Research Article

A Bibliometric Analysis on the Environmental Goods and Services Sector (EGSS)[1]

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Abstract

The aim of this study is to analyze articles published on EGSS from 1993 to 2023 using bibliometric methods in line with the European Union's net zero emissions target. In this way, it is intended to provide a holistic perspective to researchers interested in the subject. Additionally, it is desired to raise awareness about the need for more research in this field by emphasizing the necessity of conducting studies. Co-authorship analysis, country analysis, author keyword formation analysis, analysis of co-cited authors and co-cited journals, and bibliographic connection analysis of authors and journals were conducted on 279 articles obtained from the Web of Science database. The data were analyzed using VOSviewer 1.6.20 software. Researchers' interest in the subject has increased in recent years, peaking in 2022 with 30 articles. As a result of the analysis, the authors with the most co-authorship are Sufyan Ullah Khan and Minjuan Zhao. China, the USA, the UK, and Spain are the countries where the most publications on the subject have been made. The country with the most connections to other countries is England. The three most commonly used keywords are environmental economy, sustainable development, and environmental goods and services. The most common citation was made to the Organisation for Economic Co-Operation and Development. The most influential journals in the field of research are the Journal of Cleaner Production and Ecological Economics. The journals with the highest connections are Ecological Economics, Journal of Environmental Management, and Journal of Cleaner Production. The Monthly Labor Review is the journal that has contributed the most to the literature on EGSS. Sufyan Ullah Khan and Minjuan Zhao are the authors with the most bibliometric connections; the journal with the most bibliometric connections is Ecological Economics.

Keywords: Environmental Goods and Services, Environmental Products, Bibliometric Analysis

Introduction

With the end of World War II in 1945, while most of the colonized countries were trying to grow rapidly to solve their economic problems and get rid of backwardness, the USA and its allies aimed to restructure the post-war world economy (Diebold, 1962:356-357).

Those who rebuilt the world economy after the war, especially through international organizations such as the International Monetary Fund and the International Bank for Reconstruction and Development established in 1944, have turned to international cooperation on economic issues and promoted faster growth. Thus, the world economy demonstrated extraordinary economic growth that exceeded expectations between 1960 and 1980 (Bayoumi, 1995:48-49). During the 1970-1980 period, the relationship between growth, social development, and the environment began to be increasingly discussed, and these discussions continued throughout the 1990s. During this period, environmental issues have become more visible due to the rapid increase in industrialization, depletion of natural resources, and the rise in environmental pollution. Issues related to the environment have begun to be perceived as a global problem. The World Commission on Environment and Development introduced the term sustainable development in 1987 and prepared a report titled "Our Common Future" (World Trade Organization, 2024).

With the participation of 197 countries, the United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992. To strengthen the global response to climate change, countries initiated negotiations in 1995. As a result of these negotiations, the steps to be taken in the fight against climate change have been clarified thanks to the Kyoto Protocol, which was signed in 1997 but came into force in 2005. In 2015, in Paris, the parties to the UNFCCC agreed for the first time at the 21st Conference of the Parties to work together to combat climate change (United Nations, 2024). Based on the UNFCCC and adopted by the European Union (EU) Council Decision on April 22, 2016, the Paris Agreement aims to strengthen the global fight against climate change (with the end of the Kyoto Protocol post-2020) (Republic of Turkey Ministry of Environment, Urbanization and Climate Change, 2024; Official Journal of the European Union, 2016).

The EU signed the European Green Deal on December 11, 2019, to fulfill its commitments under the Paris Agreement and has shown its determination to achieve climate neutrality by 2050. One of the first key elements of the Green Deal, the EU Climate Law, was enacted by the EU in July 2021 (European Commission, 2024a). The EU, which is pursuing ambitious policies and close cooperation with international partners within the Union, is seriously combating climate change and environmental degradation. The EU has created a list of EGS to facilitate

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the comprehensive definition of environmental activities across member states, as provided for under Regulation No. 691/2011. This list includes 46 product and activity groups (Eurostat, 2016:9). European Commission (EC) aims to reduce net greenhouse gas emissions by at least 55% by 2030 and to make Europe a climate-neutral continent by 2050. The EU is working to reduce emissions across all sectors, from industry and energy to transportation and agriculture, in order to achieve its decarbonization targets (European Commission, 2024b). As long as climate change is a global threat, it is important that solutions are taken at the global level. The green transformation necessitates changes in economic structures. The process of gradual decarbonization of the world economy leads to the development of environmental products, known as EGS, which can mean new products and production activities or adapted existing businesses. To this end, the EC demonstrates its commitment to green transformation with this list of 46 product groups and 46 activity groups defined in the Annex to the Implementing Regulation (EU) No 2015/2174 (Eurostat, 2016).

The path to net zero emissions requires significant emissions reductions in all emitting sectors over the next few decades. Considering emissions, pollution, public health, environmental and atmospheric damage, EGSS will continue to be important and research in this area will increase. In the literature, it is seen that bibliometric studies on green economy (Albayrak, 2023; Torun, 2023), green jobs (Apostel and Barslund, 2024; Mathieu, 2023; Durmaz et al., 2023) green management approach (Kurt, 2024), green entrepreneurship (Kurtulgan, 2024; Kuzgun, 2024), green marketing (Gürdin, 2020; Savaş, 2022; Etlioğlu, 2023), green logistics (Tetteh et al, 2024; Deste et al., 2023; Çavdar, 2021), green innovation (Odabaş, 2024), bibliometric studies have increased in recent years. However, bibliometric analysis research on EGSS (environmental economics or eco-industry) is limited. This study aims to present a general picture of the literature on EGSS and to reveal the parameters that constitute the intellectual structure of the subject. Thus, it is aimed to create a database for future studies in this field and it is expected that researchers related to the subject of the study can easily explore the literature. Using the VOSviewer bibliometric analysis tool, this study aims to identify the most important contributions made to EGSS by the researchers working on the subject with various indicators such as country, institution, author, journal, number of publications and citation structure, citation relationships and keywords, co-occurrence relationships and co-authorship relationships.

Conceptual Framework -*EGSS*

EGSS is a concept that encompasses all economic activities aimed at environmental protection and the sustainable management of natural resources (Eurostat, 2016:8). In line with the goal of protecting the environment and managing the use of natural resources, EGSS consists of a heterogeneous group that produces goods and services. This sector aims to prevent, reduce, and avoid environmental pollution while producing eco-

friendly products and services. EGSS is also defined as the environmental economy or eco-industries (Eurostat, 2016:12). EGSS plays a critical role in ensuring environmental sustainability and conserving natural resources. It makes significant contributions both in the production of eco-friendly products and in the efficient use of resources. The scope of EGSS encompasses a wide range of technologies aimed at reducing environmental pollution, renewable energy systems, and organic farming. Additionally, the potential of EGSS to promote economic growth and employment further enhances the future significance of this field. The increase in global demand for eco-friendly products will drive the growth of the EGSS sector and will be an important tool in achieving the sustainable development goal (World Trade Organization, 2022:4).

Green economy is an approach that combines environmental sustainability with economic growth. In this context, although similar concepts are used in different regions, each region has developed terms that reflect its own environmental activities and economic understanding. In the USA, concepts such as Green Goods and Services or Green Technologies and Practices are generally prominent, while in the EU, a more specific approach known as the EGSS is used. The EU defines EGSS in terms of environmental activities or products. Green technologies generally encompass innovations focused on improving the environment and increasing resource efficiency. Environmental activities, on the other hand, include activities aimed at protecting the environment or managing natural resources. Environmental products, on the other hand, are a result of environmental activities. The definition of EGSS by the European Statistical Office Eurostat has been approved by the the Organisation for Economic Co-Operation and Development (OECD) and United Nations today and is recognized as a global standard (Apostel and Barslund, 2024:1-4).

As stated in Article 3.5 of Regulation (EU) No. 691/2011, the EU has created a summary of economic activities as indicators using the EGS approach to facilitate the standardization of environmental activities across member states. This list consists of 46 product groups and 46 activity groups and is included in the Annex of EU Commission Implementing Regulation No 2015/2174 (Eurostat, 2016:9).

Bibliometric Studies Related to EGSS
Numerous scientific studies related to EGSS, which aims to protect environmental resources for future generations, have been conducted using VOSviewer and VoS mapping and clustering methods. A total of 515 articles related to EGSS are listed on the vosviewer.com website, of which 418 were published between 2015 and 2024 (VOSviewer, 2024b). Among these studies, Haunschild, et al. (2016) aimed to map 222 060 studies in the literature on climate change between 1980-2014 from a bibliometric perspective. The finding of the study reveals that the total number of articles has shown a strong increase, doubling every 5-6 years. It is also stated that research on climate change has increased in the field of "engineering and

social sciences" compared to other fields and that the research is dominated by the USA.

Olczyk's (2016) study aims to reveal how the academic literature on international competition has developed and grown over the past 70 years through a bibliometric analysis. This study presents a comprehensive analysis using citation data obtained from databases such as Web of Science (WoS), Scopus, and Google Scholar. In the analysis, the structure and development processes of the literature were examined using software such as HistCite, Pajek, and VOSviewer. The findings of the study reveal the growth pattern in the international competition literature. Using bibliometric indicators and network citation analysis, the key journals in this field, important authors, the main pathways of information flow, and which aspects of the research areas stand out are determined. Additionally, the key routes and term co-occurrence analysis have been examined in more detail to identify the main research themes in this literature.

Holmberg and Hellsten (2016) conducted a content and sentiment analysis of tweets related to climate change discussions posted between September 17 and October 8, 2013, following the Intergovernmental Panel on Climate Change reports. In the study, the VOSviewer software was used for the semantic network analysis of the words in the tweets. The findings of the research indicate that users who express opinions or participate in discussions about climate change generally make posts focused on sharing information. These users are individuals who exhibit convinced and mature perspectives on climate change. On the other hand, some Twitter (X) users who are not convinced about climate change have adopted a defiant attitude by using words that reflect their negative feelings. This situation reveals that discussions about climate change on social media are not merely about information sharing, but also involve opposing views and emotional expressions. The study provides important insights into how social media data can be used as a tool to understand the social dynamics in public opinion formation and climate change discussions.

Zaharia et al. (2016) conducted a bibliometric analysis using the Scopus database and VOSviewer software to examine the progress of research in the field of energy within the context of green economy and sustainable development. In the study, a detailed analysis was conducted to understand the growth and development processes of research in the field of energy, and the main sub-themes discussed in these studies were aimed to be identified. The findings of the research reveal that topics such as sustainable energy, green energy, and renewable energy are the main areas of research at the international level. This study contributes to our understanding of how scientific contributions and discussions in the field of energy are shaped globally by revealing research trends from the perspective of the green economy and sustainable development.

Marx et al. (2017a) examined the effects of global warming on tea production in their study. For this purpose, they analyzed 14 articles indexed in the WoS database and 17 articles that cited these articles. In the study, the thematic content of these articles was revealed using the VoSviewer software. The findings obtained highlight the significance of climate change on tea production. In particular, it has been observed that discussions on the impacts of climate change and the adaptation strategies developed to cope with these impacts are coming to the forefront. This analysis provides a scientific framework on how tea production will be affected by climate change and how to adapt to this situation. In another study, Marx et al. (2017b) examined 1039 articles on the effects of climate change on viticulture between 1974 and 2016. In this study, the data obtained from articles in the WoS database were examined using the bibliometric analysis method. As a result of the analysis, it was observed that the number of publications related to viticulture has rapidly increased over the years, especially after the year 2000, when this number increased tenfold. These findings indicate the increasing scientific interest in the impacts of climate change on agriculture and the significant growth of research conducted in this field. Both studies highlight significant trends in the literature examining the impacts of climate change on various areas of the agricultural sector and ways to cope with these impacts, while also emphasizing how serious the effects of global warming on different agricultural products have become as a research topic.

Homrich et al. (2018) conducted a bibliometric analysis using 327 articles obtained from the WoS and Scopus databases to examine the circular economy literature. This analysis aims to map the main themes, trends, and structure of the literature in the field of circular economy. The findings of the research indicate that there is no consensus on terminology and definitions regarding the circular economy. In the literature, it has been revealed that the concept of circular economy carries different meanings in different contexts and that there is a lack of standardization due to the diversity of research in this field. This situation shows that studies on the circular economy sometimes progress using contradictory or inconsistent terminologies. Another important finding of the study is the development of a definition based on semantic analysis. This definition proposal has emerged as an effort to reduce the existing diversity and uncertainty in the circular economy literature. Homrich and his colleagues aimed to define the concept of the circular economy more clearly and understandably with this proposal. This study provides a foundation for the literature on circular economy to progress in a more consistent and systematic manner, emphasizing the need to eliminate terminological ambiguities in the literature. Additionally, it makes a significant contribution to the idea that research and practices related to the circular economy should be based on a more robust conceptual framework.

Apostel and Barslund (2024) present a comprehensive literature review on the measurement and characterization of green jobs worldwide. The study examines the existing methods in detail by addressing the different ways of defining and measuring green jobs. The authors

distinguish between output-based and process-based approaches regarding the classification and measurement of green jobs. The findings of the research reveal the diversity of various conceptual choices and techniques used in measuring green jobs. The authors emphasize the need to update the classification systems for green and brown jobs. These classifications allow for the separation of jobs based on their environmental impacts into "green" (based on environmentally friendly and sustainable business processes) or "brown" (based on environmentally harmful and unsustainable business processes). Apostel and Barslund argue that research should focus on these areas in order to classify green jobs more accurately and meaningfully. This study provides a significant contribution to how green jobs can be measured and classified within the context of the green economy and sustainable development, offering a guiding foundation for future research.

The objective of this study is to examine bibliometric research within EGSS and address the existing literature gap. Previous bibliometric analyses have not thoroughly explored the interconnections between key elements such as co-citation, author affiliations, countries of publication, journal relationships, and keywords in EGSS-related articles. Consequently, this study seeks to significantly contribute to the EGSS literature by distinguishing itself from prior research in this area. This study employs the VOSviewer bibliometric analysis tool to examine EGSS-related articles retrieved from the WOS database between 1993 and 2023. In particular, the study focuses on the analysis of co-citation and author links, country and journal relationships, relationships between keywords, and authors publishing joint articles. The objective of this study is to provide a comprehensive mapping of the literature in the field of EGSS, with the aim of identifying current research trends and collaborations in this field. Moreover, the study identifies deficiencies in the existing literature on EGSS and recommends potential avenues for future research.

Method

Bibliometric analyses have been widely used in recent years for a more in-depth analysis of scientific studies and for the development of better research strategies. Bibliometric methods, which are a quantitative analysis technique, help to understand how scientific communities are related to each other, which topics are being researched more, and in which areas there are gaps. However, "subject" based bibliometric analyses have been steadily increasing since the 1994s. In bibliometric analyses, the most popular topics are analyzed with "key" words (Ellegaard and Wallin, 2015:1809-1810). Bibliometric analyses, which are very popular for analyzing large volumes of bibliographic scientific data, are based on analyzing, classifying and summarizing the existing literature within a certain framework (Donthu et al. 2020:1-2). The most commonly studied bibliometric network types are citation, co-citation, bibliographic coupling, keyword co-occurrence and co-authorship networks (Van and Waltman, 2014:285). The question of what the sample size should be in bibliometric analyses is

often raised. According to statistical theory, studies with larger samples are likely to have more accurate analytical results. Therefore, it is curious how the sample size will affect the findings of the analysis. While sample size is generally not a problem in institutional studies, it is a matter of curiosity how sample size will affect the findings of the study in "topic" based studies. However, in "topic" based studies, the structure of the sample is determined by the researchers. For this reason, very little work has been done on what the sample size should be, since the overall aim of evaluation is to gather as much information as possible rather than limiting the analysis to a sample. In a Belgian bibliometric study, a sample size of 100 was used and acceptable results were obtained (Rogers et al., 2020:778-779). In recent years, large databases such as WoS, Scopus, and Google Scholar have frequently been preferred for bibliometric analyses. Each of them has strengths and weaknesses in their analysis methods, data scopes, and reference citation tools. WoS is particularly known for its extensive coverage and citation data extending back to the 1900s, and therefore, it is a widely preferred database for scientific publication analyses (Li et al., 2010). The selection of the WoS database as the primary source for the study is due to the comprehensive and reliable data it provides, which is suitable for bibliometric analyses (Lee et al., 2020:368). VOSviewer, used in bibliometric analyses, is a network-based visualization tool. It is especially used in mapping the relationships between elements such as scientific publications, journals, researchers, research institutions, countries, and keywords. The data obtained from the WoS database has been mapped using the VOSviewer software. VOSviewer is the mapping of the relationships between networks consisting of scientific publications, scientific journals, researchers, research institutions, countries, keywords, or terms. The VOSviewer software is a powerful tool capable of performing various network analyses and visualizations on scientific data. With this software, elements in networks such as co-authorship, co-occurrence, citation, bibliographic coupling, or co-citation, etc., are visualized and analyzed in analyses conducted with data obtained from WoS or other databases (VOSviewer, 2024a). The shorter the distances between these elements, the stronger their relationship with each other is considered. This is an important parameter in understanding the density of connections and the degrees of relationships in the network. VOSviewer is a powerful software for the visualization and analysis of scientific networks, measuring the density and strength of relationships using two types of weights. The number of connections and total strength represent the interaction density within the network; the node size and connection strength visualize the importance and relationship density of each element. Additionally, its support for various file formats allows it to work with different data sources, enabling researchers to perform data analyses across a wide range (Adeabah et al., 2023:3).

Analysis

Bibliometric analysis was conducted in the largest database, WoS. The search has been limited to the period

from 1993 to 2023 in order to include as many articles as possible. The reason for including the year 2024 in the study, despite it not being over yet, is to provide information about the current situation. The first publication related to the subject of the study was made in 1973. However, during the 20-year period from 1973 to 1992, a total of 8 publications were made. In this study, the reason for taking the year 1993 as a reference is that environmental issues began to be evaluated at a global level for the first time with the signing of the UNFCCC in 1992, with the participation of 197 countries. This historic milestone has enabled the transfer of environmental

policies and research to a global perspective. The aim of this study is to provide an overview of the EGSS concept and to systematically classify the literature in this field through bibliometric analysis.

Data Set

The data set comprises articles published in English in the WoS database between the years 1993 and 2024. Table 1 shows the data retrieval constraints and parameters. The dataset includes 10 identifying variables from the WoS Core Collection.

Table 1. Limitations on Data

Source database	WoS
Topic	Environmental Goods and Services Sector
Years searched	1993-2024 (There are 8 publications published in a 20-year period covering the years 1973-1992)
Search field	Author, Title, Abstract, Journal of Publication, Language of Publication, Document Type, Keyword, Citation Count, Citation Date, Publication Date
Search word groups	"Environmental Goods and Services" or "Environmental Goods and Services Sector" or "Eco-Industries" or "Environmental Economy" or "Green Goods and Services" or "Green Technologies and Practices"
Key words	Authors' similar keywords
Source type	SCI-Expanded, SSCI, ESCI indexed journals
Publication name	Scientific journal name
Author name	Name and surname of the author
Publication phase	All
Document type	Article
Broadcast language	English
Data accessibility	www.webofscience.com/wos/woscc/summary/ceb19846-3006-4343-9cdf-28bae9266b49-0113f0ea3f/relevance/1
Data access date	October 19, 2024

Source: Data from WoS database, edited by the authors.
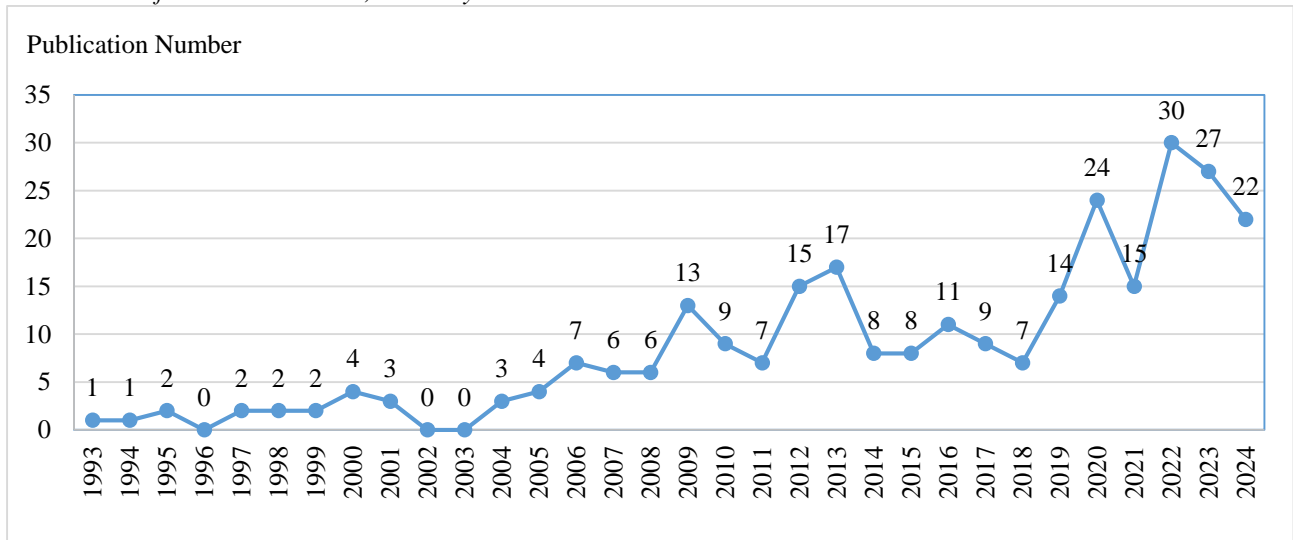
Graph 1. Years and Number of Publications (1993-2024) *Source: Data from WoS database, edited by the authors.*

The aforementioned variables have been analysis covering important information across a wide range. The purpose of this selection is to achieve the most comprehensive and thorough results possible. The titles "Environmental Goods and Services" or "Environmental Goods and Services Sector" or "Eco-Industries" or "Environmental Economy" or "Green Goods and Services" or "Green Technologies and Practices" were

used respectively in the search in the WoS database. As a result of the literature search, a total of 463 results were reduced to 279 publications after sorting by article publication type and SCI-Expanded, SSCI, ESCI index as well as English language publications (Table 2). Then, the study file consisting of only articles was included in the analysis in "txt" format.

Table 2. The Research Process

Planning Stage	Identification of studies using the titles "Environmental Goods and Services" or "Environmental Goods and Services Sector" or "Eco-Industries" or "Eco-Industries" or "Environmental Economy" or "Green Goods and Services" or "Green Technologies and Practices" in the WoS database.
Research Stage	Total Number of Publications Scanned in WoS Database :463 Number of articles : 351 Total Number of Publications Resulting from WoS Index (SCI-Expanded SSCI, ESCI): 329 Total Number of Articles in English: 279
Selection Stage	Total Number of Publications for Bibliometric Analysis: 279

Source: Data from WoS database, edited by the authors.

Findings

The study aims to examine the development of the literature related to EGSS and the research trends in this field. Data from the WoS database covering the years 1993-2024 shows how the number of publications in this field has changed over time. According to the data in Figure 1, publications related to EGSS showed a limited increase between 1993 and 2001. During this period, interest in the subject has remained quite low. However, although there was a noticeable gap in the literature in 2002 and 2003, it is observed that the number of publications has generally been on the rise since 2004, and particularly increased in recent years. 44% of the articles within the scope of the study were published between 2019 and 2023. This situation indicates that research related to EGSS has rapidly increased in recent years, and this increase has become particularly evident in the last five years. The increase observed in recent years is an indication of the growing global calls for the development of eco-friendly technologies and the establishment of environmental sustainability strategies. Especially in the 2020s, topics such as the circular economy, green technologies, and sustainable development are at the center of international policies and research

Co-Authorship Analysis
Scientific collaboration is a characteristic of contemporary academic research. Researchers are no longer independent actors, but rather team members seeking solutions to political, economic and social problems, bringing together complementary skills and interdisciplinary approaches around common goals. Co-authorship analysis is conducted to uncover collaboration between authors. This type of analysis can also be done on a country and institutional basis. Bibliometric analyses show that collaboration between researchers in different countries and geographies has increased since the 1980s (Sonnenwald, 2007:643). In the co-authorship analysis (Figure 1), which shows the collaboration between researchers, a network map was created with at least 2 publications and 1 citation criterion.
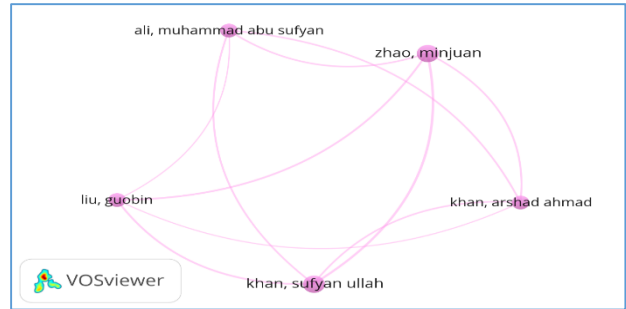

Fig. 1. Co-Authorship Network Visualization

The rationale for maintaining a relatively low threshold value is to enhance the number of authors included in the analytical process. 20 out of 834 authors meet this criterion. As a result of the analysis, 1 cluster (5 authors), 10 links and total link strength was determined as 19. In the ranking of the number of citations, A. N. Sarkar ranked first with 101 citations, Sufyan Ullah Khan, Minjuan Zhao and N. Hanley ranked second with 72 citations and Ian J. Bateman ranked third with 58 citations. In the joint total link strength ranking, which shows the total strength of a researcher's links with other researchers, Sufyan Ullah Khan and Minjuan Zhao share the first place with 9 total link strengths, Muhammad Abu Sufyan Ali and Sufyan Ullah Khan are in second place with 7 links, and Guobin Liu is in third place with 6 links. The researchers who wrote the most articles are Sufyan Ullah Khan, Minjuan Zhao, Aurora de Fatima Sanchez-Bautista, Jose Maria Ponce-Ortega, Ian J. Bateman.
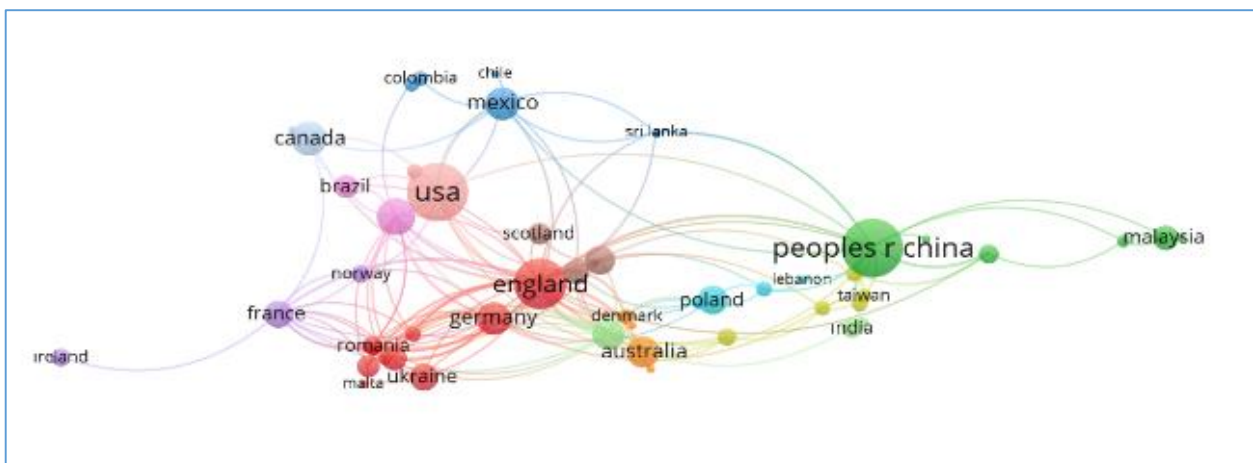

Fig. 2. Co-authorship Country Network Visualization

Co-authorship Country Analysis

As a result of the analysis conducted on 67 countries that meet the criteria of at least 1 publication and 1 citation, 12 clusters, 164 links and 188 total link strengths were identified (Figure 2).

In the publication ranking, China and the USA share the first place with 43 articles, the UK ranks second with 31 articles and Spain ranks third with 17 articles. According to Mendiluce (2024), the US sees the transition to clean energy as a major economic and industrial opportunity. In addition, Mendiluce states that weather and climate disasters have caused great damage to the US economy in the last three years and China continues to grow unabated with a green industrial strategy for the future. These developments may have increased research in the US and China.

In the ranking of countries with the highest number of citations, the USA ranks first with 1443 citations, the UK second with 884 citations and China third with 836 citations. In the total linking power ranking, the UK (43) ranks first, Italy (23) ranks second, while Germany, China and Spain (18) rank third. Turkey ranks last with 1 publication, 13 citations and zero total link strength.

Co-Occurrence Author Keywords Analysis

Keywords give an idea about provide insight into the content of a study. Keywords in a study, consisting of three to five (or more) words, represent the opinion of the author(s) on the topic of the study. The analysis of keywords contributes to the identification of research topics that are popular both in the past and currently (Pesta et al., 2018).

Figure 3 presents a network visualization showing how frequently the authors' keywords are used together in article studies. In this visual, each node represents a keyword, while the connections indicate that these keywords are used together in the same article. In other words, the lines between the nodes serve as an indicator of which keywords appear together more frequently and are related to each other in research studies. In network visualization, there are differences in terms of size. Larger nodes indicate more frequently used keywords, while smaller nodes represent less commonly used terms that may still be important. This also provides a useful representation for understanding the importance and frequency of keywords in the literature. Different colors, on the other hand, indicate which thematic group the keywords belong to. These thematic color groups visually present the research trends in the literature and the areas where more intensive studies have been conducted. In the study, the minimum number of keyword formations has been set to 3. In the analysis, 36 of the total 976 keywords meet the criterion. In the analysis of keywords meeting the criteria, 12 clusters, 164 links and 188 total link strengths were identified. As a result of the analysis, the term environmental economy ranks first with 22 occurrences and 18 link strengths. With 22 repetitions and 15 link strengths, the term sustainable development ranks second and with 16 repetitions and 13 link strengths, the term environmental goods and services ranks third.
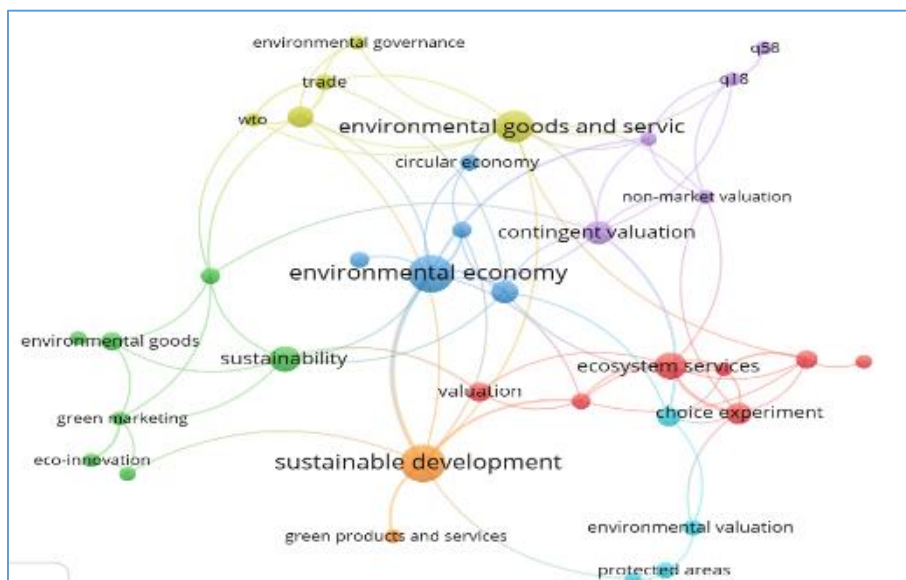

Fig. 3. Co-Occurrence Author Keywords Analysis

The environmental economy includes the production of goods and services, such as organic vegetables, renewable energy (or waste) and wastewater treatment, which help to protect the environment or conserve natural resource reserves. Moreover, the environmental economy is vital for Europe's transition to a competitive climate neutrality under the European Green Deal (Eurostat, 2024). Cluster 1 (blue) revolves around the words environmental economy, circular economy, circular economy, recycling, recycling, sustainability. Cluster 3 (light green) environmental goods and services revolves around the words trade, environmental governance, climate change and World Trade Organization (WTO).

As a keyword in WoS, q18 stands for Agricultural and Natural Resource Economics; Environmental and

Ecological Economics / Environmental Economics: refers to Government Policy. The presence of q18 and q58 as keywords in the WoS database may be due to their environmental relevance.

Co-Citation Cited Authors
Co-citation analysis is a powerful technique used in the in-depth examination of scientific literature. This analysis reveals the intellectual structure of a specific research field and some characteristics of the scientific community by examining the relationships and connections of its fundamental elements (authors, citations, journals) (Zhao,

2006:1578). Thus, the most influential publications and authors in the field of research are identified (Backhaus et al., 2011:941). Additionally, co-citation analysis is a unique way to understand the intellectual structure and cognitive dynamics of an academic field. This analysis allows for understanding both the foundational works of the past and how these works have shaped modern scientific thought. Additionally, by tracking the evolution of science, it is an important tool for examining the direction of future research and the development processes of innovative ideas (Surwase et al., 2011:180).
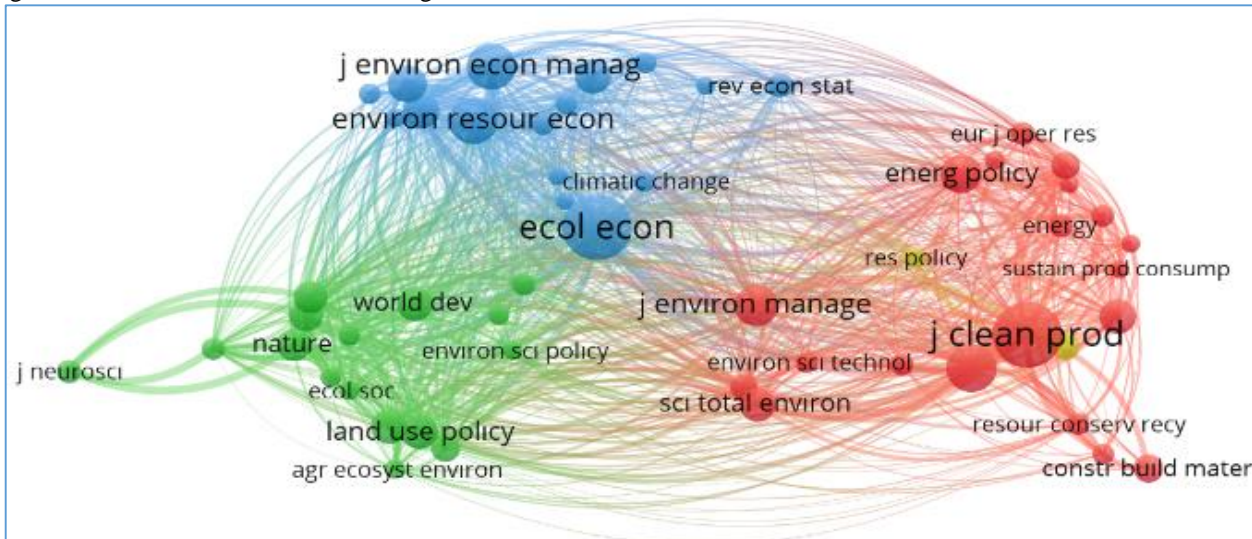

Fig. 4. Author Co-Citation Network Image

Fig.5. Journal Co-Citation Network Image

Co-authorship analysis was first introduced in 1981. The basic assumption is based on the premise that as the frequency of two authors citing each other in a paper increases, the collaboration and relationship between these authors will also become stronger (White and Griffith, 1981:163). In accordance with the specifications of the analysis program, a minimum of 20 citations is required. Nevertheless, in order to conduct a more comprehensive examination of the subject, the minimum number of citations was established at 15. According to the analysis of 9087 authors, a total of 12 authors, 3 clusters, 41 links and 444 total link strengths were identified (Figure 4). The top 5 most co-cited authors are OECD (42), Commission Europe (29), Eurostat (31), N. Hanley (30), and I. J. Bateman (28). I. J. Bateman also ranks first with 151 total connection strengths. R. J. Johnston comes second with 103 total link strength and

Commission European third with 95 total link strength. These findings show that the authors involved are the most influential authors in the research and that the authors are linked to each other. Moreover, the fact that the authors are often quoted together means that the intellectual structure between them is strong.

Co-Citation Cited Sources
Publishing in journals with prestigious indexes and receiving as many citations as possible are very effective in recognizing researchers. At least 20 citation criteria were determined and 54 out of 6449 journals meet this criterion. As a result of the analysis, 4 clusters, 1075 links and total link strength 28487 were determined from 54 journals (Figure 5). Journal of Cleaner Production ranks first with 258 citations, Ecological Economics ranks second with 255 citations and Sustainability-Basel ranks

third with 133 citations. 4831 total link strength ranked Ecological Economics first, Journal of Cleaner Production second with 4211 total link strength and Environmental & Resource Economics third with 2648 total link strength (Figure 6). Journal of Cleaner Production and Ecological Economics are the top 2 journals in both the highest number of citations and total link strength. This finding shows that Journal of Cleaner Production and Ecological Economics are the most influential journals in the researched field.

Bibliographic Coupling of Authors
The term bibliographic coupling was first coined by Kessler (1963). The concept of bibliographic linkage relates to two documents that both refer to a common document and occurs when two documents refer to a common third document. It is often used as a measure of similarity between documents. At the same time, bibliographic linkage analysis is important as it also shows documents that are not linked (Ma et al., 2022). The bibliographic citation analysis of authors is a powerful tool for understanding scientific relationships and interactions in a research field. This analysis helps map inter-author connections and collaborations through citations of authors' articles and publications (McCain, 1990:433). Van Eck and Waltman (2014) took this analysis further by examining the strength of citation relationships and the dynamics of scientific networks.

These types of analyses help us understand the flow of information in scientific fields and discover emerging research themes.

For the bibliographic coupling analysis of 834 authors, 5 authors who met at least 3 publication criteria were identified. As a result of the analysis, 1 cluster, 3 links and 306 total link strength were identified (Figure 6). Sufyan Ullah Khan and Minjuan Zhao rank first with 72 citations and 290 total link strength. Then Aurora de Fatima

Sanchez-Bautista, Jose Maria Ponce-Ortega ranked second with 24 citations and 147 total link strength and Ian J. Bateman ranked third with 58 citations and 290 total link strength.
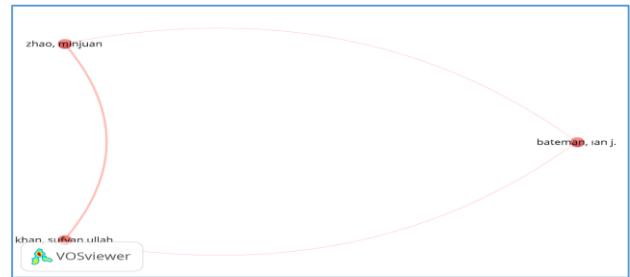

Fig. 6. Authors Bibliographic Link Network Image

Bibliographic Coupling of Sources
Bibliographic link analysis of journals is an effective method used to map the relationships and interactions of journals in a specific field. This type of analysis allows for the examination of collaborations and scientific interactions between journals through the citations they make to each other. In this analysis, the minimum number of documents is set to 5 and the minimum number of citations is set to 0. According to these criteria, only 5 out of the 191 journals analyzed meet this criterion.

As a result of the analysis, there are 2 clusters consisting of 5 journals, with 7 connections and a total connection strength of 11 (Figure 7). Ecological Economics ranks first with 10 articles, 250 citations and 8 total link strengths. Then the Journal of Environmental Management ranks second with 6 articles, 148 citations and a total of 5 link strengths and the Journal of Cleaner Production ranks third with 6 articles, 141 citations and a total of 5 link strengths. These findings show that the journals are interconnected in terms of the research topic.
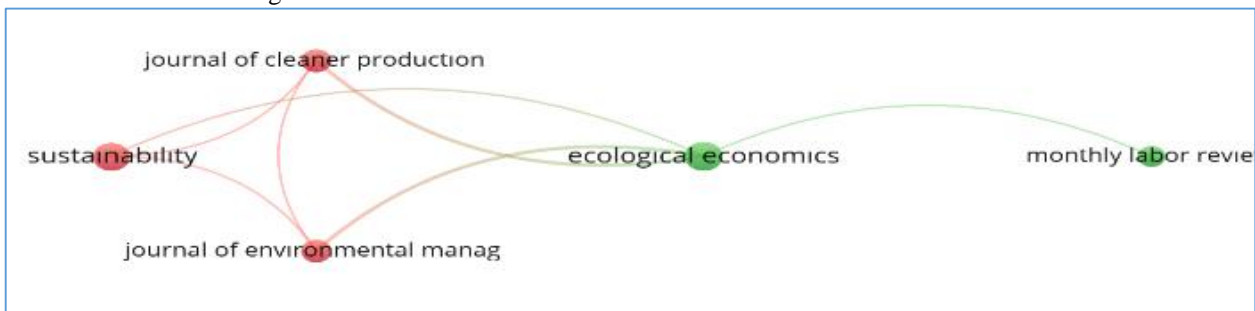

Fig. 7. Journals Bibliographic Link Network Image

Conclusion

The WTO has consistently recognized the need for continued cooperation among international institutions to tackle global environmental challenges. Given that environmental problems extend beyond national borders, international cooperation in addressing them is of utmost importance.

Given the close relationship between economic stability and climate change, environmental transformation has the potential to support future economic strength. In this

context, facilitating the development of environmental goods and services is important for countries to reduce greenhouse gas emissions and adapt to climate impacts. This paper provides an up-to-date overview of the literature on EGSS and complements and extends previous work in scope and time.

This paper assesses the progress of the literature in the field of environmental goods and services sector. The characteristics of the existing literature, leading authors, publications, organizations and collaborations are analyzed. A bibliometric analysis is adopted to assess the

evolution and development of the existing literature with English articles published in SCI-expanded, SSCI and ESCI indexed journals in the WoS database, covering the period 1993-2023. The development of the environmental goods and services sector can play a decisive role in helping countries achieve a sound economic structure in the future by promoting sustainable economic activities.

In the research, it is observed that the number of scientific studies on the environment in the WoS database for the period 1993-2023 has increased in recent years. The most studies on the subject were conducted in 2022 with 30 articles. The data were analyzed with VOSviewer 1.6.20 software. As a result of the analysis, Sufyan Ullah Khan and Minjuan Zhao were the most collaborating authors on environmental goods and services. China, the US, the UK and Spain were identified as the countries with the most publications on environmental issues. The UK also has the most links with other countries. Environmental economy, sustainable development and environmental goods and services are the most frequently used keywords. The OECD has the most co-citations. The most influential journals for research are Journal of Cleaner Production and Ecological Economics. Ecological Economics, Journal of Environmental Management and Journal of Cleaner Production are the most linked journals. Monthly Labor Review is the largest contributor to the literature on EGSS.

For most countries, EGSS is important for decarbonization goals to combat climate change and mitigate environmental problems. Data on EGSS sheds light on the debate on the ecological transition, especially in the context of environmental economics or eco-industry. Examining this data can reveal gaps in existing research and guide future academic work. Various stakeholders such as researchers, academics, institutions and decision makers can deepen their knowledge and understanding of environmental goods and services.

The limitations of this study are that only WoS database was preferred, English articles indexed in SCI-Expanded, SSCI and ESCI were selected and defined keywords were used. Subsequent scientific studies may include Scopus and Google Scholar databases. Furthermore, the dataset can be deepened for EGSS analysis by including scientific journals indexed outside SCI-Expanded, SSCI and ESCI, articles published in languages other than English, books, book chapters and conference proceedings.

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