



Interdependence of Key Climate Change Concepts: A Bibliometric Analysis

Florentina CHITU*, Andra Nicoleta MECU**, Gheorghe HURDUZEU***, Georgiana Ionela MARIN****, Liviu Andrei TOADER*****

ARTICLE INFO

Article history:

Accepted July 2023

Available online July 2023

JEL Classification

Q54, Q56, Q57, Q59

Keywords:

climate change, green economy, circular economy, bibliometric analysis

ABSTRACT

The effects of climate change have a visible impact on all areas, both in the short, medium and long term, but adapting, trying to mitigate and combat the phenomenon, as well as reducing greenhouse gas emissions, can be elements of the sustainable development of a society, looking at socio-economic and relevant long-term aspects. This paper aims to analyse and present a link between the key concepts of climate change at the confluence of the green economy and the circular economy through a bibliometric analysis, highlighting the importance and evolution of these concepts as recorded in scientific papers in several international databases. The results of our work are intended to complement current research on climate change by interlinking specific terms, thus improving current concepts in the literature.

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1. Introduction

Recent years have predicted major changes in climate, based on the idea that in some countries the temperature is abnormally high or temperature inversions are increasing, the winter period is changing and becoming much harsher, phenomena unusual for the period a few decades ago. While local spaces are slowly showing signs of sustained changes, it has been at least two decades since scientists from all over the world have warned about climate transformations and their possible effects on life on Earth in the medium and long term (International Panel on Climate Change, 2014).

Specialists in the field are increasingly concerned and are trying to make the population aware of the seriousness of the situation at global level, including the effect of rising average annual temperatures is caused by this phenomenon, which also causes sea level rise through excessive and accelerated melting of glaciers. In addition, this imbalance, found in all natural systems, also causes changes in precipitation, with the effects visible in increased floods, hurricanes and droughts.

In the journal BioScience, scientists write that the vital signs of the Earth have reached the red level of danger and humanity is facing a climate emergency (Oregon State, 2022).

Both "circular economy" and "climate change" are repeatedly cited in the European Green Deal. It is assumed that the circular economy is a fundamental pillar to achieve sustainable economic and social development in environmental terms. Circular economy issues are designed to promote economic growth and generating employment without compromising the environment, positioning itself as a cornerstone for a resilient economic recovery with low carbon emissions (Cristache N et al, 2019).

Researchers argue the major importance by highlighting the direct positive impact the circular economy has in the fight against climate change. A significant example to support the above idea is how steel, aluminium, cement and plastics are produced and processed, and sustainable practices could reduce greenhouse gas emissions by up to 40% in these industries by 2050 (MacArthur, 2021).

Some studies point out that the circular economy can be a driver of economic growth by quantifying a net benefit of €1.8 trillion for Europe in 2030, and in India the annual benefit could reach \$624 billion by 2050. These economic increases are relative to the current period (Aguirre et al., 2022)

Growth and the green economy have become global trending topics in recent years. As defined by the UN Environment Programme, the green economy refers to an economic model that results in social equality and a visible improvement in the well-being of the population while reducing environmental risks. This

*, **, ***, ****, ***** Bucharest University of Economic Studies, Bucharest, Romania. E-mail addresses: florentina.chitu@rei.ase.ro (F. Chitu – Corresponding author), andra.mecu@stud.ase.ro (A. N. Mecu), gheorghe.hurduzeu@rei.ase.ro (G. Hurduzeu), maringheorgiana17@stud.ase.ro (G. I. Marin), liviuatoader2005@yahoo.com (L. A. Toader).

definition aims to preserve, enhance and eventually rebuild natural capital as an essential economic asset and source of well-being.

Since Web of Science contains a wider variety of documents than other databases, it will be employed in this study's bibliometric analysis. The literature part will then be altered to address certain aspects of climate literacy. This paper aims to find the answer to the following question: what are the key notions associated with the concept of climate change in specialized literature. The methodology will next be discussed, including search methods, the creation of the bibliometric database, and data analysis. The outcomes will then be presented and debated (Antohti V.M. et al, 2022).

2. Problem Statement

Due to ongoing climate change events that threaten society's way of life, publications on climate change literacy are growing every year. Climate experts predict that global warming will have an impact on national security, environmental and human health, and economic development. As a result, numerous scholars are investigating climate change literacy in order to evaluate the general public's understanding of the issue and create policies that address it and its effects. In addition, Sustainable Development Goal 13 places a strong emphasis on people having a good understanding of climate change, including how to mitigate its effects and how to adapt to its effects.

Previous studies have been conducted to review the concepts described in the previous steps through the bibliometric analysis of the most important publication databases, as summarized in the table:

Table 1. Existing bibliometric analyses on key climate change concepts

Authors	Year	Time frame	No. of articles included	Database	Terms
Wang et al.	2022	2002-2020	757	Scopus, WoS	transition, sustainability transition, socio-technical transition, energy transition, innovation and governance
Suhaimi & Mahmud	2022	2001-2021	740	Scopus	climate literacy
Gradinaru & Matei	2022	1975-2021	6936	WoS	bioeconomics, bioeconomy, bio-based economy
Fu & Waltman	2022	2001-2018	120000	Scopus, WoS	physical sciences, paleoclimatology, climate-change ecology, climate technology, and climate policy
Santos & Bakhshoodeh	2021	1910-2020	29943	WoS	climate" (CL) and "climate change/global warming/climate emergency" (CC/GW/CE)
Camon Luis & Celma	2020	2016-2019	41592	Google Scholar, Scopus, WoS	circular economy
Zhang et al.	2019	2001-2018	381	WoS	green financing, climate financing, carbon financing, green investment, and green bond.
Ruiz-Real et al.	2018	2006-2017	743	WoS	circular economy, environment
Wang et al.	2018	1981-2016	14891	WoS	climate change, global warm, greenhouse gas
Nobre & Tavares	2017	2006-2015	122	Scopus	circular economy

Source: Authors' Computation

3. Research Questions/Aims of the research

This paper aims to find the answer to the following question: what are the key notions associated with the concept of climate change in specialized literature.

A first objective is to identify major research sources and themes related to the topic of our paper (Arslan et al., 2022). We will use techniques of scientific mapping of the conceptual structure through the number of articles published in a certain period of time in an international database, the keywords used by the authors, as well as the countries of origin of the authors, as input data to achieve this objective.

4. Research Methods

In this paper we have developed a bibliometric analysis to review the existing specialized literature regarding the connections between the concept of climate change and the complementary notions used in the papers, especially the synergy with the green economy and the circular economy (Wohlgezogen et al, 2020).

The research methodology includes the selection and collection of data, the bibliometric analysis performed with the VoS Viewer program, the mapping and network building (Wang et al., 2018). The co-occurrence analysis of the terms, the construction of a map of the terms and the visualization of the map were carried out as follows: we selected 3367 (three thousands, three hundred and sixty seven) open access

scientific articles from the international Web of Science database on the topic of climate change from the Economics category, for the period covered between the years 2012-2022. The upward trajectory of specialized works published in this 10-year period, can be found in the table 2.

Table 2: Existing bibliometric analyses on key climate change concepts

Year of publication	Number of published documents in Economics sector
2022	326
2021	481
2020	488
2019	409
2018	383
2017	335
2016	269
2015	189
2014	178
2013	154
2012	155

Source: Web of Science statistical data (Authors' computation)

Bibliometric analysis emerged in the 1960s as a method of objectively identifying a research area, predicting future development trends, research activity and possible collaborations. Bibliometrics is a transparent, quantitative, repeatable method. Bibliometric analyses focus on a specific aspect of the multi-level perspective or its use in a related field.

A bibliometric analysis is a state-of-the-art analysis technique for the scientific literature in a particular field of research that helps researchers understand the development of that field. It captures key characteristics of the content of the literature, such as title, authors, year of publication, issuing institution, project funding, where articles are published, etc. In addition, the aim of bibliometric analysis is to provide a constantly updated overview of the literature.

Bibliometric analysis illustrates the progress and trend of research. Its results provide concrete references for the recognition of current issues with the most citations.

5. Findings

Based on the analysis carried out, the results show a fast increase in recent years of works on climate change, being in a considerable rise since 2015, from 189 scientific articles, until 481 in 2021, and in mid-October, registering 326 works in the economic field. This reinforces the fact that in recent years the importance of climate change has increased, the subject being an intensely debated one.

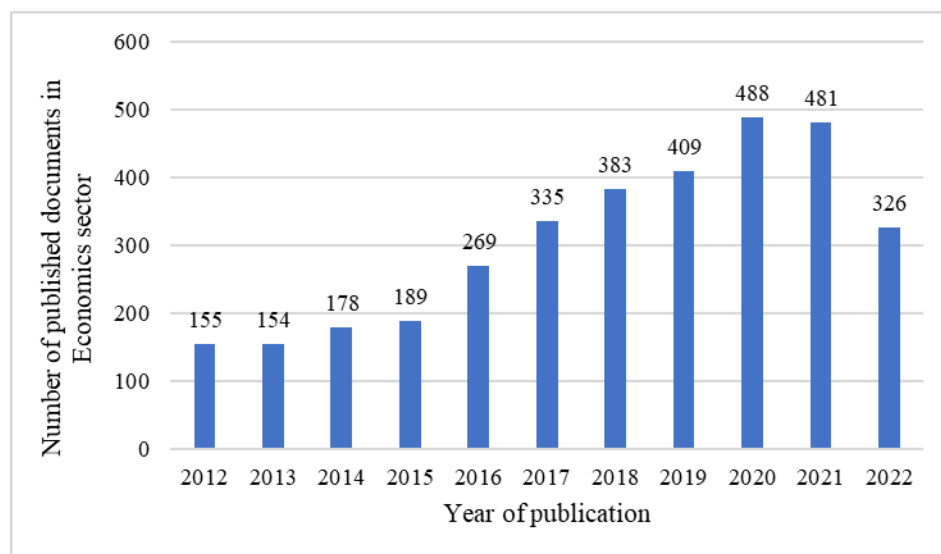


Figure 1. Number of published documents in Economics sector (annual data, 2012-2022)

Source: Web of Science statistical data (Authors' computation)

The most characteristic terms of climate change research were identified with the help of a natural language processing approach, finding a minimum number of occurrences of a keyword in at least 12 articles, such as: change impacts, energy poverty, sustainable consumption, circular economy; and a maximum number of occurrences of some keywords, in 999 articles such as climate change, in 801 climate-change, in

409 policy, in 294 impact, in 236 energy, in 225 risk, in 228 economics, in 174 renewable energy, etc. These keywords were selected by the program with the highest total link strength, as can be seen in figure 2.

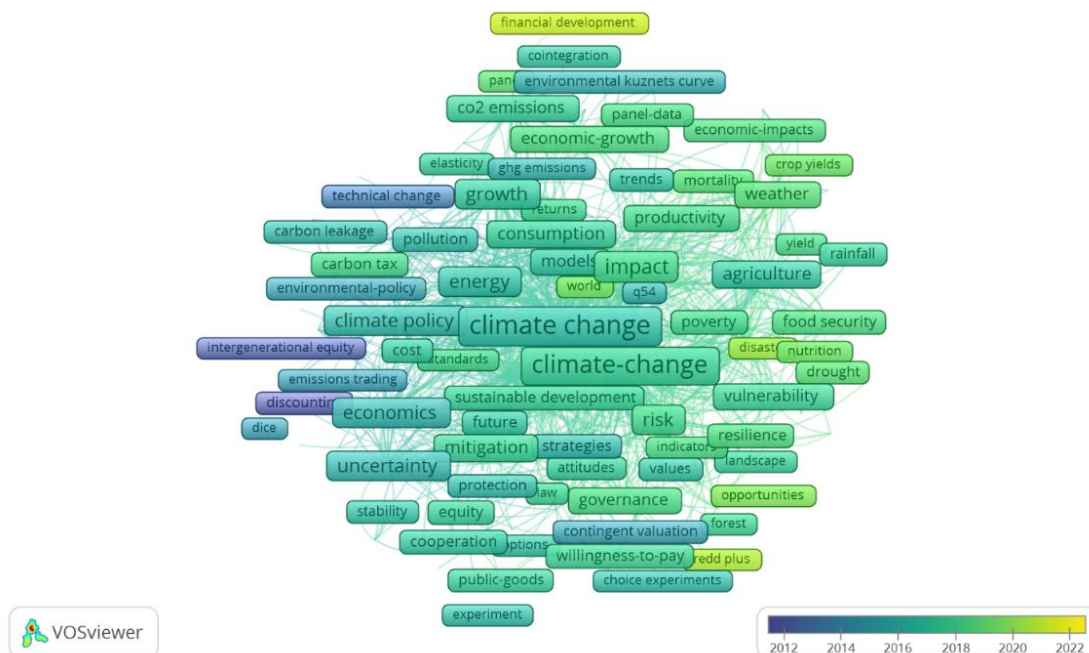


Figure 2. Overlay visualization of keywords

Source: Map create in VOSviewer (Authors' computation)

It is also worth exploring where the enthusiasm for researching the subject mainly comes from, regarding this action by linking it to the countries of origin of the authors (Mourgenot, Doussoulin, 2022). Figure 3 summarizes the authors' country of origin information. It presents a clear picture showing that the main contributors to the recent progress of this field are mainly from the US, Europe and a few other developed countries. It is not surprising to see the dominance of US researchers in this field, as the World Bank, UN and many other most influential international organizations are based in the US, which can greatly facilitate and encourage relevant research. But for years, Europe has been the most enthusiastic promoter of global cooperation in the field of climate change.

In the international negotiations regarding climate agreements, developing countries have played an increasingly important role, as can be seen in figure 3, the fact that in recent years countries such as Peru, Ghana, Nepal, Cameroon have participated intensively in the research of the subject.

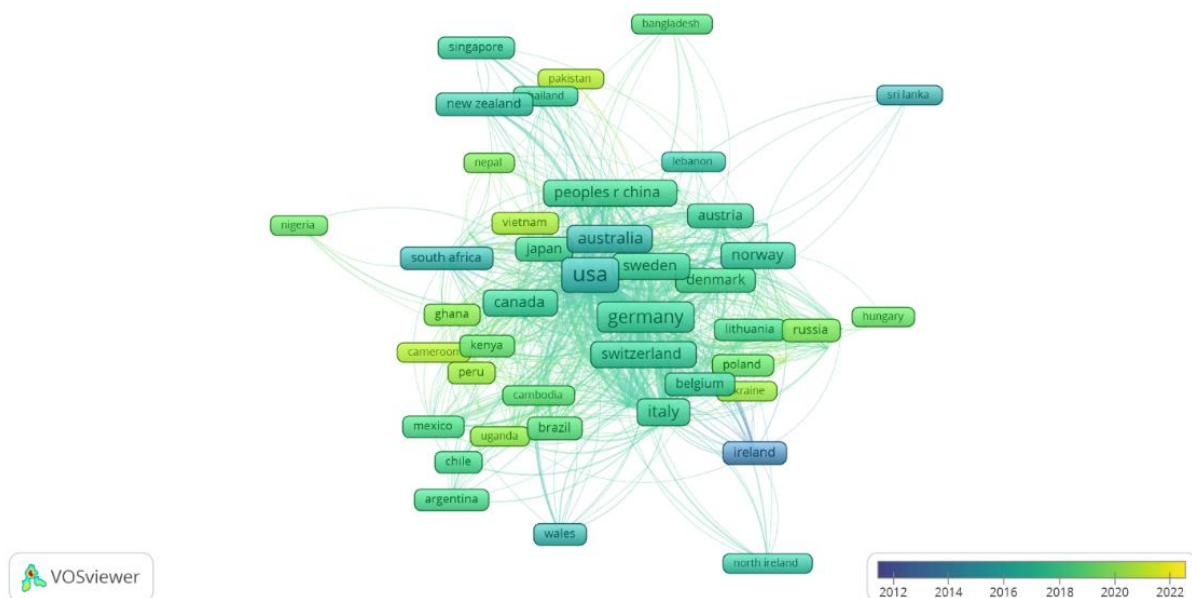


Figure 3. Countries of origin of the authors of the publications

Source: Map create in VOSviewer (Authors' computation)

Moreover, we also noticed which are the most cited works from the specialized literature in the articles analyzed by us, respectively who are the authors of these articles.

Table 3. The most cited works from the specialized literature

Authors	Paper	Journal	Year	Citations
Nicholas Stern	The economics of climate change	American Economic Review, 98 (2), 1-37	2008	850
Martin I Weitzman	On modeling and interpreting the economics of catastrophic climate change	Review of economics and statistics, 91 (1), 1-19	2009	769
Holtzeakin D., Selden T. M.	Stoking the fires – Co2 emissions and economic-growth	Journal of public economics, 57 (1), 85-101	1995	716
Melissa Dell; Jones F Benjamin, Olken A Benjamin	What do we learn from weather? The new climate-economy literature	Journal of economic literature, 52 (3), 740-798	2014	668
Melissa Dell; Jones F Benjamin, Olken A Benjamin	Temperature shocks and economic growth; evidence from the last half century	American economic journal-macroeconomics, 4 (3), 66-95	2012	638

Source: Authors' Computation

6. Conclusions

Through ranking analysis and visual illustration of a number of key factors from a sample of 3367 (three thousands, three hundred and sixty seven) relevant publications, we consider that this information has set a visual picture for this topic.

Based on the keyword analysis in the specialized literature, climate shifts must continue to be considered a topic of advanced research.

We noticed that at a country-level, developed countries, especially the USA, hold key leadership positions in terms of comprehensive strength with the largest numbers of publications as well as a greater academic influence.

In the European Union, Germany is the most interested in climate change research, along with Switzerland and Italy; Romania has seen a popularity of this concept in recent years.

Through the analysis of keywords published in recent years, this paper also explores the changing trends of hot topics which researchers concern in the area of climate change.

Uncertainty is closely linked to climate change, a fact that makes Economic Operators unable to plan their work activity.

Although we started from the premise that there is a connection between climate change and the circular economy, the bibliometric analysis showed us that for these 2 elements, despite the interdependence between them, there aren't many studies that covers these concepts at once.

To identify future research directions, in addition to the literature metrology described here, it is deemed necessary to undertake a more detailed literature review around the most interesting current research topics and methods in the field of climate change.

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