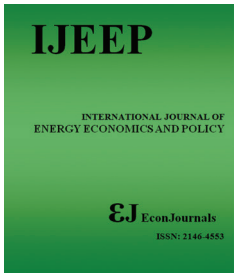

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A Bibliometric Analysis of Climate Investing

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ABSTRACT

This research article seeks to provide a comprehensive review of climate investing and anticipated future developments by using bibliometric study. Climate investing is a well-researched subject of study, and the massive increase in publications in recent years indicate the breadth and depth of the topic. Affiliation statistics show that the majority of research is centered in the USA, Australia and the UK, offering up new possibilities for climate investing research in developing countries. The authors examined 1091 articles related to climate investing from the Scopus database since 1971, using the bibliometric review technique to provide numerous viewpoints from previous climate investing studies associated with carbon offsetting, green bonds, impact investing, sustainable stock indices, climate-themed funds, ESG screening, divestment from fossil fuels, climate-aligned funds, and climate-smart agribusiness and suggests future study directions. This research may be helpful to policy makers, particularly those from developing nations, in understanding the challenges of climate investing.

Keywords: Climate Investing, Climate Change, Sustainability, Bibliometric Study, Carbon Footprint, Environment Policy
JEL Classifications: Q01, Q54, Q28, Q56

1. INTRODUCTION

Climate change is an alarming phenomenon for the international community, because it presents major hazards to human health, the environment, and economic stability (Ramos et al., 2022). As the world's economies continue to grow and change, investors must examine the possible dangers and risks linked with climate change in their investment decisions (Hansen, 2022).

Hurricanes, floods, and other extreme weather events have lately become frequent and more severe in recent days. They may harm infrastructure and interfere with supply lines, resulting in financial losses. (Zabin et al., 2022). Sectors such as fishery, forestry, agriculture are particularly sensitive to the effects of climate change viz. changes in temperature and precipitation patterns (Aryal et al., 2020). Additionally, the shift towards a low-carbon economy may lead to stranded assets, such as fossil fuel reserves become unburnable and fossil fuel-dependent industries may decline (Wen et al., 2023). In contrast, investors will benefit greatly from the shift to a low-carbon economy, because more money is anticipated to be invested in low-carbon technologies like renewable energy and energy efficiency (Tian et al., 2022).

There are several tools and methods which are used for climate investing, including Carbon offsetting (Gössling et al., 2007), Green bonds (Maltais and Nykvist, 2020), Impact investing (Barber et al., 2021), Environmental, Social and Governance (ESG) screening (Verheyden et al., 2016), Sustainable stock indices (Bianchi and Drew, 2012), Climate-themed funds (Gewirtzman et al., 2018), Divestment from fossil fuels (Plantinga and Scholtens, 2021), Climate-aligned funds (Dafermos et al., 2021), Climate-smart agri-business (Shilomboleni, 2022).

Climate investing is the incorporation of climate-related risks and opportunities into investment decision-making. It offers investors a number of benefits, including alignment with long-term

sustainability goals, portfolio risk management, access to growth opportunities, portfolio diversification, improved transparency and accountability, increased awareness of climate change, and investments that are compliant with regulatory requirements.

Some of the limitations associated with the climate investing are, lack of data and standardization, difficulty in quantifying risks and opportunities, short-term focus of the investors, lacking knowledge of the shift to a low-carbon economy, having few investment alternatives, and unpredictable regulatory and policy environments, lack of long-term performance data, lack of transparency and standardization in data reporting.

The goal of this research paper is to give a summary of the history and present situation of climate investing by using bibliometric analysis, including the risks and opportunities associated with climate investment. Additionally, this paper will investigate the possible impact of climate change on diverse sectors and to identify sectors that may be particularly vulnerable or robust in the context of a rapidly changing environment.

2. OVERVIEW OF CLIMATE INVESTING

Climate change is one of the most pressing issues confronting the world today. If left unaddressed, it has the potential to cause significant economic and societal destruction. The financial industry could play a crucial part in resolving this issue, as the decisions made by investors and financial institutions can have a significant influence on the shift to a low-carbon economy (Monasterolo, 2020). Climate investing, the practice of investing in companies and projects that are focused on addressing climate change and its effects, has emerged as an important strategy for achieving this transition (Chatzitheodorou et al., 2019).

2.1. Types of Climate Investments

The most common types of climate investments are in sustainable agriculture, sustainable transportation, energy efficiency, and renewable energy (Mahat et al., 2019). Investments in renewable energy, including solar and wind power, have been proven to perform well with low risk (Rastogi et al., 2020). Energy efficiency investments, such as building retrofits, have also been found to have strong performance and low risk (Mikulić et al., 2021). Sustainable transportation investments, such as electric vehicles and public transportation, have been found to have mixed performance and moderate risk (Davis, 2019; Seker and Aydin, 2020). Sustainable agriculture investments, such as regenerative farming, have been found to have strong performance and low risk (Katz-Rosene, 2020).

Table 1 shows potential for investment in Climate investing products by 2030. Building and Transport are most promising areas for potential investments. In case of renewables, wind and solar energy lead the change with highest potential in Asian region. East Asia and Pacific seems to have highest potential in terms of attracting likely investments in ecofriendly instruments.

2.2. Financial Performance of Climate Investing

Examining the financial results of businesses that are committed to mitigating climate change has been one important subject of study

Table 1: Investment prospects by sector and region till 2030 ($Billion)

By Region	Solar	Wind	Biomass	Small hydro	Geothermal	All renewables	Electric transmission and distribution	Industrial energy efficiency	Building	Transport	Waste	Total
Middle East and North Africa	46	50	0	1	0	97	21	1	92	50	4	265
Europe and Central Asia	39	51	6	7	6	109	0	57	410	78	11	665
Latin America and Caribbean	44	118	45	11	14	232	0	21	901	1460	26	2640
East Asia Pacific	537	231	48	34	16	66	392	143	13235	1357	53	16046
Sub-Saharan Africa	63	27	3	3	27	123	0	0	153	499	8	783
South Asia	211	111	16	0	0	338	0	85	1543	255	13	2234
Investment Potential by Sector	940	588	118	56	63	1765	413	307	16334	3699	115	22633

Source: IFC report (Houerou, 2016)

on climate investing. Studies have found that these companies tend to have strong financial performance, with higher returns on investment and lower volatility compared to companies that are not focused on climate change (Zhou et al., 2022). According to the MSCI survey, companies in their ESG (Environmental, Social and Governance) index, which includes companies that have strong sustainability practices, outperformed the MSCI World Index by 2.5% per year from 2007 to 2016. Another study by Mercer found that a portfolio of companies with high sustainability ratings outperformed a traditional portfolio by 6% over a 10-year period (Reid et al., 2021).

2.3. Strategies and Approaches

Another area of research has been the examination of the different strategies and approaches that can be used in climate investing. These include investing in clean energy companies and technologies, investing in companies that are focused on reducing their carbon emissions, and investing in firms that are focused on climate change adaptation. A great way to encourage the development of clean energy sources and lower greenhouse gas emissions is to invest in renewable energy firms (Rokhmawati, 2021). Investing in firms that are committed to lowering their carbon footprint can help to alleviate the consequences of climate change and accelerate the transition to a low-carbon economy (Linnenluecke et al., 2019). It will also assist to mitigate the possible negative consequences of climate change on the economy and society.

2.4. Government Policies and Regulations

Studies have found that government policies, such as carbon pricing and renewable energy targets, can have a huge influence on renewable energy industry growth and the development of new technologies (Pradhan and Ghosh, 2022). A study by Andrews-Speed (2012) found that a carbon price of $40 per tonne of CO_2 would lead to a three-fold increase in investment in clean energy technologies. A study by the International Energy Agency found that renewable energy targets can lead to a significant increase in investment in the sector.

3. METHODOLOGY

A literature review is the process of locating, evaluating, and combining the body of completed and documented work produced by academics, researchers, and practitioners (Fink, 2014). A systematic literature review is commonly used by academics and practitioners because it is perceived to be scientific proof. It is difficult to conduct a rigorous study without reflecting the ideas of the relevant literature. As a result, a thorough, systematic examination of the literature is required (Tranfield et al., 2003).

The authors undertook a bibliometric study in order to give a detailed analysis and bridge the gap in the literature on climate investing. Through this study, the authors not only acknowledge present and past research trends in the field of climate investing, but they also provide a peek of prospective future research areas.

3.1. Selection of Appropriate Search Terms

The study contains research publications linked to the Scopus database that date back 52 years, or from 1971 to the present. Scopus database, created by Elsevier in 2004, is a citation and abstract database. As of December 2022, Scopus covers 11768 publishers, 34346 peer-reviewed journals, and 36377 articles in areas such as health sciences, social sciences, management, engineering etc. The Scopus database has a far larger reach than the Web-of-Science database and hence authors zeroed upon the articles only from the Scopus database. One of the limitations associated with Scopus is, the articles before 1996 are difficult to retrieve. For their bibliometric analyses, authors employed a variety of software programmes, including R, Gephi, and VOS Viewer.

3.2. Initial Search Outcome

Authors chose "Climate Investing" as their primary keyword during the Scopus database search while searching in the field "Article title, abstract, keywords." 1449 items in total were found during the initial search. These results were further limited to "article" and "review" document types to obtain 1091 documents which have been used in the bibliometric analysis.

3.3. Descriptive Statistics

Details about the number of articles that were selected from the Scopus database are shown in Table 2. The overall total number of documents assessed were 1091, which includes the 991 articles and 100 review papers. Total 689 journals were used to extract information related to these articles.

Authors of these articles used 3235 keywords and there are 5334 frequently used keywords in the articles commonly known as Keywords Plus. The evaluation of the literature spans a period of fifty-two years, with an average of 18.8 citations per document. 276 documents with only one author each, are produced by a total of 254 single writers. The total number of writers are 3427, and together they authored 1091 articles, averaging 0.318 documents per author.

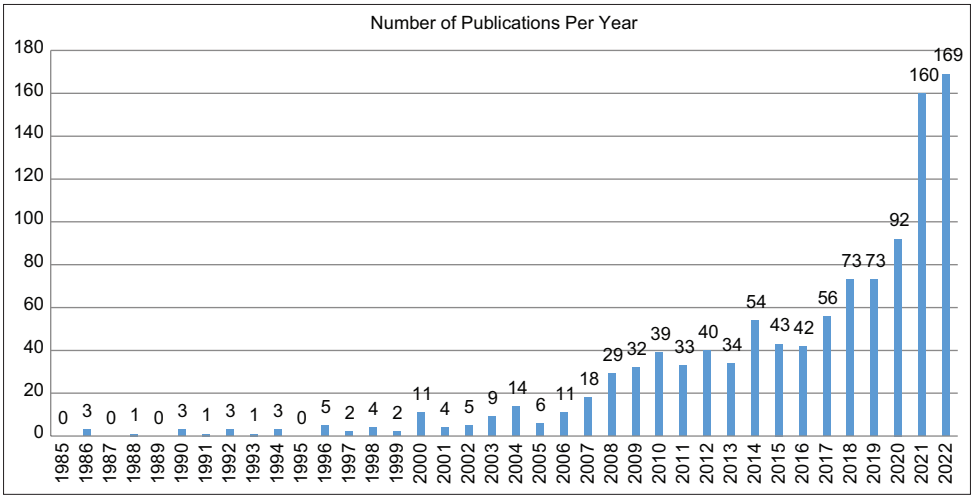
3.4. Annual Publications

Figure 1 depicts the researchers' total number of research articles published on climate investing between 1985 till 2022. Between the period of 1971 to 1984, there were hardly any publications associated with the subject, and hence the period has been omitted from the above figure. The current analysis indicates total 1091 documents published between 1971 to 2023 spanning 52 years with annual growth rate of 4.89 per year.

Table 2: Descriptive statistics

Details	Count
Documents	1091
Sources (Journals, Books, etc.)	689
Average citations per doc	18.8
Keywords plus (ID)	5334
Authors	3427
Author's keywords (DE)	3235
Timespan	1971:2023
Authors	3427
Authors of single-authored docs	254
Single-authored docs	276
References	54225
Document types	
Article	991
Review	100

Figure 1: Annual number of publications



Source: Created by authors from bibliometric analysis

In 1970's there were hardly any publications, whereas in 2022 there were 169 publications associated with climate investing indicating the depth and scope of the subject for the future research, as the number of publications have steadily increased over a period. The graph depicts a steady increasing pattern of paper releases throughout time, with no lulls, demonstrating a growing interest among scholars in the field of climate investing.

4. ANALYSIS OF THE DATA

The data obtained from the Scopus database was evaluated utilizing bibliometric analysis methodologies and several free softwares such as Gephi, R, and VOS Viewer. The authors divided their study into four areas for bibliometric analysis: journals, countries, keywords, authors. To facilitate further analysis, these groupings have been further broken into a number of other categories.

4.1. Authors with Highest Influence

Table 3 lists the top 15 most important and prominent researchers who have made substantial contributions to the field of climate investing. These writers have contributed to new theoretical advancements in the field of climate investing and helped test ideas that have previously been developed using empirical experiments. This has provided a foundation for future study on the subject. The table's data is organized in descending order, with the author who contributed the most being noted first. With 5 solo publications and 1.28 co-authored papers, Li Y has published the most research articles since 1971. Banerjee O ranks number 2 with 4 individual publications and 1.71 co-authored publications. The contributions of the other writers have been appropriately acknowledged in the table.

Table 3: Authors with highest influence

Authors	Articles	Articles fractionalized
Li Y	5	1.28
Banerjee O	4	1.71
Fuss S	4	0.76
Zhang J	4	1.28
Zhang Y	4	0.9
Aerts J C	3	0.3
Causevic A	3	0.64
Fujino J	3	0.67
Guan D	3	0.68
Gupta J	3	1.5
Jongman B	3	0.3
Kumar P	3	0.59
Li J	3	0.92
Li M	3	0.6
Li X	3	0.87

Table 4: Country wise representation of corresponding authors

Country	Articles	SCP	MCP	MCP_ratio
USA	173	138	35	0.202
United kingdom	78	53	25	0.321
China	48	33	15	0.313
Australia	47	37	10	0.213
Germany	36	25	11	0.306
Canada	29	19	10	0.345
Netherlands	26	12	14	0.538
Sweden	23	10	13	0.565
France	21	9	12	0.571
India	21	18	3	0.143
Spain	20	15	5	0.25
Brazil	17	10	7	0.412
Italy	17	11	6	0.353
Japan	14	14	0	0
Switzerland	13	9	4	0.308

SCP: Single country publication, MCP: Multiple country publication

4.2. Countries Represented by Corresponding Authors

The corresponding author's and their co-author's affiliations are shown in Table 4. The acronyms SCP and MCP stand for single country publishing by multiple authors and multi-country publication by multiple authors, respectively. The MCP Ratio is the percentage of all published publications that are multi-county articles. The information given below enables readers to comprehend how each nation has contributed to the topic's research as well as how authors from other nations have collaborated.

According to the table, the United States made the most research contribution on the subject of climate investing, with a total of 173 research papers, of which 138 are single-country studies and just 35, or 20.2%, are multi-country publications. As the MCP Ratio is lower in the United States, it implies smaller multi-country collaborations, but the same is 32.1% and 31.3% in the United Kingdom and China, respectively, suggesting stronger multi-country collaborations. Among the notable nations contributing to the research field are China, and Australia, China and the UK, yet the total amount of publications is equivalent to that of the United States alone. This demonstrates a far higher degree of research interest and attention in the United States on the problem of climate investing.

4.3. Keywords

A study topic can be split into several subfields, and each subfield can subsequently be examined from diverse perspectives using a variety of frameworks and approaches. The literature generates a number of relevant keywords that highlight the importance of the field study. By applying keyword analysis, it is feasible to comprehend both, the breadth and depth of the research field.

Figure 2: Word cloud

4.3.1. Most frequently used words

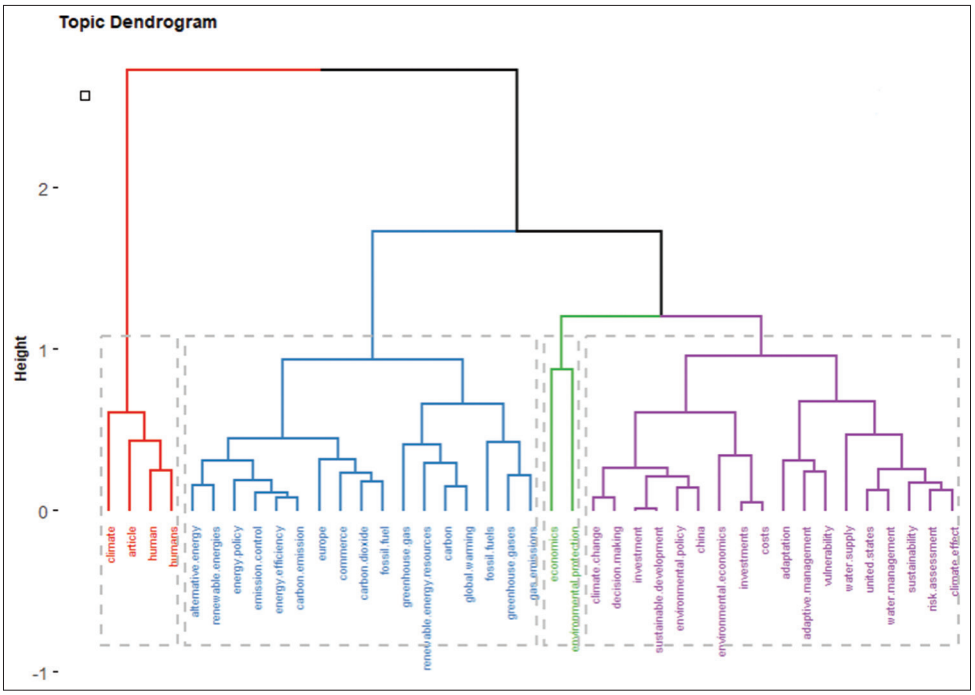
If we refer to the word cloud in Figure 2, we can see that the most dominant word in the overall analysis is "climate change". It represents the consistency and dominance of the subject area in the last 25 years. Other prominent keywords include "investments," "carbon dioxide," "sustainable development," "decision making," "investment" which are all related to operational aspects of the climate investing and lot of research has been done on these areas in the developed world. Climate change is the process of considering the environmental and social impact of investments in relation to the goal of reducing carbon dioxide emissions and promoting sustainable development. This may involve evaluating the potential carbon footprint of investments and incorporating this information into decision making processes to ensure that investments align with sustainability goals. It also may involve considering other sustainable development factors like labor practices, biodiversity conservation and human rights in investment decision making process. Thus, the word cloud reflects some of the prominent keywords associated with the climate change and climate investing process.

4.3.2. Factorial analysis

The dendrogram may be used to explain the hierarchical grouping connection between the items. It is a tree representation that is used in many contexts to highlight clusters created during the investigation. Figure 3 depicts a dendrogram for "Climate Investing" which has been divided into four cluster topics.

The first cluster represents keywords associated with impact of climate change and climate investing on humans. Cluster two represents several topics related to climate investing in two major branches. The first major branch discusses about the emission control, investments in efficient alternate/renewable energy resources and development of sustainable energy policy as well

Figure 3: Factorial analysis



as thought process from European region related to cut back on spending on and using carbon dioxide-producing resources like fossil fuels. The second section examines the impacts of climate change, such as greenhouse gases, global warming, and gas emissions. And associated pollution, unrestricted use of fossil fuel and its impact on environment and need for investment in proper climate investing resources.

Third cluster represents economics of climate investing associated with the environmental protection, which may not always be favorable in short term period, but considering the climate impact and long term investments in sustainable resources and good companies have always provided better returns. Forth cluster with two major branches discusses about policy making, adoptability, sustainability, preservation of natural resources and need for climate investing.

4.3.3. Keywords and co-occurrence networks

Keywords are often found after the abstract in research publications and highlight essential themes or concepts linked with the research article. Each academic paper typically includes six to eight keywords. Some crucial keywords are always repeated in different study pieces over time. This phenomenon is known as keyword co-occurrence, and it offers researchers with a lot more analytical meaning.

Keyword co-occurrence assists in finding the most significant research subareas linked with any given domain, as well as describing the proximity of one research subarea to another. As a result, it aids in comprehending the significant co-occurred terms related with any certain topic of interest. Figure 4 depicts the keyword co-occurrence for the topic of climate investing.

4.4. Most Important Journals

The top 15 journals are shown in Table 5. They have made significant contributions to the publication of research articles related to climate investing. Typically, researchers look at how many papers have been published in the top-tier journals in their specific study area to learn about current and historical hot themes in the field.

The journals are arranged in order of articles published, with the highest number of studies on the subject of climate investing published in the Journal of Cleaner Production in the previous 15 years, followed very closely by Energy Economics and Business Strategy and The Environment.

4.5. Three-Fold Plot

Figure 5 shows a three-fold map that helps us comprehend the link between author, author keywords, and journal name (or source) related with climate investing. This data may be used to determine the most prominent writers in the subject field, who can be approached for advice and collaboration, important subtopics that can be identified based on the author keywords, and valuable journals associated with the publication of these research articles. The journal information can be used to find possible journals for future articles in the same field of study.

4.6. Structures and Countries

4.6.1. Most influential countries

In the case of financial products, it has been noted that the original location of the product has the most initial research, followed by research connected with operational efficiency of the product. Later, when the financial product becomes available in established and emerging nations, they begin to contribute to the product's study. Table 6 lists each country's average number of articles cited, total number of citations, and number of papers produced. With 782 total research articles, 4051 citations, and an average article citation of 23.72, the United States leads the leaderboard, which is followed by the United Kingdom, having 2745 citations associated with 297

Figure 4: Keyword co-occurrence

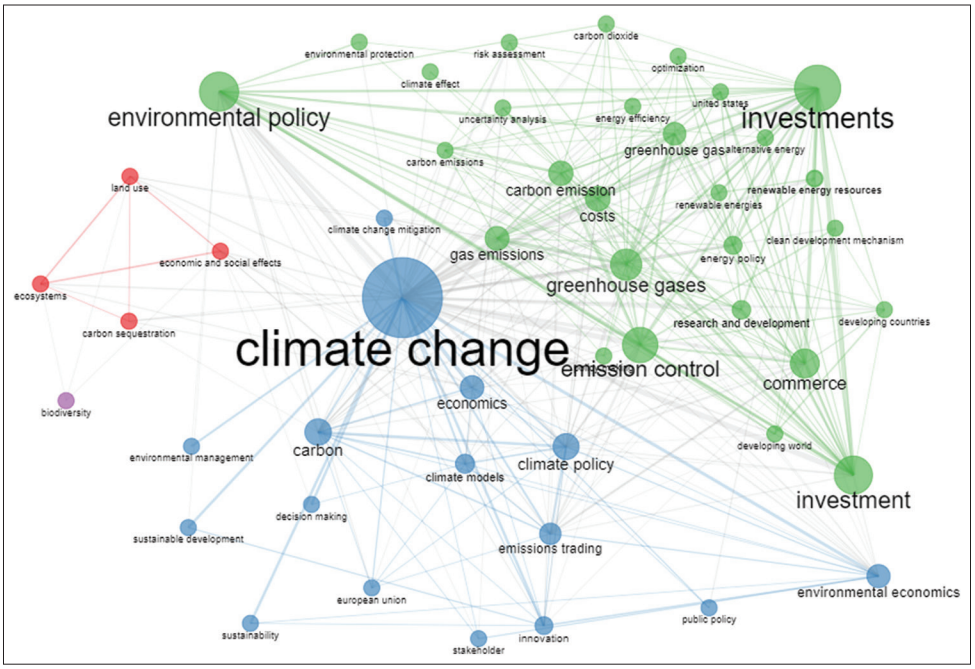


Figure 5: Three-fold plot

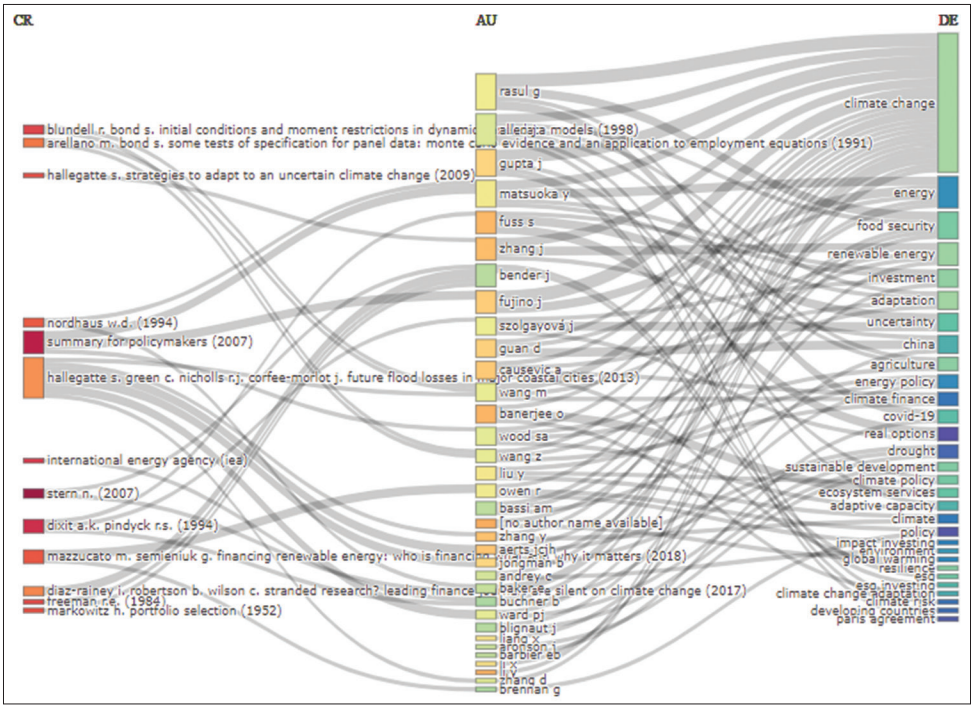


Table 5: Most productive journals

Source	h_index	g_index	m_index	TC	NP	PY_start
Journal of cleaner production	10	18	0.588	538	18	2007
Energy economics	7	9	0.226	140	9	1993
Business strategy and the environment	5	6	0.5	181	6	2014
Environmental and resource economics	4	7	0.222	56	10	2006
Applied geography	3	4	0.3	109	4	2014
Ecological economics	3	6	0.2	280	6	2009
Food policy	3	4	0.429	48	4	2017
Journal of business venturing	3	3	0.083	370	3	1988
Research policy	3	3	0.071	41	3	1982
Resource and energy economics	3	5	0.2	42	5	2009
Resources, conservation and recycling	3	4	0.429	96	4	2017
World development	3	3	0.75	69	3	2020
Electricity journal	2	2	0.2	12	2	2014
Environment, development and sustainability	2	3	0.167	374	3	2012
Europe - Asia studies	2	2	0.091	32	2	2002

TC: Total citations (from the Scopus database), NP: Number of publications, ABDC category is associated with 2019 categories published by Australian Business Deans Association, SJR rank is obtained from Scimago (2022) Journal and Country Rank

publications, and an article citation average of 35.19. According to the statistics, the USA is the nation that makes the greatest contributions to the subject of climate investing, with the most publications and the highest average article citations, both of which suggest higher levels of research quality. While other nations like the United Kingdom, Australia, and China have made significant contributions to the subject, they are in no way comparable to the USA.

4.7. Most Relevant Affiliations

Table 7 below represents most relevant affiliations of the authors with different educational universities. Most of the universities in the list belong to USA and UK confirming that highest amount of work related to climate investing has been done in these leading universities. Some of the universities in China are also present at slightly lower ranks in the table.

Table 6: Statistics of country wide publications of research articles

Country	Freq	TC	Average article citations
USA	782	4051	23.42
United Kingdom	297	2745	35.19
Australia	201	1684	35.83
China	195	1001	20.85
Germany	155	796	30.62
Netherlands	129	657	22.66
Canada	112	623	17.31
France	99	530	26.5
Spain	94	476	22.67
Brazil	90	346	15.04
Italy	83	305	25.42
Sweden	82	295	29.5
South Africa	75	225	37.5
India	74	218	12.82
Switzerland	69	193	14.85

5. A STUDY OF CO-CITATIONS

5.1. Maximum Cited Articles

Citations serve as a general indicator of the quality of the research paper, publication, and authors in a certain field of study. New research articles that add to the pool of knowledge always receive a lot of citations.

Table 7: Most Relevant affiliations

Affiliation	Articles
University of leeds	28
Stanford university	24
University of Tasmania	23
Universidade De Lisboa	17
University of California	17
University of Cambridge	16
University of Florida	16
Imperial college London	15
Tsinghua university	15
Wageningen university	15
Wageningen university and research	14
Beijing normal university	12
Delft university of technology	12
London school of hygiene and tropical medicine	12
University of bath	12

The top 15 most-cited research publications in the field of climate investing are shown in Table 8. The articles are listed in decreasing order, with the article with the most citations at the top and the others listed in order of total citations. "Global determinants of future river flood risk" by (Winsemius et al., 2016), with 496 citations, is the most referenced research paper. The writers of this article have covered the worldwide flood danger brought on by socioeconomic growth and climatic change. The authors predict that South East Asian and African nations would be most impacted by this transition, and they describe potential corrective strategies including impact investment. "Benefits of restoring ecosystem services in urban environments" is the title of the second research paper, which has 406 citations and was written by (Elmqvist et al., 2015). These frequently cited publications were written by renowned specialists in both climate change and climate investing.

5.2. Co-citation Analysis

Co-citation analysis related to climate investing is displayed in Figure 6. At first, 3427 writers were taken into account for the

Table 8: Maximum cited articles

Article name	Journal	Authors	DOI	TC	TC per Year
"Global drivers of future river flood risk"	"Nature Climate Change"	(Winsemius et al., 2016)	10.1038/nclimate2893	496	62
"Benefits of restoring ecosystem services in urban areas"	"Current opinion in environmental sustainability"	(Elmqvist et al., 2015)	10.1016/j.cosust. 2015.05.001	406	45.11
"The future of the global food system"	"Philosophical Transactions of the Royal Society B: Biological Sciences"	(Godfray et al., 2010)	10.1098/rstb. 2010.0180	394	28.14
"Increasing stress on disaster-risk finance due to large floods"	"Nature Climate Change"	(Jongman et al., 2014)	10.1038/nclimate2124	337	33.7
"Warming of the Indian Ocean threatens eastern and southern African food security but could be mitigated by agricultural development"	"Proceedings of the national academy of sciences"	(Funk et al., 2008)	10.1073/pnas. 0708196105	327	20.44
"Climate change, connectivity and conservation decision making: back to basics"	"Journal of Applied Ecology"	(Hodgson et al., 2009)	10.1111/j. 1365-2664.2009.01695.x	325	21.67
"Environmental Externalities and Cost of Capital"	"Management science"	(Chava, 2014)	10.1287/mnsc. 2013.1863	321	32.1
"Climate change and extreme weather events: can developing countries adapt?"	"Climate policy"	(Mirza, 2003)	10.1016/S1469-3062 (03) 00052-4	318	15.14
"Observed adaptation to climate change: UK evidence of transition to a well-adapting society"	"Global environmental change"	(Tompkins et al., 2010)	10.1016/j.gloenvcha. 2010.05.001	274	19.57
"Smart integration"	"IEEE Power and Energy Magazine"	(Vojdani, 2008)	10.1109/MPE.2008.929744	240	15
"Spatial and Temporal Trends of Global Pollination Benefit"	"PLoS one"	(Lautenbach et al., 2012)	10.1371/journal.pone. 0035954	230	19.17
"Water management and crop production for food security in China: A review"	"Agricultural water management"	(Khan et al., 2009)	10.1016/j.agwat. 2008.09.022	211	14.07
"Car free cities: Pathway to healthy urban living"	"Environment International"	(Nieuwenhuijsen and Khreis, 2016)	10.1016/j.envint. 2016.05.032	204	25.5
"Modeling benefits from nature: using ecosystem services to inform coastal and marine spatial planning"	"International Journal of Biodiversity Science, Ecosystem Services and Management"	(Guerry et al., 2012)	10.1080/21513732.2011.647835	203	16.92
"Coal seam gas and associated water: A review paper"	"Renewable and Sustainable Energy Reviews"	(Hamawand et al., 2013)	10.1016/j.rser. 2013.02.030	190	17.27

Source: Created by authors from bibliometric analysis

analysis. Disconnected nodes that represented standalone articles were taken out of those. The top 50 nodes and their co-citation analysis are shown in the image. The author performs better in terms of co-citation the larger the node and font. The top 5 writers by co-publications are Heinkel R, Hong H, Friede G, Fama E.S., and Chava S, according to the figure.

5.3. Data Clustering

Using the data clustering approach, a different primary collection of articles on the study topic may be generated. It has been established that papers related to the same sector have comparable features and study areas. As a result, the existence of various articles in the same cluster aids us in understanding the co-occurrence together with sub-themes linked with the research topic. Table 9 shows how the authors utilized data clustering to find the common study themes linked with the issue of climate investing. Clusters 1,2,3,4,5 each constituted 28,27,9,30,6 articles, and PageRank analysis was performed to identify the top 6 articles from each cluster.

Figure 6: Co-citation analysis

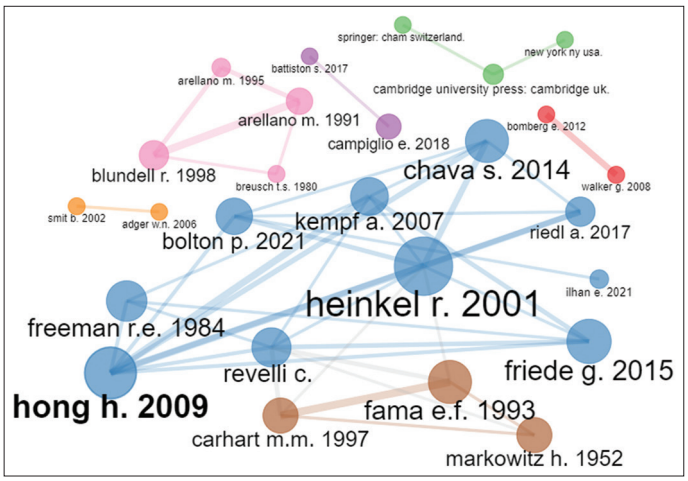


Table 9: Top climate investing research publications with co-citations per cluster

Cluster 1:	Cluster 2:
(Fuss et al., 2008)	(Tompkins et al., 2010)
(Bender et al., 2019)	(Rizzati et al., 2023)
(Abadie et al., 2017)	(Ogra, 2022)
(Granoff et al., 2016)	(Trebilco et al., 2021)
(dos Santos et al., 2023)	(Ngo et al., 2022)
(Stroombergen and Lawrence, 2022)	(Cormack et al., 2020)
Cluster3:	Cluster 4:
(Hall et al., 2017)	(Flammer, 2021)
(Kul et al., 2020)	(Pástor et al., 2021)
(Patala et al., 2021)	(Fisher-Vanden and Thorburn, 2011)
(Gürsan and de Gooyert, 2021)	(Santi, 2023)
(Petrovich et al., 2021)	(Bolognesi and Burchi, 2023)
(Vogl et al., 2021)	(Zeidan, 2022)
Cluster 5:	
(Zeng et al., 2022)	
(Caglar and Ulug, 2022)	
(Majeed et al., 2022)	
(Celik and Alola, 2022)	
(Khan et al., 2022)	
(Horobet et al., 2021)	

Cluster 1 represents risk assessment related to climate change, impact of carbon emissions, uncertainty associated with changed weather conditions, and judgement associated with climate investing for better future. Cluster 2 represents adoptive management associated with climate change and climate investing. It discusses about the problems associated with scarcity of natural resources due to climate change, decision making and adaptation of proper strategies and investments with long term horizons for sustainable development.

Cluster 3 represents developing and adoption of environmental policy measures and associated investments required due to climate change. Some of the policy measures include reduction of greenhouse gases, reduction of can-dioxide emissions. It also addresses the uncertainty analysis of climate change and climate investing. Cluster 4 discusses about acclimatization due to climate change, creation and adoption of new energy policy and associated investments, use of alternate energy resources, ill effects of climate change such as flooding, global warming and better use of technology like satellite imagery to reduce destruction of properties and casualties.

Cluster 5 reflects investments in renewable energy sources and a decrease in the usage of fossil fuels for economic development. It also focuses on government policies related to climate investing and its overall impact on reducing the carbon footprint.

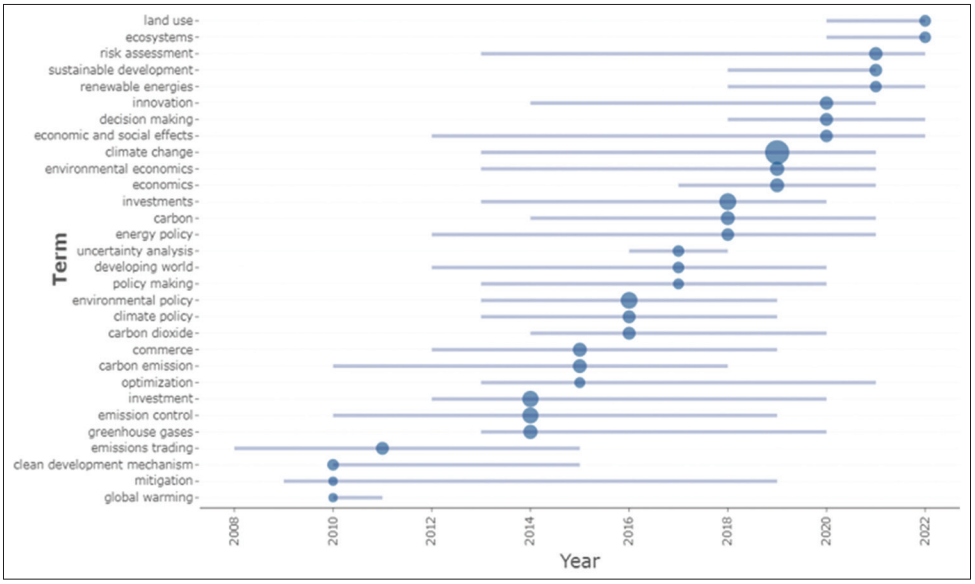
Cluster analysis assists us in comprehending the link between diverse clusters and also help us to understand various sub themes and associations with the topic. Climate change and climate investing are common themes across all clusters indicating their overall importance.

6. CONCLUSION

In the context of climate change, climate investing is a significant topic. The current surge in publications (2020, 2021, and 2022) indicates the depth and promise of climate investing despite the fact that it is a widely researched issue with an increasing number of publications. As a result, the goal of this study is to look at the evolution of climate investing and to suggest future research areas in the field. By employing a thorough study of the literature and bibliometric evaluation of 1091 research papers from the Scopus database that were published over the course of 52 years, the article summarizes the most notable research papers, keywords, authors, and the associated research clusters to discover an evident background and research boundaries of climate investing.

The United States, according to the statistics, is the largest contributor to climate investing research, followed by the United Kingdom, Australia, and China. Except for China and India, emerging market economies make little input to climate investing research. Citation analysis, analysis of research papers and authors indicate that the most prominent writers of climate investing research were Li Y., Banerjee O., Fuss S., Zhang J., and Zhang Y. The majority of these authors are from developed countries, showing a paucity of research contributions from emerging economies. The primary keyword-based dimensions

Figure 7: Trend topics



of climate investing research, according to keyword analysis, are the keywords "climate change," "climate investing," "carbon dioxide," "sustainable development," and "decision making."

Environmental policy, investments, greenhouse gases, and emission control are sub topics of climate investing, according to PageRank analysis and keyword co-occurrence. Some significant themes were identified by each cluster through cluster-based analysis, including risk assessment, adoptive management, the formulation and implementation of environmental policies, the development of new energy policies, and a decrease in the use of fossil fuels related to climate investing.

These studies have significant implications for future scholars and researchers. To investigate new topics of study related to climate investing, several sub-themes derived from the results can be connected. This research may be helpful to policy makers, particularly those from developing nations, in understanding the challenges of climate investing. To comprehend the breadth and prospects linked with climate investing research, this research article may be helpful for students at many stages, including research scholars and senior research fellows.

6.1. Future Trends in Climate Investing

There are several emerging research trends in the field of climate investing that are likely to gain traction in the coming years include Climate scenario analysis, Physical risk assessment, Climate-related financial disclosures, Climate-aligned portfolios, Climate-integrated risk management, Impact of government policies on climate investing.

Overall, climate investing research will continue to concentrate on evaluating the possible risks and possibilities linked with climate change, developing strategies and tools for integrating climate considerations into investment decision-making, recognizing the possible effects of climate change on the world economy and financial markets.

Figure 7 below indicates some of the trend topics in the form of keywords that also provide potential glimpse on the future trends. These key words include "Land use," "Ecosystems," "risk assessment," "Sustainable development," "Renewable Energies."

6.2. Limitations

The study exclusively used the Scopus database, which has certain benefits and drawbacks that are thoroughly covered in the methodology. Furthermore, writers may have overlooked certain articles from journals that are only covered by Web of Science. The number of occurrences will be minimal because the majority of prominent journals are covered by both the Scopus and the Web of Science databases.

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