

RESEARCH ARTICLE OPEN ACCESS

When TCFD Meets TNFD: Can It Revolutionize Corporate Sustainable Risk Management?

Xiaoyu Liu¹  | Yazeed Alkhrijah² | Monomita Nandy¹  | Suman Lodh³ 

¹Brunel Business School, Brunel University of London, Uxbridge, UK | ²Imam Mohammad Ibn Saud Islamic University, Riyadh, Saudi Arabia | ³Kingston Business School, Kingston University London, Surrey, UK

Correspondence: Monomita Nandy (monomita.nandy@brunel.ac.uk) | Yazeed Alkhrijah (ymalkhrijah@imamu.edu.sa)

Received: 14 August 2025 | **Revised:** 17 November 2025 | **Accepted:** 25 November 2025

Keywords: biodiversity | climate change | literature review | risk management | sustainability reporting | TCFD | TNFD

ABSTRACT

Amid escalating environmental risks, this study explores the novel integration of the Task Force on Climate-related Financial Disclosures (TCFD) and the Taskforce on Nature-related Financial Disclosures (TNFD) as a transformative approach to corporate sustainable risk management. Firms currently grapple with fragmented ESG frameworks and overlapping disclosure mandates, which heighten reporting burdens and exacerbate information asymmetry. Through a systematic literature review and bibliometric analysis of 276 peer-reviewed articles, this research uncovers significant redundancies in sustainability reporting and a pronounced imbalance between the established TCFD literature and the nascent TNFD scholarship. The study reveals that embedding biodiversity risks within climate disclosures enhances corporate resilience, transparency, and strategic adaptability. A critical theoretical synthesis drawing on legitimacy, stakeholder, institutional, agency, and signaling theories demonstrates that aligning TCFD and TNFD frameworks fosters coherent, credible, and cost-effective reporting. This integration not only streamlines compliance but also strengthens investor confidence and governance quality. By mapping thematic clusters and identifying disclosure challenges, governance drivers, and adaptive strategies, the study offers a timely and original contribution to sustainability discourse. It provides actionable insights for scholars, regulators, and policymakers seeking to harmonize climate and nature-related disclosures and advance global standards for integrated environmental risk management.

1 | Introduction

The integration of climate and biodiversity risks into corporate financial decision making has become increasingly vital amid escalating global environmental challenges (Hristov and Searcy 2025; Stefanescu 2022; Marco-Fondevila and Álvarez-Etxeberria 2023). The Task Force on Climate-related Financial Disclosures (TCFD) and the Taskforce on Nature-related Financial Disclosures (TNFD) have emerged as leading frameworks to enhance corporate transparency and risk management in response to these risks (Jérôme and Poretti 2025; Chalabi-Jabado and Ziane 2024). Despite their growing prominence, significant hurdles persist in their practical adoption (Morrison et al. 2024), driven by inconsistent regulatory standards (Huang and Ge 2025; Yoon et al. 2025),

fragmented reporting practices (Kerret and Gray 2007), and a substantial reporting burden on corporations. Recent empirical work shows that large firms¹ already disclose nature-related impacts alongside climate, which indicates an interest toward unified environmental risk management (Trim and Jones 2025). However, existing research has not yet systematically examined how the convergence of TCFD and TNFD frameworks can address fragmentation in sustainability disclosure and advance an integrated model for corporate sustainable risk management.

A key issue for firms is the reporting burden resulting from complying with multiple Environmental, Social and Governance (ESG) frameworks like TCFD and TNFD, which increase costs and risks of inaccurate disclosures (Chan et al. 2024). This

This is an open access article under the terms of the [Creative Commons Attribution](https://creativecommons.org/licenses/by/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2025 The Author(s). *Business Strategy and the Environment* published by ERP Environment and John Wiley & Sons Ltd.

fragmentation stems from the inherent difficulty in connecting climate and nature-related risks, as climate change accelerates biodiversity loss, and ecosystem degradation amplifies climate vulnerabilities (Sambo et al. 2023). Recognizing this interdependence, standard setters employed common principles, such as governance, risk management, and scenario analysis, to develop TCFD and TNFD. However, their regulatory adoption varies significantly: TCFD is mandatory in jurisdictions like the UK and EU but remains voluntary in many other countries, while TNFD is largely voluntary globally (Nieto and Papathanassiou 2024). Alongside this discrepancy, the risks associated with biodiversity loss, such as supply chain disruptions and reputational damage, are severe, highlighting the urgency for integrated approaches (Yang et al. 2024).

Current research underscores the financial implications of climate and biodiversity risks, showing their direct impact on corporate performance, accounting practices, cost of capital, and strategic decisions (Chaurasia and Singh 2023). Yet, a notable imbalance exists, with climate risks receiving far greater attention than biodiversity risks (Fontanier et al. 2025), suggesting gaps in holistic sustainability strategies (Rising et al. 2022). Companies often face significant uncertainty in quantifying and disclosing biodiversity-related risks due to the lack of standardized metrics and methodologies, leading to less rigorous reporting and oversight compared with climate disclosures. Robust ESG disclosures, when executed effectively, can yield substantial financial benefits, such as reduced capital costs and enhanced market valuation, driven by increased investor confidence and improved stakeholder relations (Hu et al. 2024). However, critical analyses reveal pervasive issues such as greenwashing, inconsistent ESG rating methodologies, and superficial compliance, raising serious doubts about the authenticity and reliability of ESG practices and their actual financial and operational impacts, exacerbated by the extensive reporting burden (Ding et al. 2024).

Thus, in this research, we examine if the integration of TCFD and TNFD frameworks could transform corporate sustainable risk management strategies. We conduct a systematic literature review (SLR) and bibliometric analysis to critically analyze the following related research questions:

1. How does the fragmentation of existing climate and nature-related disclosure frameworks increase firms' reporting burdens and information asymmetry, and what are the implications for sustainable risk management?
2. To what extent do corporate governance structures and stakeholder engagement influence the quality and effectiveness of integrated TCFD and TNFD reporting practices?
3. How can the alignment of biodiversity and climate risk assessments within the TCFD and TNFD framework strengthen firms' financial resilience and strategic adaptation to environmental risks?
4. What theoretical and policy pathways can support the harmonization of TCFD and TNFD to promote globally consistent, transparent, and cost-effective sustainability reporting?

Through an in-depth analysis of recent high-quality research papers, this study reveals critical insights into the current challenges and opportunities surrounding the need for integrating these two frameworks in sustainable risk management. Firstly, fragmented reporting frameworks significantly elevate firms' cost of capital and amplify conservative accounting practices, intensifying financial pressures and complexity in corporate sustainability reporting (Free et al. 2024). Secondly, although integrating ESG criteria into corporate financial practices has been shown to reduce financing costs and encourage innovation, the persistent issues of symbolic compliance and duplicative reporting severely hinder the realization of these potential benefits, undermining both investor confidence and regulatory effectiveness (Al-Shaer and Zaman 2018). Thirdly, current disclosure practices under TCFD and TNFD predominantly prioritize climate transition risks while often marginalizing physical and biodiversity-related risks, further complicating corporate risk assessment and exacerbating overall reporting difficulties. This imbalance significantly reduces the frameworks' effectiveness in addressing comprehensive sustainability risks (Gebhardt et al. 2024). Lastly, market reactions to ESG disclosures reflect investor sentiment that strongly rewards transparency and accuracy but harshly penalizes perceived inconsistencies or complexities in reporting practices. These dynamics demonstrate the critical need for simplified yet robust disclosure mechanisms to facilitate better strategic responses by firms and more informed decision-making by investors (Vestrelli et al. 2024).

In summary, this detailed analysis strongly proposes the necessity of regulatory harmonization to effectively alleviate the extensive reporting burden and enhance the practical effectiveness of corporate risk management. Policymakers and regulators must focus on aligning and harmonizing TCFD and TNFD requirements, adopting globally recognized standards and metrics. This integration would significantly streamline sustainability reporting processes, reduce corporate compliance costs, and improve overall transparency and accountability. By promoting deeper and more consistent integration between TCFD and TNFD, policymakers can meaningfully advance global sustainability objectives, fostering an environment where corporations proactively and effectively manage the interconnected risks of climate change and biodiversity loss.

The remainder of this paper is organized as follows. Section 2 describes the methodology including our sample selection strategy and article clustering. In Section 3, we elaborate and focus on our findings from the SLR and bibliographic analysis. The paper concludes in Section 4 by drawing critical insights from existing academic literature and proposing a future research agenda related to the integration of the TCFD with the TNFD framework in sustainability risk management.

2 | Methodology

2.1 | Sample Selection

Following prior research in business and finance, Figure 1 presents a PRISMA diagram that outlines the process of identifying, selecting, screening, evaluating eligibility, and incorporating data into the study (Ed-Dafali et al. 2025; Alaamri et al. 2024).

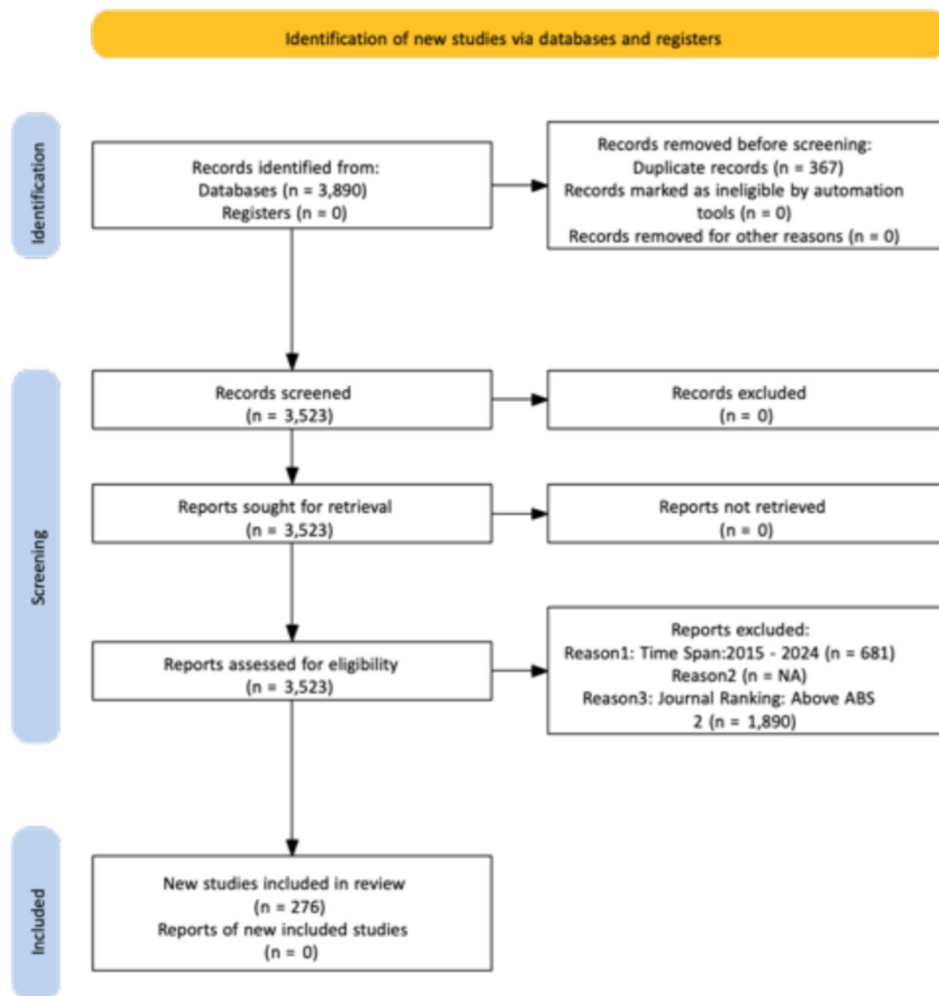


FIGURE 1 | PRISMA flow diagram for the systematic literature review.

We use this process to ensure a structured, transparent, and replicable analysis of existing research on the integration of TCFD and TNFD to incorporate sustainability performance and risk management (Roberts et al. 2021). The sample selection process is designed to identify high-quality, peer-reviewed articles from Scopus that explore the practical application of TCFD and TNFD in risk management and corporate sustainability reporting.

The process begins with a Boolean search strategy across multiple databases, utilizing four keyword groups (Appendix 1). We combined these groups into two sets: (A AND C) OR (B AND C) for risk assessment studies and (A AND D) OR (B AND D) for risk evaluation and reporting studies, which yield an initial pool of 3890 articles, a similar sample to existing studies. After deduplication, 3523 unique articles are counted. We then applied a time filter (2015–2025) to reflect recent developments in TCFD and TNFD applications, reducing the sample to 2842 (Billio et al. 2024). The main reason to consider the start date as January 1, 2015, is the introduction of the Paris Agreement (Rogelj et al. 2016). The cutoff date in 2025 is February 28, 2025. After restricting to article, review type, and English language, the final sample consists of 2261 papers. To ensure academic rigor, we selected only journals ranked ABS 2 or higher, resulting in 423 articles to ensure the quality of research (Drivas and Kremmydas 2020). Finally, a detailed abstract

review identified 276 articles directly relevant to the application of TCFD and TNFD in risk management and sustainability reporting (Vestrelli et al. 2024).

This rigorous process ensures a robust sample, capturing the practical application of TCFD and TNFD frameworks, their reporting burden, and their impact on corporate sustainability, providing a solid foundation for subsequent analysis.

2.1.1 | SLR

This study employs a SLR to investigate the research questions. The SLR aims to synthesize existing knowledge, identify research gaps, and explore potential synergies between climate and nature risks, ensuring a structured and reproducible analysis (Awuah et al. 2024; Roberts et al. 2021). The review process is designed to provide a comprehensive understanding of how these frameworks influence corporate performance, risk management, and disclosure practices, with a focus on addressing emerging challenges in sustainable risk management.

Given the nascent stage of TNFD, the SLR acknowledges the limited direct evidence of TCFD and TNFD integration, adopting an exploratory approach to uncover emerging trends. The

276 articles are subjected to thematic synthesis to categorize findings into key areas, including financial impacts, disclosure challenges, drivers of disclosures, and adaptive strategies for disclosures, aligning with the study's research questions. Following the conventions of SLRs, relevant research articles have been categorized based on thematic focus and methodological approach. The detailed classification is presented in Table 1 (Gulluscio et al. 2020; O'Dwyer and Unerman 2020). This approach ensures a robust analysis, leveraging indirect evidence from climate and biodiversity risk literature to address the scarcity of integrated studies.

To unify the findings from our SLR, we propose a conceptual framework that connects the four thematic clusters: financial impacts, disclosure challenges, governance drivers, and adaptive strategies within an integrated model of sustainable risk management. As illustrated in Appendix 2, the framework positions TCFD and TNFD integration as a central mechanism that reduces information asymmetry, enhances disclosure credibility, and strengthens strategic resilience. Each cluster is mapped to a relevant theoretical lens. Cluster 1 draws on portfolio theory and natural capital valuation, emphasizing the integration of ecological and financial assets in risk assessment. Cluster 2 is informed by legitimacy theory and stakeholder theory, highlighting how social expectations and stakeholder engagement shape disclosure practices. Cluster 3 relates to institutional theory and agency theory, focusing on governance structures and institutional pressures that influence sustainability reporting. Cluster 4 is grounded in the resource-based view and signaling theory, explaining how firms leverage internal capabilities and external communication to build credibility and competitive

TABLE 1 | System of article categorization for cluster.

¹ Climate and natural risks' financial impacts
Climate change
Climate risk
Biodiversity
Financial performance
Financial markets
B. Challenges in climate and biodiversity disclosures
Biodiversity disclosure
Climate disclosure
TCFD
Greenwashing
Impression management
C. Governance and stakeholder drivers of disclosure practices
Corporate governance
Corporate strategy
Managers
Stakeholder
D. Adaptive strategies for environmental resilience
Adaptation
Business strategy
Climate change adaptation
Green finance

advantage in sustainability disclosures. This framework offers a coherent structure for interpreting the literature and highlights the synergistic potential of aligning climate and nature disclosures. It also provides a foundation for future empirical research and policy development aimed at harmonizing ESG reporting standards.

2.1.2 | Bibliographic Analysis

To complement the SLR, this study employs bibliometric analysis to quantitatively assess the intellectual structure and evolution of research on the integration of the TCFD and TNFD frameworks in corporate sustainable risk management.

Analysis adopts two key approaches: performance analysis and scientific mapping. Performance analysis is conducted using publication counts and citation rates to evaluate the productivity and impact of the field, providing insights into the growth trajectory and influence of TCFD and TNFD research over time (Aria and Cuccurullo 2017). Scientific mapping, on the other hand, utilizes co-citation analysis and keyword co-occurrence analysis to map the intellectual structure, identifying foundational works and thematic clusters within the literature (Ferreira et al. 2016). Co-citation analysis highlights influential studies shaping the field, while keyword co-occurrence analysis reveals research hotspots and thematic connections, such as the interplay between climate risk and biodiversity disclosure. This dual approach, supported by tools like the bibliometric package in VOSviewer, enables a comprehensive examination of the field's development, uncovering patterns and gaps in the integration of TCFD and TNFD (Khurshid and Islam 2025).

3 | Findings

3.1 | SLR

This section synthesizes findings from a SLR of 276 peer-reviewed articles (2015–2024) to examine the proposed research question related to the integration of TCFD and TNFD frameworks in corporate sustainable risk management and reporting. A detailed mapping of keywords and their frequencies, derived from bibliometric data, has been included in Table 2 to support the analysis of thematic prominence across these clusters.

3.1.1 | Climate and Natural Risks' Financial Impacts

The financial implications of climate change and biodiversity loss on corporate performance have garnered increasing attention, particularly amid growing global focus on sustainability (Pankratz et al. 2023). The integration of the TCFD and TNFD frameworks aims to assist companies in identifying and disclosing these risks, providing consistent and comparable information to support decision making by investors and stakeholders. This cluster examines how these risks influence corporate debt costs, operational vulnerabilities, and overall value, while highlighting current trends and research gaps.

TABLE 2 | Mapping of keywords to systematic literature review clusters with word frequencies.

Cluster	Matched keywords (frequency)
A. Climate and natural risks' financial impact	Asset pricing (4), banking (6), banks (3), capital (3), capital flow (3), carbon (7), carbon emission (11), carbon emissions (7), climate change exposure (3), climate change risk (3), climate change risks (7), climate risk (55), climate risks (11), credit risk (5), economic activity (3), economic analysis (6), economic development (3), economic growth (3), economic impact (6), economics (9), financial markets (6), financial performance (3), financial risks (6), financial stability (6), financial system (10), firm value (4), investments (15), risk (7), risk assessment (86), risk management (22), risk spillover (4), systemic risk (6), transition risk (11), transition risks (6), valuation (5),
B. Challenges in climate and biodiversity disclosures	Accountability (6), biodiversity disclosures (3), climate disclosure (5), corporate disclosure (3), disclosure (3), environmental disclosure (6), governance approach (9), greenwashing (3), impression management (3), information asymmetry (4), integrated reporting (5), sustainability (19), tcfd (11), tcfd recommendations (3), transparency (6), voluntary disclosure (4)
C. Governance and stakeholder drivers of disclosure practices	Corporate governance (8), corporate social responsibility (6), corporate strategy (9), governance (5), institutional framework (3), institutional investors (4), managers (3), policy makers (3), policy making (8), public policy (4), stakeholder (9)
D. Adaptive strategies for environmental resilience	Adaptation (10), adaptive management (25), business development (3), business strategy (3), climate adaptation (6), climate change adaptation (8), climate policy (3), decision making (18), decision-making (4), environmental management (6), environmental policy (18), green finance (4), green innovation (4), innovation (7), mitigation (5), resilience (4), strategic approach (4), supply chain management (3), sustainable development (23), sustainable development goal (3), sustainable development goals (3), sustainable finance (4)

Evidence suggests that climate risks significantly shape corporate financial strategies. For instance, Ferdous et al. (2024) demonstrate that firms exposed to climate risks tend to adopt conservative accounting practices, particularly in environmentally sensitive industries, potentially reducing financial transparency and exacerbating information asymmetry. Taylor (2023) explores climate risk management from an actuarial perspective, underscoring the potential of scenario analysis tools in addressing uncertainty, though these tools remain limited in integrating biodiversity risks. Orpizewski et al. (2024), through an event study, reveal that negative ESG news triggers significant market reactions in stock and option markets, emphasizing the critical role of disclosure quality in shaping investor responses.

On the biodiversity front, Treepongkaruna (2024) highlight the impact of natural capital depletion on long-term corporate value, noting that the TNFD framework struggles with data availability and standardization challenges in quantifying such risks. Kedward et al. (2023) investigate the synergistic effects of climate and biodiversity risks, finding that firms often overlook their interplay in disclosures, resulting in incomplete risk assessments. Further insights underscore the deepening link between financial performance and climate and nature-related risks yet point to persistent inconsistencies in disclosure practices and a neglect of opportunity reporting (Chen et al. 2024; Flammer et al. 2021).

Integrating TCFD's climate risk quantification with TNFD's natural capital assessment can create a unified measurement system, enabling firms to capture both transition and physical risks holistically (Berkman et al. 2024). This integration

directly supports sustainable risk management by aligning financial materiality with ecological dependencies, thereby improving firms' long-term resilience. So, future research should prioritize developing precise quantification methods, particularly for biodiversity risks, and explore how integrated frameworks can enhance disclosure comparability to mitigate information asymmetry and bolster corporate financial decision making (Dietz and Stern 2015).

3.1.2 | Challenges in Climate and Biodiversity Disclosure

The current status of corporate climate and biodiversity information disclosure is unsatisfactory. Keyword analysis indicates critical issues with information disclosure (five occurrences), governance (eight occurrences), transparency (six occurrences), and greenwashing (three occurrences). Firms often practice selective disclosure, especially emphasizing risk-related information rather than opportunities, creating information asymmetry in markets (Cheynel and Levine 2020).

Audit quality and governance structures are pivotal for enhancing the substantive and reliable nature of disclosures (Callery 2023). Studies have found that increased female representation on corporate boards significantly improves environmental disclosure quality, reducing symbolic disclosures and greenwashing (Carvajal et al. 2022). However, firms face considerable standardization issues with data integration between TCFD and TNFD frameworks, increasing auditing difficulty and costs, consequently affecting the accuracy and credibility of disclosures (Taylor 2023).

Institutional investors positively influence disclosure quality improvements, actively engaging through corporate boards to advance strategic biodiversity and climate disclosures. Nevertheless, shortcomings in current auditing and regulatory mechanisms remain substantial barriers to achieving comprehensive transparency and authenticity in corporate disclosures (Ali et al. 2024; Pham et al. 2024).

These studies reveal a persistent disconnect between symbolic legitimacy seeking disclosures and substantive reporting practices, highlighting a key tension between legitimacy theory and stakeholder theory, which question the credibility of voluntary reporting under fragmented frameworks (Orazalin et al. 2024). Also, aligning TCFD and TNFD to unify disclosure indicators reduces information asymmetry from fragmented reporting, strengthening the effectiveness of sustainable risk oversight. Future developments should focus on strengthening governance structures and auditing mechanisms to address the integration challenges of TCFD and TNFD frameworks, thereby enhancing transparency and the effectiveness of corporate information disclosure relevant for risk management.

3.1.3 | Governance and Stakeholder Drivers of Disclosure Practice

Governance structures and stakeholder influence are key drivers for effective integration of the TCFD and TNFD frameworks (Kraft 2018). The frequent occurrence of keywords such as corporate governance (eight occurrences) and stakeholders (nine occurrences) underscores their significance in managing environmental risks. Board gender diversity has been notably associated with increased strategic environmental disclosures, thereby enhancing corporate transparency and governance effectiveness (Haque and Jones 2020).

Foreign institutional investors and long-term investors play essential roles in promoting corporate environmental disclosures and strategic actions (Fan and Zhao 2025). Specifically, these stakeholders drive the optimization of governance structures, compelling firms to adopt more proactive environmental risk management measures (Ali et al. 2024). The banking sector, a critical stakeholder, notably excels in its risk management functions, aiding firms in effectively identifying and managing climate and biodiversity risks (Lee and Alam 2024; Shabir et al. 2024).

However, despite the positive association between governance quality and disclosure depth, the evidence remains inconclusive regarding whether governance mechanisms mitigate or reinforce institutional pressures toward homogenized reporting, indicating an unresolved theoretical divide within institutional theory (Solimene et al. 2025). Integrating TCFD and TNFD guides firms to build unified environmental risk governance structures, reconciling stakeholder demands to improve the synergy of sustainable risk responses. Therefore, future research should explore optimizing governance structures and stakeholder interactions to maximize the synergistic effects of TCFD and TNFD integration (Carvajal et al. 2022) leading toward risk management.

3.1.4 | Adaptive Strategies for Environmental Resilience

Strategic responses and innovation pathways adopted by firms in facing environmental risks are critical. Keywords such as innovation (seven occurrences), strategy (nine occurrences), and adaptive management (25 occurrences) emphasize the significance of strategic innovation in environmental risk management. Current research indicates that green finance policies effectively encourage corporate technological innovation and strategic transformation, mitigating negative impacts associated with climate risks (He et al. 2024).

However, corporate strategic responses predominantly exhibit short-termism, overlooking complex long-term systemic risks, particularly reflected in insufficient corporate applications of scenario analyses within the TCFD framework (Huiskamp et al. 2022). Strategic integration of the TNFD framework similarly suffers from incomplete implementation, necessitating further theoretical and practical enhancements (Carvalho et al. 2023).

Optimizing supply chain resilience (supply chain management, three occurrences) and risk management strategies offers firms effective short- and long-term strategic tools (Er Kara et al. 2021), significantly reducing disruptions from physical climate risks like extreme weather (Ge et al. 2025). Additionally, promoting green finance provides strategic pathways and helps firms achieve sustainable development and long-term risk management goals (Lee et al. 2024). Promoting green finance through the integration of TCFD's climate adaptation strategies and TNFD's biodiversity-focused measures creates compound resilience solutions that enhance firms' ability to cope with extreme environmental risks.

Although adaptive strategies foster innovation and resilience, the literature remains fragmented in linking these practices to measurable financial outcomes (Danese and De Marchi 2024; Zheng and Iatridis 2022; Zennaro et al. 2024). This fragmentation underscores the need for an integrated conceptual model that connects strategic adaptation with disclosure quality and long-term value creation. By advancing a more effective integration of the TCFD and TNFD frameworks, firms can strengthen this linkage, enhancing strategic responsiveness and achieving long-term sustainability in the face of environmental risks.

3.1.5 | Integrative Theoretical Perspectives on TCFD and TNFD Convergence

This section builds on the conceptual framework presented in Appendix 2, offering a deeper synthesis of how key theories intersect across the four thematic clusters identified in our SLR (Figure 2). This section plays a pivotal role in elevating the conceptual coherence of the study by moving beyond a descriptive listing of theories and instead interrogating their relevance, interplay, and limitations in the context of integrated sustainability disclosures. The inclusion of multiple theoretical lenses: legitimacy, stakeholder, institutional, agency, and signaling reflects the complexity of ESG reporting, but their

Percentages of Theories applied

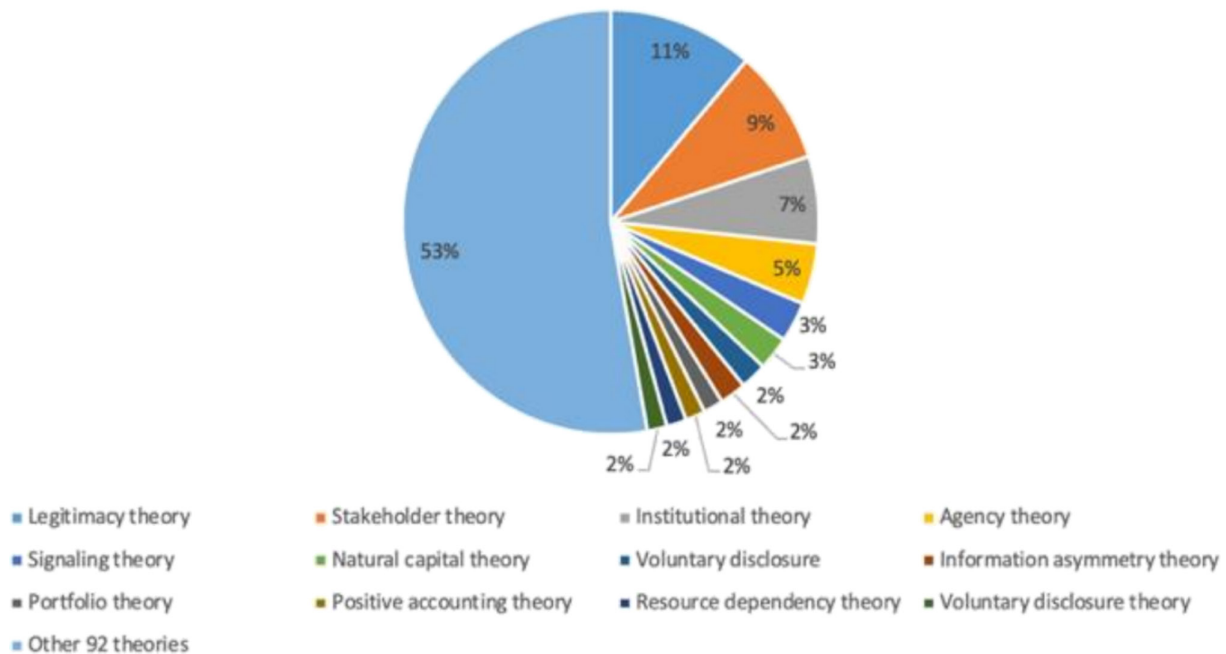


FIGURE 2 | The pie chart of theory applied.

true analytical value lies in how they intersect and diverge across corporate behavior, regulatory environments, and market expectations.

A critical insight emerging from this synthesis is the tension between symbolic and substantive compliance. Legitimacy theory explains why firms may adopt TCFD and TNFD frameworks to maintain reputational capital, yet this can lead to superficial disclosures if not reinforced by stakeholder accountability mechanisms (Suchman 1995; Talbot and Boiral 2018). Stakeholder theory, in contrast, demands deeper engagement and responsiveness, revealing a conceptual gap between external perception and internal governance (Freeman 1984; García-Sánchez et al. 2023).

Institutional theory offers a structural explanation for convergence in reporting practices, but its predictive power is limited when voluntary frameworks like TNFD lack enforcement (Solimene et al. 2025). Agency theory partially addresses this by focusing on governance structures, yet it assumes rational actors and overlooks the normative pressures that drive ESG adoption (Gebhardt et al. 2024). Signaling theory, while bridging disclosure and investor response, risks oversimplifying the credibility dynamics when firms face conflicting regulatory and stakeholder demands (Chan et al. 2024; Flammer et al. 2021).

By critically juxtaposing these frameworks, the section underscores that no single theory sufficiently captures the multidimensional nature of TCFD and TNFD integration. Instead, a layered theoretical approach is necessary, one that accounts for strategic intent, institutional constraints, stakeholder influence, and market signaling (Al-Shaer and Zaman 2018; O'Dwyer and

Unerman 2020). This integrative perspective not only strengthens the analytical foundation of the paper but also sets the stage for future empirical research that can test these theoretical intersections in practice.

3.2 | Bibliographic Analysis

3.2.1 | Performance Analysis

3.2.1.1 | Number of Publication. The publication trends illustrated in Figure 3 distinctly demonstrate a growing scholarly interest in the TCFD and TNFD frameworks between 2015 and 2024, aligning closely with global emphasis on corporate sustainability and associated environmental risks. Initially, the research output is relatively modest, increasing marginally from 13 articles in 2015 to 16 by 2018. However, a significant acceleration occurred post-2021, with publications sharply rising to a peak of 102 in 2024. This rapid growth corresponds with heightened regulatory pressures in jurisdictions such as the UK and EU, which mandate increased transparency on climate and biodiversity risks, thereby stimulating extensive academic inquiry into the financial implications of these risks (Gebhardt et al. 2024; Hu et al. 2024).

The significant surge observed in 2024 indicates a critical turning point where academic attention expanded notably toward the TNFD framework, emphasizing the importance of biodiversity alongside climate considerations (Nieto and Papathanassiou 2024). Despite this promising development, a critical examination reveals that TCFD-focused studies have predominated historically, possibly reflecting a lag in academic adaptation to integrating biodiversity risks comprehensively.

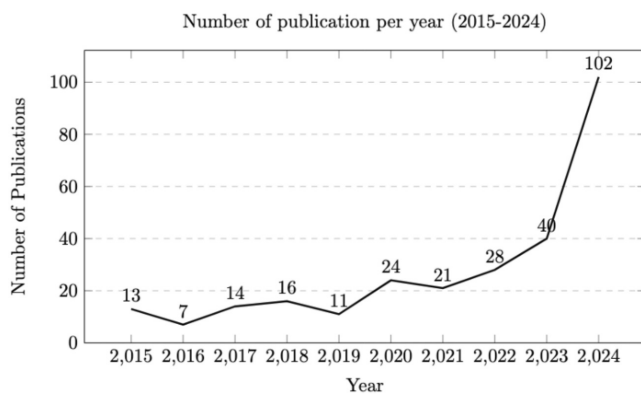


FIGURE 3 | Publication trends of TCFD and TNFD-related articles from 2015 to 2024.

Recent research highlights the persistent challenges in standardizing disclosures and ensuring consistent data availability, a fundamental barrier in holistically addressing combined climate and biodiversity risks (Lodh et al. 2024).

Furthermore, studies examining market reactions to corporate disclosures underline the critical role of transparency and disclosure quality in shaping investor behavior and market stability, underscoring the real-world implications of effective disclosure practices (Feng et al. 2024). Nevertheless, a deeper critical analysis suggests that although regulatory mandates have accelerated publication volume, the practical implementation and depth of corporate strategies integrating both TCFD and TNFD remain underexplored. This indicates an essential area for future research, specifically focusing on evaluating the effectiveness and practical impacts of integrating these frameworks in corporate sustainability strategies and risk management practices (Chan et al. 2024).

Beyond these publication trends, the growing convergence of climate finance, accounting, and environmental governance literature suggests the rise of a truly interdisciplinary research frontier. This evolution implies that future TCFD and TNFD studies should not only quantify disclosure outcomes but also examine how cross-disciplinary collaboration can enhance the credibility and comparability of sustainability reporting (Hales 2023; Orazalin et al. 2024).

Overall, these findings suggest a maturing research landscape yet highlight significant practical and conceptual gaps that warrant further academic and practical attention, particularly regarding the comprehensive integration of climate and biodiversity risks within corporate disclosure practices.

3.2.1.2 | Highly Cited Literature Analysis. An analysis of the top five highly cited articles (Table 3) within the TCFD and TNFD domains reveals distinct stages of research development. TCFD research demonstrates maturity with a strong emphasis on financial implications and disclosure practices related to climate risks, whereas TNFD literature is relatively nascent, focusing primarily on the interplay between nature-related risks and corporate governance (Griffin and Sun 2024).

Within the TCFD domain, highly cited studies have established substantial theoretical and empirical groundwork. Krueger

et al. (2020) empirically emphasized institutional investors' growing concern over climate risks, significantly influencing the integration of such risks into investment strategies. Flammer et al. (2021) expanded this narrative by highlighting how shareholder activism can effectively drive voluntary climate risk disclosures, underlining governance mechanisms that enhance transparency. Talbot and Boiral (2018) further contributed by critically assessing how sustainability reports in the energy sector often involve impression management regarding greenhouse gas emissions, illustrating challenges in effective disclosure practices.

Conversely, the emerging TNFD literature highlights initial efforts in integrating biodiversity risks with corporate governance. Haque and Jones (2020) provided empirical insights into how board gender diversity can enhance biodiversity disclosures among European firms. Similarly, Adler et al. (2018) examined biodiversity and threatened species disclosures among Fortune Global companies, identifying critical gaps and governance challenges. Carvajal et al. (2022) emphasized the critical relationship between board gender diversity and effective biodiversity reporting, demonstrating initial governance-driven efforts toward better nature-related risk disclosures.

These studies collectively underline distinct but complementary trajectories in TCFD and TNFD research. While TCFD literature is more advanced in theoretical depth and practical implementation, TNFD research contributes novel insights on governance structures and accountability mechanisms. Future research opportunities exist in synthesizing these frameworks to create an integrated, holistic approach to corporate sustainability and disclosure.

3.2.2 | Science Mapping

3.2.2.1 | Co-Citation Analysis. This study utilizes journal co-citation analysis, incorporating network visualization (Figure 4) and citation metrics (Table 4), to explore the academic landscape and research priorities associated with the TCFD and TNFD frameworks within corporate sustainable risk management. At the center of this analysis is Business Strategy and the Environment (28 articles, 303 citations), which serves as a key interdisciplinary node, integrating research across corporate strategy, environmental governance, and sustainability practices.

Accounting, Auditing and Accountability Journal (26 articles, 170 citations) significantly contributes to discussions on corporate accountability, governance, and disclosure transparency, emphasizing rigorous accounting practices essential for managing environmental risks. Additionally, Journal of Business Ethics (26 articles, 266 citations) provides insights into the ethical dimensions of corporate governance, highlighting moral responsibilities and implications in sustainability disclosures.

Journal of Financial Economics (25 articles, 208 citations) emphasizes the financial impacts of corporate disclosures on investor behavior and market stability, reinforcing the significance of transparent environmental risk management. Energy Economics (seven articles, 233 citations) provides focused insights on the

TABLE 3 | Top cited articles on TCFD and TNFD (2015–2024).

TCFD			
Title	Author(s)	Year	Citation
The importance of climate risks for institutional investors	Krueger P.; Sautner Z.; Starks L.T.	2020	872
Modelling and measuring sustainable wellbeing in connection with the UN Sustainable Development Goals	Costanza R.; Daly L.; Fioramonti L.; Giovannini E.; Kubiszewski I.; Mortensen L.F.; Pickett K.E.; Ragnarsdottir K.V.; De Vogli R.; Wilkinson R.	2016	520
Endogenous growth, convexity of damage and climate risk: How Nordhaus' framework supports deep cuts in carbon emissions	Dietz S.; Stern N.	2015	241
Shareholder activism and firms' voluntary disclosure of climate change risks	Flammer C.; Toffel M.W.; Viswanathan K.	2020	210
GHG reporting and impression management: an assessment of sustainability reports from the energy sector	Talbot D.; Boiral O.	2018	209
TNFD			
Title	Author(s)	Year	Citation
European firms' corporate biodiversity disclosures and board gender diversity from 2002 to 2016	Haque F.; Jones M.J.	2020	133
Biodiversity and threatened species reporting by the top Fortune Global companies	Adler R.; Mansi M.; Pandey R.	2018	86
United Nations Decade on Biodiversity: a study of the reporting practices of the Australian mining industry	Adler R.; Mansi M.; Pandey R.; Stringer C.	2017	71
Biodiversity disclosure, sustainable development and environmental initiatives: Does board gender diversity matter?	Carvajal M.; Nadeem M.; Zaman R.	2022	66
Biodiversity reporting for governmental organisations: evidence from English local councils	Gaia S.; Jones M.J.	2020	39

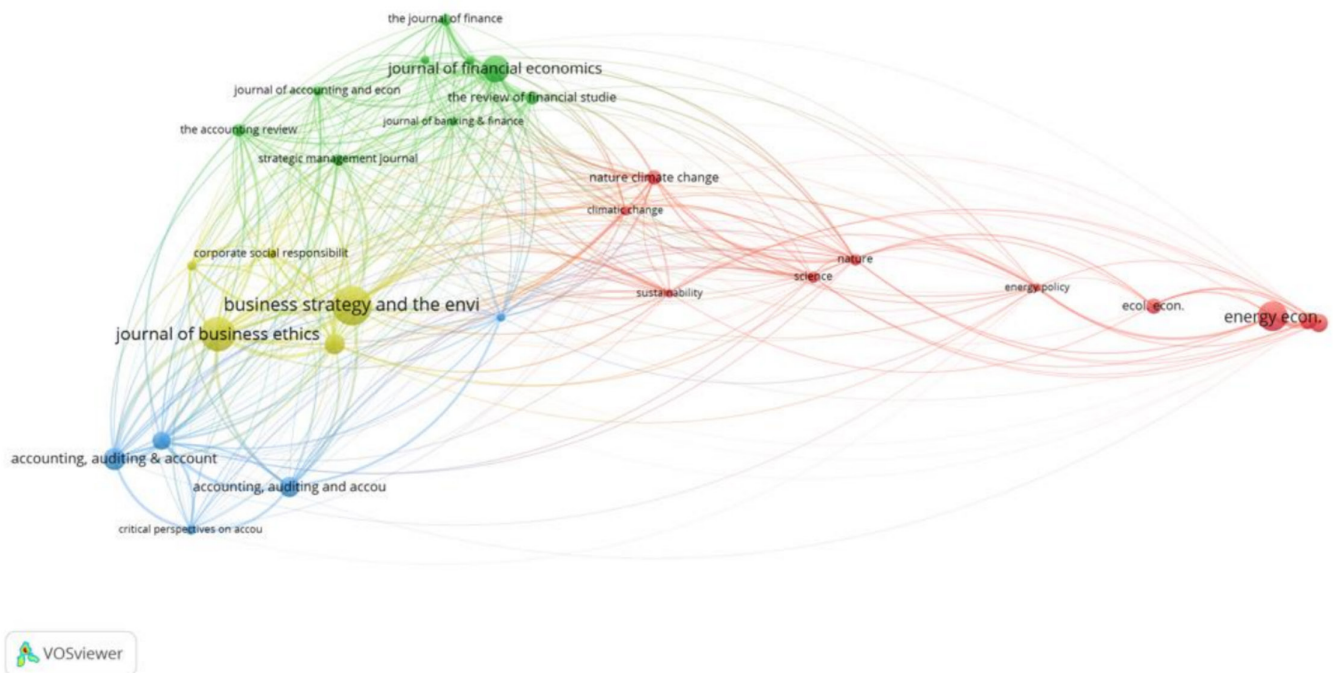
**FIGURE 4** | Network diagram for co-citation journals.

TABLE 4 | Key Journals in TCFD and TNFD research based on publication and citation metrics.

Journal name	Number of article	Citations
Business Strategy and the Environment	28	303
Journal of Business Ethics	26	266
Energy Economics	7	233
Journal of Financial Economics	25	208
Accounting, Auditing and Accountability Journal	26	170

economic implications and strategic responses associated with climate risk management, particularly within the energy sector.

Critically, the current co-citation network reveals clear disciplinary divisions, with limited integration between TCFD-related financial disclosures and TNFD-oriented biodiversity research. For instance, Morrison et al. (2024) highlight challenges in aligning corporate climate actions with their reported strategies, reflecting inconsistencies in disclosure practices. Andersson and Arvidsson (2024) further demonstrate the complexities corporations face in maintaining environmental transparency during disruptive events like the Covid-19 pandemic, underscoring the need for stronger integration between governance structures and sustainability reporting.

The co-citation network reveals that while accounting and finance journals continue to dominate citation patterns, emerging linkages with environmental economics and ethics journals indicate a gradual methodological integration across disciplines. This interdisciplinary convergence suggests a potential shift in reporting practices, from compliance-driven disclosure toward evidence-based governance and accountability frameworks. Building on this trend, future research should bridge existing theoretical and practical gaps by fostering cross-disciplinary collaboration and leveraging insights from ethics, finance, and environmental economics to advance a more comprehensive and integrated approach to corporate sustainability risk management.

3.2.2.2 | Keywords co-Occurrence Analysis. This study employs a keyword co-occurrence network analysis (Figure 5) to elucidate the complex interplay between climate-related financial risks, biodiversity considerations, corporate sustainability strategies, and disclosure practices within the integrated application of the TCFD and TNFD frameworks. Four primary thematic clusters emerge distinctly from this visualization, each encapsulating critical areas of scholarly and practical emphasis.

The first cluster (red) prominently features terms such as “climate risk,” “carbon emission,” “transition risks,” “environmental disclosure,” and “information asymmetry,” emphasizing the financial implications and reporting dimensions of climate change. The frequent occurrence and strong interconnection of “climate risk” (55 occurrences), “carbon emission” (11

occurrences), and “environmental disclosure” (six occurrences) underscore how climate-related disclosures significantly shape corporate financial strategies, particularly concerning transparency and market perception (Chalabi-Jabado and Ziane 2024). The prominence of “transition risks” (six occurrences) in this cluster highlights the substantial market concerns regarding regulatory shifts toward sustainability, suggesting corporations increasingly face pressure to enhance disclosure quality to reduce perceived uncertainties (Bua et al. 2024). However, critical examination reveals persistent gaps, such as limited integration of biodiversity risks in existing climate disclosures, indicating an essential area for expanded future research.

The second cluster (yellow) centers around “risk assessment” (86 occurrences), “risk management” (22 occurrences), “investment” (15 occurrences), “economics” (nine occurrences), and “sustainable development” (23 occurrences). This cluster emphasizes the role of strategic financial decisions in addressing sustainable risks. The strong linkage between “risk assessment” and “investment” indicates a significant scholarly focus on ESG integration within investment practices, reflecting market advantages obtained by firms that effectively incorporate sustainability (Ben-Amar et al. 2024). Nevertheless, the frequent co-occurrence of these terms alongside “economics” suggests market mechanisms for pricing climate and biodiversity risks remain underdeveloped, pointing toward a critical limitation requiring attention from both academic researchers and financial practitioners.

The third cluster (blue) involves “biodiversity” (15 occurrences), “sustainability” (19 occurrences), “natural capital” (31 occurrences), “stakeholder” (nine occurrences), and “transparency” (six occurrences). The cluster reveals academic attention to biodiversity disclosure as a strategic issue in corporate sustainability, emphasizing the necessity of incorporating natural capital into financial and sustainability reporting. The significant presence of “natural capital” underscores growing recognition of biodiversity’s economic importance. However, a closer critical look at the connections highlights a notable gap between biodiversity and core financial concepts, such as “investment” or “valuation,” suggesting current biodiversity reporting practices might lack the depth required for meaningful market integration (Maechler and Boisvert 2024). Addressing this gap is crucial for enhancing both the effectiveness and credibility of corporate biodiversity disclosures.

Finally, the fourth cluster (green) contains themes of “corporate governance” (eight occurrences), “policy making” (eight occurrences), “institutional investors” (four occurrences), “public policy” (four occurrences), and “corporate social responsibility” (six occurrences), highlighting governance structures’ essential role in driving corporate responses to climate and biodiversity challenges (Todaro et al. 2021). This cluster’s emphasis on governance and stakeholder influence aligns closely with earlier findings that effective corporate governance structures, including active roles played by institutional investors, significantly enhance transparency and disclosure quality (Cosma et al. 2022). Nevertheless, the lower frequency and limited direct connections with biodiversity and natural capital underscore an underexplored potential: enhancing governance structures to facilitate integrated disclosures under TCFD and TNFD frameworks.

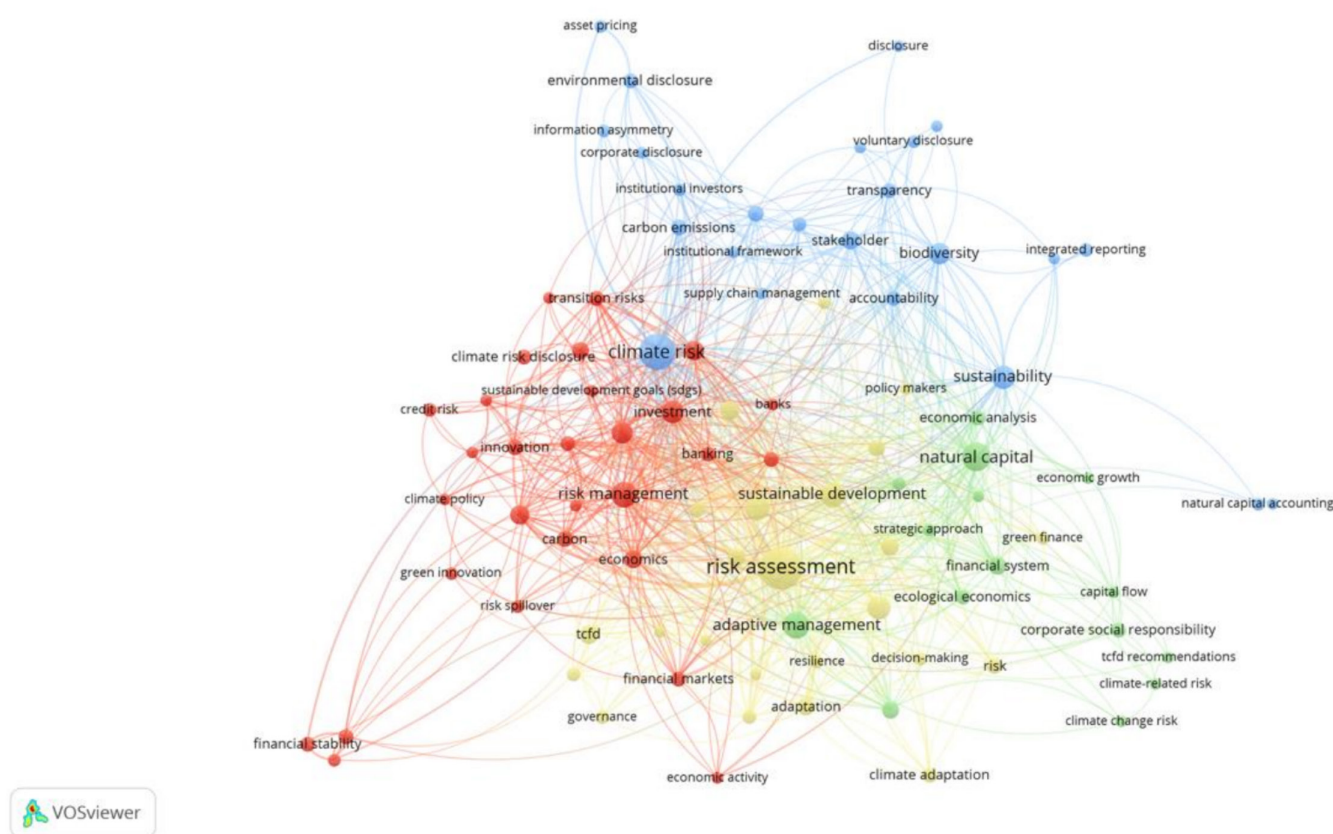


FIGURE 5 | Network diagram for keywords.

In conclusion, this keyword co-occurrence network analysis elucidates critical thematic areas in current research: climate risks and disclosures, sustainable investment practices, biodiversity integration, and governance structures. While extensive connections are evident within these clusters, important research gaps persist, particularly regarding the deeper integration of biodiversity risks with financial practices and market mechanisms. The convergence of climate and biodiversity-related keywords demonstrates a methodological opening for interdisciplinary reporting practices. Integrating ecological metrics with financial indicators under the TCFD and TNFD framework could enhance the consistency and decision usefulness of corporate disclosures, encouraging firms to adopt a unified approach to sustainability transparency (Troullaki et al. 2021). Despite this emerging convergence, the literature still lacks integrated analytical models that connect ecological and financial dimensions. Therefore, future research should focus on bridging these theoretical and methodological gaps by incorporating interdisciplinary insights from ecological economics and behavioral finance to develop a more comprehensive framework for managing corporate sustainability risks.

4 | Conclusion and Future Research

This study systematically addressed four core research questions through a combined SLR and bibliometric analysis of 276 peer-reviewed articles:

First, Fragmentation and Reporting Burden: We found that fragmented ESG frameworks significantly increase firms' reporting

burdens and information asymmetry, leading to conservative accounting practices and reduced strategic clarity (Hummel et al. 2019). This fragmentation undermines the effectiveness of sustainability risk management by inflating compliance costs and diluting disclosure comparability (Tarmuji et al. 2016). Second, Governance and Stakeholder Influence: Our analysis revealed that governance structures, particularly board diversity and institutional investor engagement, play a critical role in enhancing disclosure quality (Adams 2017). However, stakeholder pressures vary widely, and governance mechanisms often struggle to reconcile symbolic legitimacy with substantive accountability (Maniora 2018). Third, Alignment of Climate and Biodiversity Risks: Evidence shows that integrating biodiversity risks into climate disclosures strengthens firms' financial resilience and adaptive capacity (Boiral and Heras-Saizarbitoria 2020; Velte 2021). Yet, methodological gaps and inconsistent metrics hinder full alignment, limiting the strategic utility of integrated disclosures (Flammer et al. 2021). Fourth, Theoretical and Policy Pathways: Drawing on five dominant theories: legitimacy, stakeholder, institutional, agency, and signaling, we proposed a conceptual framework (Appendix 2) that supports harmonization of TCFD and TNFD (Adams 2017). This framework offers a coherent foundation for globally consistent, transparent, and cost-effective sustainability reporting.

By synthesizing fragmented insights across climate and nature-related disclosures, this study extends existing literature by providing the first integrative evidence linking disclosure burdens, governance mechanisms, biodiversity and climate risk alignment, and theoretical pathways in one comprehensive SLR

and bibliometric design. The use of a SLR combined with bibliometric analysis was particularly suited to this aim, as it enabled a comprehensive, unbiased mapping of evolving research patterns, theoretical convergence, and methodological gaps across a rapidly expanding and interdisciplinary field (Tumewang et al. 2025).

4.1 | Theoretical Implications

The above findings contribute to ESG scholarship by synthesizing multiple theoretical lenses into a unified framework for understanding integrated disclosures. It highlights conceptual tensions, such as symbolic versus substantive compliance and institutional convergence versus stakeholder specificity, that shape corporate sustainability behavior. The layered theoretical approach strengthens the analytical foundation for future empirical testing.

4.2 | Practical Implications

For corporate practitioners, the findings underscore the need to streamline ESG reporting processes and embed biodiversity metrics into existing climate risk assessments. Firms should prioritize governance reforms that enhance board diversity, audit quality, and stakeholder responsiveness to improve disclosure credibility and strategic resilience.

4.3 | Policy Implications

Policymakers must accelerate efforts to harmonize TCFD and TNFD standards, moving toward mandatory, interoperable frameworks. Regulatory clarity and standardized metrics are essential to reduce compliance burdens, improve market comparability, and foster investor confidence. The proposed conceptual framework offers a roadmap for aligning disclosure principles across jurisdictions.

4.4 | Limitations

While this study offers a robust synthesis of existing literature, it is constrained by the limited empirical evidence on actual TCFD and TNFD integration in corporate practice. The reliance on indirect indicators and theoretical extrapolation may overlook sector-specific nuances and regional regulatory dynamics. Moreover, bibliometric tools, while powerful, may underrepresent emerging grey literature and practitioner insights.

4.5 | Future Research Directions

To address these gaps, future research should conduct longitudinal case studies of firms adopting both TCFD and TNFD to assess their behavioral and financial outcomes. It should also focus on developing and testing standardized biodiversity metrics that can be embedded within climate risk models, thereby enhancing comparability and analytical precision. Further

studies could explore cross-sectoral and cross-jurisdictional variations in governance responses to integrated ESG frameworks, providing insights into regulatory and institutional influences. In addition, examining investor reactions to integrated disclosures through event studies and sentiment analysis would offer valuable evidence on market perceptions and financial implications. Collectively, these directions will help validate the proposed conceptual framework and advance the practical relevance of integrated sustainability reporting.

Author Contributions

Xiaoyu Liu: writing – original draft, visualization, methodology, formal analysis, data curation. **Yazeed Alkhrijah:** project administration, writing – review and editing. **Monomita Nandy:** writing – conceptualization, review, methodology. **Suman Lodh:** writing – review and editing.

Funding

This work was supported and funded by the Deanship of Scientific Research at Imam Mohammad Ibn Saud Islamic University (IMSIU) (grant number IMSIU-DDRSP2502).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

There is no new data generated.

Endnotes

¹ Throughout this paper, the terms “firm” and “company” are used synonymously, both denoting corporate entities involved in commercial or financial activities.

References

- Adams, C. A. 2017. “Conceptualising the Contemporary Corporate Value Creation Process.” *Accounting, Auditing & Accountability Journal* 30, no. 4: 906–931.
- Adler, R., M. Mansi, and R. Pandey. 2018. “Biodiversity and Threatened Species Reporting by the Top Fortune Global Companies.” *Accounting, Auditing & Accountability Journal* 31, no. 3: 787–825.
- Alaamri, Y., K. Hussainey, M. Nandy, and S. Lodh. 2024. “The Impact of Audit Quality and Climate Change Reporting on Corporate Performance: A Review and Future Research Agenda.” *Journal of Accounting Literature* 46, no. 4: 611–629.
- Ali, R., I. M. García-Sánchez, B. Aibar-Guzmán, and R. U. Rehman. 2024. “Is Biodiversity Disclosure Emerging as a key Topic on the Agenda of Institutional Investors?” *Business Strategy and the Environment* 33, no. 3: 2116–2142.
- Al-Shaer, H., and M. Zaman. 2018. “Credibility of Sustainability Reports: the Contribution of Audit Committees.” *Business Strategy and the Environment* 27, no. 7: 973–986.
- Andersson, F. N. G., and S. Arvidsson. 2024. “The Impact of the Covid-19 Pandemic on the Environmental Sustainability Strategies of Listed Firms in Sweden.” *Business Strategy and the Environment* 33, no. 2: 462–476.
- Aria, M., and C. Cuccurullo. 2017. “Bibliometrix: An R-Tool for Comprehensive Science Mapping Analysis.” *Journal of Informetrics* 11, no. 4: 959–975.

- Awuah, B., H. Yazdifar, and H. Elbardan. 2024. "Corporate Reporting on the Sustainable Development Goals: a Structured Literature Review and Research Agenda." *Journal of Accounting and Organizational Change* 20, no. 4: 617–646.
- Ben-Amar, W., D. C. Herrera, and I. Martinez. 2024. "Do Climate Risk Disclosures Matter to Financial Analysts?" *Journal of Business Finance & Accounting* 51, no. 7–8: 2153–2180.
- Berkman, H., J. Jona, and N. Soderstrom. 2024. "Firm-Specific Climate Risk and Market Valuation." *Accounting, Organizations and Society* 112: 101547.
- Billio, M., M. Costola, I. Hristova, C. Latino, and L. Pelizzon. 2024. "Sustainable Finance: a Journey Toward ESG and Climate Risk." *International Review of Environmental and Resource Economics* 18, no. 1–2: 1–75.
- Boiral, O., and I. Heras-Saizarbitoria. 2020. "Sustainability Reporting Assurance: Creating Stakeholder Accountability Through Hyperreality?" *Journal of Cleaner Production* 243: 118596.
- Bua, G., D. Kapp, F. Ramella, and L. Rognone. 2024. "Transition Versus Physical Climate Risk Pricing in European Financial Markets: a Text-Based Approach." *European Journal of Finance* 30, no. 17: 2076–2110.
- Callery, P. J. 2023. "The Influence of Strategic Disclosure on Corporate Climate Performance Ratings." *Business & Society* 62, no. 5: 950–988.
- Carvajal, M., M. Nadeem, and R. Zaman. 2022. "Biodiversity Disclosure, Sustainable Development and Environmental Initiatives: Does Board Gender Diversity Matter?" *Business Strategy and the Environment* 31, no. 3: 969–987.
- Carvalho, S. H. C. D., T. Cojoianu, and F. Asci. 2023. "From Impacts to Dependencies: a First Global Assessment of Corporate Biodiversity Risk Exposure and Responses." *Business Strategy and the Environment* 32, no. 5: 2600–2614.
- Chalabi-Jabado, F., and Y. Ziane. 2024. "Climate Risks, Financial Performance and Lending Growth: Evidence From the Banking Industry." *Technological Forecasting and Social Change* 209: 123757.
- Chan, K. J. D., B. Cheung, and L. Y. Shen. 2024. "An Economic Foundation for Assessing the Credibility of Corporate Net Zero Transition Pathways." *Business Strategy and the Environment* 33, no. 8: 8868–8881.
- Chaurasia, A., and A. Singh. 2023. "Navigating Biodiversity and Climate Risk: a Systematic Review and Research Agenda." *International Journal of Accounting, Business and Finance* 3, no. 1: 50–75.
- Chen, J., X. Luo, and Q. Ding. 2024. "Climate Risk and Renewable Energy Technological Innovation: an Institutional Environment Perspective." *Risk Analysis* 44, no. 3: 566–581.
- Cheyne, E., and C. B. Levine. 2020. "Public Disclosures and Information Asymmetry: a Theory of the Mosaic." *Accounting Review* 95, no. 1: 79–99.
- Cosma, S., S. Principale, and A. Venturelli. 2022. "Sustainable Governance and Climate-Change Disclosure in European Banking: the Role of the Corporate Social Responsibility Committee." *Corporate Governance: The International Journal of Business in Society* 22, no. 6: 1345–1369.
- Danese, G., and V. De Marchi. 2024. "Business Adaptation Strategies to Climate Change: a Systematic Review." *Journal of Cleaner Production* 485: 144322.
- Dietz, S., and N. Stern. 2015. "Endogenous Growth, Convexity of Damage and Climate Risk: How Nordhaus' Framework Supports Deep Cuts in Carbon Emissions." *Economic Journal* 125, no. 583: 574–620.
- Ding, R., G. Jacoby, M. Liu, T. Wang, and Z. Wu. 2024. "Does Climate Risk Shape Firms' Accounting Conservatism?" *Journal of International Financial Markets Institutions and Money* 97: 102081.
- Drivas, K., and D. Kremmydas. 2020. "The Matthew Effect of a Journal's Ranking." *Research Policy* 49, no. 4: 103951.
- Ed-Dafali, S., Z. Adardour, A. Derj, A. Bami, and K. Hussainey. 2025. "A PRISMA-Based Systematic Review on Economic, Social, and Governance Practices: Insights and Research Agenda." *Business Strategy and the Environment* 34, no. 2: 1896–1916.
- Er Kara, M., A. Ghadge, and U. S. Bititci. 2021. "Modelling the Impact of Climate Change Risk on Supply Chain Performance." *International Journal of Production Research* 59, no. 24: 7317–7335.
- Fan, H., and K. Zhao. 2025. "Uncovering the Intensity of Climate Risk and Opportunity: Awareness and Effectiveness." *British Accounting Review* 57, no. 2: 101469.
- Feng, L., D. Huang, F. Chen, and F. Liao. 2024. "Leveraging Climate Risk Disclosure for Enhanced Corporate Innovation: Pathways to Sustainable and Resilient Business Practices." *International Review of Financial Analysis* 96: 103724.
- Ferdous, L. T., N. Atawnah, R. Yeboah, and Y. Zhou. 2024. "Firm-Level Climate Risk and Accounting Conservatism: International Evidence." *International Review of Financial Analysis* 95: 103511.
- Ferreira, J. J. M., C. I. Fernandes, and V. Ratten. 2016. "A Co-Citation Bibliometric Analysis of Strategic Management Research." *Scientometrics* 109: 1–32.
- Flammer, C., M. W. Toffel, and K. Viswanathan. 2021. "Shareholder Activism and Firms' Voluntary Disclosure of Climate Change Risks." *Strategic Management Journal* 42, no. 10: 1850–1879.
- Fontanier, B., T. M. Bachmann, C. Putavy, V. Morisset, and S. Brahmi. 2025. "Exploring Biodiversity Footprint Methods Applied to the French Nuclear Fleet." *Journal of Cleaner Production* 513: 145735.
- Free, C., S. Jones, and M. S. Tremblay. 2024. "Greenwashing and Sustainability Assurance: a Review and Call for Future Research." *Journal of Accounting Literature* 47, no. 4: 739–764.
- Freeman, R. E. 1984. "Corporate Views of the Public Interest".
- García-Sánchez, I. M., R. Ali, and R. U. Rehman. 2023. "Is There a Complementary or a Substitutive Relationship Between Climate Governance and Analyst Coverage? Its Effect on Climate Disclosure." *Business Strategy and the Environment* 32, no. 6: 3445–3464.
- Ge, W., Z. Qi, Z. Wu, and L. Yu. 2025. "Abnormal Temperatures, Climate Risk Disclosures and Bank Loan Pricing: International Evidence." *British Journal of Management* 36, no. 2: 726–744.
- Gebhardt, M., A. Schneider, F. Siedler, P. Ottenstein, and H. Zülch. 2024. "Climate Reporting in the Fast Lane? The Impact of Corporate Governance on the Disclosure of Climate-Related Risks and Opportunities." *Business Strategy and the Environment* 33, no. 7: 7253–7272.
- Griffin, P. A., and E. Y. Sun. 2024. "Climate-Related Financial Risk: Insights From a Semisystematic Review of the Literature and Implications for Financial Reporting." *International Journal of Accounting* 59, no. 2: 2450007.
- Gulluscio, C., P. Puntillo, V. Luciani, and D. Huisinigh. 2020. "Climate Change Accounting and Reporting: a Systematic Literature Review." *Sustainability* 12, no. 13: 5455.
- Hales, J. 2023. "Everything Changes: A Look at Sustainable Investing and Disclosure Over Time and a Discussion of "Institutional Investors, Climate Disclosure, and Carbon Emissions". *Journal of Accounting and Economics* 76, no. 2–3: 101645.
- Haque, F., and M. J. Jones. 2020. "European Firms' Corporate Biodiversity Disclosures and Board Gender Diversity From 2002 to 2016." *British Accounting Review* 52, no. 2: 100893.
- He, F., L. Duan, Y. Cao, and S. Wen. 2024. "Green Credit Policy and Corporate Climate Risk Exposure." *Energy Economics* 133: 107509.

- Hristov, I., and C. Searcy. 2025. "Integrating Sustainability With Corporate Governance: a Framework to Implement the Corporate Sustainability Reporting Directive Through a Balanced Scorecard." *Management Decision* 63, no. 2: 443–467.
- Hu, H., E. Lazar, J. Pan, and S. Wang. 2024. "Environmental Performance and Credit Ratings: a Transatlantic Study." *International Review of Financial Analysis* 96: 103635.
- Huang, S., and J. Ge. 2025. "Do Environmental Regulations Truly Reduce Risks? Evidence From the Heterogeneity of Resource-Based Cities." *Risk Analysis*.
- Huiskamp, U., B. ten Brinke, and G. J. Kramer. 2022. "The Climate Resilience Cycle: Using Scenario Analysis to Inform Climate-Resilient Business Strategies." *Business Strategy and the Environment* 31, no. 4: 1763–1775.
- Hummel, K., C. Schlick, and M. Fifka. 2019. "The Role of Sustainability Performance and Accounting Assurors in Sustainability Assurance Engagements." *Journal of Business Ethics* 154, no. 3: 733–757.
- Jérôme, T., and C. Poretti. 2025. "Stock Market Reaction to the Voluntary Adoption of Nature-Related Financial Disclosure: an Event Study." *Finance Research Letters* 71: 106389.
- Kedward, K., Ryan-Collins, J., and H. Chenet. 2023. "Biodiversity Loss and Climate Change Interactions: Financial Stability Implications for Central Banks and Financial Supervisors." *Climate Policy* 23, no. 6: 763–781.
- Kerret, D., and G. M. Gray. 2007. "What Do We Learn From Emissions Reporting? Analytical Considerations and Comparison of Pollutant Release and Transfer Registers in the United States, Canada, England, and Australia." *Risk Analysis: An International Journal* 27, no. 1: 203–223.
- Khurshid, R., and A. U. Islam. 2025. "ESG Literature Mapping: Insights From Bibliometric Analysis." *International Journal of Disclosure and Governance* 22, no. 2: 476–503.
- Kraft, B. 2018. "Shedding Light on Stakeholder Power in a Regulated Market: A Study of Variation in Electric Utilities' Climate Change Disclosures." *Organization & Environment* 31, no. 4: 314–338.
- Krueger, P., Z. Sautner, and L. T. Starks. 2020. "The Importance of Climate Risks for Institutional Investors." *Review of Financial Studies* 33, no. 3: 1067–1111.
- Lee, C. C., H. Song, and J. An. 2024. "The Impact of Green Finance on Energy Transition: Does Climate Risk Matter?" *Energy Economics* 129: 107258.
- Lee, S., and M. Z. Alam. 2024. "The Impact of Climate Risk on Bank Profitability Through Liquidity Creation Channel: Empirical Evidence From G7 Countries." *Journal of Asset Management* 25, no. 7: 726–739.
- Lodh, S., N. Deshmukh, and A. Rohani. 2024. "Stemming the Tide: Does Climate Risk Affect M&A Performance?" *Business Strategy and the Environment* 33, no. 2: 858–881.
- Maechler, S., and V. Boisvert. 2024. "Valuing Nature to Save It? The Centrality of Valuation in the new Spirit of Conservation." *Global Environmental Politics* 24, no. 1: 10–30.
- Maniora, J. 2018. "Mismanagement of Sustainability: What Business Strategy Makes the Difference? Empirical Evidence From the USA." *Journal of Business Ethics* 152, no. 4: 931–947.
- Marco-Fondevila, M., and I. Álvarez-Etxeberria. 2023. "Trends in Private Sector Engagement With Biodiversity: EU Listed Companies' Disclosure and Indicators." *Ecological Economics* 210: 107864.
- Morrison, L. J., J. Jia, and M. P. Arora. 2024. "Decoupling the Climate Walk From the Climate Talk: Evidence From Australia." *Business Strategy and the Environment* 33, no. 7: 7368–7382.
- Nieto, M. J., and C. Papathanassiou. 2024. "Financing the Orderly Transition to a Low Carbon Economy in the EU: the Regulatory Framework for the Banking Channel." *Journal of Banking Regulation* 25, no. 2: 112–126.
- O'Dwyer, B., and J. Unerman. 2020. "Shifting the Focus of Sustainability Accounting From Impacts to Risks and Dependencies: Researching the Transformative Potential of TCFD Reporting." *Accounting, Auditing & Accountability Journal* 33, no. 5: 1113–1141.
- Orazalin, N., C. G. Ntim, and J. K. Malagila. 2024. "Understanding the Relation Between Climate Change Risks and Biodiversity Disclosures: An International Analysis." *Journal of Accounting Literature*.
- Orpiszewski, T., M. J. Thompson, and P. Schwendner. 2024. "The Stock and Option Market Response to Negative ESG News." *International Journal of Accounting*: 2440002.
- Pankratz, N., R. Bauer, and J. Derwall. 2023. "Climate Change, Firm Performance, and Investor Surprises." *Management Science* 69, no. 12: 7352–7398.
- Pham, L., D. Hay, A. Miihkinen, E. R. Myllymäki, L. Niemi, and J. Sihvonen. 2024. "Climate Risk Disclosures and Auditor Expertise." *British Accounting Review*: 101439.
- Rising, J., M. Tedesco, F. Piontek, and D. A. Stainforth. 2022. "The Missing Risks of Climate Change." *Nature* 610, no. 7933: 643–651.
- Roberts, L., A. Hassan, A. Elamer, and M. Nandy. 2021. "Biodiversity and Extinction Accounting for Sustainable Development: a Systematic Literature Review and Future Research Directions." *Business Strategy and the Environment* 30, no. 1: 705–720.
- Rogelj, J., M. Den Elzen, N. Höhne, et al. 2016. "Paris Agreement Climate Proposals Need a Boost to Keep Warming Well Below 2 C." *Nature* 534, no. 7609: 631–639.
- Sambo, B., M. Bonato, A. Sperotto, et al. 2023. "Framework for Multirisk Climate Scenarios Across System Receptors With Application to the Metropolitan City of Venice." *Risk Analysis* 43, no. 11: 2241–2261.
- Shabir, M., P. Jiang, Y. Shahab, W. Wang, Işık, Ö., and I. Mehroush. 2024. "Diversification and Bank Stability: Role of Political Instability and Climate Risk." *International Review of Economics and Finance* 89: 63–92.
- Solimene, S., D. Coluccia, S. Fontana, and A. Bernardo. 2025. "Formal Institutions and Voluntary CSR/ESG Disclosure: The Role of Institutional Diversity and Firm Size." *Corporate Social Responsibility and Environmental Management* 32: 5147–5166.
- Stefanescu, C. A. 2022. "Linking Sustainability Reporting Frameworks and Sustainable Development Goals." *Accounting Research Journal* 35, no. 4: 508–525.
- Suchman, M. C. 1995. "Managing Legitimacy: Strategic and Institutional Approaches." *Academy of Management Review* 20, no. 3: 571–610.
- Talbot, D., and O. Boiral. 2018. "GHG Reporting and Impression Management: an Assessment of Sustainability Reports From the Energy Sector." *Journal of Business Ethics* 147: 367–383.
- Tarmuji, I., R. Maelah, and N. H. Tarmuji. 2016. "The Impact of Environmental, Social and Governance Practices (ESG) on Economic Performance: Evidence From ESG Score." *International Journal of Trade, Economics and Finance* 7, no. 3: 67–74.
- Taylor, N. 2023. "Making Financial Sense of the Future: Actuaries and the Management of Climate-Related Financial Risk." *New Political Economy* 28, no. 1: 57–75.
- Todaro, N. M., F. Testa, T. Daddi, and F. Iraldo. 2021. "The Influence of Managers' Awareness of Climate Change, Perceived Climate Risk Exposure and Risk Tolerance on the Adoption of Corporate Responses to Climate Change." *Business Strategy and the Environment* 30, no. 2: 1232–1248.
- Treepongkaruna, S. 2024. "Corporate Sustainability and Biodiversity Reporting: a Proactive Business Strategy to Mitigate Litigation and Reputational Risks." *Business Strategy and the Environment* 33, no. 7: 6640–6651.

- Trim, I., and A. Jones. 2025. "Do the World's Largest Companies Integrate Natural Capital Risks and Opportunities Into Their Operations in a Meaningful Way?" *Biological Conservation* 302: 110916.
- Troullaki, K., S. Rozakis, and V. Kostakis. 2021. "Bridging Barriers in Sustainability Research: A Review From Sustainability Science to Life Cycle Sustainability Assessment." *Ecological Economics* 184: 107007.
- Tumewang, Y. K., C. G. Ntim, and F. Haque. 2025. "Task Force on Climate-Related Financial Disclosures: A Systematic Literature Review and Future Research Agenda." *Business Strategy and the Environment*.
- Velte, P. 2021. "Determinants and Consequences of Corporate Social Responsibility Assurance: a Systematic Review of Archival Research." *Society and Business Review* 16, no. 1: 1–25.
- Vestrelli, R., A. F. Colladon, and A. L. Pisello. 2024. "When Attention to Climate Change Matters: the Impact of Climate Risk Disclosure on Firm Market Value." *Energy Policy* 185: 113938.
- Yang, P., T. Fiedler, and C. Free. 2024. "The Visibility of Climate-Related Disclosures by Large Australian Companies." *Australian Accounting Review* 34, no. 4: 265–282.
- Yoon, B., Y. Choi, and G. H. Kim. 2025. "Regulatory Trends in Climate Disclosure: a Focus on Implications for Industrial Transition." *Journal of Cleaner Production* 521: 146087.
- Zennaro, G., G. Corazza, and F. Zanin. 2024. "The Effects of Integrated Reporting Quality: a meta-Analytic Review." *Meditari Accountancy Research* 32, no. 7: 197–235.
- Zheng, L., and K. Iatridis. 2022. "Friends or Foes? A Systematic Literature Review and Meta-Analysis of the Relationship Between eco-Innovation and Firm Performance." *Business Strategy and the Environment* 31, no. 4: 1838–1855.

Appendix

Table for search strategy

Group	Keywords	Number of publications	Comments
Stage 1: General search			
A	"TCFD*" OR "Task Force on Climate-related Financial Disclosures*" OR "Climate Disclosure*" OR "Climate-related Reporting*" OR "Climate risk"	5684	General search in TCFD and climate disclosure
B	"TNFD*" OR "Task Force on Nature-related Financial Disclosures*" OR "Nature Disclosure*" OR "Biodiversity disclosure*" OR "Natural Capital"	4621	General search in TNFD and nature capital
C	"Risk Evaluation*" OR "Disclosure*" OR "Reporting*" OR "Indicators*" OR "Natural Capital Valuation*" OR "Transparency"	1,299,171	General search in risk assessment
D	"Risk Evaluation*" OR "Disclosure*" OR "Reporting*" OR "Indicators*" OR "Natural Capital Valuation*" OR "Transparency"	1,611,809	General search in risk evaluation
Stage 2 Integrated search			
E	Group A and Group C	2127	Research in TCFD and risk assessment
F	Group A AND Group D	860	Research in TCFD and risk evaluation
G	Group B and Group C	336	Research in TNFD and risk assessment
H	Group B AND Group D	678	Research in TNFD and risk evaluation

Appendix

Conceptual framework.

