A Bibliometric Analysis of the Evolution and Diffusion of Climate Finance Literature

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Article Info

ABSTRACT

This study conducts a comprehensive bibliometric analysis to examine the intellectual structure, evolution, and diffusion of climate finance literature from 2000 to 2024. Drawing data from the Scopus database, the study applies co-authorship, citation, keyword co-occurrence, and country collaboration analyses using VOSviewer. The findings reveal that *climate finance* and *climate change* are central themes, anchoring an interdisciplinary knowledge network that encompasses economic, policy, justice, and innovation-related subfields. Temporal analysis shows a progression from early focus on emissions and treaties toward recent interest in green bonds, financial innovation, and climate risk. Key contributors and collaborative hubs are identified, with the United Kingdom, United States, and Germany emerging as dominant producers of climate finance scholarship. Despite growing global interest, the analysis highlights regional imbalances in research production and calls for more inclusive, equitable academic collaboration. This study provides valuable insights for future research and policy formulation by mapping the trajectory and scope of the climate finance discourse.

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1. INTRODUCTION

Over the past two decades, climate finance has emerged as a critical instrument in the global response to climate change. Defined broadly, climate finance refers to the financial resources allocated to support mitigation and adaptation initiatives that aim to reduce greenhouse gas emissions and manage the impacts of a changing climate [1]. The need for such financing stems from the recognition that climate change poses systemic risks to economies, societies, and ecosystems, and requires coordinated international efforts supported by substantial financial commitments. As articulated in key agreements such as the Paris Agreement, developed countries are expected to mobilize $100 billion annually to assist developing nations in addressing climate-related challenges [2]. This growing emphasis has elevated climate finance to a central topic in

both academic literature and global policymaking discussions.

The literature on climate finance has expanded significantly, reflecting its growing importance in the intersection of environmental economics, sustainable development, and global governance. Initial studies focused on conceptualizing climate finance and delineating its scope, often distinguishing between public and private flows, mitigation and adaptation targets, and domestic versus international channels [3]. Over time, the research has broadened to cover complex issues such as the effectiveness of financial mechanisms, the role of multilateral development banks, innovative instruments like green bonds, and equity considerations in climate finance allocation [4]. The increasing volume of research underscores the need for a comprehensive mapping of scholarly developments to better understand how the field has evolved and which themes dominate the discourse.

Despite the significant policy relevance of climate finance, the diffusion of related knowledge across disciplines and geographies has been uneven. While some scholars have examined the governance structures and institutional mechanisms that underpin climate finance, others have explored its implications for financial markets, climate risk disclosure, and corporate social responsibility [5], [6]. The interdisciplinary nature of the field has contributed to a fragmented knowledge base, where insights are dispersed across journals in economics, finance, political science, environmental studies, and international development. This diffusion, while enriching, also poses challenges for synthesizing the intellectual trajectory and identifying influential contributors, collaboration networks, and emerging subfields.

Recent advancements in bibliometric techniques have enabled systematic and quantitative assessments of scholarly literature, offering a robust approach to trace the evolution and diffusion of knowledge within a domain [7]. Bibliometric analysis allows researchers to uncover citation patterns, co-authorship structures, thematic clusters, and trends in publication output over time. In the context of climate finance, such an approach is particularly valuable in highlighting research hotspots, neglected areas, and influential works that have shaped the academic landscape. Furthermore, it aids in identifying regional or institutional disparities in knowledge production, thereby informing policy and research funding strategies.

The urgency of climate action, combined with the rising attention to financial mechanisms as enablers of sustainability transitions, underscores the importance of understanding how academic knowledge in this area has proliferated. Governments, investors, and multilateral institutions are increasingly reliant on research-based evidence to design effective climate finance frameworks. As a result, there is a growing demand for meta-level analysis that not only maps the contours of the climate finance literature but also provides strategic insights for future research directions. By integrating bibliometric tools with qualitative interpretation, scholars can provide a holistic view of the field's progression and impact.

Despite the proliferation of climate finance research, there remains a lack of comprehensive bibliometric studies that systematically trace its intellectual structure, key contributors, and thematic evolution over time. Much of the existing research is either conceptual or policy-focused, leaving a gap in meta-analytical assessments that can consolidate dispersed knowledge and reveal underlying patterns of scholarly influence, collaboration, and growth. Without such a synthesis, efforts to advance climate finance theory, practice, and policymaking may be hindered by duplication, fragmentation, or blind spots in the academic discourse. This study aims to conduct a comprehensive bibliometric analysis of the evolution and diffusion of climate finance literature from its inception to the present.

2. METHODS

This study employed a quantitative bibliometric approach to systematically analyze the evolution and diffusion of climate finance literature. The data were extracted from the Scopus database, one of the most comprehensive repositories of peer-reviewed academic publications. The search strategy was designed to capture relevant documents using the query terms "climate finance", "climate-related financial flows", and "green climate funding" within titles, abstracts, and keywords. The time frame was restricted to publications from 2000 to 2024 to capture the growth of the field in alignment with global climate policy developments. Only articles, conference papers, and reviews written in English were included to ensure quality and consistency. After initial retrieval, the data were manually cleaned to eliminate duplicates, incomplete records, and irrelevant documents. The final dataset was exported in RIS format and analyzed using VOSviewer (version 1.6.x), a widely used software for constructing and visualizing bibliometric networks. The analysis focused on four key components: (1) co-authorship analysis to explore collaboration patterns among authors, institutions, and countries; (2) citation analysis to identify highly cited documents and influential contributors; (3) keyword co-occurrence analysis to detect dominant research themes and thematic clusters; and (4) temporal mapping to trace the diffusion and evolution of topics over time. A minimum threshold of five keyword occurrences was applied in the co-word analysis to ensure robustness while reducing noise. All network visualizations, including density and cluster maps, were interpreted qualitatively to provide insights into the intellectual and structural development of the climate finance literature.

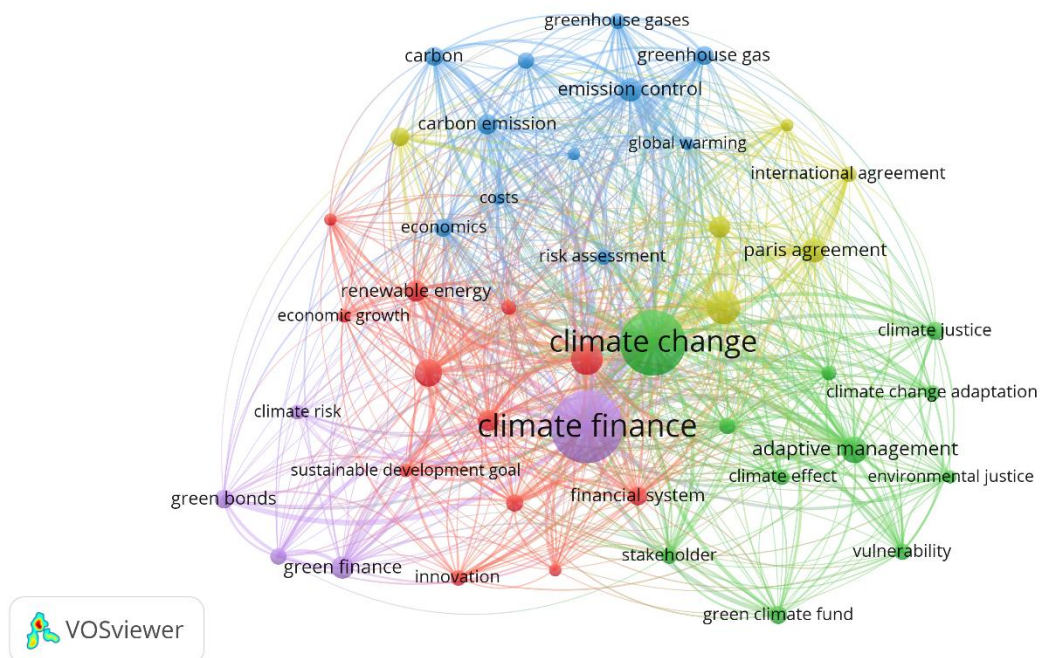## 3. RESULTS AND DISCUSSION

3.1 Keyword Co-Occurrence Network

Figure 1. Network Visualization
Source: Data Analysis Result, 2025

The keyword co-occurrence visualization provides a comprehensive overview of the thematic structure within the climate finance literature. At the center of the

map, the terms *climate finance* and *climate change* dominate as the most frequently co-occurring keywords, indicating their foundational role in the field. Their large node size and central position reflect high frequency and centrality in the network, meaning that much of the literature revolves around the interconnection between financial mechanisms and climate policy frameworks. This also confirms the tight coupling between economic interventions and environmental imperatives in contemporary scholarly discourse. Surrounding these central terms are multiple distinct clusters representing thematic subfields. The red cluster, positioned to the left, includes terms like *renewable energy*, *economic growth*, *climate risk*, and *economics*. This cluster reflects the economic and developmental dimensions of climate finance, emphasizing how investments in renewable technologies, sustainable development goals, and climate-related risks are framed in terms of macroeconomic and growth-related outcomes. It indicates that one major stream of literature analyzes how climate finance interacts with long-term economic trajectories and energy transition policies.

The green cluster to the right brings together terms such as *climate change adaptation*, *climate justice*, *environmental justice*, and *vulnerability*. This reflects a socio-environmental orientation in the literature, focusing on equity, resilience, and the impacts of climate change on marginalized communities. The presence of *adaptive management* and *green climate fund* suggests scholarly attention to institutional mechanisms that aim to make climate finance more inclusive and effective in addressing regional vulnerabilities and adaptation needs. In the upper section of the map, the blue and yellow clusters indicate a more policy and science-driven subset of the literature. Keywords like *greenhouse gas*, *carbon emission*, *emission control*, and *global warming* (blue cluster) highlight the scientific basis of climate interventions, often rooted in environmental science and mitigation technologies. Meanwhile, the yellow cluster—with terms such as *international agreement*, *paris agreement*, and *risk assessment*—points to the governance and regulatory aspect of climate finance. This shows that another significant body of research explores how international frameworks, treaties, and risk models guide and constrain the implementation of climate finance policies.
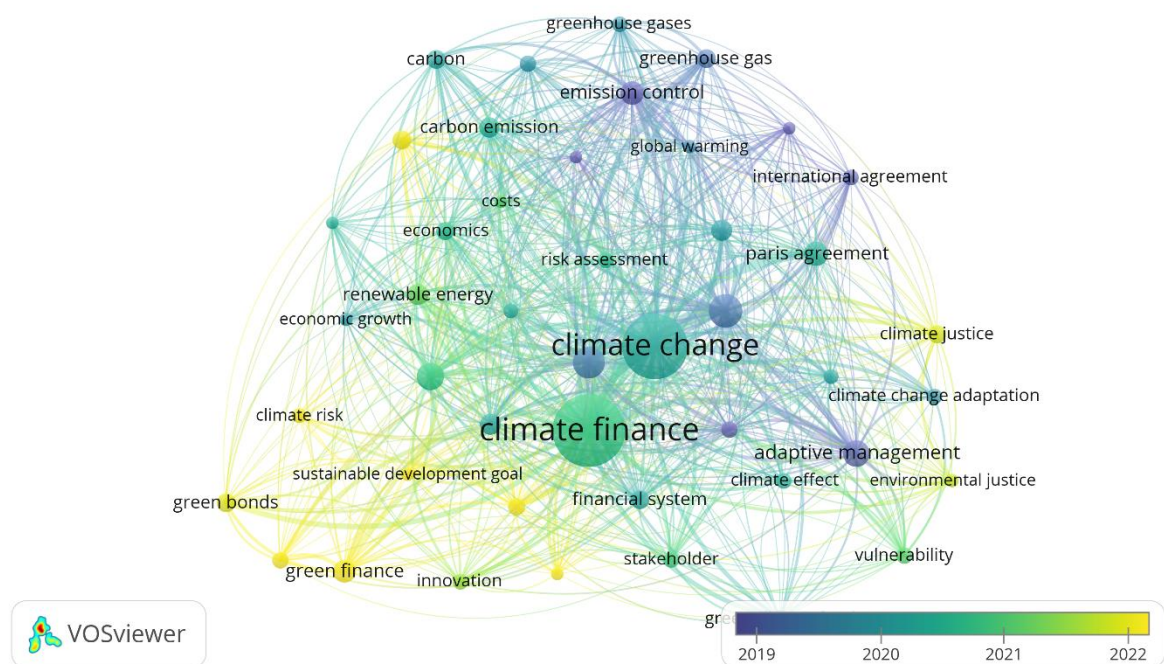
Figure 2. Overlay Visualization
Source: Data Analysis Result, 2025

The overlay visualization maps the temporal evolution of keywords in the climate finance literature from 2019 to 2022, using a color gradient from purple (older) to yellow (newer). Central terms such as "climate finance" and "climate change" appear in green, indicating that their prevalence has been sustained throughout the entire period, particularly around 2020. These terms represent the core of the field, anchoring a wide network of related topics and remaining consistently relevant over time. Their green hue also reflects a steady production of literature that continues to draw on these foundational concepts. Emerging themes are highlighted in yellow, such as "green finance", "innovation", "green bonds", and "climate risk". These newer terms suggest a recent shift in scholarly interest toward market-based mechanisms and financial instruments designed to support sustainability transitions. The prominence of these keywords in the outer periphery indicates that they are gaining attention as the field evolves to include private sector engagement and innovative tools to mobilize climate-related investments. This trend underscores a growing integration of climate finance with broader economic modernization and risk management strategies. In contrast, older keywords shown in blue and purple—such as "global warming", "greenhouse gas", "carbon emission", and "international agreement"—indicate earlier scholarly focus areas rooted in climate science and policy frameworks like the Paris Agreement. These topics formed the initial foundation upon which the climate finance discourse was built, emphasizing mitigation and regulatory coordination.
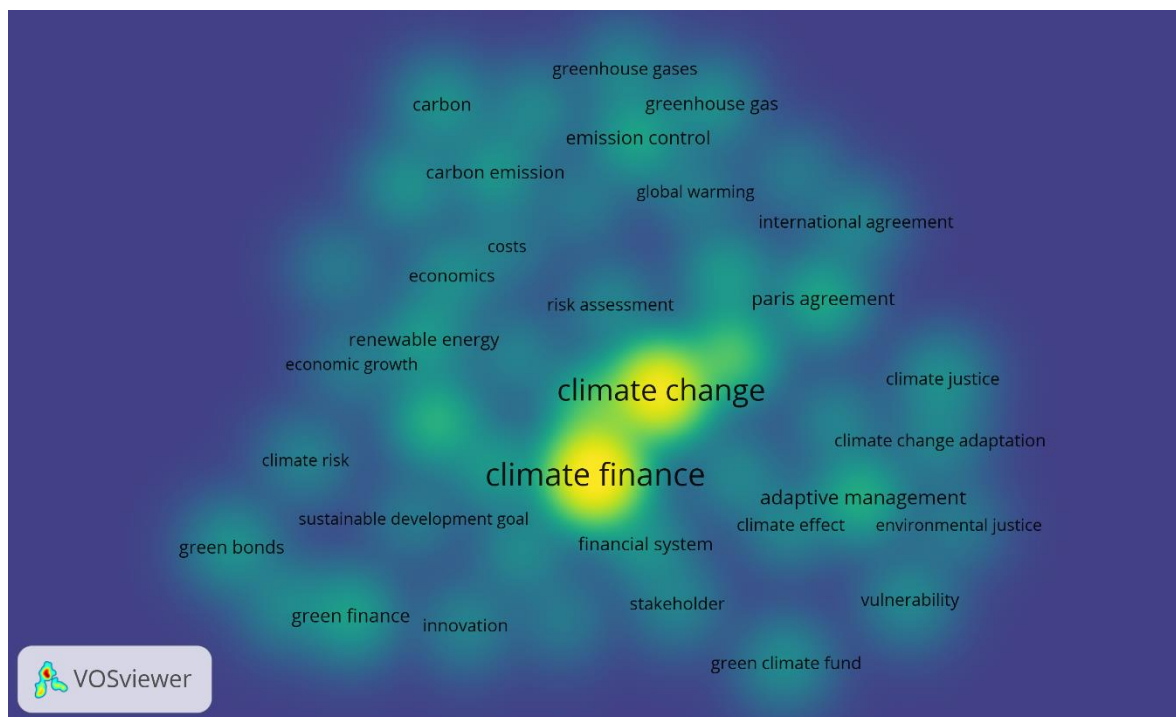

Figure 3. Density Visualization
Source: Data Analysis, 2025

The heatmap visualization illustrates the frequency and intensity of keyword occurrences in the climate finance literature. Central terms such as "climate finance" and "climate change" are shown in bright yellow, indicating their high density and dominant presence across the corpus. These keywords serve as the thematic anchors of the field,

around which a significant portion of research activity is concentrated. Their centrality and intensity affirm their foundational role in structuring the discourse, with numerous studies exploring their intersections, implications, and policy relevance. Surrounding the core are secondary clusters of moderate intensity—represented in green—including terms like "renewable energy", "green finance", "financial system",

"climate risk", and "Paris Agreement". These terms signify thematic subfields that, while not as dominant as the core, still represent active areas of scholarly engagement. Meanwhile, peripheral terms such as "green climate fund", "stakeholder", and "adaptive management" appear in cooler shades (blue/green), suggesting less frequent usage but potential for growth.
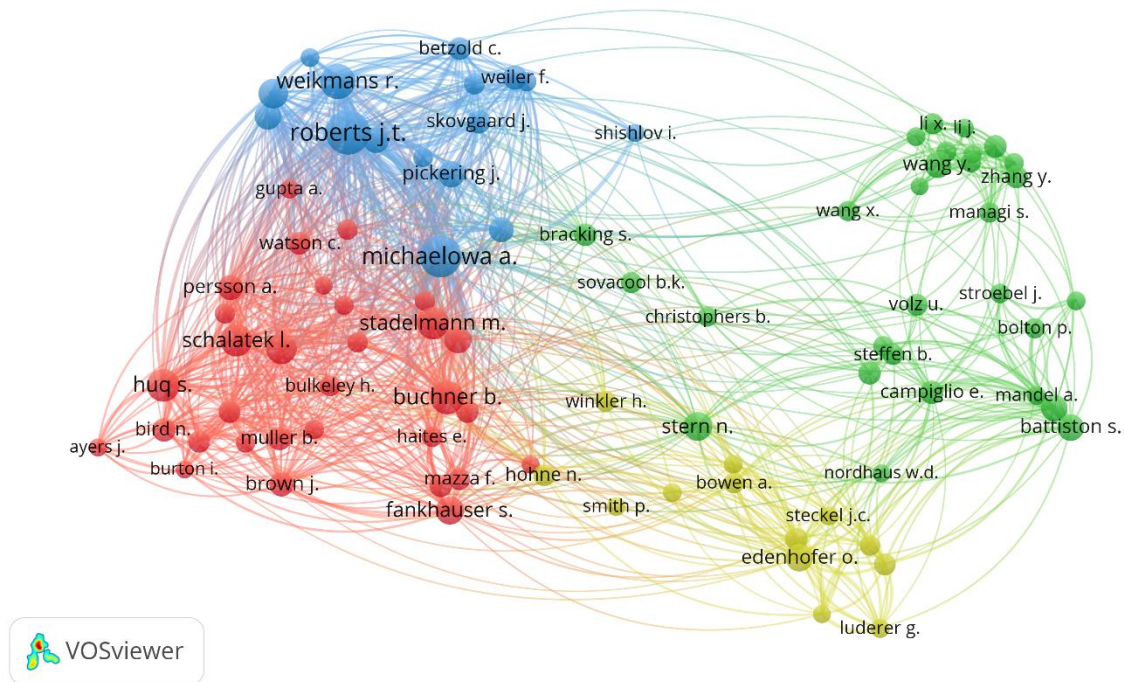
3.2 Co-Authorship Network

Figure 4. Author Collaboration Visualization
Source: Data Analysis, 2025

The co-authorship network visualization reveals distinct clusters of collaboration among scholars in the field of climate finance. Central figures such as michaelowa a., roberts j.t., and buchner b. occupy pivotal positions, bridging multiple research communities. The red cluster, anchored by authors like schalatek l., huq s., and stadelmann m., reflects a highly interconnected group focused on governance, equity, and adaptation. The blue cluster, led by roberts j.t. and weikmans r., appears to emphasize institutional and international climate negotiations. In contrast, the green

cluster, featuring li x., wang y., and campiglio e., represents a technically inclined group likely focused on finance, economics, and quantitative modeling. Finally, the yellow cluster—with key nodes such as stern n., edenhofer o., and nordhaus w.d.—signifies a policy-economics domain, often cited for foundational work in climate economics. The strong intra-cluster and moderate inter-cluster links suggest both disciplinary specialization and cross-field collaboration, highlighting the multidimensional nature of climate finance research.
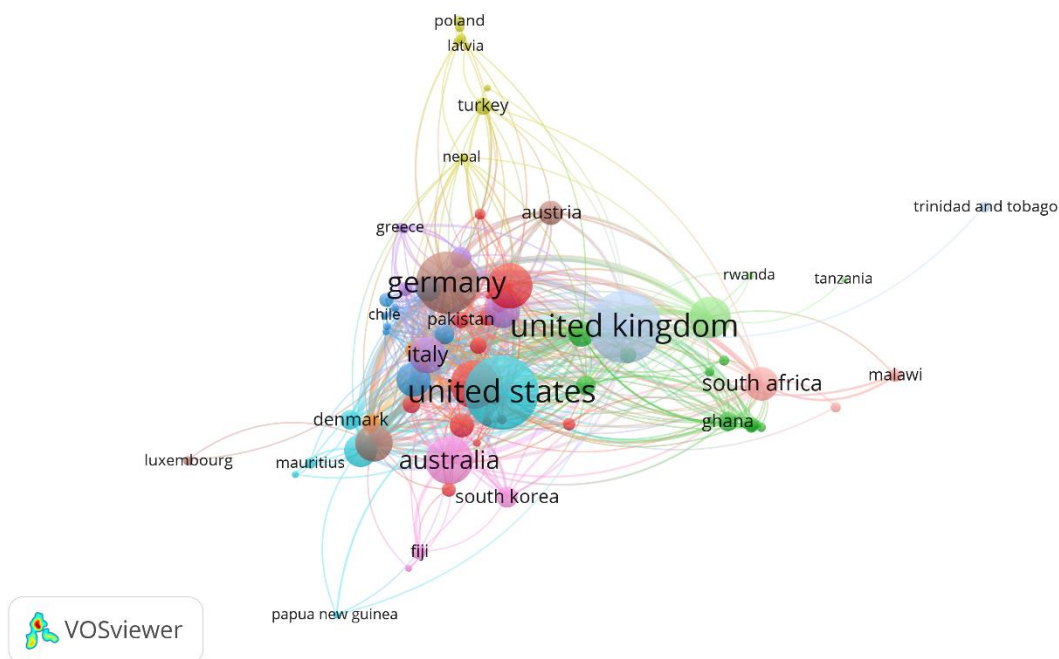
Figure 5. Country Collaboration Visualization
Source: Data Analysis, 2025

The country-level co-authorship network visualization reveals that the United Kingdom, United States, and Germany are the most central and collaborative nations in climate finance research, as indicated by their large node sizes and dense connections. These countries act as major hubs, maintaining strong bilateral and multilateral research ties with both developed and developing nations.

The network also shows active involvement from countries like Australia, Italy, South Africa, and Pakistan, which serve as regional bridges linking various research clusters. Notably, while some countries like South Korea, Turkey, and Ghana show moderate integration, others such as Malawi, Trinidad and Tobago, and Papua New Guinea appear on the periphery with limited collaborations.

3.3 Citation Analysis

Table 1. Top Cited Research

Citations	Authors and year	Title
514	[8]	Influencing behaviour: The mindspace way
454	[9]	A bibliometric analysis on green finance: Current status, development, and future directions
385	[10]	Food Security and the Dynamics of Wheat and Maize Value Chains in Africa and Asia
365	[11]	Role of information and communication technologies and innovation in driving carbon emissions and economic growth in selected G-20 countries
354	[12]	Globalization and carbon emissions: Is there any role of agriculture value-added, financial development, and natural resource rent in the aftermath of COP21?
282	[13]	A review of Africa's transition from fossil fuels to renewable energy using circular economy principles
270	[1]	Climate Finance

Citations	Authors and year	Title
252	[14]	How do policies mobilize private finance for renewable energy?—A systematic review with an investor perspective
243	[15]	Low-carbon transition risks for finance
238	[16]	Multivariate non-normally distributed random variables in climate research - Introduction to the copula approach

Source: Scopus, 2025

Discussion

The findings of this bibliometric analysis reveal a dynamic and rapidly evolving field at the intersection of climate change and finance. The dominance of terms such as *climate finance* and *climate change* across all visualizations reflects their central role in the scholarly discourse. These keywords act as conceptual anchors around which diverse research themes—ranging from mitigation strategies and renewable energy investments to adaptive management and climate justice—have been structured. Their co-occurrence with policy-specific terms like *Paris Agreement* and *green climate fund*, as well as with instruments such as *green bonds* and *financial systems*, indicates a broad and interdisciplinary expansion of the literature. This expansion aligns with the real-world urgency to mobilize capital for climate action and reflects how scholars have responded by building frameworks, mechanisms, and metrics to support financing transitions to sustainability.

The thematic clusters from the keyword co-occurrence network provide valuable insight into the intellectual organization of the field. The red cluster, centered on *renewable energy, economic growth, climate risk*, and *sustainable development goals*, points to a strand of literature focused on developmental economics and the macro-financial impact of climate policies. This is complemented by the green cluster, which concentrates on *climate change adaptation, climate justice*, and *environmental justice*, reflecting growing concerns about equity, vulnerability, and the socio-political ramifications of climate finance allocation. The blue cluster focuses on the science-policy interface, covering topics like *greenhouse gas, emission control*, and *global warming*,

underscoring the foundational scientific basis from which climate finance policy derives legitimacy and targets. Finally, the yellow and purple nodes associated with *green finance, innovation*, and *stakeholder engagement* suggest emerging paradigms that emphasize market-driven, participatory, and innovative solutions to climate challenges.

The overlay visualization further refines this thematic understanding by illustrating the temporal evolution of keyword prominence. Terms like *green finance, green bonds, innovation*, and *climate risk* appear in yellow, indicating their relative novelty and growing popularity since 2021. These newer keywords signal an epistemic shift from traditional, policy-heavy analyses to research focusing on financial innovation and private sector engagement. Their positioning at the periphery of the network reflects the exploratory nature of this research frontier. In contrast, earlier terms like *carbon emission, global warming*, and *international agreement* appear in darker shades, showing they were dominant in earlier phases of climate finance discourse. This suggests a trajectory in which foundational environmental concerns have gradually been integrated with pragmatic and applied financial strategies, pointing toward a maturation of the field.

The heatmap visualization confirms these trends by highlighting areas of high research density. The brightest spots appear around *climate finance, climate change*, and closely related terms such as *financial system, renewable energy*, and *sustainable development goal*. This concentration reflects the sustained academic interest in topics that align closely with global climate policy frameworks such as the United Nations Sustainable Development Goals (SDGs) and the Paris Agreement. The

more muted but still active zones on the periphery—such as *vulnerability*, *stakeholder*, and *adaptive management*—indicate niche but growing areas of research that are likely to expand as the field embraces more community-based and inclusive approaches to finance.

At the author level, the co-authorship network reveals several influential figures who act as intellectual nodes within the field. Authors like Michaelowa A., Buchner B., Roberts J.T., and Stern N. are shown to be highly central, not only through the frequency of citations but also through their collaborative ties across clusters. These researchers have significantly shaped various subfields, from the economics of climate change to governance structures and financial flows. The clustering of authors also reflects epistemic communities: the red cluster tends to focus on political economy and adaptation, the green cluster on financial risk modeling and macroeconomic structures, and the blue cluster on institutional frameworks and climate diplomacy. These communities are interlinked but also retain some disciplinary boundaries, highlighting both the interdisciplinary and segmented nature of climate finance research.

The country-level co-authorship map further illustrates the global distribution of knowledge production. The United Kingdom, United States, and Germany dominate the landscape, not only in terms of publication volume but also through extensive international collaborations. Their central position underscores their role as intellectual and funding hubs in global climate finance research. Other notable contributors include Australia, Italy, and South Africa, each playing important roles in linking North–South collaborations. Interestingly, countries like Pakistan, Ghana, and Nepal appear within the network, albeit with lower node sizes, indicating the rising involvement of Global South nations in contributing local insights and empirical evidence. Nevertheless, peripheral countries like Malawi, Trinidad and Tobago, and Papua New Guinea show limited integration,

suggesting persistent inequalities in academic participation that mirror global imbalances in financial flows and research capacity.

Taken together, the authorial and national collaboration networks emphasize the importance of cooperative research ecosystems. High connectivity within and across clusters enhances the diffusion of ideas, fosters interdisciplinary innovation, and helps align scholarly outputs with practical climate finance needs. However, the networks also point to areas requiring attention—particularly in promoting the inclusion of underrepresented regions and integrating more diverse perspectives into the scholarly conversation. Capacity-building initiatives, joint funding mechanisms, and equitable data-sharing platforms could support a more democratized and globally relevant climate finance literature.

From a strategic perspective, this bibliometric analysis offers several implications for both academia and policy. For researchers, the findings highlight key themes and potential gaps in the literature. For instance, while mitigation and financial innovation are well-covered, areas like climate justice, indigenous perspectives, and localized adaptation strategies remain less explored. These underdeveloped areas present fertile ground for future studies. For policymakers, the bibliometric maps can serve as navigational tools to identify leading thinkers, institutional hubs, and research hotspots to inform evidence-based policy formulation. Moreover, understanding the temporal trends and thematic shifts in academic focus can help align funding priorities and research agendas with emerging global needs.

4. CONCLUSION

This bibliometric study provides a comprehensive overview of the evolution, thematic structure, and diffusion patterns of the climate finance literature from 2000 to 2024. The analysis highlights the centrality of climate finance and climate change as foundational themes, around which various

subfields such as green finance, adaptation strategies, climate justice, and financial innovation have developed. The temporal visualization shows a clear shift from foundational environmental and policy concerns toward more recent emphases on risk, finance mechanisms, and private-sector engagement. Co-authorship and country-level collaborations reveal that academic output is concentrated in developed countries, particularly the United Kingdom, the United States, and Germany, although emerging contributions from the Global South are increasingly evident. Despite the field's growth, challenges remain in addressing regional disparities and integrating underrepresented voices into the discourse. Future research should prioritize interdisciplinary approaches, amplify localized perspectives, and explore underdeveloped but essential themes such as community finance, social equity, and behavioral finance for climate resilience. The insights offered by this bibliometric mapping serve as a guidepost for scholars, institutions, and policymakers seeking to deepen their engagement with the complex, rapidly evolving landscape of climate finance.

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