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Mapping of Deforestation Research across the Globe: A Scientometric Assessment on Web of Science Database

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Abstract **- The present paper explores the Scientometrics analysis of "DEFORESTATION" from the year 2014 to 2018. A total of 6698 data was downloaded from the web of science database, the data analyzed through Histcite and Bibexcel software. In this study discussed the growth of deforestation year by year. The study to examine the year wise distribution of contributions, authorship pattern, co-author index and degree of collaboration, relative growth rate and doubling time, country-wise distribution of records and so on. The study revealed that the Degree of Collaboration was high in 2018 (0.92). The study analyzed the relative growth rates (RGR) has increased from 2015 (0.60) to 2018 (1.44) in the span of five years. The doubling time (DT) has rapidly decreased while calculated year wise i.e. 2015 (1.15) to 2018(0.48). Maximum of publication published in USA country 2013 (30.1%), a number of records published on articles 6138 (91.6%). Number of publications is published in 2018 (23%). Regarding the language, 95.5% (6397) of the publications published in the English language.**

Keywords: **Scientometrics, RGR, DC, Doubling Time, Deforestation**

I. INTRODUCTION

Scientometrics is the important field of the study in recent decades. Scientometric is the Quantitative description of science and technology. Scientometrics is "the measurement of scientific output and the impact of scientific findings on public policy". This study analyzes the keyword in the field of deforestation.

Deforestation is arising as the major global problem to the society and environment. It is like a severe penalty to the planet and indicating the end of life on this planet. The regular cutting of the forests is creating lots of depressing effects over the climate, environment, biodiversity, whole atmosphere as well as threatening the cultural and physical survival of the people. There are many reasons for the deforestation such as wood cutting because of the increasing human population and industrial interests of people. Woods are considered as the most important product of the forest and structural component of the physical requirement of the peoples. Exploding people's population requires more land to live and harvesting so they need to cut the forests. In this way, deforestation is going on more rapidly to fulfill the people's needs in many ways. Still, the effects of deforestation are faster than the deforestation itself. It is affecting the human lives to a great extent by forcing the negative changes to the surroundings and environment.

A. Web of Science

Web of Science is previously called a Web of Knowledge. Web of Science is an online subscription-based on scientific citation indexing service originally produced by the Institute for Scientific Information(ISI) now maintained by Clarivate Analytics (Previously maintained by the Intellectual Property and Science Business of Thomson Reuters), that provides a comprehensive citation search.

II. REVIEW OF LITERATURE

Thangamani T, Palaniappan M, and Vinothkumar C (2018) in their article analyzed the Bibliometric analysis of the Journal "Nature" covers 13499 articles of 59 volumes in five years from 2013 to 2017. The aim of study was to analyze the year wise distribution of articles & citations, authorship pattern of articles, collaborative author's publications, ranking of authors based on publications and h-index score, most productive countries and institutions, and etc. in the year 2015 highest number of 2944(21.81%) articles was published out of 13499 articles in five years. The anonymous author has been the first rank in top contributing articles (987). Wang J has the first position of the topmost authors contributed in "Nature" journal, which produced 54 articles and also having first place in h-index 41 with 17031 citations. The USA has contributed the highest number of articles 5815with 31.07%. Majority of the participants are contributing from the University of California with 980 (7.25%) articles. The maximum number of records published in Editorial Materials with 4719(34.96%) articles. The word "Expression" was the most occurred keyword in this research with 359(2.65%) articles.

Alex, P and Preedip Balaji, B (2010) has studied the climate change research output from India in a five-year period 2005-2009. It examines the key factors including a number of works published on the topic of climate change science and the journals publishing this research work and their position in rankings. Climate change research in India is mapped based on papers abstracted in the ISI Science Citation Index. There were 25,081 publications published all over the world; a total of 25,081 publications, Indian subcontinent have published 391 papers in all, and these were published in more than 101scholarly journals. The scope of the paper is limited to studying the growth and

dynamics of Indian research output in climate change research of a five year period (2005-2009).

Yajun Song Tianzhong Zhao (2013) has discussed this Bibliometric is study analyzes 937,923 keywords from 78,986 articles concerning forest ecology and conducts a serial analysis of these articles' characteristics. The records, published between 2002 and 2011, were downloaded from the Web of Science database, and their keywords were exported by Java processing programs. The effect of forest ecology studies focused on forest diversity, conservation, dynamics and vegetation in the last decade. Developed countries, such as the USA, Canada, and Germany, were the most productive countries in the field of forest ecology research. The findings of this study may be applicable for development and administration forest ecology research.

Kumaresan, R. and his co-authors R. (2014) has performed this study analyses Scientometrics research trends in fish stock assessment. The maximum number of publications were (202) published in 2013. The relative growth rate decreased from 0.45 in 2001 to -0.13 in 2008. The average doubling time is 7.96 years. The original research articles were predominant in fish stock assessment research. Collaborative research is dominant over single author research and the degree of collaboration is 0.88. Regarding the language, 98.48% of the publications published in the English language. Fisheries Research journal scored first place with 293 publications. The National Oceanic and Atmospheric Administration, Washington, DC occupies the first place with 125 publications (6.3%). Overall, the USA contributed 651 publications and scored first place.

Joshi, K., Kshitij, A., & Garg, K. C. (2010) have studied "Scientometric profile of global forest fungal research" during 1987-2008. The bibliographic details included document type, the title of the paper, authors, and their affiliation, name of the journal with its place of publication. The total number of papers taken up for analysis was 3313 records. The results indicate that the number of publications has increased significantly especially during 2004 -2008. The number of articles published in English with 3198 (96.6 %) records. A total of 3313 publications, over 619 journal titles are originating from 50 countries and 839 institutions. The USA is the topmost publication published in this study. China leads in terms of the highest rate of annual growth of published papers.

III. OBJECTIVES OF THE STUDY

The following are the important objectives of the study

1. To examine the year wise Authorship Pattern,
2. To observe the Activity index of India,
3. To determine the Degree of Collaboration,
4. To measure the Relative Growth Rate and Doubling Time,
5. To analysis of Co-Authorship Index,
6. To the development of time serious analysis,

IV. METHODOLOGY

Scientometric details about the keyword "Deforestation" for data collection are reachable in a web of science database which is published by Thomson Reuters [WOS]. The keyword "Deforestation" for five years during the year 2014 - 2018 to take for the study 6698 records were retrieved in the present study, and the data has been collected on 26th Feb 2019 The collected data analyzes through Histcite, Bibexcel and calculated using Excel to find out the result. VOS viewer is used to generating and visualization of bibliographic networks.

V. DATA ANALYSIS AND INTERPRETATION

TABLE I YEAR WISE PUBLICATION OF DEFORESTATION RESEARCH

S. No.	Publication Years	Records	Percent
1	2014	1039	16%
2	2015	1258	19%
3	2016	1353	20%
4	2017	1473	22%
5	2018	1575	23%
Total		6698	100%

Above the Table shows the year-wise publication of records during the year of 2014 to 2018. The year 2014 contains 1039 records with an average of 16 percentages. The then year of 2015 contains 1258 records with an average of 19 percentages. The then year of 2016 contains 1353 records with an average of 20percentages. The then year of 2017 contains 1473 records with an average of 22percentages. The then year of 2018 contains 1575 records with an average of 23 percentages. According to the year wise publication of records; the year 2018 is containing more records of 1575 with 23 percentages.

TABLE II DOCUMENT WISE DISTRIBUTION

S. No.	Document Type	Records	Percentage
1	Article	6138	91.6
2	Review	312	4.7
3	Editorial Material	85	1.3
4	Article; Proceedings Paper	70	1.0
5	Letter	24	0.4
6	News Item	18	0.3
7	Correction	13	0.2
8	Article; Data Paper	12	0.2
9	Review; Book Chapter	11	0.2
10	Book Review	6	0.1
11	Meeting Abstract	6	0.1
12	Article; Book Chapter	2	0.0
13	Article; Retracted Publication	1	0.0

It could be observed from the table thirteen types of sources are there. An article is a leading source with 91.6 (6138) percent of the total documents. Then review, editorial material article; proceedings paper are following second, third and fourth position respectively (4.7%, 1.3%, and 1.0%).

TABLE III YEAR WISE AUTHORSHIP PATTERN OF DEFORESTATION RESEARCH

Years	Single Authors	Double Authors	Three Authors	Four Authors	Five Authors	Above five Authors	Total
2014	93	145	219	170	133	279	1039
2015	114	183	236	208	164	353	1258
2016	137	227	234	204	176	375	1353
2017	146	200	274	253	197	403	1473
2018	124	214	273	242	210	512	1575
Total	614	969	1236	1077	880	1922	6698

Above the table for the study of authorship pattern, the deforestation research publications are arranged separately as single, double, three, four, five and more than five authors. It reveals that 29% of articles were contributed by the above five authors. Followed by three authors with 18%, four authors accounting 16%, two authors accounting for 15% articles, five authors are contributed accounting for 13% and least number of authors contributing in single authors accounting for 9% articles.

TABLE IV ACTIVITY INDEX OF INDIA

S. No.	Years	Global output	Indian output	Activity Index
1	2014	1039	47	84.16
2	2015	1288	43	111.38
3	2016	1353	58	88.83
4	2017	1473	52	107.59
5	2018	1575	55	109.04
Total		6698	255(3.80%)	100.00

Activity Index is the ratio of the country's share in the worlds publication output in the given field to the country's share in world's publication output in all fields.

Mathematically, activity index has identified by the following formula as

$$\textbf{Activity Index} = [\frac{\frac{Ci}{Co}}{\frac{Wi}{Wo}}] * \mathbf{100}$$

For example, (1039/6698) / (47/255) *100 = 84.16

1. If the Activity index is =100 indicates that a country's research effort in the given field corresponds precisely to the world average,
2. If the activity index is > 100 reflects higher than average activity,
3. If the activity index is < 100 indicates lower than average activity.

Above the table find out The Activity index is 100 so the activity index indicates that a country's research effort in the given field corresponds precisely to the world average.

TABLE V COUNTRY WISE DISTRIBUTION

S. No.	Country	Records	Percentage
1	USA	2013	30.1
2	Brazil	1192	17.8
3	UK	885	13.2
4	Germany	670	10.0
5	Australia	505	7.5
6	Peoples R China	491	7.3
7	France	407	6.1
8	Netherlands	355	5.3
9	Canada	331	4.9
10	Indonesia	321	4.8
11	Mexico	289	4.3
12	India	255	3.8
13	Spain	240	3.6
14	Japan	233	3.5
15	Switzerland	198	3.0

The table indicates that the country-wise distribution of that table USA is the leading Country to publishing records related to the topic deforestation on the top fifteen authors. The USA is publishing 2013 records during the year of 2014 to 2018. And Brazil followed the next position, publishing 1192 records. Then the following countries are publishing records respectively. A total of 6698 records, India published 255(3.8%) records in worldwide.

TABLE VI DEGREE OF COLLABORATION

Years	Single Authors (NS)	Multiple Authors (NM)	Total Authors (NS+NM)	Degree of Collaboration
2014	93	946	1039	0.91
2015	114	1144	1258	0.91
2016	137	1216	1353	0.90
2017	146	1327	1473	0.90
2018	124	1451	1575	0.92
Total	614	6084	6698	0.90

The table shows the details about the degree of collaboration which indicate a trend in single and multiple authors during 2014 – 2018 as shown in a Table. The degree of collaboration ranges from 0.90 to 0.92 and the average degree of collaboration is 0.90. The DC is calculated by using the formula of K. Subramaniyam, 1982.

The formula is where,

$$\mathbf{DC} = \frac{\mathbf{Nm}}{\mathbf{Ns} + \mathbf{Nm}}$$

DC = Degree of Collaboration
NM = Number of Multi Authors
NS = Number of Single Authors

$$\mathrm{DC} = \frac{6084}{614 + 6084} = 0.90$$

In the present study, the value of DC is 0.90.

TABLE VII MOST PROLIFIC AUTHORS WITH H-INDEX DISTRIBUTION OF DEFORESTATION

S. No.	Authors	Records	Citation sum within H-Core	All citations	H-Index
1	Herold M	45	667	801	16
2	Reddy CS	29	91	157	7
3	Brockhaus M	29	363	431	14
4	Ciais P	26	1837	1905	12
5	Lambin EF	25	440	487	13
6	Peres CA	24	670	718	12
7	Barlow J	24	431	487	10
8	Aragao LEOC	24	571	618	10
9	van Noordwijk M	24	231	296	12
10	Fearnside PM	24	695	738	9

According to the most prolific author's distribution of that table, Herold M is the leading author to publishing records related to the topic deforestation. Herold M is publishing 45 records and having 801 citations with 16 H-index during the year of 2014 to 2018. Then the following authors are publishing above 30 records related to the topic: Reddy CS (29), Brockhaus M (29) and Ciais P (26). The following authors are ranked in respectively. Ciais p is having a more number of citations in this study.

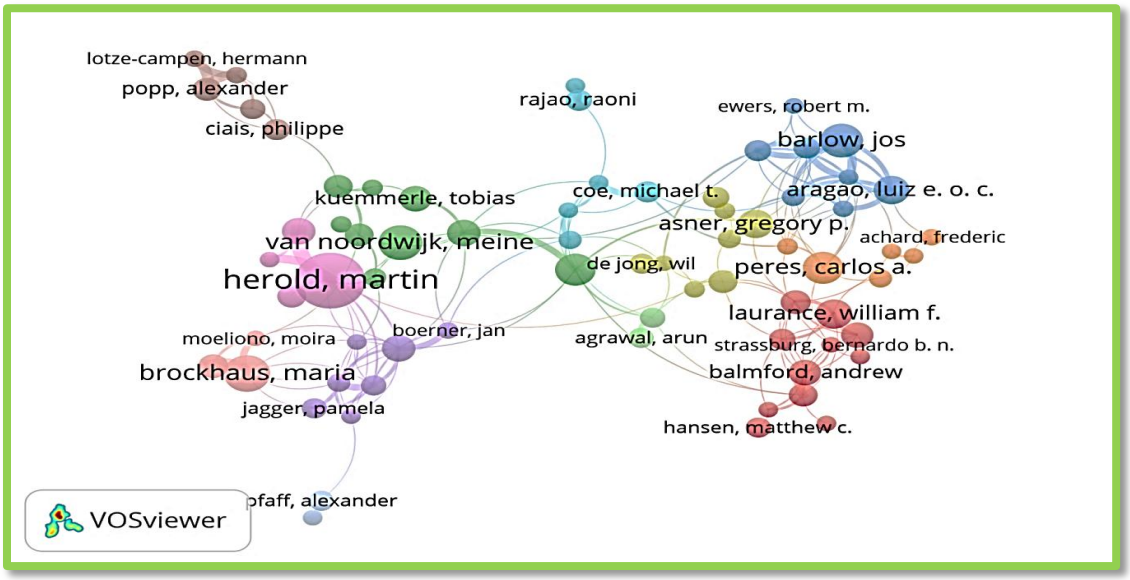

Fig. 1 Network visualization of Co-Authorship with Prolific Author

It will clearly define the Relative Growth Rate and Doubling Time of a record during the year 2014 to 2018. According to the table, the result indicates the Relative Growth Rate was increased the year to year. In the year 2014, the relative growth rate is none, it is increased to 1.44 in the year 2018. The Doubling time is decreased one year to next year. In 2015 a Doubling time value is 1.15, it is decreased up to 0.48 in the year of 2018. It means the value of Relative Growth Rate is 0.85 during the year 2013 to 2017. The Doubling Time mean value is 0.57 during the year 2014 to 2018.

TABLE VIII RELATIVE GROWTH RATE (RGR) & DOUBLING TIME

Years	No. of publications	Cumulative Total of publications	W1	W2	R(a) W2-W1	Mean R(a)	Doubling Time (Dt)	Mean (Dt)
2014	1039	1039	6.94	6.94	-	0.85	-	0.57
2015	1258	2297	7.13	7.73	0.60		1.15	
2016	1353	3650	7.21	8.20	0.99		0.70	
2017	1473	5123	7.29	8.54	1.25		0.55	
2018	1575	6698	7.36	8.80	1.44		0.48	
Total	6698							

TABLE IX ANALYSIS OF SINGLE VS MULTI-AUTHOR

S. No.	Authorship pattern	Publications	Percentage
1	Single Author	614	09.16%
2	Multi-Author	6084	90.84%
Total		6698	100%

The table shows the result of the contribution of a single author and multiple authors. According to the table, the distribution of this authorship pattern shows the multiple authors are more contributed than a single author. The multiple authors publishing 6084 records with an average of 90.84 percentages, but the single author only contributed to 614 works with an average of 9.16 percentages.

TABLE X ANALYSIS OF CO-AUTHORSHIP INDEX

Years	Single Authors		Two Authors		Three Authors		Four Authors		Five Authors		Above five Authors		Total
	No	CAI	NO	CAI	No	CAI	No	CAI	NO	CAI	NO	CAI	
2014	93	98	145	96	219	114	170	102	133	97	279	94	1039
2015	114	99	183	100	236	102	208	103	164	99	353	98	1258
2016	137	110	227	116	234	94	204	94	176	99	375	96	1353
2017	146	108	200	94	274	100	253	107	197	102	403	95	1473
2018	124	86	214	94	273	94	242	95	210	101	512	113	1575
Total	614		969		1236		1077		880		1922		6698

This table shows the co-authorship index during the year of 2014 to 2018. The table shown co-author index for single authors decline from 98 in the year 2014 to86 in the year 2018, and then the CAI for the two authors is declined from 96 to 94 and three authors is declined started from 114 to 94 and four authors is declined started from 102 to 95 and five author is declined from 97 to 101 and then above five author is declined started from 94 to 113 during the year 2013 to 2017.

TABLE XI KEYWORD ANALYSES

S. No.	Keywords	Records
1	Deforestation	2188
2	Conservation	996
3	Biodiversity	677
4	Land-Use	622
5	Climate-Change	576
6	Management	466
7	Forest	456
8	Dynamics	409
9	Brazilian Amazon	359
10	Impacts	323

The table shows the top 10 keywords contributing to this research. The word "Deforestation" occupies the first position with 2188 records. Then Conservation has the Second position with 996 records, followed by Biodiversity, Land-Use and Climate Change Have respectively third, fourth and fifth place.

TABLE XII TIME SERIOUS ANALYSIS

Years	No. of Publications	X	X^2	XY
2014	1039	-2	4	-2078
2015	1258	-1	1	-1258
2016	1353	0	0	0
2017	1473	1	1	1473
2018	1575	2	4	3150
Total	6698		10	1287

Straight line equation:

$Yc = a+bX$

Since $\sum X=0$

$a = \sum Y/N = 6698/5 = 1339.6$

$b = \sum XY/\sum X^2 = 1287/10 = 128.7$

Estimated literature in 2028 is when X = 2029 – 2019 =10

$= 1339.6 + (128.7 \times 10) = 2626.6$

Estimated literature in 2033 is when X = 2034 – 2019 =15

$= 1339.6 + (128.7 \times 15) = 3270.1$

$= 1339.6 + (128.7 \times 20) = 3913.6$

The calculated value of Time Serious Analysis output of Deforestation for the year 2029 is 2626.6 and research output for the year 2034 is 3270. With the application of the

formula, the Time serious analysis calculated from the results for the year 2029 and 2034, it is found that the Future trend of growth of research output in Deforestation research may take increasing for upcoming years. The expectation from the calculations proved there is positive Growth in research output of Deforestation.

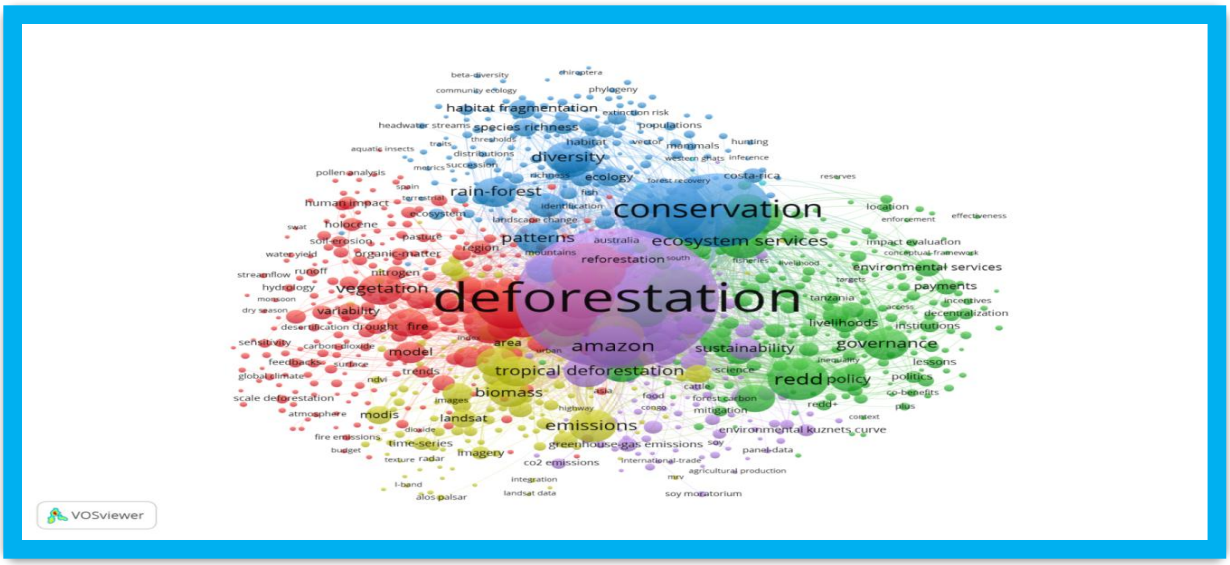

Fig. 2 Network visualization of Co-Occurrence with Keywords

VI. FINDINGS OF THE STUDY

1. The most number of records published in the year of 2018. In the year of 2018 contains1575 records with an average of 23 percentages. The least number of records are published in the year of 2014. In the year of 2014 is containing 1039 records with an average of 16 percentages.
2. An article is a leading source with 91.6 (6138) percent of the total documents. Then review, editorial material article; proceedings paper are following second, third and fourth position respectively (4.7%, 1.3%, and 1.0%).
3. The normal DC rate is 0.90 to 0.92. The average degree of collaboration rate is 0.90.
4. The Relative Growth Rate is increased the year (2014) to year (2018). A mean growth rate is 0.85. Doubling time is decreasing in a year to year. In the year 2015, a DT is 1.15 but in the year of 2017, a DT is 0.48. A mean Doubling time is 0.57.
5. The multiple authors publishing 6084 records with an average of 90.84 percentages, but the single author only contributed to 614 works with an average of 9.16 percentages.
6. The word "DEFORESTATION" is the most used keywords with 2188 records.
7. The calculated value of Time Serious Analysis output of Deforestation for the year 2029 is 2626.6 and research output for the year 2034 is 3270. , it is found that the Future trend of growth of research output in Deforestation research may take increasing for upcoming years.

VII. CONCLUSION

Deforestation is arising as the most important global problem to the society and environment. It is like a serious penalty to the planet and representing the end of life on this world. The continuous cutting of the forests is creating lots of negative effects over the climate, environment, biodiversity, whole atmosphere as well as threatening the cultural and physical survival of the human being. Most of the deforestation research is going on the United States America (USA). And this study well developed on upcoming years. In this study Deforestation research is covered 6698 records from 2014 to 2018 at the global level and contributing number of authors in this study.

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