

The Missing Link in ESG: Local Vulnerability as a Governance Blind Spot—A Systematic Review and Bibliometric Analysis

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Abstract

This study examines how vulnerability is addressed within ESG-related research and identifies the governance limitations that hinder its effective integration into sustainability frameworks. Although ESG has become a dominant mechanism for sustainability assessment and climate-related governance, vulnerability remains insufficiently incorporated as a core analytical dimension. To address this gap, the study combines a systematic literature review with a bibliometric analysis based on 829 publications indexed in the Scopus database between 1996 and 2026. Using Bibliometrix v.5.3.0 and VOSviewer v.1.6.20, the study analyzes the evolution, conceptual structure, thematic development, and intellectual organization of the field. The findings reveal that ESG-related research is rapidly expanding and is strongly associated with themes such as climate change, resilience, adaptation, and sustainability. However, vulnerability remains comparatively underdeveloped and weakly integrated within the dominant knowledge structure. The results further demonstrate that existing ESG approaches prioritize generalized and risk-based performance metrics while overlooking the spatial, social, and institutional dimensions that shape exposure and adaptive capacity at the local level. The study contributes to the literature by highlighting vulnerability as a governance blind spot within ESG systems and emphasizes the need for more integrated, place-based, and context-sensitive sustainability frameworks capable of supporting resilience and climate adaptation.

Keywords: ESG frameworks; governance; sustainability metrics; geospatial indicators; vulnerability; corporate finance



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1. Introduction

Sustainability has become the central pillar of global governance, institutional investment, and organizational responsibility, in response to mounting climate risks, environmental fragility, and the growing exposure of populations to systemic disruptions [1]. Within this context, Environmental, Social and Governance (ESG) frameworks have emerged as dominant instruments for evaluating sustainability performance. Promoted as evidence-based tools for long-term value creation, ESG metrics aim to quantify corporate and policy alignment with environmental goals, social standards, and governance integrity [2]. They serve not only as investment screening tools but also as regulatory benchmarks and strategic planning guides across sectors.

Despite their institutional prominence, ESG frameworks reveal a critical conceptual and operational gap: the systematic omission of vulnerability. Although ESG indicators

often reference environmental risk or social equity, they are typically structured around performance metrics optimized for quantifiability, comparability, and investor relevance [3]. This has resulted in a narrow view of sustainability in terms of technocratic control, financial exposure management, and reputational risk avoidance, while marginalizing the deeper structural and spatial conditions that shape harm. Most notably, vulnerability—defined as the susceptibility of people and ecosystems, due to their exposure, sensitivity, and lack of adaptive capacity—is rarely embedded meaningfully within ESG assessment models [4].

This omission is a critical shortcoming in the context of climate change, where environmental stressors strike unevenly, and their consequences are shaped by territorial specificities. Effective resilience cannot be achieved through generic compliance or standardized metrics alone; it requires strategies attuned to the specific geographic, socio-economic, and institutional conditions of each territory. Localized approaches that integrate place-based risks and structural fragilities are more effective at anticipating and managing crises. Without this level of granularity, ESG frameworks not only fall short—they actively obscure the root causes of vulnerability [5].

Importantly, this paper does not claim that ESG and city or local vulnerability belong to the same analytical level. ESG is primarily examined as a corporate and institutional sustainability-governance framework, while vulnerability is understood as a territorial condition shaped by exposure, sensitivity, adaptive capacity, infrastructure quality, socio-economic inequality, and local governance capacity. The contribution of this study lies in examining the governance gap between these two levels: the corporate/institutional level at which ESG systems are designed, reported, and evaluated, and the local or territorial level at which sustainability risks are experienced. Therefore, the relationship between ESG and vulnerability is approached as a multi-level governance problem rather than as a direct equivalence between corporate ESG indicators and city-level vulnerability indicators.

This research addresses this gap by examining how vulnerability is conceptualized and integrated within ESG-related research and by identifying governance approaches, indicators, and analytical directions that may support a more place-based integration of vulnerability into ESG frameworks. Building on a multi-level governance and double-materiality perspective, the study connects corporate and institutional ESG systems with the territorial conditions through which climate-related and sustainability risks are experienced. In this framework, ESG is understood as a mechanism of disclosure, accountability, investment decision-making, and risk management, while vulnerability is understood as a local and spatially differentiated condition shaped by exposure, sensitivity, adaptive capacity, infrastructure fragility, socio-economic inequality, and institutional preparedness. By emphasizing this cross-level relationship, the study advances a governance approach that is both territorially grounded and systemically informed. The aim is not only to improve the analytical accuracy of ESG assessments, but also to reorient them toward more inclusive, context-sensitive, and adaptive forms of climate resilience and disaster prevention.

This paper is structured as follows. Section 2 reviews the literature on ESG frameworks, the conceptual distinction between risk and vulnerability, the governance gap that limits the integration of vulnerability into ESG, and the indicators and approaches that support a more place-based understanding of resilience. Section 3 presents the materials and methods, outlining the combined use of systematic literature review and bibliometric analysis, the search strategy, the selection criteria, and the analytical tools employed. Section 4 reports the bibliometric results, focusing on the evolution, structure, and thematic orientation of the field. Section 5 discusses the findings in relation to the research questions and the broader debate on sustainability governance, while Section 6 concludes by summarizing the main contributions of the study. Finally, Section 7 addresses the limitations of the research and identifies directions for future investigation.

2. Literature Review

2.1. Conceptual Foundations of the ESG-Vulnerability Nexus

This study's central theoretical issue revolves around the various analytical levels at which researchers typically examine ESG and vulnerability. ESG frameworks are commonly applied at the corporate or institutional level, where they function as mechanisms of sustainability governance, disclosure, investment evaluation, accountability, and risk management. In contrast, vulnerability is mostly investigated at the urban, local, or regional scale, where climate-related hazards are manifested through different degrees of exposure, sensitivity, adaptation capacity, infrastructural conditions, social disparities, and local governance capabilities. Hence, ESG and urban vulnerability are not considered synonymous or on the same level of analysis in this study. Instead, it sees their relationship as a multi-level governance problem [6].

The analytical intersection of ESG and local vulnerability is conceptualized by the interaction between corporate sustainability systems and the specific territorial contexts where environmental and social risks materialize. ESG decisions are not geography-agnostic. Corporate activity, infrastructure investment, supply chain organization, climate adaptation finance, stakeholder engagement, and public-private governance structures directly or indirectly impact cities, regions, and communities. These consequences are especially relevant in regions with high exposure to environmental hazards, poor infrastructure, limited adaptation capacity, and socio-economic inequality. In this context, ESG frameworks not only impact the company performance but also the distribution of sustainability-related risks and benefits among different locations [7,8].

Theoretically, this link can be justified through three complementary theoretical frameworks. Stakeholder theory expands the scope of corporate responsibility beyond shareholders and investors to include the importance of communities that are affected, government agencies, employees, suppliers, and local residents for sustainability governance. In this context, companies and institutions must consider the consequences of their decisions on the areas and communities where they operate [9]. The concept of double materiality states that sustainability assessment should take into account both the impact of environmental and social risks on firms and the impact of firms' activities on society, ecosystems, and local development conditions. This perspective is particularly relevant for linking corporate ESG disclosure to location-specific vulnerability because it emphasizes the need to consider the externalities of business activities in vulnerable and exposed areas. Third, the socio-ecological vulnerability theory accounts for the emergence of harm as the interaction of hazards, exposure, sensitivity, and adaptive capacity. This perspective argues that, in addition to the presence of environmental hazards, climate risk is also shaped by social, geographic, infrastructural, and institutional factors that affect the capacity of local systems to anticipate, absorb, react to, and recover from shocks [10].

In this context, urban and local vulnerability is relevant to ESG, as it is the spatial setting in which sustainability risks are faced and managed. A business, investor, or institution may report excellent overall ESG performance while operating in, investing in, or having an impact on areas where vulnerability is still high. As a result, standardized ESG metrics are unlikely to accurately reflect the alignment of sustainability efforts with the actual needs of affected communities and places. This creates a gap in governance between corporate sustainability assessments and local risk conditions [11].

Figure 1 summarizes the multi-level analytical framework adopted in this study. It clarifies that ESG, and local vulnerability do not operate at the same analytical level; rather, ESG functions mainly at the corporate and institutional governance level, while vulnerability is experienced at the city, local, and territorial level. Their relationship is therefore understood through transmission mechanisms that connect ESG decisions, disclosures,

investments, and accountability practices with place-based vulnerability conditions and resilience outcomes [12,13].

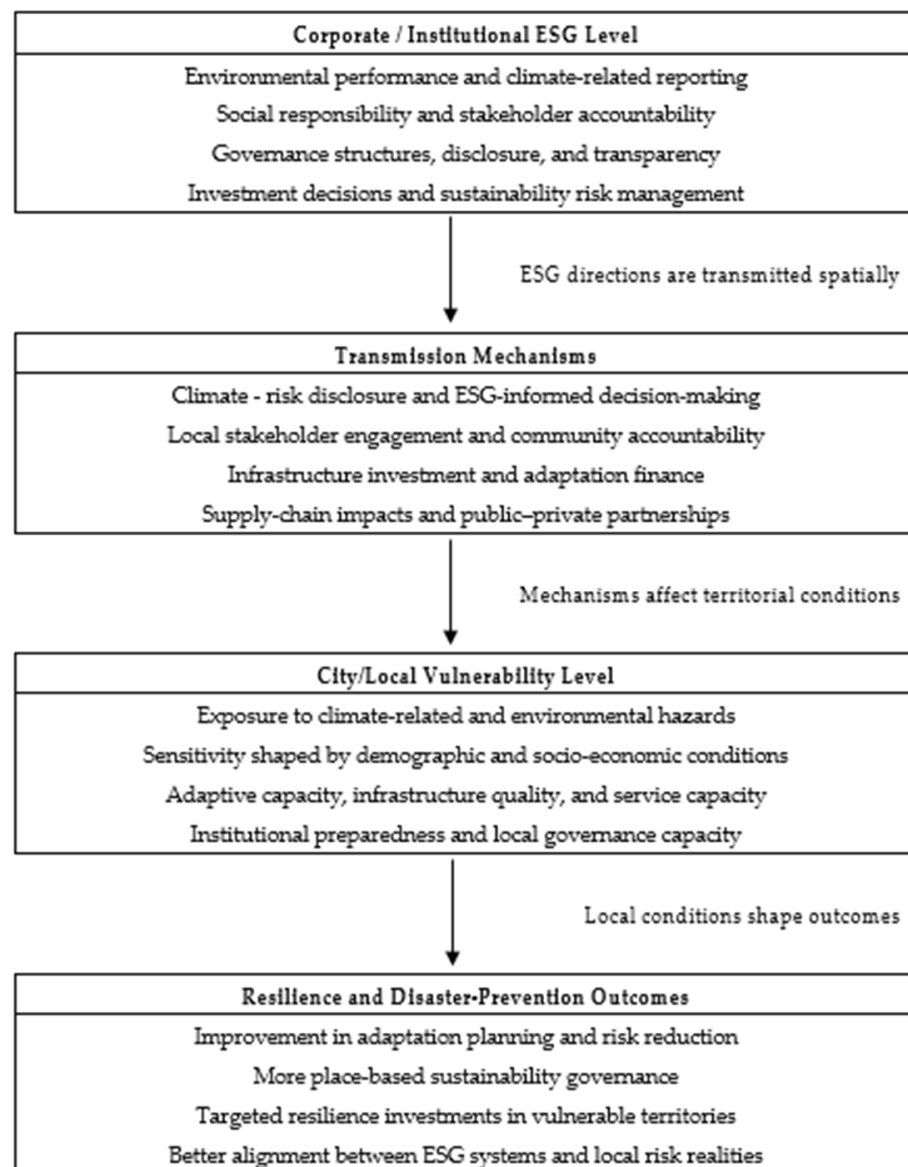


Figure 1. Multi-level Analytical Framework Linking ESG and Local Vulnerability.

2.2. ESG Frameworks and the Limits of Risk-Based Approaches

ESG frameworks have become central in sustainability governance, widely used to guide investment decisions, regulatory practices, and organizational strategies. Their strength lies in their ability to translate complex environmental and social issues into standardized and measurable indicators, allowing comparability across institutions and markets. In this way, ESG has evolved into a system that prioritizes quantification, performance tracking, and transparency [14].

However, this structure is inherently shaped by a strong reliance on standardization. ESG metrics are designed to be comparable and scalable, which leads to a preference for indicators that can be easily measured and integrated into financial models. As a result, ESG is closely aligned with financial risk logic, where sustainability is largely interpreted through concepts such as risk exposure, risk mitigation, and risk-adjusted performance [15]. This is also reflected in the dominant ESG risk terminology. As identified in the literature, most ESG-related risk concepts are rooted in portfolio-level thinking, including terms

such as risk exposure, diversification risk, and ESG risk factors. Even when addressing climate-related issues, risk is typically framed in categories such as climate risk or transition risk, reinforcing a perspective that prioritizes financial implications rather than broader socio-environmental conditions [16].

This approach creates a significant limitation. By focusing on what can be measured and quantified, ESG frameworks simplify complex and dynamic realities into standardized indicators. This produces what has been described as an “illusion of control”, where uncertainty and complexity are reduced to manageable metrics, giving the impression that risks are fully understood and governed [17].

At the same time, the literature highlights the absence of a clear and consistent taxonomy of ESG risks. Different studies use varying definitions, categories, and measurement approaches, resulting in fragmentation and lack of coherence across the field. This inconsistency limits the ability of ESG frameworks to provide a comprehensive understanding of sustainability challenges.

2.3. Conceptualizing Vulnerability: Beyond Risk and Hazard

The concept of vulnerability occupies a central position in climate-related research, yet it remains inconsistently defined and often insufficiently distinguished from related concepts such as risk and hazard. In the literature, vulnerability is commonly understood as the set of conditions—physical, social, economic, and environmental—that increase the susceptibility of a system, community, or individual to harm. This definition, widely adopted by frameworks such as those of IPCC and UNDRR, emphasizes that vulnerability is not a singular attribute, but a multidimensional condition shaped by exposure, sensitivity, and adaptive capacity. In this sense, vulnerability reflects not only the presence of a threat but the structural characteristics that determine how that threat translates into impact [18].

A critical distinction must therefore be made between risk and vulnerability, as the two are often conflated within both academic and policy discourse. Risk is typically conceptualized as the outcome of the interaction between hazard, exposure, and vulnerability, commonly expressed as: $\text{Risk} = \text{Hazard} \times \text{Exposure} \times \text{Vulnerability}$ [19].

This formulation highlights that vulnerability is not equivalent to risk but rather a determining component of it. While hazard refers to the potential occurrence of a damaging event and exposure to the presence of people or assets in affected areas, vulnerability captures the underlying conditions that shape the capacity to anticipate, cope with, and recover from such events. Two regions may be exposed to the same hazard yet experience vastly different outcomes depending on their socio-economic conditions, institutional capacity, and infrastructural resilience. The analytical separation of these concepts is therefore essential for understanding the uneven distribution of climate impacts [19,20].

Despite this distinction, much of the existing literature—particularly within ESG-related research—tends to collapse vulnerability into generalized notions of risk. This reduction overlooks the fact that vulnerability is not simply a measurable outcome but a systemic property, deeply embedded in social structures, spatial configurations, and governance arrangements. It is shaped by factors such as inequality, infrastructure deficits, demographic composition, and institutional effectiveness, all of which operate across different scales and interact in complex, often non-linear ways [21].

Furthermore, vulnerability is not a static condition but a dynamic and evolving process. Its spatial dimension reflects the geographical variability of risk drivers, as vulnerability is inherently place-based and influenced by local environmental, socio-economic, and political contexts. Its temporal dimension captures how vulnerability changes over time, whether through gradual processes such as urbanization and climate change, or through repeated exposure to shocks that alter the resilience of communities. In addition, its

management dimension highlights how policy interventions and governance practices can either reduce or unintentionally exacerbate vulnerability, producing outcomes such as shifting or redistributed risk, maladaptation, or increased exposure in other areas [22].

These dynamic characteristics make vulnerability difficult to capture through standardized indicators, particularly those designed for comparability across contexts. Unlike risk, which can often be modeled through probabilistic approaches, vulnerability requires a more nuanced and context-sensitive understanding that integrates qualitative and quantitative dimensions. It demands an analytical framework capable of capturing interactions between environmental pressures and social systems, rather than treating them as separate domains [3,23].

2.4. The Governance Gap: Why Vulnerability Is Missing in ESG

The limitations of ESG frameworks become most evident at the governance level, where the absence of vulnerability as an operational dimension reveals a significant structural gap. While ESG systems are designed to support sustainability-oriented decision-making, they are primarily shaped by a logic of measurability and standardization, which prioritizes what can be quantified and reported over what is contextually relevant [24]. As a result, vulnerability remains largely invisible within ESG frameworks, creating what can be described as a “vulnerability blind spot”.

This blind spot is closely linked to the way ESG approaches conceptualize and manage risk. By focusing on aggregated indicators and generalized metrics, ESG frameworks tend to overlook the spatial and social heterogeneity of real-world conditions. Vulnerability, however, is inherently place-based and shaped by localized factors such as infrastructure quality, institutional capacity, and socio-economic inequalities. The absence of disaggregated and context-sensitive data limits the ability of ESG systems to capture these dynamics, leading to an incomplete representation of climate-related challenges [11].

The literature provides clear evidence that this gap has tangible implications. Empirical studies show that sustainability investments and ESG-driven initiatives often fail to reach the areas most exposed to environmental and social risks. For example, research on eco-innovation projects in environmentally fragile regions of Southern Italy demonstrates that funding tends to be directed toward areas with higher institutional visibility and readiness, rather than those with greater vulnerability. Similar patterns have been observed in European peripheral regions, where the lack of detailed vulnerability data results in the exclusion of highly exposed communities from development planning processes [25].

These outcomes are further reinforced by fragmented governance structures. Environmental, social, and disaster risk policies frequently operate in parallel rather than in an integrated manner, with limited coordination across sectors and administrative levels. This fragmentation is associated with weak data harmonization, overlapping institutional mandates, and insufficient collaboration between policy domains. In such contexts, ESG frameworks—when applied without integration—do not resolve these issues but may instead reproduce them, reinforcing existing silos rather than bridging them [26].

At the same time, ESG systems tend to overlook the role of structural inequalities in shaping vulnerability. Factors such as poverty, aging infrastructure, geographic isolation, and unequal access to resources are central to understanding how risk is distributed across populations, yet they are rarely incorporated into ESG assessments in a meaningful way. Instead, risk is often treated as a linear and quantifiable variable, detached from the complex socio-economic conditions that determine exposure and adaptive capacity [27].

These combined factors point to a fundamental misalignment between ESG frameworks and the realities of climate risk governance. While ESG provides a structured approach to sustainability assessment, it does not adequately account for the territorial,

social, and institutional dimensions of vulnerability. The result is a governance system that captures performance but fails to diagnose underlying fragilities, leaving the most exposed regions insufficiently addressed within sustainability strategies.

2.5. Indicators and Approaches to Capture Vulnerability

Addressing the limitations of current ESG frameworks requires a shift toward approaches that can capture the multidimensional and place-based nature of vulnerability. Existing literature provides important methodological foundations for such integration, particularly through the development of analytical tools that combine environmental, social, and spatial data. Among these, the Social Vulnerability Index (SoVI) and the Regional Risk Index (RRI) stand out as key instruments for assessing how vulnerability is distributed across territories and how it interacts with hazard exposure [28,29].

The Social Vulnerability Index (SoVI) has been widely used to identify populations with reduced capacity to respond to and recover from environmental hazards, relying on socio-economic and demographic indicators to capture underlying fragilities. By mapping the spatial distribution of vulnerable groups, SoVI highlights the uneven nature of risk and provides a basis for more targeted and equitable policy interventions. Similarly, the Regional Risk Index (RRI) integrates hazard exposure with social vulnerability, producing composite assessments that reflect both environmental pressures and the characteristics of affected populations. This approach recognizes that risk cannot be understood in isolation from vulnerability and emphasizes the need for integrated, multi-dimensional analysis [30].

These tools demonstrate that vulnerability can be operationalized through measurable indicators, but they also reveal the importance of combining quantitative data with spatial analysis. Geospatial technologies, multi-hazard models, and GIS-based approaches allow for the identification of localized risk patterns, capturing how different hazards interact with socio-economic conditions across specific territories. Such approaches move beyond generalized assessments and enable a more precise understanding of where and how vulnerability manifests [31].

Within this context, the integration of vulnerability into ESG frameworks requires a reconsideration of how indicators are defined across the environmental, social, and governance dimensions. In the environmental dimension, indicators must reflect not only ecological performance but also exposure to hazards such as droughts, floods, and land degradation [32]. In the social dimension, greater emphasis is needed on factors such as inequality, demographic structure, and access to critical infrastructure, which directly influence adaptive capacity [33]. In the governance dimension, attention must be given to institutional preparedness, coordination mechanisms, and the ability of local authorities to translate risk assessments into effective policy responses [34].

A key concept emerging from the literature is that of localized or idiosyncratic vulnerability, which emphasizes that risk is shaped by context-specific characteristics rather than uniform conditions. Territories differ significantly in terms of environmental exposure, socio-economic structures, and governance capacity, meaning that standardized indicators are insufficient to capture the complexity of real-world conditions. Recognizing this variability is essential for developing more accurate and effective resilience strategies [35].

In this regard, the role of local and regional governance becomes critical. Local authorities are directly engaged with the realities of climate risk and are better positioned to identify context-specific vulnerabilities, coordinate responses, and implement adaptation measures. However, their capacity to do so depends on access to detailed data, appropriate analytical tools, and governance frameworks that integrate vulnerability into decision-making processes [36].

The literature highlights a clear gap in the way vulnerability is addressed within ESG frameworks. Although ESG is widely applied in sustainability governance, vulnerability is not systematically integrated and is often reduced to general references to risk, without adequately capturing its spatial, temporal, social, and governance dimensions. A key reason for this gap is the difference in analytical scale between the two concepts. ESG is usually developed and applied at the corporate or institutional level, whereas vulnerability is experienced and assessed at the local, city, or territorial level [37]. Existing studies rarely provide a consistent framework for connecting these levels or for explaining how corporate ESG decisions, disclosures, investments, and accountability mechanisms relate to the local conditions that shape exposure, sensitivity, adaptive capacity, and resilience. This creates a disconnect between how sustainability is measured and how climate-related risks are actually experienced by territories and communities.

Accordingly, the objective of this study is not to develop an empirical city-level vulnerability model, but to critically assess how vulnerability is represented, connected, and operationalized within ESG-related scholarship, and to identify the governance and conceptual gaps that limit its integration.

Based on this, the study is guided by two research questions:

RQ1: What governance gaps hinder the integration of vulnerability into ESG, and which existing indicators support resilience and disaster prevention?

RQ2: What frameworks can operationalize vulnerability within ESG systems, and what further research is needed to support their implementation?

3. Materials and Methods

The identification phase of the study was conducted using the Scopus database, and citation database by Elsevier B.V., Amsterdam, the Netherlands. was accessed through on 1 April 2026. The database was selected because it provides broad multidisciplinary coverage of peer-reviewed scientific literature and is widely used for systematic literature searches and bibliometric investigations [38,39]. The search covered publications indexed between 1996 and 2026 and resulted in an initial dataset of 829 records. The bibliographic records retrieved from Scopus included publication titles, abstracts, author keywords, affiliations, source information, cited references, and citation data, which formed the basis for the subsequent analysis.

The identification phase was conducted using the Scopus abstract and citation database, provided by Elsevier B.V., Amsterdam, the Netherlands, and accessed on 1 April 2026. The bibliometric analyses were conducted during the same analysis period using R version 4.5.1, developed by the R Foundation for Statistical Computing, Vienna, Austria, together with the bibliometrix package version 5.3.0 and its Biblioshiny interface, developed by K-Synth Srl, Naples, Italy; accessed also on 1 April 2026. Keyword co-occurrence and source co-citation networks were visualized using VOSviewer version 1.6.20, developed by the Centre for Science and Technology Studies, Leiden University, Leiden, the Netherlands; accessed on 1 April 2026. These tools supported the analysis of publication trends, thematic development, collaboration patterns, and bibliometric networks.

The combined use of a systematic literature review and bibliometric analysis was considered appropriate for this study because ESG and vulnerability research is fragmented and interdisciplinary. Bibliometric methods allow for the systematic examination of thematic evolution, conceptual relationships, intellectual structures, scholarly collaboration, and underdeveloped research areas. Therefore, the analysis was not limited to word-frequency statistics but was used to examine how vulnerability is positioned within the broader ESG knowledge structure and to identify governance blind spots that remain insufficiently addressed in the literature.

Methodologically, this study adopted an evidence-synthesis and science-mapping design that combined a systematic literature review, bibliometric analysis, and conceptual framework development. The systematic literature review was used to examine how vulnerability, resilience, adaptation, climate risk, and ESG are defined, connected, and operationalized in the literature. The bibliometric analysis was used to map the intellectual, conceptual, thematic, and collaborative structure of the field through publication trends, source distribution, country collaboration, keyword co-occurrence, co-citation analysis, and thematic mapping. Finally, the conceptual framework synthesis was used to interpret these findings through a multi-level governance and double-materiality perspective, linking corporate and institutional ESG systems with city and local vulnerability conditions. Therefore, the methodology did not aim to estimate a direct empirical or causal relationship between individual companies and specific cities. Instead, it provided a structured academic basis for identifying how the two research domains are connected, where they remain fragmented, and why vulnerability represents a governance blind spot within ESG-related scholarship.

The development of the search query followed an iterative and reflexive process aimed at maximizing both relevance and comprehensiveness. Initial exploratory searches employed narrower keyword combinations primarily centered on ESG terminology and governance-related expressions. However, these early attempts yielded limited and fragmented results and failed to adequately capture the intersection between vulnerability, resilience, and sustainability governance. This limitation was attributed to the conceptual dispersion of the topic across multiple disciplines and the absence of standardized terminology explicitly linking vulnerability with ESG frameworks. Consequently, the search strategy was progressively expanded to incorporate a broader set of interrelated terms, including climate-related expressions such as “climate change”, “climate adaptation”, and “climate resilience”, alongside sustainability-oriented concepts such as “Sustainable Development Goals”, “SDGs”, and “Agenda 2030”. In addition, terms reflecting risk and adaptive dimensions, including “vulnerability”, “adaptive capacity”, and “risk reduction”, were integrated together with hazard-related keywords such as “natural disasters” and “extreme weather”. This refined query was designed to overcome the fragmentation observed in earlier searches and to ensure the inclusion of studies addressing vulnerability both directly and indirectly within governance and sustainability contexts, ultimately resulting in a dataset of 829 records see Figure 2.

Moreover this investigation was conducted through an extensive review of the existing literature, utilizing the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses, see Supplementary Material) framework and the scoping study approach outlined by [40] in Figure 3.

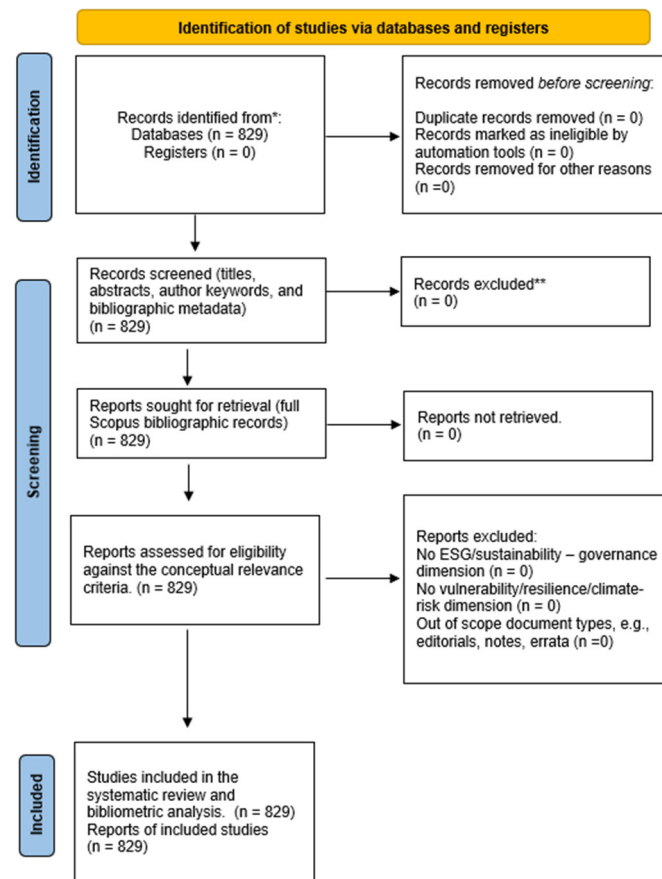


Figure 2. PRISMA flow chart for systematic review process. * Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers). ** If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

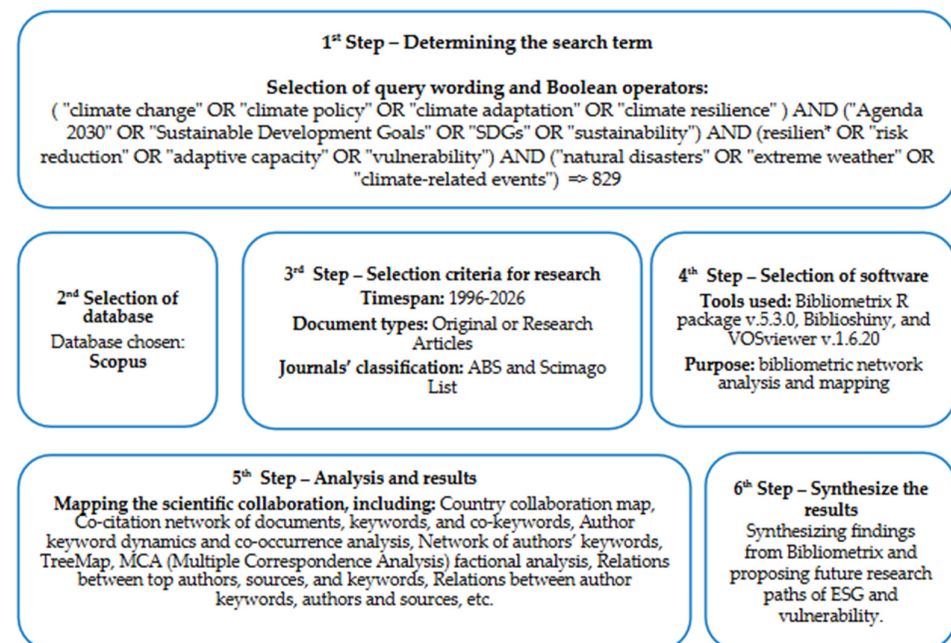


Figure 3. Research design and methodological process of the study. Authors' elaboration. * is a truncation/wildcard operator that matches zero or more characters, allowing the retrieval of variant word endings, plural forms, and derivations (e.g., climat* retrieves climate, climatic, climatology, etc.).

4. Results

To address the relevance of the bibliometric corpus, the dataset was not treated merely as a large collection of publications, but as a purposively constructed body of literature directly connected to the research objective of examining the relationship between ESG and vulnerability. The selection logic was based on conceptual relevance rather than on publication volume alone. Publications were considered relevant when they addressed at least one dimension related to ESG, sustainability governance, climate-related governance, institutional decision-making, disclosure, accountability, or sustainability assessment, together with at least one dimension related to vulnerability, resilience, adaptation, adaptive capacity, disaster risk, natural hazards, territorial exposure, or place-based climate risk. This logic ensured that the corpus captured the intersection between ESG-related sustainability research and vulnerability-oriented climate governance. Studies focusing exclusively on corporate financial performance, investment returns, ESG ratings, or market valuation without any connection to vulnerability, resilience, climate risk, sustainability governance, or territorial impacts were not considered central to the analysis. Similarly, studies dealing only with physical hazards or environmental change, without reference to governance, adaptation, sustainability frameworks, institutional response, or social vulnerability, were treated as outside the core scope of the study. This distinction was necessary because the objective of the study is not to map ESG research in general, nor vulnerability research in isolation, but to examine how the two domains are connected, fragmented, or insufficiently integrated [41,42].

The full list and characteristics of the 829 studies included in the systematic review are provided in Table S1, Supplementary Material. Table 1 presents the dataset, which comprises 829 documents published between 1996 and 2026, indicating a relatively broad temporal coverage that captures the evolution of the field over approximately three decades. The presence of 5561 authors and 5389 author keywords reflects a highly fragmented and diverse research landscape, suggesting that the topic is interdisciplinary and still developing without a tightly consolidated scholarly core. This is further supported by the large number of sources (402), which indicates that the literature is dispersed across multiple journals rather than concentrated in a few leading outlets.

Table 1. Main Information of the Bibliometric Analysis.

Timespan	1996:2026
Authors	5561
Authors Keywords	5389
Sources	402
Authors of single-authored docs	0
References	7082
Documents	829
International Co-Authorship	30.40%
Document Average Age	3.86
Co-Authors per Doc	11.4
Average citations per doc	15.52

A notable characteristic of the dataset is the complete absence of single-authored documents, alongside a high average of 11.4 co-authors per paper. This highlights the strongly collaborative nature of the field, likely driven by the complexity of topics such as ESG, climate risk, and vulnerability, which require contributions from multiple disciplines

including environmental science, economics, and governance studies. The international co-authorship rate of 30.40% further reinforces this observation, indicating a moderate but significant level of global research collaboration [43]. The average document age of 3.86 years suggests that the corpus is strongly concentrated in recent publications, reflecting the growing academic and policy interest in ESG, climate-related risk, resilience, and vulnerability. However, the Annual Growth Rate reported by the bibliometric software is not used as the basis for interpreting the development of the field, because the 2026 data are incomplete and include only publications indexed up to March 2026. For this reason, publication dynamics are interpreted through the annual scientific production curve rather than through the Annual Growth Rate indicator.

In terms of scientific impact, the average of 15.52 citations per document indicates a moderate citation performance, suggesting that while the field is gaining attention, it has not yet reached a stage of high consolidation or citation intensity typical of more mature research domains. The total of 7082 references also reflects a substantial knowledge base, supporting the depth of the bibliometric analysis.

Figure 4 presents the annual scientific production of the corpus. The trend shows a long period of limited publication activity, followed by a gradual increase after 2010 and a marked rise after approximately 2018. However, the final year, 2026, must be interpreted with caution because it includes only publications indexed up to March 2026. Consequently, the apparent decline or incomplete value for 2026 should not be interpreted as a decrease in scholarly interest. Similarly, the Annual Growth Rate indicator is not used as the basis for interpreting the development of the field, because the inclusion of a partial year may distort automated growth calculations. Instead, the analysis focuses on the visible pattern across complete years and treats 2026 only as an indication of the most recent indexed literature.

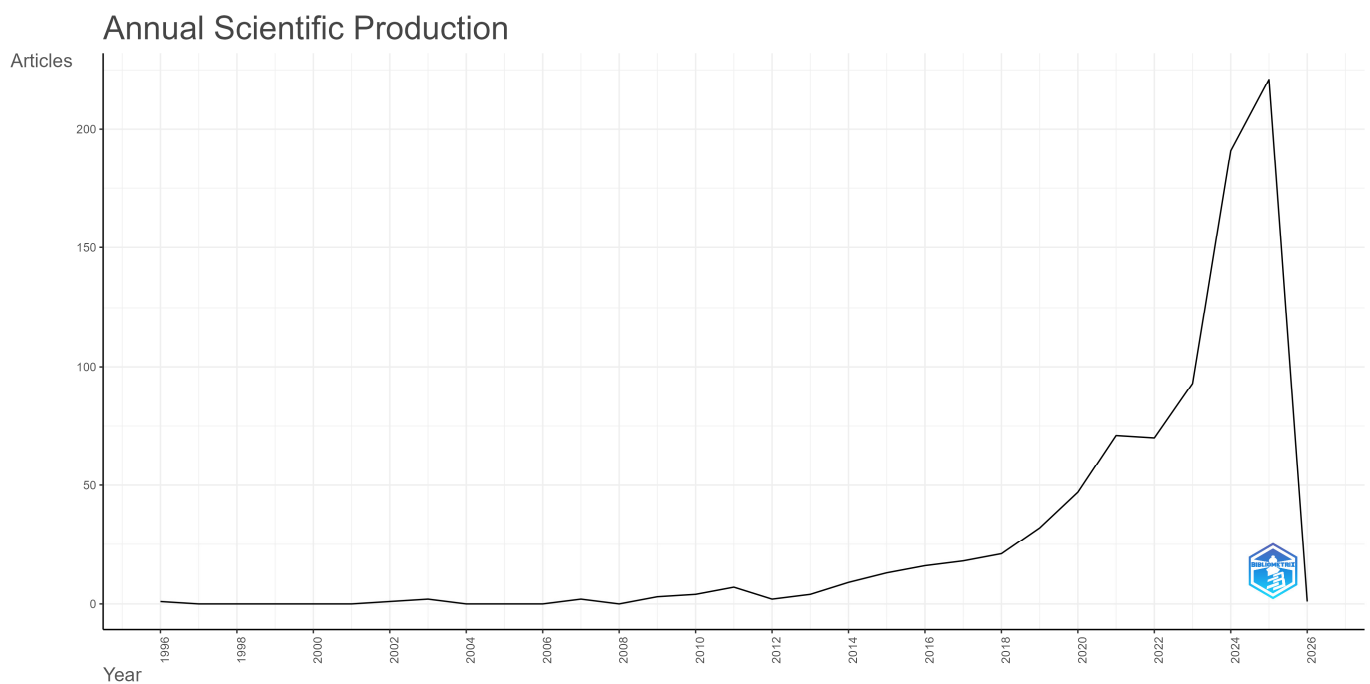


Figure 4. Annual Scientific Production by Bibliometrix version 5.3.0.

A significant shift occurs after approximately 2018, where the number of publications increases sharply. This rapid growth phase accelerates further after 2020, reaching a peak in the most recent years. This trend reflects the mainstreaming of ESG frameworks in both academic and institutional contexts, combined with heightened awareness of climate-related risks and resilience. The sharp increase suggests that the field is currently in an

“climate change”. This supports the core argument of the study that vulnerability remains conceptually present but not fully integrated into the main analytical and governance frameworks, including ESG. Instead, the literature appears to prioritize adaptation and resilience as operational concepts, while vulnerability is treated more as a supporting or background condition.

The co-citation analysis of sources in Figure 6 provides insight into the intellectual structure of the field by identifying the most influential journals and how they are interconnected within the scientific literature. The network reveals a dense and clustered structure, indicating that the research domain is built upon a relatively well-established but still multidisciplinary knowledge base.

Co-citation analysis of sources

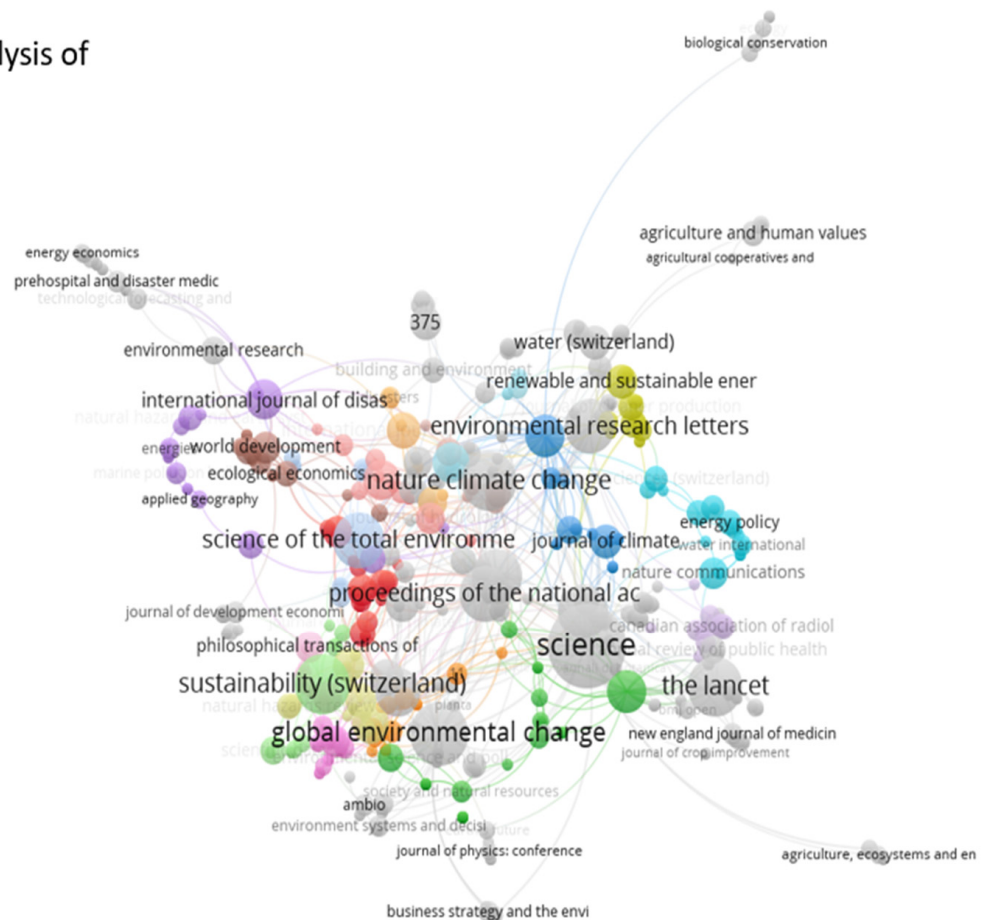


Figure 6. Co-citation analysis of sources by VOSviewer v.1.6.20.

At the core of the network, highly influential journals such as *Science of the Total Environment*, *Nature Climate Change*, *Proceedings of the National Academy of Sciences*, and *Environmental Research Letters* occupy central positions. Their prominence reflects their role as foundational sources that shape the scientific discourse on climate change, environmental systems, and sustainability. These journals act as key knowledge hubs, connecting different thematic areas and facilitating the integration of research across disciplines.

Surrounding this core, several distinct clusters emerge. One cluster is strongly oriented toward environmental science and climate systems, emphasizing topics such as global environmental change, ecological processes, and natural systems. Another cluster is more closely associated with sustainability and policy-oriented research, with journals such as *Sustainability (Switzerland)* and *World Development*, reflecting the growing importance of governance, development, and socio-economic dimensions in the literature. A further

cluster includes high-impact general science and health-related journals, such as *The Lancet*, indicating the increasing recognition of the links between climate change, human health, and societal impacts.

The structure of the network highlights the interdisciplinary nature of the field, where environmental science, policy studies, economics, and public health intersect. However, it also reveals a certain degree of fragmentation, as different clusters remain partially separated, suggesting that integration across disciplines is still incomplete. This fragmentation is particularly relevant in the context of ESG and vulnerability research, where concepts are often developed in parallel rather than within a unified analytical framework.

In Figure 7, the analysis of the most relevant words provides a clear overview of the dominant concepts shaping the research field and highlights the relative importance of key themes within the literature. The results show a strong concentration around a small number of highly frequent terms, indicating a relatively focused but still evolving conceptual structure.

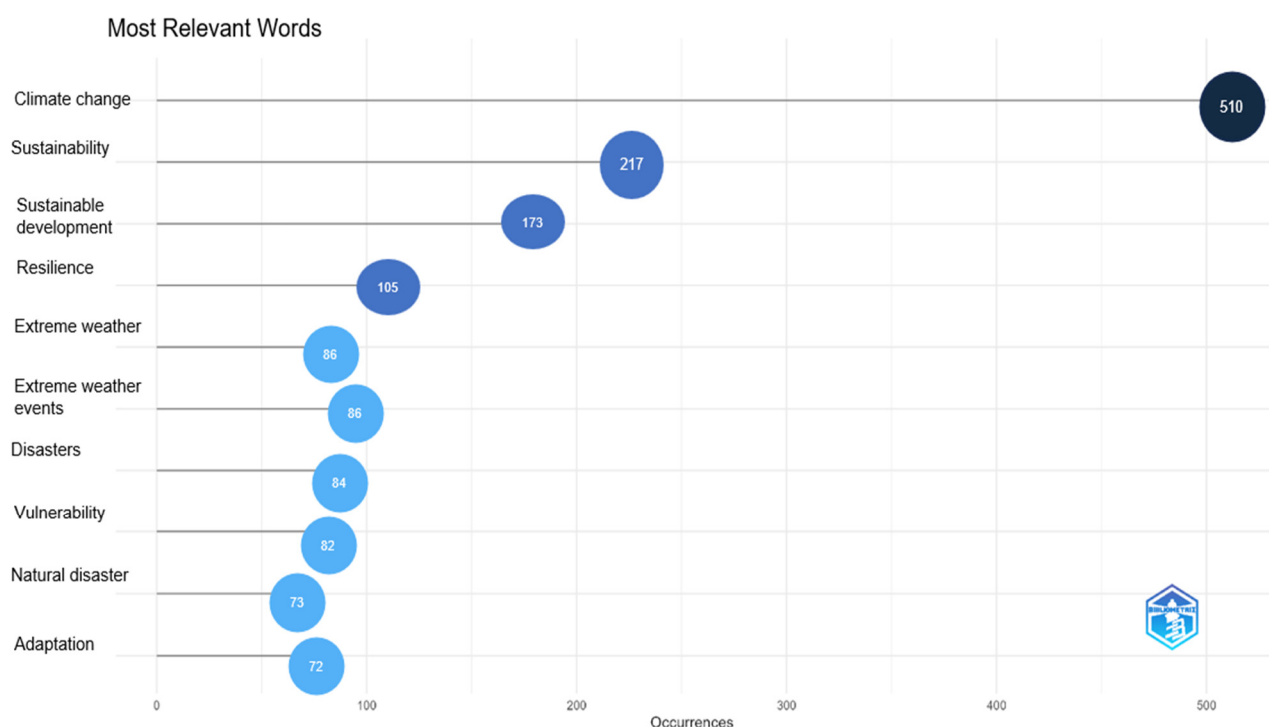


Figure 7. Most Relevant Words by Bibliometrix v.5.3.0.

“Climate change” is by far the most dominant term, significantly exceeding all others in frequency. This confirms that the entire body of literature is fundamentally structured around climate-related challenges and reinforces its role as the central driving force of the research domain. The prominence of this term reflects the growing global attention to climate risks and their implications across environmental, social, and governance dimensions.

Following this, terms such as “sustainability” and “sustainable development” appear with high frequency, indicating that the field is strongly embedded within broader sustainability frameworks and policy agendas. These concepts act as a bridge between environmental concerns and governance-related discussions, linking climate issues with long-term development strategies.

At the next level, terms such as “resilience”, “adaptation”, “extreme weather”, and “disasters” highlight the operational focus of the literature. These keywords reflect an emphasis on how systems respond to climate impacts, particularly in terms of managing risks and enhancing the capacity to cope with environmental shocks. The relatively high

frequency of these terms suggests that the literature is largely oriented toward solutions, response mechanisms, and risk management strategies.

In contrast, “vulnerability” appears with noticeably lower frequency compared to resilience and adaptation. This is a critical finding. Although vulnerability is conceptually linked to climate risk and is essential for understanding uneven impacts, its lower prominence indicates that it is not as central in the research discourse. Instead, the literature seems to prioritize reactive and adaptive approaches over the deeper structural analysis of why certain regions or populations are more exposed and less capable of responding to risks.

In Figure 8, the thematic map provides a structured overview of the research field by classifying themes according to their centrality (relevance) and density (development). This allows for the identification of well-established themes, emerging topics, and areas that remain underdeveloped within the literature.

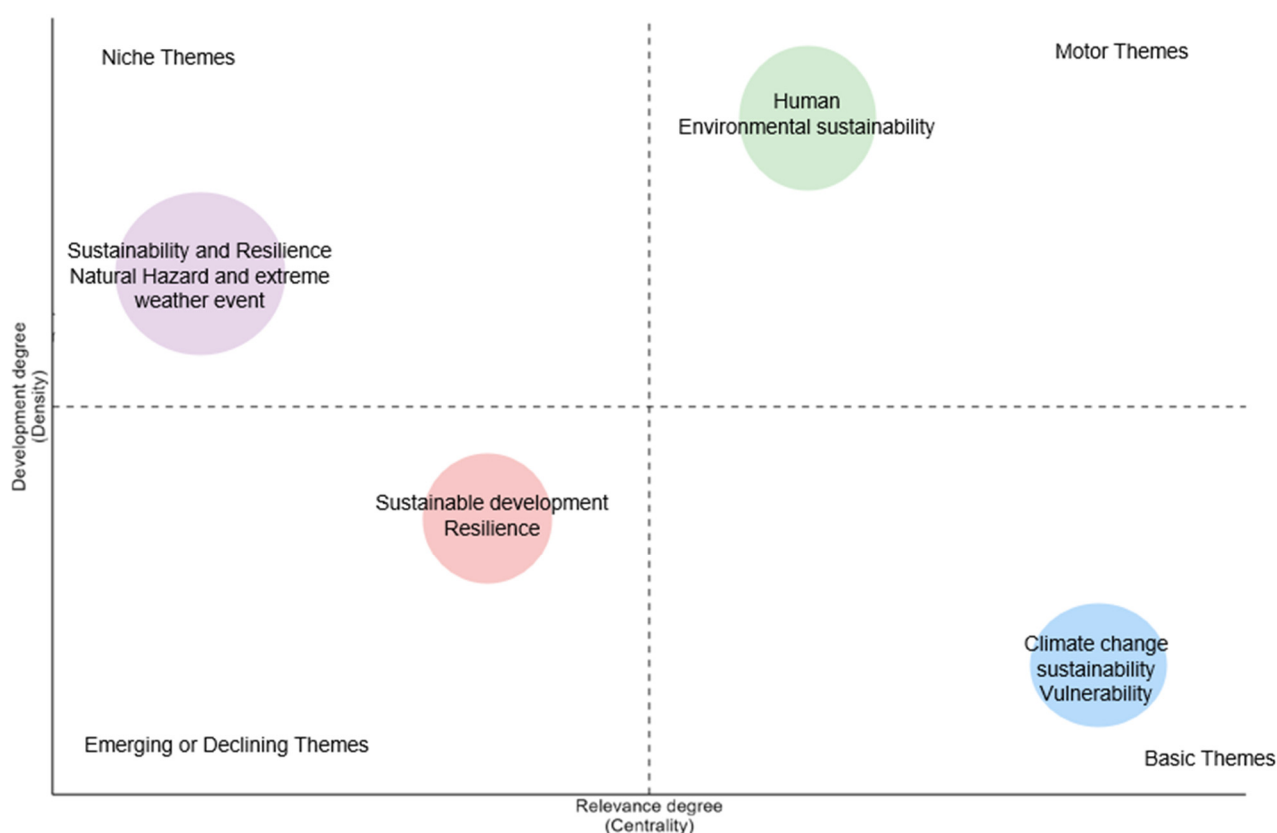


Figure 8. Thematic Map by Bibliometrix v.5.3.0.

The lower-right quadrant, representing basic themes, includes “climate change”, “sustainability”, and notably “vulnerability”. These themes are highly central, meaning they are fundamental to the field and widely connected to other topics. However, their low density indicates that they are not yet fully developed conceptually. This is particularly significant for “vulnerability”, which, despite being a core concept, appears insufficiently elaborated and lacks a strong, consolidated research structure. This finding strongly supports the main argument of the study, highlighting vulnerability as a critical but underdeveloped dimension within ESG-related research.

In contrast, the upper-right quadrant, which represents motor themes, includes topics such as “environmental sustainability” and “human”. These themes are both highly central and well-developed, indicating that they play a driving role in the evolution of the field.

Their strong position suggests that current research is actively advancing in areas related to human impacts, environmental systems, and climate-related events.

The upper-left quadrant, corresponding to niche themes, includes more specialized topics such as “natural hazards”, “extreme weather events”, and “sustainability and resilience”. These themes are well-developed internally but less connected to the broader research field, indicating that they are more specialized or isolated areas of study.

Finally, the lower-left quadrant, representing emerging or declining themes, includes terms such as “sustainable development”, “resilience”. Their position suggests that these topics are either in a transitional phase of development or undergoing redefinition within the literature. Given their relevance in other parts of the analysis, it is more likely that these themes are evolving rather than declining.

The thematic map reveals a field that is partially consolidated but still conceptually unbalanced. While climate change and sustainability dominate as core themes, vulnerability remains underdeveloped despite its central importance. This imbalance highlights a key gap in the literature and reinforces the need for a more systematic integration of vulnerability into ESG and sustainability frameworks.

The conceptual structure map, based on Multiple Correspondence Analysis (MCA), reveals in Figure 9 the underlying intellectual organization of the research field by grouping related keywords into distinct clusters. The figure clearly identifies two major conceptual domains, indicating a fundamental division in how the literature approaches climate-related research.

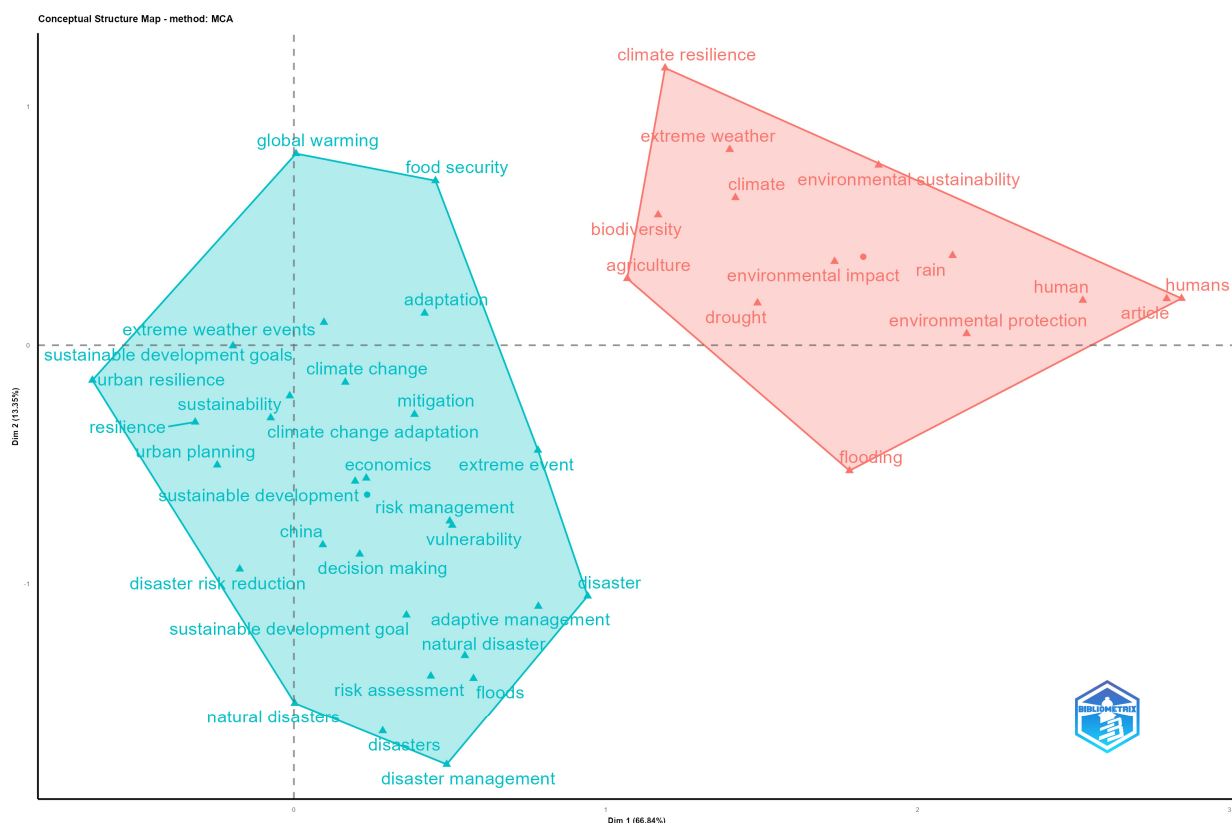


Figure 9. MCA Method by Bibliometrix v.5.3.0.

The first cluster (on the left) is centered around terms such as “climate change”, “sustainability”, “resilience”, “adaptation”, “risk management”, and “vulnerability”. This cluster reflects a governance-oriented and policy-driven perspective, where the focus is on managing climate risks, developing adaptation strategies, and integrating sustainability

into decision-making processes. The presence of terms such as “disaster risk reduction”, “urban resilience”, and “sustainable development goals” further emphasizes the applied and strategic nature of this body of research. Importantly, “vulnerability” appears within this cluster, but it is not positioned as a dominant or defining concept, suggesting that it is embedded within broader discussions rather than being treated as a central analytical focus.

In contrast, the second cluster (on the right) is structured around terms such as “climate”, “extreme weather”, “biodiversity”, “agriculture”, “drought”, “flooding”, and “environmental impact”. This cluster reflects a more environmental and natural science-oriented perspective, focusing on physical processes, ecological systems, and the direct impacts of climate change. The inclusion of terms such as “human” and “environmental protection” indicates that this cluster also incorporates human-environment interactions, but primarily from an impact assessment rather than a governance perspective.

The clear separation between these two clusters highlights a significant conceptual divide within the literature. On one side, research is focused on environmental processes and climate impacts, while on the other, it is oriented toward governance, adaptation, and policy responses. The limited overlap between these clusters suggests that integration between these perspectives remains incomplete.

The lower centrality of “vulnerability” in the keyword co-occurrence network should therefore be understood as an indication of weak conceptual integration rather than as standalone evidence of governance failure. The governance implication emerges when this bibliometric pattern is read alongside the literature showing that ESG systems often translate sustainability into standardized performance, disclosure, and risk-management metrics. In this sense, the bibliometric results reveal the structure of the academic debate, while the conceptual review explains why the weaker integration of vulnerability matters for ESG.

5. Discussion

The bibliometric findings should not be interpreted as direct proof that vulnerability is a governance blind spot within ESG frameworks. Rather, they provide structural evidence about how the research field is organized and how vulnerability is positioned within ESG-related sustainability scholarship. The co-occurrence, thematic, and conceptual maps show that vulnerability is present in the literature but is less central and less strongly integrated than related concepts such as climate change, resilience, and adaptation. Therefore, the governance blind-spot argument is not derived from keyword frequency alone, but from the combined interpretation of bibliometric evidence and conceptual analysis.

The findings of this study should be interpreted through the combined contribution of the bibliometric analysis and the conceptual review. The bibliometric results show that vulnerability is present within ESG-related sustainability scholarship, but it remains less central and less strongly integrated than themes such as climate change, resilience, adaptation, and sustainability. This pattern does not, by itself, prove a governance failure. Rather, it indicates that vulnerability occupies a comparatively weaker position within the intellectual and thematic structure of the field. The conceptual review explains why this matters: ESG frameworks tend to translate sustainability into standardized, comparable, and risk-oriented indicators, while vulnerability is spatially differentiated, socially embedded, and institutionally mediated [11,20,23].

The findings of this study should be interpreted through the combined contribution of the bibliometric analysis and the conceptual review. The bibliometric results show that vulnerability is present within ESG-related sustainability scholarship, but it remains less central and less strongly integrated than themes such as climate change, resilience, adaptation, and sustainability. This pattern should not be interpreted as direct proof that

vulnerability is a governance blind spot within ESG frameworks. Rather, it provides structural evidence about how the research field is organized and how vulnerability is positioned within it. The governance argument emerges when this bibliometric evidence is read together with the conceptual literature, which shows that ESG frameworks tend to prioritize standardized, comparable, and risk-oriented indicators, while vulnerability requires place-based, social, spatial, and institutional analysis [6,16].

This distinction is important because resilience and adaptation are often treated as operational responses to climate-related risks, whereas vulnerability refers to the underlying conditions that determine who or what is most exposed, most sensitive, and least able to adapt. If ESG systems focus primarily on aggregate risk exposure, disclosure, and performance metrics, they may overlook the territorial conditions that shape actual climate impacts. Therefore, the governance challenge is not simply that ESG frameworks lack additional indicators, but that existing indicators often fail to connect corporate and institutional sustainability assessment with local exposure, adaptive capacity, infrastructure fragility, social inequality, and institutional preparedness [45,46].

The contribution of this study lies in mapping and critically interpreting the knowledge structure that connects ESG, vulnerability, resilience, and sustainability governance. The analysis does not propose a new empirical city-level vulnerability index, nor does it claim to provide a direct causal test between corporate ESG practices and specific local vulnerability outcomes. Instead, it shows that vulnerability remains weakly embedded within ESG-related research and is often treated as a secondary concept compared with resilience, adaptation, and climate risk. This finding is academically relevant because it identifies a conceptual and governance gap in the existing literature and clarifies why further empirical and policy-oriented research is needed to connect ESG frameworks with local and territorial vulnerability.

The results also suggest that a more integrated ESG approach requires place-based vulnerability indicators and stronger links between corporate/institutional ESG systems and local governance realities. Tools such as social vulnerability indices, regional risk indices, GIS-based assessment, and multi-hazard models can help make local vulnerability more visible within ESG-related decision-making. However, their integration requires a multi-level governance perspective because the relevant information is often distributed across corporate disclosures, public authorities, spatial datasets, and local adaptation planning processes. This reinforces the need for ESG approaches that are not only comparable across organizations, but also sensitive to the territorial contexts in which sustainability risks are experienced [47,48].

Overall, the bibliometric analysis and conceptual review play complementary roles in this study. The bibliometric analysis identifies the structural position of vulnerability within the literature, while the conceptual review explains the governance significance of this pattern. Taken together, these findings support the argument that vulnerability remains insufficiently incorporated into ESG and that future ESG frameworks should more explicitly integrate place-based vulnerability indicators.

6. Conclusions

This study examined the role of vulnerability within ESG frameworks, highlighting a critical gap between how sustainability is measured and how climate-related risks are actually experienced across territories. Within the corpus analyzed in this study, the findings indicate that vulnerability remains insufficiently integrated into ESG-related research, particularly in relation to place-based and governance-sensitive understandings of climate risk [27].

The study also identified key governance limitations that hinder the effective integration of vulnerability into ESG systems. These include the reliance on generalized indicators, the lack of context-sensitive data, and the fragmentation of policy and analytical approaches across disciplines and scales. As a result, ESG frameworks tend to prioritize measurable outcomes over underlying structural conditions, overlooking critical factors such as inequality, infrastructure, and local exposure that determine real-world vulnerability [32,49,50].

The contribution of this research lies in identifying vulnerability as a missing but essential component of ESG and in providing a foundation for its more systematic integration. By linking conceptual gaps with empirical patterns observed in the literature, the study highlights the need to move beyond risk-centered approaches toward frameworks that incorporate vulnerability as a core dimension of sustainability assessment. Such a shift is necessary to ensure that ESG systems are not only analytically robust but also capable of supporting equitable, context-sensitive, and effective responses to climate-related challenges.

7. Limitations and Future Research

This study presents several limitations that should be acknowledged. First, the analysis is based exclusively on the Scopus database, which, although comprehensive and widely recognized, does not capture all relevant publications. Studies indexed in other databases or included in gray literature may provide additional insights, particularly in applied or policy-oriented contexts. Second, the reliance on bibliometric methods introduces certain constraints related to data standardization and keyword selection. Despite the iterative refinement of the search query, the conceptual dispersion of terms such as vulnerability, resilience, and ESG may have led to the inclusion or exclusion of studies that interpret these concepts differently across disciplines.

In addition, while the systematic literature review supports a qualitative understanding of how vulnerability is addressed, it remains limited by the heterogeneity of existing studies and the absence of a unified conceptual framework. This fragmentation makes it challenging to directly compare findings and to establish consistent operational definitions, particularly in relation to governance and indicator development. Furthermore, the study focuses primarily on conceptual and methodological dimensions, without empirical validation of the proposed integration of vulnerability into ESG systems at the case-study level.

Future research should also focus on the development of standardized yet flexible frameworks that can operationalize vulnerability within ESG systems without losing sensitivity to local conditions. This includes the integration of geospatial data, multi-hazard models, and socially disaggregated indicators, as well as the exploration of governance mechanisms that can support cross-sectoral coordination. In addition, there is a need to further investigate the relationship between vulnerability, resilience, and sustainability performance, in order to move beyond fragmented approaches and toward more coherent and integrated analytical models.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su18147167/s1>, Table S1: Study characteristics of the 829 included studies; PRISMA Checklist [40].

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