MAPPING OF LITERATURE OF RAINWATER HARVESTING: A SCIENTOMETRIC STUDY

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Abstract:
The present study analyzed research output of rain water harvestingfor durationof 10 years from 2012 toand 2021. Web of Science database a provider from clarivate analytics has been used to download citation and source records. Histcite application software program had been used to provide the datasets. Analysis component makes a specialtyof the parameters like quotation impact at nearby and international stage, influential authors and their overall output, ranking of contributing establishments and international locations.

Keywords: Agriculture, Bibliometric, Groundwater, Histcite, Mapping, Rain Water Harvesting (RWH), Rooftop, Science, Scientometric

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Introduction:

Water is an important element for all human beings in the world. Our body consists mostly of the water. We need water for drinking, cooking, washing, agriculture and to run our industries. We usually take it for granted because of its availability; but when in scarcity it becomes our most precious resource. India has a long tradition of water harvesting.[1]

In the history of India's water sector, the past two decades are characterized by a boom in water harvesting. For instance, many water harvesting structures were built for improving aquifer storages and groundwater quality. Rainwater is a major source of fresh water and the activity of collecting rainwater directly for beneficial use or recharging it into the ground to improve groundwater storage in the aquifer is known as rainwater harvesting (RWH). Dependence on groundwater to meet the growing demands has increased tremendously. When there is a gross misbalance between the natural recharge and extraction of water over a period of time, the decline of the water table becomes significant with reduction of yield. The only option available for the present day society is to improve the recharge over and above the natural processes. RWH and recharge is one such promising option that has artificial recharge methods. It is estimated that with careful artificial recharge schemes and waste water recycling, ca. 25% of India's water requirements in 2050 can be met. The main purpose of this paper is to review the Rain water harvesting material on the Web of Science database to supplement the current supply of information on this topic and to create a suitable framework for the future development of this resource in this field. Therefore the Scientometric study is important Rain Water Harvesting at global level. [9]

The term rainwater harvesting is generally taken to mean the immediate collection of rainwater from the surface on which it falls directly. This definition includes streams, rivers, lakes, etc. The flow in is omitted. This includes water collected from the boundaries of a property, roof and surfaces. Rainwater harvesting is the scientific method of collecting or storing water from areas where it rains. This includes using rainwater for domestic or agricultural purposes. Rainwater harvesting has been practiced since ancient times.[10]

Scientometric:

A complex of quantitative mathematical and statistical methods used to investigate such aspects as research staff, and to define evolutionary & prospectus of science (Bonitz, 1999). Scientometric is a very recent term. It is often used synonymously with the term Bibliometric. Scientometric is the science of measuring and analysis science in practice, Scientometric is a formed structure part of science of science methodology including the complex of mathematical and statistical method, used to analysis the quantitative characteristic of science as an enterprise (voverience and Trumpiene 1994).

Review of Literature:

There is no Scientometric study had been published so far on "Rain Water Harvesting" however, there are few other Scientometric studies available, which quantitatively and qualitatively analyze global literature on and many more studies.

NaikUmesha, (2021),Activity Index (AI) and extent of collaboration: a case study of rainwater harvesting literature with a Scientometric overview. This paper has assessed the research activity by different countries with the help of Activity Index (AI) and the collaboration and its impact. The SCOPUS publication records are made use of for the analysis of RWH research activities. The quality of the publications is analyzed in terms of citations received to the papers and Spain has come on the top having 42 citations per paper. Out of the 141 countries which have at least one publication on RWH, 132 (94%) have at least one paper written in collaboration with other countries. US is the collaboration hub of many countries and the strength of collaboration of India, China, UK, and Brazil is noteworthy.

VincenzaNotaro, (2016),Reliability Analysis of Rainwater Harvesting Systems in Southern Italy. Water scarcity is a current problem for many Mediterranean urban areas due to increasing demand for water. Population growth and expansion of urban and industrial areas. Climate change will increase the pressure on water resources. Rainwater harvesting (RWH) can be an effective alternative to water scarcity. The model's performance was evaluated using data from more than 100 different sites throughout the Sicilian region. This regional analysis provided results with practical application, e.g. Identify optimal rainwater tank size and annual system reliability curve as a function of average annual rainfall. Uncertainty related to regional model estimates was also assessed.

Lorgio G. Valdiviezo Gonzales, (2021),Scientometric study of drinking water treatments technologies: Present and future challenges. This paper was purpose of the study was to develop a Scientometric study about the drinking water treatments in the period 2010–2020 for providing the state of art of the studies about the

drinking water treatments in diverse knowledge areas and new orientations for future research. For this purpose, a search of the information was performed both in the Web of Science (WoS) and Scopus databases, and all articles and reviews related to the field of water treatment or chemistry were included. The results showed that China, the USA and the Netherlands have the majority of the most cited publications and various related multidisciplinary topics, such as infrastructure, technologies and pollution. Therefore, the study allows concluding that there is a need for research on different technologies that contribute positively to obtaining quality water for consumption and for the use of routine activities, being the combination and integration of the different treatment processes a challenge for future studies.

Bhagat M. P., (2021),Mapping of Osteoarthritis Research Output at Global Level: A Scientometric Study. This Paper analyzed research review articles output for a period of five years between 2016 to and 2020. Web of Science database a service from Clarivate Analytics has been used to download citation and source data. His cite application software has been used to present the datasets. Analysis part focuses on the parameters like citation impact at local and global level, influential authors and their total output, ranking of contributing institutions and countries and scientographical mapping of data is presented through graphs usingVOSviewer software mapping technique.

Sadia Rahman, (2014),Sustainability of Rainwater Harvesting System in terms of Water Quality. This study focused only on rainwater harvesting system on a small scale basis. Further research could be performed on large scale residential, commercial or industrial sector. More comprehensive studies for better quantification of energy and climate factors should be made for proper development of the system. Rainwater could be highly polluted by pesticides in any agricultural region. Hence, biological and chemical analysis should be done before adopting harvested rainwater as a source of daily water.

Khaparde V., (2013),TheBibliometric Analysis of Research Publication of Department of Chemistry, Dr. Babasaheb Ambedkar Marathwada University, from 1975 to 2012. It analyzed all the 774 research publications from the 144 journals. It examines year- wise distribution of papers, authorship pattern, journal in which author publish, it revealed that the number of publications has increased consistently from the year 1975 to the year 2012. 25% of the total publications have been made in 2009, 2010, and 2011. And the majority of the publications are made with 4 authors. And also the majority of the research paper published in Journal of Heterocyclic Chemistry.

Sangita Mishra S., (2020),Design of Rooftop Rainwater Harvesting Structure in a University Campus. This paper has studied at designing a rooftop rainwater harvesting structure for the Amity University Mumbai campus. This will help in artificial recharge of groundwater in this area in addition to fulfilling water scarcity conditions. The main building was selected as the required catchment area for rainwater harvesting considering the water demand in university campus and the supply. Further, different parts of the RWH system were designed based on standard guidelines. This initiative can increase the water supply for construction work, gardening and also will help in artificial recharge of ground water thus enriching both the surface and the ground water resources.

In the recent years, the study on Scientometric analysis in different subject field conducted by many researchers. The following few studies related to the objectives of this study have been reviewed in the research paper.

Web of Science:

The Web of Science (WoS; previously known as Web of Knowledge) is a website that provides subscription-based access to multiple databases that provide comprehensive citation data for many different academic disciplines. It was originally produced by the Institute for Scientific Information.

Scope & limitation of the study:

The research publications were retrieved from the Web of Science core collections Database on the topic Rain Water Harvesting, which is scattered over the period from 2012 to 2021. The search was carried out using the key word “Rain Water Harvesting” in the topic field. A total of 811 publications have been downloaded.

Methodology:

The research publications were retrieved from the Web of Science core collections Database on the topic Rain Water Harvesting, which is scattered over the period from 2012 to 2021. The search was carried out using the key word 'Rain Water harvesting' in the, topic field. A total of 811 publications were downloaded and the same was analyzed using the software HistCite, Microsoft Excel as per the objectives of the study.

Objectives:

The main objective of this study was to use Scientometric mapping and analyze the key

features of Rain Water Harvesting research activities at global level such as: the rate of growth and doubling time on Rain Water Harvesting research, The research publications were retrieved from the Web of Science core collections Database on the topic Rain Water Harvesting, which is scattered over the period from 2012 to 2021. The search was carried out using the key word "Rain Water Harvesting" in the topic field. A total of 811 publications were downloaded and the same was analyzed using the software HistCite, Microsoft Excel as per the objectives of the study.

1. To examine the distribution of the Publication Year wise.
2. To find out authorship pattern ofPublication Year wise.
3. To find out the distribution oftypes ofDocuments.
4. To find out the Distribution of authors rankingof authors.
5. To find out the Ranking ofAuthor'sAffiliation.
6. To find out the distribution of the Publication Country/Regions wise.
7. To find out the distribution of the Publication Language wise.
8. To find out the average pages per Year&Documents.
9. To find out the Keyword wise distribution of the Publication.

Hypothesis:

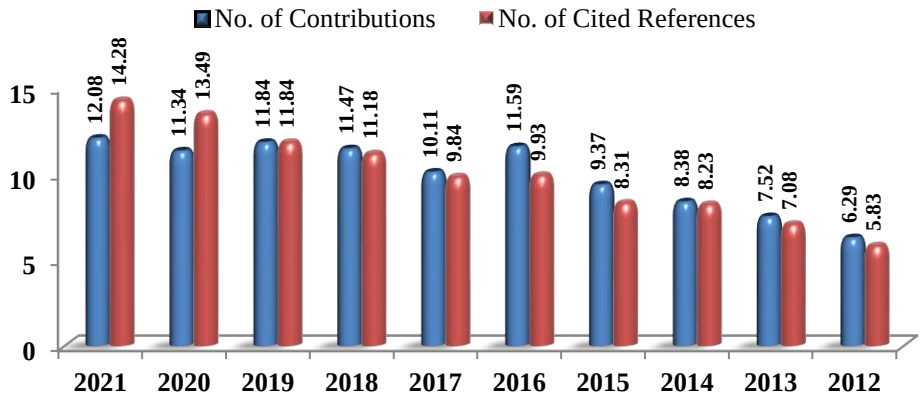
1. Among the Publication, English is the predominant language.
2. USAPublicationsis dominant over other Publication.

Data Analysis and Interpretation:

Table No. 1
Distribution of the Publications Year wise

Year	No. of Contributions	%	No. of Cited References	%
2021	98	12.08	6019	14.28
2020	92	11.34	5686	13.49
2019	96	11.84	4994	11.84
2018	93	11.47	4715	11.18
2017	82	10.11	4149	9.84
2016	94	11.59	4188	9.93
Year	**No. of Contributions**	**%**	**No. of Cited References**	**%**
2015	76	9.37	3503	8.31
2014	68	8.38	3468	8.23
2013	61	7.52	2983	7.08
2012	51	6.29	2457	5.83
Total	**811**	**100.00**	**42162**	**100.00**

Graph No. 1
Distribution of the Publications Year wise



[

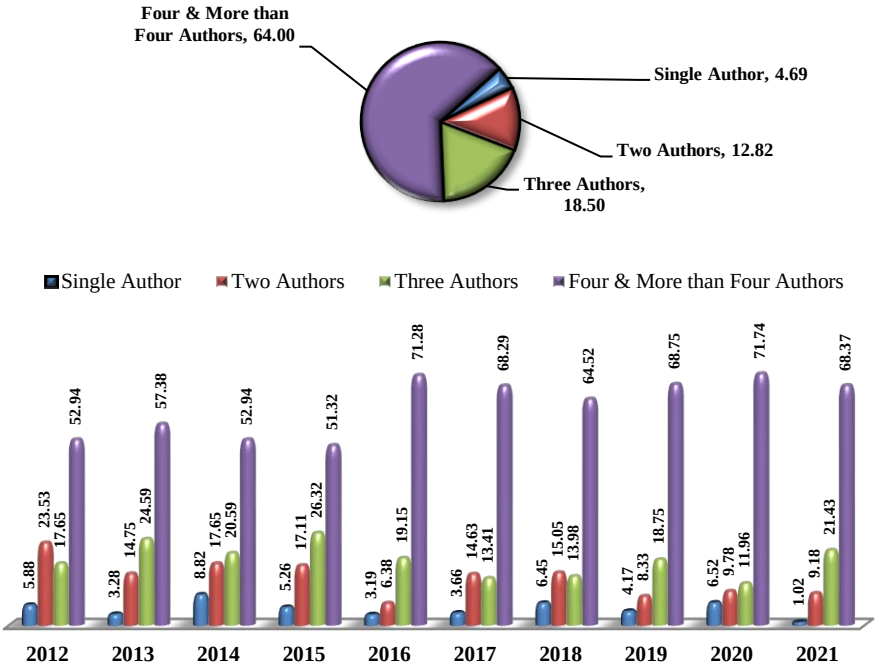
Table No. 1 & Graph No. 1] Shows that the numbers of research documents published from 2012 to 2021 are gradually increased. According to the publication output from the Table no.1 The year wise distribution of research documents, 2021 has the highest Number of research documents 98 (12.08%) with 811 of total documents. It is noticed that the increase in publications with 98 of

total local citation score the year 2021 has 6019 (14.28%) research documents and it stood in First position with 42162 of total local citation score. It is observed that the increase in "publications" may not create impact on "citation score" yet the quality matters on total "global citation scores".

Table No. 2
Authorship pattern of Publications Year wise

Authors	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total	%
	No. of Contributions											
Single Author	3	2	6	4	3	3	6	4	6	1	**38**	**4.69**
Two Authors	12	9	12	13	6	12	14	8	9	9	**104**	**12.82**
Three Authors	9	15	14	20	18	11	13	18	11	21	**150**	**18.50**
Four & More than Four Authors	27	35	36	39	67	56	60	66	66	67	**519**	**64.00**
Total	**51**	**61**	**68**	**76**	**94**	**82**	**93**	**96**	**92**	**98**	**811**	**100.00**

Graph No. 2
Authorship pattern of Publications Year wise

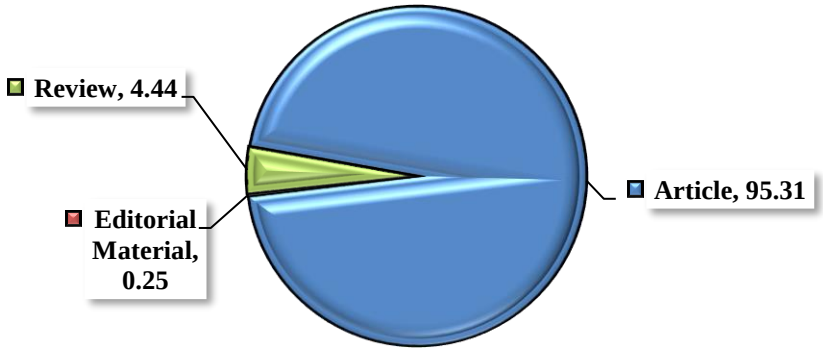


[Table 2 and Category 2] It was found that in 2012-2021, out of a total of 811 articles, the number of articles published by "one author" was 38 (4.69%) and the number of articles published by "four and more authors". 519 (64.00%). In 2014, 2018 and 2020, a maximum of 6 articles were published by "Single Author" and in 2016 and 2021, "Four and more authors" published a maximum of 67 articles.

Table No. 3
Distribution of types of Documents

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
Article	47	58	65	73	93	78	88	94	83	94	**773**
Editorial Material	-	-	-	-	-	-	-	-	1	1	**2**
Review	4	3	3	3	1	4	5	2	8	3	**36**
Total	**51**	**61**	**68**	**76**	**94**	**82**	**93**	**96**	**92**	**98**	**811**

Graph No. 3
Distribution of types of Documents

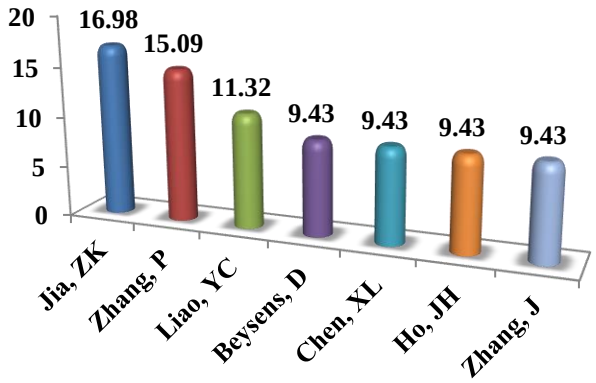


[Table No. 3 & Graph No. 3] indicates that the out of 811 total numbers of documents; Articles are 773, followed by Editorial Material 2, followed by Review 36. Articles are the most common type of document in Publication.

Table No. 4
Distribution of authors ranking of authors

Sr. No.	Author Name	Count of Author	%
1	Jia, ZK	9	16.98
2	Zhang, P	8	15.09
3	Liao, YC	6	11.32
4	Beysens, D	5	9.43
5	Chen, XL	5	9.43
6	Ho, JH	5	9.43
7	Zhang, J	5	9.43
8	4 Times 23 Authors	4	7.55
9	3 Times 46 Authors	3	5.66
10	2 Times 229 Authors	2	3.77
11	1 Times 3117 Authors	1	1.89

Graph No. 4
Distribution of authors ranking of authors



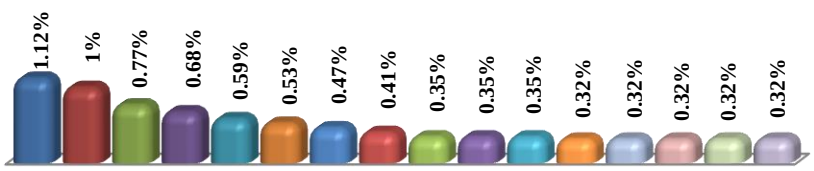
[Table No. 4 & Graph No. 4] Showed that the ranking of authors of research articles. In the rank analysis the authors who have published more than 5 articles or more are considered into account to avoid a long list. it was observed that there is total of 3454 authors records and it shows the top 11

most productive authors during 2012-2021. Jia ZK published 9 (16.98%)articles, followed by Zhang P 8(15.09%) articles, Liao, YC 6 (11.32%) articles,Beysens, D, Chen, XL, Ho, JH, Zhang, J shows 5 (9.43%) articles, and other authors have contributed less than 9.43 % during the period of study. The data set clearly depicts that no matter how many publications that an author brings out yet the quality publications alone shows impact in the form of total local citations score and total global citations score.

Table No. 5
Ranking of Author's Affiliation

Sr. No.	Affiliations	Record Count	%
1	Northwest A F University China	38	1.12%
2	United States Department of Agriculture USDA	34	1.00%
3	Chinese Academy of Sciences	26	0.77%
4	CGIAR	23	0.68%
5	Indian Council of Agricultural Research ICAR	20	0.59%
6	Wageningen University Research	18	0.53%
7	University of California System	16	0.47%
8	Commonwealth Scientific Industrial Research Organisation CSIRO	14	0.41%
9	INRAE	12	0.35%
10	State University System of Florida	12	0.35%
11	UniversidadeEstadualPaulista	12	0.35%
12	Centre National De La RechercheScientifique CNRS	11	0.32%
13	League of European Research Universities LERU	11	0.32%
14	University of Chinese Academy of Sciences CAS	11	0.32%
15	University of Florida	11	0.32%
16	University of Pretoria	11	0.32%
17	Ten times Affiliations	3	0.88%
18	Nine times Affiliations	5	1.33%
19	Eight times Affiliations	3	0.71%
20	Seven times Affiliations	7	1.44%
21	Sixtimes Affiliations	19	3.36%
22	Five times Affiliations	23	3.39%
23	Four times Affiliations	33	3.89%
24	Three times Affiliations	82	7.25%
25	Two times Affiliations	210	12.38 %
26	One times Affiliations	885	26.09 %
27	NA	1842	31.01 %
Total		**3392**	**100.00 %**

Graph No. 5
Ranking of Author's Affiliation



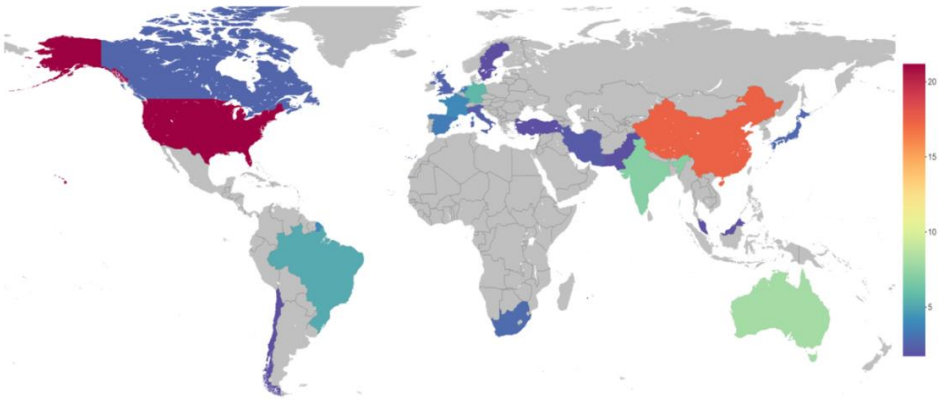
The distribution of published papers by institution wise the [Table No. 5 & Graph No. 5]reveals that out of 811 contributors, the highest number of contributors are contributed form the Northwest A F University China 38 (1.12%) and 34 (1.00%) of contributors are contributed form United States Department of Agriculture USDA. The Chinese

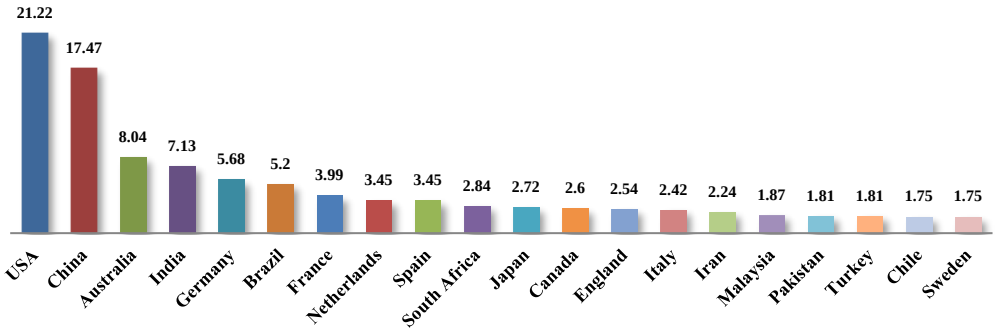
Academy of Sciences 26 (0.77%) Institution stands on Third place and 885 with one publication and respectively.

Table No. 6
Distribution of the Publication Country/Regions wise

Sr. No.	Country	Count of Country	%	Sr. No.	Country	Count of Country	%
1	USA	351	21.22	11	Japan	45	2.72
2	China	289	17.47	12	Canada	43	2.6
3	Australia	133	8.04	13	UK	42	2.54
4	India	118	7.13	14	Italy	40	2.42
5	Germany	94	5.68	15	Iran	37	2.24
6	Brazil	86	5.2	16	Malaysia	31	1.87
7	France	66	3.99	17	Pakistan	30	1.81
8	Netherlands	57	3.45	18	Turkey	30	1.81
9	Spain	57	3.45	19	Chile	29	1.75
10	South Africa	47	2.84	20	Sweden	29	1.75

Graph No. 6
Distribution of the Publication Country/Regions wise



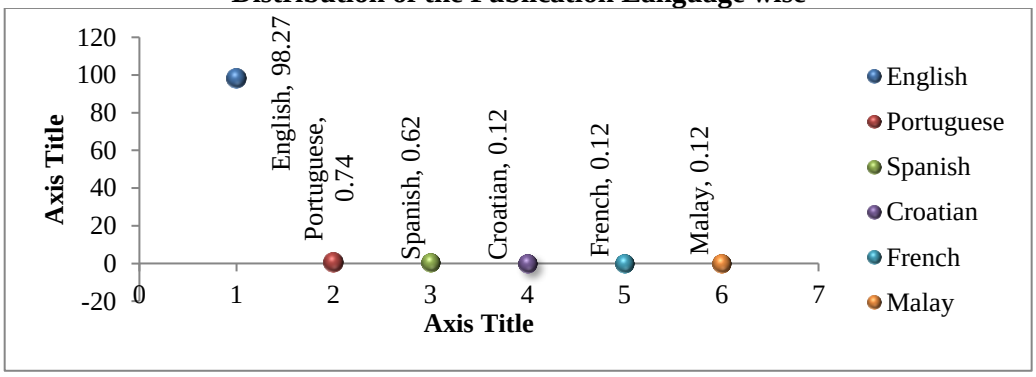


[Table No. 6 & Graph No. 6] shows that out of 3454 Countries, 351 (21.22%) Countries are most USA. Followed by China 289 (17.47%), Australia 133 (8.04%), India 118 (7.13%), Germany 94 (5.68%) on fifth position. Hypothesis No. 2 is valid USA Publications is dominant over other Publication.

Table No. 7
Distribution of the Publication Language wise

Language	Contributions	Percentage
English	797	98.27
Portuguese	6	0.74
Spanish	5	0.62
Croatian	1	0.12
French	1	0.12
Malay	1	0.12
Total	**811**	**100.00**

Graph No. 7
Distribution of the Publication Language wise



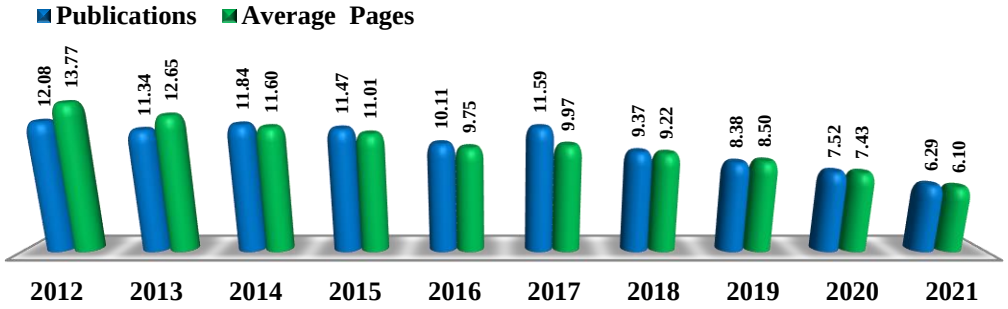
[Table no. 7 and Graph No. 7] represent the language wise distribution of publications from 2012 to 2021. The English language came first position with 797 (98.27%). It is followed by Portuguesewith 6 (0.74%) and Spanishwith 5 (0.62%), respectively. Hypothesis No. 1 is valid, Among the Publication, English is the predominant language.

Table No. 8
Average pages Publications per year

Year	No. of Contributions	No. of Pages	%
2021	98	1410	**13.77**
2020	92	1295	**12.65**
2019	96	1187	**11.60**
2018	93	1127	**11.01**
2017	82	998	**9.75**
2016	94	1021	**9.97**

2015	76	944	**9.22**
2014	68	870	**8.50**
2013	61	761	**7.43**
2012	51	624	**6.10**
Total	**811**	**10237**	**100.00**

Graph No. 8
Average pages Publications per year



[Table No. 8 and Graph No. 8] Shows that the average pages per year. The maximum pages1410 (13.77%) ware covered in the year of 2021 and minimum pages 624 (6.10%) wear covered in the year 2012 contribution was 51.

Table No. 9
Keyword wise distribution of the Publication

Sr. No.	Keyword	Count of Keyword	%
1	Rainwater harvesting	90	20.98
2	Climate change	34	7.93
3	water use efficiency	31	7.23
4	Irrigation	27	6.29
5	water harvesting	27	6.29
6	yield	26	6.06
7	water quality	20	4.66
8	Evapotranspiration	18	4.20
9	sustainability	17	3.96
10	Runoff	15	3.50
11	Soil moisture	13	3.03
12	water management	13	3.03
13	drinking water	12	2.80
14	Maize	12	2.80
15	Drought	11	2.56
16	Energy harvesting	11	2.56
17	grain yield	11	2.56
18	Nitrogen	11	2.56
19	Biomass	10	2.33
20	Rainwater	10	2.33
21	water stress	10	2.33
Total			**100.00**

Graph No. 9
Keyword wise distribution of the Publication

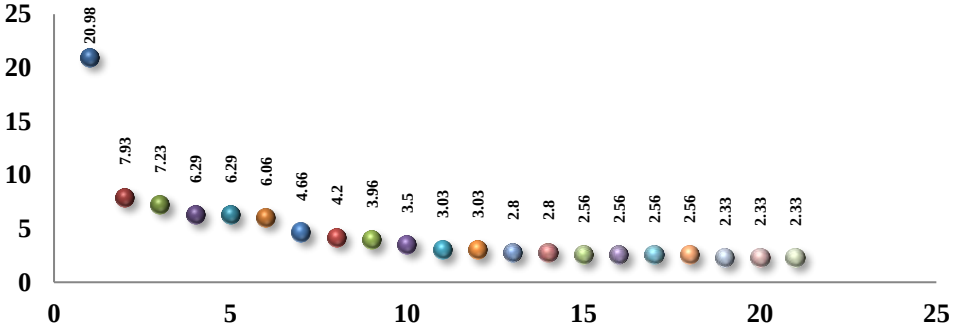


Table No. 9 & Graph No. 9] presents the top 21 keywords mostly used by the researchers in their publications. It is clearly seen from the above table that the word "Rainwater harvesting" has been used 90(20.98%) times by the Researchers with total link strength is 3943. Followed by "Climate change" are 34 (7.93%) occurrences, Followed by "water use efficiency" is 31 (7.23%) occurrences, Followed by "Irrigation" and "water harvesting" is Fifth position with 27 occurrences, Occurrences and total links strength is 3943.

Conclusion:

In this Study we can observed, the number of papers published in "Rain water harvesting" has gradually increased during2012-2021. The study has shown that 811 research review documents have been published in Rain water harvesting during the period. It could be identified that the author's wise analysis the following authors 'Jia ZK', and 'Zhang P' were acknowledged the most prolific authors based on the number of research papers contributed. Articles are the most common type of document in Publication and English is the predominant language. It study shows that the country wise analysis the following countries USA, China, Australia, India, Germany isthe network visualization depicting collaboration trends among major authors, countries and institutions is expected to be useful to the scientific community in analyzing the research trends on "Rain water harvesting". It will be help the librarians and Researcher to guide and analysis.

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