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**Business Climate Adaptation and Resilience.
A Systematic Literature Review (2013-2023)**

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Business Climate Adaptation and Resilience. A Systematic Literature Review (2013-2023)

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Abstract

Climate change is causing significant disruptions to the socio-ecological systems in which organisations operate. To navigate these turbulent times, businesses must develop robust strategies to manage climate-related risks and uncertainties. In this context, climate adaptation and climate resilience are no longer peripheral concerns but central to organisational viability and competitive advantage. This SLR examines a decade of research on business climate adaptation and resilience, spanning from 2013 to 2023. Employing a novel methodological framework that integrates bibliometric techniques and machine learning methods, this review synthesises the evolution of theoretical and empirical studies in the field. It identifies key themes, including sector-specific adaptation strategies, resilience-building approaches, and knowledge gaps across industries. The findings highlight the uneven growth in research across different sectors and underscore the urgent need for long-term strategic planning to enhance climate resilience. This paper provides valuable insights for scholars, practitioners, and policymakers, guiding future research and informing strategies for improving business responses to climate change.

JEL CLASSIFICATIONS: Q54; Q56; M19

Keywords: climate adaptation; climate resilience; Systematic Literature Review; business resilience; climate change.

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1. Introduction

The escalating impacts of climate change are causing significant disruptions to the socio-ecological systems in which organisations operate (IPCC, 2022). Rising global temperatures, shifting precipitation patterns and the increasing frequency and intensity of extreme weather events are presenting unprecedented challenges for businesses across sectors (Winn et al., 2011). While certain industries, such as agriculture and tourism, are particularly vulnerable due to their climate-sensitivity (Kaján & Saarinen, 2013; Masud et al., 2017), the risks associated with climate change directly or indirectly affect the entire productive system along value chains (Howard-Grenville et al., 2014). These risks differ fundamentally from typical business challenges such as regulatory changes, market fluctuations, or technological shifts, due to their scale, unpredictability, and long-term nature (Linnenluecke & Griffiths, 2010; Howard-Grenville & Lahneman, 2021). To navigate these turbulent times and seize opportunities arising from climate change, businesses must not only commit to reducing the environmental impact of their activities through climate mitigation efforts, but also develop robust strategies to manage climate-related risks and uncertainties (Klein et al., 2005). In this context, climate adaptation (defined as longer-term adjustments in response to actual or anticipated environmental changes) and climate resilience (the capacity to absorb and recover from climate-related disruptions) are no longer peripheral concerns but central to organisational viability and competitive advantage (Busch, 2011). More broadly, as essential components of human communities, businesses play a crucial role in developing responses commensurate with the challenges posed by climate change (Berkhout et al., 2012; Nyberg & Wright, 2022). Although the topic of organisational climate resilience emerged in management literature nearly three decades ago (Hart, 1995; King, 1995), research remained scarce and fragmented until recently (Linnenluecke et al., 2013). Over the past decade, driven by growing evidence and intensity of climate change, as well as increased attention from businesses, governments, and international organisations to the challenges related to climate adaptation and resilience, research in this field has gained substantial momentum (Díaz Tautiva et al., 2024). Given the rapid expansion of literature on this subject, there is a pressing need for an updated comprehensive synthesis to take stock of current knowledge, identify key themes and gaps, and chart directions for future research. This article aims to address this need by providing a systematic review of research on business climate adaptation and resilience published over the past decade (2013-2023). Specifically, our review seeks to address the following questions:

RQ1. How has research on business climate adaptation and resilience evolved over the past decade in terms of theoretical developments and empirical findings?

RQ2. What gaps exist in the current literature, and what are promising directions for future research?

To address these questions effectively in the context of rapidly expanding scientific output, we propose a novel methodological framework for conducting Systematic Literature Reviews (SLRs). This approach combines bibliometric methods and advanced machine learning techniques to process large-scale bibliographic corpora efficiently. By synthesising and critically reviewing the current state of knowledge on organisational climate adaptation and resilience, this review aims to provide scholars, practitioners, and policymakers with a comprehensive understanding of the field. This can inform more effective strategies for enhancing organisational responses in the face of escalating climate challenges and guide future research efforts to address critical knowledge gaps.

The paper is structured as follows: Section 2 provides a theoretical background on organisational climate adaptation and resilience. Section 3 outlines our novel methodological approach for conducting Systematic Literature Reviews. Section 4 presents our findings, encompassing both the bibliometric analysis and the narrative synthesis of literature. Finally, in the last section we discuss the implications of our findings, identify research gaps, and propose directions for future research.

2. Theoretical Background

The integration of environmental concerns into business and management studies has been gradual and challenging. As Gladwin et al. (1995) and others (Howard-Grenville & Lahneman, 2021; Nyberg & Wright, 2022) have noted over different periods, business and management scholars have struggled to incorporate variables beyond the economic sphere in their research. This stemmed from inherent difficulties in conceptualising the economic system as a subset embedded within broader social and environmental systems (Daly, 1974). However, there were notable exceptions to this trend. As early as 1995, King introduced in management research the concept of "ecological surprises": potential sudden, unexpected

environmental changes that could significantly impact business operations (King, 1995). King's work underscored the importance of organisational preparedness and adaptability in the face of environmental uncertainties, laying the groundwork for subsequent research on climate adaptation in business. Over a decade later, a significant shift occurred with Berkhout et al.'s (2006) paper, one of the first to adopt an organisation-focused perspective on climate adaptation. This work established several key research directions that have since become prominent in the field. The paper proposed a typology of business responses to climate change, analysed internal factors influencing adaptation approaches, and challenged the simplistic notion of adaptation as a straightforward response to climate stimuli. Instead, it portrayed adaptation as a complex, iterative learning process involving search, experimentation, and feedback.

Linnenluecke & Griffiths (2010) marked another important milestone in the literature by identifying the two main dimensions of organisational response to climate change: adaptation, defined as "longer-term adjustments that organisations can take in response to actual or predicted environmental change," and resilience, understood as the business capacity "to absorb the impact and recover from drastic environmental change associated with weather extremes." Empirically, the distinction between these two dimensions is not always clear-cut as they often intersect and overlap. Similarly, in the literature, there is no consensus on the boundaries between these two concepts. A clear example in this regard is the influential paper by Busch (2011), which refers to adaptation as both "steady changes of mean temperatures and increasing frequency and intensity of extreme weather events" and proposes an empirically-derived framework for how organisations can build the capacity to adapt to both immediate responses to extreme weather events and longer-term adjustments to gradual environmental changes. Nevertheless, in the present review, we have decided to adopt the conceptual categories of adaptation and resilience as heuristic tools, considering them useful for highlighting the main aspects of organisational responses to climate change. This approach is supported by the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2022), which defines adaptation as "In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects" and resilience as "the capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure".

Linnenluecke et al.'s (2013) review was a significant milestone in organisational climate adaptation research. As the first comprehensive review on the topic, it critically assessed the then-sparse literature across individual, firm, industry, and institutional levels. It also set the agenda for subsequent research by identifying key areas needing attention, such as the gap in cross-disciplinary work integrating findings from the natural sciences into business thinking on climate adaptation and by calling to expand traditional firm adaptation perspectives to account for the complex, uncertain, and far-reaching impacts of climate change.

In the last decade the field has witnessed significant growth and diversification. Researchers have explored climate adaptation and resilience across various sectors, scales, and geographical contexts, generating rich empirical insights and further refining theoretical frameworks. However, as our analysis will reveal, this growth has been uneven, with some areas seeing substantial progress while others remain underexplored. The present study aims to provide a comprehensive assessment of these developments, mapping the evolution of the field over the past decade. By doing so, we seek not only to take stock of current knowledge but also to chart a course for future research that can further enhance our understanding of how businesses can effectively adapt to and build resilience against climate disruptions in an era of unprecedented environmental change.

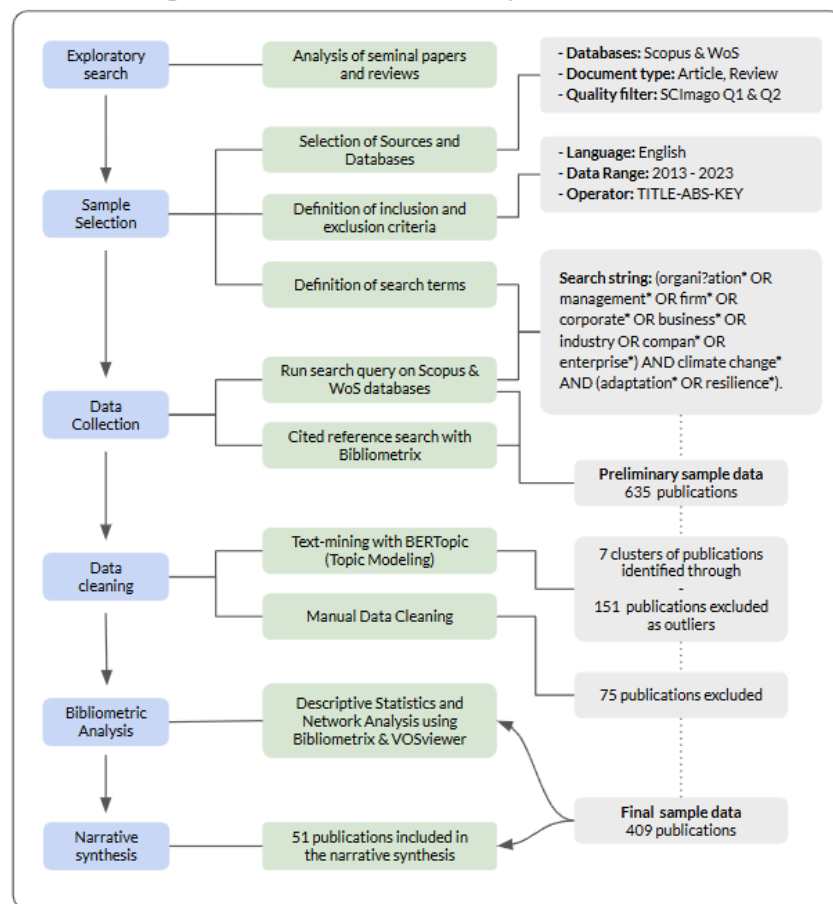
3. Methodology

Over the past decade, there has been a significant surge in the annual output of scientific publications across all disciplines, largely attributed to the “publish or perish” imperative (Grimes et al., 2018). This growth has led to an information overload, with scholars finding it increasingly challenging to keep pace with the sheer volume of articles being published in their respective fields (Parolo et al., 2015; Severin & Chataway, 2021). This issue becomes particularly pronounced for researchers undertaking the task of conducting systematic literature reviews as the goal of such reviews is to produce comprehensive scholarly syntheses that consolidate all relevant empirical evidence on a specific research area.

To address this issue, our study introduces a novel, integrated approach to Systematic Literature Reviews (SLRs). We developed a methodological framework, illustrated in **Figure 1**, that combines bibliometric methods (Donthu et al, 2021) and advanced machine learning

techniques (Vayansky & Kumar, 2020) to process large-scale bibliographic corpora. This framework aims to serve as a valuable tool for scholars seeking to obtain a comprehensive and accessible overview of the state of the art of research in their field of interest in a time-efficient manner. Additionally, it is highly effective for identifying the most relevant and impactful publications in a given area. The transparency, replicability, and coherence of the proposed framework are ensured by adherence to the PRISMA protocol for Systematic Reviews (Moher et al., 2009).

Figure 1 - Methodological Framework



Authors' elaboration

To begin our research process, in April 2024, we conducted an exploratory search. Our approach involved two main components. First, we selected and reviewed papers with high normalised citation counts (e.g. Busch, 2011; Steiger et al., 2019). Normalised citations are widely acknowledged as a reliable impact indicator, as they enable a comparable assessment of citation impact across papers, adjusted for publication year (Bornmann, 2015). Secondly, we thoroughly examined key literature reviews addressing firm adaptation to climate change

and related topics (Linnenluecke et al., 2013; Howard-Grenville & Lahneman, 2021; Díaz Tautiva et al., 2024). This preliminary step served three crucial purposes: it enabled us to align our perspective with the current scholarly discourse, identify prominent theoretical frameworks, and compile a list of frequently used keywords in the field of climate adaptation in business.

The second step encompassed defining the sources and databases for our search. Following best practices in the field (Paul et al., 2021), we selected Web of Science and Scopus as our primary databases. Recognizing the individual limitations of each database, we opted to combine the results from both sources, a strategy widely recommended in recent literature (Kraus et al., 2020, 2022). Within the datasets, we restricted our query to the "article" and "review" categories, thereby focusing on publications that have undergone peer review and thus been subject to academic quality control measures (Seuring et al., 2021). With regards to the selection of sources, to ensure that our review remained firmly anchored within the disciplinary context of Business and Management studies, and to guarantee the overall quality of our output, we restricted our search to articles published in journals listed in the first and second quartiles of the Scimago Business Management and Accounting journal ranking (www.scimagojr.com, last accessed 1st of September 2024).

Step three entailed establishing clear inclusion and exclusion criteria to refine our search results. We limited our query to articles published in English and, in accordance with our research objectives, restricted our search to publications from the last decade (2013–2023). Our cut-off date was set at December 2023, which allowed us to include articles published or made available in early access up to this point. To ensure comprehensive coverage while maintaining semantic relevance, we chose to confine our search to titles, abstracts, and keywords of scientific publications.

The fourth step involved crafting a comprehensive search string. Drawing from literature reviews and seminal papers identified during our exploratory search, we developed the following query: ("organi?ation*" OR "management*" OR "firm*" OR "corporate*" OR "business*" OR "industry" OR "compan*" OR "enterprise*") AND "climate change*" AND ("adaptation*" OR "resilience*").

Step five was data collection. We executed our search query on April 16, 2024, in both Scopus and Web of Science Core Collection databases. The Scopus query yielded 386 documents, while the Web of Science query produced 624 entries. After merging the datasets

from Scopus and Web of Science and eliminating duplicates, we obtained a consolidated set of 630 unique articles. To ensure comprehensive coverage, we conducted a cited reference search using the Bibliometrix tool (Aria & Cuccurullo, 2017). This approach, widely used to enhance the thoroughness of systematic reviews (Garfield, 2004), allows to identify locally highly cited publications that are not part of an initial dataset. Through this process, we identified 5 additional relevant publications that were not captured by our initial search, possibly due to the absence of key terms in their metadata. These were manually added to our dataset.

The sixth step involved data cleaning, which consisted of two phases. We began by performing topic modeling on the abstracts of publications in our dataset. Topic models are a class of unsupervised ML techniques designed for extracting latent variables from large sets of data (Vayansky & Kumar, 2020; Churchill et al., 2022). They are particularly effective for identifying latent themes within textual data, but their applications extend to other fields, including environmental science and bioinformatics (Girdhar et al., 2014; Liu et al., 2016). Instead of using the widely-adopted Latent Dirichlet Allocation (LDA) model (Meena & Kumar, 2022; Wu et al., 2023) or its extensions, we opted for the BERTopic machine learning algorithm (Grootendorst, 2022). This choice was motivated by BERTopic's superior capacity in capturing the semantic nuances of text (Ma et al., 2024) and its distinctive feature of identifying a "noise" topic. This feature prevents the misclassification of unrelated documents, thereby enhancing the overall quality of topic representations. Employing the BERTopic algorithm (v0.16.4), we were able to cluster the publications in our dataset into seven distinct semantic clusters while also identifying 151 outlier documents that did not align with any of the identified topics. These latter publications, while containing our search string terms, primarily focused on climate mitigation, urban adaptation policies, or public policies on adaptation and resilience. The second phase of our data cleaning involved a manual review process. Two independent reviewers scrutinised the title and abstract of each record in our preliminary sample to assess its relevance for inclusion in the review or classification as an outlier. In cases where both reviewers concurred on a publication's inclusion or exclusion, it was accordingly re-categorized. This process resulted in the removal of an additional 75 publications from the dataset. Following this comprehensive cleaning procedure, our final dataset comprised 409 records spanning 108 distinct publication sources. For transparency and to facilitate replication, a comprehensive list of both included and excluded papers is provided in the supplementary material. The integration of topic modeling

strengthened our methodological framework significantly. First, BERTopic's preliminary identification of outliers and semantic clustering provided a structured framework that streamlined the subsequent manual review process. Second, the combination of computational and human verification provided methodological triangulation, leveraging the pattern-recognition capabilities of ML alongside the contextual understanding of human expertise. Third, the topic modeling results directly informed the organisation of our narrative synthesis, with the identified clusters serving as the foundational structure for presenting our findings. A visual representation and in-depth analysis of the topic modeling results will be elaborated upon in the next chapter.

Step seven focused on bibliometric analysis, using two of the most widely employed tools in bibliometric research: Bibliometrix (Aria & Cuccurullo, 2017) and VOSviewer (Van Eck & Waltman, 2010). Bibliometrics applies statistical methods to analyse data such as publication and citation counts (Broadus, 1987). This approach has become increasingly popular in business and management research in recent years (Donthu et al., 2020, Khan et al., 2021), driven by the development of tools like Bibliometrix and VOSviewer, and by the growing availability of large scientific databases like Web of Science and Scopus. Its popularity also reflects the growing need for efficient tools to navigate the ever-expanding volume of scientific publications. In our study, we used Bibliometrix to perform descriptive statistics and VOSviewer to perform a co-citation analysis on our dataset. The results of our bibliometric analysis will be presented in the discussion section.

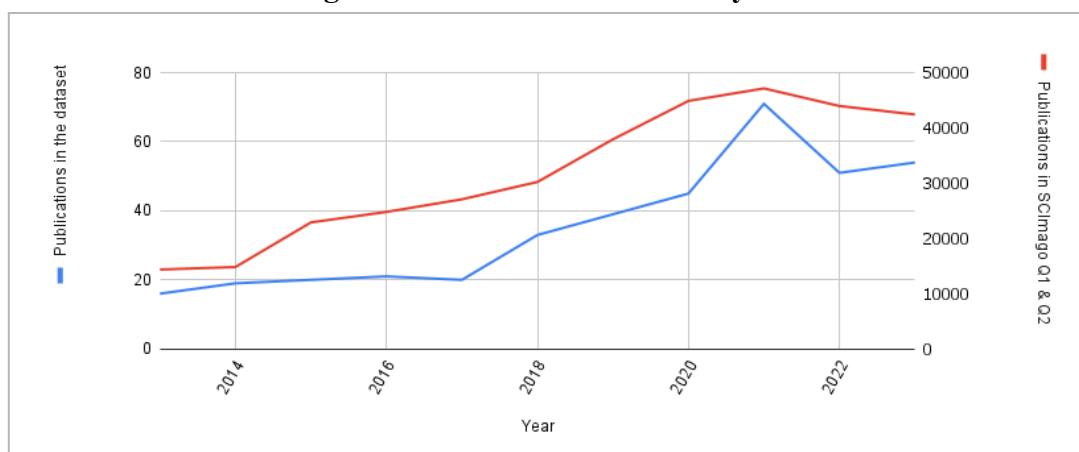
The final step was the narrative synthesis. First, two reviewers analysed the results obtained from clustering the publications through topic modeling and assessed their validity and effectiveness in representing the prevalent themes in our dataset. The evaluation was positive, leading to the decision to structure the narrative synthesis around the 7 clusters generated by the BERTopic algorithm. Due to the large number of papers in some clusters, a quantitative selection method was employed to identify the papers for comprehensive review. For each cluster, we selected the top 5th percentile of publications based on normalised citations, while ensuring a minimum of 5 publications per cluster, for a total of 39 articles. Additionally, the reviewers identified 18 further articles for full-text review that had been excluded from the quantitative selection but were deemed relevant for the study. Both reviewers thoroughly analysed the full text of the 57 selected articles. After this, the articles that were assessed by both reviewers as being appropriate for inclusion in the narrative synthesis were added to the final set. This process resulted in a total of 51 papers being included in the narrative review.

4. Results

4.1 Bibliometric Analysis

This section presents the results of our bibliometric analysis, including basic statistical characteristics and co-citation analysis. We begin by exploring the yearly output of research on business climate adaptation and resilience over the past decade, as shown in Figure 2. The graph reveals a substantial increase in scholarly production on this topic, with the number of annual publications tripling over the period. To contextualise this growth, we compared it to the overall increase in publications within the field of Business and Management, estimated using the upper 50th percentile of SCImago Business, Management and Accounting Journals. The compound annual growth rate⁵ (CAGR) of publications in our dataset was 12.92%, slightly higher than the 11.45% CAGR observed among scientific output in the sector overall. This comparison suggests that while research on climate adaptation is growing rapidly, it is largely in line with the general growth trend in business and management publications. This alignment suggests that the increasing output on our topic of research could be attributed to the broader trend of expanding scholarly production in the field.

Figure 2 - Publications over the years



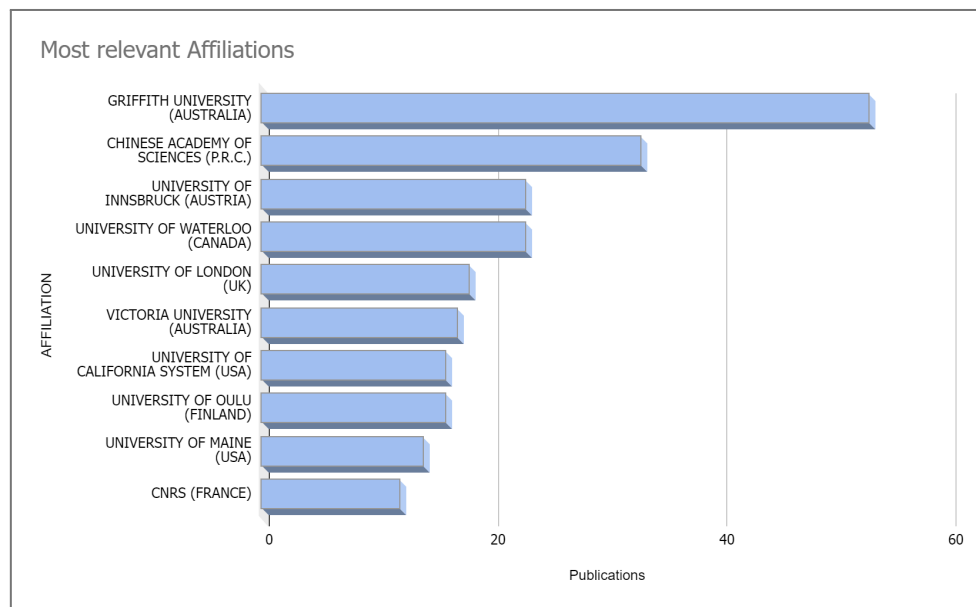
Authors' elaboration

Figure 3 illustrates the top 10 most prolific institutional affiliations in our dataset. Griffith University in Australia tops the list with 53 publications, primarily focusing on climate adaptation in tourism, followed by the Chinese Academy of Sciences, world's largest research organisation, with 33 articles. The list also includes some of the most prominent global

⁵ The compound annual growth rate is calculated as a geometric average of annual growth rates. It is commonly used in Business and Economics research.

research institutions, such as the French Centre National de la Recherche Scientifique (CNRS) and the federal systems of the University of London and University of California. Interestingly, the list also includes smaller institutions with substantial scientific output on climate adaptation in tourism, such as Victoria University (Australia) and the University of Maine (USA), as well as those prominent in the sub-field of adaptation in winter tourism, namely University of Waterloo (Canada), University of Oulu (Finland) and University of Innsbruck (Austria). The strong presence of institutions focused on tourism research, anticipates the results of our topic modeling analysis, which will be discussed in the following chapter.

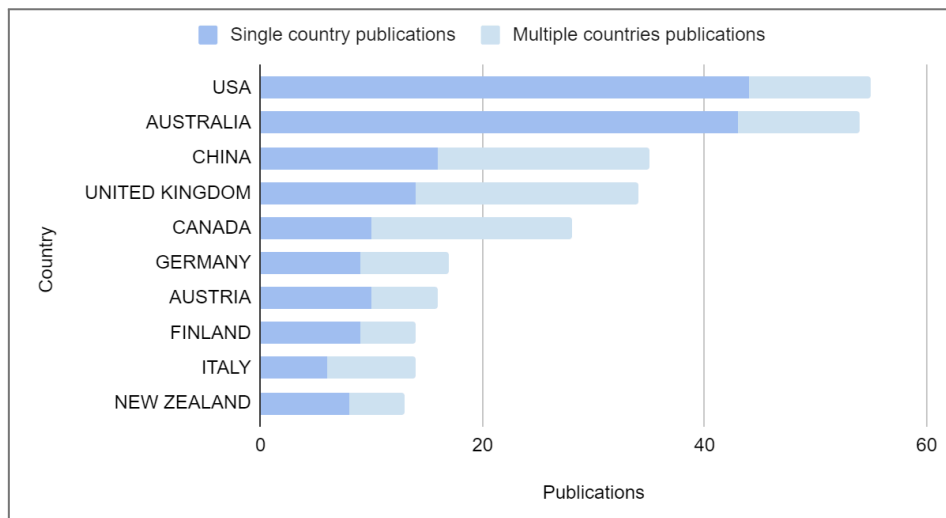
Figure 3 - Most relevant Affiliations



Authors' elaboration

Figure 4 presents an overview of the geographical distribution of research on firms' climate adaptation through a display of corresponding authors' countries. While scientific powerhouses like the USA, China, and the UK are well represented, the graph also highlights the significant contributions of countries that do not rank as highly in overall scientific output, such as Austria, Finland, and New Zealand. This suggests that the field benefits from both broad scientific capabilities and specialised expertise.

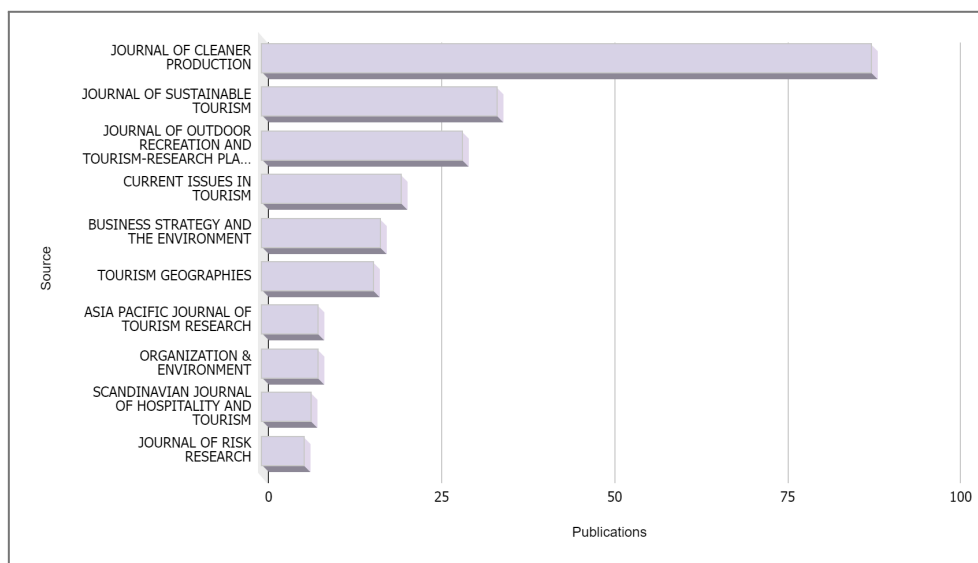
Figure 4 - Most relevant countries by corresponding author



Authors' elaboration

Figure 5 illustrates the most relevant journals within our dataset. The *Journal of Cleaner Production*, a leading source for transdisciplinary sustainability research, leads with 88 articles, followed by the *Journal of Sustainable Tourism* (34 articles) and the *Journal of Outdoor Recreation and Tourism* (29 articles). Notably, among the top 10 sources, six are tourism-related, underscoring the sector's prominence in climate adaptation research. The remaining top journals cover sustainable business practices (*Business Strategy and the Environment*, *Organization & Environment*), and risk management (*Journal of Risk Research*).

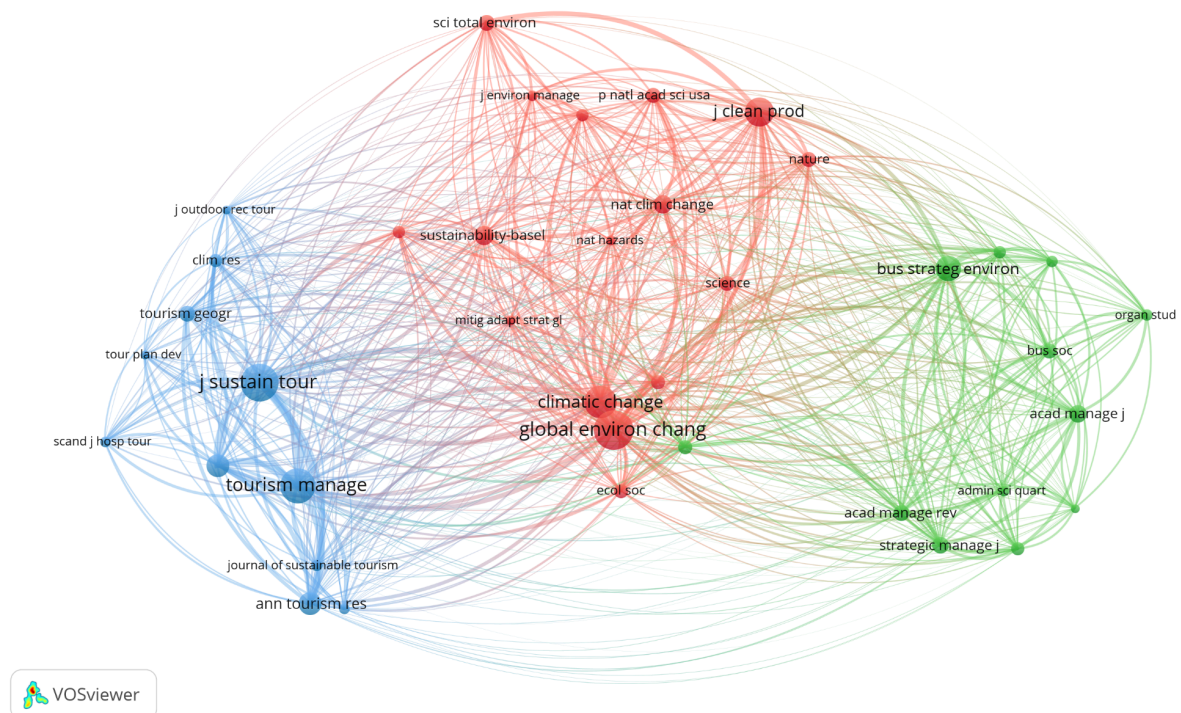
Figure 5 - Most relevant Sources



Authors' elaboration

To further explore the intellectual structure of the dataset, the VOSviewer clustering algorithm was employed to create a visual representation of the most cited sources within the dataset and their co-citation network (Figure 6). This analysis revealed three interconnected clusters representing distinct yet related research areas. The first cluster focuses on tourism management, with the *Journal of Sustainable Tourism* (578 citations) and *Tourism Management* (520 citations) as key nodes. The second cluster encompasses management studies, prominently featuring *Business Strategy and the Environment* (336) and the *Academy of Management Journal* (194). Bridging these two, the third cluster represents interdisciplinary climate change research, with *Global Environmental Change* (608) and *Climatic Change* (459) as central nodes. This visualisation demonstrates the significant engagement of management scholars studying climate adaptation with interdisciplinary and natural science literature. Moreover, it underscores, once again, tourism sector's prominence in academic discussions on climate adaptation.

Figure 6 - Co-citation network of cited sources

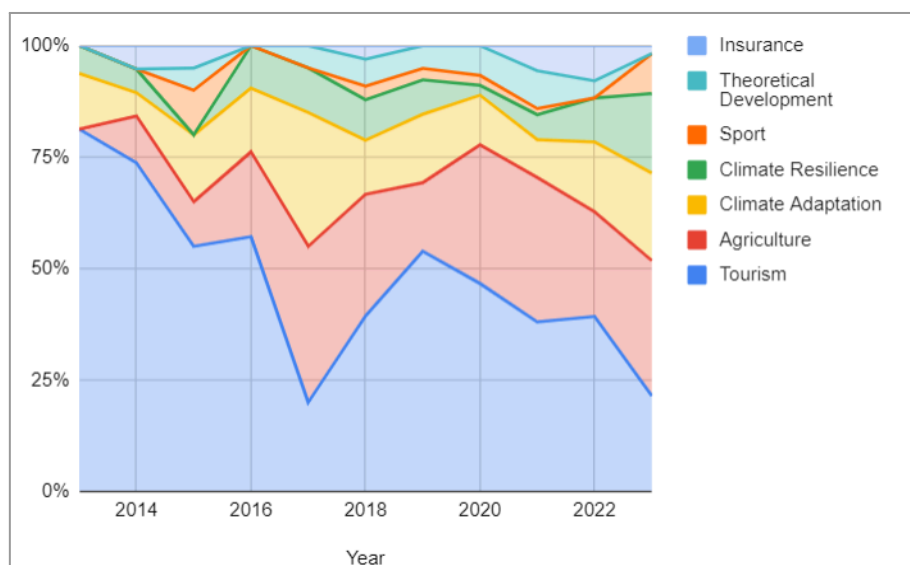


Authors' elaboration using the VOSviewer software

4.2 Narrative synthesis

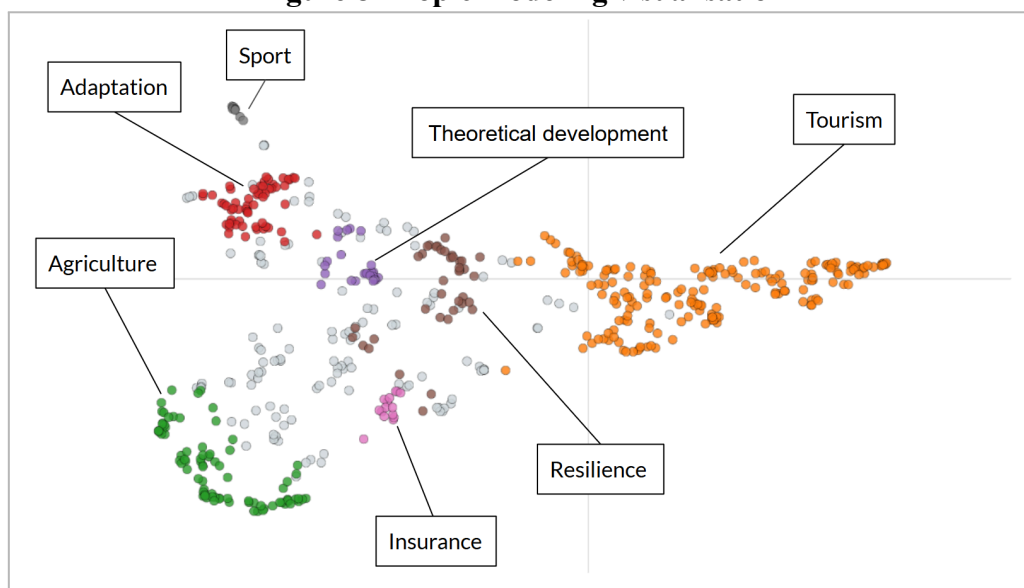
The results of our topic modeling analysis, visualised in Figures 7 and 8, offer valuable insights into the structure and key focus areas of research on climate adaptation and resilience. These findings provide a strong empirical basis for organising our narrative synthesis. The two figures present complementary views of the research landscape. Figure 7 illustrates the temporal evolution of publication distribution across different clusters, while Figure 8 provides a spatial representation of the relationships between these research areas.

Figure 7: Distribution of publications by year and cluster



Authors' elaboration

Figure 8 - Topic modeling visualisation



Authors' elaboration

Table 1 complements these visualisations by detailing the themes associated with each cluster and their respective publication percentages.

Table 1 - Topics' themes and distribution

Labelled cluster	%	Topics
Theoretical Development	4.4%	Theoretical works proposing new approaches in business and management studies to address environmental challenges.
Climate Adaptation	14.4%	Cross-industry adaptation studies at various levels, including individual decision-making, firm-level, industry-level, and institutional-level. It also includes a limited number of sector-specific studies in construction, property and utilities.
Climate Resilience	8.6%	Studies on business and supply-chain resilience to extreme weather events
Insurance	3.2%	Sector-specific papers exploring how insurance can help manage risks associated with climate change and natural disasters.
Agriculture	24.4%	Sectoral studies on climate adaptation and resilience strategies in the agricultural sector.
Tourism	42.3%	Sectoral studies on climate adaptation and resilience strategies in the tourism industry.
Sport	2.7%	Works exploring adaptation strategies employed by sports organisations to cope with climate change.

Authors' elaboration

A key observation, which will be further discussed in the next section, is that Tourism (42.3% of publications) and Agriculture (24.4%) have been dominant themes within the field over the last decade. However, examining the temporal trends in Figure 7 we can see that their relative share is decreasing over time, giving way primarily to increased focus on the Climate Adaptation and Climate Resilience clusters. This shift suggests a growing interest in broader, cross-sectoral approaches to climate challenges. Moreover, by analysing the spatial relationships between clusters in Figure 8, we observe that Tourism and Agriculture are partially isolated from the remainder, suggesting a degree of specialisation in their research focus within the broader field. In contrast, the Climate Adaptation and Climate Resilience clusters occupy more central positions in the graph, underscoring their pivotal role within this research domain. Notably, the spatial proximity of these two clusters confirms the conceptual relatedness of the concepts of adaptation and resilience, as discussed in the theoretical framework section. Of particular note is the central positioning of the Theoretical

Development cluster between Climate Adaptation and Climate Resilience, which suggests its fundamental role in informing both research areas. This positioning, moreover, highlights the significance of theoretical advancements in shaping the overall trajectory of climate adaptation and resilience research. Each of the research clusters identified through topic modeling will be explored in detail in the following paragraphs.

4.2.1 Theoretical Development

The conceptual papers in this cluster reveal a growing recognition within management scholarship of the inadequacy of traditional organisational theories in addressing the complex challenges posed by climate change. A key theme across several papers in the cluster is the need to have a significant shift from firm-centric approaches towards more holistic, cross-scale and systems-based perspectives. Howard-Grenville & Lahneman (2021) and Williams et al. (2021) argue for the integration of concepts derived from ecology and environmental sciences into management theory, emphasising the interdependencies between organisational resilience and broader social-ecological systems. In this sense, drawing from resilience theory in socioecology, Clément & Rivera (2017) apply the adaptive cycle concept to organisational transformation providing a valuable framework for understanding the non-linear nature of organisational responses to climate adversity. A key insight from their paper is the concept of maladaptive response: the authors argue that firms' protective adaptations to climate change (actions aimed at preserving existing core business features) may inadvertently degrade local ecosystems, thereby constraining their future adaptive capacity. This proposition underscores the interconnectedness of organisations and ecological systems, emphasising the relevance of 'feedback loops' between these systems and highlighting the need for a more holistic approach to organisational resilience. Nyberg & Wright (2022) offer a more radical perspective on the topic, arguing that management scholarship has been complicit in perpetuating unsustainable business practices by prioritising profit maximisation over ecological concerns. Their call for "climate-proofing" management research challenges the very foundations of business scholarship, advocating for a fundamental reimagining of organisational forms and practices in the face of the climate crisis. Moreover, they question the growth paradigm that has long dominated management thinking, highlighting that "economic growth has a much stronger connection to environmental degradation than to human well-being"; in response, they propose a series of alternative economic models compatible with the ecological limits of Earth's biophysical

systems. Doh et al.(2019)'s work is notable for its attempt to address some of the key challenges identified in the above-mentioned papers, particularly the need for more collaborative, cross-sector approaches to climate adaptation. The authors propose a novel framework of "collective environmental entrepreneurship" that attempts to bridge environmental entrepreneurship with cross-sector partnerships. Their approach recognizes that addressing Grand Challenges like climate change requires collaboration across private, public, and non-profit sectors. While this approach offers a potential path forward, it falls short of the more radical reconceptualization called for by scholars like Nyberg and Wright. These papers clearly demonstrate how diverse the perspectives on climate adaptation and resilience can be; this conceptual fragmentation is the central theme of Hillmann's (2021) comprehensive review on organisational resilience. Her work provides a critical analysis of the evolution of the concept of resilience in the business and management literature and highlights the multidisciplinary nature of research on this topic. However, it also underscores the conceptual ambiguity and lack of clarity in the field, with different disciplines offering varying and sometimes conflicting definitions, methodologies, and approaches to resilience. For these reasons, she argues that organisational resilience, in its current state, should be considered as an umbrella concept loosely encompassing a set of diverse organisational phenomena.

4.2.2 Climate Adaptation

The analysis of articles within this cluster reveals a broad consensus regarding the categories of climate risks facing businesses. These include physical, regulatory, and market risks. These risks have the potential to disrupt various aspects of a company's value chain, from resource supply to production and distribution (Weinhofer & Busch, 2013). Sakhel's (2017) study suggests that firms often recognize regulatory risks first, while frequently underestimating the long-term physical and market risks posed by climate change. This short-term focus is a recurring theme in the literature, highlighting the challenges companies face in integrating long-term climate risks into their strategic planning (Ng, 2018).

The impact of such myopia could prove costly for businesses. For instance, Zhang et al. (2018) provide compelling evidence of the tangible effects of global warming on business performance. Their study covering over 500,000 Chinese manufacturing plants reveals that high temperatures significantly reduce manufacturing output primarily through decreased total factor productivity (TFP). Their projections suggest that by the mid-21st century,

increased temperatures could reduce Chinese manufacturing output by 12% annually. Climate impacts also have significant financial implications for businesses, as demonstrated by Huang et al. (2022), who found that firms exposed to higher climate risks face less favourable financing conditions, including higher interest rates and more stringent covenant constraints. These findings underscore how climate risks permeate various aspects of business operations, affecting not only physical assets and processes but also financial stability and growth potential.

Climate Risk Management

Weinhofer & Busch (2013) demonstrate that firms generally employ a conventional three-phase approach to corporate risk management (identification, assessment, and response/adaptation) when addressing climate-related risks. However, the researchers uncover that companies often encounter significant challenges in effectively implementing this approach due to considerable uncertainty in assessing their exposure to climate risks, particularly extreme events. Building on these findings, Pinkse & Gasbarro (2019) reveal that firms with a higher perceived vulnerability and lower control over climate impacts are more likely to adopt non-routine adaptation measures.

Factors Influencing Adaptation Strategies

The choice and effectiveness of adaptation strategies can be influenced by various factors, both internal and external to the business. Focusing first on internal factors, the literature emphasises the crucial role of managerial perceptions and attitudes in shaping corporate responses. For instance, Bremer & Linnenluecke (2017), drawing on strategic choice theory, demonstrate that environmental attitudes and climate change knowledge serve as precursors to how decision-makers prioritise adaptation strategies. Their findings indicate that this relationship is mediated by the perceived risk associated with climate change. Delving deeper into perceived risk, Kump (2021) proposes an "environmental belief model" to elucidate the conditions under which environmental threats trigger organisational change. According to her model, managers are more likely to initiate change when they believe their firms are susceptible to climate threats, perceive these threats as serious, see the benefits of change outweigh the costs, and receive external cues prompting action. Moving from the managerial to the firm level, another significant internal factor that emerges is company size. Juhola et al. (2024), in their study of renewable energy companies in Finland, observe that larger

companies tend to be more familiar with climate risks and conduct more comprehensive assessments compared to smaller firms.

External factors, such as institutional pressures, also play a crucial role. Sakhel's (2017) empirical investigation suggests that regulatory frameworks, rather than market forces or physical threats, are the main drivers of corporate climate action. Regulated companies perceive significantly higher regulatory risks and implement more regulatory risk responses compared to their unregulated counterparts. Notably, however, no significant disparities emerge between regulated and non-regulated entities in their perceptions of, or responses to, physical and market risks. A limitation of Sakhel's study lies in its focus on the ETS (Emissions Trading System) as a regulatory model, given its flexible, market-based approach in contrast to more stringent command-and-control environmental policies. A more nuanced perspective on this topic is provided by Daddi et al. (2020). Drawing upon institutional theory their research examines how coercive, normative, and mimetic pressures influence companies' climate change sensitivity and the adoption of mitigation and adaptation strategies. Interestingly, it suggests that coercive pressures are negatively related to climate change sensitivity, while normative and mimetic pressures have a positive relationship.

A valuable contribution to the discussion, from a different perspective, is offered by Herrmann & Guenther (2017), who focus on the barriers that hinder companies from implementing climate change adaptation strategies, examining both internal and external factors. Concentrating on small and medium-sized enterprises (SMEs) within the supply chains of multinational enterprises (MNEs), they develop an empirically-derived scale of adaptation barriers comprising the following factors: corporate knowledge, corporate resources, corporate objectives, corporate processes, collective knowledge, and corporate incentives.

Implementing and improving adaptation strategies

The implementation of adaptation strategies varies widely across industries and firms, reflecting the diverse nature of climate-related risks and organisational contexts (Ng, 2018; Juhola et al., 2024). For instance, Weinhofer & Busch (2013) provide a detailed account of prevalent strategies within the energy sector, highlighting a focus on enhancing operational flexibility, optimising and innovating processes, and employing financial hedging and insurance mechanisms. Complementarily, Juhola et al. (2024) demonstrate that energy

production diversification and investment in emerging technologies are predominant strategies within the renewable energy sector.

The literature suggests several avenues for improving the effectiveness of corporate adaptation processes. Knowledge sharing and collaboration emerge as crucial elements. Orsato et al. (2019) explore how private companies can use social learning through communities of practice to develop strategies for anticipatory adaptation to climate change. Herrmann & Guenther (2017) emphasise the importance of collaboration and knowledge sharing between multinational enterprises and their suppliers in overcoming adaptation barriers. A comprehensive approach to climate adaptation is also crucial. Weinhofer & Busch (2013) advocate for a dual perspective, urging companies to adopt both an 'inside-out' approach to assess their impact on climate change and an 'outside-in' perspective to evaluate how shifting climate patterns may affect their business operations.

The reviewed literature also underscores critical policy implications for advancing climate adaptation in Business. Weinhofer & Busch (2013), and Juhola et al. (2024) emphasise that governments should facilitate access to climate data and projections, ensuring that businesses can integrate this knowledge into their risk assessment and strategic planning processes. Sakhel (2017) stresses the importance of policies that promote long-term planning and investment in adaptation, suggesting that well-designed regulatory frameworks are vital in motivating businesses to adopt effective adaptation strategies. More nuanced perspectives on regulation are offered by several scholars (Pinkse & Gasbarro, 2019; Daddi et al., 2020; Huang et al., 2022), arguing that policies which enable and incentivize proactive corporate climate adaptation (rather than relying solely on command-and-control regulations) can more effectively foster widespread adoption of adaptation strategies across the private sector.

4.2.3. Climate Resilience

Recent research has shed light on the diverse strategies that businesses employ to develop resilience in the face of climate-related risks and natural disasters. McKnight & Linnenluecke (2019) investigated the relationship between disaster types and firm responses. Their research highlights a key distinction between anticipatory and reactive strategies, correlating these approaches with specific disaster attributes. The study found that when disasters exhibit even impact dispersion and high expected recurrence, firms tend to employ anticipatory responses. Conversely, firms are more likely to resort to reactive responses when facing disasters with

erratic impact dispersion and lower expected recurrence. This pattern can be attributed to risk perception: when the likelihood of direct impact seems lower, businesses may be less motivated to allocate resources to preventive measures. Taking a more structured approach, Huiskamp et al. (2022) introduced the "climate resilience cycle," a framework rooted in the recommendations on scenario analysis by the Task Force on Climate-Related Financial Disclosures (TCFD). This cyclical model encompasses five distinct phases, offering businesses a methodical approach to scenario planning, impact assessment, and response formulation. The authors distinguish between two domains of resilience: stability, which focuses on the preservation of current operations despite disruptions, and change, which involves the transformation of business models to address evolving climate risks. While both studies contribute valuable insights to the field of business resilience, they approach the subject from different angles. McKnight & Linnenluecke (2019) provide empirical insights into corporate behaviour across various disaster scenarios, whereas Huiskamp et al. (2022) present a prescriptive framework for proactive resilience planning.

Within the academic debate on business resilience to climate-related risks, particular attention has been paid to the unique challenges faced by small and medium-sized enterprises (SMEs). Operating in resource-constrained environments, SMEs are especially vulnerable to climate-related risks. Halkos et al. (2018) explored the barriers SMEs face in building resilience to extreme weather events, identifying both internal and external obstacles. Internally, limited resources and managerial perceptions play a key role, while externally, institutional conditions and stakeholder support are crucial factors. Corroborating these findings, Bak et al. (2023), in their review of supply chain resilience in SMEs, emphasise that collaboration with customers and suppliers is critical for SMEs to achieve resilience and highlight that limited budgets and difficulty in obtaining financing restrict SMEs' ability to invest in resilience measures. However, they also reveal a silver lining, noting that SMEs' inherent agility and flexibility can serve as advantages in developing resilience strategies. Bak et al. also underscore the importance of information systems and technology adoption for SME resilience, though they acknowledge that resource constraints can limit such investments. Emerging technologies, particularly Artificial Intelligence (AI), are increasingly recognized as potential tools for enhancing business resilience to climate-related risks. In this context, Effah et al. (2023) explore how AI capabilities (such as predictive analytics and forecasting) can be leveraged to build resilience against extreme weather risks in the cocoa supply chain. Their study demonstrates how these machine learning-based technologies,

combined with remote sensing techniques, can be highly effective in preventing damage to supply chains caused by extreme weather events.

4.2.4. Insurance

The articles in this cluster paint a broad picture of the challenges and opportunities facing the insurance industry in adapting to climate change. A common theme across the studies is the particular vulnerability of the insurance sector to climate-related risks, due to its fundamental role as a risk management industry, designed to safeguard individuals and organisations against potential or uncertain losses (Stechemesser et al. 2015; Thistlethwaite & Wood, 2018). As climate change drives an increase in the frequency and intensity of extreme weather events, the financial burden on insurers escalates. This growing pressure underscores the need for the insurance industry to fundamentally reassess and adapt its operational frameworks to effectively manage these challenges. In light of this, Stechemesser et al. (2015) provide a foundational framework, through the lens of dynamic capabilities, for understanding how insurance companies are adapting to climate change. Drawing from Busch (2011), they identify three key organisational capabilities: climate knowledge absorption, climate-related operational flexibility, and strategic climate integration. These capabilities enable insurers to internalise climate-related information, adjust operations in the short term, and implement long-term strategic changes. The authors' empirical analysis reveals a positive relationship between these capabilities and financial performance, suggesting that proactive adaptation to climate change can generate competitive advantages. This hypothesis is further supported by Gatzert & Reichel's (2022) study on climate risk awareness in the insurance industry. Their findings reveal a positive association between climate risk awareness and firm value, as measured by Tobin's Q. Another significant insight from their study is the higher level of climate risk awareness observed among larger insurers and those in the property and casualty (P&C) sector. This outcome is logical, as larger insurers typically have more resources to allocate to emerging risks and may be more exposed to global trends due to their broader geographical reach. The heightened awareness among P&C insurers can be attributed instead to their direct exposure to physical climate risks through their coverage of property damage and business interruption. These differences in climate change awareness and adaptation between insurance sub-sectors are further confirmed by Thistlethwaite & Wood (2018), who explore the structural challenges the industry faces in adapting to climate change. They introduce the concept of "rescaling": the

need for insurers to adjust their risk management practices to account for the broader spatial and temporal aspects of climate risks. Their study finds that while reinsurers are more likely to adopt climate change risk management (CCRM) practices, most primary insurers continue to rely on "nested" organisational logics focused on short-term, localised risks rather than adapting to long-term, global climate risks. This discrepancy exemplifies what the authors term a "tragedy of the horizons," where insurers' inadequate preparation for future climate impacts not only jeopardises their financial stability but also poses systemic risks to the broader economy. However, while climate-related risks pose significant threats, they also present opportunities for the sector. On one hand, these challenges open avenues for sector growth through the development of innovative insurance products tailored to emerging climate risks. On the other hand, they position the insurance industry as a pivotal player in helping businesses across all sectors mitigate their climate-related risks. In this regard, Porrini & Schwarze (2014), in their review of European insurance models for addressing natural hazards, provide important insights into the potential dual role of insurance in climate adaptation. Firstly, the authors emphasise that insurance can serve both as a mechanism for post-disaster financial recovery and as a proactive tool for risk reduction. Insurers can incentivize risk-reducing behaviours among policyholders by offering lower premiums to those who implement measures to reduce their vulnerability to climate-related risks. This approach creates a virtuous cycle: as policyholders invest in adaptation measures, they reduce their risk exposure, which in turn allows insurers to offer more affordable coverage. Secondly, they discuss that, as new types of risks emerge due to climate change, there is a corresponding potential for the development of innovative insurance and financial products, such as catastrophe bonds (cat bonds), parametric insurance, and weather derivatives. These instruments represent a shift from traditional insurance models towards more sophisticated tools enabling access to additional funds to cover potential large-scale losses, facilitate risk transfer beyond the insurance sector to capital markets, and most importantly, expand the possibility of insuring against climate risks to disadvantaged populations. In this context, Biffis et al. (2022) highlight that weather index insurance has gained particular attention as a potential tool for managing climate risks, especially for smallholder farmers in developing countries. These products link payouts to objectively measurable weather indices, potentially overcoming problems of traditional crop insurance like moral hazard, adverse selection, and high administrative costs. However, as shown by Tadesse et al. (2015), despite its promise and continued pilot testing, actual uptake of weather index insurance has been far below

expectations in low-income countries, due to limitations, particularly regarding basis risk (the potential mismatch between index triggers and actual losses).

4.2.5. Agriculture

Agriculture stands at the forefront of climate change impacts, affected by both shifting weather patterns and increased frequency and intensity of extreme events (Masud et al., 2017). Papers in this cluster address various themes related to the adaptation and resilience of agricultural businesses to climate risks in different productive contexts. A significant portion of the literature focuses on the multidimensional factors influencing farmers' and fishermen's climate change adaptation behaviours and intentions. Arunrat et al. (2017) provide valuable insights into farmers' adaptation decisions in Thailand's Yom and Nan basins. Their research highlights how a combination of socio-economic factors, including access to credit, farm income, social capital, and agricultural experience, as well as receiving specific training and information on climate adaptation, significantly influences farmers' likelihood to implement adaptive strategies against floods and droughts. These findings are corroborated by Senyolo et al. (2018) in their paper studying the adoption of climate-smart agricultural technologies (CSA) in South Africa. They confirm the importance of economic means availability and the central role played by farmers' awareness and knowledge regarding the effects of climate change in leading to the adoption of climate-resilient technologies. Notably, the research suggests that involving farmers in the development of new technologies, within the framework of CSA policies and institutional interventions, can significantly boost the adoption rates of these innovations. The value of bottom-up approaches to climate change adaptation is further emphasised in Silas et al.'s (2020) study of small-scale coastal fisheries in Tanzania. Their work underscores the importance of integrating fishermen's practical experience and knowledge into governmental strategies for sustainable resource management, advocating for a more inclusive and grounded approach to policy development. An innovative perspective on the topic is offered by Canevari-Luzardo et al. (2020) in their work on agricultural value-chains in Jamaica. By analysing how business network dynamics influence firms' perceptions of climate risk and their adaptive behaviours, the authors reveal the profound impact of business relationships and network structures on firms' exposure, sensitivity, and capacity to adapt to climate risks. This approach suggests that effective climate adaptation strategies must transcend the boundaries of individual farms or firms, considering instead the intricate web of relationships that collectively shape adaptive

capacity. A recurring theme in the literature is water security and management in the face of changing climate patterns, particularly regarding drought risks. In this context, Yang et al. (2023) provide an in-depth analysis of water resource management in the arid Aksu River Basin in northwest China. Their study emphasises the need for adaptive management strategies that can respond to changing environmental conditions and socio-economic pressures. By proposing a "three red lines" policy focusing on limiting total water use, increasing efficiency, and maintaining ecological standards, they demonstrate how adaptive management can significantly reduce system vulnerability and improve resilience. A less explored but relevant theme in this cluster is the impact of climate change on agricultural labor productivity. Morabito et al. (2021) examined the health risks and productivity losses associated with heat exposure among agricultural workers in Italy, proposing adaptive strategies such as working in shaded areas or adjusting work hours. Their findings indicate that working in the shade could reduce productivity losses by over 80% compared to working in direct sunlight, while shifting work hours to earlier in the day could reduce losses by up to 33%. These results underscore the importance of human resource management in climate adaptation strategies.

A subset of six papers within the cluster examines climate adaptation in the wine industry, primarily in developed countries. Ollat et al. (2016) provide a broad perspective on the challenges and opportunities that climate change presents for the global wine industry. Their work demonstrates that climate change impacts are unevenly distributed across wine-growing regions, likely creating winners and losers among wine regions, with warmer areas potentially experiencing reduced wine quality and market competitiveness. The economic impact extends beyond immediate production concerns, potentially reshaping traditional wine hierarchies, with some regions losing their long-established reputations while others benefit from newly favourable conditions. The authors also highlight potential land and water conflicts that may arise as growers consider relocating vineyards to cooler or higher altitudes in response to changing climatic conditions. Adaptation solutions proposed by Ollat et al. (2016) encompass a combination of technical and organisational changes to ensure the survival and competitiveness of wine producers in this evolving landscape. Building on this topic, Galbreath et al. (2020) conducted an in-depth examination of how wineries in South Australia are adapting to variations in temperature and precipitation. Their findings indicate that wineries with robust internal learning systems (characterised by continuous knowledge acquisition, integration, and implementation) adapt more effectively to changing climatic

conditions. Their study also reveals that wineries with greater absorptive capacity are more likely to adopt innovative technologies and new grape varieties better suited to evolving climate patterns.

4.2.6 Tourism

The cluster on climate adaptation in tourism is the largest in our dataset, comprising 173 publications. This prominence can be attributed to the sector's inherent high sensitivity to climate change (Kaján & Saarinen, 2013). However, tourism's dependence on climate is not new. As Weir (2017) notes, environmental changes have consistently influenced tourism throughout history, with the sector demonstrating remarkable adaptability over time. Nevertheless, he emphasises that the scale and pace of contemporary climate change are unparalleled. This underscores the urgent need for adaptation strategies that meet these new challenges. In this context, Kaján and Saarinen (2013) highlight that climate adaptation in tourism is a complex phenomenon. Different systems (e.g., destinations, communities) are affected by climate change and different attributes (e.g., income, landscapes) are at risk. For this reason, they stress the importance of developing comprehensive adaptation strategies that extend beyond business-focused solutions and incorporate community-based approaches. In this context, Calgaro et al. (2014) propose the Destination Sustainability Framework (DSF). This framework is designed to assess the vulnerability and resilience of tourism destinations in the face of various shocks (such as natural disasters) and stressors (including climate change). They emphasise that feedback loops are crucial in climate adaptation for tourist destinations. These loops refer to the dynamic responses to shocks and stressors and how these responses impact future vulnerability and resilience in the system. Positive actions can lead to improved preparedness and greater resilience, while ineffective responses or inaction can create vicious cycles of increased vulnerability. The relationship between environmental adversity and adaptation strategies is further explored in the work of Rivera & Clément (2019). Their case study of U.S. ski resorts reveals that adaptation responses follow an inverted U-shaped curve in relation to the intensity of climate adversity. At low levels of adversity, organisational inertia and perceived stability limit adaptation efforts. As adversity increases to medium levels, adaptation peaks, driven by tangible threats and viable response options. However, at high levels of adversity, adaptation efforts diminish as the costs outweigh the benefits and protective strategies become less effective. The focus on ski resorts in Rivera & Clément's study is not coincidental. Within our dataset, ski tourism stands out as

the most extensively studied industry, accounting for 44 publications. This attention stems from the sector's heavy reliance on specific climatic conditions, making it one of the first sectors to feel the tangible impacts of climate change. Steiger et al. (2019) offer a comprehensive analysis of the impacts of environmental changes on ski tourism. They identify several key effects, including reduced snowfall, shorter and less predictable ski seasons, contraction of ski areas, shifts in competitiveness among ski destinations, and impacts on local employment and property values. The severity and timing of these impacts vary based on the pace of climate change and the adaptive responses of skiers, ski destinations, and competing destinations. In this context, snowmaking emerges as a crucial adaptation strategy. However, its sustainability, both economic and environmental, is not guaranteed. While it helps mitigate climate variability impacts, snowmaking demands large capital investments and incurs high operational costs. Moreover, it requires substantial water and energy inputs, potentially contributing to the very problem it seeks to mitigate: climate change. Scott et al. (2024) attempt to clarify this issue, demonstrating that the impacts of snowmaking vary greatly depending on local geographical characteristics and economic factors. Their findings show that snowmaking can range from a sustainable solution to a potential maladaptation, with the latter more likely in regions facing water scarcity or relying on carbon-intensive electricity production.

Shifting focus to coastal tourism, we find that climatic conditions such as temperature, humidity, wind flow, and precipitation play an equally central role in shaping destination attractiveness. Graff Zivin & Neidell (2014) provide crucial insights into this relationship, demonstrating that outdoor leisure follows an inverted U-shape with temperature. Specifically, they show that outdoor activity peaks around 76-80°F (24-27°C) and declines at both higher and lower temperatures. This finding underscores the narrow range of climatic conditions that coastal destinations rely on for optimal attractiveness. Several studies in our dataset delve deeper on this topic. For instance, Susanto et al. (2020) investigate the effects of temperature, humidity, precipitation, and extreme events like floods or droughts on international tourist arrivals in Indonesia. Their findings reveal that as temperatures rise and humidity increases, the number of tourists tends to decline. Interestingly, they also note varying responses based on tourists' countries of origin, with visitors from similar climates (e.g., Southeast Asia) less affected by temperature changes compared to those from Europe or North America. While rising temperatures pose challenges for some types of destinations, they may benefit others. Proebstl-Haider's (2021) review of summer outdoor activities in

Austria highlights that climate change is expected to have a positive impact on the national tourism sector, projecting an extended season for activities like hiking, biking, and water sports. However, this positive outlook is tempered by potential negative impacts on some other activities such as climbing and alpine touring, which may face challenges due to increased heat and extreme weather events.

4.2.7. Sport

The sports sector, much like agriculture and tourism, is inherently "climate-dependent" (Dingle & Stewart, 2018) and thus particularly vulnerable to the impacts of climate change. Both gradual shifts, such as rising mean temperatures, and extreme weather events like floods and droughts pose increasingly significant challenges to the industry. However, this topic remains relatively underexplored in the literature (Orr, 2023), as confirmed by our analysis, which identified only 11 publications focused on this theme. Despite their limited number, these studies address critical issues: they explore the major risks faced by sport organisations and sport event organisers, examine the adaptation and resilience strategies employed to mitigate these risks, and propose innovative frameworks for risk identification, assessment, and effective adaptation implementation. McCullough's (2023) review of sport ecology research highlights how climate change is already pushing sport organisations to implement adaptation strategies, such as relocating facilities threatened by sea level rise or cancelling/delaying events due to extreme weather conditions. However, McCullough observes that these initiatives are often driven more by economic considerations than environmental concerns, a finding echoed in Dingle & Stewart's (2018) study of Major Australian Sport Stadia (MASS) organisations. Their study offers an overview of the main climate change-related challenges faced by MASS, including uncertainty about long-term climate change policy, water issues (reduced rainfall, higher evaporation, water restrictions), energy issues (higher costs, GHG emissions compliance), and waste issues (emissions from landfill, higher disposal costs). Interestingly, while most MASS organisations considered their facilities to be generally resilient to direct physical impacts of climate change, they identified secondary effects, such as policy changes and increased resource costs, as more pressing. Moreover, the study highlights how the lack of financial resources and climate management capabilities serve as major barriers to implementing adaptation strategies. To address the apparent lack of climate management capabilities in sport organisations, Orr & Inoue (2019) introduced the Climate Vulnerability of Sport Organizations (CVSO)

framework. This conceptual tool aims to help sport managers assess their organisation's climate risks and determine appropriate responses. The CVSO framework comprises two main components: Climate Impact on Organizations (CIO) and Organizational Climate Capacity (OCC), the latter referring to an organisation's ability to adapt to climate changes with minimal disruption. Building on this, Orr (2023) further refined the framework by conducting a Delphi study to establish indicators for assessing OCC. This process identified six dimensions of OCC: infrastructural resources, natural resources, planning and development resources, human resources, financial resources, and network/relationship resources. The development of frameworks like CVSO represents a significant step towards more systematic approaches to climate risk management in sports. However, the limited number of studies in this area underscores the need for further research to better address the specific adaptation needs of this climate-dependent sector.

5. Discussion

The past decade has witnessed significant advancements in research on climate adaptation and resilience, reflecting the growing recognition of climate change as a critical business challenge by both academia and industry. This review reveals a substantial expansion in the field, both in terms of volume and depth of studies, with a notable proliferation of sector-specific research, particularly in climate-sensitive industries such as tourism and agriculture. However, the limited number of studies focused on other climate-sensitive sectors critical to societal resilience, such as energy production and transportation, exposes a clear gap in the current literature. A key finding from this review is the pervasive challenge businesses face in balancing short-term operational needs with long-term climate resilience (Sakhel, 2017; Thistlethwaite & Wood, 2018). This tension, evident in studies spanning various industries, from energy companies (Weinhofer & Busch, 2013) to ski resorts (Rivera & Clément, 2019), underscores the critical role of policy in shaping business responses to climate change. It points to the necessity for carefully designed regulations that incentivize proactive adaptation and counteract short-term thinking (Sakhel, 2017; Daddi et al., 2020). In this context, frameworks and models for assessing climate risks and planning adaptation strategies, such as the "climate resilience cycle" proposed by Huiskamp et al. (2022), could prove highly valuable for businesses. However, a significant gap in the literature stems from the lack of studies examining the implementation of these frameworks in diverse real-world

business settings beyond limited pilot studies. The role of technology in adaptation emerges as another important theme, particularly in recent years (Senyolo et al., 2018; Effah et al., 2023; Juhola et al., 2024). However, the literature also reveals significant barriers to technology adoption, particularly for SMEs, including limited financial resources and insufficient knowledge (Senyolo et al., 2018; Bak et al., 2023). The critical role of knowledge acquisition, integration, and application in developing effective adaptation strategies is a recurring theme throughout the literature. Studies in various contexts, from insurance (Stechemesser et al., 2015) to viticulture (Galbreath et al., 2020), highlight how firms with robust learning systems and greater absorptive capacity are better able to adapt to changing climatic conditions. This underscores the importance for business of investing in climate-related knowledge and capabilities, as well as fostering organisational cultures that support continuous learning and innovation.

While this SLR provides a comprehensive overview of research on climate adaptation and resilience in business, several methodological limitations should be acknowledged. The reliance on two primary databases (Web of Science and Scopus), while standard practice, may have excluded relevant publications indexed in other databases or specialised repositories. The focus on English-language articles creates a potential language bias, possibly overlooking valuable research published in other languages, particularly from regions highly impacted by Climate Change. Furthermore, the restriction to journals in the first and second quartiles of the Scimago Business Management and Accounting ranking, while ensuring quality, may have excluded relevant research from emerging publication venues. Additionally, by focusing exclusively on peer-reviewed journal articles, the SLR may have missed relevant insights from practitioner reports, conference proceedings, policy documents, and other forms of grey literature that could provide valuable practical perspectives on business adaptation to climate change.

Our implementation of BERTopic as a data mining tool for data cleaning and thematic clustering, while innovative and valuable for our investigation, presents certain limitations. The model's sensitivity to parameter configurations and reliance on non-deterministic algorithms introduces variability in output, potentially impeding exact replication efforts. To address this challenge, we employed default parameters throughout the analysis and conducted multiple iterations to verify results consistency. Additionally, the dynamic nature of underlying libraries and dependencies may also lead to result inconsistencies over time,

highlighting the importance of strict version control protocols. Lastly, the manual review process for excluding outlier documents and selecting papers for narrative synthesis, while conducted rigorously by two independent reviewers, inherently carries some risk of subjective bias.

Our SLR highlights several critical areas that warrant further scholarly attention. First, there is an urgent need to broaden research beyond the prevailing focus on tourism and agriculture. Sectors like construction, transportation, and energy production, which play a pivotal role in societal resilience and are highly sensitive to climate change, remain comparatively understudied. Second, future research should prioritise the development of rigorous methodologies to assess the economic impacts of adaptation strategies. A key focus should be on evaluating the long-term financial implications of various approaches, such as comparing the effects of anticipatory versus reactive strategies. This knowledge gap extends to how climate adaptation initiatives affect business market valuations and investor attitudes. Third, it is critical to further examine the role of technological adoption and innovation in enhancing corporate climate resilience. In this context, special attention should be directed towards the growing significance of machine learning and artificial intelligence (AI), as they offer unprecedented capabilities to improve current climate risk management. Recent advancements in remote sensing technology also play a crucial role in this context. Specifically, the proliferation of micro-satellites and improvements in sensor resolution (Gil et al., 2017) have dramatically enhanced our ability to monitor and respond to climate-related risks (Munawar et al., 2022). Furthermore, the integration of these capabilities with machine learning algorithms has opened new possibilities for climate risk management by enabling the automated analysis of vast high-temporal-frequency geospatial and atmospheric data for precise monitoring, assessment and prediction of weather events (Avand et al., 2021). Research could examine how these technologies are being applied across different sectors. For example, it would be relevant to study how, in the insurance industry, the combination of high-resolution remote sensing data and machine learning is being used to address basis risk challenges in weather insurance instruments, such as parametric insurance and weather derivatives. Fourth, the concept of maladaptation requires further investigation. Our review revealed instances where adaptation strategies potentially created negative feedback loops or undermined long-term resilience. Future research should aim to develop frameworks for evaluating the sustainability and systemic impacts of adaptation strategies, with particular attention to their influence on broader social-ecological systems. To address this, it would be

highly valuable to work on the development of harmonised climate adaptation and resilience taxonomies, along with robust measurement tools for corporate adaptation and sustainability alignment. Such standardisation could also serve a second purpose, namely helping to bridge the current funding gap for climate adaptation initiatives by offering sustainability-focused investors clear, reliable metrics to evaluate the validity and sustainability of adaptation and resilience projects. Fifth, it would be equally important to explore various innovative financing mechanisms for scaling up private sector investment in adaptation, such as green bonds, resilience bonds, catastrophe bonds, and blended finance instruments that combine public and private capital. Finally, the potential of nature-based solutions in business adaptation strategies represents an emerging area requiring dedicated research attention (Singh & Chudasama, 2021). These approaches, which leverage natural systems to enhance resilience, could offer cost-effective and sustainable adaptation pathways, but their application in business contexts remains understudied.

6. Conclusion

This paper presents a comprehensive systematic literature review examining business climate adaptation and resilience research from 2013 to 2023. Through a rigorous analysis, we synthesised the theoretical and empirical evolution of the field, identifying critical themes such as sector-specific adaptation strategies and persistent knowledge gaps across industries. A significant methodological contribution of this study is the development of an innovative SLR framework that integrates bibliometric analysis with advanced topic modeling, enabling the systematic processing of large-scale bibliographic corpora while maintaining analytical rigour. Key findings include the uneven growth of research across sectors, a persistent tension between short-term operational needs and long-term resilience building and the crucial role of knowledge acquisition and organisational learning in the implementation of adaptation strategies. Looking forward, several research priorities emerge as particularly pressing: the need for rigorous empirical studies examining the economic impacts of adaptation strategies, the development of standardised frameworks for assessing adaptation effectiveness, the investigation of innovative financing mechanisms, and the exploration of nature-based solutions in business contexts. Additionally, more attention should be directed toward understanding and preventing maladaptation risks. While our review provides a

comprehensive synthesis of the field, readers interested in deeper exploration of specific themes are encouraged to consult the complete list of reviewed papers available in the supplementary materials, which provides a valuable resource for further research and investigation. By synthesising current knowledge and identifying future research directions, this work aims to support both scholars and practitioners in fostering more resilient business practices in response to accelerating climate challenges.

Declarations

The authors declare that they did not receive funding/support from any organisation for the submitted work.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary Materials

Supplementary data to this article can be found online at:

https://drive.google.com/file/d/1jIgdGqR2Ajp5_Pxpr9FWovHHHjUOtRvg/view?usp=sharing

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