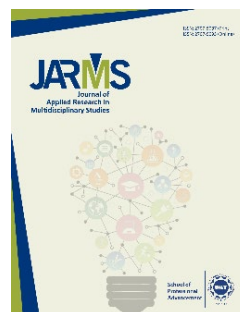
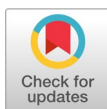



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The Role of Climate Finance in Accelerating Climate Action: A Bibliometric and Content Analysis of Literature

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Abstract

The study aims to conduct an updated bibliometric analysis, and systematic literature review to understand the current states and role of climate finance research area in accelerating the climate action and to propose the future research directions. This study analyses the reasons behind the recent gain the valuable attention of climate finance, specifically towards sustainable development goal 13 (SDG-13) due to international negotiations. The main conclusions show that: (1) research on climate finance evolved in the last 5 years; (2) the majority of the literature, authors, and institutions involved in this field are from Germany, France & China; and (3) a significant amount of the academic literature on climate finance concentrates on financing for renewable energy, the low-carbon transition, and the difficulties associated with climate funding. The study provides some practical implementations to regulatory bodies and policy makers. It also provides some future directions to researchers in climate finance from the perspective of lower-middle income countries (LMIC's) with certain limitations regarding the lack of supplementary techniques while adapting climate finance for climate action.

Keywords: bibliometric analysis, climate action, climate finance, SDG 13

Introduction

The world is facing climate challenges in the form of increase in carbon emission, fossil fuels, greenhouse gases, global warming and natural disasters (Bilgili et al., [2024](#)). The United Nations (UN) has established the Sustainable Development Goals (SDGs) globally and set targets to achieve these goals by 2030 (Arora & Mishra, [2019](#)). From the total of 17 SDGs, one is climate action (SDG-13) to quickly respond to combat climate change and its impacts (United Nations, [2022](#)). The key factors driving the pursuit of this goal include the ongoing and intensifying climate crisis, the

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unchecked rise in greenhouse gas emissions necessitating a transition to carbon-neutral economies (Bergsvik et al., [2024](#)).

Following the Paris Agreement 2015, the progress of UN climate summits in the sequential series of United Nations Framework Convention on Climate Change (UNFCCC), and Conference of the Parties 26 (COP26) to 29th COP in Baku has consistently underscored the pivotal role of climate finance in achieving the SDG-13 targets. The upward trends in climate finance and the growing emphasis on climate action (Lejano, [2024](#); Vorontsova, [2022](#)) encourage researchers to enter emerging areas of study that are still less explored. Progress in the exploration of this wide area has encouraged researchers to contribute to climate finance to attain climate action (Zhongping et al., [2023](#)).

The concept of climate finance is crucial to understand, as it has the transformational power to achieve climate action (SDG-13). This is possible since it aims to implement initiatives to attain SDG-13 by contributing towards the environment, society, and governance (ESG) (Liu et al., [2024](#)). The effort to recognize missed research opportunities by financial economists on climate finance was overcome in 2016 (Hong et al., [2020](#)). In addition, IFC 2016 coined green finance (Chandran & Chandran, [2024](#)). The benefits of climate finance have also been expressed by (Long et al., [2022](#)), who stated that it supports the mitigation of and efforts toward climate action in developing countries.

Green and sustainable finance covers a wide range of environmental and social issues. These two terms have been used together by (Cheng et al., [2021](#); Popescu et al., [2021](#)), whereas green and sustainable finance (G&SF) have been used interchangeably and as an umbrella by (Naeem et al., [2023](#)). Whereas Deb and Chen ([2024](#)) explained that the terms climate finance, sustainable finance and green finance are somehow related at some length but not interchangeable and different to each other. At this stage, it is important to differentiate these terms. As per the United Nations Environment Program (UNEP), green finance is used for environmental purposes specifically dangers such as industrial pollution, water sanitation, and biodiversity preservation (Bergsvik et al., [2024](#)). Whereas sustainable finance is not only suitable for environmental purposes but also for social goals (Shang & Jin, [2023](#)). Climate finance involves analyzing local and global funding for public and private investments to mitigate climate change and adapt to its impacts (Giglio et al., [2021](#); Long et al., [2022](#)). Climate

finance combines knowledge and approaches from various disciplines, including environmental science, economics, finance, and energy policy (Kouwenberg & Zheng, [2023](#)). Climate finance and carbon bonds are more narrowly focused on addressing climate change (Kouwenberg & Zheng, [2023](#)). In the UN's convention on UNFCCC (climate change), climate finance is defined as, "local, national, or transnational financing drawn from public, private, and alternative sources of financing that seeks to support mitigation and adaptation actions that will address climate change" (unfccc.int). Thus, it is evident that these three terms, climate finance, sustainable finance and green finance are different (Deb & Chen, [2024](#)). For instance, sustainable finance addresses societal goals whereas, climate finance and green finance do not. This study precisely uses climate finance for operationalization, and describes its flow for financial resources for all programs, projects, policies that address climate action and SDG-13.

Studying climate finance is important and crucial for achieving SDG 13 climate action because of two key factors. Firstly, global warming and the SDG 13 climate action initiative demand substantial funding for IoT, renewable energy, and reducing greenhouse gas emissions. According to a study (Boehm et al., [2021](#)), financial flows toward climate finance must reach a total of USD 5 trillion annually until 2030 to attain the climate control target of 1.5°C. They established the New Collective Quantified Goal (NCQG) on climate finance, which aims to triple annual funding (Falduto et al., [2024](#)). This includes increasing financial support for climate risk countries from the previous 100 billion USD annually to 300 billion USD per year by 2035 (Serda et al., [2024](#)).

Secondly, a key concern for nations is how climate finance can address the challenges and obstacles to attaining SDG 13 climate goals. Climate change has a growing impact on the global economy, with implications for sustainability, the long-term survival of industries and capital, the resilience of social structures, and investor concerns about adapting to the associated risks and scaling up climate action through climate finance. This raises the question regarding the extent to which climate finance would help achieve the targets outlined in Sustainable Development Goal 13, which aim to address climate action.

Despite a few previous studies (Deb & Chen, [2024](#); Shang & Jin, [2023](#)), climate finance is a broad field that incorporates numerous subjects and academic disciplines, yet it currently lacks a unified research structure. The

interdisciplinary nature of climate finance frameworks creates difficulties for researchers seeking to form complete and cohesive models. A literature gap exists regarding in-depth review papers, and only a handful of studies offer suggestions for future research pathways based on thorough analysis, especially when climate finance is assessed for the sake of SDG-13 climate action. This study fills the existing knowledge gap by expanding on prior research through a comprehensive bibliometric and content analysis.

This bibliometric study on climate finance is different from previous studies in three ways. This study highlights the urgency of climate action through climate finance, incorporating keywords related to both in its search terms. A broad search strategy has been adopted with multiple key terms (e.g., climate finance, green finance, sustainable finance, carbon finance, climate investment, Climate Bond, climate action, climate change mitigation, climate change adaptation, net-zero emission, decarbonization and Sustainable Development Goal 13). Secondly, an updated bibliometric analysis has been included in this study by incorporating publications through the end of 2024. Finally, to construct a conceptual framework, this study combines the content analysis with bibliometric analysis that explicitly details the antecedents, mediators, moderators, and outcomes of climate finance.

While prior studies have explored sustainable finance broadly, a significant research gap exists regarding an updated, interdisciplinary framework that synthesizes the antecedents and outcomes of climate finance specifically in the context of global climate action imperatives.

Thus, the imperative of climate action is climate finance. The bibliometrics and content analysis address the following research questions.

- What is the volume of climate finance studies published, and how are they distributed over time, across different countries, and in various journals?
- Which articles and authors have been most influential in climate finance research?
- What are the current emerging themes in the climate finance literature?
- What are the future directions for policymakers for imperatives of climate finance towards attaining SDG13?

Research Method

To assess the literature on climate finance, a bibliometric analysis and content analysis have been chosen. A bibliometric analysis is a descriptive analysis that provides valuable insights and tools for literature trend identification, author and institution contribution, citation, and co-citation analysis. In addition to bibliometric analysis, content analysis provides a reliable foundation for a comprehensive overview, allowing an analysis of the emerging themes in literature, quality assessment of current literature, identification of gaps for future directions, bias reduction, and evidence synthesis. This research focuses on the imperatives of climate finance, and the PRISMA statement (Moher et al., [2010](#)) and Scopus directory has been chosen for bibliometric analysis in sustainable finance literature (Hartanto et al., [2024](#)).

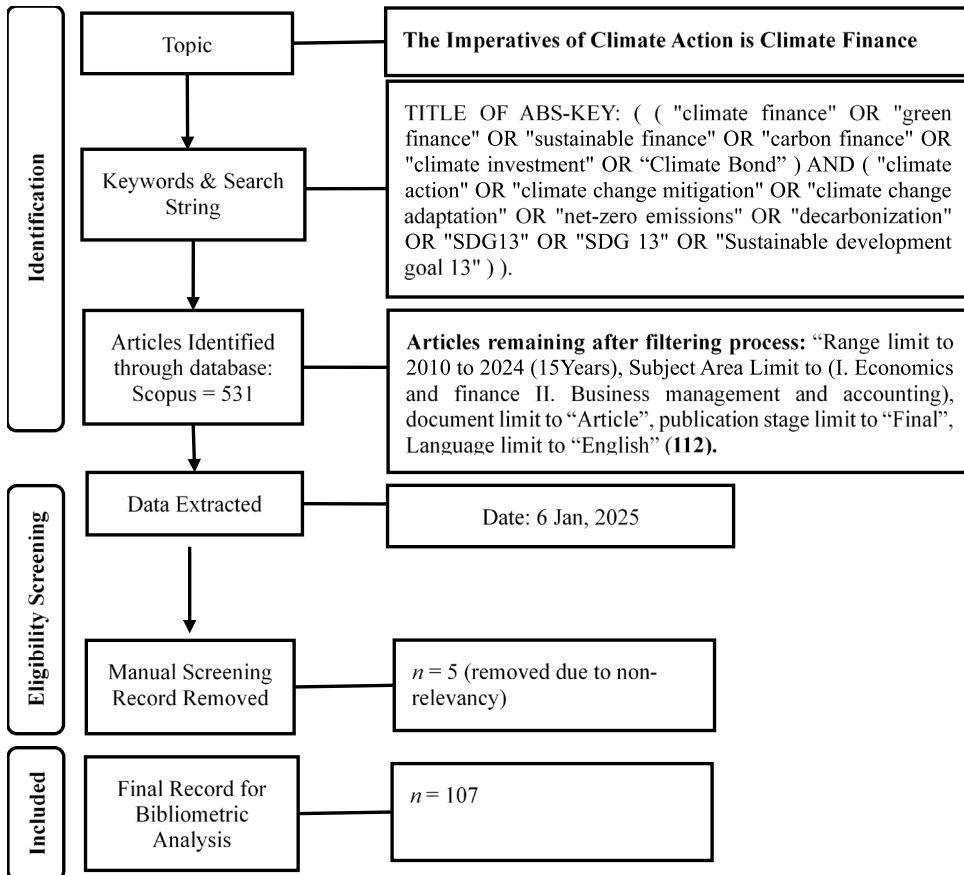
Data Extraction and Refinement

The Scopus database was selected as the primary data source due to its comprehensive coverage of peer-reviewed literature in social sciences, economics, and environmental management. Compared to other databases, Scopus offers superior metadata for bibliometric analysis and ensures high-quality indexing of journals relevant to sustainable finance and climate policy (Baas et al., [2020](#)). The data was extracted by keywords such as climate finance, green finance, sustainable finance, sustainable development goal-13 and climate action. To make the search narrow and to attain relevant results, Boolean operators, OR with addition to AND were used while search was conducted on Scopus databases.

In the initial stage, a search through article title, abstract and keywords identified 531 documents, spanning unlimited period. As the research was restricted to fifteen years (2010 to 2024), it excludes only 5 articles. In the second stage, research filter was restricted to i. Economics and finance, ii. Business management and accounting subject areas, and obtained 185 articles. In next stage the final selection was 112 articles which were published in English language and were published and are on final level. At the final stage, as per PRISMA flowchart manual screening was performed and the filtration process revealed only 107 articles that were selected for bibliometric analysis.

Figure 1

PRISMA Flow Diagram Outlining the 04 Steps Taken to Find and Evaluate Sources for the Evaluation (Moher et al., 2010)



Note. Method of Filtration adapted from (Shang & Jin, 2023)

Data Analysis

This study divided data analysis into two parts. In the first part, a statistical software “Bibliometric” accessible through R-Studio was used for bibliometric tests and analysis. R-studio provides the most powerful interface that makes it easy to examine bibliometric maps (Bhatnagar & Sharma, 2022). In the second part, a thematic and content analysis was performed in which literature was reviewed in more detail, and conceptual framework and emerging theme and its current and future directions have been identified (Sovacool et al., 2023).

Results

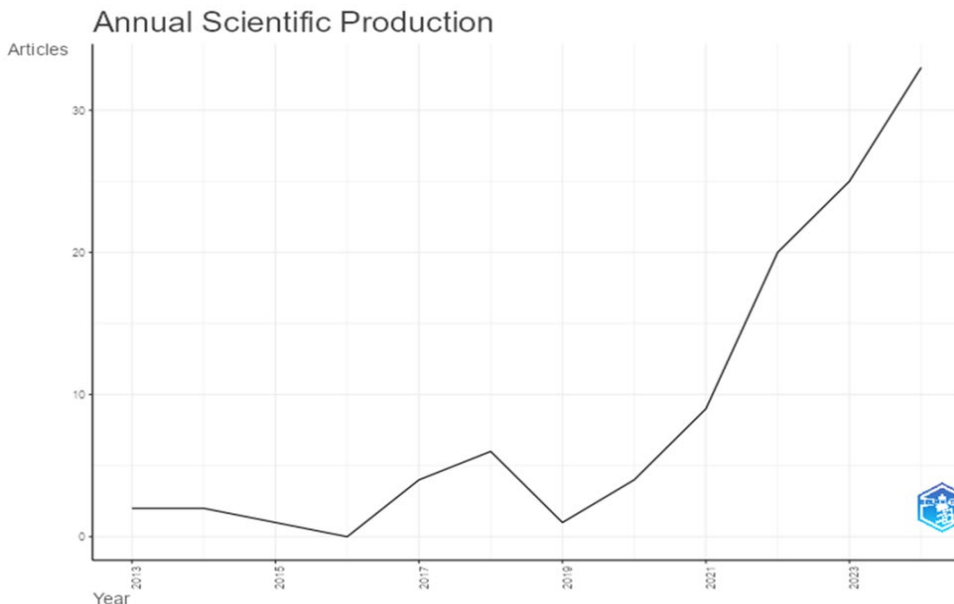
Using the R-studio for bibliometric analysis on the 107 articles, the following results have been derived.

Annual Scientific Production

The annual scientific production graph in Figure 2 shows that during the years 2016-2024, the slope remains fairly stable, and outlines very few publications. A moderate increase has been observed during 2017 to 2018 that indicates an emerging trend followed by publications, but between 2019 to 2020 there is a slight downward slop, probably due to some external factor like COVID19 pandemic (Waqas et al., [2024](#)). During 2021 to 2024 a very sharp increase shows a high number of publications in climate finance indicating a critical focus gained by researchers regarding this topic. The sharp rise during this tenure aligns with policy discussion such as COP26 held in 2021, COP27 in 2022, COP28 in 2023 and COP29 in 2024. The data interoperates the increasing acknowledgment of the importance of climate finance in addressing climate action, moving towards achieving the ultimate goals set in Paris agreement 2015.

Figure 2

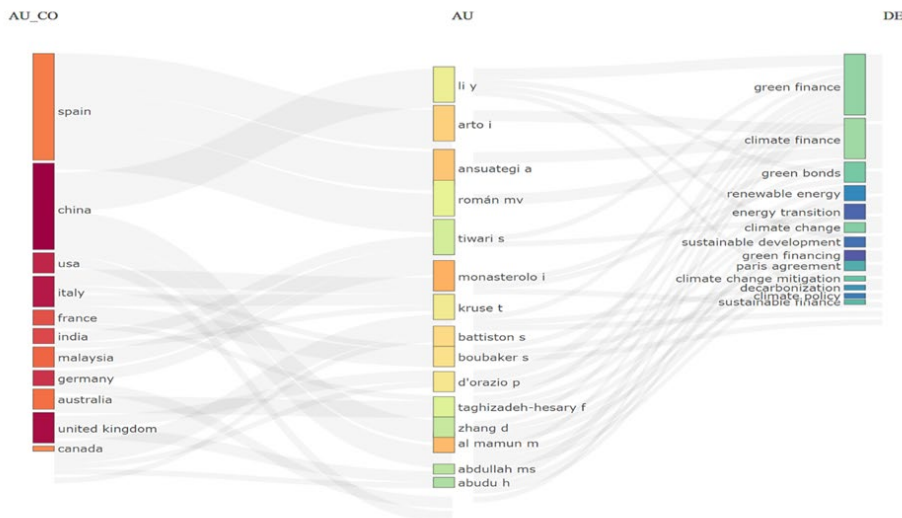
Annual Scientific Production Chart



Three-Field Plot

In Figure 3, the left column (AU_CO) shows Spain to be the leading country followed by China, as contributing countries in the list, whereas these are followed by USA, Italy, France, India and so on. In the middle column (AU), key authors include Li as the top contributor likely connected to China focusing on green finance, green bonds and sustainable finance. Monasterolo, a major contributor from Italy or Spain working on climate finance and sustainable development follows Li. Similarly, Arto and Roman likely from Spain, can be seen connecting green finance to energy transition. The third column (DE) lists the research topics, green finance and climate finance as the dominant themes associated with the top publications. Green bonds, energy transition, and climate change emphasize policy relevance which is followed by leading themes. Overall, this sankey plot diagram visualizes the interplay between top contributing countries, leading authors, and the top keywords for climate finance.

Figure 3
Three-field Plot (Sankey Diagram)



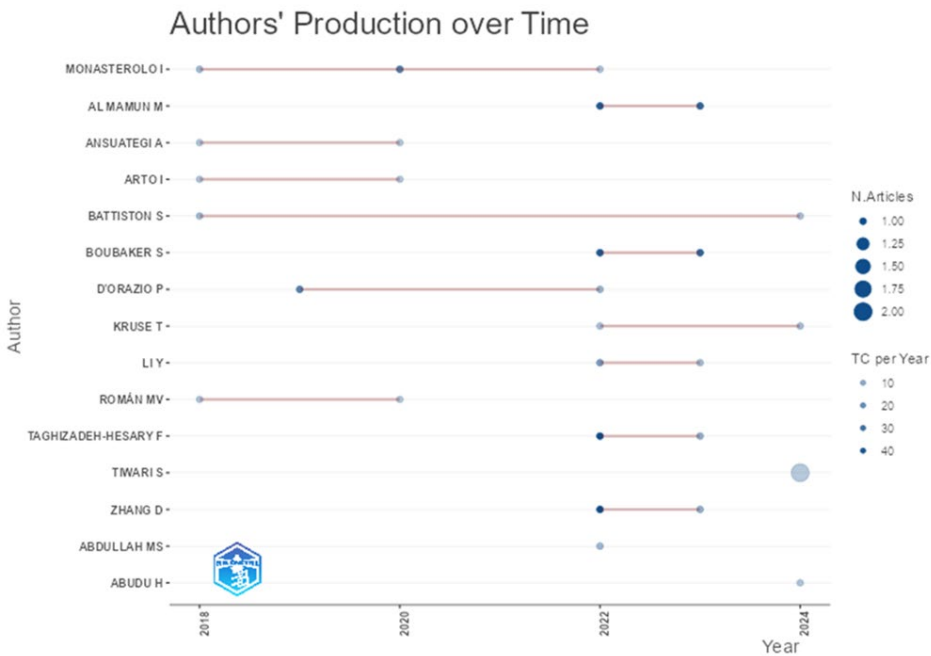
Authors' Production Over Time

In Figure 4, the vertical axis lists the contributing researchers, Monasterolo, Al Mamun, Taghizadeh-Hesary, and others as the prominent

contributors to climate finance. On the horizontal axis, the time frame from 2018 to 2024, indicates when researchers actively published articles. In N. Articles mentioned on right side as key metrics, the large circle is for Monasterolo consistently publishing articles across multiple years. Authors that are more impactful and gained more citations per year, like Taghizadeh-Hesary, have a larger and darker circle in the year 2024 in TC per year. The lines between the horizontal and vertical axis connecting dots across the years indicate contributions from researchers. It is demonstrating that Battiston is the sustained contributor between the entire graph from 2018 to 2024. During 2022 to 2024 there is a surge in publications from authors.

Figure 4

Authors' Production

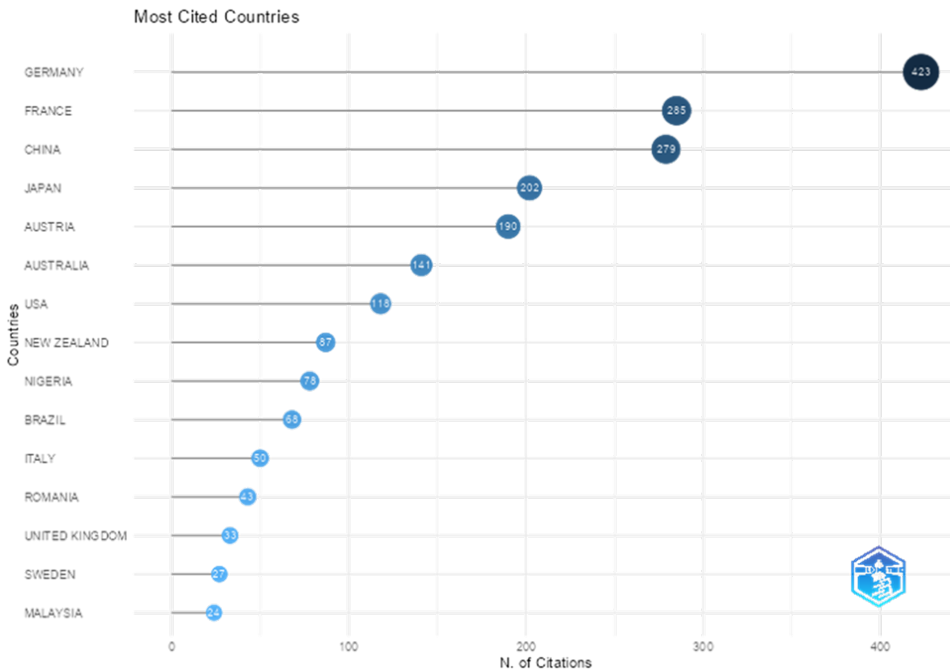


Most Cited Countries

The results in Figure 5 indicate the outstanding performance given by Germany as a country with the highest number of 423 citations. France, China, Japan, & Austria with some margin also contribute significantly to the field, followed by the Germany. One the bottom side, Malaysia, Sweden, United Kingdom and Romania are the countries that emerged in this field

with smaller contributions. Finally, the impact factor and high citation countries represented by higher bubbles are the leaders, potentially correlating as part of global climate action with a focus on climate finance. Whereas the disparities highlight regions requiring more support and attention in the field of climate finance.

Figure 5
Most Cited Country



Most Relevant Words

In Table 1, the dominance of climate change occurrence is 30, reflecting the foundational link between climate action and mobilizing climate finance. Finance emerges twenty times, and climate finance is 04. Although ‘climate finance’ is seldom seen, but it represents the focus within the context of finance category. Themes regarding carbon emission, emission control, environmental economies lead with the most frequency followed by climate change. Sustainable development, green finance, and phrases related to the developing world can be seen in rarity and require much focus and attention for climate finance. Similarly, to achieve the SDG-13, as linked with the themes of carbon dioxide, environmental policy, carbon,

climate change mitigation, it is imperative to critically focus on climate finance.

Table 1

Most Relevant Words

Words	Occurrences
climate change	30
Finance	20
carbon emission	10
emission control	10
environmental economics	10
green economy	10
financial system	9
carbon dioxide	8
environmental policy	8
adaptive management	7
alternative energy	7
Carbon	7
climate change mitigation	7
sustainable development	7
green finance	5
gross domestic product	5
Investment	5
Investments	5
climate finance	4
developing world	4

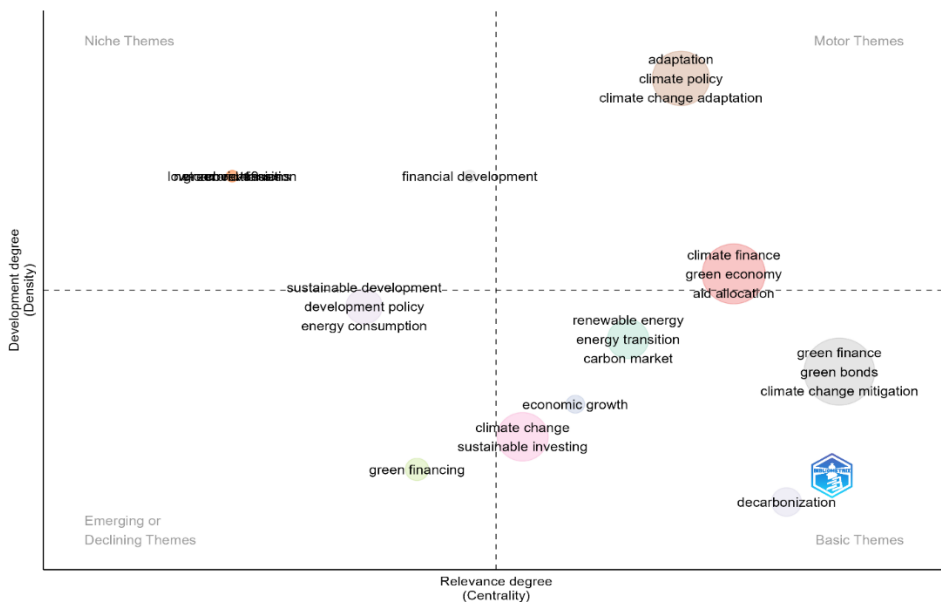
Trend of Topic

In Figure 6, the word cloud visually captured the most frequently used keywords in the research domain of climate finance (Bhardwaj et al., [2023](#)). The keywords “climate change,” “carbon emission,” and “emission control” are prominently featured, underscoring their centrality to the discourse. Terms such as “finance,” “climate finance,” and “environmental economics” highlight the integration of climate change mitigation with the financial system. Keywords such as “sustainable development,” “green economy,” and “alternative energy” reflect the field’s emphasis on addressing climate challenges through risk assessment and CO2 emission. Thus, the word cloud reinforces the need for finance and climate finance as

Basic Themes (Bottom-Right Quadrant)

Themes such as climate finance, green economy, green bond, green finance, mitigation, climate change, and decarbonization are foundational themes with low density but high relevance. Regardless of their rarity and lack of development, these themes are nonetheless crucial. The imperatives of climate action reflect the centrality of climate finance, also enabling green bond, green finance and mitigation. For the broader sustainable development goals, the interconnectedness of green finance, green economy, and aid collection are the basic themes.

Figure 7
Thematic Mapping



Niche Themes (Top-Left Quadrant)

Financial development and low carbon transition themes have limited relevance but are highly developed in the central discourse. They represent mature and specialized areas that are not yet fully connected to the climate strategy and climate finance.

Emerging or Declining Themes (Bottom-Left Quadrant)

This quadrant lacks strong representation, indicating limited focus on underexplored or outdated areas in this dataset. Development policy, energy

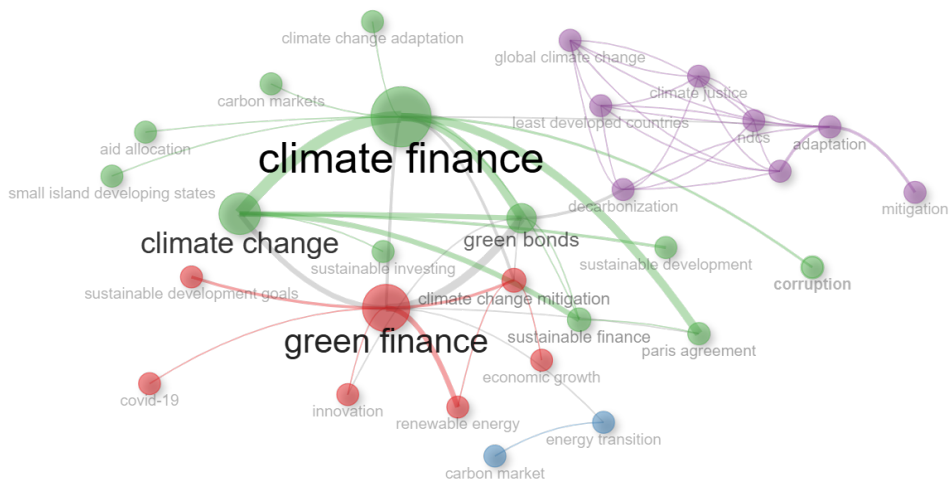
consumption, and green financing have lower density and relevance. They represent the areas with declining themes or those emerging in importance. The significance of these might indicate opportunities for future research or areas losing current relevance.

Author's Keyword Network

In Figure 8, the visualization represents the author's keyword network with several clusters. The green cluster appeared to be the largest and central hub to connect other clusters to the main network. The critical themes are climate finance and climate change, represented by the large size of nodes. These are strongly connected with others and represent foundational themes, showing an integrative role in connecting green bond, Paris agreement, carbon markets, and sustainable finance.

Figure 8

Authors Keyword



The lower left (red cluster) is smaller but distinctive, with large nodes indicating focused topics by researchers. The central keyword in red cluster is green finance that is connected with red small nodes representing innovation, renewable energy, covid-19, sustainable development goals, climate change mitigation, and innovation.

The upper right (purple cluster) shows that the size of nodes is not very big; the edges are connected with a group interlinked with the purple cluster,

representing some isolation among densely interconnected nodes. It represents the global climate change, climate justice, adaption, mitigation and decarbonization. The bottom right, smallest (blue cluster) and most isolated cluster has connection between only carbon market and energy transition with medium nodes size.

Emerging Themes in The Domain of Climate Finance

Using thematic mapping, keywords, and clusters in the examined papers, as well as content and thematic analysis of the articles, the developing topics in climate financing are found (Hidayat-ur-Rehman & Hossain, [2024](#)). The most common terms (green finance and investment, climate policy and industrial framework, renewable energy, low-carbon investments, regulatory frameworks on climate finance, green economic development, and climate risk) are noteworthy because they point to new and significant directions for future study in the field of climate finance (Hong et al., [2020](#)). The multifaceted character of climate finance, which includes environmental, economic, social, and technical aspects, is demonstrated by these developing issues taken together (Giglio et al., [2021](#)). The newest topics in climate finance scholarship are listed below.

Green Finance and Investments

An important term used in climate finance is green finance, which underlines investments hindering sustainability (Fu et al., [2023](#)). Therefore, it links green bonds with emission decreases. Bakhsh et al. ([2024](#)) explored its role in proffering renewable energy transitions across OECD countries. Similar to this, Ali et al. ([2024](#)) analyzes green financing in OECD-15 countries, focusing on its implications for economic growth and environmental outcomes. Combined with green financial instruments, such as green bonds and loans, targeted investments into sustainable infrastructure are becoming increasingly recognized as an important vehicle to meet climate targets. They illustrate not only capital deployment but also how green financing allows alignment with international climate mitigation strategy.

Policy and Institutional Frameworks

Good institutional governance and efficient policy frameworks form the prerequisite basis for climate finance (Bilgili et al., [2024](#)). Bergsvik et al. ([2024](#)) showed that a governance system positively enhances the flows of money into sustainability and, for this purpose, openness helps stimulate

accountability within the climate accords. Sadiq et al. (2024) established how tough rules enhance the green funding mechanism by ensuring the actual compliance of all activities towards the climate objectives. Based on these studies, policy-driven strategy is a powerful approach as successful green finance approaches require that very capable regulatory frameworks place financial mechanisms beside environmental concerns in order.

Technological Innovation

Technological innovation is a constantly recurring theme, which often leads to advancements in efficiency using resources and renewable energy (Cheng et al., 2021; Zhang, Chen & Lau, 2022). Businesses are employing technology in achieving low-carbon economies (Van et al., 2023). Monasterolo and de Angelis (2020) explored the role of innovation in mitigating systemic risks that are linked with low-carbon investments. The outcome of these experiments highlights how the right combination of climate financing with technology makes it possible to achieve breakthroughs in energy efficiency and carbon reductions and helps to promote a long-term economic revolution.

Economic Growth and Development

The relationship between environmental results and economic growth is an important aspect of climate finance research (Bai et al., 2022; Serda et al., 2024). Ali et al. (2024) employed the Environmental Kuznets Curve to show how green funding reduces emissions while encouraging the development of GDP in OECD-15 countries. Economic development and stability improve the distribution of green money for renewable projects (Bakhsh et al., 2024). Such studies show that climate financing and economic growth can complement each other in helping countries achieve sustainability without sacrificing their developmental objectives.

Climate Risk and Adaptation

An important element of climate financing is addressing climate risks and promoting adaptation strategies (Agbehadji et al., 2023; Muchiri et al., 2022). Monasterolo and de Angelis (2020) studied the effect of green financing on reducing risk exposure in high-vulnerability areas. Sadiq et al. (2024) highlighted how investments in clean energy technology facilitate financial markets adaptation to climate concerns. Based on these studies, green financing ensures resilience against future environmental challenges

as well as mitigating risks (Shang & Jin, [2023](#)). This is based on the double role it will play in the present and for the future climate change adaptation.

Conceptual Framework for Climate Finance

Since it enables adaptation and mitigation actions, climate finance is crucial in solving the world's climate crisis. A good number of reports on climate finance based on the UNFCCC framework (Bergsvik et al., [2024](#); Sautner et al., [2023](#)) reveal that the Paris Agreement focuses more on the issue of accountability and transparency in financial flows to achieve the 2°C global temperature goal (Monasterolo et al., [2020](#)). According to research, the transparency of global governance makes climate finance arrangements more effective and clearer.

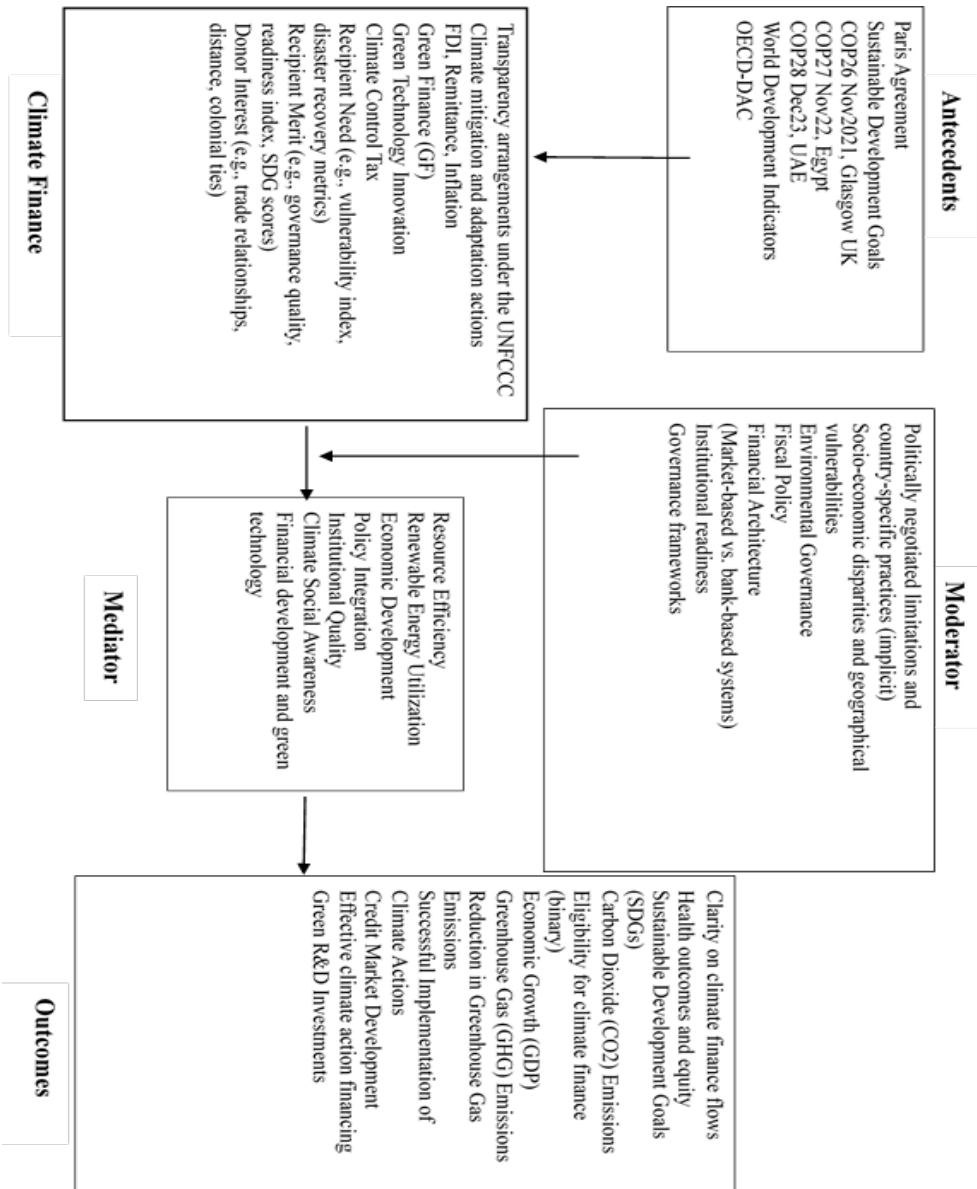
For the integration of climate finance into the international agenda, the structural framework of climate finance has been provided by the SDG's (Linnenluecke et al., [2020](#)). Climate finance also contributes significantly in affordable and clean energy (SDG-7) and in climate action (SDG-13) alongside providing support in economic growth and health equity for the achievement of socioeconomic goals (He et al., [2023](#)).

The distribution and application of climate funds are substantially influenced by the geopolitical environment (Du et al., [2023](#); Zhang, Mohsin, & Taghizadeh-Hesary, [2022](#)). Funding flows are influenced by donor-recipient dynamics, which include elements such as governance quality, geopolitical concerns, and past trade relationships (Zoungrana et al., [2024](#); Bakhsh et al., [2024](#)). This can be particularly noticed in green finance projects, especially when trade dependencies and colonial ties are among the uncertainties that make the process more complicated (Ali et al., [2024](#)). Other studies show that rich and poor countries differ in access to climate finance and, therefore, demand customised strategies to respond to regional vulnerabilities (Huang & Punzi, [2024](#)).

Innovations in technology and green finance are among the important forces driving climate action. Investment in green technologies, renewable energy, and environmental taxes has shown tangible reductions in emissions of greenhouse gases (Barwińska-Małajowicz et al., [2024](#)). The use of renewable energy and financial development has a positive impact on climate-friendly technologies based on econometric estimates (Ali et al., [2024](#)). Institutional capacity and preparedness of financial markets are also

significantly enhanced for effective climate finance (Nakouwo & Zhang, 2024).

Figure 9
Conceptual Framework



The effectiveness of climate money is tempered by governance frameworks and institutional preparedness. Strong fiscal and governance frameworks position nations to better utilize climate finance for adaptation and mitigation plans (Hsu & Schletz, [2024](#)). According to Bergsvik et al. ([2024](#)), the UNFCCC's transparency procedures enhance financial flow accountability and traceability, ensuring that monies are utilized for their intended purposes. Besides, it is crucial to find solution for green finance for SDGs among geopolitical tensions (Bakhsh et al., [2024](#)).

Despite great achievements, challenges still persist. The inability to meet the target, set by rich nations, of \$100 billion yearly for climate funding erodes trust and development among developing nations (Zoungrana et al., [2024](#)). These concerns require creative financial structures and greater global cooperation to bridge the current gaps (Boncheva & Delgado, [2024](#)).

Conclusion

Climate finance has attracted much attention from academic scholars around the world because of the growing concern regarding climate change and environmental sustainability. The main objective of this study was to analyze the development of climate finance research using a bibliometric methodology and content analysis. The importance of a novel bibliometric study on climate financing is not taken into account in current bibliometric research. The total articles selected for the bibliometric analysis based on the database of Scopus were 107. The selections were made considering various factors such as language, field of study, time period, and relevance to research. Compared to the concepts of green finance and environmental finance, climate finance has a different practical meaning and scope.

The findings indicate that research on climate finance began 15 years ago, and the UNFCCC 2010 conference accelerated the field's development. Furthermore, the results indicate that environmental sciences, environmental studies, business and management, and economics are the main scientific disciplines that contribute to climate finance. The results imply that climate finance research is more multidisciplinary in character than business finance literature. Germany, France, & China lead the world in climate finance research as per this analysis, with Japan and Austria following closely after. There isn't much study on climate finance coming from underdeveloped nations generally.

Energy Economics, Ecological Economics and International Organizations Research Journal are the three primary journals that publish on climate financing issues. The Journal of Ecological Economics and the Journal of Business Ethics have the most referenced articles, despite the fact that these journals lead in terms of published papers. With the exception of a small number from the US and the UK, the bulk of the influential and productive writers in the subject come from Italian, German and Chinese universities, according to the findings. Similarly, when it comes to co-authorship, the UK and China have the most active researchers, although USA has the some level of intellectual collaboration.

The use of bibliometric and content analysis techniques has significant limits, despite the fact that they offer insightful information. The use of Scopus might lead to geographical coverage bias or limited thematic coverage. It is possible that pertinent papers indexed in other databases, such as Web of Science or Google Scholar, were not included in the data collection because it was limited to the Scopus database from 2010 to 2024. This restriction could result in a less thorough portrayal of the subject, especially regarding new topics and local viewpoints. Furthermore, the worldwide application of findings may be limited due to the omission of noteworthy contributions in other languages depending solely on English-language publications.

The bibliometric analysis may ignore the qualitative richness and contextual subtleties of the research in favor of quantitative measures like co-authorship networks and citation patterns. Content analysis takes a lot of effort, especially when screening and synthesizing a large database (107 articles), even though it provides specific insights. Finding recurring patterns and themes is made more difficult by the selected research diverse approaches, terminologies, and scopes. Furthermore, because the topic of climate finance is still developing, some new areas might not yet have enough research to support climate action. These drawbacks emphasize the necessity of supplementary techniques to enhance the review results.

To advance the field, future studies ought to investigate the efficacy of blockchain-enabled smart contracts in reducing the 'transparency tax' associated with multilateral climate adaptation funds. Additionally, it is necessary to research the specific institutional barriers that prevent small and medium-sized enterprises (SMEs) in lower-middle-income countries (LMICs) from accessing climate bonds for green technology adoption.

Directions for Policymakers

The Policy makers, the UN, and parties of Paris Agreement should form a climate finance mechanism to raise funds for climate adaptation and move towards vulnerable regions such as Asia and Pacific countries. A realistic approach must be taken to not only track but ensure an equal distribution of climate funds in vulnerable regions to achieve SDG 13.

The local governments should also work on innovative ideas such as blockchain and climate finance instruments such as climate bonds and blended finance. Policy makers may also propose solutions that combine public funds with private contribution to scale-up climate finance in green infrastructure, renewable energy, urban infrastructure, sustainable agriculture, innovation and development, and climate resilient development.

For the sake of efficient management and transparency in climate finance, the power should be delegated to regional governance framework, specifically focusing on green policy. Policy makers may take advantage from Asian Development Bank (ADB), Asian Infrastructure Investment Bank (AIIB) to streamline climate financial flows.

The carbon credits schemes should be encouraged alongside other proposals such as green taxation, and subsidy reforms may also be raised to support fossil fuel consumption and green transportation by policy makers. Likewise, SMEs should be encouraged through grants and low-interest loans to adapt green practices for climate resilience.

Author Contribution

Muhammad Waqas: writing - original draft, data curation. **Shabana Naveed:** Writing – review & editing. **Rizwana Bashir:** supervision.

Conflict of Interest

The authors of the manuscript have no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

Data Availability Statement

The data associated with this study will be provided by the corresponding author upon request.

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