Bibliometric Study on Ecology (1999 - 2010)

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Abstract - **The study analyses 58611 research papers published in Ecology as ISI Web of Knowledge database for the period 1999-2010. The study reports the country growth in this field is computed during the study period. The study also maps ecology research on other dimensions such as institutional productivity, nature of collaboration in research, and institutional specialization. It examines highly cited papers, and lists prominent and productive scientists in this field. This study highlights the research priorities of few important countries in collaborative research. The focus of research is slowly shifting from internal collaboration to domestic and international collaboration, supported by increasing funding from government agencies in ecology research.**

Keywords: **Bibliometric Study, Ecology**

I. Introduction

Bibliometrics is the study dealing with qualification of written communication which helps in the measurement of the published knowledge. Bibliometric studies are gradually becoming inter-disciplinary in nature and are used to identify the pattern of publication, authorship and citation analysis with the hope that such regularities can give an insight into the dynamics of the area under consideration [1]. Bibliometric studies are suitable for evaluating the scientific achievements of individual subjects, people, country, etc. The major areas of bibliometric studies concentrate on distribution of literature by country-wise, subject-wise, language-wise, etc. Further, bibliometric research is useful to identify the subject relationship, structure of knowledge, pattern of communication, etc.

Ecology is the scientific study of the relations that living organisms have with respect to each other and their natural environment. Ecology is a sub-discipline of biology, the study of life. Ecology is a human science as well. There are many practical applications of ecology in conservation biology, wetland management, natural resource management (agriculture, forestry, fisheries), city planning (urban ecology), community health, economics, basic and applied science and human social interaction (human ecology). Ecosystems sustain every life-supporting function on the planet, including climate regulation, water filtration, soil formation (pedogenesis), food, fibers, medicines, erosion control, and many other natural features of scientific, historical or spiritual value. Ecology is the study of environmental systems, or as it is sometimes called, the economy of nature. "Environmental" usually means relating to the natural, versus human-made world; the "systems" means that ecology is, by its very nature, not interested in just the components of nature individually but especially in how the parts interact. More properly ecology is used only in the sense that it is an academic discipline, no more evaluative than mathematics or physics. When a normative or evaluative term is needed then it is more proper to use the term "environmental", i.e., environmental quality or "environmentally degrading". Most professional ecologists are not terribly unhappy when ecology is used in the normative sense, preferring the wider public awareness of environmental issues today compared to the widespread ignorance of three decades ago [2].

II. Related Studies

Ecology, as a scientific discipline and an organizational network, has moved to recognize the relevance of urban places and urban processes. For example, in 1998 the Ecological Society of America's (ESA) annual meeting featured workshops and symposia announcing "The New Urban Focus" and "Urban Ecological Systems: A New Frontier." More recently ESA identified the theme of their 2004 annual conference as "Ecological Explorations of Inhabited Areas [3].

While ecological analysis of human-dominated ecosystems has been described as a relatively new scientific activity [4] the field has given rise to a growing portfolio of research including dedicated journals, local and international conferences, foundation support and federal initiatives. As a fusion of social science and ecology, urban ecology exists "on one of the busiest research intersections between social and biophysical processes [5]".

R. Revathi and S. Ravi examined India's performance based on its publication output in Biodiversity during 1992-2009, based on several parameters, including the country annual average growth rate, global publication share, rank among ten countries of the world, national publication output, authorship pattern, high productive Indian Institutes etc [6].

III. Objectives

The main objective of the present study is to find the publication growth of Ecology literature and compare India with top 10 countries. The other objectives are:

1. To measure the quantum of literature on ecology during the period from 1999 to 2010;
2. To examine the relative growth rate and doubling time, bibliographic forms in the field of ecology;
3. To study the authorship pattern, degree of collaboration, author index in the field of study;
4. To rank the Indian Institution in the field of study;
5. To study the top 50 sources of the publication.

IV. Methodology

For the purpose of the study, the ISI Web of Knowledge database which includes Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI) was interrogated for all records of papers published by scientists/academicians from the part of the R& D activity that has resulted in publication in peer-reviewed journals. It has been identified that a total of 58,611 publications were available on Ecology in ISI Web of Knowledge from 1999 to 2010. The bibliographic indicators such as Authorship Pattern, Author Index, Degree of Collaboration, Growth Rate, Doubling time were employed to verify the objective of the study.

V. Analysis And Discussion

The data thus identified has been analysed by using SPSS package and Excel package and the same has been discussed below:

Ecology publications covered in ISI Web of Knowledge of the top 10 countries and Indian contributions are shown in Table I.

Table I Country-wise Distribution

S.No.	Countries/ Territories	No. of Records	% of Records	Cumulative	Cum. %
1	United States	22960	39.17	22960	39.17
2	England	5688	9.70	28648	48.88
3	Canada	4373	7.46	33021	56.34
4	Australia	4186	7.14	37207	63.48
5	Germany	3776	6.44	40983	69.92
6	France	3295	5.62	44278	75.55
7	Spain	2391	4.08	46669	79.62
8	Brazil	1957	3.34	48626	82.96
9	Italy	1754	2.99	50380	85.96
10	China	1672	2.85	52052	88.81
11	India	729	1.24	52781	90.05
12	Others	5830	9.95	58611	100
		58611	100		

Out of 58,611 publications, 56.34% of contribution are from USA, England and Canada. 39.17% of contributions are from USA alone and ranks top in the position. It is followed by England 9.70%; Canada 7.46% and Australia 7.14%. Indian Contribution on ecology is only 1.24%.

Year-wise distribution of ecology publications retrieved from ISI Web of Knowledge database is shown in Table II.

It may be observed in Table II that 53.98% of publications of the study period were covered during the period 1999-2006. 46% of publications appeared only during the last four years i.e. 2007 to 2010.

The Relative Growth Rate (RGR) and Doubling time (Dt) has been calculated for the period 1999 to 2010 on ecology publication and the same is shown in Table III.

From the Table III, it can be seen that the Relative Growth Rate (RGR) lies between 0.138 and 0.722. The Doubling Time (Dt) increases every year since 1999 to 2010 from 0.086 to 5.033 shows the number of articles increased every year and doubled in the year 2001 and clearly shows the gradual growth during the study period 1999 to 2010. The doubling time is the period of time required for a quantity to double in size or value. When the relative growth rate is constant, the quantity undergoes exponential growth and has a constant doubling time or period which can be calculated directly from the growth rate.

TABLE II YEAR-WISE DISTRIBUTION OF PUBLICATIONS

S.No.	Years	No. of Records	% of Records	Cumulative	Cum. %
1	1999	3088	5.27	3088	5.27
2	2000	3271	5.58	6359	10.85
3	2001	3448	5.88	9807	16.73
4	2002	3608	6.16	13415	22.89
5	2003	3941	6.72	17356	29.61
6	2004	4298	7.33	21654	36.95
7	2005	4697	8.01	26351	44.96
8	2006	5287	9.02	31638	53.98
9	2007	5965	10.18	37603	64.16
10	2008	6576	11.22	44179	75.38
11	2009	6893	11.76	51072	87.14
12	2010	7539	12.86	58611	100
		58611	100		

TABLE III RELATIVE GROWTH RATE AND DOUBLING TIME

Year	No. of Records	Cumulative	W1	W2	RGR	Doubling Time
1999	3088	3088	---	8.035	---	0.086
2000	3271	6359	8.035	8.758	0.722	0.959
2001	3448	9807	8.758	9.191	0.433	1.600
2002	3608	13415	9.191	9.504	0.313	2.212
2003	3941	17356	9.504	9.762	0.258	2.691
2004	4298	21654	9.762	9.983	0.221	3.132
2005	4697	26351	9.983	10.179	0.196	3.530
2006	5287	31638	10.179	10.362	0.183	3.790
2007	5965	37603	10.362	10.535	0.173	4.012
2008	6576	44179	10.535	10.696	0.161	4.300
2009	6893	51072	10.696	10.841	0.145	4.780
2010	7539	58611	10.841	10.979	0.138	5.033

The number of countries having the Activity Index value of more than 100 reflects higher activity of the research than the worlds' average and less than 100 reflects less activity of the research than the worlds' average. It is observed from the Table IV that in the entire countries activity index is less than 100 and shows the less activity of the ecology research. It is also observed that for any country, the Activity Index fluctuates from one block period to another block period.

To find the degree of collaboration, these publications further analysed on “Single Author”, “Two Authors”, “Three Authors” and “More than three authors” based on comparative Countries. Further “Degree of Collaboration” among comparative countries has also been calculated and the same is shown in Table V.

Further the Degree of collaboration indicates that more than 80% are collaborative research in ecology. It can be seen from the Table V that collaborative research is prevailing in all comparative countries in the field of ecology. The degree of collaboration lies between 0.79 and 0.94.

Authors Profile of the top 10 contributors based on the number of records are show in Table VI.

TABLE IV- ACTIVITY INDEX OF COMPARATIVE COUNTRIES

S.No.	Country	1999-2001	2002-2004	2005-2007	2008-2010	Total
1	United States	3846 (15.36)	4787 (15.83)	6303 (15.48)	8024 (14.96)	22960
2	England	983 (0.97)	1174 (0.96)	1542 (0.94)	1989 (0.92)	5688
3	Canada	690 (0.52)	842 (0.53)	1272 (0.60)	1569 (0.56)	4373
4	Australia	647 (0.47)	859 (0.52)	1171 (0.52)	1509 (0.51)	4186
5	Germany	634 (0.42)	753 (0.41)	1022 (0.41)	1367 (0.42)	3776
6	France	520 (0.30)	590 (0.28)	869 (0.31)	1316 (0.35)	3295
7	Spain	341 (0.14)	419 (0.14)	600 (0.15)	1031 (0.20)	2391
8	Brazil	236 (0.08)	316 (0.09)	496 (0.10)	909 (0.14)	1957
9	Italy	243 (0.07)	294 (0.07)	488 (0.09)	729 (0.10)	1754
10	China	114 (0.03)	237 (0.06)	489 (0.09)	832 (0.11)	1672
11	India	102 (0.01)	144 (0.02)	195 (0.02)	288 (0.02)	729
12	Others	1451 (1.47)	1432 (1.20)	1502 (0.94)	1445 (0.68)	5830
	Total	9807	11847	15949	21008	58611

TABLE V AUTHORSHIP PATTERN OF COMPARATIVE COUNTRIES

S.No.	Year	Single Author	Two Authors	Three Authors	More than Three Authors	Total	DC
1	USA	4908	6303	5393	6356	22960	0.79
2	England	1149	1228	1551	1760	5688	0.80
3	Canada	791	1155	930	1497	4373	0.82
4	Australia	662	1049	883	1592	4186	0.84
5	Germany	697	858	781	1440	3776	0.82
6	France	391	529	666	1709	3295	0.88
7	Spain	200	473	585	1133	2391	0.92
8	Brazil	118	473	505	861	1957	0.94
9	Italy	155	283	352	964	1754	0.91
10	China	101	250	339	982	1672	0.94
11	India	109	223	175	222	729	0.85
12	Others	3148	2188	199	295	5830	0.46
	Total	12429	15012	12359	18811	58611	0.79

TABLE VI TOP 10 AUTHORS PROFILE

Sl.No.	Author Name	No. of Records	Affiliation	Country	Citations
1	SHINE R	108	Univ Sydney, Sch Biol Sci, Sydney, NSW 2006	Australia	1766
2	LUISELLI L	76	Ctr Environm Studies Demetra SRL, I-00198 Rome	Italy	588
3	POULIN R	74	Univ Otago, Dept Zool, Dunedin 9054	New Zealand	1397
4	STENSETH NC	63	Univ Oslo, Dept Biol, CEES, N-0316 Oslo	Norway	2286
5	GASTON KJ	61	Univ Sheffield, Dept Anim & Plant Sci, Sheffield S10 2TN, S Yorkshire	England	2245
6	HOBSON KA	58	Environm Canada, Saskatoon, SK S7N 3H5	Canada	1997
7	CHEREL Y	50	CNRS, UPR 1934, Ctr Etud Biol Chize, F-79360 Villiers En Bois	France	992
8	HOLT RD	45	Univ Florida, Dept Biol, Gainesville, FL 32611	USA	2241
9	LINDENMAYE R DB	45	Australian Natl Univ, Fenner Sch Environm & Soc, Canberra, ACT 0200	Australia	1544
10	BOZINOVIC F	43	Pontificia Univ Catolica Chile, Ctr Adv Studies Ecol & Biodivers, Santiago 6513677	Chile	456

TABLE VII BIBLIOGRAPHIC FORM

S.No.	Document Types	No. of Records	% of Records
1	Article	49508	84.4688
2	Review	2806	4.7875
3	Proceedings	1643	2.80323
4	Editorial Material	889	1.51678
5	Book Review	784	1.33763
6	Meeting Abstract	580	0.98958
7	Book Chapter	281	0.47943
8	News Item	257	0.43848
9	Letter	221	0.37706
10	Others	1642	2.80152
	Total	58611	100

As like that of other discipline, the journal articles are predominant in ecology too. It is followed by Review, Proceedings. Editorial Material, Book Review, Meeting Abstract, Book Chapter, News Item, Letter, etc. on ecology.

It is observed from the Table VI that authors from Australia holds the first position by contributing 108 articles in the field of ecology. It can also be seen that among the top 10 authors two authors are from Australia. Based on the citations received the author from Norway holds the first position followed by the author from England.

Ecology publications further grouped into their bibliographic form. The distribution of the bibliographic form is shown in Table VII.

It is observed from the Table VIII that the top 50 source titles provides 27% of articles of the study period 1999-2010. Overall the 58611 articles were appeared in 4786 source titles. Among this 4736 source titles published 73% of articles.

Indian contribution accounts to 1.24% in ecology publications. The contributions of the Indian Institutions with more than 5 articles has been analysed and the same is shown in Table IX.

It is observed from the Table IX, 60% of Indian contributions are from 40 institutions. 40% contributions are provided by 797 other institutions. Indian Institute of Science contributes 5.90% of the total contributions. IISc ranks first, followed by National Institute of Oceonology, Banaras Hindu University, as second and third ranks respectively.

TABLE VIII TOP 50 JOURNALS

S.No.	Source Titles	No. of Records	% of Records
1	Ecology	855	1.46
2	Marine Ecology Progress Series	843	1.44
3	Hydrobiologia	645	1.10
4	Oikos	525	0.90
5	Oecologia	472	0.81
6	Ecological Modelling	462	0.79
7	Biological Conservation	445	0.76
8	Proceedings Of The National Academy Of Sciences Of The United States Of America	416	0.71
9	Science	410	0.70
10	Forest Ecology And Management	407	0.69
11	Ecology Letters	378	0.64
12	Molecular Ecology	357	0.61
13	Applied And Environmental Microbiology	352	0.60
14	Journal Of Experimental Marine Biology And Ecology	335	0.57
15	Landscape Ecology	334	0.57
16	Nature	323	0.55
17	Marine Biology	321	0.55
18	Ecological Applications	314	0.54
19	Journal Of Biogeography	307	0.52
20	Journal Of Applied Ecology	293	0.50
21	Freshwater Biology	286	0.49
22	Proceedings Of The Royal Society B Biological Sciences	284	0.48
23	American Naturalist	282	0.48
24	Journal Of Zoology	276	0.47
25	Trends In Ecology Evolution	274	0.47
26	Biodiversity And Conservation	273	0.47
27	Journal Of Animal Ecology	272	0.46
28	Canadian Journal Of Zoology Revue Canadienne De Zoologie	268	0.46
29	Conservation Biology	248	0.42
30	Journal Of Wildlife Management	246	0.42
31	Journal Of Industrial Ecology	237	0.40
32	Journal Of Mammalogy	231	0.39
33	Landscape And Urban Planning	227	0.39
34	Plant Ecology	227	0.39
35	Journal Of Fish Biology	223	0.38
36	Functional Ecology	218	0.37
37	Ecography	216	0.37

38	Journal Of Ecology	214	0.37
39	Biological Journal Of The Linnean Society	198	0.34
40	Journal Of The Marine Biological Association Of The United Kingdom	198	0.34
41	Environmental Biology Of Fishes	194	0.33
42	Polar Biology	194	0.33
43	Journal Of Herpetology	193	0.33
44	New Phytologist	192	0.33
45	Plos One	192	0.33
46	Estuarine Coastal And Shelf Science	190	0.32
47	Evolution	190	0.32
48	Journal Of Vegetation Science	190	0.32
49	Fems Microbiology Ecology	187	0.32
50	Austral Ecology	185	0.32
	Others	43012	73.39
	Total	58611	100.00

TABLE IX INDIAN INSTITUTIONS

S.No.	Indian Institutions	Record Count	% of Records
1	Indian Inst Sci	43	5.90
2	Natl Inst Oceanog	37	5.08
3	Banaras Hindu Univ	31	4.25
4	Wildlife Inst India	29	3.98
5	Univ Delhi	28	3.84
6	Indian Inst Technol	24	3.29
7	Andhra Univ	20	2.74
8	Ashoka Trust Res Ecol Environm	12	1.65
9	Indian Stat Inst	12	1.65
10	Annamalai Univ	11	1.51
11	Ne Hill Univ	11	1.51
12	Nat Conservat Fdn	9	1.23
13	Pondicherry Univ	9	1.23
14	Gauhati Univ	8	1.10
15	Univ Madras	8	1.10
16	Cent Rice Res Inst	7	0.96
17	Gb Pant Inst Himalayan Environm Dev	7	0.96
18	Natl Inst Adv Studies	7	0.96
19	Salim Ali Ctr Ornithol Nat Hist	7	0.96
20	Univ Agr Sci	7	0.96
21	Univ Kashmir	7	0.96
22	Chinese Acad Sci	6	0.82
23	Madurai Kamaraj Univ	6	0.82
24	Mangalore Univ	6	0.82

25	Natl Ctr Biol Sci	6	0.82
26	Natl Ctr Biol Sci	6	0.82
27	Univ Maryland	6	0.82
28	Atree	5	0.69
29	Bharathidasan Univ	5	0.69
30	Bombay Nat Hist Soc	5	0.69
31	Indian Agr Res Inst	5	0.69
32	Int Crops Res Inst Semi Arid Trop	5	0.69
33	Jadavpur Univ	5	0.69
34	Jawaharlal Nehru Ctr Adv Sci Res	5	0.69
35	Kumaun Univ	5	0.69
36	Nat Hist Museum	5	0.69
37	Natl Remote Sensing Ctr	5	0.69
38	Smithsonian Trop Res Inst	5	0.69
39	Univ Mysore	5	0.69
40	Wildlife Conservat Soc	5	0.69
	Others	294	40.33
	Total	729	100.00

VI. Conclusion

This study indicates that there is intense competition in the realm of research and development in ecology. Due to technological importance and expected economic activity, ecology has been intensively investigated by scientometric methods. In this paper the current status of ecology has been presented. Initially frequency and percentile method have been evolved chronologically and demographic means. The progress has further been measured using growth rate, doubling time, and activity index. As expected USA is a leading contributor of the field of study. England, Canada, Australia, and Germany have substantial contributors in this subject. As like that of other discipline collaborative research is predominance. In the present decade the doubling time of ecology literature is once in three years. It is concluded in this study that the constant relative growth rate leads to exponential growth.

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