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Exploring the Bibliometric Landscape of Biodiversity Finance: Integrating Nature into Financial Risk Assessment

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ABSTRACT

The accelerating biodiversity crisis has prompted a paradigm shift in the financial sector, where integrating nature into financial risk assessment is becoming increasingly vital. This study conducts a comprehensive bibliometric analysis to explore the intellectual landscape of biodiversity finance, focusing on how biodiversity is being incorporated into financial theory, investment practices, and sustainability governance. Using the Scopus database and VOSviewer software, the study analyzes co-occurrence networks, temporal trends, density visualizations, and collaboration patterns among authors, institutions, and countries. The findings reveal that "biodiversity," "finance," and "sustainable finance" serve as conceptual anchors, while emerging themes such as "decentralized finance," "green bonds," and "ESG" indicate growing innovation in the field. The United Kingdom and United States lead global collaborations, with strong linkages to European and Asian institutions. This research contributes theoretically by clarifying the field's multidimensional evolution and practically by identifying knowledge gaps and strategic entry points for policy, investment, and academic advancement. Limitations include database coverage and lack of qualitative content analysis, suggesting future research directions. Overall, the study underscores the critical role of interdisciplinary collaboration in advancing biodiversity-aligned financial systems.

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1. INTRODUCTION

The accelerating biodiversity crisis has emerged as one of the defining challenges of the twenty-first century [1]. Scientific assessments, including the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), have highlighted unprecedented rates of species extinction, habitat loss, and ecological degradation. These declines not only endanger ecosystems but also threaten the very foundation of global economies, as biodiversity underpins food security, water regulation, climate stability, and public health. While climate change has long dominated discussions of environmental risks, biodiversity is now increasingly recognized as an equally urgent systemic issue [2], [3]. The integration of biodiversity

considerations into financial decision-making has, therefore, become essential for aligning economic systems with ecological sustainability [4].

Parallel to these ecological concerns, the financial sector is undergoing profound transformation in how it assesses and manages risks. Traditional financial risk frameworks have centered on macroeconomic fluctuations, credit and market risks, and geopolitical instability [5]. Yet these frameworks have often underestimated the systemic risks posed by ecological degradation. As awareness of nature-related risks grows, a new paradigm has emerged. This field encompasses financial instruments, investment strategies, and policy mechanisms that channel capital toward the conservation and sustainable use of biodiversity, while also embedding nature into broader risk assessment. The shift reflects an acknowledgment that biodiversity is not a peripheral issue but rather integral to long-term financial stability [6].

Globally, biodiversity finance initiatives have expanded through both public and private mechanisms. Multilateral development banks, sovereign green bonds, biodiversity credits, and blended finance models are being deployed to address financing gaps in conservation. At the same time, investors are increasingly demanding disclosure standards that capture nature-related risks [7]. The launch of the Taskforce on Nature-related Financial Disclosures (TNFD) in 2021 exemplifies the movement to establish frameworks that enable financial institutions to identify, assess, and report biodiversity-related risks and opportunities. These initiatives signal a growing consensus that mainstream finance must integrate biodiversity into its core operations if sustainable development goals are to be realized [8].

Despite this momentum, the research landscape on biodiversity finance remains fragmented. Studies span multiple disciplines yet often operate in silos. Some research emphasizes the ecological valuation of ecosystem services, others focus on financial instruments like green bonds, while still others examine regulatory frameworks and disclosure standards. This fragmentation creates challenges for policymakers, investors, and scholars who seek a comprehensive understanding of how biodiversity can be integrated into financial systems. The lack of systematic mapping of knowledge domains has constrained the field's conceptual clarity and hindered the translation of research into practice.

Bibliometric analysis provides a powerful tool to address these challenges [9]. By mapping the intellectual structure of biodiversity finance, bibliometrics can reveal the thematic clusters, intellectual roots, and emerging trends that define the field. Such analysis is not merely descriptive but also strategic: it can highlight research gaps, guide funding priorities, and support the design of financial innovations that effectively integrate biodiversity into risk assessment. In light of the complexity of biodiversity finance, a bibliometric perspective is timely and necessary to consolidate knowledge, identify synergies across disciplines, and chart future directions.

Although biodiversity finance has gained visibility in global policy and financial discourse, the academic landscape remains underexplored and lacks systematic synthesis. Existing studies are dispersed across domains and journals, making it difficult to discern overarching patterns of knowledge production. Moreover, while climate finance has been extensively mapped and theorized, biodiversity finance has yet to receive comparable attention in bibliometric research. This absence of a consolidated overview limits the ability of scholars and practitioners to assess how biodiversity considerations are being embedded into financial risk assessment, what conceptual frameworks dominate the discourse, and where future research should be directed. Without such mapping, the field risks remaining fragmented, potentially undermining its capacity to inform robust financial governance and effective conservation strategies. The objective of this study is to explore the bibliometric landscape

of biodiversity finance with a specific focus on its integration into financial risk assessment.

2. METHODS

This study employed a bibliometric analysis approach to systematically examine the scholarly landscape of biodiversity finance, with a particular focus on its integration into financial risk assessment. Bibliometric analysis is a quantitative method that utilizes publication and citation data to identify trends, patterns, and structural relationships within academic literature. This approach was chosen to capture the multidisciplinary nature of biodiversity finance and to reveal the evolution of its intellectual foundations across time. By applying bibliometric techniques, the study aimed to map thematic clusters, co-authorship networks, and keyword co-occurrences to understand how the topic has developed and where critical research gaps remain.

The data for this analysis were sourced from the Scopus database, which was selected for its comprehensive coverage of peer-reviewed journals across disciplines relevant to biodiversity finance, including environmental science, economics, business, and sustainability studies. The search query included combinations of keywords such as "biodiversity finance," "nature-related financial risks," "ecosystem services valuation," and "financial risk assessment," and was limited to publications in English between 2000 and 2025. The initial dataset was refined by filtering for journal articles and reviews to ensure academic rigor. Duplicate records, non-research articles, and irrelevant documents were excluded through manual screening based on abstracts and titles.

The bibliometric analysis was conducted using VOSviewer, a specialized software tool for constructing and visualizing bibliometric networks. Three main analytical techniques were applied: co-authorship analysis to identify collaboration patterns among authors and institutions; co-citation analysis to uncover the foundational literature shaping the field; and keyword co-occurrence analysis to detect dominant themes and emerging topics. Visualizations generated by VOSviewer allowed for the identification of research clusters and the mapping of temporal trends in publication activity.

3. RESULTS AND DISCUSSION

3.1 Keyword Co-Occurrence Network

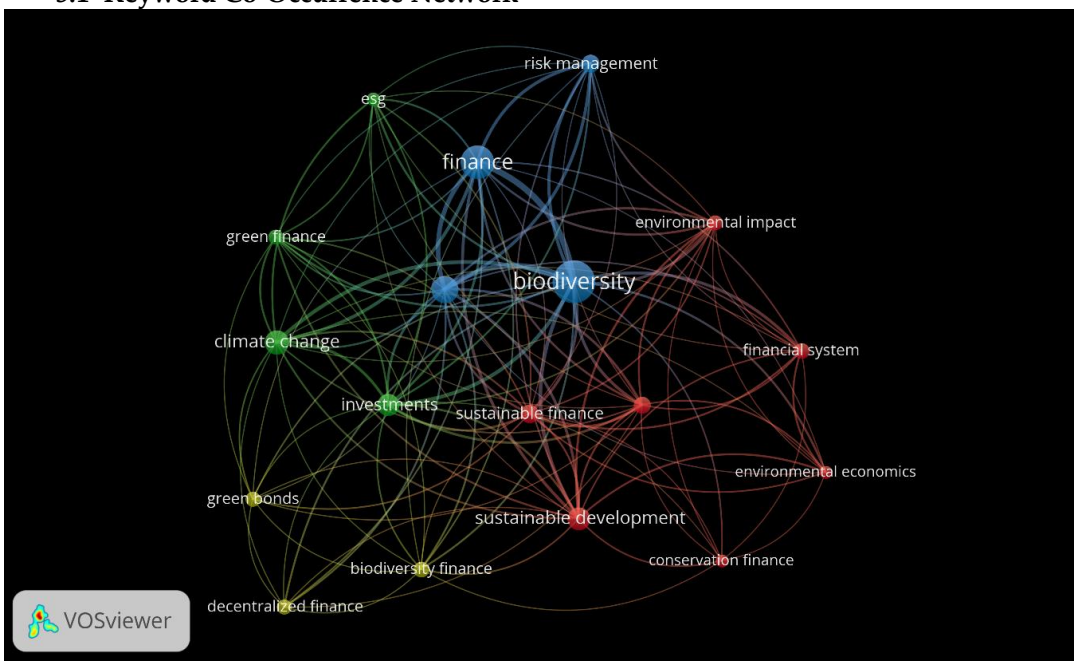

Figure 1. Network Visualization

Source: Data Analysis Result, 2025

Figure 1 reveals a highly interconnected and interdisciplinary structure where the core concept of "biodiversity" anchors the entire map. This central node, colored in blue, is directly linked with keywords such as "finance," "sustainable finance," and "risk management," suggesting that biodiversity is increasingly being treated as a critical dimension of financial decision-making. The strength and thickness of the connecting lines (edges) between "biodiversity" and these terms highlight the scholarly emphasis on integrating ecological considerations into economic frameworks, especially through the lens of financial risk, capital allocation, and sustainability transitions.

The blue cluster, which includes "finance," "risk management," "environmental impact," and "financial system," represents the financial governance dimension of biodiversity finance. This grouping illustrates how biodiversity is being conceptualized within the financial risk discourse. The proximity between "biodiversity," "finance," and "risk management" indicates a growing interest in quantifying and mitigating nature-related financial risks, particularly in response to frameworks such as the Taskforce on Nature-related Financial Disclosures (TNFD). Additionally, the connection to "environmental impact" and "financial system" suggests that biodiversity loss is not only seen as an ecological crisis but also as a potential systemic risk to the stability of markets and institutions.

On the left side of the map, the green cluster encompasses terms like "climate change," "green finance," "ESG," "green bonds," "decentralized finance," and "investments." This cluster reflects a sustainability investment orientation, where biodiversity finance is aligned with broader environmental, social, and governance (ESG) practices. The close linkage between "green bonds" and "biodiversity finance" indicates that these instruments are being utilized to mobilize capital for conservation and ecosystem restoration. Furthermore, the presence of "decentralized finance" points to emerging innovation in fintech and blockchain solutions that could be leveraged to democratize biodiversity-related funding mechanisms.

Meanwhile, the red cluster highlights the development economics perspective of biodiversity finance, with terms such as "sustainable development," "conservation finance," and "environmental economics." These terms suggest a policy-oriented and macroeconomic framing, where biodiversity is positioned within sustainable development agendas and conservation-focused funding schemes. The intersection between "sustainable finance" and both the financial and development clusters reflects its role as a bridging concept—linking institutional finance to planetary boundaries and developmental goals. This convergence reinforces the idea that biodiversity finance operates at the intersection of environmental justice, economic development, and financial innovation.

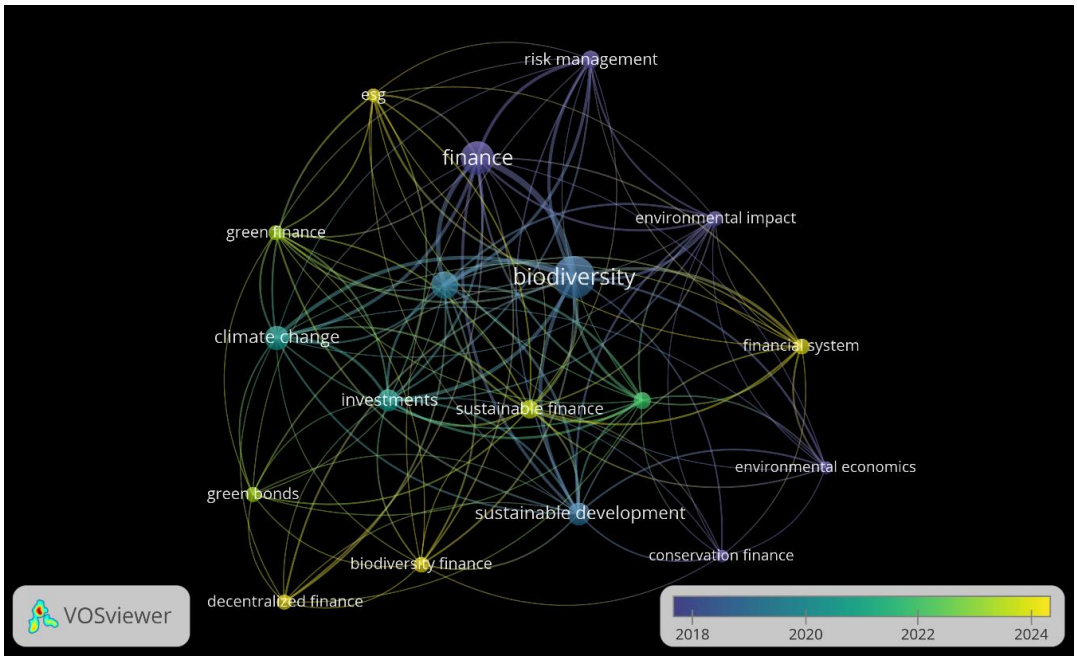

Figure 2. Overlay Visualization

Source: Data Analysis Result, 2025

Figure 2 illustrates the temporal evolution of biodiversity finance research, as indicated by the color gradient from blue (older, ~2018) to yellow (more recent, ~2024). Central nodes like "biodiversity," "finance," and "sustainable finance" are shaded light blue, suggesting that they have been foundational topics in the field since its early stages. These core concepts formed the backbone of biodiversity finance discourse, focusing on aligning ecological sustainability with financial frameworks. Their strong centrality and extensive interlinkages with surrounding terms also confirm their status as the primary convergence points of multidisciplinary research efforts. Newer topics, highlighted in yellow such as "biodiversity finance," "decentralized finance," "green bonds," "ESG," and "financial system" reflect the emerging frontiers of scholarly and policy attention. The bright yellow color of "biodiversity finance" indicates that this exact phrase has gained momentum only in more recent years, likely due to increasing institutional attention (e.g., TNFD, CBD finance targets) and the demand for dedicated financial instruments for biodiversity protection. Similarly, terms like "decentralized finance" and "ESG" reflect innovations in fintech and corporate governance that are pushing biodiversity finance into more practical, measurable, and investment-grade formats. Moreover, the outer nodes such as "environmental impact," "environmental economics," and "conservation finance" retain darker or bluish hues, implying that while these concepts are important, they may not have experienced the same recent surge in scholarly attention. This suggests a shift in focus from traditional environmental economics toward more market-oriented and investment-driven frameworks

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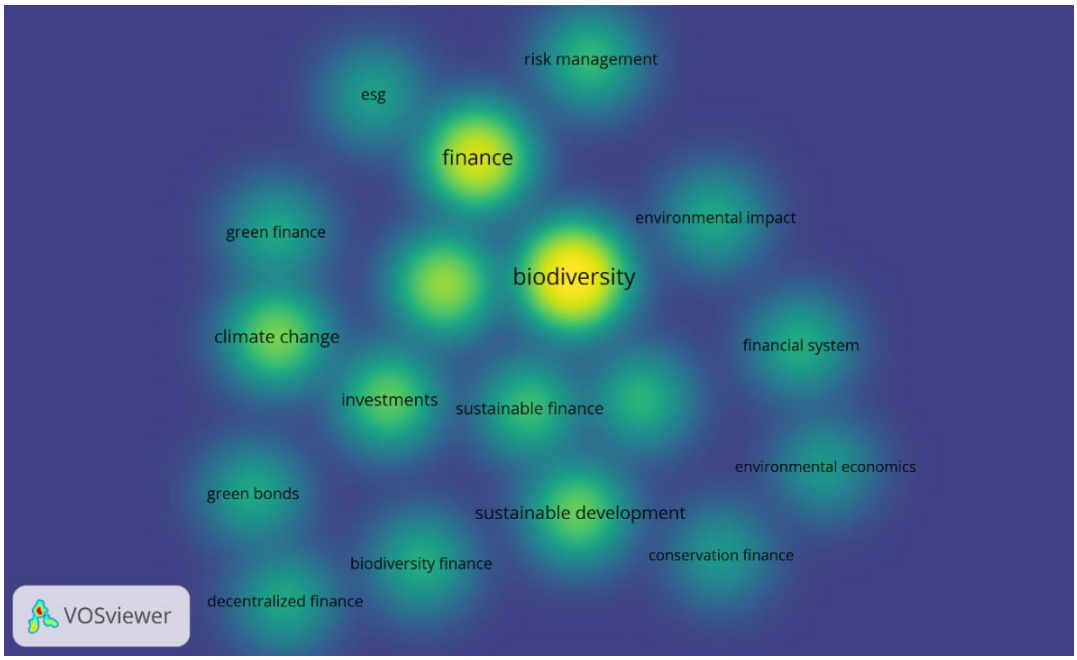

Figure 3. Density Visualization
Source: Data Analysis, 2025

Figure 3 above highlights the concentration of research activity in the field of biodiversity finance, with brighter yellow areas indicating higher publication and co-occurrence intensity. The terms "biodiversity" and "finance" are the most central and densely connected, indicating their dominant role in the literature. The brightness surrounding these terms suggests that they are not only frequently studied independently but are also frequently discussed together and marking a strong convergence of ecological and financial discourse. The neighboring density of "sustainable finance" and "investments" also reflects the mainstreaming of biodiversity concerns within capital allocation and sustainable investment frameworks.

Surrounding nodes such as "climate change," "green finance," "risk management," and "sustainable development" show moderate density, suggesting their significant—though slightly less central—role in the thematic structure. Meanwhile, terms like "biodiversity finance," "decentralized finance," and "conservation finance" appear in lower-density zones, indicating either emerging areas of research or underdeveloped subfields. This distribution suggests that while core discussions have formed around biodiversity's financial implications, there remains room for deepening inquiry into more specialized and innovative mechanisms such as biodiversity credits, decentralized mechanisms, and conservation-linked finance tools.

3.2 Co-Authorship Network

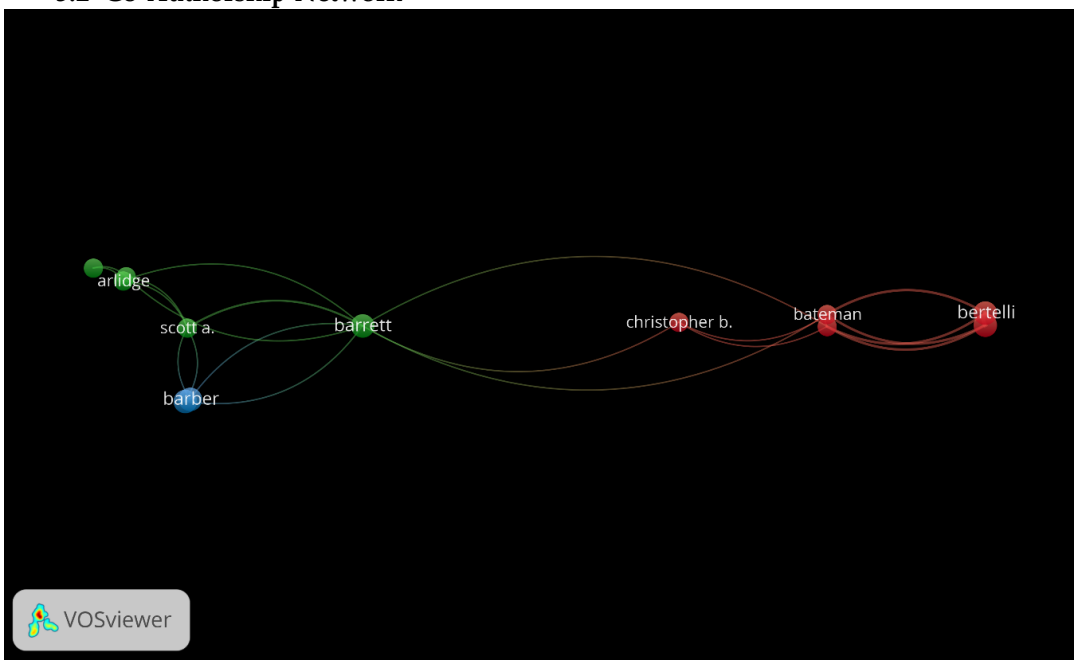

Figure 4. Author Collaboration Visualization
Source: Data Analysis, 2025

Figure 4 reveals two main collaborative clusters in the field of biodiversity finance, connected through a central bridging author, Barrett. On the left, a cluster composed of authors such as Arlidge, Scott A., and Barber (in green and blue) indicates close-knit collaborations focused on shared research themes, likely within ecosystem valuation or conservation finance. On the right, another prominent cluster includes Christopher B., Bateman, and Bertelli (in red), suggesting a separate but interlinked research stream, possibly oriented toward environmental economics or policy evaluation.

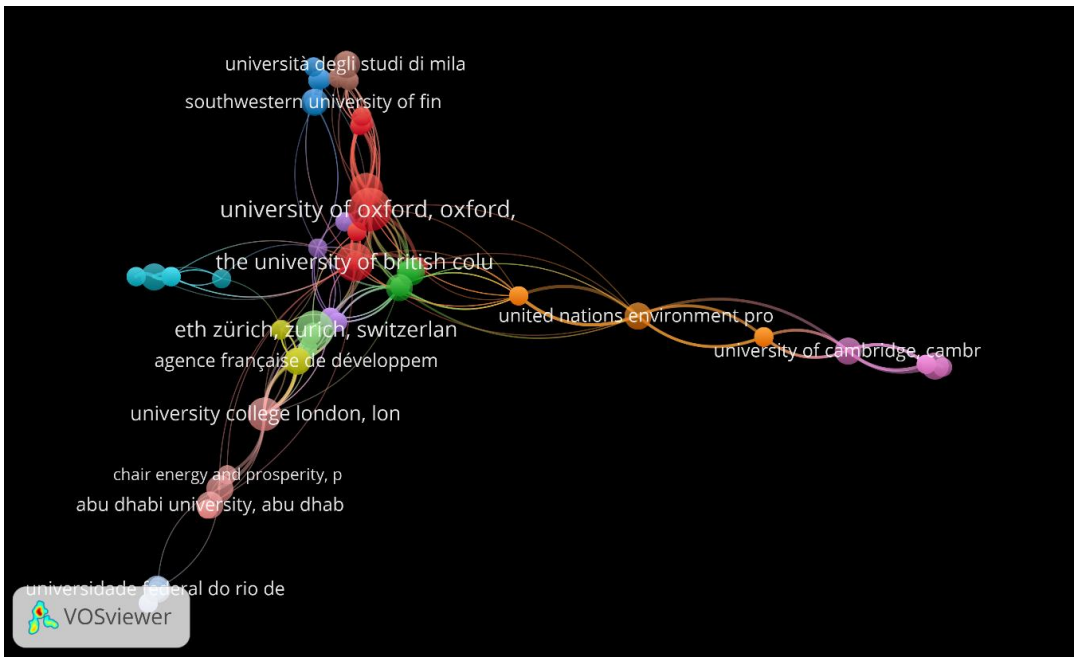

Figure 5. Affiliation Collaboration Visualization
Source: Data Analysis, 2025

Figure 5 reveals a vibrant and globally distributed collaboration structure in biodiversity finance research. The University of Oxford emerges as the central hub, closely connected with other major institutions such as ETH Zürich, University College London, The University of British Columbia, and United Nations Environment Programme, indicating its pivotal role in facilitating interdisciplinary and international research linkages. Several regional clusters are visible: European institutions like ETH Zürich and Université degli Studi di Milano are closely networked with UK-based universities, while another cluster shows collaboration between Cambridge, UNEP, and global policy-focused institutions. Meanwhile, institutions from Latin America (e.g., Universidade Federal do Rio de Janeiro) and Asia (e.g., Abu Dhabi University) appear more peripheral but still connected to the global network.

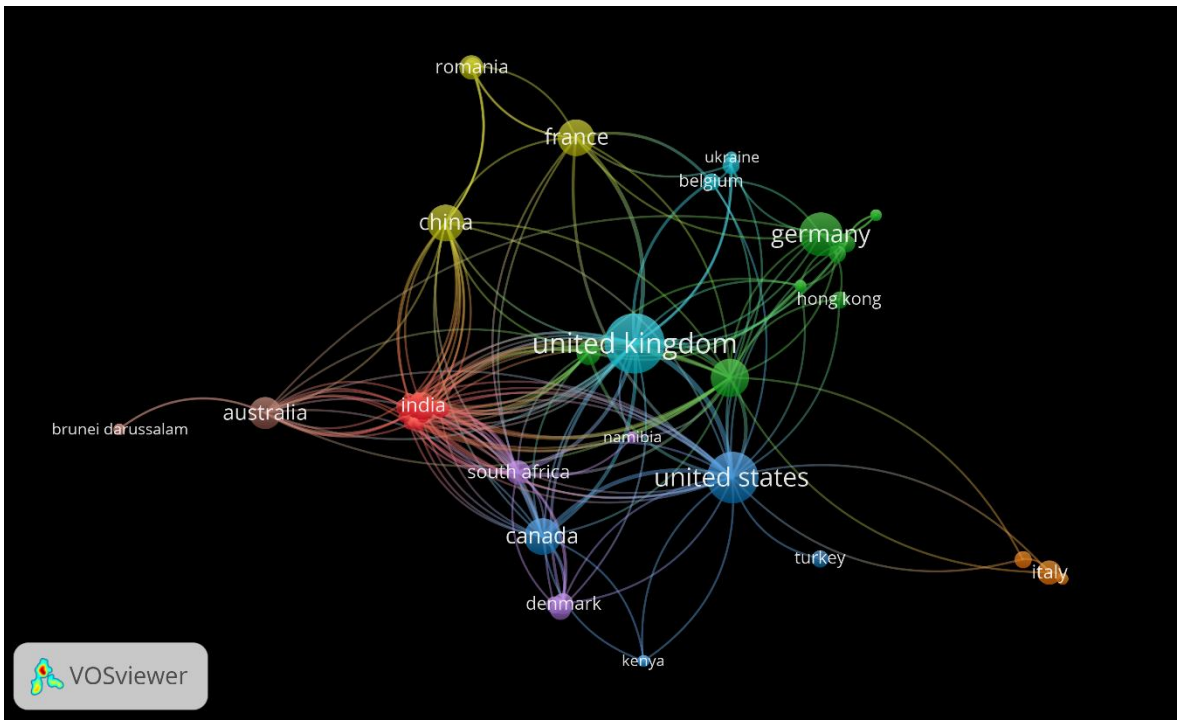

Figure 6. Country Collaboration Visualization
Source: Data Analysis, 2025

Figure 5 reveals that the United Kingdom and the United States serve as the two major hubs in global biodiversity finance research, with extensive co-authorship ties to countries across Europe, Asia, Africa, and Oceania. The strong linkages between the UK, Germany, Canada, India, and China suggest a dynamic and interconnected research landscape, driven by both transatlantic and transcontinental collaboration. India emerges as a key connector in the Global South, bridging work between Australia, South Africa, and the UK, while Germany and France anchor the European cluster alongside Belgium and Romania. The presence of countries such as Namibia, Kenya, and Brunei Darussalam—though more peripheral—reflects growing inclusivity and the participation of developing nations in the biodiversity finance discourse.

3.3 Citation Analysis

Table 1. Top Cited Research

Citations	Authors and year	Title
1860	[10]	Global biodiversity conservation priorities

Citations	Authors and year	Title
358	[11]	Successes and limitations of phytotechnologies at field scale: Outcomes, assessment and outlook from COST Action 859
88	[12]	The under-financing of protected areas in the Congo Basin: So many parks and so little willingness-to-pay
64	[2]	Biodiversity finance: A call for research into financing nature
55	[13]	Biodiversity loss and climate change interactions: financial stability implications for central banks and financial supervisors
51	[14]	Sustainable agri-food investments require multi-sector co-development of decision tools
50	[15]	Risky business: An uncertain future for biodiversity conservation finance through REDD+
47	[16]	How do Investors Value Environmental Harm/Care? Private Equity Funds, Development Finance Institutions and the Partial Financialization of Nature-based Industries
42	[17]	Resource extraction, greenhouse emissions, and banking performance
39	[18]	Should biodiversity offsets help finance underfunded Protected Areas?

Source: Scopus, 2025

Practical Implication

This study offers actionable insights for policymakers, financial institutions, and sustainability practitioners aiming to integrate biodiversity into financial systems. By mapping the evolving intellectual structure of biodiversity finance, the findings help identify which themes—such as sustainable finance, green bonds, and ESG—are gaining momentum and thus offer potential levers for investment and policy intervention. Financial regulators and standard-setting bodies, including the Taskforce on Nature-related Financial Disclosures (TNFD), can utilize the knowledge clusters revealed in this analysis to align reporting frameworks with the most researched and impactful dimensions of nature-related risk. For investors, the emergence of terms like "decentralized finance" and "biodiversity finance" highlights areas of financial innovation that could drive next-generation investment instruments. Moreover, the collaborative network analysis enables institutions and governments to identify key academic and institutional actors for strategic partnerships, thus accelerating capacity building and interdisciplinary solutions in biodiversity-aligned finance.

Theoretical Contribution

Theoretically, this study advances the conceptual foundations of biodiversity finance by offering a systematic bibliometric overview of how ecological concerns are being embedded into financial risk frameworks. Unlike prior studies that treated biodiversity as a peripheral theme in sustainability or conservation economics, this study positions biodiversity as a core concept interfacing directly with financial constructs such as risk management, investment, and governance. The identification of co-authorship and institutional collaboration networks contributes to the literature by revealing the intellectual geography of the field, highlighting who is shaping the discourse and through what lenses. Furthermore, the temporal and density visualizations enrich theory-building by showing how the field has evolved—from conservation-centric models to more complex frameworks involving ESG, green finance, and decentralized financial mechanisms. This multidimensional mapping thus provides a foundation for theorizing biodiversity finance as a transdisciplinary domain that merges environmental, economic, and technological logics.

Limitations

Despite its comprehensive scope, this study has several limitations. First, the analysis is based solely on the **Scopus** database, which, while extensive, may exclude relevant grey literature, policy papers, or regional publications in biodiversity finance that are not indexed. This could result in an underrepresentation of contributions from the Global South or from practice-oriented fields. Second, the reliance on keyword co-occurrence and bibliometric metadata does not capture the full semantic or qualitative depth of the research themes, which may lead to surface-level interpretations of complex concepts like "risk management" or "ecosystem services." Third, while VOSviewer offers robust visualization, it does not account for citation contexts or the quality of engagement between authors and concepts. Future research may benefit from mixed-method approaches combining bibliometric mapping with content analysis or expert interviews to generate a more nuanced understanding of the intellectual and practical dimensions of biodiversity finance.

4. CONCLUSION

This study provides a comprehensive bibliometric overview of the rapidly evolving field of biodiversity finance, with a particular focus on its integration into financial risk assessment. Through co-occurrence mapping, temporal analysis, density visualization, and collaboration networks, the research reveals a growing convergence between ecological sustainability and financial systems. Core concepts such as biodiversity, finance, sustainable development, and ESG have emerged as central pillars in the academic discourse, while newer themes like decentralized finance and biodiversity-specific instruments are gaining traction. Institutional and international collaboration networks underscore the global relevance of the topic, although disparities in participation remain. By illuminating the intellectual structure, thematic clusters, and strategic actors within the field, this study not only strengthens the theoretical foundation of biodiversity finance but also offers practical guidance for policymakers, investors, and researchers working to embed nature into mainstream financial systems.

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