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CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT: A BIBLIOMETRIC ANALYSIS BASED ON SCOPUS DATABASE

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Abstract

This research aimed, using certain variables, to examine the international literature sources such as articles and papers between 1993-2021 via the Scopus database and subject them to bibliometric analysis on current vital topics, "climate change" and "sustainable development." Bibliometric analysis, frequently used in academic studies in recent years, has allowed investigation of the primary criteria, such as author names, article counts, citations and publication year of scientific publications. The current research has determined 343 scientific publications by typing "climate change" and "sustainable development" into the document search bar on the Scopus database. In the study, VOSviewer Software was used to perform bibliometric analysis and mapping of the publications indexed in the Scopus database. The study has found that most studies on topics "climate change" and "sustainable development" were conducted in 2021, with 44 studies. The rising number of studies in 2021 shows the growing importance of these issues in the modern world. The study will guide those who will work on "climate change" and "sustainable development" in terms of showing how the relationship between these two issues is addressed in the literature.

Keywords: *Climate Change, Sustainable Development, Bibliometric Analysis.*

İKLİM DEĞİŞİKLİĞİ VE SÜRDÜRÜLEBİLİR KALKINMA: SCOPUS VERİ TABANINA DAYALI BİBLİYOMETRİK BİR ANALİZ

Öz

Bu araştırma günümüzde önemli görülen "iklim değişikliği" ve "sürdürülebilir kalkınma" konuları ile ilgili 1993-2021 yılları arasında uluslararası literatürde yayımlanmış olan makale ve bildiri gibi kaynakların Scopus veri tabanında belirli değişkenler ile incelenmesini ve bibliyometrik analize tabi tutulmasını amaçlamaktadır. Bibliyometrik analiz, son yıllarda yapılan akademik çalışmalarda çok fazla kullanılmaktadır. Bibliyometrik analiz yöntemi sayesinde yapılmış olan bilimsel yayınların yazar bilgisi, makale sayısı, atıf sayısı ve yıl gibi temel ölçütleri incelenmektedir. "iklim değişikliği" ve "sürdürülebilir kalkınma" konularında yapılan yayınlara Scopus veri tabanı üzerinden başlık sekmesine "climate change" and "sustainable development" şeklinde iki anahtar kelime yazılarak 343 bilimsel yayına ulaşılmaktadır. Scopus veri tabanında yer alan yayınların bibliyometrik analizini yapmak ve haritalandırmak için "VOSviewer" yazılımından faydalanılmaktadır. Sonuç olarak "iklim değişikliği" ve "sürdürülebilir kalkınma" konularında en fazla çalışma 2021 yılında 44 adet çalışmayla olmaktadır. Yapılan çalışmaların 2021 yılında artış göstermesi günümüz dünyasında bu konuların öneminin arttığının göstergesidir. Çalışma, literatürde bu iki konu arasındaki ilişkinin nasıl ele alındığını göstermesi açısından "iklim değişikliği" ve "sürdürülebilir kalkınma" konusunda çalışacaklara yol gösterecektir.

Anahtar Kelimeler: *İklim Değişikliği, Sürdürülebilir Kalkınma, Bibliyometrik Analiz.*

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1.INTRODUCTION

Climate is one of the fundamental elements making life on earth possible. However, after the Industrial Revolution in the 18th century, the emerging environmental contaminants have threatened the climate system. Therefore, the Industrial Revolution is a turning point for the future of both humanity and the earth. This period was the beginning of the Anthropocene era, in which human beings have affected the climate system. According to the IPCC (2013), the impact of humanity on the climate system is clear, and anthropogenic greenhouse gases have reached their highest levels since the Industrial Revolution. Human-induced greenhouse gases cause globally increasing temperatures by affecting the gas ratios in the atmosphere. According to the OECD (2012) Environmental Outlook report 2050, if fossil-fuel-based energy production continues to grow, there will be a 50% increase in greenhouse gas rates by 2050. Similarly, Climate Action Tracker (2021) anticipates that if the current policies persist, global average temperatures will increase by more than 2°C towards the end of the century. Accordingly, the increase in greenhouse gas rates will cause an increase in global temperatures, causing climate change to become more prominent and vigorous.

In 1987, the United Nations Brundtland Commission defined sustainability as “meeting the needs of the present without compromising those of posterity” (United Nations 1987). Sustainability means the progress of social, economic, and environmental sustainability altogether, on the same basis and direction. Living in a world where natural sustainability actively continues is only possible by consuming natural resources like soil, water, wood, air, etc., at a reasonable rate. Individuals need to use not only theirs but also of society and country efficiently and responsibly to establish economic sustainability. Social sustainability preserves the social welfare of a country, an organization, or a community in the long term (Circular Ecology 2021). Sustainable development is a piece of the puzzle in the broad spectrum of the sustainability concept. As Circular Ecology (2021) states, sustainable development is a different way of achieving sustainability.

According to the United Nations (2021a), sustainable development creates a framework for improving people’s lives and reducing the human-induced hazards that cause the climate crisis. It is necessary to restrict greenhouse gases by taking realistic and applicable steps to limit the global temperature rise to 1.5°C compared to the pre-industrial period. However, today, most efforts to prevent the climate crisis are far from reality and cause more greenhouse gas emissions, and thus, the desired success cannot be achieved. As Bartelmus (2013) states, economic sustainability actually means more and continuous production. In such a case, as Daly (1992a) declared, in this world where eco-systems are finite, combating climate change cannot be done under the name of sustainable development. Therefore, the scientific data revealed by the studies conducted in the sustainable development and climate change contexts are of great importance. A bibliometric analysis carried out through analytical tools and keywords offers a vast framework for researchers and readers to understand and interpret the studies. The results guide researchers in the field by identifying effective research institutions and proficient scientists. It contributes to scientific communication by revealing the researchers’ contents and orientations in network clusters. Thus, researchers evaluating the current situation in the field can turn to advanced research areas (Karagöz and Şeref 2019:795; Martínez-López et al. 2018).

In order to analyze previous research on “climate change” and “sustainable development,” the current study classified and mapped the data from the Scopus database using the VOSviewer program. This study has preferred the Scopus database as it contains more international scientific studies and abstracts. The study’s primary purpose is to reveal the importance of “climate change” and “sustainable development”, which affect almost every aspect of our lives today, on a global scale, via scientific data and statistics. In addition, the study is essential because no research in the literature deals with and examines both issues and provides an introductory idea for future studies.

CLIMATE CHANGE

Climate refers to the average weather pattern over long periods in vast regions around the world, as opposed to short-term weather changes observed in a particular location (Browne 2021; United Nations 2021e; University of Michigan 2021).

Since the existence of the Earth (about 4.6 billion years), there have been changes in the climate system. Climate can change the geographical, biological, and cultural characteristics of the planet. In addition, the studies carried out in the past century have shown that human-induced effects have caused changes in the climate system. After the Industrial Revolution, climate changes have led to the Anthropocene age. In this period, forest area destructions, improper agricultural activities, excessive increase in production and consumption, rising energy need, urbanization, high population growth, excessive coal, oil, and natural gas uses caused the people to release the greenhouse gases, such as carbon dioxide, methane, nitrous oxide, fluorinated gases to the atmosphere at a level that would cause a change in the atmosphere's structure (Browne 2021; Gürçam 2022:4; IPCC 2018; UNEP 2022; United Nations 2021d). Greenhouse gases released into the atmosphere because of human activities behave like a greenhouse glass, trap the reflected heat, and increase the world's global average temperature faster than the pre-industrial period (Browne 2021; Canada 2019; Damtoft et al. 2008:116; European Commission 2021).

The Intergovernmental Panel on Climate Change (IPCC), established in 1988 by the United Nations Environment Program (UNEP) and the World Meteorological Organization (WMO), has been entrusted with preparing scientific assessment reports on climate changes, effects, and future risks (IPCC, 2021). It has been over 30 years since the global response to the climate crisis was launched, based on the findings of the IPCC and various scientists on the climate crisis. However, the fight against the climate crisis has not been at the desired level, and global temperatures have increased depending upon increasing greenhouse gases.

Temperatures are expected to rise even more if current policies tackling the climate crisis continue. Some of the findings regarding the climate crisis are as follows:

In terms of temperature and greenhouse gas increases:

- Average global temperatures increased by over 1.1°C compared to the pre-industrial period.
- The global average temperature between January and October 2019 was 1.1 ± 0.1 °C above pre-industrial conditions (1850-1900). It is almost definite that the 2015-2019 and 2010-2019 averages will be the warmest five-year and ten-year periods, respectively. Since the 1980s, each successive decade has been hotter than the last (WMO, 2019).
- 2019 was the second warmest year on record (Borunda, 2020). 2016, which started with a fierce El Niño, remains the warmest year.
- Sizeable areas of the Arctic were unwontedly hot in 2019. Temperatures were higher than recent averages in most land areas, including South America, Europe, Africa, Asia, and Oceania. While the temperature was exceptionally high in the Alaska state of the US, it was colder than the last average over a large area of North America (WMO, 2019).
- Greenhouse gases, which are the main reason for the increase in global temperatures, have spiked because of fossil fuel uses. While global carbon dioxide concentrations were 315.98 ppm in 1959, they increased rapidly to 414.24 ppm in 2020 (United Nations, 2020).

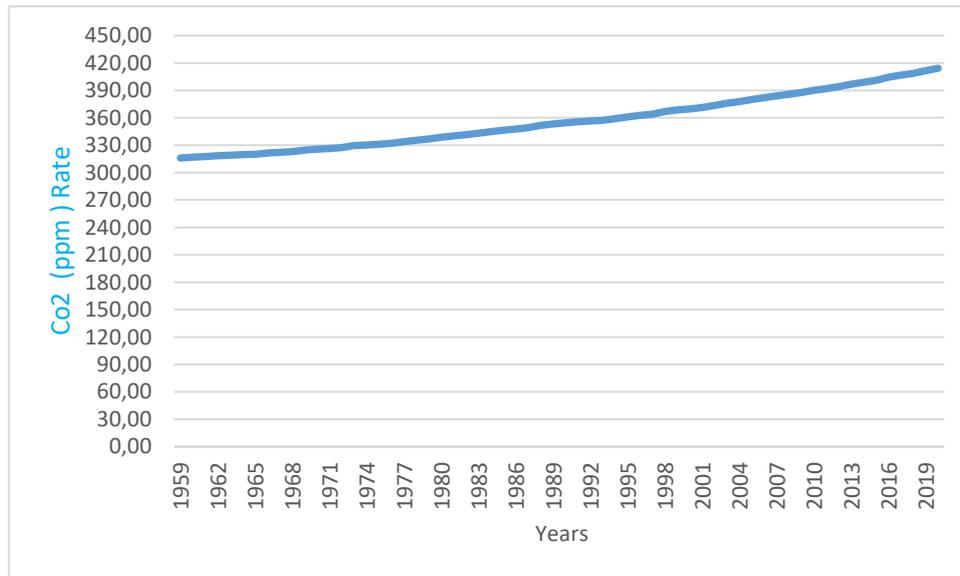


Chart 1: Increase in atmospheric carbon dioxide.

Source: Created by the authors using UN data.

In terms of sea-level rise:

- Sea level has risen 8-9 inches (21-24 centimeters) since 1880.
- There is a rapid increase in sea-level rise. It increased by 0.14 inches (3.6 millimeters) per year between 2006 and 2015, while it rose by an average of 0.06 inches (1.4 millimeters) per year during most of the 20th century.
- The tides experienced along the coastline of the USA have increased between 300% and 900% compared to 50 years ago.
- Even though the world reduces its greenhouse gas emissions by 2100, the sea level will increase by over 12 inches (30.48 cm) compared to 2000. However, if greenhouse gas increases continue at today's high levels, an increase of approximately 8.2 feet (2.5 meters) is predicted in sea level height by 2100, compared to 2000 (Lindsey, 2020; WMO, 2019).

In terms of melting glaciers

- There has been a shrinkage of approximately 18 meters in the glaciers observed since the 1980s.
- Since 1979, the area covered by sea ice in the Arctic has shrunk by about 40 percent.
- Observed long-term averages detected a reduction in snow blanket (IPCC, 2018; NOAA, 2019).
- The continued long-term melting of the Arctic Sea Glacier was confirmed in 2019.
- Until 2016, the size of the Antarctic glacier had increased slightly over the long term. However, at the end of 2016, this increase ended. Since then, the mass of the Antarctic glacier has declined relatively (US EPA, 2021; WMO, 2019).
- Based on Greenland Ice Covering Total Ice Mass Balance measurements, there was a net ice loss of 329 Gigatons (Gt) for September 2018 - August 2019. Data from the Gravity Recovery and Climate Experiment (GRACE) satellites showed that Greenland lost about 260 Gt of ice per year on average during 2002-2016. The loss was at a maximum of 458 Gt in 2011/12 (WMO, 2019).

As understood from the findings on climate change, the crisis affects a wide area. Therefore, while the devastating effects of climate change on humans and other living things happen today, these impacts may also arise in the future (Cramer et al., 2018: 973).

2. SUSTAINABLE DEVELOPMENT

In the early 1800s, the debate on whether natural resources would meet the needs of the increasing human population came to the fore with the Population Theory declared by the British demographer and political economy theorist Thomas Robert Malthus. Malthus stated that although the human population increases in a geometric series, the capacity to provide the people with their livelihood grows in an arithmetic series. Therefore, he has argued that population growth is likely to exceed the natural resource capacity to meet needs (Coomer, 1981; Dixon and Fallon, 1989; Rostow, 1978). Hence, if measures are not taken soon, natural resources will run out rapidly, resulting in great misery (Eblen and Eblen, 1994; Du Pisani, 2006: 89).

Since the middle of the 20th century, the increasing pressure of human activities has caused the symmetry between society and the environment to deteriorate rapidly. Concerns have increased that growth and development patterns will become unsustainable in case severe and adverse impacts of human activities on the planet continue unchecked (Paxton 1993). These concerns have been documented in such works as *Silent Spring* by Rachel Carson (1962), *Tragedy of the Commons* by Garrett Hardin (1968), *The Blueprint for Survival* by the Ecologist (1972), and *Limits to Growth* report by the Club of Rome (1972) (Du Pisani, 2006: 89; Sustainable Development Commission, 2021). Concerns have raised the questions about the likelihood of Malthus's assumption and about whether or not a development process is sustainable (Kates et al., 2001).

The report 'The limits to growth (1972)' has dealt with the sustainability of the global development paradigm in the axis of agriculture, industry, natural resources, environment, and population. The report has warned that the world has a physical life span, and thus population boost, industrial production, and pollution will reach the limit and lead the world to a disaster at the end, if not prevented (Basiago, 1999; Meadows, 1972; Rostow, 1978). Along with Green movements, the first environmental non-governmental organizations, such as Greenpeace and Friends of the Earth, were established in those days. Again, in this period, while environmental groups became more outspoken, ecology became the ideology of some people (Du Pisani, 2006: 89).

The concept of sustainable development received its first significant international acceptance at the UN Conference on the Human Environment held in Stockholm in 1972, although it was not explicitly referred to. Namely, at the conference, they agreed that development and the environment, which are fundamental to sustainable development, can be managed in a mutually beneficial way, although they have been dealt with as separate issues until the (Basiago, 1999; Dernbach, 2003; Paxton, 1993; Sustainable Development Commission, 2021). To this end, the conference declared that: A point has been reached in history where we have to shape our actions more cautiously for their global environmental consequences. Because of ignorance and indifference, we can massively and irreversibly damage the earth's nature where our lives and well-being depend. Conversely, through complete knowledge and wise actions, we can achieve a better life for ourselves and future generations in an environment more in harmony with human needs and hopes. Defending and improving the human environment for present and future generations have become an imperative goal for humanity (United Nations, 1972).

In the 1980s, the sustainable development paradigm became popular, and its use became more widespread. The United Nations formed a group of 22 people from developed and developing countries to determine long-term environmental strategies for the international community. The World Commission on Environment and Development (WCED) presented its report entitled *Our Common Future*, also known as the *Brundtland Report*, to the UN in 1987 (Goodland and Daly, 1996; United Nations, 1987). The Commission recommended developing sustainable development, which means "meeting the present generation's needs without compromising the ability of the next generation to meet their needs." The report, focusing primarily on people's needs and interests, dealt with promoting economic growth and fair redistribution of resources to underdeveloped countries to meet the basic needs of all humanity. While emphasizing that economic growth, social equality, and nature can exist together, underlined the components of environment, economy, and society, which are the foundations of

sustainable development. The report covered sustainable solutions to population, agriculture, food security, biodiversity, energy options, industry (Du Pisani, 2006: 92).

Sustainable development is a broad, multidimensional concept that includes different but interrelated issues. In this direction, sustainable development consists of three main parts: a) Economic sustainability, which expresses a production system that meets current consumption needs without compromising future needs, b) Social sustainability, which comprises concepts such as equality, empowerment, accessibility, participation, cultural identity and institutional stability, c) environmental sustainability concerning the ecosystem integrity and carrying capacity of the natural environment (Daly 1992b; Lobo, Pietriga, and Appert 2015; Moreira et al. 2022:1).

Some researchers have claimed that the Brundtland Report published in 1987 inspired the United Nations Conference on Environment and Development (UNCED), known as the Rio Earth Summit, in 1992 (Mensah 2019:7). In other words, the concept of sustainable development was the basis of the UNCED held in Rio de Janeiro in 1992. The conference has been the first international initiative to draw up action plans and strategies to develop and advance a sustainable development model. Over 100 presidents, 178 national governments' representatives, and many civil society organizations' representatives attended the conference. The conference dealt with the sustainable development concept as a solution to the environmental degradation problems discussed by the Brundtland Commission in the "Our Common Future report" in 1987 (Sustainable Development Commission 2021).

Sustainable development is one of the common goals of almost all countries today (Salo et al. 2022:242), because, since the Brundtland Report, the sustainable development discourse has been very influential in global and national governance frameworks. The most comprehensive global governance framework in sustainable development is the 17 Sustainable Development Goals (SDG) and the 2030 Agenda for Sustainable Development. The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, includes the targets set to ensure sustainability, less poverty, environmental protection, human welfare, and peace (de Jong and Vijge 2021:1–2; United Nations 2021b).

Some argue that sustainable development is the most efficient argument for overcoming human-induced environmental problems. To this end, international steps have been taken over the past ten years, such as the Paris Climate Agreement, the International Geosphere-Biosphere Program (IGBP), the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES), and the Plant-for-the-Planet. The entire world seeks not only to eliminate poverty and other deprivations, improve health and education, reduce inequality using economic growth-promoting strategies, but also protect our oceans and forests by tackling climate change. However, despite all these efforts, the IPBES 2019 report has stated that the ecosystem's self-renewal capacity has decreased since 1970 (IPBES 2019). The 2021 United Nations Sustainable Development Goals report, on the other hand, stated that the world has deviated from reaching the 17 SDGs by 2030 due to health, economic and social reasons due to COVID-19 (United Nations 2021c). This worrisome trend calls for urgent, appropriate interdisciplinary approaches to global sustainable development to understand and cure the mechanisms that systematically link humans and natural systems.

3. RESEARCH METHODOLOGY

3.1. Purpose of the research

The current study conducted in the Scopus database, and based on the topics of "climate change" and "sustainable development," aimed to evaluate the publications published between 1993-2021, considering criteria such as authors, publication date, number of citations, author collaboration, and the most widely used word. In addition, this study is significant for presenting the latest status of the studies on "climate change" and "sustainable development" and guiding future studies.

3.2. Data Collection

The current study has employed the bibliometric analysis, using the keywords "climate change" and "sustainable development" to obtain the results, such as the most cited author, the most productive author

or authors, and the distribution of keywords. “VOSviewer” software was used to map the results. According to Van Eck and Waltman (2017:2), the “VOSviewer” program designed to analyze bibliometric networks focuses on figuratively displaying these networks. The advantage of this software is that it is free and open-source. The study data examined in January 2022 were from 343 studies indexed in the Scopus database covering 1993-2021. Scopus, created by Elsevier in November 2004, is a multidisciplinary and comprehensive bibliographic database that analyzes citations and enables international scientific research (Sánchez, de la Cruz Del Río Rama, and García 2017:9–10).

3.3. Research Method

Bibliometric analysis refers to analyzing documents or publications within the framework of the specific characteristics and revealing the findings (Garfield 1972). Here, studies or publications on particular fields are investigated according to various parameters. The obtained data, such as keywords, the number of authors, the number of citations, the research topic, etc., are evaluated (Temizkan, Çiçek, and Özdemir 2015). Hence, bibliometric analysis, which has a wide field of study, can provide readers with relevant findings and even reveal deep information about a single journal or a particular topic (Garfield 1972).

The major limitation of the research was using the Scopus database for data collection because “climate change” and “sustainable development” subjects were scanned only over the study headings, and the contents were not possible to investigate.

3.4. Findings

The articles published between 1993-2021 were investigated on the Scopus database using the “climate change” and “sustainable development” keywords. The analysis of the studies by year is in Table 1. The table shows that the first research was conducted on this subject in 1993. While very few studies were conducted until 2008, the number of studies conducted after 2008 has increased. While the numbers of studies were 3, 4, or 5 until 2008, the number reached 13 that same year. The year with the highest number of studies on “climate change” and “sustainable development” was 2021, with 44 studies. Although the increasing number of researchers over the years affects this case, the main issue is that the topics of “climate change” and “sustainable development” have become more visible and remarkable.

Table 1: Yearly Distribution of the Studies by the Subjects of “Climate Change” and “Sustainable Development”

Years	The number of Articles	Years	The number of Articles	Years	The number of Articles
1993	2	2004	5	2013	22
1995	2	2005	3	2014	6
1996	1	2006	5	2015	21
1997	3	2007	4	2016	27
1998	3	2008	13	2017	15
2000	1	2009	14	2018	26
2001	6	2010	19	2019	29
2002	7	2011	16	2020	27
2003	5	2012	17	2021	44

Source: Prepared by the authors using the Scopus database.

Table 2 shows the distribution of the most productive 18 authors on “climate change” and “sustainable development.” K. Halsnaes and M. Munasinghe are the most productive authors, with seven studies each. Markanya, A. holds the second rank with six studies.

Table 2: Distribution of the Most Productive Authors on “Climate Change” and “Sustainable Development”

Author	The Number of Publications	Author	The Number of Publications
Halsnaes, K.	7	Shukla, P. R	3
Munasinghe, M.	7	Fernández, M.	3
Markandya, A.	6	Fujimori, S.	3
Robinson, J.	5	Gaillard, J.C.	3
Cohen, S.	4	Gupta, J.	3
Halsnæs, K.	4	Jaboyedoff, M	3
Hasegawa, T.	4	Sokona, Y.	3
Nolon, J.R.	3	Sudmeier-Rieux, K.	3
Sanwal, M.	3	Zalikhonov, M.C.	3

Source: Prepared by the authors using the Scopus database.

Table 3 shows the distribution of the most cited publication names, publication places, publication years, and the number of citations of the authors researching “climate change” and “sustainable development.” The most cited work is the article “Sustainable development and climate change initiatives” published in Cement and Concrete Research magazine in 2008, written by Damtoft, J.S., Lukasik, J., Herfort, D., Sorrentino, D., Gartner, E.M., and received 646 citations. The second most cited study is “climate change and interconnected risks to sustainable development in the Mediterranean,” published by Cramer, W ., Guiot, J., Fader, M., (...), Tsimplis, MN, Xoplaki, E. in the journal of Nature Climate Change in 2018, and received 344 citations.

Table 3: Distribution of Authors Researching “Climate Change” and “Sustainable Development” by Citations

Publication Name	Authors	Source	Publication Year	Number of Citations
“Sustainable development and climate change initiatives”	Damtoft, J.S., Lukasik, J., Herfort, D., Sorrentino, D., Gartner, E.M.	Cement and Concrete Research 38(2), pp. 115-127	(2008)	646
“Climate change and interconnected risks to sustainable development in the Mediterranean”	Cramer, W., Guiot, J., Fader, M., (...), Tsimplis, M.N., Xoplaki, E.	Nature Climate Change 8(11), pp. 972-980	(2018)	344
“Land-use and climate change risks in the Amazon and the need of a novel sustainable development paradigm”	Nobre, C.A., Sampaio, G., Borma, L.S., (...), Silva, J.S., Cardoso, M.	Proceedings of the National Academy of Sciences of the United States of America 113(39), pp. 10759-10768	(2016)	281
“Linkages between climate change and sustainable development”	Beg, N., Morlot, J.C., Davidson, O., (...), Parikh, K., Atiq Rahman, A.	Climate Policy 2(2-3), pp. 129-144	(2002)	161
“Climate change and sustainable development: Towards dialogue”	Cohen, S., Demeritt, D., Robinson, J., Rothman, D.	Global Environmental Change 8(4), pp. 341-371	(1998)	156
“Climate change and sustainable development: Expanding the options”	Swart, R., Robinson, J., Cohen, S.	Climate Policy 3(SUPPL 1), pp. S19-S40	(2003)	134
“Climate change, sustainable development and India: Global and national concerns”	Sathaye, J., Shukla, P.R., Ravindranath, N.H.	Current Science 90(3), pp. 314-325	(2006)	106

“Sustainable development: Climate change - The Chinese challenge”	Zeng, N., Ding, Y., Pan, J., Wang, H., Gregg, J.	Science 319(5864), pp. 730-731	(2008)	99
“Addressing the climate change-sustainable development nexus: The role of multistakeholder partnerships”	Pinkse, J., Kolk, A.	Business and Society 51(1), pp. 176-210	(2012)	96
“Persistent women and environment linkages in climate change and sustainable development agendas”	Resurrección, B.P.	Women’s Studies International Forum 40, pp. 33-43	(2013)	85
“Climate change: Learning from gender analysis and women’s experiences of organising for sustainable development”	Dankelman, I.	Gender and Development 10(2), pp. 21-29	(2002)	84
“Integrating climate change and sustainable development in a place-based context”	Wilbanks, T.J.	Climate Policy 3(SUPPL 1), pp. S147-S154	(2003)	74

Source: Prepared by the authors using the Scopus database.

Figure 1 gives the document distribution of the “climate change” and “sustainable development” subjects according to their study fields. Accordingly, the study field with the highest number of documents is environmental science, with 189 (27.7%) documents. While social sciences are in second place with 159 (23.3%), earth and planetary sciences are in third place with 60 (8.8%).

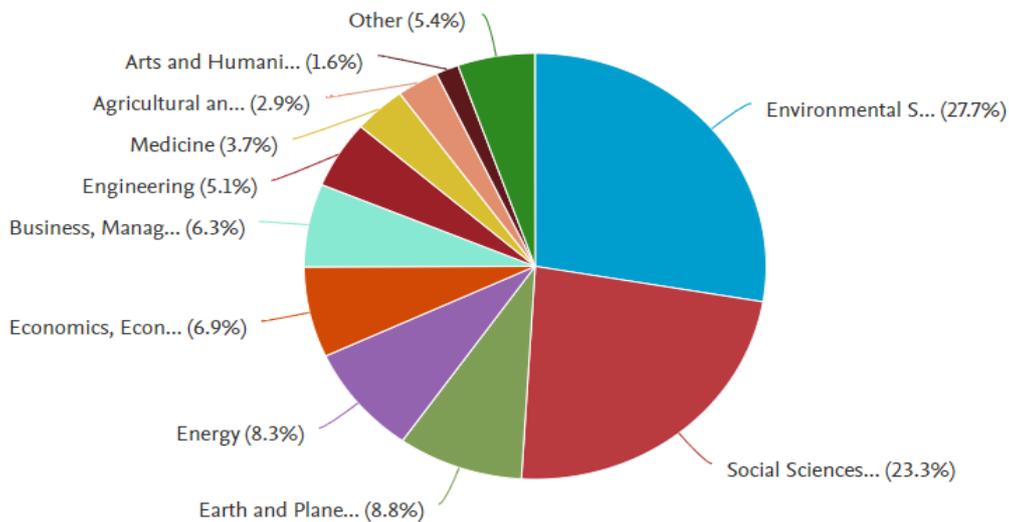


Figure 1: Distribution of documents indexed in the Scopus database according to the studies of “climate change” and “sustainable development.”

Source: Scopus (2022)

Figure 2 shows that the types of scientific publications indexed in the Scopus database on “climate change” and “sustainable development” are research articles, book chapters, review articles, conference papers, editorials, books, notes. The most scientific publications on “climate change” and “sustainable development” are research articles (48.7%) with 167 publications. While the second most popular scientific publications are book chapters (17.5%) with 60, review articles (13.7%) are in the third rank with 47.

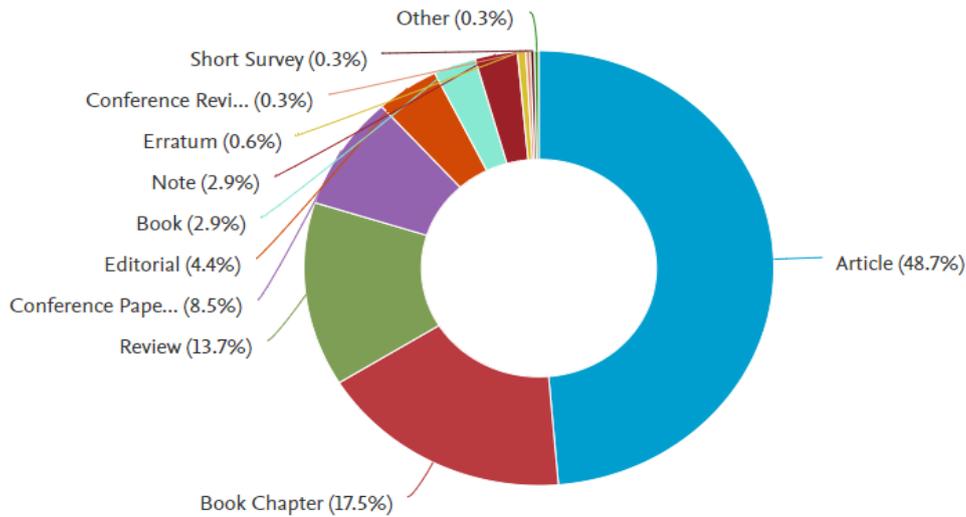


Figure 2: Distribution of scientific publications on “climate change” and “sustainable development” by publication types in the Scopus database

Source: Scopus (2022)

When the minimum numbers of documents and citations of the authors are selected as *one* in the VOSviewer software program, 637 of 809 authors in total meet the threshold value. Figure 3 shows the information on the most collaborating authors. The authors who collaborated most in research on “climate change” and “sustainable development” are separated into four clusters. The first cluster is red and covers nine co-authors. The second is green, which has six cooperating authors. The third cluster is blue, and there are six collaborating authors also in this cluster. The fourth in mustard yellow includes four collaborating authors.

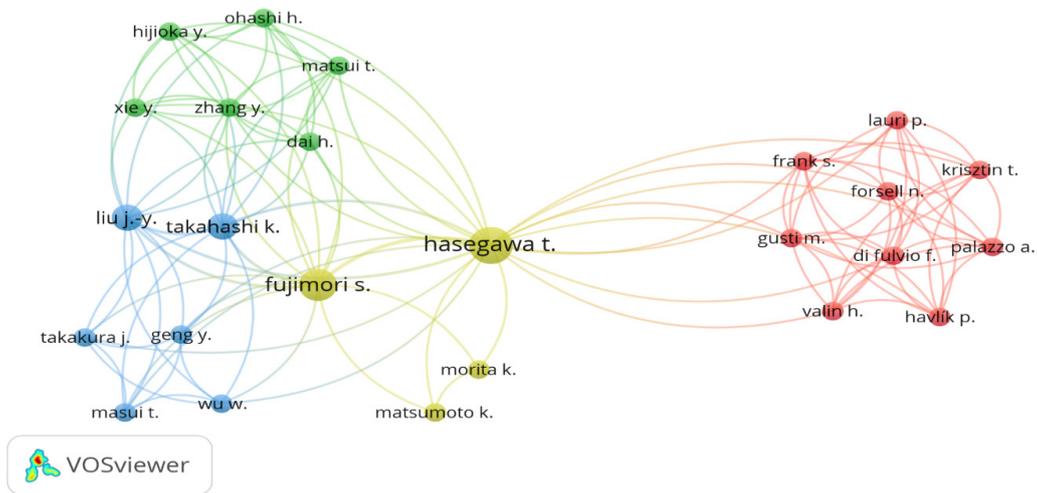


Figure 3: Network Map of Authors Who Collaborated the Most in Research on “Climate Change” and “Sustainable Development.”

Table 4 shows the distribution of studies on “climate change” and “sustainable development” by country. There are 85 countries conducting studies on these fields in the Scopus database. However, the table shows the top 15 countries. The leading country in these fields is the USA, with 56 publications. The second is the UK, with 49 publications, while India ranks third, with 29. Turkey has three publications on “climate change” and “sustainable development” published in the Scopus database. The authors who have worked on these areas are Konyalı and Kiper (2012); Ucal and Xydis (2020); Kılış, Krajačić, Duić, Rosen and Ahmad Al-Nimr (2021). While

Konyalı and Kiper researched without collaborating with any writer from abroad, Ucal prepared his work with a researcher from Denmark; Kilikis has prepared his study in collaboration with researchers from Croatia, Canada, and Jordan.

Table 4: Distribution of Studies on “Climate Change” and “Sustainable Development” by Country

Countries	The Publication Numbers	Countries	The Publication Numbers	Countries	The Publication Numbers
USA	56	Canada	22	Italy	12
UK	49	Australia	21	Japan	11
India	29	Denmark	17	Bangladesh	10
China	26	Netherlands	17	Norway	10
Germany	24	South Africa	13	Sweden	10

Source: Prepared by the authors using the Scopus database.

Figure 4 shows the countries that cooperate most in research on “climate change” and “sustainable development.” When the minimum number of documents and minimum citations of the countries are selected as 1 in the VOSviewer software program, 76 of the total 85 countries meet the threshold value. The figure shows the cooperating countries in clusters of 11 different colors. The first cluster (red) covers Cyprus, France, Germany, Hong Kong, Israel, Italy, Morocco, Spain, Vietnam; the second cluster (dark green) Nigeria, Hungary, Mexico; the third cluster (blue) India, China, Indonesia, Malaysia, Nepal, Pakistan, United Arab Emirates, Uzbekistan; the fourth cluster (yellow) Japan, Portugal, Ukraine, Austria. The fifth cluster (purple) includes Canada, Turkey, Jordan, Serbia, Slovenia, Croatia; the sixth cluster (light blue) Bangladesh, South Korea, Senegal; the seventh cluster (orange) Norway, Colombia, Switzerland. The eighth cluster (brown) encloses the UK, Denmark, Singapore, Sri Lanka; the ninth cluster (purple) Australia, Netherlands, Sweden, Uganda; the tenth cluster (pink) Ghana, Kenya, Saudi Arabia, South Africa; the eleventh cluster (light green) the USA, Cameroon, and Russia federation. The USA, appearing in the eleventh cluster, is the most collaborating country, with 56 broadcasts and 28 connections.

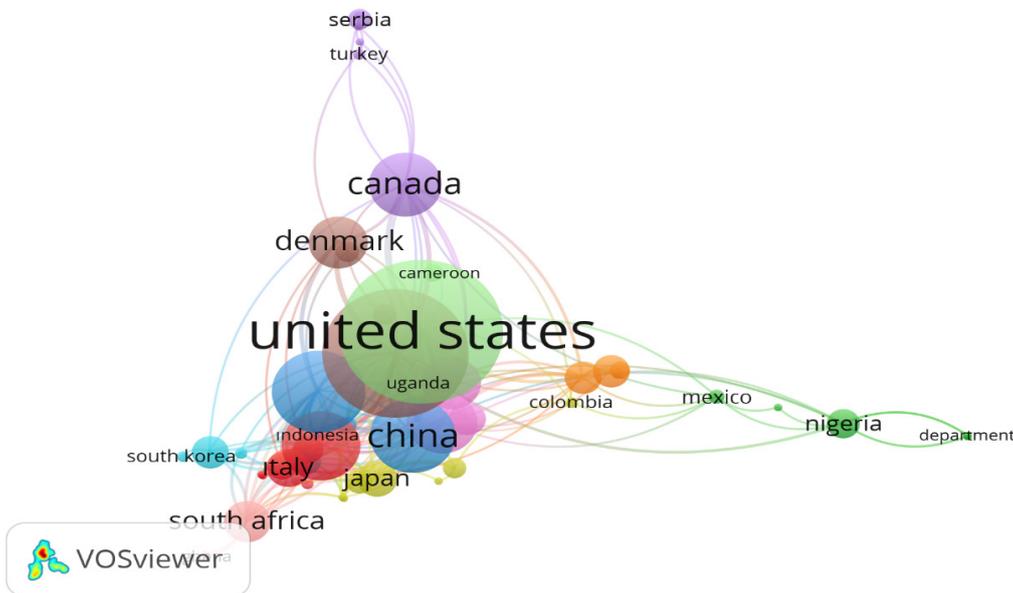


Figure 4: Network map of the Most Collaborating Countries in Research on “Climate Change” and “Sustainable Development.”

After assigning the minimum document and citation numbers as “one” in the inter-institutional collaboration analysis in the VOSviewer program, out of the 713 institutions, 579 met the threshold value. Figure 5 shows the institutions that cooperate the most in scientific publications about “climate change” and “sustainable development.” These institutions were gathered in a single red cluster. This cluster covered many institutions such as “Canadian Forest Products, Community and Environmental Affairs, Vancouver International Airport

Authority, Department of Geography, University of British Columbia, International Center for Sustainable Cities, University of Victoria, Britannia Development Cooperation, Sustainable Energy Science, and Technology Panel.”

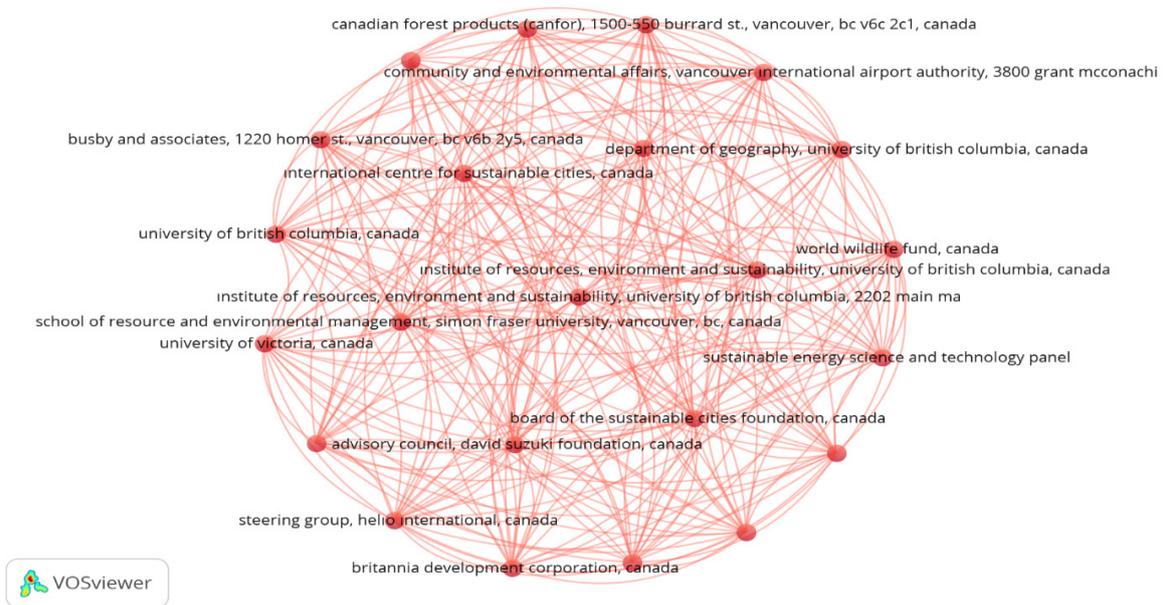


Figure 5: Network map of Institutions the Most Collaborating on “Climate Change” and “Sustainable Development” Studies.

The VOSviewer software program was used to identify the most frequently used words in studies on “climate change” and “sustainable development.” Figure 6 shows the keywords in four colored clusters: red (cluster one), green (cluster two), blue (cluster third), and yellow (cluster fourth). The most frequently used words in the studies listed in the Scopus database are “climate change” (113) and “sustainable development” (97) in the green cluster (second cluster). The second most used words are “adaptation” (20), “sustainable development goals” (18), “mitigation” (13) in the red cluster, and “sustainability” (15) in the blue.

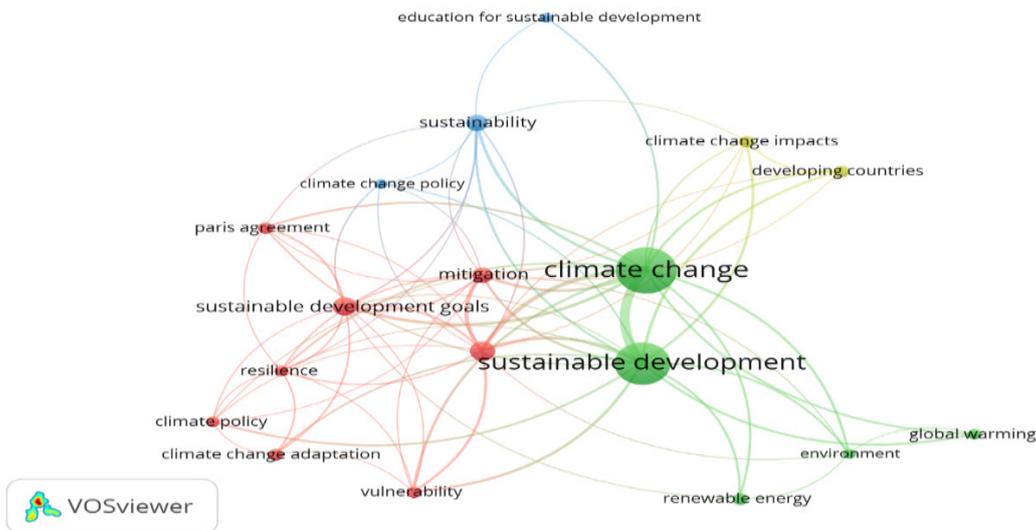


Figure 6: Network Map of Keywords Related to Research on “Climate Change” and “Sustainable Development.”

4. RESULT

The current study has examined scientific research on “climate change” and “sustainable development.” The main reason for carrying out the bibliometric analysis of “climate change” and “sustainable development” in this study was the increasing importance of these issues in recent years and the desire to contribute to future studies. In this study, 343 academic studies performed between 1993-2021 were reached using the Scopus database. The VOSviewer software was used to visualize the analyzed data. While the years between 2016 and 2021 were the years with the most studies on “climate change” and “sustainable development”, the top five authors are Halsnaes, K., Munasinghe, M., Markandya, A., Robinson, J., Cohen, S. While the most cited study with 646 citations was the study titled “Sustainable development and climate change initiatives” published in 2008, environmental sciences and social sciences were the fields with the most studies. Most of the academic studies were published as articles, followed by books. The country with the highest number of publications was the United States, followed by the United Kingdom, India, China and Germany respectively. While the United States was the country with the highest collaboration in research on “climate change” and “sustainable development.” The concepts “climate change” and “sustainable development” were used 113 and 97 times, respectively.

Today, an immense amount of academic research is published. However, day by day, the increasing publication numbers make it harder to conduct elaborative research and get complete information from the literature. Bibliometric analysis, which has gained substantial significance within these difficulties, contributes to the accessibility of many studies on the subjects examined. Programs such as VOSviewer and R-BiblioSshiny-Bibliometrix, used in bibliometric analyzes, provide researchers with more practical information by creating a visual map of the obtained data and support this map with visual tools.

The steps taken from the past to the present on climate change and sustainable development are insufficient. The main reasons for this insufficiency are the uncompromising attitudes of the countries, their interest-oriented approaches and the multinational companies' interests, which are very important to the neoliberal policies when compared to human life and nature. As long as multinational companies have a desire to make a profit, approaches away from environmental concerns in the fight against climate change and sustainable development will be far from solving climate crisis and ecological problems. The structure offered by the neoliberal system has developed applications to even sell the air with the understanding of gaining more profit instead of tackling climate change and ensuring sustainable development and giving up the concept of limitless production and consumption. Climate change poses a threat all over the world as a global crisis and security problem. In this respect, studies on climate change and sustainable development and the findings obtained from studies are of great importance (Gürçam 2021; Gürçam and Konuralp 2022; Konuralp 2020).

As a result, in the process beginning in the UN Framework Convention on Climate Change in 1992 and still continuing today with Paris Agreement, the current study based on the keywords “climate change” and “sustainable development” revealed that the number of academic studies increased after 2000 when the impacts of climate change began to show itself globally. Especially after the Kyoto Protocol, these studies accelerated and reached the peak with 44 studies in 2021. Increasing social awareness and more visible climate changes have contributed to rising studies. Furthermore, surprisingly, the fact that more studies have been conducted on “climate change” and “sustainable development” in the countries (USA, UK, India, China and Germany) that have the largest share in greenhouse gas emissions and the resulting climate change is another result of the study. This study is important because it can be considered a starting line for other studies to be carried out in this period of increasing environmental sensitivity by focusing on environmental problems -especially climate change, which is a global crisis.

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