International Journal of Social Science and Entrepreneurship ***(IJSSE)*** ***Vol 3 , Issue 2***
ISSN (Online): 2790-7716 , ISSN (Print): 2790-7724 ***April to June 2023***

Climate Literacy: Assessment of Its Growth and New Trends

Imtiaz Ali
PhD Scholar in Economics, Greenwich University
imti_malik@yahoo.com

Farhan Ahmed
Assistant Professor Economics, NED University, Karachi
fahmed.ned@gmail.com

Abstract

A bibliometric analysis of 1337 papers from the Web of Science database published between 2000 and 2023 (January) was conducted to provide an overview of climate literacy. The study's objectives were to survey the body of literature on climate literacy, examine the connections among the authors, organizations, and nations that were active in the subject, and ascertain the rate of growth in that field during the previous 23 years. To find the current research interests, thematic and keyword analysis were done. With a total of 1337 articles published over the last three years, the data revealed a rising trend in the number of publications about climate change. The study discovered that Hong, Huang-Yao was the most prolific author and that the United States of America, China, the United Kingdom, and Australia had the greatest influence on the research produced on climate literacy. Prestigious universities contributing to climate literacy publications included the Australian National University, the University of Leeds and the University of Oxford. The journal with the most significant number of papers related to climate literacy was Sustainability, ranking first in the Web of Science. Based on the bibliometric study, the authors recommend that future research focus on climate literacy among youth and the associations between the various components of climate literacy.

Keywords: *Climate Change; Climate Literacy; Growth; Bibliometrics*

Introduction

The term "climate change" refers to a long-term shift in global weather brought on by industrial and human activity, particularly in the previous few decades. Because of these activities, the climate will continue to change, the surface temperature will gradually rise, and the atmospheric layer will gradually thin out, which will have significant consequences for the planet (UNFCCC, 2020). As the Earth's surface temperature rises, the Arctic Sea ice will diminish, global and regional boundary patterns will alter, and the season for forest fires will lengthen (Quarderer, Fulmer, Hand, & Neal, 2021). Rapid and unpredictable global climate change impacts human lifestyle and longevity. (Fu & Waltman, 2022). Fu ed al. (2020) assert that humans and the environment are independent because of their connections. The impact of an environmental change can significantly affect human life. Thus, there is an increasing emphasis on creating cutting-edge ways to reduce climate change and support environmental sustainability. New technologies are also being investigated to aid with these efforts.

In light of the urgency of climate change, recent research by Limaye, et al., (2020) shows that the younger generation is increasingly supporting the importance of environmental sustainability. According to Salas, et al., (2019), young people are disproportionately impacted by the negative effects of climate change. This includes the occurrence of extreme weather conditions, which can affect pupils' ability to learn, interrupt school operations, and have long-term health effects. The responsibilities of teachers may shift to include disaster first responder duties as a consequence of climate change, leading to a modification of the school environment (Costa, et al., 2015). Consequently, there has been a recent trend toward a rise in the number of students who are chronically absent from school (Ramírez, et al., 2012). The lack of recreational options and reduced crop and farm productivity attributed to El Nino and La Nina have resulted in students losing interest in their education and feeling fatigued. Moreover, the increased household expenses and food costs due to these factors have further exacerbated the situation (Mardiyati, Natsir, & Nailah, 2021).

There has been a recent surge in interest in climate change literacy as a study issue, with the principal goal being the stabilization of the climate on Earth by the year 2025 (Otto, Donges, Cremades, & Schellnhuber, 2020). Climate literacy refers to a fundamental understanding of the principles of climate science and key concepts related to climate change, as described by Limaye et al. (2020), and based on previous work. Furthermore, it involves a recognition of climate change and a willingness to engage with the associated concepts, themes, and issues, as noted by Danis (2013). Stated differently, a person who is climate literate is

knowledgeable about the fundamentals of climate science, can evaluate information and communicate about climate change in a straightforward manner, and is also capable of taking responsible action to reduce unsustainable practices that hurt the environment. According to Anderson (2012), the study of climate change is a multi-disciplinary endeavour that primarily emphasizes achieving sustainable development goals. As a result, incorporating climate-related subjects into the education system can equip individuals with a solid education to recognize and potentially address these concerns. By integrating climate literacy into the curriculum, young individuals can better understand the effects of climate change and its impact on society (Kuthe, Körfgen, Stötter, & Keller, 2019).

An in-depth bibliometric investigation into climate literacy research was carried out so researchers worldwide could combine their findings into a comprehensive summary. Bibliometric analysis is a relatively new method that helps academics comprehend the progression of a particular study subject by examining the scientific literature associated with that field (Santos & Bakhshoodeh, 2019). Furthermore, Fu and Waltman (2022) state that bibliometric analysis is aimed at providing a consistent and current overview of published research. As a result, the purpose of this study is to examine the patterns of publishing and citation of literature that relates to climate literacy. The study aims to: (1) monitor the development of climate literacy-related scientific publications; (2) explore the relationships and collaborations among authors, organizations, and institutions working in this area; and (3) gain a deeper comprehension of the framework and thematic foci of climate literacy research.

Because it contains a wider variety of texts than other databases, the Web of Science database will be employed for bibliometric analysis in this investigation. In the following step, the literature section will review several facets of climate literacy. After that, the methodology will be described, including topics such as search strategies, the construction of the bibliometric database, and data analysis. When then, the findings will be addressed after they have been presented.

Materials and Methods

In this research, we construct a bibliometric analysis for the purto evaluate the literature on the issues of climate change literacy. Previous research has established that bibliometric analyses are a specific scientific publication that examines the year-to-year changes in scholarly output regarding the number of publications and the number of citations to those articles (Pham, et al., 2021; Ha, et al., 2020). Using keywords that specify the topic's structure concerning each article and give information on trends by year, bibliometric studies

can be performed (Zupic & Cater, 2015). One way to do such an analysis is to detail the topic's organizational structure and explain how each article fits into that framework. That is to say; bibliometric analysis is an effective tool for studying the expanding volume of literature devoted to a specific topic, as well as the interconnections between authors, institutions, and countries.

According to Hernández-Torrano and Brayeva (2020), a bibliometric analysis typically incorporates five steps in the workflow, as indicated in Figure 1. These stages are research design, data collecting, data analysis, data visualisation, and discussion. According to Thu et al. (2021), the examination of the scientific network is carried out in three steps, including co-authorship analysis, citation analysis, and topic keyword analysis.

In order to gauge degrees of collaboration, the first stage of co-authorship analysis looks at the relationships between the authors, nations, and organizations involved in climate change literacy research. The analysis of citations then focuses on the journals cited in studies on climate change literacy, offering details on how the area has evolved across different academic fields.

Additionally, the keyword analysis in climate change literacy seeks to pinpoint the primary themes, subtopics, and research questions while also examining keyword co-occurrence to gauge the scope of the field and multidisciplinary involvement. In this study, Table 1 presents the results of these basic bibliometric studies.

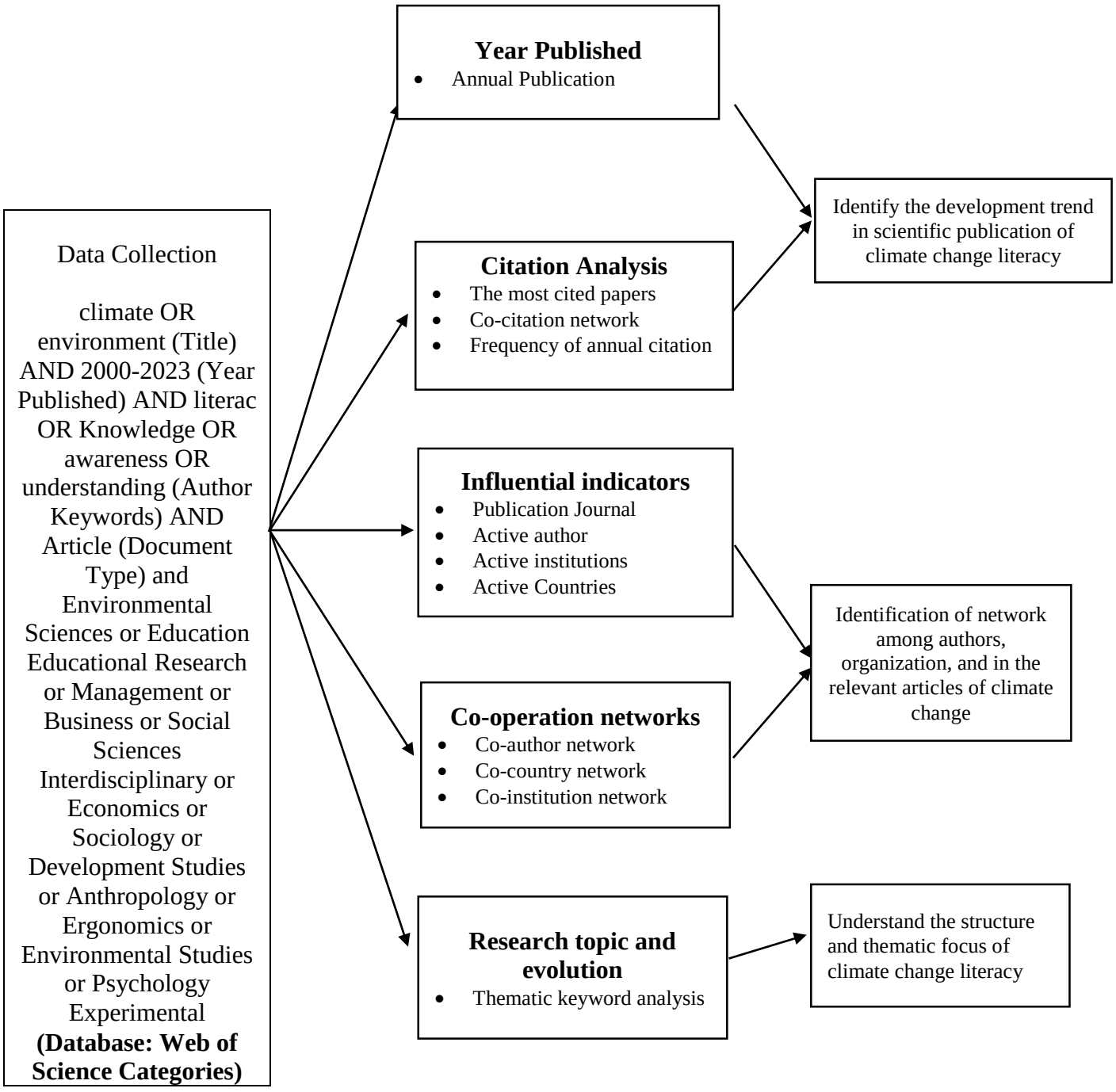
Table 1.
The Applications of Critical Bibliometric Analysis

Key Bibliometric Analyses	Description
Co-authorship (authors and countries)	Using co-authorship analysis, which entails looking at the joint articles written by researchers and their respective countries to find patterns of collaboration, this study aims to analyse the network of researchers who collaborate with one another.
Journals' citations	It refers to exploring the links among various citations.
Network based on various keywords	It means to identify and develop a network based on selected keywords taken from titles, abstracts, and from journals.

For this investigation, the Web of Science was chosen to extract the relevant published papers based on the keywords. The Web of Sciences provides the search for articles that are published in well-reputed journals from a wide variety of research areas.

We searched for related articles on climate change literacy using particular keywords and an appropriate operator approach that conformed to syntax. Web of Science (http://www.webofscience.com) was utilized on the 25th of January, 2023, for searching the relevant articles to use for data for analysis. The time span covered by the searches was from 2000 to 2023, carried out during the last week of January 2023.

Figure 1.
Framework for the "Bibliometric Analysis"



In order to look for previously conducted research, a keyword search for climate literacy was performed. This search included climate or a combination of phrases like "weather" with the words "literacy* OR knowledge OR awareness OR understanding." In the search syntax of Web of Science, the sign "*" specifies that any character can be used. After that, the search is limited to the article's title, abstract, and any keywords it contains. The chosen materials were both authored in English and were articles or reviews indexed under the subject heading of social sciences. The total number of documents that were acquired was 1338. Therefore, the search query utilized to retrieve a database from the Web of Science is presented below in

Table 2.
Description of search

Query String	**Number of Documents**
We searched with: “climate OR environment (Title) AND 2000-2023 (Year Published) AND literac OR Knowledge OR awareness OR understanding (Author Keywords) AND Article (Document Type) and Environmental Sciences or Education Educational Research or Management or Business or Social Sciences Interdisciplinary or Economics or Sociology or Development Studies or Anthropology or Ergonomics or Environmental Studies or Psychology Experimental”	1337

The next phase involved filtering the data that had been collected. When the documents are retrieved from the Web of Science, they are put through a filter that examines their titles, abstracts, and keywords to filter irrelevant studies. However, this is a manual filter method that may contain a bias in the data. Therefore, after applying the filter, there were 1337 papers considered acceptable, which were the ones that went on to the data analysis step.

Web of Science data was gathered and exported to CSV format for analysis. VOSviewer software was utilized for additional analysis. To extract quantifiable data, such as publication trends, Microsoft Excel was employed. An open-source application called VOSviewer developed bibliometric maps to show the relationships between sources, authors, nations, and themes. Authors, organizations, countries, publications, and keywords were represented as nodes, and the connectedness between nodes indicated how connected they were. The space between nodes represented the connections between various elements of the research topic.

For better contextual understanding, the "Discussion" section studied and interpreted data from bibliometric maps of co-authorship, co-citation, and co-occurrence.

Results and Discussion

Identification of Trends among the Publication related to Climate Change Literacy

Investigating trends in the publications and citations is furnished to determine the progressive research patterns into a particular subject over a set period of years. The results are shown in Figure 1 which shows an increase in the number of publications and citations related to climate change literacy from the year 2000 to the year 2023.

The Web of Science database was utilized to conduct bibliometric analysis on the 1337 publications related to climate literacy published between 2000 and 2023 that were analyzed in this study using bibliometric techniques. The analysis revealed a substantial growth in the number of publications on climate change literacy over the past two decades. Notably, there was a significant increase in the records between 2010 and 2022, with the number of publications rising from 25 to 213. Therefore, this research provides evidence that publications related to climate change literacy are rapidly increasing.

As can be observed, the number of publications on climate change literacy is growing annually. This is a direct result of climate change events, which continue to take place and disrupt everyday life in society (Steffen, et al., 2015). Expert scientists of climate and environment predict that the temperature of the Earth will rise, which will have consequences for economic growth, human and environmental health, and national security (Longworth, 2008). Assessing people's awareness of climate change has become a significant focus of many scholars. Consequently, researchers are proposing policies related to climate change and its impact while concentrating on climate change literacy. Sustainable Development Goal 13 also stresses the importance of climate change literacy for individuals, notably their ability to understand, mitigate and adapt to the effects of climate change events[1].

Figure 2 also shows that the number of citations remained consistent throughout the analyzed period. From 2003 to 2011, there was a steadily increasing trend in the total number of citations. Whereas between 2012 and 2021, the number of citations increased significantly, reaching a peak of 4335 in 2021. Subsequently, the number of citations a bit drops to 4264 citations in 2022 (Table 3).

[1] UN. Sustainable Development Goal 13. Sustainable Development Goals Knowledge Platform. 2016 https://sdgs.un.org/goals/goal13"

Figure 2.
The Growth Trends of Published Documents by Year

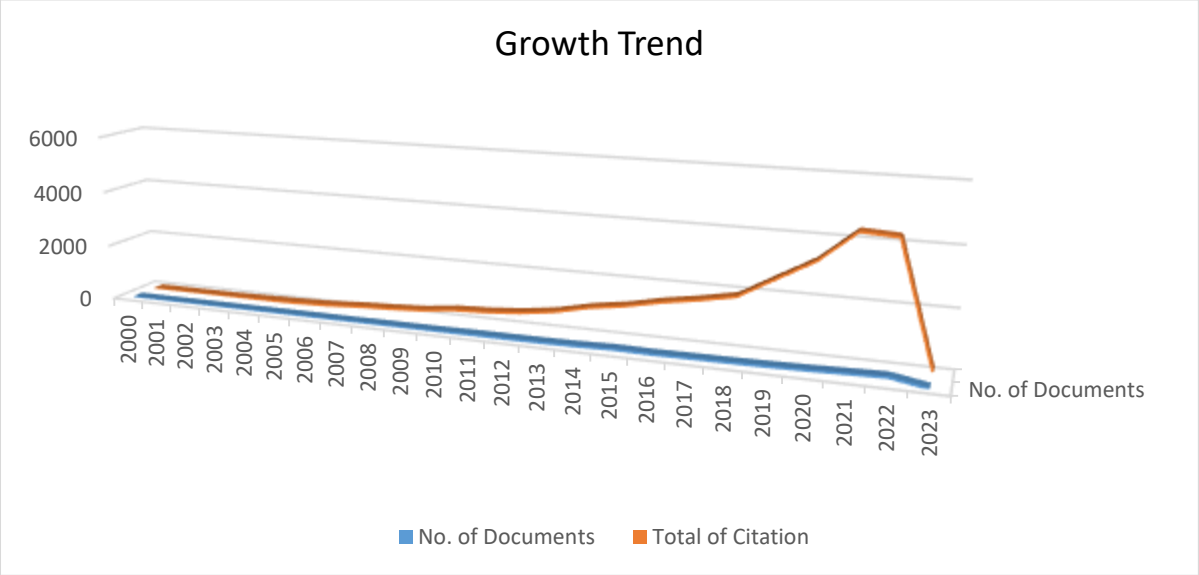


Table 3.
Year-wise frequency from 2000 to 2023 (January)

Year	No. of Publications	No.of Citations
2000	4	1
2001	1	0
2002	4	1
2003	7	11
2004	10	30
2005	15	53
2006	16	91
2007	14	169
2008	22	219
2009	22	287
2010	25	427
2011	39	481
2012	40	581
2013	45	747
2014	61	1021
2015	95	1204
2016	77	1462
2017	91	1662
2018	100	1901
2019	116	2604
2020	142	3296
2021	178	4335
2022	213	4264
2023	1	127

Citation Analysis of Journals

This investigation turned up a total of 532 journals, but only 34 of those provide basic research on climate change literacy. The top 10 influential documents that have contributed more to the research on climate change literacy are listed in Table 4. For the purpose of ranking, this study conducts an analysis of the total number of documents, citations, total link strength and Journal Impact Factor.

Table 4.
The top 10 Influential publications.

Rank	Source	Frequency of Documents	Frequency of Citations	Total link strength	Journal Impact Factor
1	Sustainability	67	437	44	3.889
2	Environmental Science & Policy	39	953	55	6.53
3	Global Environmental Change-Human and Policy Dimensions	29	2294	101	9.523
4	Journal Of Knowledge Management	28	826	11	8.689
5	Ecology And Society	24	984	62	4.403
6	Regional Environmental Change	21	466	46	4.4
7	International Journal of Environmental Research and Public Health	20	104	9	3.39
8	Climate And Development	19	157	20	4.28
9	Climatic Change	17	95	30	4.743
10	Computers In Human Behavior	15	761	3	6.829

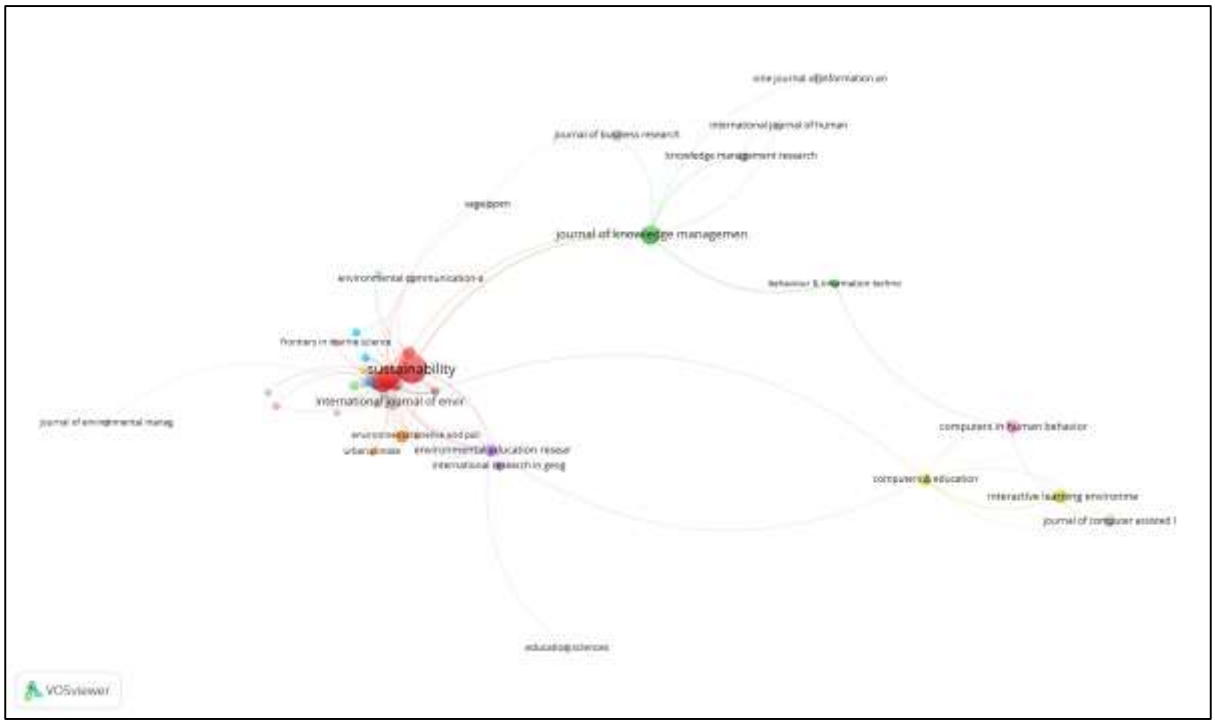
The investigation revealed that Sustainability published more research studies related to climate change that is 67 articles are published with a total of 437 citations. Following this was Environmental Science & Policy, with 39 published documents and 953 citations, and Global Environmental Change-Human and Policy Dimensions, with 29 published documents and the highest number of citations, i.e., 2294 in the collected data. Other journals in this field contributed from 28 to 15 documents per journal, with citations ranging from 95 to 984. The findings suggest that scholars produce a considerable quantity of high-quality publications and citations in their associated initiatives (Djeki, Degila, & Bondiombouy, 2022).

Upon analysis, it was discovered that the journal Sustainability and Environmental Science & Policy was the most significant publication for publishing research on the linkages between

environmental and climate concerns. Based on their influence (as measured by the Journal Impact Factor) over the course of the previous twenty years (Long, Plucker, Yu, Ding, & Kaufman, 2014), it is possible to draw the conclusion that the research published in these journals is of very high quality and is very relevant to the topic under investigation. Global Environmental Change-Human and Policy Dimensions have the highest indicators in terms of Total link strength, with a linkage of 101. This is followed by Ecology and Society, which has a linkage of 62, and Environmental Science & Policy, which also have linkage with 55.

Figure 3 displays the findings of the investigation into the network of journals representing various fields connected to the research topic. The visualization demonstrates that "Sustainability" is the most prolific journal and has many linkages to other journals that concentrate on research issues connected to climate change. Also, most of the journals included in the visualization are associated with fields of climate study, which is consistent with the research focus on climate change literacy.

Figure 3.
The network connection among the influential journals.



The Authors' Contributions

Table 5 contains information regarding the top 10 active Authors based on the total number of published articles and citations for each author. According to the study's findings, authors

affiliated with institutions in almost every region of the world. In the meantime, the number of articles produced by the authors has remained relatively constant, with an average of three to five pieces per author.

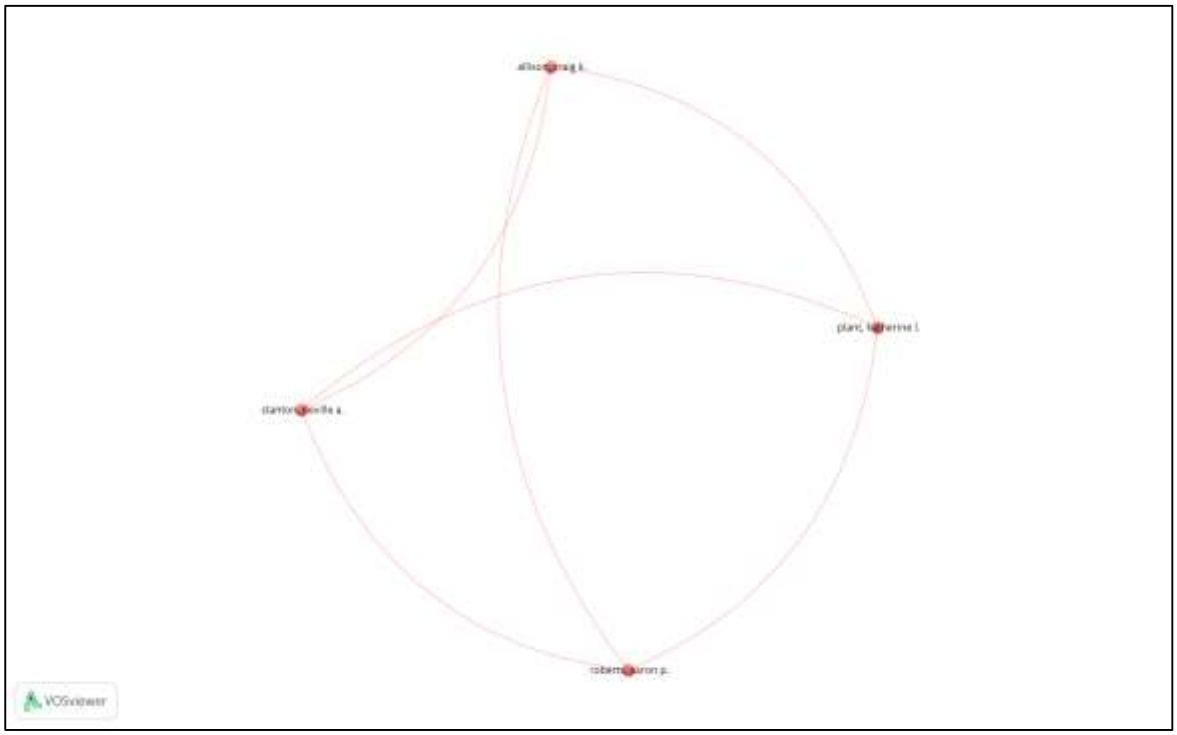
Table 5.
Top 10 Authors in the Field of climate literacy

S.No.	Name	Affiliation	Country	Documents	Citations
1	Hong, Huang-Yao	National Chengchi University Taipei	Taiwan	5	69
2	Reyes-Garcia, Victoria	Icta & Icrea, Autonomous University of Barcelona	Spain	5	56
3	Swartling, Asa Gerger	Stockholm Environment Institute (Sei)	Sweden	4	59
4	Petrescu, Dacinia Crina	Babes-Bolyai University	Romania	4	10
5	Petrescu-Mag, Ruxandra Malina	Babes-Bolyai University	Romania	4	10
6	Anser, Muhammad Khalid	University Of Architecture and Technology Xi'an	China	3	54
7	Andre, Karin	Stockholm Environment Institute (Sei)	Sweden	3	41
8	Bogner, Franz X.	Z-Mnu University of Bayreuth	Germany	3	39
9	Begum, Rawshan Ara	Macquarie University Sydney	Australia	3	33
10	Allison, Craig K.	University Of Southampton	Uk	3	10

Based on the results, Hong Huang-Yao from Taiwan holds the top position with five published documents and 69 citations. At the same time, Victoria Reyes-Garcia from Spain ranks second with five publications and 56 citations. Asa Gerger Swartling from Sweden is in third place, having produced four publications and receiving 59 citations. Two Romanian authors occupy the fourth and fifth positions with similar documents and citations. The remaining authors have published three documents, with Rawshan Ara Begum from Australia receiving 33 citations, Muhammad Khalid Anser from China receiving 54 citations, Karin Andre from Sweden receiving 41 citations, Franz X. Bogner from Germany receiving 39 citations, and Craig K. Allison from the UK receiving only ten citations. While their publication and citation count suggests expertise in climate and environmental concerns, it is essential to consider other factors, such as the quality and relevance of their work, when evaluating their knowledge in this field.

According to Figure 4, which depicts collaborations between authors with at least three publications, four distinct groups are visibly connected through nodes. These groups appear to be closely collaborating. Furthermore, the analysis reveals that there is a strong level of cooperation and connection among scholars who are studying climate literacy topics.

Figure 4.
Network connection among the Co-authorship with at least three publications



The Most Influential Paper

Table 6 displays the top ten most-cited articles out of 1337 published papers, arranged based on the number of citations received in the past five years. The study reveals that the most esteemed article in climate literacy research is "A Knowledge-Based Approach to the Statistical Mapping of Climate," authored by Daly, C. et al. (2009) from the USA. This article has been cited 797 times, positioning it at the top. The paper focuses on the present state of a knowledge-based framework for mapping climate and employs algorithms from PRISM to demonstrate how the framework addresses complex climate mapping situations. Most of the citations are found in the climate literacy section of the article.

Table 6.
Summary information of the top 10 cited publications

Rank	Title of the article	1st Author	Institution	Total Citations	Five years evolution of Citations
1	"A Knowledge-Based Approach to The Statistical Mapping of Climate"	Christopher Daly	"USDA-NRCS National Water and Climate Center, USA"	797	55, 46, 33, 35, 33
2	"The Evolution of Protege: An Environment for Knowledge-Based Systems Development"	John H Gennari	"Biomedical And Health Informatics, University of Washington, USA"	472	24, 20, 24, 11, 8
3	"The Effects of Gender on Climate Change Knowledge and Concern in The American Public	Mccright, Aaron M.	"Michigan State University, East Lansing, MI, USA	431	39, 60, 55, 49, 57
4	Spatial Knowledge Acquisition from Direct Experience in The Environment: Individual" "Differences in The Development of Metric Knowledge and The Integration of Separately Learned Places"	Toru Ishikawa	The University of California, Santa Barbara, USA"	356	27, 40, 36, 48, 24
5	"Public Engagement with Carbon and Climate Change: To What Extent Is the Public 'Carbon Capable'?"	Lorraine Whit marsh	"School Of Psychology, Cardiff University UK"	244	24, 25, 21, 26, 19
6	"Securing Indigenous Politics: A Critique Of The Vulnerability And Adaptation Approach To The Human Dimensions Of Climate Change In The Canadian Arctic"	Emilie S. Cameron	"Department Of Geography and Environmental Studies, Carleton University, Canada"	229	23, 35, 34, 32, 22
7	"Local Perspectives on A Global Phenomenon-Climate Change In Eastern Tibetan Villages"	Anja Byg	"Environment al Change Institute, Oxford University Centre for The Environment"	224	17, 23, 21, 27, 10

8	"Conceptualising Joint Knowledge Production in Regional Climate Change Adaptation Projects: Success Conditions and Levers For Action"	Dries Hegger	"Utrecht University, Netherlands"	221	29, 28, 27, 23, 16
9	"Sustaining The Environment Through Recycling: An Empirical Study"	T._Ramayah	"School Of Management, Universiti Sains Malaysia"	214	18, 35, 29, 37, 37
10	"Team Climate, Empowering Leadership, And Knowledge Sharing"	Yajiong Xue	"East Carolina University, Greenville, North Carolina, USA"	212	19, 28, 29, 40, 25

The Contribution of Institutions

The most productive academic institutions, as measured by the total number of publications, are listed in Table 7. Following the completion of the investigation, it was determined that a total of 1920 distinct organizations had contributed documents to 1337 of the published articles. Based on the results, it was possible to see that the three Australian institutions with the most related research themes were all located in Australia.

According to the findings, the Australian National University in Australia comes in first place with a total of 14 articles, followed by the University of Leeds from the United Kingdom with 14 articles and 205 citations, the University of Oxford of the United Kingdom with 13 articles, and the Chinese Academy of Sciences in China with 12 articles, University of Cape Town (South Africa) and University of Oslo – UiO (Norway) also have 12 publications. The remaining educational establishments have between nine and ten papers that have been published. As seen in Table 7, Australia is the country that is taking the lead in scientific research, as well as actively building and investigating the area of interest.

According to the results of the citation study, the University of Oxford in the United Kingdom is cited by most authors (649), the second more cited university is The University of Melbourne, Australia, which has citations 584, and the University of Oslo – UiO in Norway, with 518 citations.

Table 7.
Profiles of the top 10 publication Institutions

S.No	Institutions	Country	Articles	Citations
1	Australian National University	Australia	14	287
2	University of Leeds	United Kingdom	14	205
3	University of Oxford	United Kingdom	13	649
4	Chinese Academy of Sciences	China	12	250
5	University of Cape Town	South Africa	12	123
6	University of Oslo - UiO	Norway	12	518
7	University of Helsinki	Finland	10	121
8	The University of Melbourne, Australia	Australia	10	584
9	The University of the Sunshine Coast, Queensland, Australia	Australia	10	284
10	The London School of Economics and Political Science	England	9	100

The Contribution Made by Each Country

The results of a study of the contributions made by the top 10 countries are presented in Table 8. According to the study's findings, most articles on climate change literacy were provided by authors from the United States of America. There were 292 such publications, representing 21.84% of the total documents. The remaining countries that contributed are as follows: China, with 137 publications (10.25%), England with 116 articles (8.68%); Australia, with 112 publications, Germany with 101 publications (7.55%); Canada, with 82 publications (6.13%), Netherlands, with 71 publications (5.31%), Spain, with 58 publications (4.34%), France, with 52 publications (3.89%), and South Africa, with 47 publications (3.52%).

Table 8.
List of Top 10 Countries based Publications and citations

Rank	Country	No. of Articles	Percentage	Citations	Percentage
1	USA	292	21.84	8421	33.72
2	China	137	10.25	2021	8.09
3	United Kingdom	116	8.68	2189	8.77
4	Australia	112	8.38	2165	8.67
5	Germany	101	7.55	1764	7.06
6	Canada	82	6.13	2558	10.24
7	Netherlands	71	5.31	1598	6.40
8	Spain	58	4.34	933	3.74
9	France	52	3.89	745	2.98
10	South Africa	47	3.52	461	1.85

In addition, the top 10 countries responsible for climate change are all industrialized nations, which have been confronted with the effects of climate change over the past two decades. The effects of climate change in these countries have prompted the adoption of new management practices and policies geared toward mitigating the effects of climate change (Sawassi & Khadra, 2021). In addition, climate changes have an effect on many industrialized countries in terms of socioeconomic aspects, such as the production of agriculture (disrupting food production) (Roson & Mensbrugghe, 2012), influence on human health (Fu & Waltman, 2022) and tourism owing to temperature variations. These factors are all impacted by climate change (Roson & Mensbrugghe, 2012). It is clear from this account that there are significant interactions taking place between the socioeconomic system and the climatic system (Filho, et al., 2018).

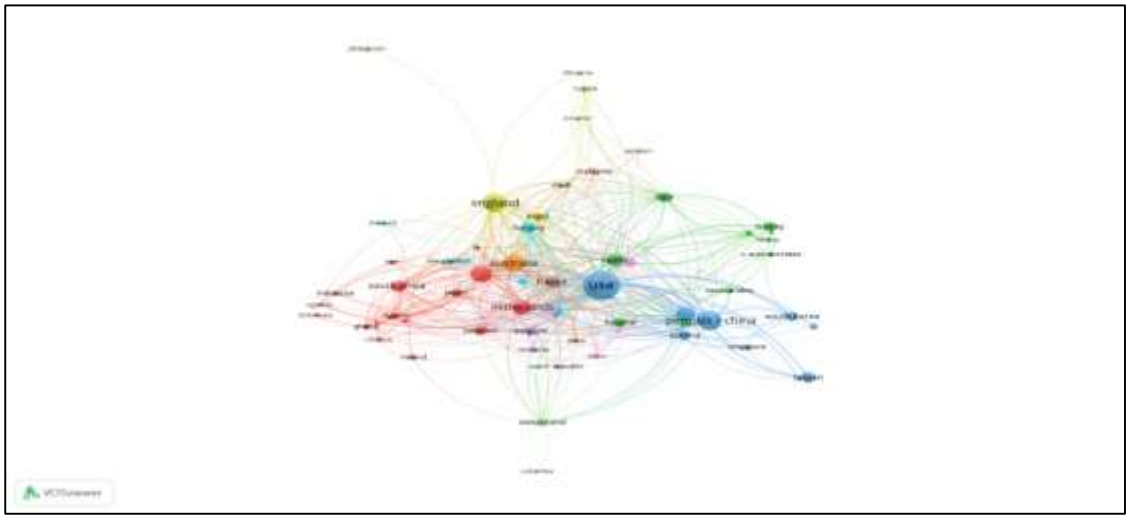
The United States of America has received 8421 citations, making it the country with the most significant total number of citations out of all the countries in the world. This is followed by Canada, which has received 2558 citations, and England, which has received 2189 citations. The remaining nations have a citation total that ranges between 461 to 2165 in total. Because of this, it is possible to conclude that the United Kingdom and other countries in Europe, all of which speak English, are the countries that have made the most significant contributions to this sector (Matsumoto, 2019).

The purpose of the co-authorship analysis that was carried out was to determine which writers from each country have collaborated on at least five publications relating to the subject of the research. This was done on a country-by-country basis. The countries that have worked together on climate change literacy projects are shown in Figure 5, along with the authors involved in those countries' efforts.

The research finding states that out of the 129 countries, only 66 are connected, indicating that researchers are collaborating on studies related to climate change literacy. The United state of America, Australia, England and China are countries that have strong linkage with other countries. However, some countries like the Philippines, Lithuania, Mexico, and Colombia have weaker collaboration with other nations compared to others due to their less strong relationships with other countries.

Figure 5.

The network connection among Co-Authorship Countries

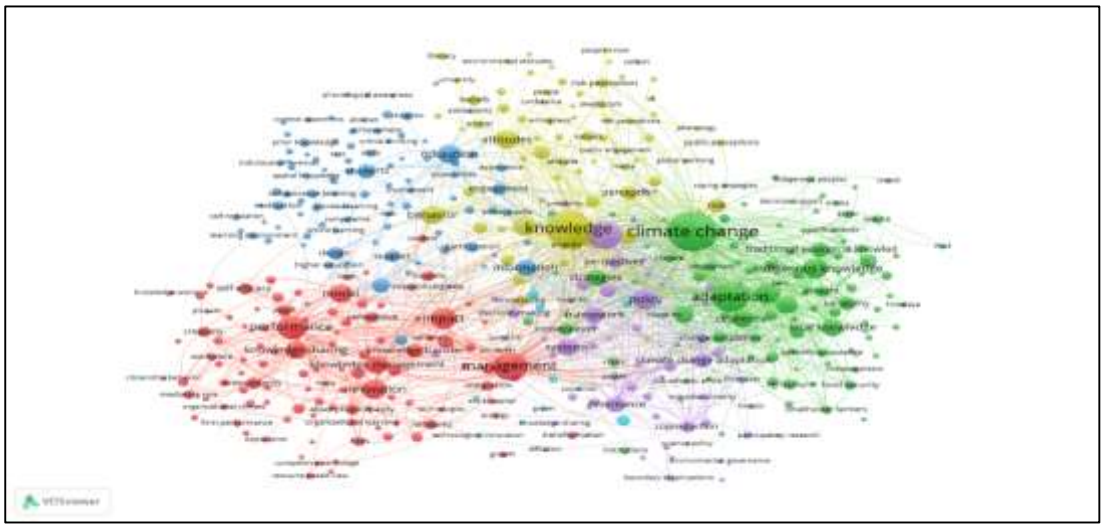


Analyses of Related Themes and Keywords

For the analysis, we employed the approach of Goksu (2021) for the thematic keyword analysis in which we identified the keywords and then analyzed them accordingly. The results of the thematic analysis are shown in Figure 6 which comprised the 437 most frequent keywords. The criteria for the selection of the keyword is to be at appeared at least five times in the data. A node in the network represents each possible keyword. The size of the lines that connect the nodes indicates how strongly the nodes are connected. The type of colour used to indicate the connections between the nodes was used to identify how closely related the keywords were to one another.

Figure 6.

Network connection of Co-occurrence of 437 Most Influential Keywords



Based on the findings, several major areas that are connected in some way include climate change and knowledge, adaptation, management, and performance. A research gap in understanding the role of youth and other groups in climate literacy was shown by the visualization, which showed that academics studying climate literacy tended to concentrate on educational and governmental institutions. Also, the analysis of various components of climate literacy was mostly done on an individual basis, concentrating on perceptions and subject-matter knowledge. As a result, the second study gap relates to the interaction between attitudes and actions, while other elements, such as attitudes and behaviours towards the environment, which have been highlighted in prior studies (Faver & Munoz, 2013), continue to be ambiguous and unpredictable (Miller & Hayward, 2014). Some elements are equally imprecise and unpredictable.

Conclusion and the Way Forward

This systematic bibliometric analysis on climate change literacy has been prepared due to the rising interest in climate change and climate literacy as topics of discussion. Using the VOSViewer software, this paper analyzed the past twenty-four years (2000-2023) of publications related to climate change. The main focus is to explore the relationship among, countries, institutions, authors, and relevant keywords. The study finds that the frequency of publications dramatically moved upward from 2007 to 2023. It is likely to indicate that the focus towards climate change is increasing globally. Nevertheless, the number of citations fluctuated quite a bit during this period. It is also found that the United States of America was the most active country in publishing articles and containing the most prolific institutions and authors. This is probably due to the language's nature and their encounters with climate change-related issues. In addition, the countries that were the most productive in publishing articles on climate change literacy demonstrated a strong connection with each other. The exceptions to this rule were Australia, the UK, and China, all of which are top countries regarding the number of climate experts per capita. In terms of authors, an average quantity of collaboration was discovered, which can be attributed to the fact that the relationship between nodes was not as strong.

In conclusion, examining the keywords revealed the breadth of the subject matter and uncovered any holes in the research. During the investigation, it was discovered that there was a substantial knowledge void regarding research on youth and their relationship with

climate literacy; hence, it was recommended that studies in this field be carried out in the near future. There is a possibility that the Web of Science database does not cover all of the articles on the topic of climate literacy. The database should include other publications, such as conference proceedings and novels. When searching for data, the term "weather" should be included as a keyword to broaden the scope of the search. Lastly, manually sorting through papers might not be foolproof, and the outcomes might be subject to error.

References

Longworth, B. (2008). *Climate Literacy The Essential Principles of Climate Sciences.* doi:https://aambpublicoceanservice.blob.core.windows.net/oceanserviceprod/education/literacy/climate_literacy.pdf

Anderson, A. (2012). Climate Change Education for Mitigation and Adaptation. *Journal of Education for Sustainable Development*, 191–206. doi:https://doi.org/10.1177/0973408212475199

Costa, R., Hanse, T. C., Moore, M., Many, M., Osofsky, J., & Osofsky, H. (2015). Teachers and School Personnel as First Responders following Disasters: Survivors and Supporters. *J Trauma Stress Disor Treat, 4*(4). doi:doi:10.4172/2324-8947.1000146

Daly, C., Gibson, W., Taylor, G. H., Johnson, G., & Pasteris, P. (2009). A knowledge-based approach to the statistical mapping of climate. *CLIMATE RESEARCH, 22*, 99–113. Retrieved from https://www.int-res.com/articles/cr2002/22/c022p099.pdf

Daniš, P. (2013). New definition of environmental literacy and proposal for its international assessment in PISA 2015. *Envigogika: Charles University E-journal for Environmental Education*. doi:https://doi.org/10.14712/18023061.419

Djeki, E., Degila, J., & Bondiombouy, C. (2022). E-learning bibliometric analysis from 2015 to 2020. *Journal of Computers in Education*, 727-754. doi:https://doi.org/10.1007/s40692-021-00218-4

Faver, C. A., & Munoz, J. D. (2013). Environmental Concern and Action: A View from the Border. . *J. Hum. Behav. Soc. Environ, 23*, 345–355. doi:https://doi.org/10.1080/10911359.2013.763712

Filho, W. L., Bönecke, J., Spielma, H., Azeiteiro, U., Alves, F., Carvalho, M. L., & Nagy, G. (2018). Climate change and health: An analysis of causal relations on the spread of vector-borne diseases in Brazil. *Journal of Cleaner Production, 177*, 589-596. doi:https://doi.org/10.1016/j.jclepro.2017.12.144.

Fu, H.-Z., & Waltman, L. (2022). A large-scale bibliometric analysis of global climate change research between 2001 and 2018. *Climatic Change*. doi:https://doi.org/10.1007/s10584-022-03324-z

Goksu, I. (2021). Bibliometric mapping of mobile learning. *Telematics and Informatics, 56*. doi:https://doi.org/10.1016/j.tele.2020.101491

Ha, C. T., Thao, T. P., Trung , N. T., Huong, L. T., Dinh, N., & Trung, T. (2020). A Bibliometric Review of Research on STEM Education in ASEAN: Science Mapping

the Literature in Scopus Database, 2000 to 2019. *Eurasia Journal of Mathematics, Science and Technology Education, 16*(10). doi:https://doi.org/10.29333/ejmste/8500

Hanifah, M., Mohmadisa, H., Yazid, S., Nasir, N., & Samsudin, S. (2020). Determination of Physical Geographical Components in the Construction of Environmental Sustainability Awareness Index of the Malaysian Society. *Asia-Pacific Social Science Review*, 142–152. Retrieved from https://www.dlsu.edu.ph/wp-content/uploads/pdf/research/journals/apssr/2020-September-vol20-3/13-determination-of-physical-geographical-components-in-the-construction-of-environmental-sustainability-awareness-index-of-the-malaysian-society.pdf

Hernández-Torrano, D., & brayeva, L. (2020). Creativity and education: A bibliometric mapping of the research literature (1975–2019). *Thinking Skills and Creativity*. doi:https://doi.org/10.1016/j.tsc.2019.100625

Kuthe, A., Körfgen, A., Stötter, J., & Keller, L. (2019). Strengthening their climate change literacy: A case study addressing the weaknesses in young people's climate. *Applied Environmental Education & Communication*, 375–388. Retrieved from https://doi.org/10.1080/1533015X.2019.1597661

Limaye, V., Grabow, M., Stull, V., & Patz, J. (2020). Developing A Definition Of Climate And Health Literacy. *Health Af, 39*, 2182–2188. doi:https://doi.org/10.1377/hlthaff.2020.01116

Long, H., Plucker, J., Yu, Q., Ding, Y., & Kaufman, J. (2014). Research Productivity and Performance of Journals in the Creativity Sciences: A Bibliometric Analysis. *Creativity Research Journal, 26*(3), 353-360. doi:https://doi.org/10.1080/10400419.2014.929425

Mardiyati, S., Natsir, M., & Nailah. (2021). Literacy and adaptation strategy of rainfed lowland farmer on climate change risk in Takalar Regency. *IOP Conference Series: Earth and Environmental Science*. doi:10.1088/1755-1315/681/1/012080

Matsumoto, K. (2019). Climate change impacts on socioeconomic activities through labor productivity changes considering interactions between socioeconomic and climate systems. *Journal of Cleaner Production, 216*, 528-541. doi:https://doi.org/10.1016/j.jclepro.2018.12.127.

Miller, S. E., & Hayward, R. A. (2014). Social Work Education's Role in Addressing People and a Planet at Risk. *Soc. Work Educ, 33*, 280–295. doi:https://doi.org/10.1080/02615479.2013.805192

Otto, I., Donges, J., Cremades, R., & Schellnhuber, H. J. (2020). Social tipping dynamics for stabilizing Earth's climate by 2050. *Proc. Natl. Acad. Sci.* doi:https://doi.org/10.1073/pnas.1900577117

Pham, H.-H., Dong, T.-K. T., Vuong, Q.-H., Luong, D.-H., Nguyen, T.-T., Dinh, V.-H., & Ho , M.-T. (2021). A bibliometric review of research on international student mobilities in Asia with Scopus dataset between 1984 and 2019. *Scientometrics*, 5201–5224. Retrieved from https://doi.org/10.1007/s11192-021-03965-4

Quarderer, N. A., Fulmer, G. W., Hand, B., & Neal, T. A. (2021). Unpacking the connections between 8th graders' climate literacy and epistemic cognition. *Journal of Research in Science Teaching*, 1527-1556. doi:https://doi.org/10.1002/tea.21717

Ramírez, A., Sarmiento, O., Duperly, J., Wong, T. W., Rojas, N., Arango, C., . . . Lobelo, F. (2012). Should they play outside? Cardiorespiratory fitness and air pollution among schoolchildren in Bogotá. *Rev. Salud. Publica*, 570–583. Retrieved from https://www.scielosp.org/article/rsap/2012.v14n4/570-583/

Roson, R., & Mensbrugghe, D. v. (2012). Climate change and economic growth: impacts and interactions. *International Journal of Sustainable Economy, 4*, 270-285. doi:https://doi.org/10.1504/IJSE.2012.047933

Salas, R., Knappenberger, P., & Hess, J. J. (2019). *The Lancet Countdown on Health and Climate Change Policy brief for the United States of America.* American Public Health Association. Retrieved from https://www.lancetcountdownus.org/wp-content/uploads/2020/11/LancetCountdownPolicyBriefforthеUS2019.pdf

Santos, R., & Bakhshoodeh, R. (2019). Climate change/global warming/climate emergency versus general climate research: comparative bibliometric trends of publications. *Heliyon*. doi:10.1016/j.heliyon.2021.e08219

Sawassi, A., & Khadra, R. (2021). Bibliometric Network Analysis of "Water Systems' Adaptation to Climate Change Uncertainties": Concepts, Approaches, Gaps, and Opportunities. *Sustainability*. doi:https://doi.org/10.3390/su13126738

Steffen, W., Richardson, K., Rockstrom, J., Cornell, S., Fetzer, I., Bennett, E., . . . Sorlin, S. (2015). Planetary boundaries: Guidinghuman development on achanging planet. *Science, 347*(6223). doi:DOI: 10.1126/science.1259855

Thu, H. L., Tran, T., Phuong, T. T., Tuyet, T. L., Huy, H. L., & Thi, T. V. (2021). Two Decades of STEM Education Research in Middle School: A Bibliometrics Analysis in Scopus Database (2000–2020). *Educ. Sci.* doi:https://doi.org/10.3390/educsci11070353

UNFCCC. (2020). *What is the Kyoto Protocol?* United Nation Climate Change. Retrieved from https://unfccc.int/kyoto_protocol

Zupic, I., & Cater, T. (2015). Bibliometric Methods in Management and Organization. *Organizational Research Methods*, 429–472. doi:https://doi.org/10.1177/1094428114562629