

Evolution of *Resilience* in Academic Literature: Shifting Toward *Social Resilience*

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Abstract

This paper examines the evolution of the term “resilience” in academic literature, tracing its shift from natural sciences toward social sciences. Using 16,826 papers from OpenAlex, we analyze topical, linguistic, and author-level trends. Results show that research remained sparse until the mid-1980s, after which usage rose sharply, with 60–70% of annual publications from 1994 to 2025 focused on social resilience. Dominant themes include mental health, disaster management, and supply chain resilience, shaped by global events such as 9/11 and COVID-19. Author analysis highlights influential scholars (e.g., Michael Ungar, Ann S. Masten, Carl Folke), strong institutional leadership from North America and Europe, and extensive global collaboration, though the Global South remains underrepresented. Linguistic analysis of abstracts reveals a tripling of the term “social” between 2014 and 2024, underscoring the field’s shift toward human-centered perspectives. These findings illustrate how resilience has transformed into an interdisciplinary framework with broad societal implications. Data and code are available via Kaggle [Buium 2025a; Buium 2025b].

1 Introduction

In an era defined by intensifying environmental crises, social disruptions, and political volatility, social resilience has emerged as a pivotal framework for understanding how communities and groups withstand and adapt to external stresses and disturbances [Adger 2000]. This multifaceted concept refers to the ability of social systems—ranging from local communities to broader societal groups—to cope with challenges arising from social, political, and environmental changes, while preserving their core functions and identity [Adger 2000; Cinner and Barnes 2019].

1.1 From Ecological to Social Resilience

Closely tied to ecological resilience, which describes ecosystems’ capacity to maintain stability amidst perturbations [Holling 1973], social resilience diverges by centering on human dynamics and their complex interplay with ecological systems—particularly for communities whose livelihoods depend on natural resources [Adger 2000]. Far from static, social resilience is a dynamic, multi-level, and evolutionary process that enables societies not only to endure adversity but also to adapt and transform in response to it [Moya and Goenechea 2022; Lorenz 2013].

1.2 Core Capacities of Social Resilience

The robustness of social resilience hinges on several interrelated capacities. Adaptive capacity allows systems to modify their structures to mitigate future disasters, while coping capacity equips them to manage and recover from past calamities [Moya and Goenechea 2022]. Participative capacity, meanwhile, reflects the ability to reshape structures through interactions with external systems—though such interventions can, at times, inadvertently reduce resilience [Lorenz 2013]. Central to these capacities is the role of social capital and networks, which research identifies as a more critical determinant of disaster survival and recovery than physical infrastructure alone [Aldrich and Meyer 2015].

Social infrastructure—built on trust, mutual support, and community cohesion—facilitates resource sharing, emotional resilience,

and collective action, often proving decisive in post-crisis contexts where physical assets are compromised [Aldrich and Meyer 2015]. For example, communities with strong social bonds have consistently demonstrated greater resilience to catastrophes, highlighting the primacy of human connections in this domain. Table 1 (page 2) contrasts ecological, psychological, and social resilience, clarifying how definitions, units of analysis, and applications differ across fields.

1.3 Challenges and Research Aim

Despite its promise, social resilience faces significant conceptual and practical challenges. An agent-centric focus often dominates, emphasizing individual or group-level responses while sidelining the broader social conditions—such as power relations, economic inequalities, and structural vulnerabilities—that shape resilience outcomes [Lorenz 2013]. This bias risks misidentifying resilience as solely a product of agency, potentially leading to ideological exploitation or neglect of systemic factors that either bolster or erode adaptive potential [Cinner and Barnes 2019].

Addressing these gaps requires integrating social dimensions into resilience frameworks, balancing transformative changes with adaptive stability to better support vulnerable populations [Moya and Goenechea 2022]. Moreover, the term “resilience” itself carries a rich history, originating in the natural sciences before evolving into a lens for social inquiry. This paper investigates that trajectory within scientific literature, analyzing a comprehensive dataset of 16,826 papers and 2,974 authors to trace how resilience has shifted from its roots in physics, biology, and ecology to a concept increasingly defined by social science perspectives. By exploring how global events—such as disasters and pandemics—and collaborative networks have steered this evolution, the study reveals the interplay between societal pressures, academic discourse, and scholarly contributions, highlighting the rising prominence of social resilience in understanding human adaptation and endurance.

2 Related Work

The concept of resilience has been studied across multiple disciplines, producing distinct but interrelated research traditions. In ecology, C.S. Holling’s seminal paper on the “resilience and stability of ecological systems” [Holling 1973] established resilience as the capacity of ecosystems to absorb disturbances without shifting to alternative stable states. This ecological framing later expanded into the notion of *panarchy*, which emphasizes adaptive cycles and cross-scale interactions in socio-ecological systems [Gunderson and Holling 2002].

In psychology and human development, Ann S. Masten’s influential work on “ordinary magic” positioned resilience as a normative process of positive adaptation in the face of adversity [Masten 2001]. This tradition overlaps with studies in family therapy and education that focus on protective factors and developmental pathways. George A. Bonanno contributed significantly to the understanding of resilience in trauma and bereavement, challenging assumptions of pathology and highlighting individual variability [Bonanno 2004].

In the social sciences, Neil Adger and colleagues emphasized so-

Table 1: *Contrasting major dimensions of resilience across domains.*

| Dimension | Ecological Resilience | Psychological Resilience | Social Resilience |
|-----------------------------|---|--|--|
| Definition | Capacity of ecosystems to absorb disturbances and maintain function without shifting to an alternative stable state [Holling 1973]. | Capacity of individuals to maintain or regain mental health, adaptation, and positive functioning after adversity [Masten 2001; Bonanno 2004]. | Collective ability of communities, institutions, or societies to cope with, adapt to, and transform in response to stresses while preserving core identity [Adger 2000; Aldrich and Meyer 2015]. |
| Unit of Analysis | Populations, ecosystems, and ecological networks. | Individual, family, or small group. | Communities, organizations, institutions, and societies. |
| Key Mechanisms | Biodiversity, functional redundancy, adaptive cycles [Gunderson and Holling 2002]. | Coping strategies, social support, developmental protective factors. | Social capital, governance, networks, trust, institutional adaptability. |
| Indicators / Metrics | Species diversity, ecosystem recovery time, persistence of ecological functions. | Psychological well-being, post-traumatic growth, absence of pathology. | Community cohesion, disaster recovery, institutional stability, equitable resource access. |
| Applications | Conservation biology, ecosystem management, climate adaptation. | Trauma recovery, developmental psychology, education, mental health interventions. | Disaster risk reduction, urban planning, sustainable development, policy design. |

cial resilience as the collective ability of groups and communities to cope with external stresses and adapt without losing identity or functionality [Adger 2000]. This perspective underscores the importance of institutions, governance, and social capital [Aldrich and Meyer 2015]. More recent studies have critiqued resilience as an ambiguous or politically laden concept, suggesting it may shift responsibility for risk management from states to individuals and communities [Cutter 2016]. These critiques highlight the dual role of resilience as both an analytic tool and a normative policy discourse.

Bibliometric and scientometric analyses of resilience have also emerged. For instance, Xu and Kajikawa [Xu and Kajikawa 2018] conducted a large-scale mapping of resilience-related literature, finding strong growth in disaster studies and sustainability science. Compared to these efforts, our work emphasizes the linguistic and topical shifts of resilience discourse over time, using OpenAlex to provide a reproducible and openly available analysis pipeline.

3 Method Overview

3.1 Data Source and Retrieval

To explore the evolution of “resilience” in academic literature, we utilized **OpenAlex**, an open-access bibliographic database. Using the Pyalex Python library, we retrieved 16,826 papers containing the keyword “resilience” in titles, abstracts, or topics. The query was intentionally broad, spanning all disciplines rather than focusing only on “social resilience.” Each API call returned up to 100 works per page, across a maximum of 100 pages. Duplicate entries were avoided by tracking unique paper IDs. In addition, 382,427 cited references were collected to enable citation network analysis; however, these references were excluded from topical analysis due to scope and volume constraints, though they remain available for future studies.

3.2 Pipeline and Data Management

Data collection was implemented as a Python pipeline, storing intermediate results in JSON format. Because of OpenAlex’s free-tier API limits, the process spanned several days. Pre-existing data hosted on Kaggle (`seed_works.json`, `reference_metadata.json`) was used where possible, while missing references were fetched in batches of 50 [Buium 2025a]. All scripts and datasets are made publicly available through a Kaggle Notebook [Buium 2025a] and a GitHub repository at <https://github.com/Saarb97/Resilience-Project> [Buium

2025c].

3.3 Validation and Preprocessing

To validate the dataset, JSON files were streamed with `ijson` to manage memory efficiently. Abstracts, stored by OpenAlex as inverted indices, were reconstructed into plain text using a custom function. Titles, abstracts, and topics were then filtered using the regex pattern `{resilience}` to ensure relevance. This process yielded a deduplicated set of papers, saved as `validated_social_resilience_papers.csv`. Abstract texts were further cleaned with the **Natural Language Toolkit (NLTK)**: tokenization, lowercasing, punctuation removal, and stop-word filtering.

3.4 Topic Classification and Analysis

Our analysis centered on OpenAlex-assigned topics [OpenAlex 2024]. The 500 most frequent topics were extracted and classified with the assistance of ChatGPT (o3-mini-high). A prompt—based on the Introduction’s definition of “social resilience”—guided the AI to separate socially oriented themes (e.g., “resilience and mental health”) from natural-science themes (e.g., ecological resilience). The validated dataset was then processed with **Pandas** to extract temporal and topical insights. Years were cleaned and filtered (1973–2024), and topics parsed into lists. Visualizations were generated with **Matplotlib**, including annual counts of social-resilience papers and top-five topics per year [Buium 2025b]. To handle the dataset’s size, memory optimization strategies were employed.

3.5 Methodological Considerations

It is important to acknowledge potential limitations. OpenAlex topic assignments may introduce classification noise, as some papers are ambiguously tagged. Likewise, restricting analysis to abstracts limits semantic depth, though it provides a consistent and computationally feasible basis for large-scale bibliometric study.

4 Results

4.1 Prevalent Topics

The most prominent topics across the dataset highlight the dominance of social dimensions of resilience. “Resilience and mental health” leads with 5,160 papers, followed by “disaster management and resilience” (1,983) and “supply chain resilience and risk management” (994). In contrast, physics-related themes fall below the top 30, underscoring that contemporary resilience research is pri-

marily socially oriented.

Table 2: *Top five resilience-related topics classified as social vs. natural sciences.*

| Social Resilience Topics | Papers | Natural/Ecological Resilience Topics | Papers |
|--|--------|---|--------|
| Resilience and mental health | 5,160 | Ecological resilience and ecosystems | 612 |
| Disaster management and resilience | 1,983 | Biodiversity and species recovery | 534 |
| Supply chain resilience and risk management | 994 | Soil and agricultural system resilience | 498 |
| COVID-19 and mental health | 742 | Climate and hydrological resilience | 463 |
| Psychological well-being and life satisfaction | 521 | Forest and coral reef resilience | 422 |

4.2 Historical Trends

The earliest recorded use of “resilience” dates back to 1818, though usage remained sparse until the mid-1980s. A turning point occurred in 1985, when “resilience and mental health” emerged as a dominant theme, appearing in three papers that year. Since then, social applications have driven the rapid growth of the term’s usage.

Prior to 1985, resilience was largely confined to ecology, biology, and related natural sciences. The subsequent expansion reflects both disciplinary broadening and global crises that brought social dimensions to the fore.

4.3 Linguistic Trends in Abstracts

Quantitative linguistic analysis underscores the growing emphasis on social themes. The frequency of the word “social” in abstracts tripled, rising from 10 occurrences per 1,000 words in 2014 to 35 in 2024. References to psychological dimensions also increased, though more modestly, doubling from 3 to 6 occurrences per 1,000 words between 2020 and 2024.

Further lexical analysis reveals the most common abstract terms: “resilience” (36,666 occurrences), “social” (17,906), “study” (8,127), “support” (7,038), and “health” (4,688). Together, these terms highlight the field’s orientation toward community support, stress management, and health outcomes, reinforcing the conclusion that resilience scholarship has increasingly adopted social science frameworks.

4.4 Author Analysis

To assess scholarly contributions, we examined 41,608 authors from resilience-related papers, focusing on publication output, citation impact, institutional affiliations, and collaboration patterns. The dataset, sourced from OpenAlex and processed as described in Section 3, provides a comprehensive picture of author activity.

4.4.1 Publication and Citation Impact

Author productivity and influence vary widely. Michael Ungar (Dalhousie University, Canada) leads with 83 papers and 14,967 citations (180 citations per paper). Ann S. Masten (University of Minnesota, US) follows with 78 papers and 37,155 citations (476 citations per paper). Carl Folke (Stockholm University, Sweden) contributed 71 papers and holds the highest citation total at 49,210.

The distribution is highly skewed: 80% of authors published fewer than five papers, while only 10 authors produced 40 or more. Citations are similarly uneven, with the top 1% accounting for nearly

30% of all citations. A striking example is C.S. Holling’s seminal work, **Resilience and Stability of Ecological Systems**, which alone garnered 15,579 citations, underscoring the enduring influence of foundational research.

4.4.2 Institutional and Geographic Distribution

Institutional affiliations reveal strong concentrations in North America, Europe, and Australia. The United States hosts 47% of authors, with major hubs at the University of Minnesota, Columbia University, and Arizona State University. Canada contributes 8%, led by Dalhousie University and the University of Manitoba. Europe accounts for 30%, with key centers in Sweden (Stockholm University, Stockholm Resilience Centre) and the UK (University of Manchester, University of Exeter). Australia contributes 7%, with institutions such as CSIRO and the University of Queensland.

Despite contributions from 50 countries, the Global South remains underrepresented, comprising only 5% of authors (e.g., South Africa’s North-West University, Brazil’s Universidade Federal do Rio de Janeiro). This disparity highlights the need for greater inclusion of perspectives from regions most vulnerable to environmental and social challenges.

Institutional specialization is evident. For instance, the Icahn School of Medicine at Mount Sinai emphasizes stress, depression, and neurological resilience. Stockholm University prioritizes social-ecological resilience, particularly water and ecosystem sustainability. Harvard University focuses on healthcare resilience (e.g., Alzheimer’s), Wageningen University on agricultural systems and climate adaptation, and the University of Queensland on environmental resilience, especially coral reefs.

4.4.3 Collaboration Patterns

Collaboration is a hallmark of resilience research, with an average of 4.8 co-authors per paper. Some researchers exhibit exceptionally high collaboration rates—Klaus Lieb (Leibniz Institute for Resilience Research, Germany) averages 17.4 co-authors per paper, while Raffaël Kalisch averages 20.6. Such patterns reflect interdisciplinary projects, particularly in mental health resilience.

In contrast, others maintain smaller collaborative circles: Froma Walsh (University of Chicago, US) averages 2.0 co-authors, and Michael Rutter (King’s College London, UK) only 1.3. Institutional networks also play a role: Harvard University stands out as a collaborative hub, with at least 220 external co-authors on resilience-focused papers, reflecting its centrality in global scholarly networks.

Notably, many highly cited works emerge from collaborative teams. For example, Brian Walker’s **Resilience, Adaptability and Transformability in Social-ecological Systems** (6,549 citations) involved an average of 5.1 co-authors, underscoring the benefits of diverse expertise. International collaboration is also common, with 60% of the 20 most-cited papers involving authors from multiple countries.

4.4.4 Research Focus and Impact

The most cited works align with the prevalent topics identified earlier. Social resilience dominates, with influential publications such as Ann S. Masten’s **Ordinary Magic: Resilience Processes in Development** [Masten 2001] and George A. Bonanno’s **Loss, Trauma, and Human Resilience** [Bonanno 2004]. Social-ecological resilience is also prominent, reflected in Carl Folke’s **Resilience: The Emergence of a Perspective for Social-Ecological Systems Analyses** and Brian Walker’s aforementioned paper, both extending the ecological foundations established by Holling [Holling 1973] and later developed in panarchy theory [Gunderson and Holling 2002]. Table 3 summarizes the ten most

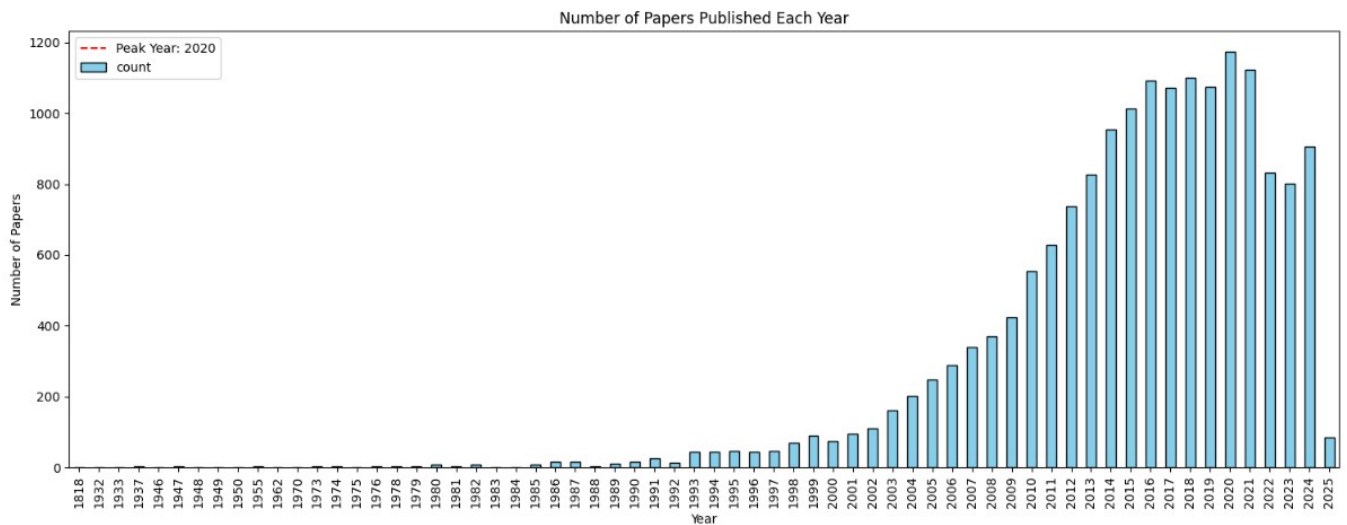


Figure 1: Percentage of resilience-related papers associated with “social resilience”. Data sourced from OpenAlex.

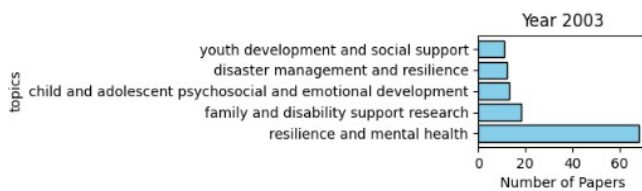


Figure 2: Top 5 topics in 2003, showing the rise of ‘disaster management and resilience’ post-9/11. Data sourced from OpenAlex [OpenAlex 2024].

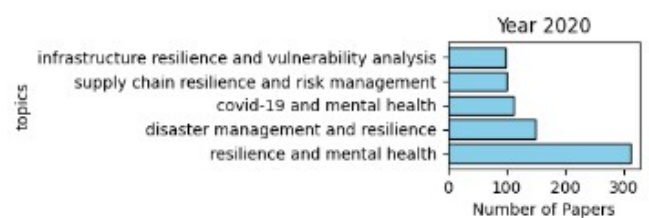


Figure 3: Top 5 topics in 2020, highlighting the emergence of ‘COVID-19 and mental health’ during the pandemic. Data sourced from OpenAlex [OpenAlex 2024].

cited resilience-related papers, illustrating the balance between ecological, psychological, and social-ecological perspectives.

An important observation is the longevity of impact. Long-standing scholars such as Brian Walker and C.S. Holling, each with 40+ year careers, produced foundational works that continue to shape contemporary research. By contrast, newer researchers like Dmitry Ivanov (Berlin School of Economics and Law, Germany) have gained rapid visibility with timely contributions—e.g., *Viability of Intertwined Supply Networks* (1,370 citations)—spurred by the COVID-19 pandemic.

5 Discussion

5.1 Notable Events and Influences

Several events appear to have shaped the trajectory of resilience research:

1. **Possible Influence of 9/11:** In 2003, as seen in figure [2], a marked increase in papers on ‘disaster management and resilience’ elevated it to the fourth most prevalent topic, a ranking it had not previously achieved. Its prominence waned until 2007, after which it rose to the second most prominent topic from 2008 to 2024, except in 2022.
2. **Emergence of COVID-19:** Following the onset of the COVID-19 pandemic in 2019, ‘COVID-19 and mental health’ entered the top five topics in 2020 (As seen in figure [3]), with over 100 papers annually from 2020 to 2024. The pandemic may also have contributed to the rise of ‘psychological well-being and life satisfaction,’ which peaked in 2022. So-

cial resilience-related topics reached their highest prevalence in 2020 and 2021, followed by a notable decline from 2022 to 2024.

The significant increase in the use of the term “social” in paper abstracts from 2014 to 2024, tripling from 10 to 35 occurrences per 1,000 words, aligns temporally with global crises such as COVID-19, suggesting these events catalyzed a deeper academic engagement with social dimensions of resilience. The parallel rise in the term “psychological,” albeit modest, from 3 to 6 occurrences per 1,000 words between 2020 and 2024, similarly correlates with the pandemic’s impact on mental health research.

5.2 Limitations

While this study offers novel insights into the evolution of resilience scholarship, several limitations must be acknowledged:

- **Database Coverage:** OpenAlex, while comprehensive and open access, may not index all journals equally, particularly those outside the Anglophone world. This could bias the dataset toward North American and European perspectives.
- **Topic Classification:** The reliance on OpenAlex-assigned topics, supplemented with ChatGPT classification, introduces potential noise. Misclassified topics could affect the proportion of papers assigned to “social resilience.”
- **Abstract-Only Analysis:** Linguistic analysis was restricted to abstracts, which may not fully represent the content of papers. Full-text mining could reveal different emphases.

Table 3: Top 10 most cited resilience-related papers in the dataset, showing domain emphasis and citation counts.

| Paper Title | Author(s) | Domain | Citations |
|---|----------------------------|-------------------|-----------|
| Resilience and Stability of Ecological Systems | C. S. Holling (1973) | Ecology | 15,579 |
| Resilience, Adaptability and Transformability in Social–ecological Systems | Brian Walker et al. (2004) | Social–ecological | 6,549 |
| Resilience: The Emergence of a Perspective for Social–Ecological Systems Analyses | Carl Folke (2006) | Social–ecological | 6,121 |
| Loss, Trauma, and Human Resilience | George A. Bonanno (2004) | Psychology | 6,043 |
| Ordinary Magic: Resilience Processes in Development | Ann S. Masten (2001) | Psychology | 5,342 |
| Panarchy: Understanding Transformations in Human and Natural Systems | Gunderson & Holling (2002) | Social–ecological | 5,105 |
| Social Capital in Post-Disaster Recovery | Daniel P. Aldrich (2012) | Social sciences | 3,982 |
| The Landscape of Disaster Resilience Indicators in the USA | Susan L. Cutter (2016) | Disaster studies | 2,447 |
| Viability of Intertwined Supply Networks | Dmitry Ivanov (2020) | Supply chain | 1,370 |
| An Integrated Framework for Resilience Research | Xu & Kajikawa (2018) | Bibliometrics | 1,105 |

- **Temporal Bias:** More recent papers naturally have fewer citations, making it difficult to compare scholarly impact across decades. Similarly, global crises (e.g., COVID-19) may temporarily inflate thematic prevalence.
- **Interpretive Ambiguity:** Resilience is often used as a buzzword or metaphor in social sciences. Counting keyword frequencies risks overestimating conceptual coherence across disciplines.

6 Future Work

Future research could extend this study in several directions. First, citation network analysis could map clusters of highly interconnected authors, revealing intellectual communities and the diffusion of resilience concepts across disciplines. Second, expanding beyond abstracts to full-text mining would allow for a richer semantic analysis, including discourse patterns and framing devices. Third, comparative analyses across bibliographic databases such as Scopus, Web of Science, or Dimensions could highlight coverage biases and validate OpenAlex-based findings. Fourth, an explicit focus on the Global South could bring forward underrepresented perspectives, especially in regions where resilience is most urgently tested by climate change, conflict, or systemic inequalities. Finally, interactive visualizations and dashboards could be developed to make resilience trends accessible to policymakers, practitioners, and the broader public, bridging the gap between academic research and applied action.

7 Conclusion

7.1 Key Findings

This study has illuminated the evolution of resilience in scientific literature, highlighting a significant shift from physical and ecological roots toward a dominance of social perspectives. Analysis of 16,826 papers from OpenAlex revealed “resilience and mental health” (5,160 papers), “disaster management” (1,983), and “supply chain resilience” (994) as prominent contemporary themes. Usage of the term increased notably after 1985, driven largely by social resilience topics influenced by external crises such as 9/11 and the COVID-19 pandemic.

Author-level analysis identified influential scholars—Michael Ungar, Ann S. Masten, and Carl Folke—whose prolific output shaped the resilience discourse. Geographic disparities emerged, favoring North American and European institutions, while highlight-

ing under-representation from the Global South, potentially limiting diverse perspectives. High interdisciplinary collaboration rates, particularly in social-ecological and mental health resilience, underscore collective expertise in addressing complex societal challenges.

7.2 Implications

The rapid growth of social thematic emphasis, with a threefold increase in the term “social” in abstracts from 2014 to 2024, signals a broader disciplinary realignment toward human-centered resilience. Institutional specialization ranged from mental health at Harvard and Mount Sinai, ecological sustainability at Stockholm University, to agricultural resilience at Wageningen University. Harvard’s central role in scholarly collaborations exemplifies resilience research’s interconnected and interdisciplinary nature.

These findings demonstrate that resilience has become not only a scientific concept but also a policy and societal lens through which crises are understood. As such, resilience research has implications for disaster response, public health, climate governance, and community development.

7.3 Future Directions

Despite its promise, resilience research still faces conceptual and practical challenges. An agent-centric bias focusing on individual or topical responses risks neglecting systemic factors such as power dynamics and inequities. This echoes critiques in the social sciences that resilience may at times function as a vague or politically loaded concept, shifting responsibility for adaptation from institutions to individuals and communities [Cutter 2016].

Future research should integrate broader social contexts into resilience frameworks, encourage representation from diverse regions, and explore the interplay between adaptive stability and transformative change. Leveraging interdisciplinary collaborations can enhance resilience research’s ability to support societies confronting an uncertain future.

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