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A SCIENTOMETRIC ANALYSIS OF ENVIRONMENTAL MANAGEMENT RESEARCH OUTPUT DURING 1989 TO 2014

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Abstract

The main objective of this article is to find out most prolific authors and journals in the environmental management research output during 1989 to 2014. This area is an interdisciplinary subject and developed dramatically over the last few decades. Scientometrics offers assess the quantitative analytical techniques with the development and growth of research in Environmental management. The total sample data retrieved from the database of Web of Knowledge, includes, SCI, SSCI, A&HCI. Total records of 61877 research articles retrieved from 22 types of different sources. Applicability of Bradford's law and Lotka's law methods was tested.

Keywords: Bradford's law of scattering, Lotka's law, authorship pattern, prolific authors, Scientometrics, citation, most productivity journals, Historigraphic analysis

1. INTRODUCTION

The "Environmental Management"(EM) is significant term today. Unplanned developmental activities as well as ever increasing population have caused enormous strain on the environment resources and hence societies across the world face several problems of environmental degradation.Need for the study is to provide accurate and timely information to smooth the progress of the environmental Management process which enables the Government and non government organizations to plan, control and operate the functional activities in effective and efficient manner.Publication productivity is the top most measure in fixing the researcher's performance capability by various national and regional governments. This has necessitated the Librarians and Library and Information Science researchers and Information Scientists to deploy a range of tools and techniques to have detailed and depth analysis of publications by the faculty and researchers, which also enable to reveal the strength and weakness, the trends that are taking place in the subject, the core journals and publications, the premier organizations and the geographical area where the particular subject research is gaining the attention, as this would greatly help the national governments in funding and providing the opportunities in the required area of research to have a balanced growth in all fields of life. Scientometrics techniques are engaged to analyze the publications on EM studies to identify the trends in the publication, the thematic pattern and so on.

2.REVIEW OF LITERATURE

Pradhan, P, and Chandrakar (2011) hasstudied the trends in authorship pattern andauthor's collaborative research in Indian chemistry literature with a sample of 53,977 articlesduring the period 2000-2009. Rattan and Gupta(2012) traced the author productivity, extent of authors' collaboration, authors' institutionalaffiliation, authors' geographic affiliation, type of publication, language of papers, number ofcitations used per article, length of papers, and year-wise distribution of papers. Amsaveni and Vasanthi (2013) traced the trend in authorship pattern and collaborative research in network security with a sample of 8051 articles during 2002 to 2011. Thavamani and Velmurugan (2013) studied the publication trends of scholarly papers in Annals of Library and Information Studies published from New Delhi. The bibliometric analysis has been conducted with 310 contributions published in the journal during the year 2002 – 2012.

3. OBJECTIVE OF THE STUDY

- ➢ To find out the most productive authors
- ➢ To test the Lotka's Law for author productivity
- ➢ To find out most productive and core journals
- ➢ To test the applicability of Bradford's Law of scattering

*3.*1 METHODOLOGY, SAMPLING, DATA COLLECTION AND LIMITATION

There are various sources contributing to the research output in the field of Environmental Management. For this study the researcher has taken the secondary sources from Science Citation Index (SCI) and Social Science Citation Index (SSCI) and Arts & Humanities Citation Index (ACHI) which is available via the Web of Science (WoS). The WoS is the search platform provided by Thomson Reuters (the former Thomson Scientific emerged from the Institute for Scientific Information (ISI) in Philadelphia). The study period is 1989 to 2014 (26 years) and the search string is "Environmental Management" only. A total of 62059 records were downloaded, after eliminate the duplicates 61877 records were found and analyzed by using the Histcite, VOSViewer and MS-Excel software as per the objectives of the study.

4. ANALYSIS OF DATA

4.1 SAMPLE DATA

The table 1 has reveal that the sample details from the web of science database; such that, time span is 1989 to 2014, totally 26 years output of EM; downloaded sample is 61,877 records; total number of contributing authors 2,14,351; total number of journals 6,191; frequently occurring words is 1,38,494; 22 types of documents; 23 types of languages; 192 countries from various continents; 28,127 institutions' from 192 countries; 73,923 sub divisions are contributed from 28,127 various institutions; 10,09,362 times cited by local and global references; 69,332 Total Local citation scores; 9,40,030 total Global citation score; and totally 30,72,359 cited reference and 1,805 h-index values were observed from the whole sample records.

Table 1: Sample data of Environmental Management Research output

S.No	Details about sample	Observed Values	S.No	Details about sample	Observed Values
1	Duration	1989-2014	9	Contributing countries	192
2	Time Span	26	10	Contributing Institutions	28127
3	Total records	61877	11	Institutions with subdivisions	73923
4	Total Number of Authors	214351	12	All Cited References	3003027
5	Total Number of Journals	6191	13	Total Local Citation Scores	69332
6	Frequently occurring words	826768	14	Total Global Citation Scores	940030
7	Document types	22	15	Total Cited References	3072359
8	Languages	23	16	H-index	1805

4.2 RELATIVE GROWTH RATE, H- INDEX, CITATION SCORES

From table 2analyses have observed that the year of 2006 has earned highest number h-index values. 2014 has highest productivity and highest cited references and highest number of contributed authors. 2007 has earned highest number of LCS and GCS.According to relative growth rates analysis, it's having contracted progressively from 0.839 at 1989 to 0.087 in the year of 2014.The whole study period sample mean relative growth rate is 0.19. Contrary to this, the Doubling Time for publication of all sources in EM research output has decreased from 0.826 years at 1989 to 7.943 years at 2014.

Table 2: Relative growth rate, citation scores, h-index, cited references and number authors of Environmental Management Research output during 1989- 2014

Year	R. o/p	log_e1^p	log_e2^p	Rt(P)	Dt(P)	h-index	CR	NA	TLCS	TGCS
1989	48	-	3.871	-	-	6	670	73	15	95
1990	111	3.871	4.709	0.839	0.826	18	2186	171	179	2425
1991	465	4.709	6.142	1.432	0.484	41	11353	877	448	7560
1992	593	6.142	6.385	0.243	2.850	53	15082	1321	723	11838
1993	689	6.385	6.535	0.150	4.613	61	19188	1478	978	17487
1994	824	6.535	6.714	0.179	3.868	66	22341	1790	1140	18339
1995	974	6.714	6.881	0.167	4.140	70	31861	2194	1342	22008
1996	996	6.881	6.903	0.023	30.465	72	32806	2322	1384	23752
1997	1099	6.903	7.002	0.098	7.060	73	42352	2710	1550	33196
1998	1137	7.002	7.036	0.034	20.294	80	44090	2806	1433	31018
1999	1268	7.036	7.145	0.109	6.346	82	48374	3272	1423	32454
2000	1543	7.145	7.341	0.196	3.527	100	65638	4161	1934	51732
2001	1532	7.341	7.334	0.007	99.000	99	63053	4218	1454	48637
2002	1751	7.334	7.467	0.134	5.174	97	73865	5004	1288	49884
2003	2012	7.467	7.606	0.139	4.990	102	85492	6224	1252	58367
2004	2008	7.606	7.604	0.002	34.65	97	86409	6109	646	53939
2005	2319	7.604	7.748	0.144	4.816	96	104862	7452	401	63011
2006	2719	7.748	7.908	0.159	4.358	**111**	124919	8956	162	63700
2007	3144	7.908	8.053	0.145	4.771	96	150169	10694	**9842**	**67974**
2008	3728	8.053	8.223	0.171	4.061	91	181415	13058	9745	65582
2009	4266	8.223	8.358	0.134	5.155	78	205399	15023	9106	62049
2010	4582	8.358	8.429	0.072	9.640	72	238354	16878	8455	56770
2011	5215	8.429	8.559	0.129	5.360	57	276262	19827	6624	44106
2012	5749	8.559	8.656	0.098	7.087	45	320536	22308	4951	32777
2013	6267	8.656	8.743	0.086	8.053	29	359393	25724	2293	17066
2014	**6838**	8.743	8.830	0.087	7.943	13	**396958**	**29701**	564	4264
Total	61877			4.979 (0.19)	289.531 (11.135)	1805	3003027	214351	69332	940030

During the study period doubling time value is 11.135 years.Relative growth rate has shown wealthy trend, which means the rate of increase is low in terms of segment, and this has been highlighted by doubling time for publications, which is more than the relative growth rate.

4.3 MOST PROLIFIC JOURNALS ON ENVIRONMENTAL MANAGEMENT RESEARCH OUTPUT

In this analytical period, scientists have produced their research papers (totally 61877 articles) dispersed over 6191 journals. The resear

cher has ranked according to their highest contributing of publications (more than 300 articles) in EM research literature among the 6163 journals. Here shows its citation scores and h-index values.

Table 3: Most productive journals of Environmental ManagementResearch output

S. No	JOURNAL	articles	TLCS	TGCS	NA	h-index
1	Journal of Environmental Management	930	2330	14297	**3410**	83
2	Environmental Management	813	1377	11925	2206	66
3	Journal of Cleaner Production	812	**2572**	10827	2533	73
4	Forest Ecology and Management	522	585	10041	1947	75

5	Agriculture Ecosystems & Environment	462	975	12141	1972	81
6	Ecological Economics	455	1547	8808	1204	68
7	Science of The Total Environment	445	693	7405	1997	63
8	Resources Conservation and Recycling	384	927	5367	1232	57
9	Environmental Monitoring and Assessment	380	274	3073	1368	38
9	PLOS One	380	0	2107	2126	22
10	Ocean & Coastal Management	379	319	3347	1133	45
11	Ecological Modelling	366	719	11436	1325	66
12	Environmental Modelling& Software	357	1130	6943	1545	62
13	Journal of Applied Ecology	346	925	13498	1633	82
14	Biological Conservation	335	764	8538	1390	68
15	**Ecological Applications**	319	830	**16431**	1143	**90**

The journal of "Journal of Environmental Management" has published the highest number of articles 930; 2330 TLCS; 14297 TGCS; 3410 number of contributing authors in the mentioned journal scaled with 83 h-index values with dominates in first place of research output EM. The journal of "Environmental Management" has 813 articles; 1377 TLCS with 11925 TGCS and the 2206 number of contributing authors measured with 66 h-index value and occupies the second position for produced the research output. The journal of "Journal of Cleaner Production" has 812 articles; 2572 TLCS with 10827 TGCS and the 2533 number of contributing authors measured with 73 h-index value and occupies the third position for produced the research output and remaining journals were produced below 800 articles.

It could be found journal of "**Journal of Environmental Management**" have highest contributions and contributors, the journal of "**Ecological Applications**" has highest citation and h-index values.

4.4 IDENTIFY THE MOST PRODUCTIVE JOURNALS THROUGH VOSVIEWER SOFTWARE

The VOSviewer software has used for extracting sample data. The downloaded data were implementing the VOSviewer software. While extracting the sample data used by VOSviewer software, the minimum 5 number of documents has produced sources (journals); out of 6163 journals were 1889 meet the threshold like published more than 5 articles.
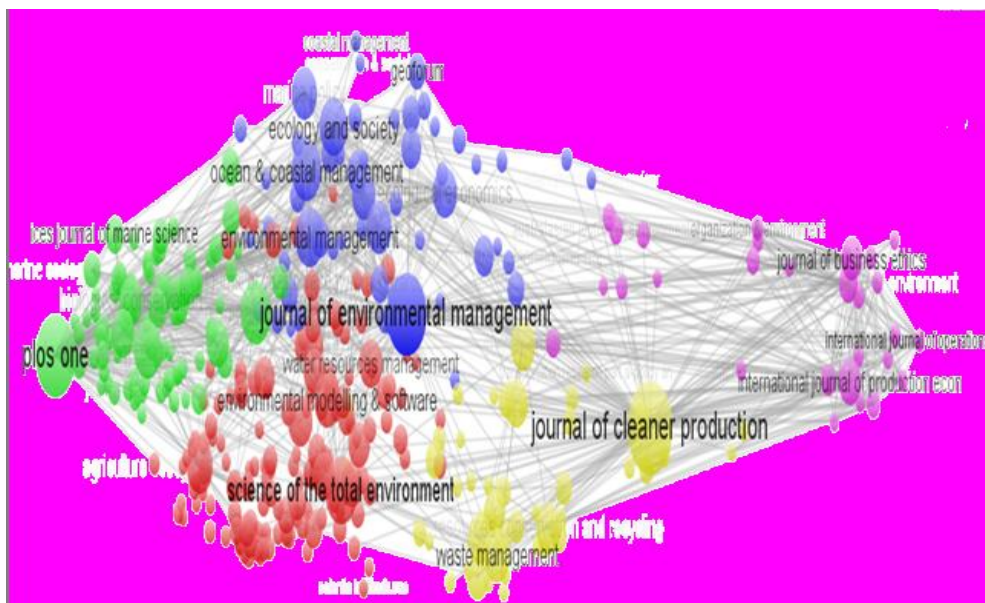

Fig.1: Using VOS Viewer Journal wise Bibliographic Couplings on Environmental Management

For each of the 1889 sources, the number of bibliographic coupling links will be calculated. This analysis has identified the variation from Histcite software and VOSViewer software.

The journal of "Journal of Cleaner Production" has 424 documents with 109974 bibliographic coupling and stood in first rank position; followed by the journal of "PLOS ONE" has 313 documents with 57415 bibliographic coupling (this journal been in the 10th place on Histcite analysis) been the second rank position; "Journal of Environmental Management" has 288 documents with 63936 bibliographic coupling value and stood in third rank position (this journal been in the 1st place on Histcite analysis) andremaining journals were been in below 150 articles.

It concludes from this analysis, "Journal of cleaner Production" and "PLOS One" was produced highest documents and highest bibliographic coupling value among the selected 1889 journals.

4.5 HISTRIOGRAPHIC ANALYSIS OF CITED JOURNALS LCS and GCS

The researcher has effort to trace the development of EM research by creating histriographic maps using HistCite software (developed by Garfield and colleagues) in aggregation with Web of Science. Here for this analysis the sample data has taken 61877 EM research papers. A histriographical map has been drawn based on two separate levels by using HistCite, such that; Local Citations Score (LCS) and Global Citations Score (GCS).

For the LCS map, selected nodes (top 30) number (25) of links, and to have a clear graph a minimum of 77 local citation scores to maximum 208 local citation scores was derived. For those thirty nodes, during 2005 to 2011 occurred 22 journals are repeated links between the LCS values has measured. Among the selected thirty nodes, the journal of "Global Environmental Change-Human and Policy Dimensions", "International Journal of Production Economics" and "Strategic Management Journal" has each 2 times occurred; and the remaining journals were occurred each one time of the selected thirty nodes.

It could be noted that the journal of "**Journal Of Cleaner Production**" has seven highest links (8596nd article at 2008) between the selected thirty nodes from this analysis; and the journal of "**International Journal of Management Reviews**" has maximum (6089th article at 2007) and the journal of "Journal Of Cleaner Production" has minimum (187th article at 2001) LCS scores measured.

According to GCS for most productive journals of the histriograph map analysis indicates that the top thirty nodes its display the years of 2005 to 2010 (duration period is 1989 to 2014) for selected 25 articles. 2005 has occurred eight journals; 2006 has occurred six journals; 2007 has occurred five journals; 2008 has occurred two journals; 2009 has occurred two journals; 2010 has occurred two journals respectively. Among the selected twenty five nodes, only 22 journals were repeatedly occurred of this GCS map. The journal of "Ecological Monographs" has 2 times occurred; the journal of "Global Environmental Change-Human and Policy Dimensions" has occurred 2 times; "Nature" occurred two times. And remaining journals were occurred each one time. The below GCS histriographic map has reveals that highest cited and links journals among the selected thirty nodes.

It concludes from the above histriographic map analysis of LCS and GCS, the researcher has identified the journals of "**International Journal of Management Reviews**" and "**Ecological Monographs**" having Maximum number citation scores among the selected nodes. So those journals were identified most productive journals from this histriographic map of the EM research output at worldwide scattering of journals.
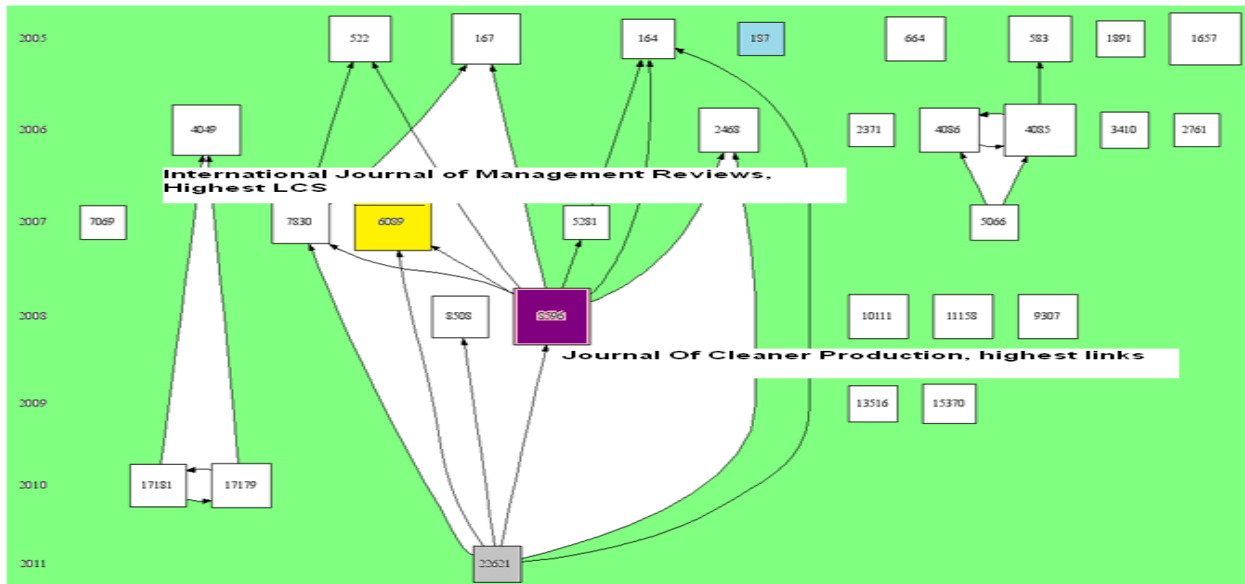
Fig. 2: Histriograph maps of LCS for journals (Nodes: 30, Links: 25; Min: 77, Max: 208)
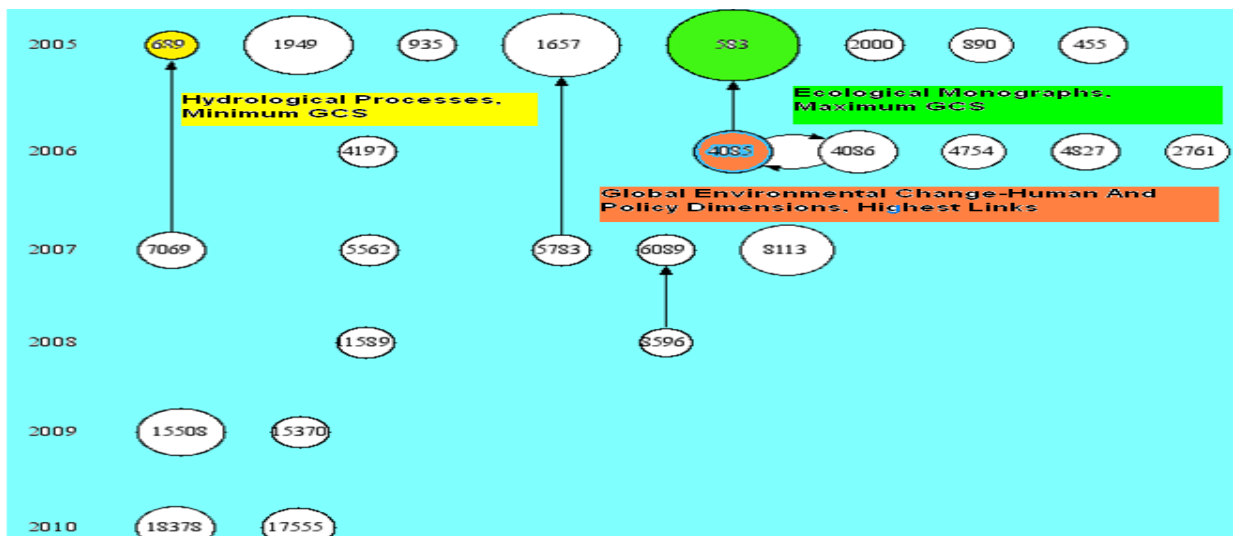

Fig. 3: Histriograph maps of GCS for journals (Nodes: 25, Links: 6, Min: 377, Max: 2069)

4.6 APPLICATION OF BRADFORD'S LAW OF SCATTERING

The aim of Bradford's law is to explain that a group of different sources could be arranged in an order of decreasing productivity and revealed that journals which yield most productive articles come first while the most unproductive tail last. However, the number of journals in each zone will increase rapidly. Then the relationship between the zones is 1: n: n^2. The total number of articles 61877 and the total number of journals are 6163.

Table 4: Showing Bradford's Distribution of sources in Environmental Management

Zone	No. of sources	No. of records	Multiplier factor
Z_1	89 (1.44)	20576 (33.25)	-
Z_2	461 (7.48)	20914 (33.80)	5.18
Z_3	5613 (91.08)	20387 (32.95)	12.18
Total	**6163**	**61877**	**8.67**

The researcher has grouped three types, such that; Zonal 1; Zonal 2 and Zonal 3. The first zone indicates the small groups of different types of sources, and it is called the nucleus or core zone. Here from this analysis, first zone representing 89 (1.44 %) of sources has produced 20576 (33.25 %) of articles. So those 89 journals (sources) were identified this subject research output in core journals. The second zone group of 461 (7.48 %) journals provides 20914 (33.80 %) articles and the third largest zone of 5613 (91.08 %) of periodicals yield the remaining 20387 (32.95 %) articles. In this study there are 61877 articles cited, one third of which 20625 in each zone. First 20576 articles are only from top ranked 89 journals. Journals second 20914 articles were from 461 journals and another 20387 articles from 5613 journals. So the present study is 89: 461: 5613::1: n: n^2 and n = 8.7 are a multiplier.

The mean value of multiplier is 8.6. Therefore, 1 x 89: 8.7 x 89: 22.09 x 89 = 1: 8.7:22.09. It should be 1: $8.7:(8.7)^2$ = 1: n: n^2 but it is 1: 8.7: $(8.7)^2$ are not equal to the 1: n: n^2 but it is almost equal.Percentage of error = 8.67 %

The Bradford multiplier between the number of references in zone 1 and zone 2 is 5.18 while it is 12.18 between zone 2 and zone 3. The average multiplier value is 8.67. According to Bradford's distribution, the relationship between the zone is 1: n: n2. In contrast is the relationship in each of the present study i.e. 89:461:5613 which does not fit into Bradford's distribution.

4.7 MOST PROLIFIC AUTHORS

214351 scientists have contributed 61877 articles produced scattered over 6191 journals on EM. The researcher has taking most productive authors and their published numbers of records were given the ranked according to their highest publications in more than 50 articles published.

Table 5: Most prolific authors of in Environmental Management

Author name	Recs. (rank)	TLCS	TGCS	TLCR	H index	Starts from	Act as solo	Act as 1st author	Co authors
Huang GH	213 (1)	684	**1915**	**624**	**45**	1994	3	11	210
Chang NB	83 (2)	138	1326	108	32	1995	1	**39**	82
Li YP	80 (3)	277	682	262	20	2004	0	35	80
Zhang FS	63 (4)	372	1316	293	21	2004	0	4	63
Liu Y	62 (5)	93	356	123	14	1997	1	22	62
Sarkis J	60 (6)	**820**	1220	472	29	1995	8	14	52
Yang ZF	60 (6)	174	584	194	17	2001	1	5	59
Zhang Y	52 (7)	57	422	81	13	2003	0	19	52
Zhang L	50 (8)	88	604	55	17	1999	0	10	50
Li Y	49 (9)	109	438	43	13	2003	0	11	49

Among 214351 authors, "Huang GH" has published 213 (highest) articles and he started research at 1994, 3 articles act as single authors, 200 articles contributed with collaborated pattern, 11 article act as first author with 684 LCS, 1915 GCS (highest), 624 TLCR (highest) with 45 h-index (highest) values measured and it occupies the first rank in

research output and only 3 articles published single authored and 11 articles acted be as first author. Remaining authors were produced below 100 articles.

It could be concludes from this analysis, the authors of "Huang GH" has highest number of contribution, highest TGCS, highest TLCR and highest h-index values. "Chang NB" is identified the active authors of first author contribution between the selected top fifty authors. Generally it is identified the active author is "Huang GH", and most productive authors were "Huang GH", "Chang NB", "Li YP", "Zhang FS" and Liu Y" EM research output.
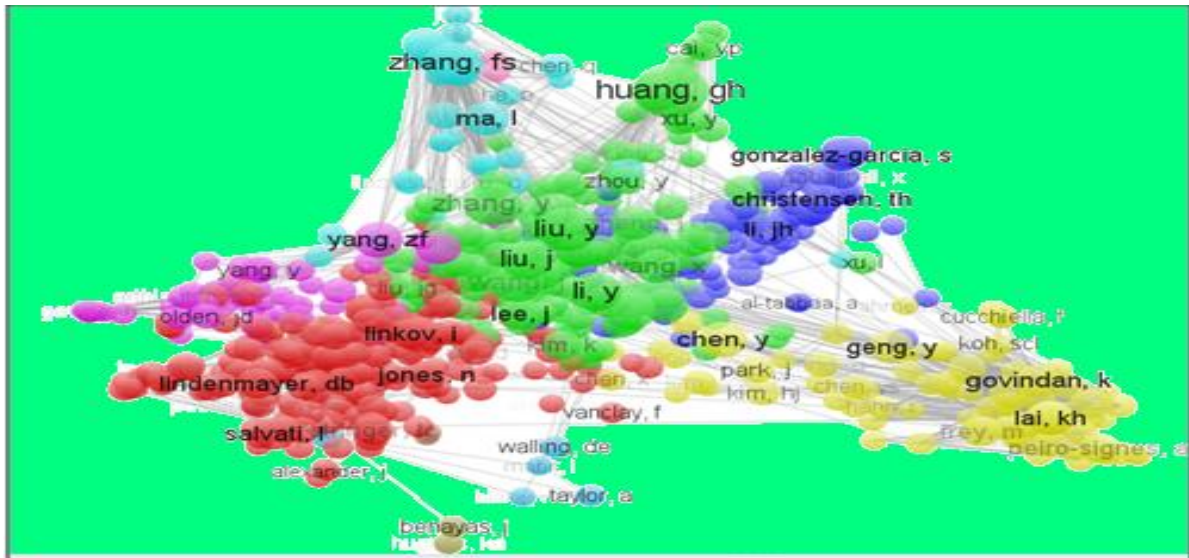

Fig.4: Using VOS Viewer prolific author's Bibliographic Couplings on Environmental Management

Using by VOSViewer software for most productive authors label view and cluster view of for belongs to their highest productivity articles on Environmental Management. The particular authors name size and coloured were isolated groups are also indicated that their positions of publication status of mentioned authors. The authors of "Huang GH"; "Liu Y"; "Zhang FS" and "Li Y" were having highest productivity of Environmental Management articles. The below label view scattering figure has reveals it clearly.

4.8 LOTKA'S LAW

P = number of X items = 51; N= maximum number of contributors = 214351

Pao (1989) proposed the way to calculate n-value and c- value of Lotka's law as in (1) and (2)

$$n = \frac{N\Sigma XY - \Sigma X \Sigma Y}{N\Sigma X^2 - (\Sigma X)^2}$$

N = number of pairs of data, X = logarithm of x, i.e. number of articles, Y = logarithm of y, i.e. number of authors, n = - 0.6781. The value of constant c is calculated using the following formula:

$$c = \frac{1}{\sum_{1}^{P-1}\frac{1}{x^n} + \frac{1}{(n-1)(P^{n-1})} + \frac{1}{2} * P^n + \frac{n}{24} * (P-1)^{n+1}} \qquad \dots (3)$$

$$\sum_{1}^{P-1} \frac{1}{x^n} = obtained\ by\ summing\ the\ first\ \mathbf{19}\ terms\ of\ \frac{1}{x^n}$$

With   x = 1, 2, 3, . . . 51;   Here, P = 51; n = value obtained using formula (2); x = number of articles. Deriving the value of n and c by Sen's Method (2010)

$x^n y = c$ Lotka Equation

Putting the value of Table-1 given in the first row in the equation (1), we get

$1^n * 101447 = c$ $[1^n = 1]$ $101447 = c$

Determining the value of n, Using the data of the second row, we can find out the value of n

Putting the data of 2nd row in equation (1), we get $2^n * 19133 = 101447$

$2^n = 101447/19133$ $= 5.301$

N = 0.723/0.301   = 2.40199N is the maximum contribution of an author. X is log (x) and

Y is log (y) where y are the authors who have x number of contribution. Where p is the number of publication groups which authors were contributed the same amount of publications. Besides, Pao also used Kolmogorov–Smirnov (K–S) test to verify if Lotka's law is matched or not under the condition that p-value is greater than thirty five.

$$K\text{-}S = \frac{1.63}{\sqrt{N}}$$ Square root value of total authors 214351 is 462.98; and verify the K-S statistic value to see if Lotka's law be capable of hold for Management Information System research output. For N value is 0.6781, therefore, K-S statistics method can be used to verify if Lotka's law could hold for the sample area publications.K-S   = 0.00352 for   N = 214351. The K-S critical value at 5% level of significance is calculated as 1.36/√∑y, where ∑y is the total number of authors under study. If the absolute maximum difference "D-Max" is less than the K-S critical value, then the null hypothesis is accepted that the observed value and theoretical distribution are the same. Kolmogorov-Smirnov test at 5% significance level obtain "best fit" for the dataset.

It is seen clearly from the above table among the proportion of all contributions made single contribution is low. Further, Lotka's Chi square model confirms the source trend. Thus the present analysis clearly invalidates Lotka's findings. In the present analysis, productivity is attributed to several factors.

Table 7: Degree of Collaboration in Environmental Management research output

Year	Single authors		Multi authored		Total	DC	Year	Single authors		Multi authored		Total	DC
	R. o/p	%	R. o/p	%				R. o/p	%	R. o/p	%		
1989	36	0.32	12	0.02	48	0.25	2002	484	4.32	1267	2.50	1751	0.72
1990	73	0.65	38	0.07	111	0.34	2003	475	4.24	1537	3.03	2012	0.76
1991	232	2.07	233	0.46	465	0.50	2004	425	3.80	1583	3.12	2008	0.79
1992	265	2.37	328	0.65	593	0.55	2005	486	4.34	1833	3.62	2319	0.79
1993	308	2.75	381	0.75	689	0.55	2006	467	4.17	2252	4.44	2719	0.83
1994	345	3.08	479	0.95	824	0.58	2007	555	4.96	2589	5.11	3144	0.82
1995	391	3.49	583	1.15	974	0.60	2008	561	5.01	3167	6.25	3728	0.85
1996	377	3.37	619	1.22	996	0.62	2009	651	5.81	3615	7.13	4266	0.85

1997	364	3.25	735	1.45	1099	0.67	2010	622	5.56	3960	7.81	4582	0.86
1998	400	3.57	737	1.45	1137	0.65	2011	601	5.37	4614	9.10	5215	0.88
1999	418	3.73	850	1.68	1268	0.67	2012	618	5.52	5131	10.12	5749	0.89
2000	483	4.31	1060	2.09	1543	0.69	2013	598	5.34	5669	11.19	6267	0.90
2001	415	3.71	1117	2.20	1532	0.73	2014	546	4.88	6292	12.41	6838	0.92
							Total	**11196 (18.03)**	**100**	**50681 (81.90)**	**100**	**61877**	**0.82**

4.9 AUTHORS HISTRIOGRAPHICANALYSIS of LCS and GCS

For the LCS map, due to the top publication (top 30) number (25) of links, and to have a clear graph a minimum of 77 local citation scores to maximum 208 local citation scores was derived. For those thirty nodes, during 2005 to 2011 more than 81 authors were contributed between the selected nodes for LCS a value has measured.Among the selected thirty nodes, only three authors were contributed as single, 11 articles were written by 22 authors of two authored team, seven articles were written by the 21 authors of three authored team, two articles were written by 8 authors of four authored team and seven articles were written by the more than five authored team.

It could be noted that the authors of "**Seuring S, Muller M**" has seven highest links (8596th article at 2008) between the selected thirty nodes from this analysis; and the author of "**Srivastava SK**" has maximum (6089th article at 2007) and the author of "Eriksson O, Reich MC, Frostell B, Bjorklund A, Assefa G, et al." has minimum (187th article at 2001) LCS scores measured.

The following results were derived from this GCS histriographic mapping analysis. For those thirty nodes, during 2005 to 2011 occurred authors' GCS values and links between the selected nodes have measured. Among the selected thirty nodes, only six authors were contributed as single, 11 articles were written by 22 authors of two authored team, five articles were written by the 15 authors of three authored team, only one article was written by 4 authors of four authored team and seven articles were written by the more than five authored team. Among those only one author (Arnold JG) has repeatedly two times contributed and remaining authors were contributed only once in EM research productivity.

It could be noted that the authors of "**Hooper DU, Chapin FS, Ewel JJ, Hector A, Inchausti P, et al.**" has highest links (4085nd article at 2006) between the selected twenty five nodes from this analysis; and the author of "**Arnold JG, Fohrer N**" has maximum (583th article at 2005) GCS scores measured.

It concludes from the above histriographic map analysis of LCS and GCS, the researcher has identified the authors of "**Srivastava SK**" and "**Arnold JG, Fohrer N"** having Maximum number citation scores among the selected nodes. That the authors of "**Hooper DU, Chapin FS, Ewel JJ, Hector A, Inchausti P, et al.**" has highest links (4085nd article at 2006) and "**Seuring S, Muller M**" has highest links (8596nd article at 2008). So those authors were identified most productive authors from this histriographic map of the EM research output.
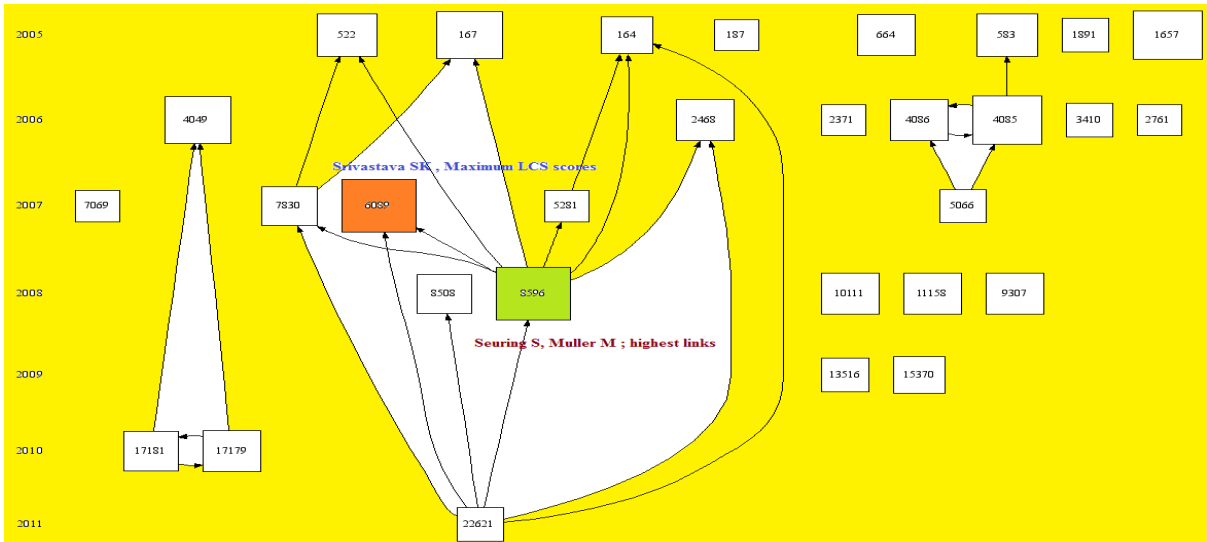
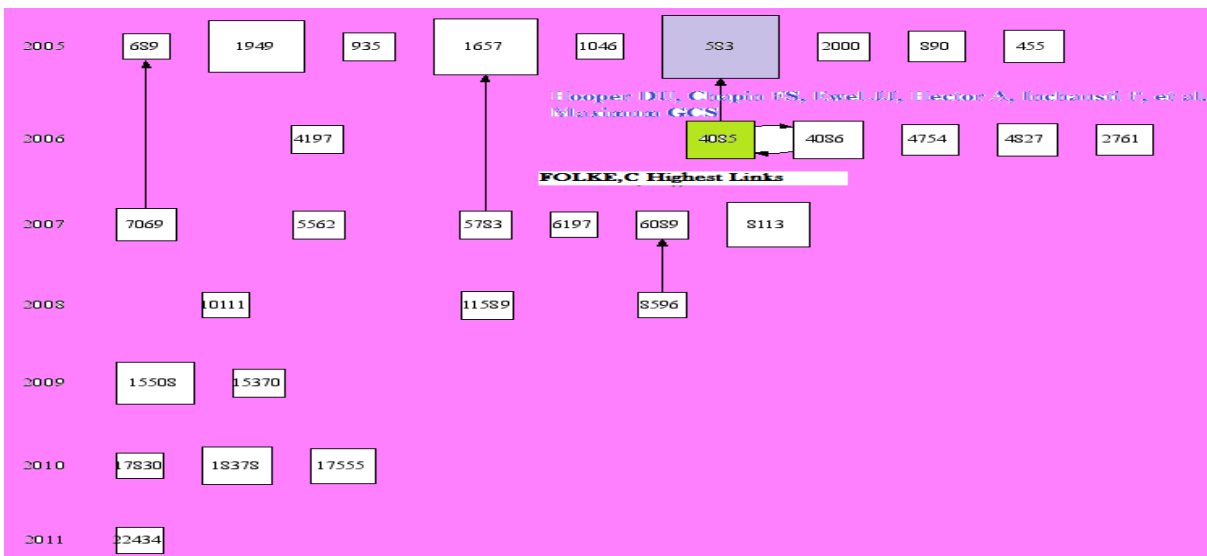**Figure 5: Histriograph maps of LCS for authors (Nodes: 30, Links: 25; Min: 77, Max: 208)**

Figure 6: Histriograph maps of GCS for authors (Nodes: 25, Links: 6, Min: 377, Max: 2069)

5.CONCLUSION

Based on this research analysis results, it is identified the year 2006 has highest number h-index values. 2014 has highest productivity, highest cited references and highest number of contributed authors. 2007 has earned highest number of LCS and GCS.The relative growth rate is 0.19 and doubling time is 11.13 years.Results from Histcite analysis, the journal of "Journal of Environmental Management" have highest contributions and contributors; the journal of "Ecological Applications" has highest citation and h-index values. From VOSviewer analysis "Journal of cleaner Production" and "PLOS One" was produced highest documents and highest bibliographic coupling values. From LCS Historiographic mapping analysis results, "Journal Of Cleaner Production" has highest links and "International Journal of Management Reviews" has maximum LCS scores measured. From CS Histriographic map analysis, "Global Environmental Change-Human and Policy Dimensions" has highest links and "Ecological Monographs" has maximum GCS scores

measured. To test Bradford's law of scattering of journals is clearlydiscount Bradford's Law of scattering.**"Huang GH"** has highest number of contribution, highest TGCS, highest TLCR and highest h-index values. **"**Chang NB" is identified the active authors of first author.Using VOSviewer analysis, "Huang GH"; "Liu Y"; "Zhang FS" and "Li Y" were having highest productivity."Srivastava SK" and "Arnold JG, Fohrer N" having highest citation scores and "Hooper DU, Chapin FS, Ewel JJ, Hector A, Inchausti P, et al."were has highest links.

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