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GREEN ECONOMICS RESEARCH TRENDS IN WORLD: A BIBLIOMETRIC STUDY

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ABSTRACT

This paper conducts a Bibliometric analysis with the aim of identifying significant contributions to the literature of green economics. There has been a rapid increase in the number of academic publications in the emerging field of green economics. Green Economics made a significant contribution to the satisfaction of environmental and human needs. In this context, the researcher has done a detailed analysis of green economics research based on the Scopus database for the period of 2012-2021. Data were inputted in MS- Excel sheet and various tables have been made for analysis of data. The highest publications were counted in 2020 with 980 articles while China was the most productive country followed by United States in green economics. K. Zaman was the top prolific author with 15 articles followed by W.W. Clark with 12 articles and the Journal of Cleaner Production was highly cited source followed by Sustainability (Switzerland) and Environmental Science and Pollution Research. This study will be useful for the future researchers and people working in this field.

KEYWORDS: ***Bibliometrics, Green Economics, Environmental Economics, Scopus, Environmental Sustainability.***

1. INTRODUCTION

The economic condition of any country depends on the natural resources available in the country, so its conservation is necessary. Decisions taken by policy makers, business people and administrators depend on the ecosystem. The degradation of the ecosystem in all areas mainly poses a risk to the livelihood of the people and hence human suffers. Therefore human and social welfare depends on nature itself. Green economy is defined as environmental risk, ecological reduction and also necessary to achieve sustainability in human activities without harming the environment. This economy also supports harmonious interaction between human and nature and it tries to meet the needs of both human and environment. It strives to establish a good relationship between humans and the environment. The importance of green economics is to meet the human needs as well as to keep the environment in mind. Green economists pay more attention to the economic decisions as it is linked with the ecosystem. Green economics is understood as a broad term. It is an independent field. It is understood as a subset of a broader investment. Green economics is closely related to ecological economics. It is seen as the economic value of measuring natural resources. Bibliometric is used for mathematical and statistical analysis. Bibliometrics word made with two words "Biblio" and "Metrics" which means metrics or measurement. According to Alan Pritchard, the word of Bibliometric is defined as the application of statistical and mathematical methods for analysis of books and other publications. These research works also track the researcher output and impact. Bibliometric has been used for analysis of green economics publications such as books, book chapters, research papers, articles and other

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publications. The main Purpose of the study measured the growth of literature in the field of Green Economics which helps researchers to find out impactful literature published. The motive of this paper is to mathematically study of research publications of the world in the field of green economics as well as to identify all aspects related to it, such as the growth of literature, the most productivity of authors, prominent subject, Year wise publication, Author Keyword Occurrence etc.

2. REVIEW OF LITERATURE

Review of literature is basically give outline of the previously published work on a specific topic. The literature's review is necessary for research work as it helps in framing the research problem. Through the review of literature researcher understand the background of the topic.

Purnomo (2021) presented Bibliometric analysis of Green Economy. A total 2319 articles were considered in this study, which was published between 1990-2019.Author described the country wise publication; the China has the highest contribution in Green economy studies. Bucharest University of economics studies is the highest research organization which published 42 documents.

Chițimiea, Miniciu, Manta, Ciocoiu & Veith (2021) examined the importance of implementing green investment within organizations and also identifies factors influencing decisions for the implementation of green investment. It included 444 articles in the period 1990–2020. Identified highly cited authors and articles, highlighted keyword occurrence which was highly used for green investment.

Saleem, Khattak, Ur Rehman & Ashiq (2021) find out the productive and influential countries USA is top most country. Bucharest University of Economic studies, Romania are highly productive organization. Data were retrieved from 1977-2020. In the year of 2019 found most successfully publication year with 118 articles published during the study year.

Amato & Korhonen (2021) has conducted comparative analysis of green economy, circular economy and bio-economy studies in terms of their respective and combined potentials for global net sustainability. Author described that e-complementary contribution of all three narratives provides important direction, but it is still incomplete and not sufficient for progress towards global net stability.

Singh & Bharati (2020) evaluated research productivity on Indian Contribution on Antibiotic Resistance and data were extracted from Scopus database 445 documents considered of this study. He finds the most productive year and observed that Karolinska institute ranked in first place with 16 publications and A.J was ranked top most corresponding author.

Singh & Bharati (2020) visualized the publications on plagiarism indexed in Scopus database. A total of 1882 publications were found during the year 2010-2019. He used VOS viewer software for visualization and analyzed the research trends and collaboration among scientist, organizations and countries.

Bharati & Singh (2020) did a Bibliometric analysis of global research productivity on Coronavirus from 2011- Feb 2020. He found 7758 papers during the study period which indexed in Scopus database. In this study author found that 2015 was most productive year with 1012 publications. USA ranked in first place with 2373 publications followed by China with 1378 publications. C. Dusten was ranked top most corresponding author with 108 articles.

Setyaningsih, Indarti & Jie (2018) described Green Manufacturing and provide an extensive Bibliometric review. Author used PoP and Google scholar for data collection and collected data in two phases. Initially obtained 374 papers and after refinement obtained 76 papers. He measures various metrics such as year of publication, highly cited publishers.

Bagal (2016) described about human needs, the material of the earth and all are connected together harmoniously and provided ten interrelated principles to covered key dimensions for green economy.

Fahimnia, Sarkis & Davarvani (2015) identify topological analysis, identification of author keywords, interrelations, collaboration and also mapping the graphically illustrate the publication and relationships with among the highest impact works and outline the articles with their most frequently occurring keywords.

Bina (2013) examined three patterns- scarcity and limits, means and ends, reductionism (separation) and unity which helped and explained for sustainable development.

3. OBJECTIVES

1. To find out the growth pattern of publication in Green Economics literature.
2. To examine the communication channels in Green Economics research.

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3. To find out the most productive authors and journals in Green Economics research.
4. To identify the most prolific country in the publication of Green Economics research.
5. To examine the highly cited source documents, countries and articles in the field of Green Economics research.
6. To identify author keywords occurrence of Green Economics research.
7. To study the language and subject wise distribution of Green Economics research.
8. To find out the top most funding sponsoring bodies in Green Economics research.

4. METHODOLOGY

For this study, Scopus database was used for data collection. TITLE-ABS-KEY (green AND economics) AND PUBYEAR > 2011 AND PUBYEAR < 2022 used in one query. A total 6514 publications were retrieved during the study period from 2012-2021 which were indexed in Scopus database. Bibliometrics laws were applied and Microsoft Excel software was used for data analysis and graphical representation of the data.

5. DATA ANALYSIS AND INTERPRETATION

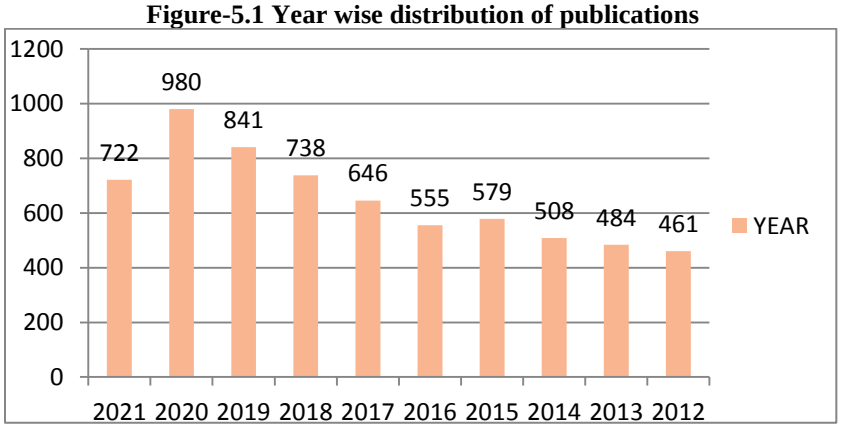
5.1. Year wise distribution

Year wise distribution of publication of Green Economics has been presented in table 5.1 and figure 5.1. A total 6514 publications were found during the study period. It is observed that the highest number of publication in 2020 with 980 articles and the least number of publication 461(7.07%) was published in 2012. It has been seen that the number of publication were increasing year by year.

Table-5.1 Year wise distribution

Year	Number of Publications	%
2021	722	11.08%
2020	980	15.04%
2019	841	12.91%
2018	738	11.32%
2017	646	9.91%
2016	555	8.52%
2015	579	8.88%
2014	508	7.79%
2013	484	7.43%
2012	461	7.07%
Total	6514	100%

Figure-5.1 Year wise distribution of publications



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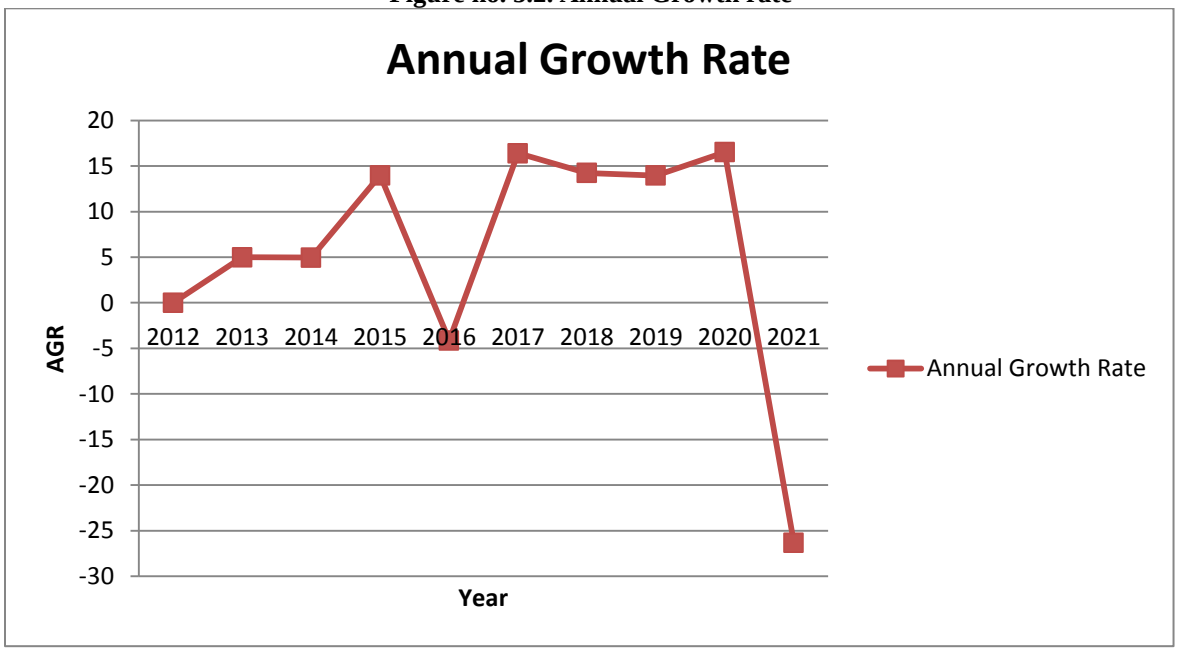
5.2 Annual Growth Rate

Table 5.2 described that the Annual Growth Rate on Green Economics research. It is found that maximum AGR found in year 2020 with 16.53 percent followed by 16.40% in 2017 during the study year from 2012-2021. Further is also seen that minimum -4.15% AGR recorded in the year 2016 followed by -26.33 in the year 2021.

Table-5.2 Annual Growth Rate of Green Economics Publications

Year	Initial Value (W1)	End Value (W2)		AGR
2012	0	461	461	0
2013	461	484	23	4.99
2014	484	508	24	4.96
2015	508	579	71	13.98
2016	579	555	-24	-4.15
2017	555	646	91	16.40
2018	646	738	92	14.24
2019	738	841	103	13.96
2020	841	980	139	16.53
2021	980	722	-258	-26.33

Figure no. 5.2. Annual Growth rate



5.3 Relative Growth Rate and Doubling Time

Table 5.3 shows that the value of the relative growth rate and doubling time of publications on Green Economics. The maximum 0.15 Annual Growth Rate was recorded in the year 2017 and 2020 followed by 0.13 recorded on 2018 and the minimum -0.04 Relative Growth Rate recorded in 2016. Further, the calculation has been made for doubling time for the publication of Green Economics. Maximum 14.32 Doubling time is calculated in year 2014 followed by 14.23 Doubling time in the year 2013. Minimum -2.27 Doubling time is recorded in the year 2021 followed by -16.37 in the year 2016. The Relative growth rate and doubling time for the year 2012 to 2021 is shown in this below table.

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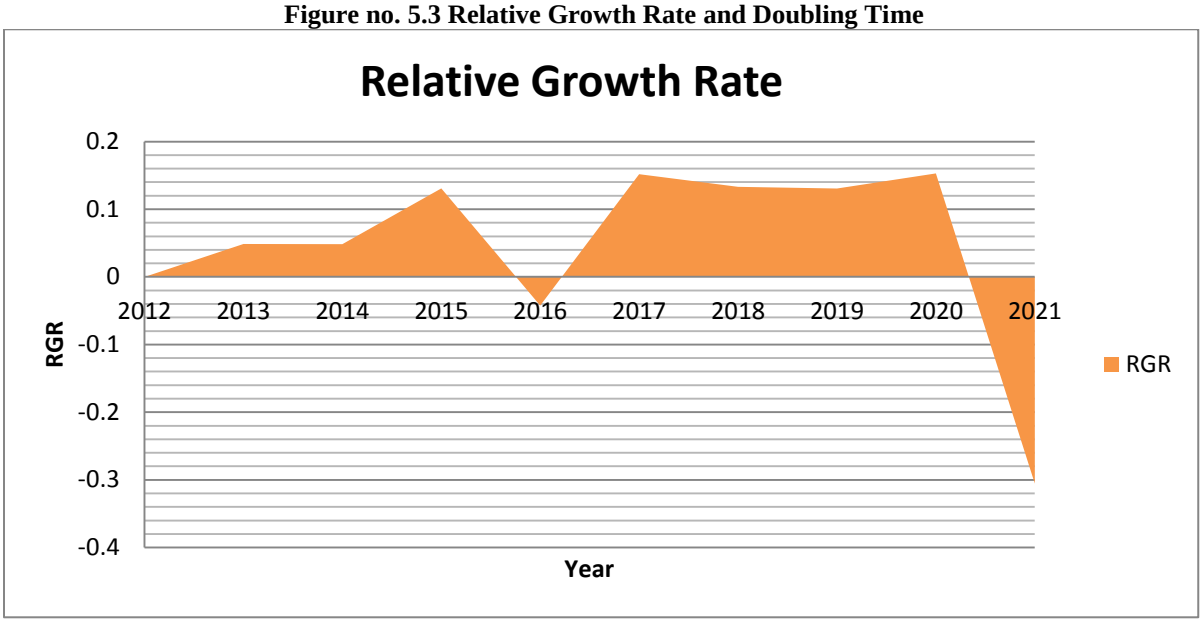
Table-5.3 Relative Growth Rate and Doubling Time of Publications

Year	Initial Value of Publications	New added Publications	End Value of Publications	W1	W2	RGR	Dt
2012	0	461	461	0.00	6.13		0.00
2013	461	484	945	6.13	6.18	0.05	14.23
2014	484	508	1453	6.18	6.23	0.05	14.32
2015	508	579	2032	6.23	6.36	0.13	5.30
2016	579	555	2587	6.36	6.32	-0.04	-16.37
2017	555	646	3233	6.32	6.47	0.15	4.56
2018	646	738	3971	6.47	6.60	0.13	5.20
2019	738	841	4812	6.60	6.73	0.13	5.30
2020	841	980	5792	6.73	6.89	0.15	4.53
2021	980	722	6514	6.89	6.58	-0.31	-2.27

Figure no. 5.3 Relative Growth Rate and Doubling Time



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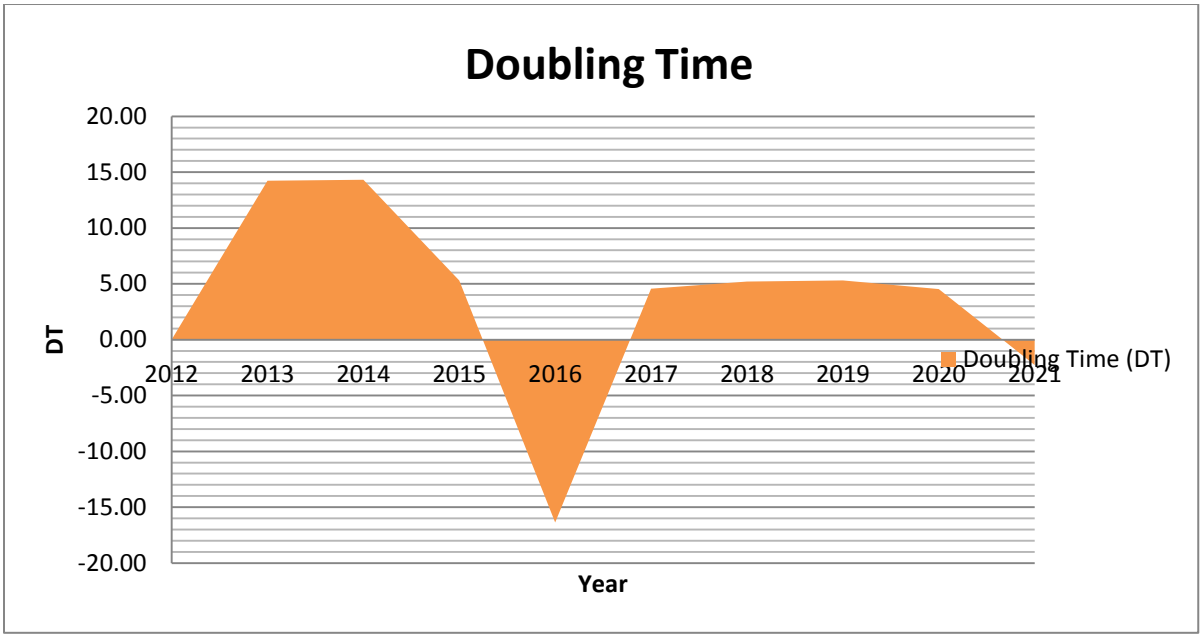

5.4. Communication Channels

Table and Figure 5.4 show the communication channels with their number of publication. It is observed that maximum number of 4376 (67.17%) documents were published in article type, followed by conference paper 1259 (19.32%), Review 419(6.43%) and other communication channels are published than 1% literature.

Table-5.4 Communication Channels

Sr.No.	Communication Channels	Number of Publication	%
1.	Article	4376	67.17839
2.	Conference Paper	1259	19.3276
3.	Review	419	6.4323
4.	Book Chapter	223	3.423396
5.	Book	135	2.072459
6.	Note	29	0.445195
7.	Editorial	28	0.429843
8.	Short Survey	16	0.245625
9.	Conference Review	13	0.19957
10.	Letter	8	0.122812
11.	Erratum	7	0.107461
12.	Retracted	1	0.015352
Total		6514	100%

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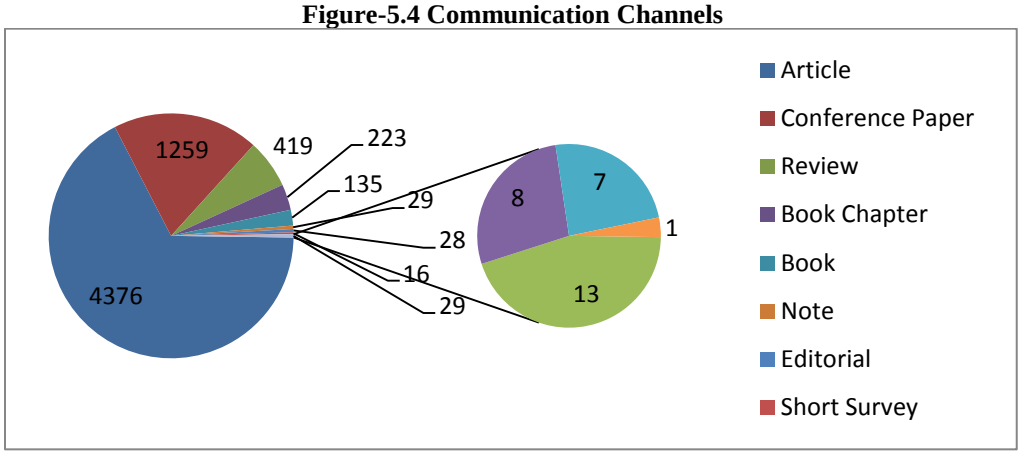
Figure-5.4 Communication Channels



5.5. Most Productive Country

Most productive countries based on Green Economics research during 2012-2021 is presented in table 5.5. It is identified more than a hundred countries around the globe have published literature in Green Economics. Among these participated countries top ten countries are ranked and presented according its publication. China published 1771(19.94%) articles in Green Economics which is ranked in first place, followed by 'United States' published 1029(11.58%) articles which is in second place, U.K. published 525 (5.91%) articles which is ranked in third place , India published 511(5.75%) articles which is ranked in fourth place, Germany published 312 (3.57% articles) which is in fifth place.

Table 5.5 Most Productive Country

Sr. No.	Countries	Number of Publication
1.	China	1771
2.	United States	1029
3.	United Kingdom	525
4.	India	511
5.	Germany	317
6.	Italy	289
7.	Australia	264
8.	Netherlands	223
9.	Spain	218
10.	Canada	216

5.6 Most cited countries

Table and Figure 5.6 visualize the top twenty most cited countries in the publication of Green Economics literature. For visualization and citations count minimum no of documents and citations were selected at least 5 by country, 256 countries with 81 thresh hold it is seen that China was the most cited country followed by United States and united Kingdom and India has been placed at fourth place in world.

Table 5.6 Twenty Most Cited Countries

Sr. No.	Country	Documents Citations	Total Link	Strength
1.	China	1833	1332	1404
2.	United States	1047	162	853
3.	United Kingdom	536	7712	847
4.	India	523	106	198
5.	Germany	324	535	578

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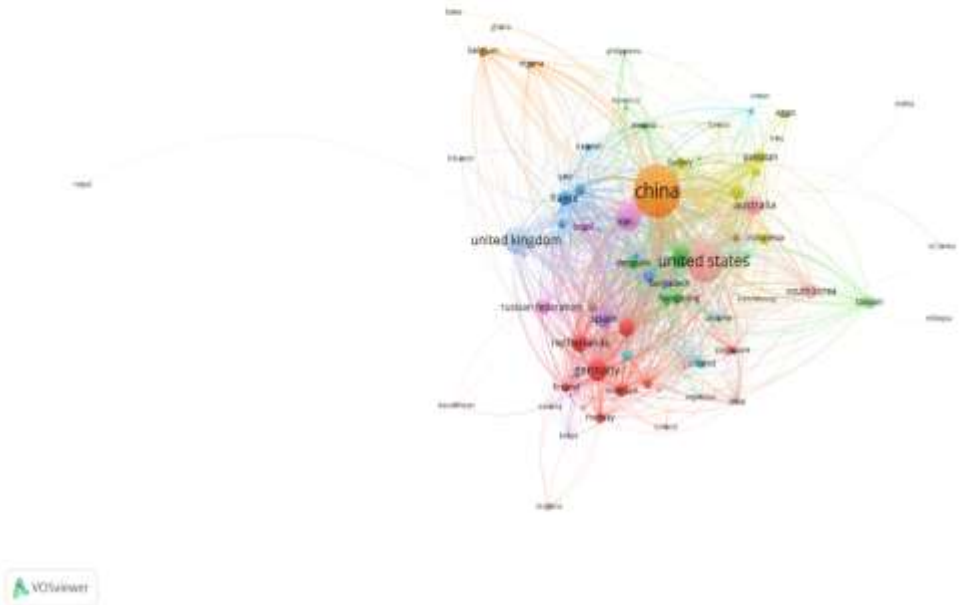
6.	Italy	301	306	397
7.	Australia	267	81	445
8.	Spain	226	208	352
9.	Netherlands	224	161	425
10.	Canada	217	753	221
11.	Malaysia	176	782	212
12.	France	159	3903	262
13.	South Korea	146	488	154
14.	Taiwan	137	3493	155
15.	Sweden	128	63	244
16.	Pakistan	103	3249	184
17.	Brazil	96	1701	159
18.	Denmark	92	1941	201
19.	Switzerland	89	1676	146
20.	Hong Kong	75	24496	151
21.	Austria	73	7127	155
22.	Finland	57	105	193

Figure 5.6 Twenty Most Cited Countries



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5.7. Most Productive Authors

Most productive authors are based on their published articles in Green Economics during the study period were presented in table-5.7. It is identified that a total of 736 authors around the globe have contributed in Green Economics. K. Zaman was identified as the most productive author with 15 articles followed by W.W Clark published 12 articles and Long, R with 11 articles.

Table 5.7 Most Productive Authors

Sr. No.	Author Name	Number of Publication
1.	Zaman, K.	15
2.	Clark, W.W.	12
3.	Long, R.	11
4.	Song, M.	11
5.	Govindan, K.	9
6.	Khan, S.A.R.	9
7.	Lin, B.	9
8.	Musango, J.K.	9
9.	Sarkis, J.	9
10.	Sharif, A.	9

5.8. Author Keyword Occurrences

Table and figure no 5.8 show the author keyword occurrences with the help of Vosviewer. This figure is showing the frequently used author keywords in Green Economics research. Top twenty keywords used in visualization and various colors shows the various keywords research area. The minimum number of occurrences of keyword was considered at 5. The number of keywords can be seen by the size of the circles, if the circle is bigger it means the larger number of the publication used this keyword. It has been observed that Sustainability term was most used author keyword followed by Sustainable Development and Green Economy.

Table 5.8 Top Twenty Authors Keyword

Sr. No.	Keyword	Occurrences	Total Link Strength
1.	Sustainability	329	171
2.	Sustainable Development	258	151
3.	Green Economy	199	125
4.	Renewable Energy	171	70
5.	Economics	168	50
6.	Climate Change	167	131
7.	China	139	37
8.	Circular Economy	117	61
9.	Energy Efficiency	109	42
10.	Green Growth	109	90
11.	Environment	94	70
12.	Economic Growth	90	76
13.	Ecosystem Services	77	40
14.	Energy Consumption	73	46
15.	Energy	67	48
16.	Co2 Emissions	60	40
17.	Green Infrastructure	57	25
18.	Policy	44	42
19.	Environmental Economics	42	32
20.	Innovation	41	27

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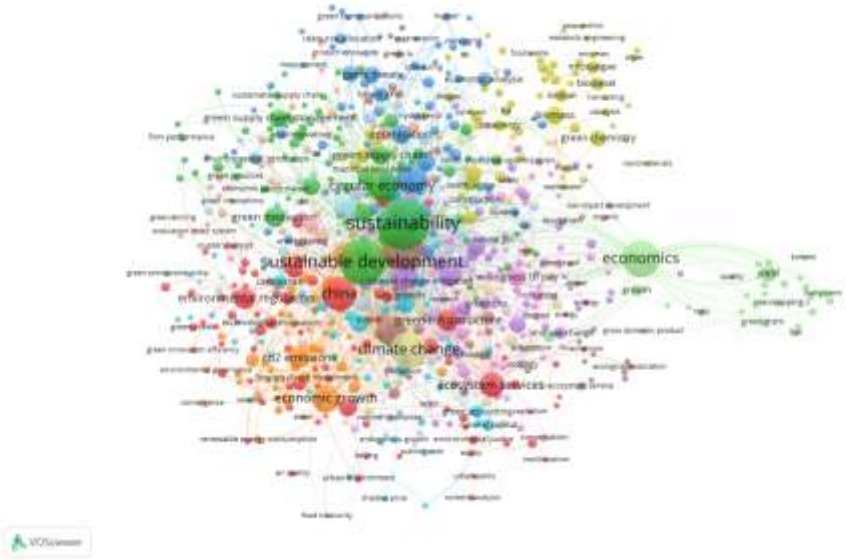
Figure 5.8 Top Twenty Authors Keyword



5.9. Subject wise distribution

Table 5.9 reveals that subject wise distribution of literature in Green Economics from 2012-2021.There are 27 subjects which are publishing articles on Green Economics. It is observed from the subject wise distribution of Green Economics 22.27 percent articles published in Environmental Science subject, 12.61 percent publication in Energy, and 11.64 percent published in Engineering, 9.36 percent of the Social Science, 6.41 percent publication in Business Management and Accounting.

Table 5.9 Subject wise distribution of Publication

Sr. No.	Subject	Number of Publications
1.	Environmental Science	2967
2.	Energy	1680
3.	Engineering	1552
4.	Social Sciences	1248
5.	Business, Management and Accounting	855
6.	Economics, Econometrics and Finance	735
7.	Agricultural and Biological Sciences	728
8.	Earth and Planetary Sciences	563
9.	Computer Science	545
10.	Medicine	372

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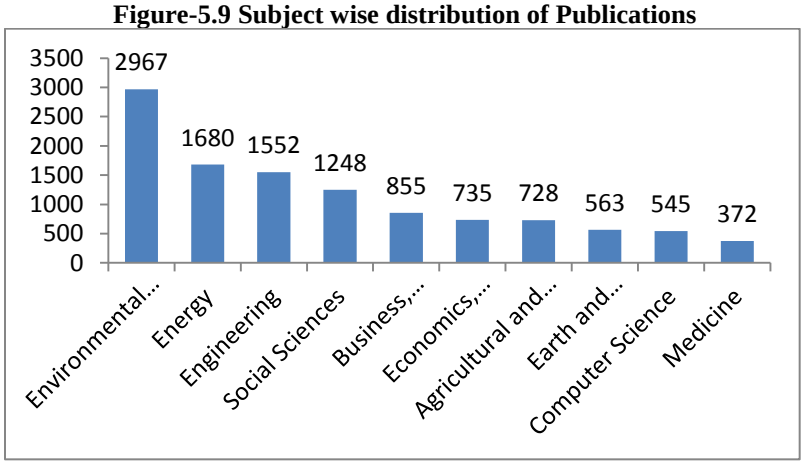
Figure-5.9 Subject wise distribution of Publications



5.10. Language wise distribution of Publications

Language wise distribution of publication based on literature published in Green Economics during the year 2012-2021 is presented in table 5.10 and figure 5.10. It is identified that Green Economics literature published in 20 languages. It has been observed that the maximum number of articles published in English Language 6330 (96.93%), followed by Chinese with 139 (2.12%) publications, Spanish with 15 (0.22%) publications, Russian with 10 (0.15%) publications, and 5 (0.07%) publications in French and rest of the publication are published in other language.

Table 5.10 Language wise distribution of publication

Sr.No	Language	Number of Publication
1.	English	6330
2.	Chinese	139
3.	Spanish	15
4.	Russian	10
5.	French	5
6.	German	5
7.	Italian	4
8.	Turkish	4
9.	Korean	3
10.	Portuguese	3

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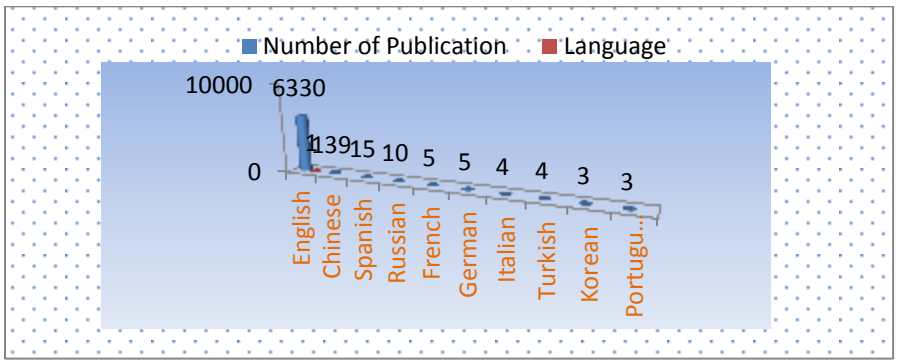
Figure 5.10 Language wise distribution of publication



5.11. Fund Sponsoring Bodies

List of fund sponsoring bodies of Green economics literature during the study period were presented in table 5.11 and figure 5.11.Total 160 bodies released funds to various institutes for conducting research in Green Economics. It has been observed that the *National Natural Science Foundation of China* has sponsored 646 times to various institutions followed by *Ministry of Education of the people's republic of China* has also given grants and European *Commission provides* with 197 grants different institutes provide fund to promote research on Green Economics.

Table 5.11 Fund Sponsoring Bodies

Sr. No.	Fund Sponsoring Bodies	Number of Grants
1.	National Natural Science Foundation of China	646
2.	Ministry of Education of the People's Republic of China	213
3.	European Commission	197
4.	Fundamental Research Funds for the Central Universities	118
5.	National Office for Philosophy and Social Sciences	105
6.	Ministry of Finance	103
7.	Ministry of Science and Technology of the People's Republic of China	90
8.	National Science Foundation	85
9.	UK Research and Innovation	82
10.	China Postdoctoral Science Foundation	78

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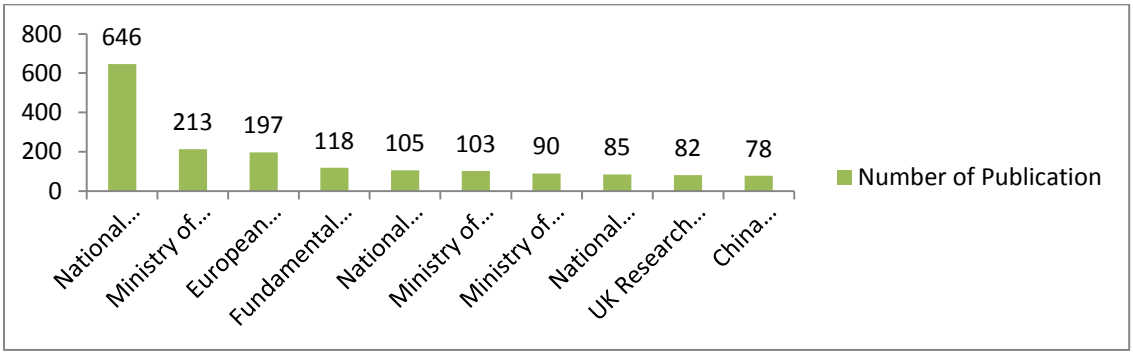
Figure-5.11 Fund Sponsoring Bodies



5.12. Most Productive Journals

Most productive journals are based on their publication of the Green Economics during the year of 2012-2021 were shown in the table 5.12. A total 160 journals have been observed for the output of 3576 articles. It is found that *Journal of Cleaner Production* with 272 (7.60%) the most productive journal followed by *Sustainability Switzerland* with 255 (7.13%) followed by top Conference Series Earth and Environmental Science with 159 (4.44%).

Table 5.12 Most Productive Journals

Sr. No.	Name of the journal	Articles	%
1.	Journal Of Cleaner Production	272	7.606264
2.	Sustainability Switzerland	255	7.130872
3.	Iop Conference Series Earth And Environmental Science	159	4.446309
4.	Environmental Science And Pollution Research	99	2.768456
5.	International Journal Of Environmental Research And Public Health	99	2.768456
6.	Energy Policy	98	2.740492
7.	Ecological Economics	96	2.684564
8.	E3s Web Of Conferences	95	2.6566
9.	Science Of The Total Environment	91	2.544743
10.	Renewable And Sustainable Energy Reviews	76	2.069351

5.13 Top twenty most cited sources

Table and Figure no. 5.13 show the highly cited sources in the publication of Green Economics literature during the study year. Only top twenty sources are taken for visualization. It is seen that Journal of Cleaner Production was highly cited source followed by Sustainability (Switzerland) and Environmental Science and Pollution Research.

Table no 5.13 Top twenty most cited sources

Sr. No.	Source	Documents	Citations	Total Link Strength
1.	Journal Of Cleaner Production	277	21	331
2.	Sustainability (Switzerland)	262	1837	186
3.	Environmental Science and Pollution Research	103	1881	120
4.	International Journal of Environmental Research And Public Health	103	146	113
5.	Energy Policy	100	162	145
6.	Science of the Total Environment	98	175	103

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7.	Ecological Economics	97	155	91
8.	Renewable and Sustainable Energy Reviews	78	2103	68
9.	Business Strategy and The Environment	74	35	66
10.	Resources, Conservation And Recycling	74	270	82
11.	Energy Economics	63	24	128
12.	Ecological Indicators	52	49	58
13.	Journal of Environmental Management	51	71	63
14.	Applied Energy	43	63	39
15.	Technological Forecasting And Social Change	41	53	55
16.	Bioresource Technology	36	7	4
17.	Journal of Environmental Economics And Management	30	62	24
18.	Landscape and Urban Planning	25	277	23
19.	Transportation Research Part E: Logistics And Transportation Review	22	13	29
20.	chemsuschem	13	20	1

Figure no. 5.13 Top twenty most cited sources

5.14. Highly cited Articles

Table 5.14 shows the ten highly cited articles in Green Economics during the year of 2012-2021. It is observed that *Hydrothermal treatment of grass: A low-cost, green route to nitrogen-doped, carbon-rich, photoluminescent polymer nanodots as an effective fluorescent sensing platform for label-free detection of Cu(II) ions* was highly cited article with 1064 citations followed by *Furfural-A promising platform for lignocellulosic*

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biofuels with 937 citations followed by *Silicon-Based nanomaterials for lithium-ion batteries: A review* with 839 citations.

Table 5.14 Highly Cited Articles

Sr.no.	Title	Authors	Cited by
1.	Hydrothermal treatment of grass: A low-cost, green route to nitrogen-doped, carbon-rich, photoluminescent polymer nanodots as an effective fluorescent sensing platform for label-free detection of Cu(II) ions	Liu S., Tian J., Wang L., Zhang Y., Qin X., Luo Y., Asiri A.M., Al-Youbi A.O., Sun X.	1064
2.	Furfural-A promising platform for lignocellulosic biofuels	Lange J.-P., Van Der Heide E., Van Buijtenen J., Price R.	937
3.	Silicon-Based nanomaterials for lithium-ion batteries: A review	Su X., Wu Q., Li J., Xiao X., Lott A., Lu W., Sheldon B.W., Wu J.	839
4.	Economical, green synthesis of fluorescent carbon nanoparticles and their use as probes for sensitive and selective detection of mercury(II) ions	Lu W., Qin X., Liu S., Chang G., Zhang Y., Luo Y., Asiri A.M., Al-Youbi A.O., Sun X.	782
5.	Classifying and valuing ecosystem services for urban planning	Gómez-Baggethun E., Barton D.N.	738
6.	A comparative overview of hydrogen production processes	Nikolaidis P., Poullikkas A.	658
7.	IDISCO: A simple, rapid method to immunolabel large tissue samples for volume imaging	Renier N., Wu Z., Simon D.J., Yang J., Ariel P., Tessier-Lavigne M.	611
8.	Bringing ecosystem services into economic decision-making: Land use in the United Kingdom	Bateman I.J., Harwood A.R., Mace G.M., Watson R.T., Abson D.J., Andrews B., Binner A., Crowe A., Day B.H., Dugdale S., Fezzi C., Foden J., Hadley D., Haines-Young R., Hulme M., Kontoleon A., Lovett A.A., Munday P., Pascual U., Paterson J., Perino G., Sen A., Siriwardena G., Van Soest D., Termansen M.	585
9.	Operations Research for green logistics - An overview of aspects, issues, contributions and challenges	Dekker R., Bloemhof J., Mallidis I.	499
10.	Recovery and recycling of lithium: A review	Swain B.	470

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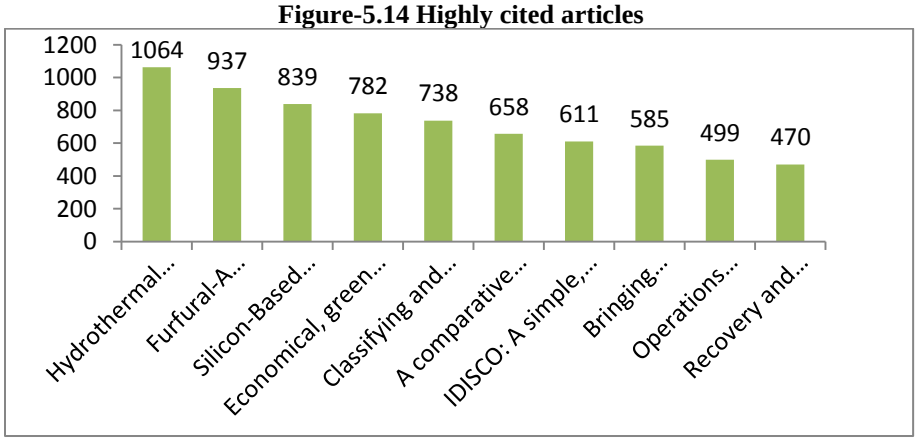
Figure-5.14 Highly cited articles



6. FINDINGS AND CONCLUSION

The overall study provides comprehensive review of the literature published on Green Economics research. Through this paper several prospective opportunities for future research are proposed. Researcher can design strategies by going through this research work. Researchers working in green economics may take cues from the study to formulate strategies. This study reveals that *China* is top most country which publish 1771 articles where as India is in fourth rank with 511 articles and in year wise distribution the number of publication has declined from 980 to 722 during 2021 to 2020 and number of publication from 738 in the year 2018 has gone up to 841 in year 2019. An average number of 651 publications are published per year during the study period. It is observed that Environmental Science, Energy, Engineering and Social science are major subject covered the Green Economics literature. Total 4376 (67%) publication are in Article form followed by Conference Paper with 1259 (19%) publications. *English* is the dominant language in the field of Green Economics. Maximum literature published in United Kingdom based journal called *Journal of Cleaner Production* with 272 articles .Top ten highly cited articles also have been observed in this study. Hydrothermal treatment of grass: A low-cost, green route to nitrogen-doped, carbon-rich, photoluminescent poly mer nanodots as an effective fluorescent sensing platform for label-free detection of Cu(II) ions is highly cited article with 1064 citations followed by Furfural platform for lignocellulosic biofuels with 937 citations. In Green Economics National Natural Science foundation of China provides maximum fund followed by Ministry of education of the People's Republic of China with 213 grants. The *Journal of Cleaner Production* was highly cited source followed by *Sustainability (Switzerland)* and *Environmental Science and Pollution Research*. This study reveals that number of publications in Green Economics is increasing and it deals with environmental sustainability which guides citizens to judicially use the eco system and sustain it for future. It is a very relevant topic for humans and environmental needs for whole world and this study will be beneficial for future.

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