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ENVIRONMENT AND/ OR ECONOMICS - A BIBLIOMETRIC PERSPECTIVE (1989-2021)

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ABSTRACT:

The current paper is an examination of published research works on the broad theme of environment as dealt in published research works in economics. Generally, it is observed that the theme of environment falls at the other end of the spectrum when economic activities are analysed. This lends the theme a more significant perspective to be examined as environment-natural and anthropogenic, forms the base of any economic activity. Besides, economic pursuits are in many ways considered antagonistic to environment, thereby creating environmental issues. In the present examination, the multiple aspects of environment as dealt in various forms in published research in economics discipline are examined through the Web of Science database for the time period of record from 1989-2021. The bibliometric analysis is supplemented with the results derived from VOS Viewer software on bibliometric aspects. Results indicate that the nature of interpretation of environment is not clearly visible in publications; although there are publications from diverse backgrounds dealing with both economics and environment. Further, the discipline of economics is the main contributor of publications on the topic but the relationship as exhibited between the two themes relates more to a supply chain kind of environment in a lab or factory kind of setting. Observations on natural environment don't find a significant mention.

KEYWORDS: *Environment, Economics, Bibliometric, Economic Activities.*

INTRODUCTION

Economics can be observed as a social science which does not have any single definition (Robbins, 2007; Association, 2022). It can range from attempting to examine the aspects of wealth (Rutherford, 2013), of scarcity and choices (Mayer, 2010) and that of both wealth and scarcity (Rutherford, 2007). It is also defined as a study of people's activities (Mayer, 2010). Economics tends to work at the theoretical and also applicable aspects (Rutherford, 2007). Environment is defined as the surrounding on various kinds of an organism; involving both

natural and human made milieu (Dictionary, 2022; Webster, 2022). In economic activities and pursuits of economy, natural environment forms the basis (Fisher & Peterson, 1976).

This kind of environment is more related to the branch of classical and neo- classical economics which recognises the limitations imposed by the environment on human activities (Thampapillai & Ruth, 2019). Malthusian ideas in this regard are amongst the most acknowledged (Kula, 1994; Bashford & Chaplin, 2017). It is very significant to observe that economic concerns have negatively impacted the environment particularly in the last 300 years (Kula, 1994). In this context, economic activities can be seen to generate externalities and the scale of these activities is highly significant in determining effects on the environment and the boundaries of economics and environment as interfaces are not having any solutions (Kumar, 2004). Human impacts on the natural environment have been less acknowledged in the name of development and accruing economic benefits (Costanza, et al., 2015) and '*homo economicus'* perspectives which have dealt with economic motives, have been the dominant factor (Kumar, 2004). These impacts are more pronounced and destructive in the last hundred years

Majority of economic studies are observed to treat the environment and development concerns separately (Thampapillai & Ruth, 2019). Within all these academic interactions, a new branch of economics has emerged in the 1960s as ecological economics (Kumar, 2004; Thampapillai & Ruth, 2019). A number of issues encompass in observing the economics environment studies (Kumar, 2004). It is also a perception that economists and ecologists have a misunderstanding amongst themselves with respect to environment (Fullerton & Stavins, 2019) but any change in one will lead to an impact on the other component (Hanley et al., 2016). International conventions and treaties are majorly an outcome of the interrelationship between economic activities and their subsequent impacts on the environment (Chichilnisky & Heal, 2013). These are also a cause of tension (Cato, 2020) and thus, perspectives of the economy and environment determine how to tackle the concerns (Hussen, 2004). In these studies, effort is also to improve the world (Daly & Farley, 2009).

In the light of these perspectives, the paper tends to check the literature on the concern of environment in research. The attempt is carried with the help of Web of Science (WoS) database through the VOS Viewer. The analysis attempts to select research papers in the database that pertain to environment as dealt in economic concerns and tends to analyse the focus of these papers through title, abstract, and key words to bring out the patterns in research. The aim is to observe the nature of content on the concern of environment and the economics involved herein. In this regard, a thorough literature review on bibliometric analysis can broadly highlight the nature of research and thrust of the research as well. It is also documented that the research on Ecosystem Services and that too specifically on Ecological Economics has gained the maximum spurt in the last few years (Xu & Marinova, 2013; Pauna et al., 2018; Zhang et al., 2019; Wang et al., 2021).

Literature Review

The significance of Ecological Economics gaining popularity as a sub discipline is a strong indicative of the study of environment in economics. Besides, bibliometric studies have attained significance as a recognised research field (Wang et al., 2020). It provides immense utility in analysing research through multiple databases and in large quantitites as well through multiple aspects (Donthu et al., 2021). These can relate to trend analysis, components and focus of research as well as the geographic dimensions of research works (Xu & Marinova, 2013; Zhang

et al., 2019). Bibliometric analysis in economics is visible in various forms and for different time periods. Since the focus of the current examination is the aspect of environment in multiple forms as observed in economic studies, literature pertaining to the topic is extracted for discussion here.

Nicholas Georgescu- Roegen is credited to the development of ecological economics and is termed as the 'father' of this branch of economics (Mayumi, 2001). In terms of its need and evolution, ecological economics can be said to have emerged significantly in the 1980s as a response to the inadequacy of existing ecological themes to incorporate the social and ecological concerns (Lawn, 2007). It is also acknowledged that the problems of environment arise due to economic undertakings (Baumgartner et al., 2006) and overexploitation of natural resources for these pursuits are the reason behind this (Andersson & Eriksson, 2010) and also pollution of various kinds (SOAS, n.d.).

Research also harps that the natural assets too come under accounting of economic activities and that a harmony between nature and humanity is the requirement for survival (Groot, 1987). But this has largely been neglected (Farber, et al., 2006).

Evolving paradigms in the discipline of economics have also seen the changing nature of relationship between human pursuits and nature and the technocratic approach is also followed by an ecocentric one (Turner et al., 1990). Besides, all these concerns, ecological economics has an action centric approach (Antunes et al., 2013). An important aspect in bibliometric analysis of the topic is that a literature analysis examining the relationship between ecology and economics is not visible (Ballandonne, 2018) although bibliometric analysis has been gaining strength in such regards (Guerrero et al., 2021). The current paper is an attempt to fill this gap by analysing publications in the field of economics and allied environmental concerns through a bibliometric examination.

While searching literature on the topic of the current study as 'Environment and Economics', it was also found that no direct reference is there for the concerns in publications in the form of research articles but books are more observed. In addition to this, a combination of economics and earth sciences is expected to generate a more applicable information on environment and sustainable development (Polasky et al., 2019). With this, the role of economics as a subject is central to such concerns (Polasky et al., 2019). The relationship between environment and economics is two sided with effects being simultaneous on each other (Panayotou, 2016).

In the process, researchers are to play a role in the form of bringing out the strengths and weaknesses of studies that are existing (Cochrane & Thornton, 1945). Geographical inequalities seem to exist strongly and, hence, require due consideration in economic studies (Crescenzi et al., 2020). The issues of economic concerns arising out of globalisation, uneven development and consequent environmental issues have made geographical observation of economics important than ever before (MacKinnon & Cumbers, 2018). Realising the importance of the topic and interrelated concerns, the present examination attempts to examine the literature through a thorough bibliometric analysis on the topic 'Environment and Economics'.

This is a broad, preliminary study to check how environmental concerns are dealt in economic studies. The search is conducted through research publication of various forms and associated aspects of titles, abstracts, key words, publishers, languages and geographies related to these publications. The output is generated, tabulated and diagramatically represented as required to support interpretation.

Database and methodology- Database for the current study is derived from the Web of Science (WoS). Previously known as Web of Knowledge, and WoS since 2004, it is one of the two large databases providing bibliographic information on multiple disciplines. It is provided by Thomson Reuters and has records from 1900 to the present. It includes several databases (Annie et al., 2015). Citation searches with diagrammatic presentations can be done through WoS (Annie et al., 2015). This makes citation search possible through indexing, citations, journals, author, country and other related bibliographic content (Ramlal et al., 2021). A commercial license is required to do analysis (Ramlal et al., 2021). It is also considered as most trusted global citation data provider in the world with 1.9 billion cited works from 171 million records (Clarivate, 2022). The WoS Core Collection gives information on more than 115 years of highest quality research works (Clarivate, 2022). The WoS Core Collection includes three indices- The Science Citation Index expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI) and, Arts and Humanities Citation Index (AHCI); all containing databases from 1989 to present (Clarivate, 2022).

Data for publications on the theme of 'Environment and Economics' is the focus of the current examination. The data generated is examined through WoS Core Collection database and analysed through the VOS Viewer software (version 1.6.18, released in January 2022). The software provides assistance in observing networks, geographies and mapping of bibliometric information for authors, geographies, key words, linkages and themes of the data. It is a software which acts as a tool for creating and visualizing bibliometric information (VOS Viewer, 2022). Default values generated by the software were not used for calculations for extracting the diagrams but the search criterion were chosen as per the nature of analysis and this is justified wherever the diagrams are inserted. The WoS Core Collection is defined as a 'premier' resource of WoS, containing more than 21,100 worldwide peer reviewed journals of high quality in more than 250 disciplines related to the sciences, social sciences and arts and humanities.

It was observed that the database generated about 7,703 results published purely on the topic 'Economics and Environment' from the time period of 1989-2021. However, it is pertinent to highlight here that the WoS database also incorporates certain errors (Franceschi et al., 2014). In the current examination, a difference was observed in the totals of certain categories of results as information generated due to the nature of pitfalls in the recorded data (Franceschi, et al., 2014) or due to data reorganistaion or others. To keep the analysis error free, attmept has been made to depict the individual results as generated for different categories. From the literature review and data generated, the bibliometric analysis is presented in descriptive, analytical and diagrammatic forms. The methodology in bibliometric analysis comprises largely of quantity (Donthu et al., 2021) .

Analysis and Results-

a. **Interpretations of the data generated on the topic 'Economics and Environment':** The search generated 7,703 works form the WoS Core Collection the topic. The details of the data for yearly results indicated an increase in the number of publications as well as citations on the topic. However, there were years where fluctuations were visible in total publications as is shown in Fig. 1. Post 2008, the number of publications and citations have increased on a constant basis with an exception of one year.

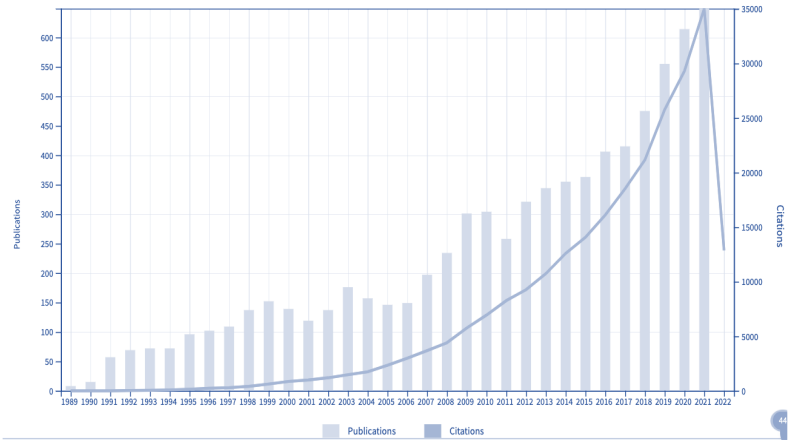


Fig. 1. Publications and Citation Record of Publications on the Topic 'Economics and Environment'

Source- Downloaded by Authors, 2022 from WoS (WoS, 2022)

The descriptive analysis is extended further to observe the distribution of this data on multiple basis. As is brought out by the literature review, other disciplines also can be important contributors in dealing with the concern in combination with economics. In the category of type of published works, following information was retrieved. Research articles dominate the results as is visible from Table 1.

Table 1. Type of Publications for 'Economics and Environment'

Publication Type	**Numbers**
Articles	6684
Review Articles	625
Proceedings Papers	450
Book Reviews	187
Editorial Materials	179
Book Chapters	62
Early Access	61
Notes	6
Reprints	4
Meeting Abstracts	4
Total	**8266**

Source- Authors, 2022 from WoS (WoS, 2022)

Table 2. depicts the information generated by the database for various disciplines listed in the WoS categories as contributors on the topic. It indicates that the topic finds a direct mention in works in economics followed by Environmental Sciences. This finding is important as nature of 'environment' in examination in economics as a social science discipline and in Environmental Sciences as a science based discipline might be different in nature.

Table 2. Contribution of Disciplines in Publications on 'Economics and Environment'

Disciplines	No. of Publications
1. Economics	1,674
2. Environmental Sciences	1,105
3. Environmental Studies	867
4. Management	560
5. Ecology	541
6. Energy Fuels	463
7. Green Sustainable Science Technology	418
8. Business	392
9. Engineering Environmental	234
10. Public Environmental Occupational Health	231
Total	**6485**

Source- Authors, 2022 from WoS (WoS, 2022)

Next analysis is done for the contributions in terms of academic affiliations and authorship on the topic. The authors of the above publications were affiliated by the institutes depicted in Table 3.

Table 3. Top 20 WoS Publication Categories on 'Economics and Environment'

Web of Science Categories	Record Count	% of 7,703
1. Economics	1674	21.73
2. Environmental Sciences	1105	14.34
3. Environmental Studies	867	11.25
4. Management	560	7.27
5. Ecology	541	7.02
6. Energy Fuels	463	6.01
7. Green Sustainable Science Technology	418	5.42
8. Business	392	5.09
9. Engineering Environmental	234	3.03
10. Public Environmental Occupational Health	231	2.99
11. Operations Research Management Science	202	2.62
12. Water Resources	201	2.61
13. Plant Sciences	198	2.57
14. Multidisciplinary Sciences	190	2.46
15. Engineering Electrical Electronic	179	2.32
16. Engineering Chemical	174	2.25
17. Regional Urban Planning	162	2.10
18. Computer Science Information Systems	158	2.05
19. Education Educational Research	138	1.80
20. Agricultural Economics Policy	137	1.77

Source- Authors, 2022 from WoS (WoS, 2022)

To extend and also simplify the examination, top ten Publication Titles are shown in Table 4.

Table 4. Top Ten Publication Titles from WoS Publication Categories on 'Economics and Environment'

Publication Titles	Record Count	% of 7,703
1. Ecological Economics	188	2.441
2. Sustainability	122	1.584
3. Journal of Cleaner Production	74	0.961
4. Journal of Economic Behaviour Organisation	61	0.792
5. Energy Policy	58	0.753
6. Renewable Sustainable Energy Reviews	53	0.688
7. IEEE Access	44	0.571
8. Environmental Resource Economics	41	0.532
9. Management Science	39	0.506
10. PLOS ONE	39	0.506

Source- Authors, 2022 from WoS (WoS, 2022)

The countries of these publications are indicated in Fig.2 below. In this Fig., USA has the maximum share in publications and appears as the core nation for this category. Besides, a close association is exhibited by maximum countries in publication. A few countries occupy the far end of the spectrum. In this, Serbia is located at the farthest end, indicating unconnected research. Canada shows a strong linkage on one side with countries such as Brazil and also USA, although it is located at the farthest end of the diagram but still exhibits a strong publication base. Germany and Australia also exhibit a high number of publications and a strong correlation and proximity with works along with Albania. Netherlands comes up as an independent node for publications and constant linkages with the core nations in the category.

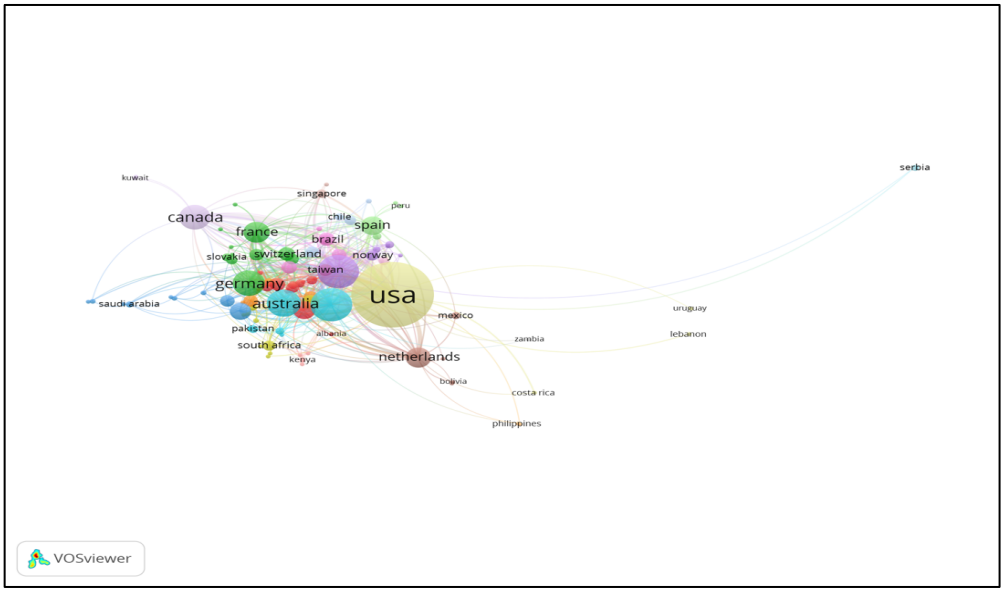


Fig.2. Countries with Publications on The Topic 'Economics and Environment'
Source- Authors, 2022 from VOS Viewer

The record of publishing houses as generated from WoS shows that Elsevier, with 2272 publications, dominated the category. It was followed by Wiley with 858 and Springer Nature with 792 published works to their credit. Considerations of languages reveals that English topped the list with 7485 publications followed by German and French with 64 and 37 works to their credit. The analysis is supplemented by the citation record of these articles.

b. Citation Report- Defined as a quantitative measure on publications and citations, it was proposed in 2005 by J.E.Hirsch to give estimation of the significance of an author's work and total research contributions (Library, 2022). Citation report of works on the Topic indicate that 218,711 published works have been cited but without self-citations and having an h-Index of 201. Further, these works have been cited 246,244 times with an average of 32.35 per item (WoS, 2022). Table 5. shows this in detail.

Table 5. Categories of Top 25 Articles without Self Citations on the Topic 'Economics and Environment'

Web of Science Categories	Record Count	% of 1,74,108
Environmental Sciences	28169	16.179
Economics	21367	12.272
Environmental Studies	18529	10.642
Management	16977	9.751
Business	13785	7.917
Green Sustainable Science Technology	13052	7.496
Energy Fuels	11913	6.842
Ecology	10066	5.781
Engineering Environmental	6912	3.97
Public Environmental Occupational Health	5514	3.167
Plant Sciences	4763	2.736
Operations Research Management Science	4644	2.667
Multidisciplinary Sciences	4634	2.662
Engineering Chemical	4605	2.645
Geography	4153	2.385
Water Resources	4017	2.307
Business Finance	3756	2.157
Regional Urban Planning	3559	2.044
Computer Science Information Systems	3146	1.807
Agronomy	2937	1.687
Engineering Industrial	2931	1.683
Engineering Electrical Electronic	2846	1.635
Biodiversity Conservation	2638	1.515
Biotechnology Applied Microbiology	2608	1.498
Materials Science Multidisciplinary	2581	1.482

Source- Authors, 2022 from WoS (WoS, 2022)

c. Exploring Linkages- Linkages between institutions and authorships was explored further to visualise the nature and extent of research works. Output indicated that for average number of publications and new authorship is constantly observed over the years. The criteria was applied by considering at least one publication contribution of the author. Visualisation of the results in Fig. 4. shows that there are group of authors who form a group and there is a concentration of published work in that group. On the other hand, maximum citations show altering strength for these author groups with one group showing high citations for the period beginning from 2014 as can be seen in Fig. 3 and 4.

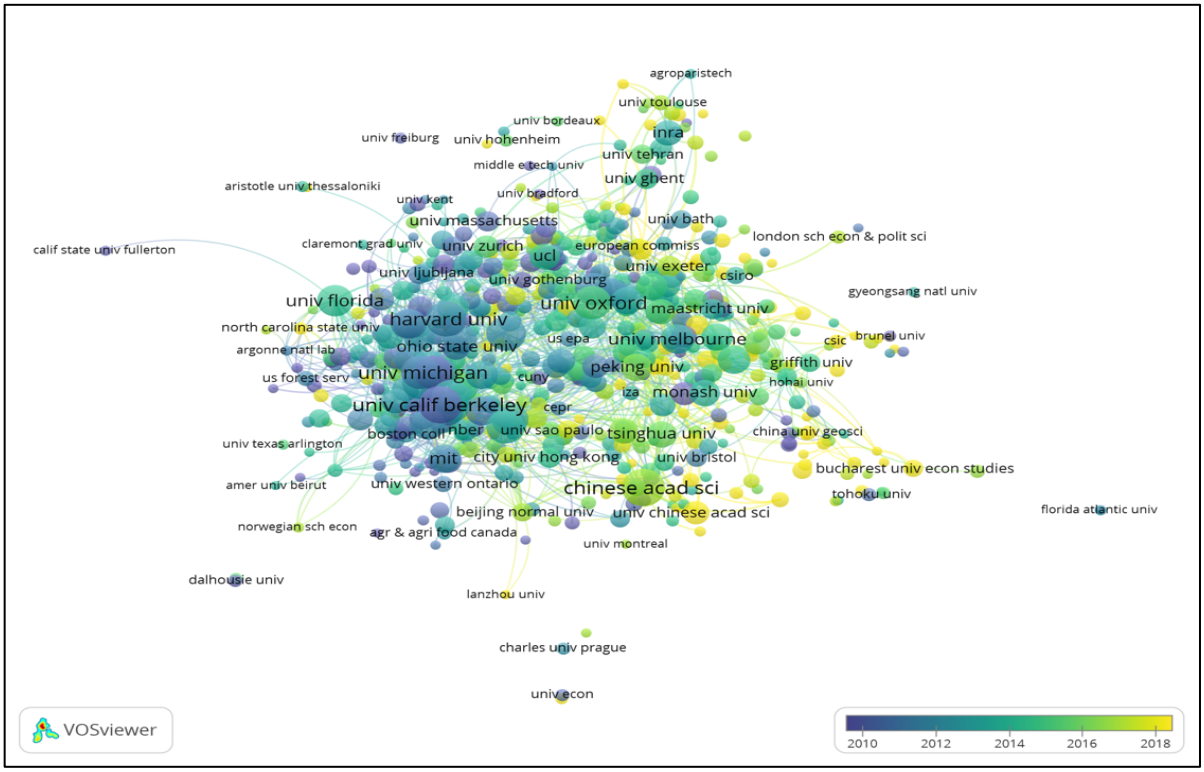


Fig.3. Linkages of Academic Centres in Publications on the Topic 'Economics and Environment'

Source- Authors, 2022 from VOS Viewer

Strong linkages were observed for the period from 2010-2018 in which the outcome has become more scattered over the years. In examining the organisation linkages for co -authorship, it was found that 4211 organisations were directly linked to each other on the criteria of a minimum of one publication. The results were varied, however, when the documents and citations were analysed independently. While giving weightage to documents and scores to average citations for visualization, results in Fig.5. revealed that the University of California Berkeley lead the group while the other 4204 institutions had overlapping display as revealed by the database indicating works in close collaborations.

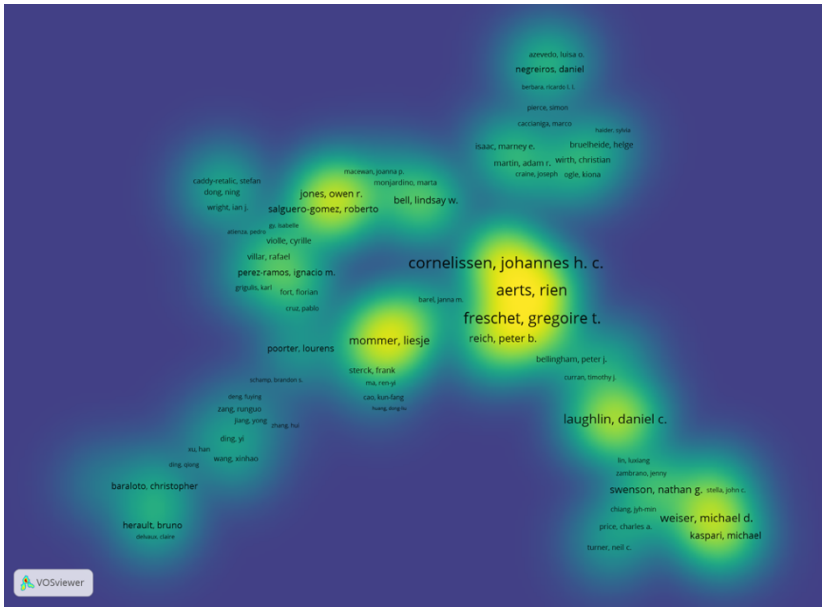


Fig.4. Authorship Linkages on the Topic 'Economics and Environment'
Source- Authors, 2022 from VOS Viewer

The association as observed is mainly within the clusters. This diagram was extracted by assigning a minimum of one co-authorship work credited to the organisation.

a. **b.**

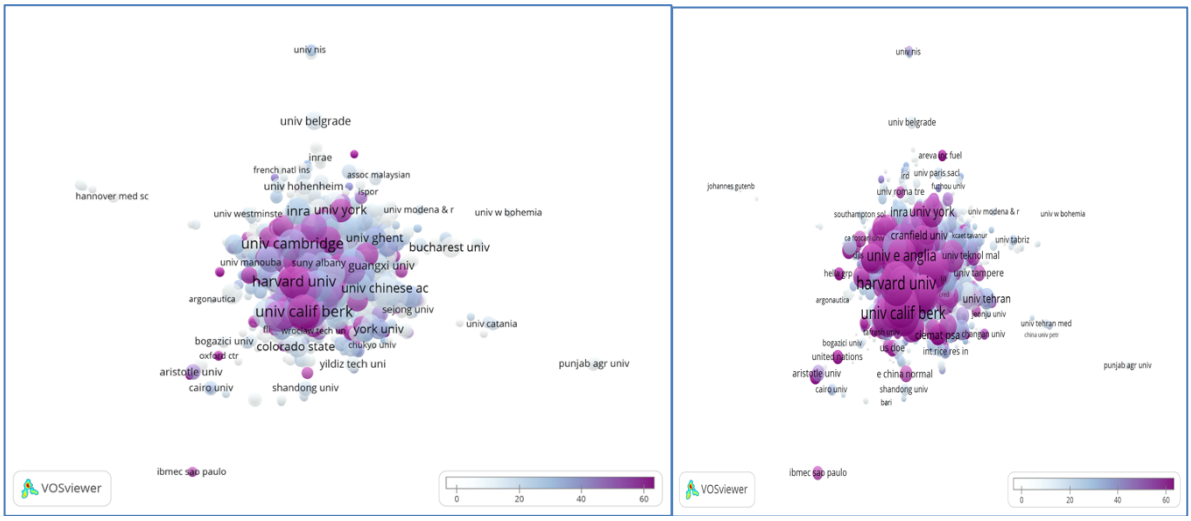


Fig. 5. Overlays Based on a. Co-Authorship and Organisations and b. Maximum Citations and Average Citations on the Topic 'Economics and Environment'
Source- Authors, 2022 from VOS Viewer

However, similar was not the case when citations were examined with average citations. In this, the maximum average citation score was with the Harvard University.

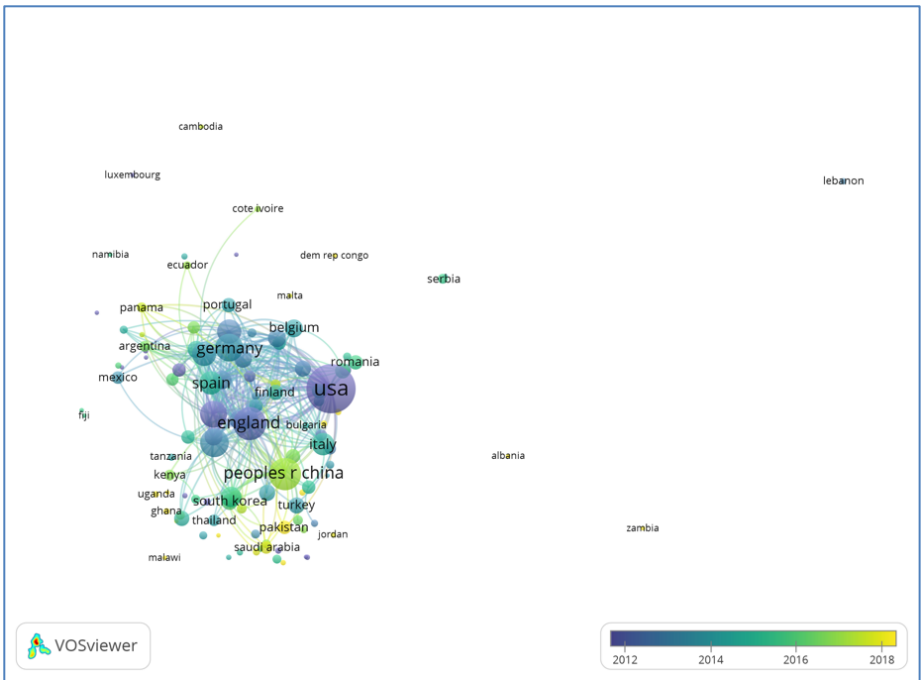


Fig. 6. Examination of Geographies of Publications with Co-Authorship on the Topic 'Economics and Environment'

Source- Authors, 2022 from VOS Viewer

When Co-authorship is analysed in relation to its geography, it was revealed that 131 out of 139 countries in the database and with a selection criteria of at least two documents for a country being set as a criteria for analysis, USA had the maximum number of documents for average publication followed by the People's Republic of China as can be seen in Fig. 6. Besides, a strong and intertwined pattern of co-authorship can be discerned between the core geographies comprising of USA and the European nations of England, Germany and Spain. These linkages gained strength from 2012 but recently the focus has been shifting towards China and Pakistan. The examination is extended to scrutinise the co-occurrence of keywords in publications. For this purpose, the criteria of a minimum occurrence of a keyword was set at two and out of 19716 author keywords, 3575 met the criteria. Economics, Environment, Sustainability, Sustainable Development, Climate Change and Power Generation Economics were the top five key words. English dominated the languages**.**

d. Keyword Analysis- The keyword analysis was generated by fixing the search at a repetition of a keyword at a minimum of 5. Out of 29, 458 keywords generated, 2029 met the threshold value. The search generated results indicated in Fig.7. and 8. Fig. 7. shows a grouping of keywords which is the first visible analysis. In this regard, the specificity of trend is observed with concentration of these groups indicating the extraction of keywords from papers of a similar category. On one hand can be seen a group in the center of the diagram with maximum strength of keywords with 'economics' dominating the result. Other groups indicate keywords from publication in health, economics, environment, energy related studies and studies dealing with ecological aspects. Fig. 8. Indicates the temporal aspects of

these keywords. It is indicated that there is a shift in keyword terminology 2010 onwards till 2018 with newer keywords lying at the outer ends of the Fig.8.

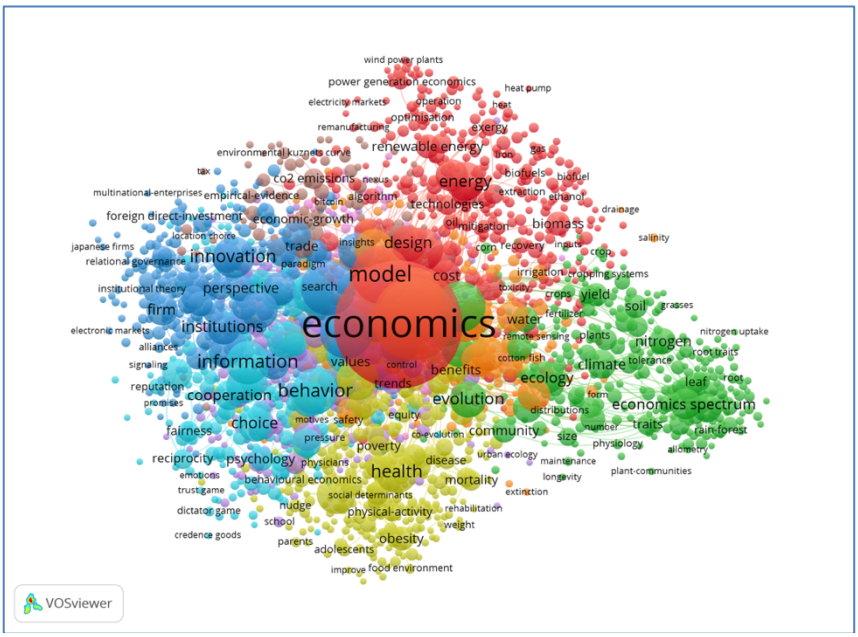


Fig.7. Output of Key Word Analysis on the Topic 'Economics and Environment'
Source- Authors, 2022 from VOS Viewer

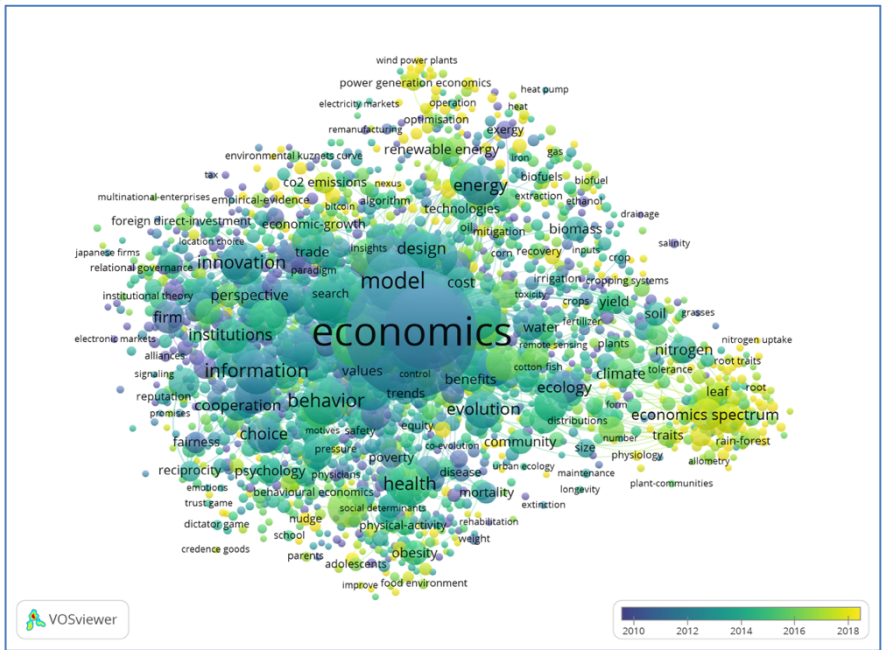


Fig.8. Output of Key Word Analysis- Temporal Trend on the Topic 'Economics and Environment'
Source- Authors, 2022 from VOS Viewer

CONCLUSIONS

The above analysis on the topic of 'Economics and Environment' aimed at finding out the treatment of natural and built environment in published works through a bibliometric case study. The WoS which was chosen for the purpose indicated an increasing trend of work in latter period of the total period of analysis. Developed countries dominate the published works category with observable works of developing countries also, but, recently. Some countries in the contributors category did not exhibit any relationship with geographies of the published works. However, it cannot be very clearly said that in what exact manner the concept of environment is incorporated in research in economics. The keyword search did indicate a shift in the evolution of terminologies, with newer words upcoming in literature. This is majorly observed in publications on energy and climate studies. It ca be concluded that the interaction of economics and environment as operating together as search indices, did not indicate much strength of relationship in publications. In fact, environmental studies somehow indicate a focus on economic studies and economic analysis seems to be operating independently in research in environmental concerns as well. But this appears less to be focused upon issues but more on production, supply chain and innovation aspects rather than on environmental concerns as expressed from time to time.

Conflict of Interest- The authors declare no conflict of interest.

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