



2023, 12 (3), 2056-2077 | Research Article

A Bibliometric Analysis of Research on Climate and Change Business Enterprises

Ayşe Meriç YAZICI ¹

Abstract

Climate change is a global issue with far-reaching impacts on various aspects of society, including businesses. Thus, business enterprises have no choice but to adapt to changing environmental conditions. This study aims to reveal the existing research trends and focus areas via a comprehensive bibliometric analysis to determine the correlation between climate change and business enterprises in literature. The methods used in the article include analyzing the data obtained from large databases such as Scopus. The article analyses the number of articles examining the relationship between climate change and businesses between 1989 and 2023, the journals in which these articles were published, authors, citation counts and keywords, co-author analyses and word networks, thematic clusters in the literature, types of publications, keywords, sources, the most productive journals according to Bradford's law, how word clouds and word trees were created for the topic, and trending topic analyses. This analysis shows the importance of research between climate change and businesses and the developments in this field. The findings of the article show that the impacts of climate change on businesses are gradually increasing and the number of researches on this subject is increasing. In addition, it is seen that an interdisciplinary approach has been adopted to examine the relationship between climate change and enterprises, and research in this field has diversified. As a result, this article provides a valuable resource for researchers who want to understand the relationship between climate change and businesses and guide research in this field. By emphasizing the size and diversity of the scientific literature on climate change, it reveals the potential for further contribution to research in this field. It provides a valuable resource for researchers, policymakers and business leaders who want to understand the relationship between climate change and businesses and to guide scientific studies in this field. The interaction of climate change and businesses is becoming increasingly important for environmental sustainability and business strategies, and this article is an important resource to illuminate this important topic.

Keywords: Climate Change, Business, Bibliometric Analysis, R Programme, VosViewer

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2023, 12 (3), 2056-2077 | Araştırma Makalesi

İklim Değişikliği ve İşletmeler Üzerine Yapılan Araştırmaların Bibliyometrik Bir Analizi

Ayşe Meriç YAZICI¹

Öz

İklim değişikliği, işletmeler de dahil olmak üzere toplumun çeşitli yönleri üzerinde geniş kapsamlı etkileri olan küresel bir sorundur. Bu nedenle, işletmelerin değişen çevresel koşullara uyum sağlamaktan başka seçeneği yoktur. Bu çalışma, literatürde iklim değişikliği ve işletmeler arasındaki ilişkiyi belirlemek için kapsamlı bir bibliyometrik analiz yoluyla mevcut araştırma eğilimlerini ve odak alanlarını ortaya çıkarmayı amaçlamaktadır. Makalede kullanılan yöntemler arasında, Scopus gibi büyük veri tabanından elde edilen verilerin analizi bulunmaktadır. Makalede, 1989-2023 yılları arasında iklim değişikliği ile işletmeler arasındaki ilişkiyi inceleyen makalelerin sayısını, bu makalelerin yayınlandığı dergileri, yazarları, atf sayılarını ve anahtar kelimeleri, ortak yazar analizleri ve kelime ağları, literatürdeki tematik kümeler, yayın türleri, anahtar kelimeler, kaynaklar, Bradford yasasına göre en verimli dergiler, konu için kelime bulutlarının ve kelime ağlarının nasıl oluşturulduğu ve trend konu analizler incelenmiştir. Bu analiz, iklim değişikliği ile işletmeler arasındaki araştırmaların önemini ve bu alandaki gelişmeleri göstermektedir. Makalenin bulguları, iklim değişikliğinin işletmeler üzerindeki etkilerinin giderek arttığını ve bu konuda yapılan araştırmaların sayısının arttığını göstermektedir. Ayrıca, iklim değişikliği ile işletmeler arasındaki ilişkiyi inceleyen disiplinlerarası bir yaklaşımın benimsendiği ve bu alandaki araştırmaların çeşitlendiği görülmektedir. Sonuç olarak, bu makale, iklim değişikliği ile işletmeler arasındaki ilişkiyi anlamak ve bu alandaki araştırmalara rehberlik etmek isteyen araştırmacılar için değerli bir kaynak sunmaktadır. İklim değişikliği konusundaki bilimsel literatürün büyüklüğünü ve çeşitliliğini vurgulayarak, bu alandaki araştırmalara daha fazla katkı yapma potansiyelini ortaya koymaktadır. İklim değişikliği ve işletmeler arasındaki ilişkiyi anlamak ve bu alandaki bilimsel çalışmaları yönlendirmek isteyen araştırmacılar, politika yapıcılar ve işletme liderleri için değerli bir kaynak sunmaktadır. İklim değişikliği ile işletmelerin etkileşimi, çevresel sürdürülebilirlik ve iş stratejileri açısından giderek daha önemli hale gelmektedir ve bu makale, bu önemli konuyu aydınlatmak için önemli bir kaynaktır.

Anahtar Kelimeler: İklim Değişikliği, İşletmeler, Bibliyometrik Analiz, R Program, VosViewer

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Introduction

Climate change has significant impacts on businesses in various sectors (Okerek et al. 2011, p.8; Wright and Nyberg, 2016, p.1634). Climate change can cause weather events such as heat waves, extreme rainfall and floods, droughts, storms and hurricanes, and melting glaciers and rising sea levels (Coumou and Rahmstorf, 2012, p.491). These events can damage infrastructure, disrupt supply chains and cause direct losses for businesses (Fischer and Knutti, 2015, p.560; Clarke et al. 2022, p.2). Climate change can have negative impacts on global supply chains by affecting the availability and quality of raw materials, components, and products (Badjeck et al. 2010, pp.376-377; Davis et al. 2021, pp.54-55). Changes in temperature, rainfall patterns, and natural disasters can affect agricultural productivity, leading to shortages and price fluctuations. In addition, rising sea levels and increased storm activity can disrupt shipping and transport routes, causing delays and increased costs (Godde et al. 2021, pp.1-2).

Governments around the world are implementing policies and regulations to reduce global warming and carbon emissions. These measures include carbon pricing, emission reduction targets, and renewable energy incentives (Baranzini et al. 2017, pp.2-3). Businesses may face increased compliance costs, stricter environmental standards, and the need to adapt their operations to meet new regulations (Carl and Fedor, 2016, pp.51-52). Increased awareness of climate change has led to changes in consumer preferences and market dynamics. Consumers increasingly demand sustainable and environmentally friendly products and services (Porter and Van der Linde, 1995, p.111; Kolk and Pinkse, 2007, pp.1-2; Turker and Altuntas, 2014, pp.838-839). Businesses that cannot adapt to these changing preferences may face declining sales and market share. In contrast, companies that adopt sustainability and climate-friendly practices can gain a competitive advantage and attract environmentally conscious customers (Yu et al. 2022, pp.4-5).

Climate change is a major societal issue and businesses are increasingly being judged on their environmental practices. Negative environmental impacts such as high carbon emissions, deforestation, or pollution can damage a business's reputation and brand image (Stern and Wolske, 2016, p.1; Jordan et al. 2018, p.83; Mora et al. 2018, p.931). In contrast, businesses that adopt sustainable practices and demonstrate a commitment to addressing climate change can enhance their reputation and increase customer loyalty (Zhang et al. 2022, pp.2-3).

Climate change also poses financial risks to businesses through increased insurance costs, asset depreciation, and investment losses. Insurers may raise premiums or reduce coverage in regions prone to climate-related risks (Frame et al. 2020, pp.782-783). Assets located in areas vulnerable to climate impacts, such as coastal properties, may lose value (Houze Jr et al. 2011, pp.291-292; van Oldenborgh et al. 2017, pp.2-3). Moreover, investments in fossil fuels and other carbon-intensive industries may become financially risky as the world transitions to a low-carbon economy (Zhang et al. 2022, pp.1914-1915). To overcome these challenges, businesses are increasingly incorporating climate change considerations into their strategies (Allam and Jones, 2019, pp.2-3). In this context, sustainable practices are being implemented, climate resilience plans are being developed, renewable energy sources are increasing, and the risks presented by the transition to a low-carbon economy are being reduced. Businesses are adopting innovation to capitalize on these opportunities (Shayan et al. 2022, pp.2-3).

This study offers a comprehensive literature review on the current state of climate change research focusing on its business impact. It also highlights the topics garnering the most attention and sheds light on potential gaps and opportunities for future research studies on climate change and business enterprises. Based on current research findings, it provides valuable insights for policymakers and business leaders, thus paving the way for more effective policies and practices. As a bibliometric analysis, this study will offer a more precise understanding of how new research will address the gaps in the field and complement the existing work by pointing to the gaps, relevant studies, publication trends and policy recommendations. As a result, it will lay the groundwork for future research endeavours.

This article is organized and sequenced as follows. First, the data and bibliometric methods used are presented, while the second section summarises the research results. The third section discusses implications and empirical gaps. The fourth section presents the conclusions of this study. Section five presents conclusions and recommendations for future research for organizations.

Bibliometric Analysis

The main objective of this research is to analyse and systematise various aspects of the existing literature at the intersection of climate change and business. This aim corresponds to the broader objective of the topic to be examined. There are two approaches that are appropriate to achieve such objectives. The first is the subjective approach, which is based on scientists' interpretation of the topic they wish to investigate (Tranfield et al. 2003, pp.215-216). The other is the objective approach based on bibliographic and quantitative methods (Di Stefano et al. 2010, pp.8-9). A combination of the two approaches seems to be necessary to grasp the structure and characteristics of any research topic. The second approach, the objective approach, is increasingly adopted to study new areas of research that attract the interest of different fields. Qualitative approaches are subject to a cognitive bias linked to the expertise of the researchers (Appio et al. 2014, p.626). Accordingly, this study proposes to use an objective and subjective approach to examine how the topic of Climate Change and Business is integrated into the business and management fields. In particular, bibliometric analysis will be adopted as the objective approach.

Bibliometric analysis is a method used to examine and evaluate scientific literature using various measures (Tunçay and Yağız, 2020, p.269). Bibliometric analysis is a powerful tool used to understand scientific communication, trends, influences, and interactions between fields (Pritchard, 1969, p.348; Verbeek et al. 2002, pp.399-400). It involves statistical analysis of bibliographic data such as citations, publication counts, author affiliations, and keywords to gain insight into patterns and trends of scientific literature (Small, 1999, pp.799-800; Grant, 2000, p.1108; Ellegaard and Wallin, 2015, p.1810).

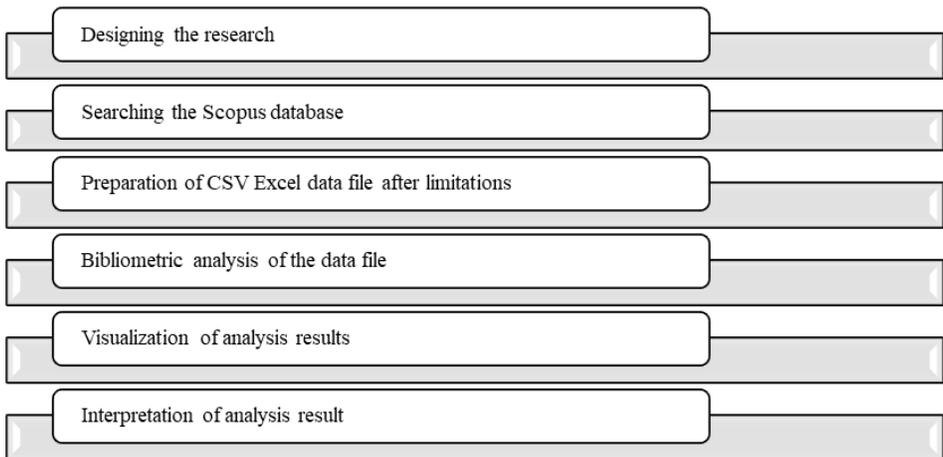
The primary purpose of bibliometric analysis is to assess the impact and influence of scientific work and also to identify important contributors and areas of research in a particular field. It provides researchers, institutions, and policy makers with valuable information about productivity, visibility, and collaboration patterns in a particular field of study (Glänzel, 1996, pp.167-168).

Methodology

The population of the study consists of all documents in the field of climate change and enterprises. For this purpose, the documents in the Scopus database between 1989-2023 (34 years) were used as a sample. In the Scopus database, Title + Abstract + Keywords + Keywords Plus sections were included by selecting the subject title, while in the Scopus database, Article Title + Abstract + Keywords + Keywords + Keywords sections were selected. The search was performed by using the quoted words "Climate change" AND "Business". As a result of the search for "Climate change" AND "Business" in the Scopus database, 8395 studies were reached. Social sciences were limited to business, management and accounting, economics, econometrics and finance, decision sciences and psychology and 1717 publications were included in the study. The data were first obtained separately in CSV excel format. Then, using R programming language, RStudio, bibliometrix and openxlsx libraries, the data were combined and transferred to Excel. During this transfer, duplicate records were automatically eliminated using a computer programme written in R language. Co-authorship of authors and co-occurrence of keywords were analysed with VosViewer software.

Research model

The aim of this research is to describe the literature on climate change and enterprises. The flow diagram created for this research is shown in Graphic 1.



Graphic 1. Figure diagram of the research

The questions sought to be answered while designing the research are as follows;

- What are the concept of climate change and the types of publications related to businesses?
- Who are the authors with the most publications on the concept of climate change and enterprises?
- What are the trending topic analyses for the concept of climate change and enterprises?

- What are the co-author analyses on the concept of climate change and enterprises?
- What are the keyword networks related to the concept of climate change and enterprises?
- How were word clouds and word trees created for the concept of climate change and enterprises?
- What are the most relevant references related to the concept of climate change and enterprises?
- Which journals are the most productive according to Bradford's law on the concept of climate change and enterprises?
- What are the most relevant words related to the concept of climate change and enterprises?
- How is the source production of concepts related to the concept of climate change and enterprises between 1989-2023?

Findings

Basic characteristics of the literature

1717 publications published between 1989-2023 were identified. In Table 1, general information about the data set obtained after the search profile of publications related to climate change and enterprises in the Scopus database in 34 years is given.



Graphic 2. Main information about data

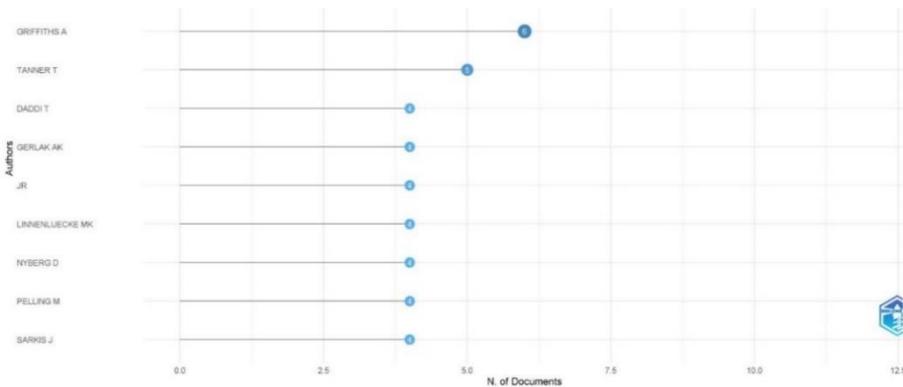
Additional summary information about the sample is provided in Table 1.

Table 1. Main Information about the sample

<i>Description</i>	<i>Results</i>	<i>Description</i>	<i>Results</i>
<i>MAIN INFORMATION ABOUT DATA</i>		Authors of single-authored docs	402
<i>Timespan</i>	1989:2023	AUTHORS COLLABORATION	
<i>Sources (Journals, Books, etc)</i>	829	Single-Authored Docs	402
<i>Documents</i>	1717	Co-Authors Per Doc	3.12
<i>Annual Growth Rate %</i>	13.58	International Authorships %	27.32

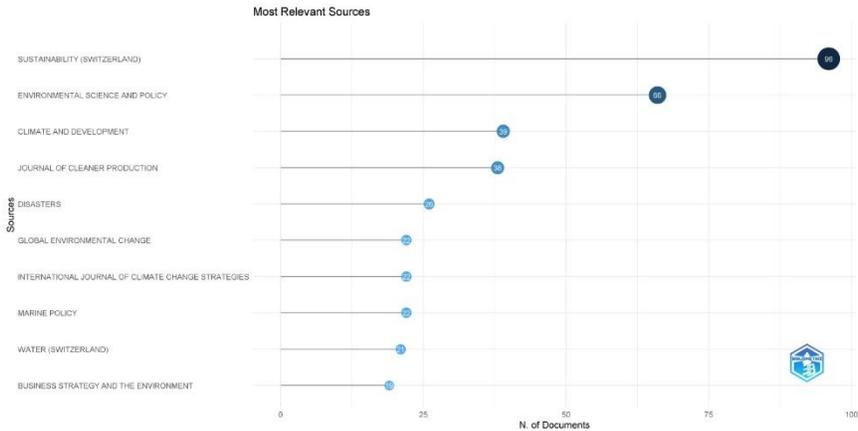
Document Average Age	6.55	DOCUMENT TYPES	
Average Citations Per Doc	23.46	Article	1367
References	1	Book	204
DOCUMENT CONTENTS		Conference Proceeding	86
Author's Keywords (DE)	4470	Book Series	45
AUTHORS		Trade Journal	17
Authors	4964		

According to Table 1, most of the published articles have more than one author and only 402 of them have only one author. Of the total 1717 publications, 1367 are articles, 204 are books, 86 are conference proceedings, 45 are book series and 17 are trade journals. This subject has an annual growth rate of 13.58 and an average of 23.46 citations per document. The average number of co-authors per document is 3.12. The percentage of international co-authors is 27.32.



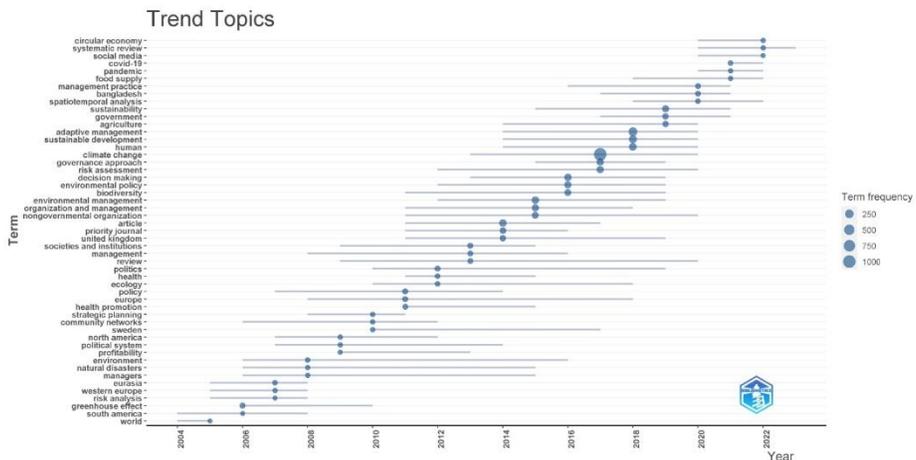
Graphic 3. Authors with the most publications

Figure 3 shows the first 9 authors with the highest number of publications in the studies on climate change and enterprises in the Scopus database. Accordingly, it is seen that the author with the highest number of publications is Griffiths, A. (6 publications), the author with the second highest number of publications is Tanner, T. (5 publications) and the number of publications of the authors in the last seven is (4 publications). Griffiths is the author with the most publications in the field of climate change and business. This is probably due to his expertise, experience, or interest in this field. It may also indicate that he has made significant contributions through his work in this field. Tanner is recognized as an important researcher in this field and is ranked second with 5 publications. This indicates that he has made important contributions to the subject. Also, the fact that Griffiths, A. is just behind him may indicate a close competition in terms of publications on climate change and business. The fact that the authors in the last seven have 4 publications each indicates that a variety of experts in this field have made significant contributions. These authors may have worked in this field with different perspectives and research approaches. This diversity may indicate that different dimensions of climate change and businesses are being addressed.



Graphic 4. Most relevant references

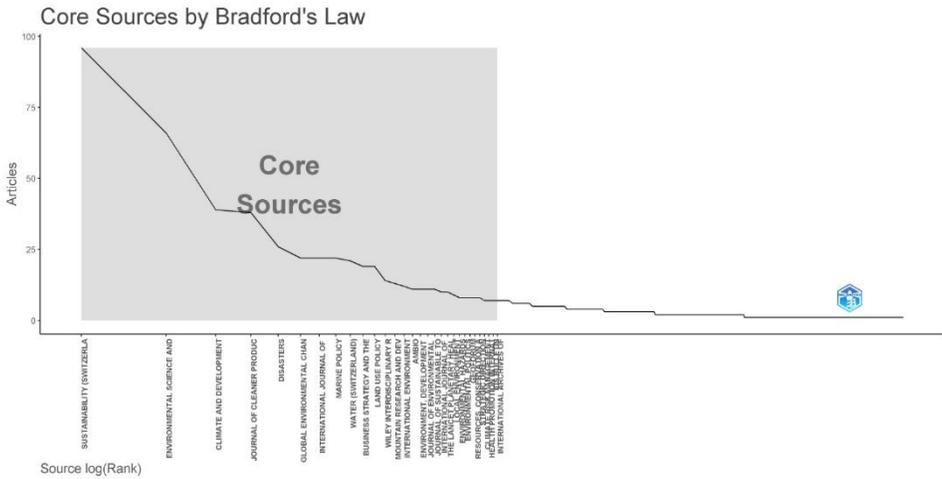
Figure 4 shows the related references. Sustainability (Switzerland) ranks first with 96 articles, followed by Environmental Science and Policy (66), Climate and Development (39), and Journal of Cleaner Production (38). Based on the results of the bibliometric analysis, it shows that Switzerland is a leading country in terms of sustainability-related research and publications. The 96 articles from Switzerland represent a significant scientific contribution in this field. This shows that the work on sustainability by universities, research organizations and scientists in Switzerland is internationally notable. It also shows that journals such as Environmental Science and Policy, Climate and Development, and the Journal of Cleaner Production constitute an important literature on sustainability issues and support research in this field. The number of articles in these journals shows how much interest these topics attract and that there is an intense scientific interaction in these fields.



Graphic 5. Trend topics

Trend topic analysis is an analysis that shows which key concepts are more common in publications in which years. This analysis shows which concepts are studied more in which years in the field. Trend topic analysis provides us with detailed information

about a field conceptually (Aydınoğlu et al. 2023, p.254). While the concept of the world between 2004-2005 or South America between 2004-2008 was a subject studied in climate change and business literature, it is seen that the number of subjects studied has increased and the concepts have changed with the increasing number of publications in recent years. In 2015 and afterward, it is seen that there has been an increase in environmental and climate change issues. It is seen that the concept of climate change is the concept with the highest frequency value, especially between 2013-2020, and the topics related to climate change gain importance following the topics in the following years. The result of the bibliometric analysis shows that the number of publications of climate change and topics in the business literature has increased in South America and in the world in general for a certain period (2004-2008). Moreover, from 2015 onwards, there is an even greater increase in environmental and climate change issues. Since 2005, the issue of climate change has received more attention, indicating that this issue is becoming more recognised by many people and organizations around the world. Various environmental events and awareness-raising campaigns may have been effective during this period. Since 2015, the increase in environmental and climate change issues shows that the number of scientists and researchers working in these fields has increased and these issues have gained more importance. It is seen that the concept of climate change has the highest frequency value between 2013-2020 and this issue has gained importance. This shows that more research is being conducted on climate change in scientific and academic circles and that this topic is becoming more prominent.



Graphic 6. Bradford's law

In 1934, Bradford's law, formulated by Samuel C. Bradford to examine the distribution of a concept in the literature, categorizes the sources publishing in this field. The criterion determined in the formation of these groups is the same number of publications in each region (Tonta and Al, 2008, pp.43-44). The difference here is that although the number of publications is the same, the number of journals will be different. The reason for this is that the productivity of journals is not the same (Srisusilawati et al. 2021, p.7). In the Bradford Law graph, where the relationship between journals and articles on climate change and businesses is analyzed, it is seen that the most productive journal in Region 1 is Sustainability (Switzerland). This means

that a researcher who wants to examine the studies on climate change and enterprises can first examine this journal. After that, it would be useful to take a look at Environmental Science and Policy journals with the 2nd region value. The journals of the 3rd region, which is the last region, can be considered as the last source to be examined by the researcher, which includes publications that are less important than the others. The result of this analysis provides an important guide to determine in which journals and sources research on climate change and business is concentrated. According to the Bradford Law graph, Sustainability magazine stands out as the most prolific journal for research on climate change and business. This suggests that this journal is a particularly essential resource for researchers. Articles in this journal may have addressed the relationship between climate change and businesses on issues such as sustainability, environmental impacts and business strategies. The journals that fall in region 2 on the Bradford Law graph represent other important sources contributing to research on climate change and business. It may be useful to browse these journals to access information from different perspectives and develop a more comprehensive understanding. Journals in the third region of the Bradford Law graph may represent less important or less prolific sources on the topic. These journals may deal with specific or narrowly focussed topics. Researchers may use these journals to further analyse or investigate more specialised topics.



Graphic 7. Word cloud

According to Figure 7, it is seen that the words adaptive management, sustainable development, human, environmental management, and decision-making are mostly used in the 1717 studies that analyzed climate change and enterprises. Then, the words water management, governance approach, organization and management, risk assessment, and environmental policy were used. The results of this bibliometric analysis show the focal points of the relationship between climate change and businesses in the literature. The impacts of climate change on businesses can change rapidly and businesses may need to adapt to these changes. Therefore, adaptive management is an important focal point in the literature. The ability of businesses to react quickly to environmental changes is an issue that this analysis emphasises.

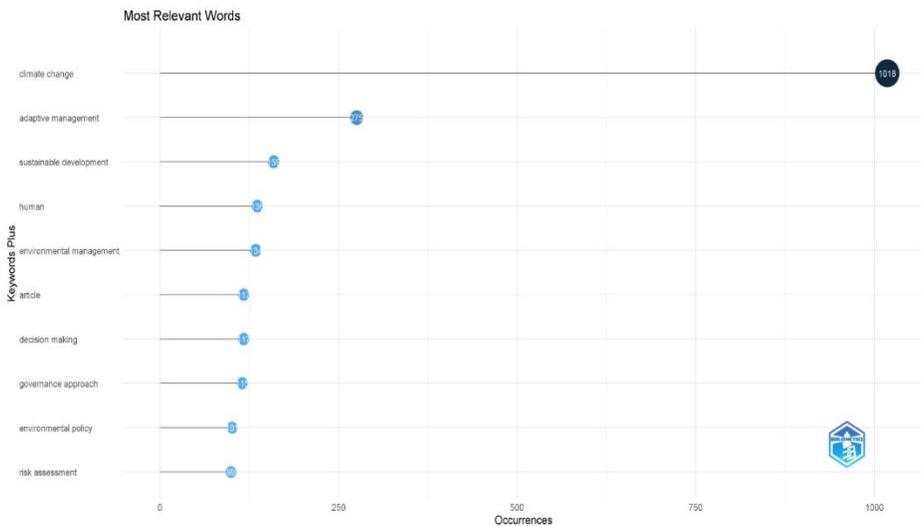
Combating climate change involves not only environmental impacts but also sustainable development goals. Businesses' adoption of this concept shows that they are not only responsible for their own profitability, but also for society and the environment. It is important for businesses to take into account not only environmental factors but also human factors to cope with climate change. The role of people in this process is at the centre of environmental management and decision-making processes. Climate change has a major impact on water resources. Therefore, the issue of water management is of strategic importance for businesses. The sustainable use of water resources and the work of enterprises on water consumption issues can increase environmental sustainability. It is important to establish effective governance and environmental policies in combating climate change. Businesses can make positive contributions to both their environment and their own business processes by adopting these policies and approaches. Climate change is an important source of risk for businesses. Therefore, risk assessment can help businesses to develop their sustainability strategies. The results of this analysis show that businesses show interest in identifying and managing these risks.



Graphic 8. Word tree

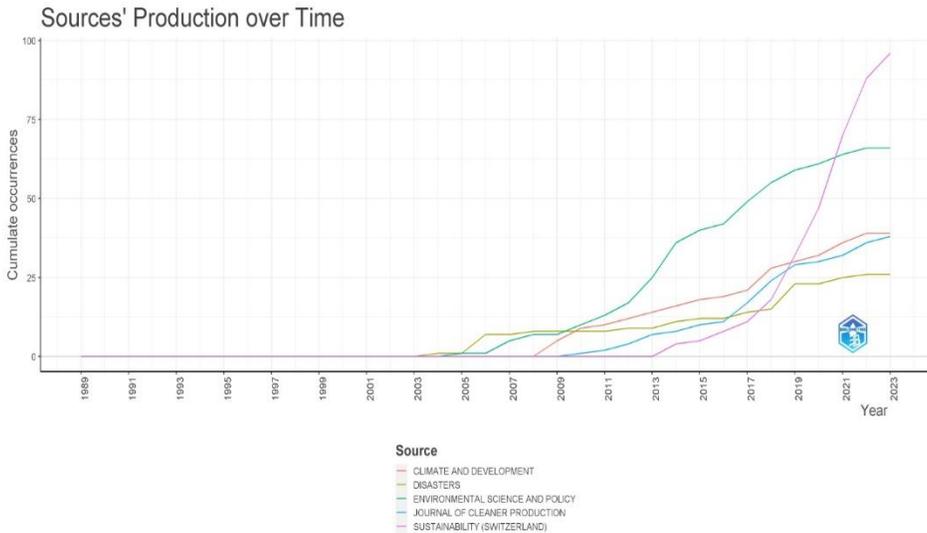
After the word cloud, a word tree was utilized to see the frequencies of the most recurrent keywords in the dataset. According to the word tree in Figure 8, it is seen that concepts such as climate change, adaptive management, sustainable development, human, and environmental management, article, decision-making, and governance approaches are frequently used concepts in studies on enterprises. This bibliometric analysis result points to very important information. Climate change is of great importance today as both an environmental and economic problem. Businesses have to consider the issue of climate change to achieve sustainability goals and manage environmental risks. It is therefore not surprising that this term is frequently used. Businesses are adopting adaptive management approaches to quickly adapt to environmental changes and uncertainties. This is an important part of succeeding in a competitive business world. Sustainable development is a concept where businesses aim to balance environmental, social and economic factors. Businesses should focus on sustainability principles for long-term success. Human and environmental management

refers to the efforts of businesses to achieve a balance between human resource management and environmental sustainability. Businesses should fulfil their responsibilities towards both their employees and the environment. This term may represent the sources from which academic research examines and publishes topics relevant to business. Articles play an important role in the development of business literature. Businesses use various methods to make strategic and operational decisions. Therefore, decision-making processes play a central role in business management. Business governance includes topics such as corporate governance principles, codes of ethics and the internal governance structure of companies. Businesses should adopt ethical and effective governance approaches.



Graphic 9. Most relevant words

Figure 9 shows that the most relevant word in 1717 publications is climate change (1018). Following climate change, the most relevant words are adaptive management (275), sustainable development (159), human (136), environmental management (134), article (117), decision making (117), governance approach (115), environmental policy (107) and risk assessment (99). The results of this bibliometric analysis show that the topic of "climate change" is an important focal point in the publication world. The number of studies on climate change is quite high compared to other topics. Other important words that studies on climate change focus on are related to concepts such as "adaptive management", "sustainable development", "human", "environmental management". These results show that there is a focus on how to achieve better management and sustainable development in relation to climate change. It also states that factors such as human impact and environmental management are also important in climate change. Concepts such as "article", "decision-making", "governance approach", "environmental policy" and "risk assessment" also indicate that research on climate change includes these topics and how they are addressed in this context.



Graphic 10. Sources' production over time

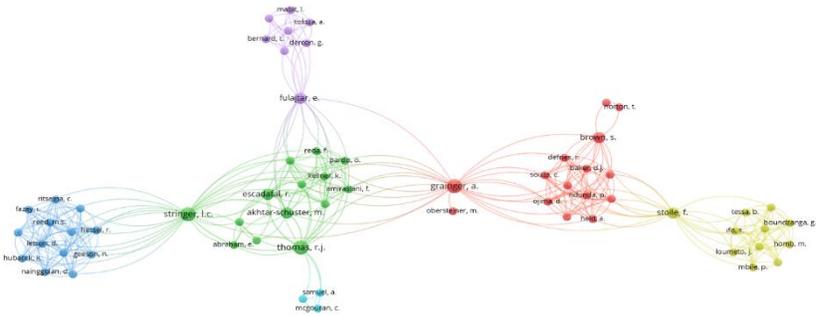
According to Figure 10, it is seen that the resource production of the concepts of "climate change" and "business", which are also used in the selection of articles between 1989 and 2023, has increased significantly, especially in 2017 and afterward in Sustainability (Switzerland). It is seen that there is an increase in the publications of the Journal of Cleaner Production in the field of climate change and enterprises after 2022. In contrast, there is a steady line in the publications of Disasters, Climate and Development, and Environmental Science and Policy, which fluctuated up and down until 2022. The results of this bibliometric analysis interestingly show that there is a significant increase in the field of climate change and business. Since 2017, global awareness of climate change and sustainability issues may have increased. With the impact of important international agreements such as the Paris Agreement and sustainability-related policy changes during this period, businesses and researchers may have focused more on these areas. After 2017, the focus on combating climate change and sustainable business practices may be due to increasing financial and economic pressures in the business world. Companies may have adopted sustainability strategies by paying more attention to their environmental and social responsibilities. Universities, research institutions and funders may have allocated more resources to research on climate change and business. This may have encouraged academics and researchers to work more in these areas. After 2022, the increase of the Cleaner Production Journal on these topics may indicate that this journal may have become an important platform in this field. Likewise, the fact that other journals have started to publish more articles on these topics may explain the reason for this increase. However, it is an interesting contrast that Disasters, Climate and Development and Environmental Science and Policy show a stable trend. The reason why these journals maintain a more constant volume of publications may be that they are concentrated in a particular area of specialisation or have a different readership. It is also important to note that these journals may be publishing research on topics not directly related to climate change and business in particular.

Network analysis of authors

In this part of the study, a cluster detection analysis was applied to observe the community-like structure in the author's co-citation network. Based on this analysis, dominant intellectual groups within the field were identified. Cluster detection analysis is a method used to identify groups or clusters of related entities within a larger network. The analysis was applied to the authors' co-citation network. The co-citation network represents the relationships between authors based on the frequency with which they are cited together in the bibliographies of various documents, indicating a link between their research (Waltman, 2016, pp.368-369). The cluster analyses (Figure 11 and Figure 12) identified six clusters based on the authors' lines of inquiry. As seen in Figure 11, in Cluster 1 (red), the most contributing authors are Grainger, A., and Brown, S.; in Cluster 2 (green), the most contributing authors are Stringer, I. C., Thomas, R. J., Escadafal, R., Akhtar-Schuster, M.; in Cluster 3 (blue), the most contributing authors are Fazey, I., Geeson, N., Hessel, R., and Hubacek, K. In Cluster 4 (yellow), the top contributing author is Stolle, F., in Cluster 5 (purple), the top contributing author is Fulajtar, E., and in Cluster 6 (turquoise), the top contributing authors are MCGouran, C., and Samuel, A.

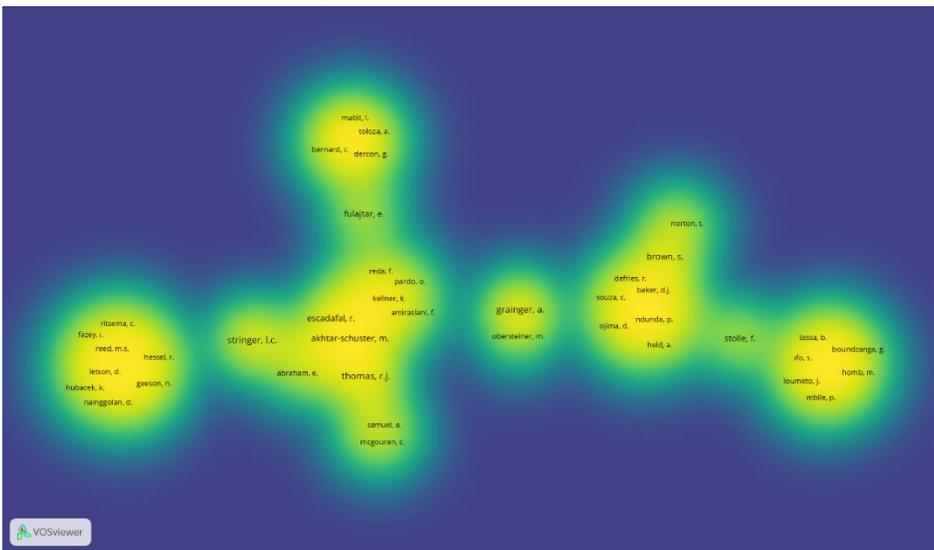
These data show six different clusters among authors obtained as a result of a bibliometric analysis. The clusters obtained from this analysis show that certain authors are concentrated in certain research areas and have made significant contributions in these areas.

Cluster 1 (Red) seems to represent an area of research in which authors such as Grainger and Brown have made the most contributions. These authors are probably pioneering figures in the field and their work is recognised as one of the main references in the field. Cluster 2 (Green) seems to represent a research area driven by authors such as Stringer, Thomas, Escadafal and Akhtar-Schuster. These authors must have made significant contributions to this field and provide important resources for those working in this area. Cluster 3 (Blue), authors such as Fazey, Geeson, Hessel and Hubacek have been identified as the top contributors to the blue cluster. This may be indicative of the importance of the area of research they are directing to the cluster. Cluster 4 (Yellow), Stolle is listed as the author who contributed the most to the yellow cluster. These authors should be prominent in the area of research that they have referred to the yellow cluster. Cluster 5 (Purple), Fulajtar is listed as the author who contributed the most to the purple cluster. These authors may have special expertise or a leadership role in the research area to which they contribute to the purple cluster. Cluster 6 (Turquoise), MCGouran and Samuel appear to be the top contributors to the turquoise cluster. They must have a specific expertise or knowledge of the research area in which they represent this cluster.



Graphic 11. Co-authorship network.

Note: The first panel identified journal network, and second panel identified network density (N=1.717 publications). Created using VOS Viewer version 1.6.19.



Graphic 12. Visual representation of co-citation clusters

Note: The first panel identified journal network, and second panel identified network density (N=1.717 publications). Created using VOS Viewer version 1.6.19.

Network analysis of keywords and key research hotspots

Figure 13 and Figure 14 show the lexical co-occurrence network of publications on climate change and businesses, which is constructed by using the relations of keywords with each other. Here, the diameter of the circles indicates the number of times a word occurs in the sample, the links between them indicate the words used together, and the thickness of the link indicates the number of times these words are used together. The

Climate change has become a serious concern worldwide and has major impacts on businesses. The bibliometric analysis of this study reflects the importance of this issue in the business world. Climate change presents both risks and opportunities for businesses. This issue brings many business opportunities such as environmental sustainability, carbon footprint reduction, energy efficiency, and green products (Urhan et al. 2023, pp.81550-81551). In this context, businesses need to develop innovative solutions to cope with climate change and build a sustainable future.

Bibliometric analysis helped us to identify key actors and studies in the relevant literature. The results of this study allowed us to identify the countries, the most cited authors, and the most cited articles in the research on climate change and businesses. This information serves as a guide for future researchers and allows them to conduct more in-depth studies on related topics.

Furthermore, the bibliometric analysis also reveals collaborations and links between different disciplines (Ellegaard and Wallin, 2015, p.1810). It shows that research on climate change frequently interacts between different disciplines such as business, environmental sciences, economics, and social sciences. This interdisciplinary collaboration enables the development of more comprehensive and holistic solutions (Matos et al. 2022, p.3).

In conclusion, the bibliometric analysis of research on climate change and businesses reveals the size and diversity of the literature in this field. The imperative for businesses to cope with climate change and build a sustainable future is increasingly emphasized. Therefore, the findings of this study provide important guidance for business leaders, policymakers and researchers. More research needs to be conducted on climate change and businesses need to increase their sustainability efforts.

Future Recommendations

As a result of the research, some key strategies that businesses can adopt to effectively address the challenges of climate change are suggested. These recommendations are as follows:

Sectoral Focus: Strategies for coping with climate change may vary by business type. Future research should examine climate change impacts and adaptation strategies specific to businesses in different sectors. For example, customised research is needed for businesses in different industries, such as the energy sector, agriculture, tourism or the financial sector.

Risk Management and Adaptation Strategies: More work needs to be done to understand how businesses will cope with climate change. How can businesses' risk management strategies be shaped based on climate change scenarios? What can adaptation strategies be? Research on these issues can guide businesses.

Green Innovation: In the fight against climate change, more focus should be placed on green innovation and sustainability efforts of enterprises. Future studies should address how businesses can make their products, processes and business models more sustainable.

Financing and Investment: More research should be done on how businesses can find the necessary resources to tackle climate change and invest in sustainable projects. This should include examining the impacts of green finance and socially responsible

investment on business.

Policy and Regulation: How should businesses interact with governments' climate change policies and regulations? Future research should examine the strategies and potential opportunities for businesses to adapt to these policies and regulations.

Co-operation and Information Sharing: How can new models and platforms be created to increase climate change-related knowledge sharing and co-operation among businesses? This should be part of future work.

Training and Awareness: More focus should be placed on training and training materials to raise awareness of business owners, managers and employees on climate change.

Data and Monitoring: Better data and analytical tools are needed for businesses to monitor and assess climate change impacts. Future research should address how businesses can be better equipped in this regard.

Social Responsibility and Reputation Management: More work needs to be done to better understand the relationship between businesses' social responsibility and reputation management strategies and combating climate change.

Global Co-operation: Climate change is an international problem. Opportunities for businesses to co-operate globally and achieve sustainability goals should be further examined.

These recommendations can help businesses improve their strategies to cope with climate change and increase their sustainability. Future research addressing these issues can help businesses find more effective and sustainable solutions.

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