3.58	4.74	0.116	5.97
1994 - 2003	215	377	4.74	5.37	0.063	11.08
2004 - 2013	788	1165	5.37	6.67	0.130	5.34

Table 2: Authorship Pattern

Year Block-Wise	1	2	3	4	5	>5	Total	DC	APP
1964 – 1973	8	3	-	-	-	-	11	0.27	1.1
1974 – 1983	21	6	6	1	2	-	36	0.42	3.6
1984 – 1993	59	36	11	7	1	1	115	0.49	11.5
1994 – 2003	74	73	40	13	8	7	215	0.66	21.5
2004 – 2013	129	238	170	117	67	67	788	0.84	78.8
Total	291	356	227	138	78	75	1165		

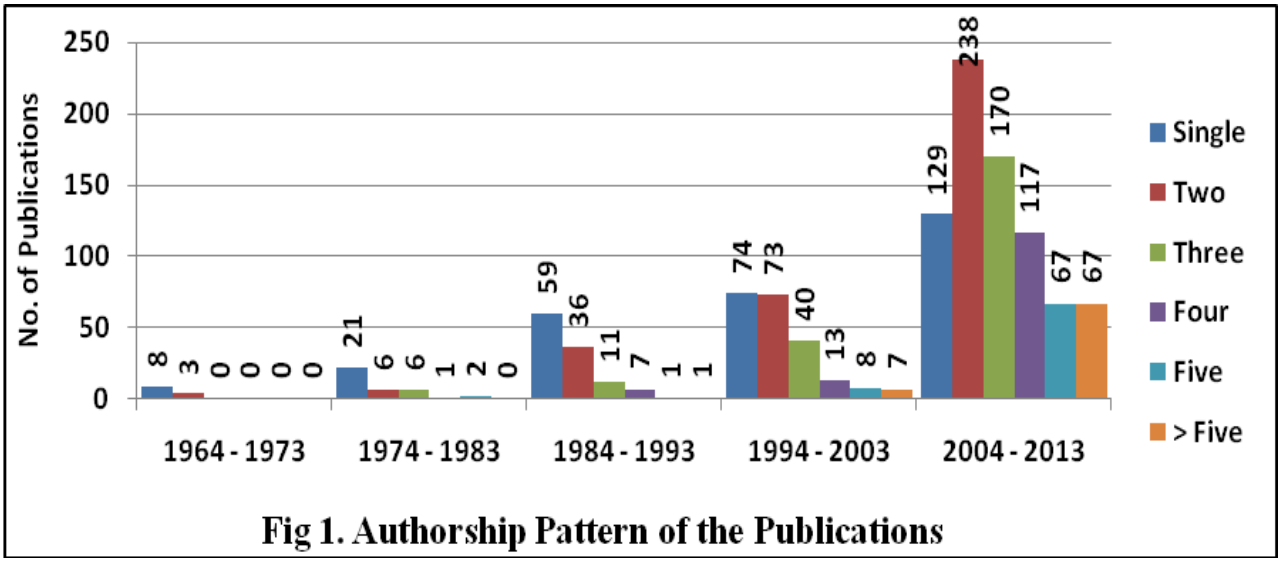

Fig 1. Authorship Pattern of the Publications

Co-Authorship Index

To assess the pattern of co-authorship, the following formula suggested by Garg and Padhi [7]. The CAI value of the data set shows that during the study period the researchers interested to work alone or with one or two persons. The CAI value of other authorship pattern in recent decade shows the changing (increasing) trend of collaborating with many researchers which means to work as a big team.

Table 3: Co-Authorship Index

Year block-wise	1	CAI	2	CAI	3	CAI	> 3	CAI
1964 - 1973	8	291.16	3	162.53	0	0.00	0	0.00
1974 - 1983	21	627.44	6	99.32	6	74.24	3	16.19
1984 - 1993	59	551.83	36	186.56	11	42.61	9	15.20
1994 - 2003	74	370.21	73	202.34	40	82.88	28	25.30
2004 - 2013	129	176.08	238	179.99	170	96.10	251	61.88

Table 4: Core Journals on Ecology

S. No.	Journal Title	No. of Papers	%
1	Tropical Ecology	166	14.25
2	International Journal of Ecology and Environmental Sciences	58	4.98
3	Ecology Environment and Conservation	53	4.55
4	Journal of Environmental Biology	45	3.86
5	Environmental Monitoring and Assessment	45	3.86
6	International Journal of Applied Environmental Sciences	35	3.00
7	Forest Ecology and Management	22	1.89
8	Hydrobiologia	21	1.80
9	Pollution Research	21	1.80
10	Environmental Conservation	18	1.55

Core Journals on Ecology

The top 10 journals in this subject area covered 37.68% of the contributions of the total contributions. There can be seen the large scattering of literature among the remaining journals. The journal "Tropical Ecology" made 14.25% contributions followed by "International journal of Ecology and Environmental sciences" with 4.98% of contributions, "Ecology Environment and Conservation" with 4.55%, etc. (Table 4).

Forms of Communication

Publications are communicated in various forms like Articles, Article in press, Conference proceedings, Conference reviews, Book, Book Chapters, Editorial, Letter, Note, Erratum, Short surveys. Articles (79.74%) are most popular form of communication by the ecological researchers in India; conference proceedings (3.86%), reviews (3.43%) and chapters (1.46%) are in the next places of preferred form of research communication. Out of all document types, articles are the most preferred document type for citing followed by reviews. Results disclosed (Lolis *et al*. [5] that scientific articles constitute the most preferred form of communication.

Table 5: Document Type of Research Communications

Document Type	1964-1973	1974-1983	1984-1993	1994-2003	2004-2013	Total	%
Article	11	17	32	178	691	929	79.74
Book					4	4	0.34
Book Chapter					17	17	1.46
Conference Paper		2	3	11	29	45	3.86
Conference Review					1	1	0.09
Editorial					2	2	0.17
Erratum				1	2	3	0.26
Note			2		7	9	0.77
Review				8	32	40	3.43
Short Survey				1	3	4	0.34
Undefined		17	78	16		111	9.53
Total	**11**	**36**	**115**	**215**	**788**	**1165**	

Author Mapping

Network analysis applied to the study of the social agents responsible for scientific publications allows us to identify the number of members in the network, the intensity of the relationship between them and the most relevant members of the network. Authors are working as a small team to produce the ecological research publications. Research network of the authors involved in ecological research in India are viewed through VOS viewer. Corresponding lines between the authors shows the relationships exists between them (figure).

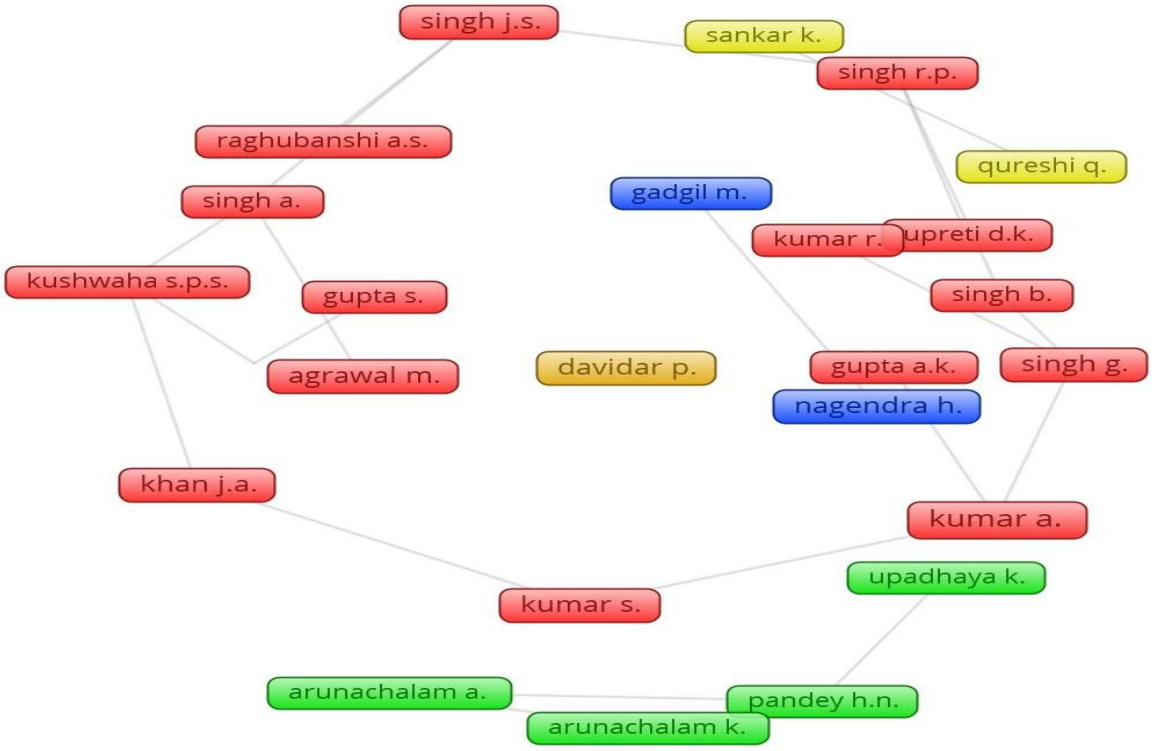

Figure 2: Research Network of Authors in Ecology Research in India

Research Impact (Citations Vs Author type) and Research Quality Index

Research Quality Index is the ratio of the number of publications to total publications and number of citations of the total citations. Research quality index is high (1.79) in the block 1994–2003 followed by 1.42 in the block 1964 - 1973. When the CPP is high, the research quality index of the publications is also high. The citation rate of the recent blocks shows that the citation age of the articles is 20 years (table 6).

Table 6: Research Quality Index

Year	Authorship-Wise Citations						Total	CPP	RQI
	1	2	3	4	5	>5			
1964 - 1973	122	12	0	0	0	0	134	12.18	1.42
1974 - 1983	80	109	39	0	30	0	258	7.17	0.84
1984 - 1993	535	199	47	122	1	27	931	8.10	0.94
1994 - 2003	614	1120	448	369	179	566	3296	15.33	1.79
2004 - 2013	785	1134	1078	895	606	863	5361	6.80	0.79
Total	2136	2574	1612	1386	816	1456	9980	8.57	

Language Distribution of Publications

Maximum number of articles (1157) is found in English language; and articles are published in Chinese, French, German and Russian. Articles are published in other languages has not been cited more.

DISCUSSION AND CONCLUSION

Literature growth on ecology in India during the study period (50 years) shows a very slow and gradual increase of research communications. In each decade, it can be seen that collaborative efforts among the authors have a good effect in literature productivity. Articles, conference proceedings and reviews are found as the major forms of their research communication. Publications are in five languages which are English, French, German, Russian and Chinese. This study found that scientific productivity in the field of ecology evidenced a steady rise during the study period. On understanding the emerging research priorities in this field, nationwide involvement of academic and research institutions, funding and infrastructure facilities will yield better outcome and to get solutions to the problems facing by the society. Collaborative efforts among the countries will give greater impact in ecological research throughout the world.

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