Growth of Literature on Climate Change Research: A Scientometric Study

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Abstract

The research productions on climate change were analysed using online database of 'Web of Science'. There were 94756 records contributed worldwide over a period of 1999-2012. The distribution of publications based on the year of production, country, language and document type of the publications were studied. Relative growth rate of the publications and doubling time was calculated. The organisations conducting climate change research and funding agencies have also been studied. The results shows that there is an increasing trend worldwide in the research publication and majority of the researches have been concentrated in environmental science and ecology, and geology. The developed countries have contributed more in the climate change research. About 60% of the researches carried out on climate change are sponsored by funding agencies which is a positive move.

Keywords

Bibliometric, Scientometric, climate change, climatic change.

Electronic access

The journal is available at www.jalis.in

Journal of Advances in Library and Information Science
ISSN: 2277-2219 Vol. 2. No.4. 2013. pp.236-242

INTRODUCTION

Scientometric, is one of the metric sciences which are developed in 21st century in library and information science, can be applied to any discipline irrespective of their period of evaluation and quantitative studies of scientific studies. Earlier scientometric study shows that climate change research has grown rapidly, especially since the 1970's (Stanhill, 2001). Scientometric researchers have extensively studied the evolution, dynamics and structures of different scientific fields, but the environmental field is rarely studied (Jappe, 2007). Scientometric studies have shown that the research on the human dimension of global environmental change has grown in the last ten years, the integration of resilience, vulnerability and adaptation research is still weak (Janssen et al. 2006). International collaboration in global environmental change research has increased faster than science on average, although collaboration with developing countries is limited (Engels and Ruschenburg, 2008; Engels et al. 2005; Jappe, 2007). Scientometric studies also show that knowledge production, the social organisation of science and interdisciplinary integration such as Biology stresses cumulative problems and prefers field studies on local scales (Jappe, 2007; Kwa, 2005) are linked. The Earth sciences, on the other hand, stress global systemic problems, which results in elaborate exchanges of data and models and costly investments in instruments all of which reinforce international collaboration and geographical concentration of its research community (Jappe, 2007). Biology and the Earth sciences are weakly integrated in the international Geosphere–Biosphere programme partly due to such spatial differences (Kwa, 2005). The present study is the scientometric analysis on climate change will bridge the gap.

2. OBJECTIVES

The following are main objectives of the study.

1. To examine the overall year wise production of articles worldwide in Climate change research during the period 1999-2012.
2. To examine the countrywise growth of literature in Climate Change during the period 1999-2012.
3. To identify the language wise distribution of articles in Climate Change research.
4. To analyse the bibliographic form/document type of the publications in climate change.

5. To identify the organisations conducting the research in climate change.
6. To identify and analyse the research contribution in the subject field of climate change.
7. To identify the funding agencies which promote the research activities in climate change.

3. HYPOTHESES

The following hypotheses are formulated for this study based on stated objectives.

- There exists substantial literature published worldwide on climate change.
- Growth of literature in climate change is comparatively higher in developed countries.
- The research productivity in climate change is dominated by English language.
- Journals are major source of publications for climate change.
- There exists steady growth in publication production.

4. METHODOLOGY

The study focused on the bibliometric analysis of research publications in Climate Change. The data collected from the international multidiscipline indexing and abstracting database 'Web of Science' and the research term used was 'Climate Change'. A total of 94756 records were identified in the field of climate change worldwide during the period 1999-2012.

Microsoft Excel software was used to classify the collected data and the classified data were analysed using SPSS software. Analysis on yearwise distribution, subject coverage, organisations which contributed papers, funding agencies was covered. Statistical tools such as frequency distribution and percentage analysis and Bibliometric techniques such as Relative Growth Rate (RGR), Doubling time (dt), were used for the study.

5. DATA ANALYSIS AND RESULTS

5.1 Year wise Distribution of Research Productivity

The year wise distribution of research publications in climate change is given in Table 1.

Table 1:Year wise Distribution of Publications

S. No.	Year	No. of Records	Percentage
1	1999	2376	2.51
2	2000	2652	2.80
3	2001	2886	3.05
4	2002	3184	3.36
5	2003	3520	3.71
6	2004	4034	4.26
7	2005	4664	4.92
8	2006	5370	5.67
9	2007	6712	7.08
10	2008	8405	8.87
11	2009	9846	10.39
12	2010	11642	12.29
13	2011	13513	14.26
14	2012	15952	16.83
Total		94765	100.00

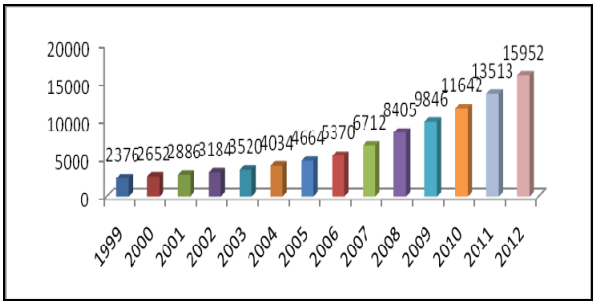

Fig.1 Year wise Distribution of Publications

The Table 1 and Fig. 1 show that a total of 94765 research publications in climate change during 1999-2012 were published with an average 6769 articles per year. There is an increasing trend in the research production in climate change.

5.2 Country wise Distribution of Research Productivity

There are 94756 contribution are available in Web of Science on Climate change research worldwide. The country wise production of research articles in Climate Change is shown in Table 2.

Table 2: Country wise Distribution of Research Productivity

S. No.	Countries/ Territories	No. of Records	% of 94756
1	USA	34551	36.46
2	England	12533	13.23
3	Germany	9174	9.68
4	Canada	7937	8.38
5	Australia	7067	7.46
6	Peoples of China	6823	7.20
7	France	5903	6.23
8	Netherlands	3897	4.11
9	Spain	3728	3.93
10	Switzerland	3484	3.68
11	Italy	3218	3.40
12	Sweden	3173	3.35
13	Japan	2850	3.01
14	Norway	2535	2.68
15	Scotland	2306	2.43
16	Denmark	1980	2.09
17	Russia	1725	1.82
18	Finland	1723	1.82
19	India	1649	1.74
20	New Zealand	1498	1.58
21	Belgium	1411	1.49
22	Brazil	1353	1.43
23	South Africa	1350	1.43
24	Austria	1297	1.37
25	Others	17413	18.38
Total		140578	148.36

It is seen from Table 2 that collaborative researches have been carried out in the area Climate change beyond the territory. More than half of the contributions are collaborative research i.e. 45,822 publications seems to be the joint contribution of two or more countries. Developed countries are contributing more in the research production. USA (34551), England (12533), Germany (9174), Canada (7937) and Australia (7067) positioned in top five places.

5.3 Language and Climate Change Research

Language wise distribution of Research publications is shown in Table 3.

Table 3: Language wise Distribution of Research Productivity

S. No.	Language	No. of Records	Percentage
1	English	93214	98.373
2	German	459	0.484
3	French	359	0.379
4	Spanish	225	0.237
5	Chinese	143	0.151
6	Portuguese	106	0.112
7	Russian	60	0.063
8	Polish	34	0.036
9	Croatian	17	0.018
10	Italian	17	0.018
11	Japanese	17	0.018
12	Czech	15	0.016
13	Korean	14	0.015
14	Turkish	14	0.015
15	Norwegian	13	0.014
16	Dutch	12	0.013
17	Lithuanian	11	0.012
18	Hungarian	6	0.006
19	Slovak	6	0.006
20	Slovenian	6	0.006
21	Estonian	3	0.003
22	Finnish	3	0.003
23	Danish	2	0.002
Total		**94756**	**100.00**

The majority of documents (98.3%) published in English language which is followed by German (459), French (359), Spanish (225), Chinese (143) and Portuguese (106).

5.4 DocumentType &Climate Change Productivity

There are different bibliographic forms such as article, review, proceedings papers, editorial materials, letter, book review, book chapter, meeting abstract, and news item. The distribution of research production in these forms is shown in Table 4.

Table 4: Document Type

S. No.	Document Type	No. of Records	Percentage
1	Article	82845	87.43
2	Review	3278	3.46
3	Proceedings Paper	2733	2.88
4	Editorial Material	2672	2.82

S. No.	Document Type	No. of Records	Percentage
5	News Item	916	0.97
6	Book Review	783	0.83
7	Letter	551	0.58
8	Meeting Abstract	520	0.55
9	Book Chapter	261	0.28
10	Correction	165	0.17
11	Reprint	15	0.02
12	Biographical Item	9	0.01
13	Chronology	4	0.00
14	Poetry	4	0.00
Total		**94756**	**100.00**

The research productions have been contributed in 14 bibliographic forms and four forms of documents such as articles, review, proceedings paper and editorial materials occupy the most of publications. They occupy 96.59% of the overall production.

5.5 Relative Growth Rate and Doubling Time

The Relative Growth Rate (RGR) and Doubling Time of the publications on climate change have been calculated and the same is shown in Table 5.

Table 5: RGR and Doubling Time of Publications

S. No.	Year	No. of Publications	Cumulative Publications	W1	W2	RGR	dt
1	1999	2376	2376	0.00	7.77	7.77	0.09
2	2000	2652	5028	7.77	8.52	0.75	0.92
3	2001	2886	7914	8.52	8.98	0.45	1.53
4	2002	3184	11098	8.98	9.31	0.34	2.05
5	2003	3520	14618	9.31	9.59	0.28	2.52
6	2004	4034	18652	9.59	9.83	0.24	2.84
7	2005	4664	23316	9.83	10.06	0.22	3.11
8	2006	5370	28686	10.06	10.26	0.21	3.34
9	2007	6712	35398	10.26	10.47	0.21	3.30
10	2008	8405	43803	10.47	10.69	0.21	3.25
11	2009	9846	53649	10.69	10.89	0.20	3.42
12	2010	11642	65291	10.89	11.09	0.20	3.53
13	2011	13513	78804	11.09	11.27	0.19	3.68
14	2012	15952	94756	11.27	11.46	0.18	3.76
Total		94765	-	-	-	-	-

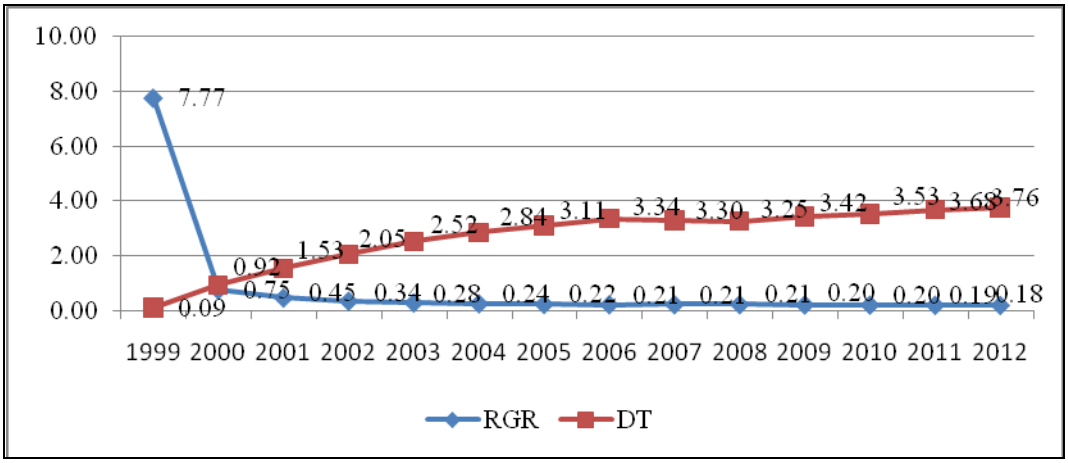

Fig. 2

The Table 5 and Fig.2 shows that there is a steady growth in the research production on climate change worldwide.

5.6 Affiliation

It is found that climate change research is being conducted in 8312 institutions in worldwide. Table 6 shows the list of top 24 organisations which contributed more than 1000 publications each.

Table 6 : Affiliation

S. No.	Organisation	No. of Records	% of 94765
1	University of California System	4204	4.44
2	Chinese Academy of Sciences	3615	3.82
3	National Oceanic Atmospheric Admin NOAA USA	1804	1.90
4	United States Department of Agriculture USDA	1747	1.84
5	National Aeronautics and Space Administration NASA	1613	1.70
6	University of London	1444	1.52
7	Commonwealth Scientific and Industrial Research Organisation CSIRO	1411	1.49
8	University of Colorado System	1391	1.47
9	University of Colorado Boulder	1348	1.42
10	University of Bergen	1322	1.40
11	US Geol Survey	1280	1.35
12	Columbia University	1272	1.34
13	National Center Atmospheric Research NCAR USA	1241	1.31
14	University of Washington	1230	1.30
15	University of Washington Seattle	1201	1.27
16	Max Planck Society	1183	1.25
17	CONSEJO Superior De Investigaciones Cientificas CSIC	1182	1.25
18	University of Oxford	1139	1.20
19	Swiss Federal Institute of Technology Zurich	1123	1.19
20	Russian Academy of Sciences	1112	1.17
21	University of Wisconsin System	1061	1.12
22	University of California Berkeley	1055	1.11
23	Texas A M University	1046	1.10
24	University of Cambridge	1004	1.06
25	Others	186325	195.61
	Total	222353	233.63

Table 6 shows that University of California System (4204), Chinese Academy of Sciences (3615), National Oceanic Atmospheric Admin (1804), United States Department of Agriculture (1747), and National Aeronautics and Space Administration (1613) are the top five contributors in Climate change research. Most of the organisations which contributed more than 1000 publications belong to United States of America.

5.7 Area of Research on Climate Change

Research publications in climate change were contributed from 149 different sub fields and the same is shown in Table 7.

Table 7: Area of Research on Climate Change

S. No.	Area of Research	No. of Records	% of 94756
1	Environmental Sciences Ecology	29121	30.73
2	Geology	18997	20.05
3	Meteorology Atmospheric Sciences	14865	15.69
4	Physical Geography	8528	9.00
5	Engineering	5195	5.48
6	Water Resources	5155	5.44
7	Marine Freshwater Biology	5135	5.42
8	Agriculture	4856	5.13

S. No.	Area of Research	No. of Records	% of 94756
9	Science Technology Other Topics	4649	4.91
10	Oceanography	4353	4.59
11	Biodiversity Conservation	3622	3.82
12	Plant Sciences	3509	3.70
13	Forestry	3072	3.24
14	Paleontology	3025	3.19
15	Energy Fuels	2456	2.59
16	Geochemistry Geophysics	2440	2.58
17	Business Economics	2370	2.50
18	Zoology	1763	1.86
19	Evolutionary Biology	1732	1.83
20	Geography	1470	1.55
21	Life Sciences Biomedicine Other Topics	1429	1.51
22	Public Environmental Occupational Health	1347	1.42
23	Government Law	1113	1.18
24	Public Administration	1104	1.17
25	Fisheries	1048	1.11
26	Chemistry	1033	1.09
27	Biochemistry Molecular Biology	898	0.95
28	Remote Sensing	885	0.93
29	Genetics Heredity	761	0.80
30	Entomology	604	0.64
31	Imaging Science Photographic Technology	580	0.61
32	Social Sciences Other Topics	558	0.59
33	Astronomy Astrophysics	544	0.57
34	Physics	541	0.57
35	International Relations	522	0.55
36	Others	12900	13.61
Total		152180	160.60

The research documents have been published in 149 research areas more than 1000 documents have been published in 35 research areas. Among them, 66.47% of the documents published in three research areas such as Environmental Sciences and Ecology (29121), Ecology (18997) and Meteorology Atmospheric Sciences (14865).

5.8 Funding Agency and Climate Change Research

There are 7622 organisations/funding agencies which sponsor for 56943 (59.03%) research projects in climate change. Out of which, 32 leading organisations/agencies provided fund for more than 100 researches and the same is shown in Table 8.

Table 8: Funding Agency

S. No.	Funding Agency	No. of Records	Perc-entage
1	National Science Foundation	4655	8.17
2	National Natural Science Foundation Of China	1574	2.76
3	European Union	1360	2.39
4	NASA	1010	1.77
5	Natural Sciences And Engineering Research Council Of Canada	990	1.74
6	Natural Environment Research Council	819	1.44
7	European Commission	762	1.34
8	National Basic Research Program Of China	672	1.18
9	Australian Research Council	606	1.06
10	Chinese Academy Of Sciences	591	1.04
11	NOAA	499	0.88
12	Deutsche Forschungsgemeinschaft	472	0.83
13	Department Of Energy US	412	0.72
14	Swiss National Science Foundation	356	0.63
15	National Science Foundation Of China	310	0.54
16	Academy Of Finland	284	0.50
17	European Community	260	0.46
18	Norwegian Research Council	199	0.35
19	Russian Foundation For Basic Research	191	0.34
20	German Research Foundation DFG	187	0.33
21	Office Of Science US Department Of Energy	175	0.31
22	Royal Society	173	0.30
23	Natural Science Foundation Of China	165	0.29
24	Research Council Of Norway	149	0.26
25	Swedish Research	143	0.25

S. No.	Funding Agency	No. of Records	Perc-entage
	Council		
26	Leverhulme Trust	142	0.25
27	Gordon And Betty Moore Foundation	139	0.24
28	Spanish Ministry Of Science And Innovation	136	0.24
29	National Geographic Society	134	0.24
30	CNRS	131	0.23
31	National Oceanic And Atmospheric Administration	129	0.23
32	CNPQ	123	0.22
33	Others	38995	68.48
	Total	56943	100.00

It is seen from Table 8 that National Science Foundation (4655), National Natural Science Foundation of China (1574), European Union (1360) and NASA (1010) sponsored for more than 1000 researches each. These four organisations collectively funded for 15.09% of the sponsored researches.

6. CONCLUSION

Climate patterns play a fundamental role in shaping natural ecosystems, the human economies and cultures that depend on them. Our climate is rapidly changing with disruptive impacts, and that change is progressing faster than any seen in the last 2,000 years. In this paper, the authors identified the growth of literature on climate change. Due to the industrialisation the climate has changed which severely affected the ecosystem. The countries sit across and concentrate on climate change in terms of the environmental policies to protect the change in the regular climate and implementing adaptation techniques. They are spending enormous fund for this research. Almost 60% of the climate change researches worldwide are sponsored by the funding agencies. It is positive move towards protecting the environment. It is also to be noted that the developed countries, mostly, are spending enormous amount towards this research. Even though the research on climate changes is in increasing trend and it finds steady growth in nature worldwide, the developing and under developed countries are facing more trouble in increasing research due to lack of funds and awareness. The capacity to adapt and mitigate the measures in reducing climate change is dependent on socio-economic and environmental circumstances and the availability of information and technology which is lack in developing and under developing countries. Societies and non-governmental organisations should respond to climate change and should make awareness among the countries for reducing the rate and magnitude of change by reducing green-house gas emissions.

REFERENCES

1. Engels A, and Ruschenburg T (2008). The uneven spread of global science: patterns of international collaboration in global environmental change research. *Sci Public Policy*, 3:5
2. Engels A, Ruschenburg T, and Weingart P (2005). Recent internationalization of global environmental change research in Germany and the US. *Scientometrics*, 62:67–85
3. Janssen M A, Schoon M L and Borner K (2006). Scholarly networks on resilience, vulnerability and adaptation within the human dimension of global environmental change. *Glob Environ Change*, 16:240-252
4. Jappe A (2007). Explaining international collaboration in global environmental change research, *Scientometrics* 71(3):367–390
5. Kwa TS (2005). Local ecologies, global science: discourses and strategies of the international geosphere–biosphere programme. *Soc Stud Sci*, 35:923–950
6. Stanhill G (2001). The growth of climate change science: a scientometric study. *Clim Change*, 48:515– 524.