

## Article

# Analyzing Climate Change Awareness Campaigns: A Bibliometric Study of Scientific Research

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**Abstract:** This study presents a bibliometric analysis of scientific research on climate change awareness campaigns, using data from the Web of Science (WoS) database and the keywords “climate change” and “campaign”. Publications from 1994 to 2024 were examined to identify key trends, author networks, and institutional contributions. Following PRISMA guidelines, 1274 records were initially retrieved; after applying exclusion criteria, 1207 documents were included in the final dataset. The results reveal a steady growth in publication output, especially over the last decade, with dominant contributions from environmental sciences, meteorology and atmospheric research, and science and technology studies. While “campaign” is frequently mentioned, it often serves as a methodological or communicative element within broader climate-related research. The United States, the United Kingdom, and Germany lead in publication volume and influence, with increased contributions from countries in the Global South. The global collaboration map highlights strong international efforts and interdisciplinary integration. Based on these findings, future research should evaluate campaign effectiveness, leverage digital tools, foster cross-regional knowledge exchange, and strengthen the link between scientific evidence and public policy. This study offers a foundation for more inclusive, impactful, and evidence-driven climate change communication strategies.

**Keywords:** climate change; awareness campaigns; bibliometric analysis; scientific research; climate communication; environmental education



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## 1. Introduction

Climate change is one of the most pressing global challenges of the 21st century, requiring not only scientific and policy-based solutions but also effective public awareness campaigns to mobilize action and foster sustainable behaviors. Additionally, it demands coordinated international efforts and significant societal transformations to mitigate its effects [1]. The phenomenon affects various aspects of human life, from environmental stability to economic and social well-being, necessitating effective strategies for public engagement and behavioral change [2]. Climate change awareness campaigns play a crucial role in fostering understanding, encouraging proactive measures, and driving policy

support. However, translating scientific warnings into compelling and actionable messages remains a significant challenge [3–5]. Despite the overwhelming scientific consensus on anthropogenic climate change and its severe consequences, public perception and response continue to be fragmented. This fragmentation stems from the spread of misinformation, deeply rooted cognitive biases, and inconsistencies in communication strategies, which hinder the effectiveness of climate change awareness efforts [6]. Scholars highlight the need for innovative, creative, and targeted awareness campaigns that can effectively address these barriers [7]. While previous studies have explored specific components of climate change communication, a comprehensive bibliometric analysis of research on awareness campaigns remains underdeveloped. This study aims to fill this gap by conducting a bibliometric review of climate change awareness campaigns using data from the Web of Science (WoS) database. This study differs from previous work by offering a quantitative, structural mapping of the research field itself, rather than analyzing the content or outcomes of specific awareness campaigns.

The structure of the present article is organized as follows. The next section offers a comprehensive review of the literature on climate change communication and awareness campaigns, highlighting theoretical perspectives and empirical findings in the field. This is followed by a detailed description of the methodological framework, including the bibliometric procedures and data selection criteria. The subsequent section presents the main results of the analysis, focusing on publication trends, thematic areas, and citation networks. Finally, the paper concludes by summarizing the key findings, discussing the study's limitations, and outlining potential avenues for future research.

### *1.1. Literature Review*

In 1896, Svante Arrhenius predicted that coal combustion could eventually lead to human extinction. Manmade activities have already warmed our planet by 1 °C since before industrial times started. This has caused significant damage to human communities and environmental structures as well [8]. In contrast, united global initiatives to eliminate the issue have proven to be lacking efficiency [9,10].

The subject of climate change communication has become more and more important among researchers and in society at large, resulting in the emerging trend of awareness campaigns through various media platforms. The impact of climate change communication and its effectiveness has been a prominent topic among researchers since the late 1990s [11].

Moser [12] argues that even though there have been some improvements made regarding communication about climate change, there are some issues that persist such as “superficial public understanding of climate change, transitioning from awareness and concern to action, communicating in deeply politicized and polarized environments, and dealing with the growing sense of overwhelm and hopelessness” [12].

This is, in part, due to public misrepresentation or, in some places, denial of climate change sciences [6]. It has been over fifty years since warning signs of environmental change appeared due to industrialization and other human efforts, yet we are still discussing whether or not this phenomenon exists [13]. Numerous studies acknowledge this issue, but the framework and theoretical insights are still hard to synthesize—this is often described as a setback in communication research [14].

Raducu [15] highlights in his article the rising popularity of online communication campaigns created by organizations and governments to translate scientists' knowledge into actions against climate change to shape the public's opinion and influence consumers in the decision-making process. Doyle [16] underscores in his research the challenges of transmitting the momentary aspects of climate change through visuals, such as melting

glaciers. These are impactful; however, they are based on already visible realities, not on future consequences.

The way climate change campaigns are created and how they are scripted and edited have an important effect on viewer engagement and perception [17]. Hussein [18] further elaborates on the importance of semantic choices, demonstrating that different words such as “global warming”, “climate change”, and “climate imbalance” create different levels of concern and perception, therefore influencing campaign effectiveness. Efficient climate change campaigns need specific messages that are tailored to different demographics and audiences.

Shahir Masri [19] revealed in their study that climate change campaigns reach college-educated Caucasians who consider themselves as Democrats unevenly. Holmberg et al. [20] explored differences in gender regarding climate change communication on Twitter. They revealed that language usage was similar, but hashtags and usernames differed significantly. These findings support the argument for creating targeted campaigns.

We often overlook the fact that a large part of climate change is impacted by citizens, not governments. Fernandez [21] states that “Households’ greenhouse gas emissions are 19% of the global annual amount, third behind emissions from the energy sector (27%) and industry (26%)” [21]. This highlights the crucial role of individual behaviors in contributing to climate change, as well as the potential for targeted public campaigns to influence such behaviors. However, many environmental campaigns remain primarily knowledge-based, aiming to address an “information deficit” [22]. Howell further argues that “environmental messages should appeal to emotions rather than simply providing factual information, to be more engaging. Climate change communications frequently use disaster framing to create a fear appeal intended to motivate mitigation action” [22].

Manuti [23] researched script creation for ethical consumption in a campaign for the European Commission by focus groups. He wanted to understand how messages influenced behaviors and attitudes. It was shown that the usage of social media platforms, such as Instagram and WhatsApp, is increasingly popular, mostly among millennials [7]. There are concerns about misinformation and the need to collaborate with influencers and experts to combat this [7]. Sanderson et al. [24] present a campaign that is health-focused, highlighting the promise of translating climate change as a public health concern to reach new audiences. In contrast, Wyners et al.’s [25] experiment reveals the limitations of digital strategies and underscores the potential of conventional offline methods when it comes to influencing political action. Stein et al. [26] studied the implications of a “true cost” campaign, highlighting transparent pricing to promote sustainable consumption.

The way climate change campaigns are evaluated is important for identifying and optimizing future directions. Some campaigns were successful in generating engagement, media coverage, and awareness [24,27,28]. However, it is necessary to conduct longitudinal studies to evaluate the long-term impact.

According to the European Environment Agency, climate change messages can be communicated through various media platforms, such as television, the Internet, social media, and newspapers [29]. In addition, they state that most of these campaigns focus on mitigation strategies and energy efficiency, but not many focus on actual adaptation measures.

In summary, the literature highlights the increasing scholarly and institutional attention given to climate change communication through awareness campaigns. Despite the breadth of studies addressing various media strategies, audience responses, and campaign typologies, there is a lack of comprehensive, quantitative syntheses of the research landscape itself. This gap underscores the need for a systematic, data-driven investigation into the evolution, structure, and influence of academic discourse on climate change campaigns.

The present study addresses this need by employing a bibliometric analysis to map trends, collaborations, and thematic clusters in the existing scientific literature.

### 1.2. Successful International Climate Change Campaigns

Some examples of successful climate change campaigns include Mr. Beast's 2019 initiative with the hashtag #TeamTrees, which surpassed its initial goal of planting 20 million trees all around the world [30]. This campaign was also supported by Elon Musk, the CEO of Tesla.

Another successful campaign was the 2014 Earth Hour Campaign, launched by the World Wide Fund For Nature (WWF). It aims to inspire anyone or any entity to be more aware of the ecological footprint they leave behind [31]. Fernández et al. (2015) [32] conducted a study that analyzed the campaign's success. They found that longer, positive, easy-to-read tweets performed best when promoting this campaign. In addition, after the campaign ended, the topic of the campaign still remained relevant for over a month [32].

While campaigns might have immense potential to raise awareness of climate change, there are still some concerns raised about whether or not they can deliver actual results and change. Jennifer Whyte from Oceana Canada states that it is not sufficient to present the problem, but rather, stakeholders should deliver a clear message on what practical change they want to see [33].

In addition, The Big Ask campaign was essential in creating the UK Climate Change Act 2008. It was launched by Friends of The Earth, who utilized an opportunity regarding climate change politics to gain support and to empower the bill's content. This campaign later expanded through Europe, highlighting its success and influential nature [34].

Moreover, Fridays For Future (FFF) and Extinction Rebellion (XR) have also significantly contributed to climate change politics since 2018. They took an innovative approach by framing climate change in a politically neutral way that addresses state actors [35].

Al Gore's The Climate Project and We Campaign combined digital and traditional media strategies to promote climate action. They were successful in their ability to drive political engagement and promote sustainable behaviors through influential opinion leaders [36].

Kim et al. [37] conducted a study where they analyzed the media presence of over 100 environmental NGOs. They found that Oceana had the most successful species-focused campaigns, and they produced the most engaging content. Their efforts are undeniable: "Thanks to campaigning by Oceana and our allies, about 75,000 miles of coastline in the United States and Belize have been protected from the threat of offshore drilling, covering more than 2.5 million square miles of ocean" [38].

### 1.3. The Bibliometric Analysis

The method of bibliometric analysis was developed in 1950. However, it gained popularity only recently in research fields such as business, management, economics, econometrics, and finance [39]. It involves conducting a rigorous analysis of voluminous scientific data. This method is often used to determine research trends, track the research landscape, and predict future directions [40,41]. Bibliometric analysis can also mean a quantitative analysis to reveal insights into the evolution of published documents over a specific period [42].

The analysis is conducted using data retrieved from different scientific databases: "Some of the common databases are Web of Science, Scopus, Pubmed, and Dimension" [43]. Collected data are then analyzed using a software called VoS Viewer, which is a tool for creating bibliometric networks [44].

Bibliometric analysis can be used regarding virtually any topic; some define it as the statistical description of literature [45,46]. It represents a quantitative method that “takes the external characteristics of scientific literature as research objects” [40].

Chen et al. [47] conducted a bibliometric analysis similar to our paper’s objective on the topic of climate change communication. The authors examined publications from 2001 to 2021 using the Web of Science (WoS) Database. They argue that climate change communication research has become a relatively independent research field and has entered a rapid development stage since the 2000s, with the number of publications increasing exponentially [47]. In addition, the paper underscores that savants have evolved from the natural science aspects of climate change and are exploring communication practices, public perceptions, and strategies regarding behavior change. This finding highlights the multidisciplinary nature of climate change research.

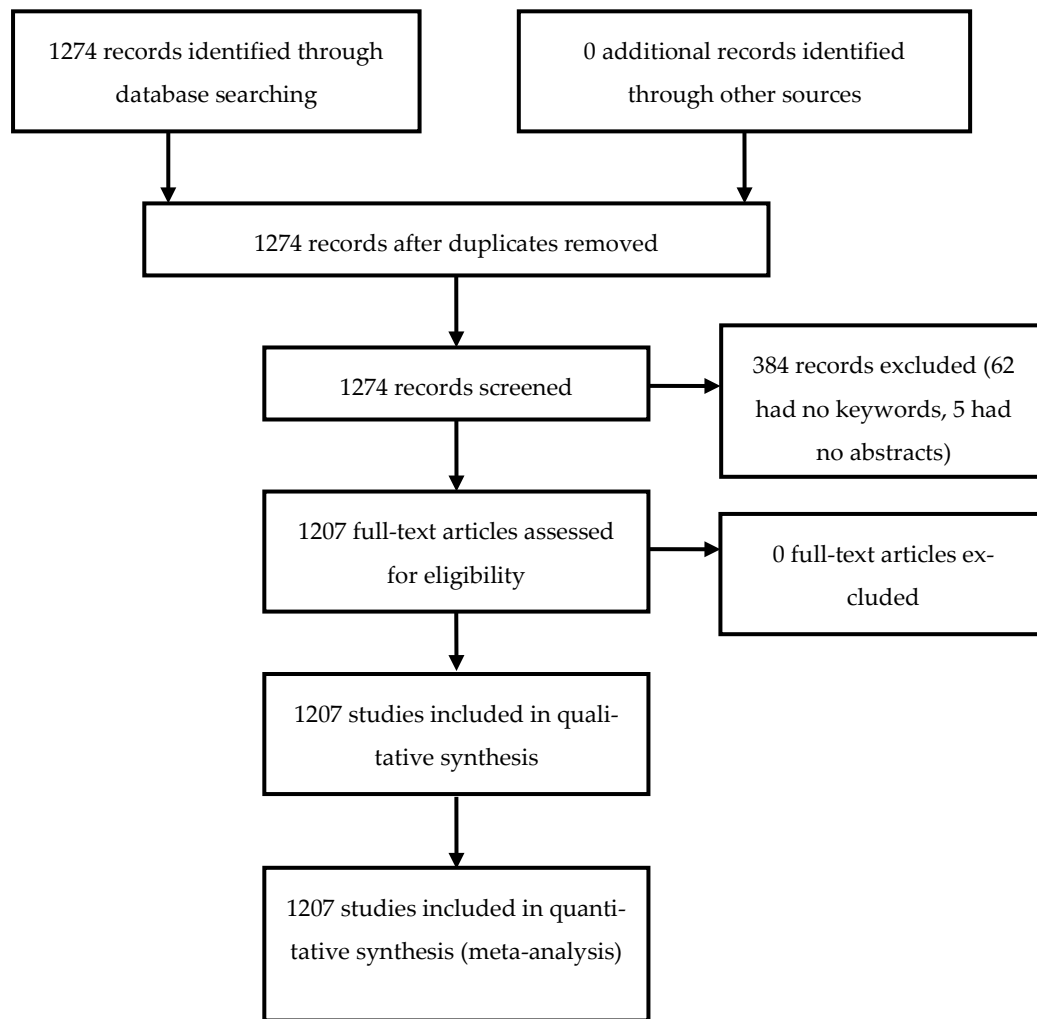
This paper aims to explore the research landscape surrounding climate change campaigns in international academic literature, as indexed in the ISI Web of Science (WoS) database. By focusing on the intersection of climate change and campaigns, this study conducts a bibliometric analysis to identify key research trends, thematic areas, and the impact of scholarly contributions in this field. The analysis seeks to highlight the evolution of research topics, the most influential authors, institutions, and countries, and the patterns of scientific collaboration. Additionally, this study examines the citation networks and the methodologies employed in climate change campaign research to assess its academic and societal influence. Finally, by mapping the existing literature, this paper aims to identify research gaps and potential opportunities for future studies in this critical area.

## 2. Materials and Methods

Our study aimed to analyze the evolution of the research landscape concerning climate change awareness campaigns. To identify relevant documents, we utilized the Web of Science (WoS) database, a globally recognized repository for high-impact scientific publications. The data were retrieved from the Web of Science Core Collection on 14 February 2025. Given the scope of our research, we employed the keywords “climate change” and “campaign” as primary filters. These terms were chosen to capture a broad yet thematically coherent dataset, encompassing studies related to public awareness efforts, policy influence, activism, and scientific campaigns addressing climate change. Keywords are deliberately assigned by authors and publishers to enhance the discoverability of research, making them a reliable indicator of thematic orientation. Moreover, titles are designed to concisely reflect the core subject of a study, making them an essential component in bibliometric analyses. Broader terms were intentionally excluded, as they risked introducing a high volume of loosely related articles not centered on campaign-based approaches. This focused strategy enabled a clearer bibliometric analysis of literature specifically addressing structured initiatives related to climate change.

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) model (Figure 1), an initial 1274 articles published between 1994 and 2024 were identified.

From this dataset, we applied additional filtering criteria: 62 articles were excluded due to the absence of keywords in their metadata, and 5 articles were removed due to the lack of an abstract. After these exclusions, a final dataset of 1207 records remained for analysis. For the bibliometric analysis, we utilized VoSviewer 1.6.20, a widely used tool for visualizing bibliometric networks. Word clouds were employed to analyze keyword distributions and highlight the most frequently occurring terms in the dataset. Additionally, Microsoft Excel 365 was used for graphical representations and statistical processing of the retrieved data.



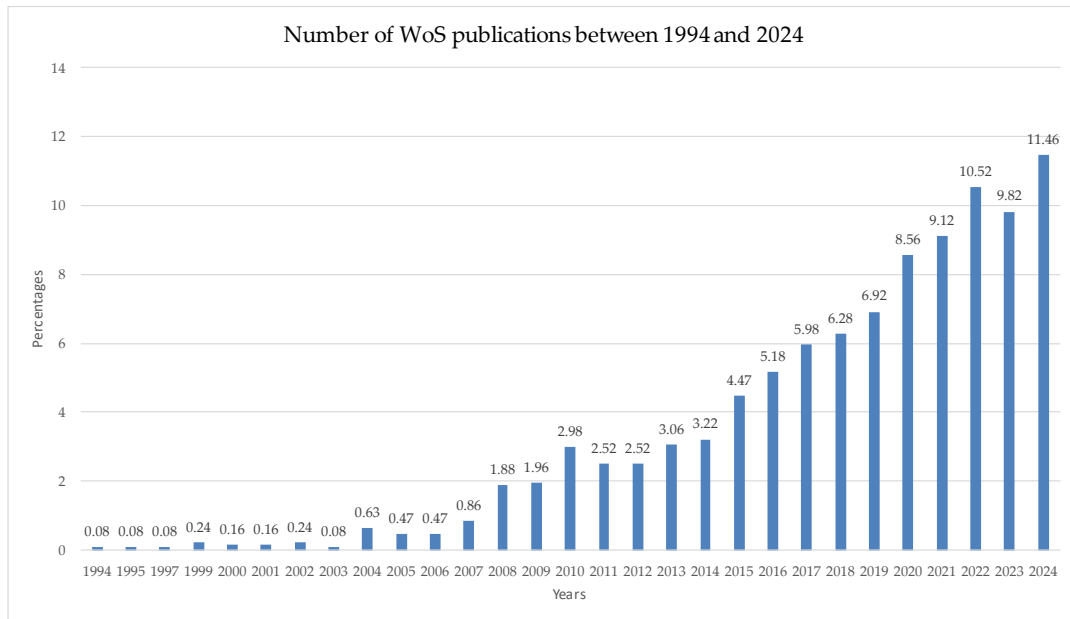
**Figure 1.** PRISMA guidelines describing the collection of documents from WoS.

### 3. Results

#### 3.1. Distribution of Document Types and the Impact of Top Contributors

From our selection of documents, 1051 were articles, 85 were proceeding papers, 30 were review articles, and 10 were book chapters. The difference up to the total of 1207 documents was represented by additional categories, including articles with early access status, data papers, editorial materials, biographical items, letters, and one note. Following an analysis of scientific publications, the results for the top three positions in terms of the number of articles published are as follows: Lelieveld, Jos, and Crowley, John N. share the first position, each with 10 published articles. Peischl, Jeff; de Gouw, Joost; and Jimenez, Jose L. are tied for the second position, each with eight articles. Harder, Hartwig D.; Paris, J. D.; Eger, Philipp; and Fischer, Horst occupy the third position, each having published seven articles. These figures highlight the significant contributions of these authors in their respective research fields.

The analysis of publication trends over the years (Figure 2), expressed as percentages, reveals a consistent growth in research output, reflecting the increasing focus and investment in the field. In the early years (1991–2003), the percentages were extremely low, often below 0.1%, indicating minimal research activity during this period. A gradual increase began in the mid-2000s, with percentages surpassing 1.0% by 2008 and reaching 2.98% by 2010.



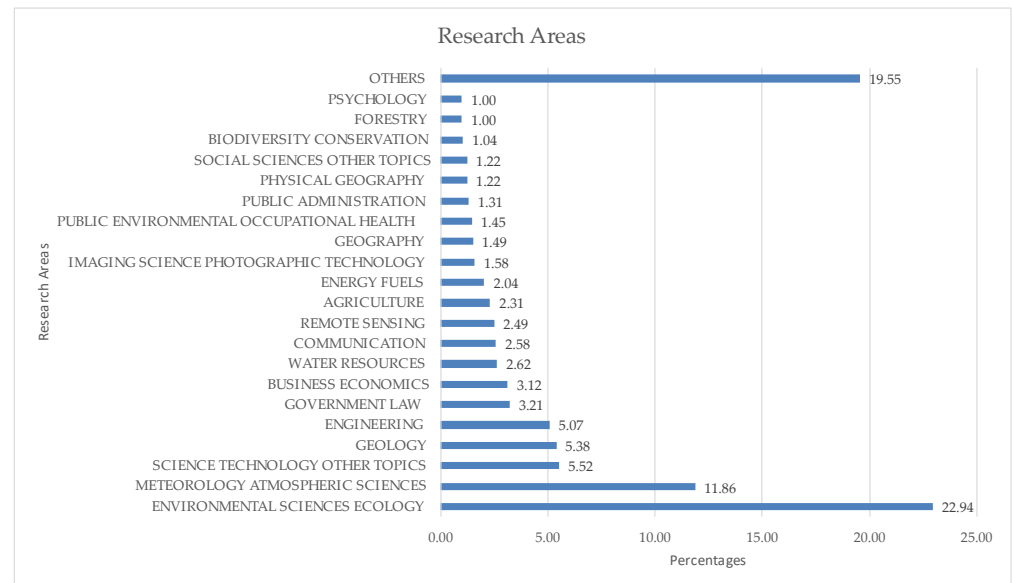
**Figure 2.** Number of WoS publications between 1994 and 2024.

From 2011 to 2016, the percentages showed steady growth, rising from 2.51% to 5.18%, marking a period of expanding research efforts. This growth accelerated after 2016, with percentages increasing sharply from 5.98% in 2017 to 11.46% in 2024. The years 2022 and 2024 stand out as peaks, with 10.52% and 11.46%, respectively, indicating a period of heightened scientific productivity. Overall, the data demonstrate a growth in research output over the past two decades, with the most substantial increases occurring in the last 10 years. This trend highlights the growing importance of the field and underscores the increasing contributions of researchers in addressing key scientific challenges. The percentages provide a clear picture of the field's evolution, showing how research activity has expanded from a niche area to a major focus of scientific inquiry.

### 3.2. Research Areas

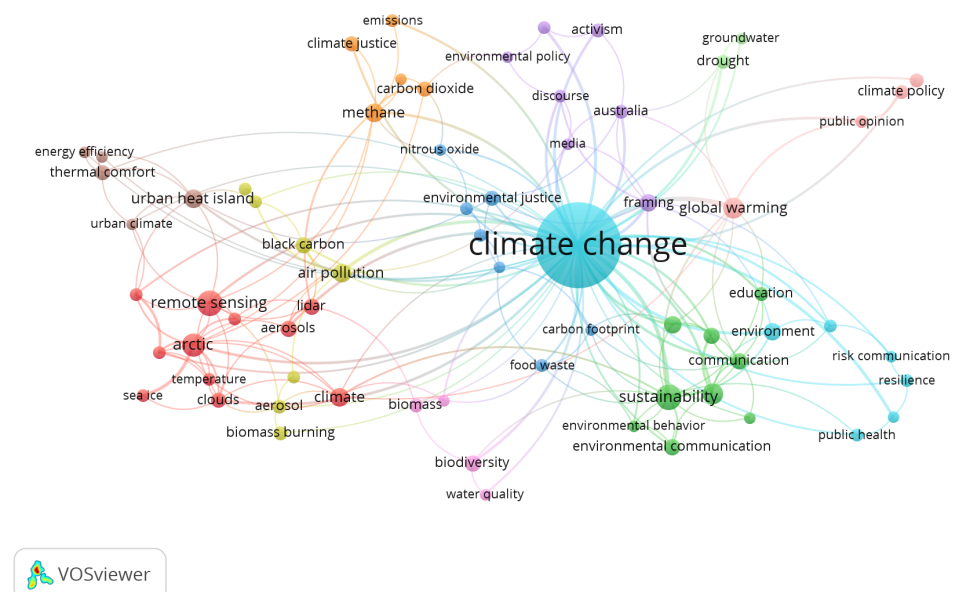
The analysis of research areas associated with the keywords “climate change” and “campaign” reveals an interdisciplinary focus, with environmental sciences ecology dominating at 22.94% (Figure 3). This highlights the central role of ecological and environmental studies in addressing climate change, reflecting the urgency of understanding its impacts on ecosystems and biodiversity. Meteorology atmospheric sciences follows at 11.86%, underscoring the importance of atmospheric processes and climate modeling in studying climate change dynamics. Other significant areas include science, technology, and other topics (5.52%), geology (5.38%), and engineering (5.07%), indicating contributions from technological innovation, geological studies, and engineering solutions to mitigate or adapt to climate change. The presence of government law (3.21%) and business economics (3.12%) reflects the growing emphasis on policymaking, governance, and economic strategies in climate change campaigns. Fields such as water resources (2.62%), agriculture (2.31%), and energy fuels (2.04%) demonstrate the focus on critical sectors directly impacted by climate change, including water management, food security, and energy transition. The inclusion of communication (2.58%) and social sciences other topics (1.22%) highlights the role of public engagement, education, and social behavior in climate change campaigns. The others category, which includes research areas that did not exceed 1% (representing fewer than 20 articles each), collectively accounts for 19.55%. While individually small, these areas—spanning disciplines such as, for example, chemistry, physics, urban studies,

international relations, and biodiversity conservation—contribute valuable insights and specialized knowledge to the broader climate change discourse. Their inclusion reflects the interdisciplinary nature of climate change research, where even niche fields play a role in addressing specific challenges.



**Figure 3.** Distribution of publications based on research area.

Figure 4 shows the network overview of the keyword co-occurrences on climate change awareness research. In our study, the analysis of the co-occurrence of keywords was analyzed using VOSviewer software. Therefore, the network visualization map of the keywords on climate change awareness research was mapped as shown in Figure 4. The map shows a total of 68 items that meet the threshold of 5. The most prominent keywords are “climate change” ( $n = 252$ ); “remote sensing” ( $n = 22$ ); “sustainability” ( $n = 22$ ); “arctic” ( $n = 19$ ); and “social media” ( $n = 15$ ). Other important keywords include terms like “global warming”, “framing”, “air pollution”, “climate”, and “communication”.



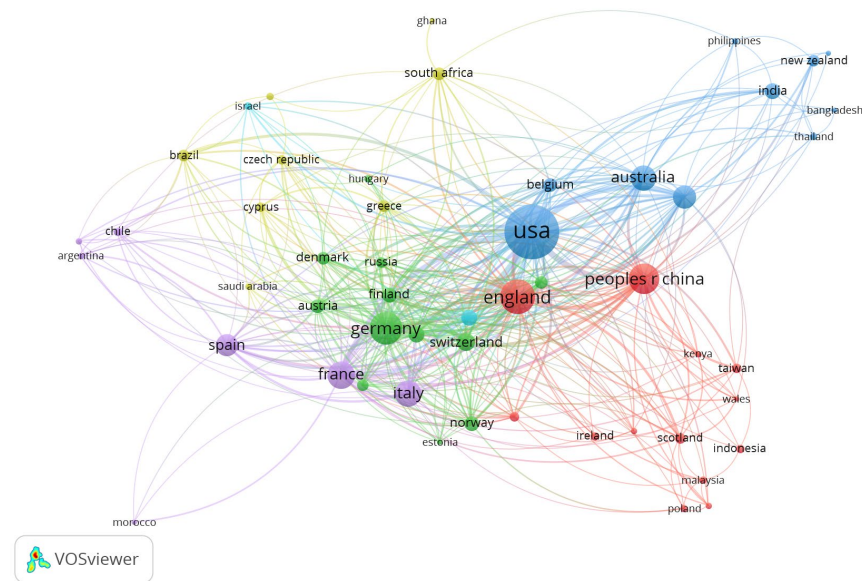
**Figure 4.** The Network visualization of keyword co-occurrence.

The keywords co-occurrence analysis showed 11 clusters. The largest is the blue one (cluster 6), with a total link strength (TLS) of 339. Cluster 1 (red) contains 11 items (TLS = 25) and 19 occurrences. It contains keywords like “aerosols”, “temperature”, “arctic”, “climate”, “clouds”, and “lidar”, which point to new technologies emerging in the field of climate change research. Cluster (green) 2 contains nine items, with a TLS of 25 and total occurrences of 22. It includes terms like “communication”, “education”, “environmental behavior”, “social marketing”, and social media.

Terms such as “media”, “environmental behavior”, “sustainable development”, “education”, and “environmental communication” all give reference to the need and the importance of communicating with the public because social media campaigns have the potential to shape the public’s perceptions and can raise awareness of this ever-evolving issue. The connection between “activism” and “media” also indicates the potential of activism that inspires social mobilization and action against climate change. Cluster 2 (green) has links to Cluster 6 (blue), which is an important observation because Cluster 6 (blue) includes terms like resilience, public health, and risk communication. This stipulates the potential of media channels for combating climate change, building resilience, and shaping public opinion.

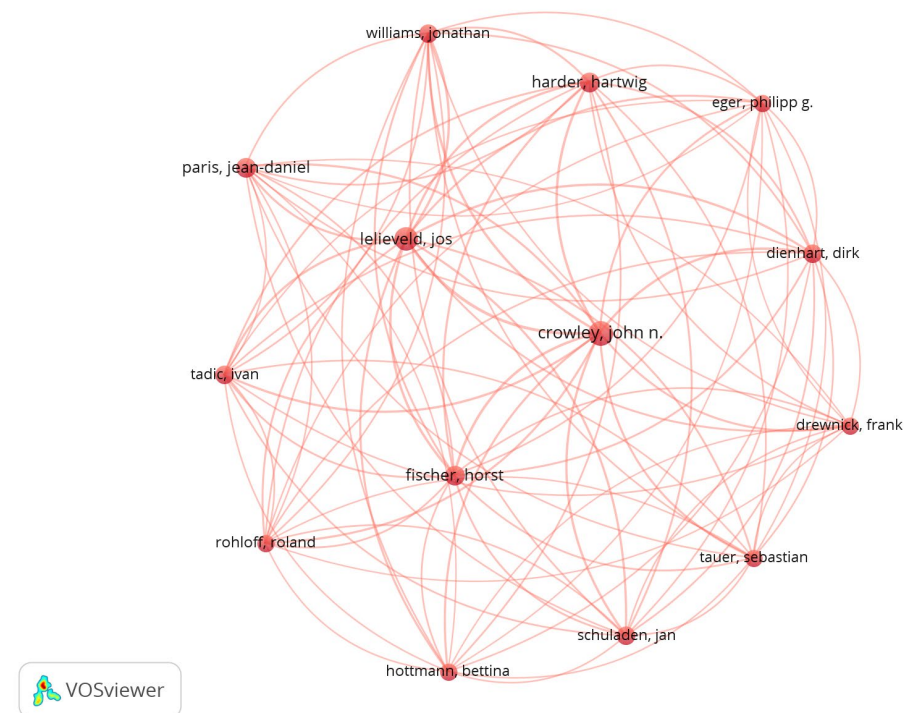
The strong link between these clusters presents a research field that is well-integrated. Climate change is a high-interest topic among many savants and scholars from different research domains, all trying to understand this multifaceted phenomenon.

Our findings from Figure 5 underscore that out of the 103 countries, 52 have published five or more publications. They also have at least five citations from 1994 to 2024. The United States of America takes the lead on the most prominently co-authored documents at 403 (cited 12,833 times, with TLS = 342). England follows with 163 documents (cited 4048 times, TLS = 197), followed by Germany with 146 documents (cited 4104 times, TLS = 232). Based on the findings, the United States is not only the most prolific but also the most prominent stakeholder in the research landscape on climate change campaign studies worldwide. Figure 5 provides an overview of the links and relationships across the globe regarding research on climate change. It includes six clusters; cluster 2 (green) with 12 items, is the largest one, with a central node in Finland. After analyzing this map, we observe the international interest surrounding the phenomenon, with nodes that represent countries and regions from all over the world. This global perception underscores the collaborative and interconnected relationships between researchers, all trying to contribute to gaining a more comprehensive understanding of the issues and wanting to find solutions in combating climate change. The placement of central nodes, such as the USA, Germany, and England, points to their notable contributions, making them major hubs that inspire research on climate change. These stakeholders represent focal points for various international initiatives and collaborations and offer a knowledge base and research framework. We can also observe regions and economies that are emerging. Nodes representing countries like Estonia, Indonesia, Colombia, and Argentina point to the evolving and growing contributions, which is a very encouraging sign, since these areas are often disproportionately affected by the impacts of climate change. Figure 5 presents specific regional clusters, like the link between European countries (e.g., Germany, Netherlands, The UK), and the connections between Southeast Asian nations (e.g., Malaysia, Indonesia). The regional collaborations presented above indicate shared interests within a specific geopolitical context. Additionally, we observed a degree of separation between nodes that represent developed countries (USA, Western Europe) and those of developing regions (Africa, Latin America). This could indicate the need to cultivate connections and knowledge-sharing experiences between the Global North and South. This way, researchers could adopt a more inclusive approach to combating climate change.



**Figure 5.** The network visualization of countries' co-occurrence.

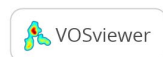
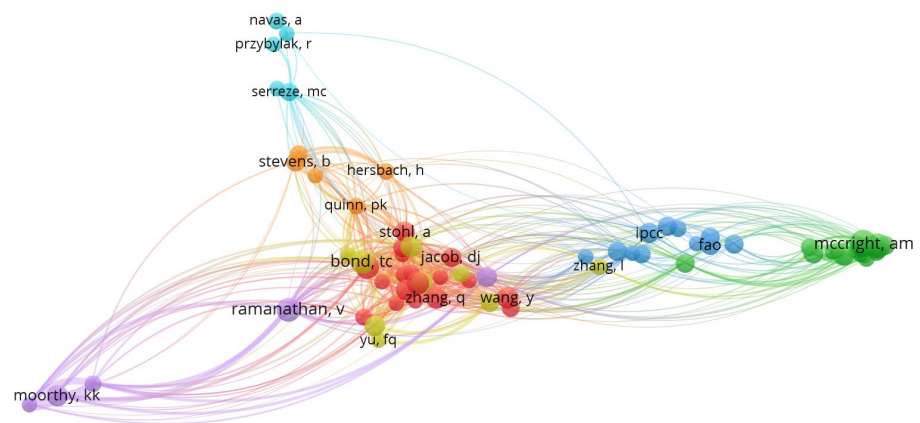
After analyzing the most cited authors, we report that out of the 43,939 authors, 71 meet the threshold of 20 citations. Mcwright, A.M. has the most with 60 citations (TLS = 146); Boykoff, M.T. has 53 citations with a TLS of 128, and then Bond, T.C. follows with 48 citations (TLS = 358). Figure 6 presents the network visualization of the co-citation of the cited authors (one red cluster) with 18 items (TLS = 205). The network is densely connected, showing that most authors have collaborated with multiple others in the group. Some authors, such as John N. Crowley, Jos Lelieveld, and Horst Fischer, appear as central figures in the network. These authors have numerous connections, suggesting that they play key roles in fostering collaboration and are highly productive within this research community.



**Figure 6.** The network visualization of cited authors.

We also wanted to report on the co-citation of the most cited authors from the data retrieved for the ISI WoS database. Out of the 43,939 authors, 71 meet the threshold of a minimum of 20 citations. Moorthy, K.K. is the most cited author, with 38 citations in total, (TLS = 556). Then, Babu, S.S. follows with 20 citations (TLS = 413), and Satheesh, S.K. has 25 citations (TLS = 402). Other important authors include names like Bond, T.C. (48 citations, TLS = 358); Jacobson, M.Z. (39 citations, TLS = 324); Andreae, M.O. (46 citations, TLS = 291); and Zhang, Q (39 citations, TLS = 235).

The network visualization map of the co-cited authors includes seven clusters. Cluster 1 (43 citations, TLS = 205) is the biggest one with 18 items, then Cluster 2 follows (61 citations, TLS = 146) with 17 items (Figure 7). The clustering of certain nodes, such as the group around “Zhang, Q.” and “Wang, Y.”, suggests the presence of sub-communities or specialized areas of focus within this broader network. Cluster 2 is the green one, containing 17 items and including authors such as Boycoff, M.T., Moser, Dunlap, and Schwarz. We can observe that a significant link between clusters 1 and 2 is McCRIGHT, A.M. These authors represent key figures whose work has significantly shaped the direction and development of the climate change awareness research field.



**Figure 7.** The network visualization of co-citation regarding cited authors.

Authors such as “Quinn, P.K.”, “Stohl, A.”, “Bond, T.C.”, “Jacob, D.J.”, “Zhang, Q.”, “Wang, Y.”, and “Yu, F.Q.” are likely other individuals within this network, potentially collaborators, colleagues, or associates of “Stevens, B.”.

### 3.3. Keyword Analysis

Further, the analysis focused on keyword exploration within the three most significant research areas: environmental sciences ecology, meteorology atmospheric sciences, and science, technology, and other topics. These fields exhibited the highest scientific output in terms of published research on climate change campaigns, reflecting their central role in the academic discourse surrounding climate-related initiatives.

The first three domains were chosen for their high relevance and extensive available literature. Due to the aim of this article, we focused our analysis on these specific domains. Future studies will encompass additional domains for a more comprehensive examination. Nonetheless, we intended to conduct an in-depth analysis of these first three domains.

Additionally, the study includes a categorization of article titles, based solely on their phrasing, without an in-depth examination of the full text. This classification was conducted using a thematic approach, where the wording of titles served as an indicator



Of the 507 identified records, only 72 articles explicitly contain the term campaign in their title, indicating that while campaigns are an important tool in combating climate change, they are not the primary focus of research in the field of environmental sciences ecology. This selection suggests a trend toward focusing on the analysis of campaign impacts on public policy, social perception, and citizen mobilization.

The thematic analysis allowed for the classification of titles into six main research directions, based solely on their wording and inferred topics, without an in-depth review of the article content.

- Public awareness and education campaigns (17 records) [19,48–63]. These campaigns aim to raise public awareness, educate, or change attitudes and behaviors related to environmental issues, climate change, and other social challenges.
- Political, advocacy, and policy-influencing campaigns (six records) [34,64–68]. This category includes campaigns designed to influence public policies, elections, or government decisions, as well as those that address political aspects of climate change and environmental governance.
- Social mobilization and civic activism campaigns (seven records) [69–75]. These campaigns involve communities, citizens, or non-governmental organizations (NGOs) in collective actions for environmental sustainability or other social causes.
- Scientific research and monitoring campaigns [76–103] (28 records). These campaigns focus on data collection, scientific research, or measurements in areas such as climate change, air quality, or other natural phenomena.
- Sustainability and corporate responsibility campaigns (10 records) [26,104–112]. This category includes campaigns led by corporations, non-governmental organizations, or other entities that promote social responsibility, sustainability, or environmental protection.
- Communication and social impact campaigns (3 records) [113–115]. These campaigns focus on public discourse, cultural narratives, and social transformation related to climate change, sustainability, and environmental policies. They analyze the role of media, communication strategies, and ideological messaging in shaping public engagement and influencing perceptions of climate issues.

In the field of environmental sciences ecology, the term campaign is mentioned 42 times. Among the keywords associated with campaign, “climate change” stands out as the most significant. It appears 12 times, accounting for 5.04% of the total keywords, and is found in 30.77% of the analyzed documents. This emphasizes its central importance in studies focusing on campaigns aimed at tackling environmental challenges. The term “field campaign” ranks second, appearing four times and making up 1.68% of the total keywords. It is present in 10.26% of the documents, reflecting the importance of field-based research initiatives in studying ecological systems and climate impacts. “Environmental campaign” ranks third, appearing three times and accounting for 1.26% of the total keywords. It is present in 7.69% of the documents, emphasizing the focus on organized efforts to address environmental challenges through advocacy and action. Several keywords share the fourth position, each appearing two times and representing 0.84% of the total keywords. These include “adaptation”, “awareness campaign”, “communication campaign”, “environmental movement”, “monitoring campaign”, and “Twitter”. All are present in 5.13% of the documents, indicating diverse approaches to environmental campaigns, from raising awareness and communication strategies to monitoring and social media engagement. The remaining keywords, each appearing once and accounting for 0.42% of the total keywords, cover a wide range of topics and include “activism”, “advocacy”, “airborne campaign”, “behavioral change”, “climate change mitigation”, “community resilience”, “environmental communication”, and “social media”. These keywords reflect the breadth of research on



in using field campaigns to improve climate models, assess air quality, and analyze the effectiveness of climate communication strategies. The thematic analysis allowed for the identification of five main research directions, grouping the articles into categories based solely on their titles and inferred focus areas, without an in-depth review of their content:

- Atmospheric measurement and observation campaigns [85,86,102,116–123] (11 records). These studies focus on large-scale atmospheric observations to study weather patterns, air circulation, and interactions between land, ocean, and atmosphere. They often involve aircraft, satellite, or ground-based measurements to improve climate models and meteorological predictions.
- Chemical composition and air pollution studies [79,84,87,88,96,124–127] (nine records). These studies analyze the concentration and distribution of pollutants, greenhouse gases, and reactive chemical compounds in the atmosphere.
- Aerosol and fine particle research [81–83,92,93,98,103,128–130] (10 records). These studies investigate the physical and chemical properties of aerosols, including soot, dust, bioaerosols, and other airborne particulates.
- Greenhouse gas monitoring [80,91,131–133] (five records). These studies measure emissions of greenhouse gases such as CO<sub>2</sub> and methane from natural and human sources.
- Climate communication and policy campaigns [49,56,78,99,134,135] (six records). These studies focus on public engagement, awareness, and policymaking related to climate change. They examine how people perceive climate risks, how clean energy initiatives can be framed for civic engagement, and how disaster preparedness campaigns can influence public behavior.

Out of the total articles that included keywords, only 12 articles featured the term campaign. Among these, “field campaign” is the most prominent keyword, appearing three times (4.29%) and present in 27.27% of the documents. This suggests that field-based measurement campaigns are a significant focus within this research area, reflecting the importance of observational studies in understanding atmospheric processes.

The remaining keywords, each appearing once (1.43%) and present in 9.09% of the documents, cover a wide range of topics. These keywords include “adaptation”, “aerosol optical depth”, “airborne campaign”, “climate change”, “methane”, “measurement campaign”, and “urban climate”, among others. While these keywords are less frequent, they highlight the diversity of research themes associated with campaigns, such as atmospheric chemistry, climate change mitigation, urban climate studies, and the use of advanced measurement techniques.

### 3.6. Science, Technology and Other Topics

The bibliometric analysis of keywords in the science, technology, and other topics research area reveals a strong focus on interdisciplinary themes, with “climate change” dominating the landscape (Figure 10). It appears 23 times, accounting for 4.20% of the total keywords, and is present in 22.77% of the analyzed documents. This underscores its central role in research addressing global environmental and technological challenges.

Following “climate change”, the keyword “sustainability” ranks second, appearing four times (0.73%) and present in 3.96% of the documents. This highlights the growing emphasis on sustainable practices and their integration into scientific and technological solutions.

Several keywords share the third position, each appearing three times (0.55%) and present in 2.97% of the documents. These include “environmental justice”, “fossil fuel divestment”, and “temperature”. These terms reflect the intersection of environmental, social, and technological concerns, such as equitable resource distribution, energy transition, and climate monitoring.



- Experimental and technological field campaigns [63,139,140] (three records). These studies involve campaigns that test new technologies, tools, and methodologies in real-world settings. They focus on experimental approaches in environmental monitoring, sustainable infrastructure, and technological adoption to assess their effectiveness in practical applications.

Out of the total articles that included keywords, only five articles featured the term “campaign”. Among these, the keyword “campaign contributions” appeared once, alongside other unique keywords such as “monitoring campaign”, “Maldives AUAV campaign”, and “virgin lands campaign”. Each of these keywords is present in the documents, indicating that they are highly specific to the individual studies in which they appear. The presence of “campaign contributions” and “monitoring campaign” suggests a focus on organized efforts, such as funding initiatives or observational studies, within this research area. Additionally, the inclusion of “Maldives AUAV campaign” and “virgin lands campaign” highlights the use of campaigns in specific geographic or thematic contexts, such as environmental monitoring or land management.

#### 4. Conclusions

This bibliometric study has revealed a significant and accelerating trend in academic interest surrounding climate change awareness campaigns. Between 1994 and 2024, the number of publications addressing this topic increased markedly, reflecting the urgency of climate-related challenges and the growing recognition of communication as a critical tool in fostering public engagement and shaping environmental policy.

The analysis of publication types, authorship patterns, and country contributions underscores the global and collaborative nature of this research area. The United States, the United Kingdom, and Germany lead in publication output and citation impact, while increasing participation from emerging economies signals a welcome shift toward greater inclusivity in scientific discourse—especially from regions most affected by climate change.

Our findings also show that while the term “campaign” appears frequently across disciplines, it is often treated as a supporting concept—typically embedded within broader frameworks related to mitigation, adaptation, or public health. The field’s interdisciplinary character is evident, integrating perspectives from environmental sciences, atmospheric research, geosciences, sustainability studies, and communication sciences.

Notably, research gaps remain. Topics such as environmental justice, permafrost, and the linkage between mitigation, adaptation, and impact require further attention. Moreover, despite the volume of research, few studies offer robust evaluations of campaign effectiveness.

To advance the field, future research should prioritize the development of empirically grounded, inclusive, and participatory communication strategies. Stronger North-South collaboration, innovative digital tools, and practical applications of research findings are key to designing awareness campaigns that not only inform but also inspire behavioral and policy change. Our analysis provides a foundation for this next phase in climate change communication research—one that is action-oriented, globally connected, and driven by evidence. In summary, the bibliometric evidence suggests that climate change awareness campaigns are becoming increasingly central to interdisciplinary research agendas. This trend underscores a shift toward more integrated approaches to climate communication, where scientific, political, and societal dimensions intersect. By making visible the structure and evolution of the research field, our analysis not only maps scholarly activity but also identifies leverage points for more impactful communication practices and policy-oriented strategies.

### *Limitations of the Study*

This study relies solely on articles indexed in the Web of Science (WoS), one of the most prominent academic databases. While WoS is highly regarded, it does not encompass the full spectrum of literature relevant to climate change and awareness campaigns. Publications in local journals, international conference proceedings, or other databases such as Scopus or Google Scholar may offer additional insights that are not captured in this analysis. Moreover, the selection of articles was based on the presence of the terms “climate change” and “campaign” in titles or keywords. Although this approach is effective for quantitative analysis, it may exclude relevant studies that use alternative terminology, such as “environmental awareness”, “public engagement”, or “sustainability communication. Conversely, some articles may have been included despite only peripherally referencing these terms.

The analysis is primarily quantitative, focusing on overarching research trends rather than providing an in-depth assessment of the quality or content of individual studies. A more comprehensive approach, such as a systematic literature review or meta-analysis, could yield deeper insights into the strategies and effectiveness of climate campaigns.

Additionally, since the study is based solely on titles and keywords, it does not explore the full content, methodologies, or findings of the articles. While this approach offers a scalable and systematic method for identifying research trends, it limits the depth of understanding of the broader context. Nevertheless, given the objective of mapping the research landscape, this method remains a robust and reproducible approach for thematic classification and trend analysis in the field of climate change campaign research. Future research should consider integrating mixed methods approaches that combine bibliometric analysis with qualitative content analysis or systematic literature reviews. Evaluation tools such as impact assessments, media framing analysis, and sentiment analysis on social media platforms may offer more nuanced insights into the effectiveness of climate awareness campaigns. Additionally, longitudinal case studies and participatory evaluation methods could strengthen the understanding of campaign impact across different cultural and policy contexts. Furthermore, the use of advanced text-mining or natural language processing (NLP) techniques could help identify relevant studies that use diverse terminology. Expanding the geographic scope and performing comparative analyses of campaigns across different countries and sociopolitical systems may also provide deeper insights into global climate communication dynamics.

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