Educational Administration: Theory and Practice
2023, 29(3), 1335-1349
ISSN: 2148-2403
https://kuey.net/

Research Article

"Navigating the landscape of green insurance: A bibliometric perspective"

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Citation: Prateek Yadav, et al (2023) "Navigating the landscape of green insurance: A bibliometric perspective", *Educational Administration: Theory and Practice*, *29*(3), 1335-1349
Doi: 10.53555/kuey.v29i3.9086

ARTICLE INFO

ABSTRACT

In response to escalating environmental challenges, the insurance sector has emerged as a crucial player in advancing sustainability by addressing climate risks and promoting environmentally responsible practices. This study provides a comprehensive bibliometric analysis of the evolving landscape of green insurance, offering a detailed examination of scholarly publications indexed in the Web of Science database between 2001 and 2023(May). By employing bibliometric tools within RStudio, the research identifies key contributors, maps thematic trends, and highlights emerging areas of interest within this growing field. The findings reveal a 10.22% annual growth rate in publications, reflecting increased global interest in green insurance. Key themes include ESG integration, climate risk management, renewable energy insurance, and carbon credit mechanisms, showcasing its alignment with sustainability goals. Regional disparities are evident, with China leading in publication volume but the Netherlands achieving greater global impact through international collaborations. Technological advancements, such as blockchain and AI, also feature prominently, highlighting their potential to transform risk management and transparency in insurance practices. The study identifies critical gaps in consumer behavior research, policy impact assessments, and green insurance applications in developing economies. These insights provide a foundation for future research and practical innovations aimed at enhancing green insurance's role in mitigating environmental risks and fostering sustainable development. This study offers valuable guidance for academics, practitioners, and policymakers, contributing to the development of effective insurance solutions to address global environmental challenges.

Keywords: Green insurance, sustainable insurance, environmental insurance, bibliometric analysis.

1. Introduction

The increasing global awareness of environmental sustainability and the growing need to mitigate the impacts of climate change have led to a heightened interest in the field of green insurance. The global focus on sustainability has driven the insurance industry's evolution towards green insurance, a concept born from the urgency to address climate risks and promote environmentally responsible practices. The insurance industry plays a vital role in mitigating and transferring risks, safeguarding individuals, businesses, and communities from various uncertainties (He & Faure, 2023). The insurance sector is crucial in managing and shifting risks, protecting people, organizations, and communities from many uncertainties (Babuna *et al.*,2020). However, environmental concerns including resource depletion, natural catastrophes, and climate change present serious hurdles to the sector itself (Lukic *et al.*, 2022). These hazards not only threaten the insurance industry's capacity to maintain a stable financial position, but they also have significant effects on society and the world economy (Stigler & Reiter, 2021; World Economic Forum 2023). The recent report generated by the Intergovernmental Panel on Climate Change (IPCC) indicates in Assessment Report suggests limiting warming to 1.5 ℃ as well as 2 ℃. In the present scenarios, prevailing worldwide inequities in incomes, energy usage, and emissions are anticipated to remain until 2050 (Matthews *et al.*, 2022). Therefore, the causes to implement green insurance stem from the urgent need to address the economic and environmental challenges posed by

climate change. As natural disasters and extreme weather events increase in frequency and severity, the financial burden on individuals, businesses, and governments has grown significantly.

In recent years, the concept of "green insurance" has emerged as a response to these environmental challenges, emphasizing the integration of sustainability principles into insurance practices (Gatzert *et al.*, 2020). Green insurance encompasses a wide range of initiatives and products designed to promote environmental protection, risk mitigation, and sustainable development (Chen *et al.*, 2020). One of the primary drivers for the adoption of green insurance is the increasing frequency and severity of natural disasters, exacerbated by climate change (Nobanee, 2022). Extreme weather events, such as hurricanes, floods, wildfires, and droughts, have caused significant economic losses and disruptions to businesses and communities (EI-Hermisy, 2021). Insurance companies are at the forefront of addressing these risks, as they are responsible for providing financial protection and facilitating recovery efforts in the aftermath of such events (Botzen, 2021).

By embracing green insurance practices, insurance companies can better assess and manage climate-related risks, develop innovative products and services, and contribute to the transition towards a low-carbon economy (Semieniuk *et al.*, 2021; sticker, 2022). This includes offering insurance policies tailored to renewable energy projects, green buildings, and sustainable insurance initiatives, as well as incorporating environmental, social, and governance (ESG) factors into underwriting and investment decisions (Brogi *et al.*, 2022, Debrah *et al.*, 2022). Moreover, green insurance can incentivize policyholders to adopt more sustainable practices by offering premium discounts or other benefits for implementing risk mitigation measures, such as energy efficiency improvements, or the use of environmentally friendly materials (Finger *et al.*, 2020). This not only reduces the potential for losses but also promotes environmentally responsible behavior among individuals and businesses.

Another aspect of green insurance is the management of carbon emissions and the promotion of carbon trading mechanisms (Xuan *et al.*, 2022). Insurance companies can play a crucial role in facilitating the development of carbon markets by providing risk transfer solutions and promoting transparency in carbon accounting and reporting. (Kenyon *et al.*, 2022; Steuer & Troger ,2022). Additionally, insurance products can be designed to protect investments in carbon offset projects or to cover potential liabilities associated with greenhouse gas emissions (Braun *et al.*, 2019).

Despite the growing body of literature on green insurance and its related concepts, there is a notable absence of comprehensive bibliometric studies that systematically analyze the development, thematic trends, and intellectual structure of this domain. Existing research primarily focuses on specific aspects of green insurance, such as policy implications or case studies, without leveraging bibliometric methods to uncover the broader evolution and interconnectedness of scholarly contributions. This gap underscores the need for a detailed bibliometric analysis to provide a holistic understanding of the field, identify emerging research areas, and inform future academic and practical advancements.

The primary objective of this study is to analyze the academic landscape of green insurance from 2001 to March 2023 using bibliometric methods. By leveraging data from the Web of Science database and employing visualization techniques in R Studio, the study aims to provide a comprehensive overview of the field's intellectual structure and research trajectory. The analysis seeks to identify key trends, contributors, and thematic areas, thereby offering insights into the development and future direction of green insurance research.

This study makes significant contributions by providing a comprehensive bibliometric analysis of green insurance research, which serves as a foundation for both academic and practical advancements. By mapping key trends, thematic evolutions, and influential works, the study offers valuable insights into the intellectual development of the field.

The paper is structured as follows: The next section presents a detailed literature review, discussing key contributions and challenges in green insurance research. The methodology section outlines the data collection and analysis processes, including the use of bibliometric tools in RStudio. The results and discussion section highlights the key findings, including trends, themes, and regional disparities. Finally, the conclusion summarizes the study's contributions and implications, identifying future research directions.

2. Literature Review

Traditionally, insurance policies have excluded or limited coverage for environmental risks due to the unpredictable nature and high costs of environmental damage (Brogi *et al.,* 2022). This exclusion stems from the challenges in assessing environmental risks and the financial liabilities they entail. However, growing recognition of the need to address environmental risks has led to the development of specialized insurance products, known as green insurance. These products aim to cover specific environmental liabilities and support sustainable development (Xing *et al.*, 2022). For instance, green building insurance provides discounts to buildings that meet energy efficiency or green certification standards, promoting sustainable construction practices (He & Chen 2021). Research has highlighted the challenges and opportunities related to green building insurance, particularly in risk management strategies for sustainable infrastructure Similarly, climate risk insurance is designed to protect individuals, businesses, and communities from financial losses due to climate change-related events, such as extreme weather or sea-level rise (Schafer *et al.*,2019). These products provide financial support for recovery and adaptation measures. Studies have explored the role of climate risk insurance in enhancing resilience and promoting sustainable development (Mariya *et al.,*2021; Hausmann, 2020).

In the broader field of sustainable finance, ESG (Environmental, Social, and Governance) insurance has gained attention for integrating sustainability considerations into insurance products. ESG insurance incentivizes companies to meet specific ESG criteria by offering coverage tailored to responsible business practices (Pugneeti *et al* 2022; Khovrak,2020). This integration encourages companies to adopt more sustainable and ethical approaches, thus supporting the broader goals of sustainable development.

Whereas, Environmental insurance, which encompasses products designed to protect against risks such as pollution or contamination, is another key component of green insurance (Yang & Zhang, 2022). These policies cover liabilities arising from environmental incidents, including cleanup costs and legal expenses. In the area of carbon credit insurance, products have emerged to mitigate risks associated with fluctuations in carbon prices. These policies support investors and project developers in the carbon offset market by providing protection against financial uncertainties (Dawson *et al.*, 2022). Research has explored the role of carbon credit insurance in supporting the development of carbon markets and enhancing transparency in carbon accounting (Ameli *et al.*, 2020). Similarly, greenhouse gas emissions insurance addresses liabilities related to emissions regulations, offering coverage for penalties and obligations associated with carbon offset programmed (Green, 2021; Lyubchich *et al.*, 2019). This form of insurance helps businesses manage their carbon footprints and comply with emissions regulations, thus contributing to corporate sustainability goals (Belousova *et al.*,2022)

Finally, renewable energy insurance covers risks related to renewable energy technologies such as solar, wind, and hydroelectric power. These policies mitigate risks including property damage, business interruption, and third-party liability, thereby enhancing the bankability of renewable energy projects (Liao *et al.*, 2022). However, challenges remain in accurately assessing and pricing the risks associated with emerging renewable energy technologies.

Despite the potential benefits of green insurance, its adoption faces challenges such as regulatory barriers, lack of standardization, and limited awareness. Addressing these challenges requires collaboration between insurers, policymakers, and stakeholders to create comprehensive frameworks, raise public awareness, and foster an environment conducive to the growth of green insurance. This review highlights the key trends and issues within the field of green insurance, providing a foundation for the bibliometric analysis that follows. Through a systematic examination of the literature, this study aims to map the evolution of research in this area and identify emerging themes and influential works.

3. Research Methodology

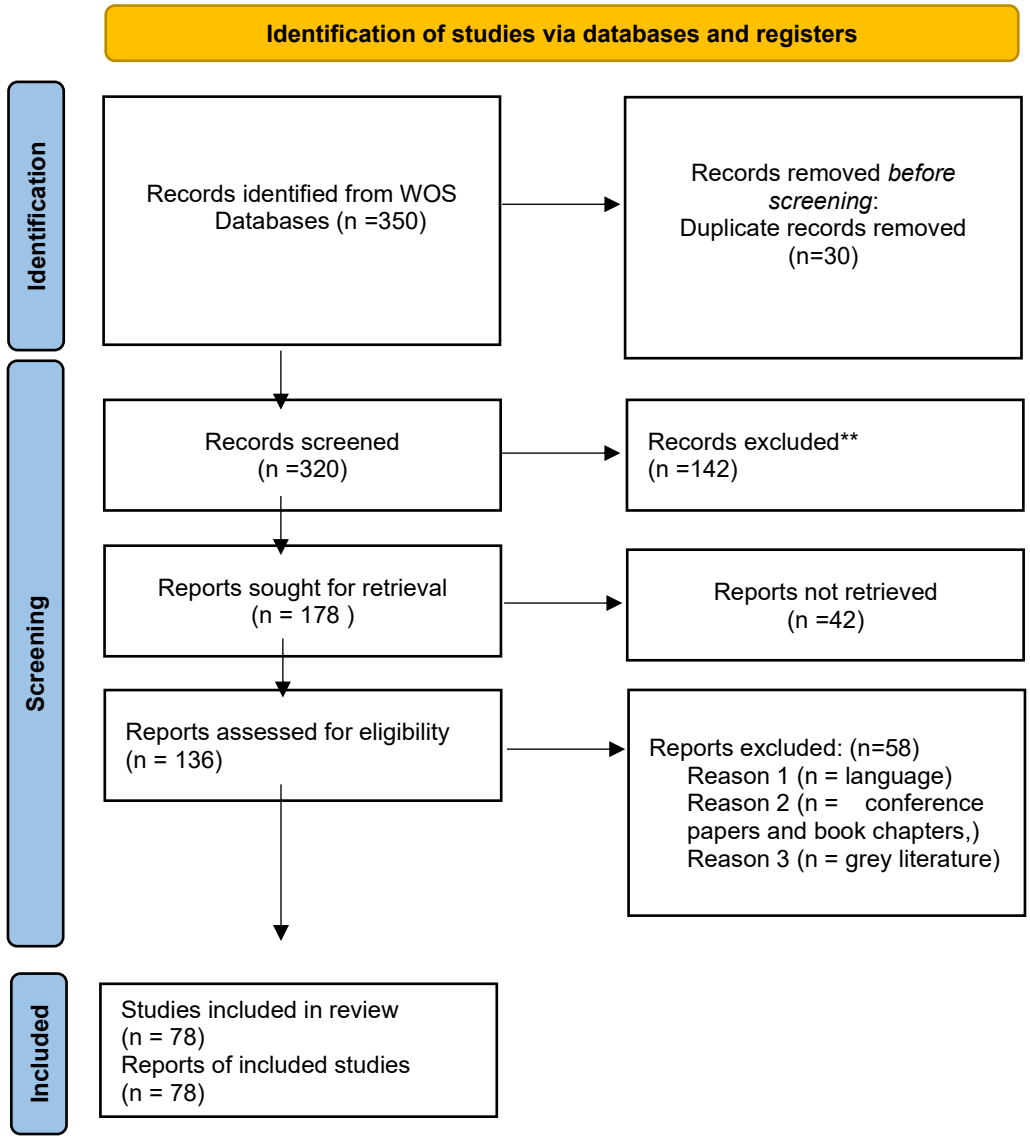
3.1 Data collection process

For this bibliometric analysis, the data was collected from the Web of Science (WOS) Core Collection database, which is one of the most comprehensive and widely used bibliographic databases for scientific literature (Paranckute, 2021; Birkle *et al.*, 2020). The WOS database indexes high-quality scholarly journals, books, and proceedings across various disciplines, ensuring a comprehensive coverage of the relevant literature.

To retrieve the relevant publications on the topic of "green insurance," a systematic search strategy was employed. The following string of keywords was used to search the WOS database: "green insurance" OR "sustainable insurance" OR "environmental insurance" OR "carbon credit insurance" OR "green building insurance" OR "climate risk insurance" OR "ESG insurance" OR "Renewable energy insurance." OR "greenhouse gas emissions insurance." These key words were selected to ensure the inclusion of a broad range of articles related to green insurance.

The search was conducted across the WOS Core Collection, which includes the following indexes: Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), Conference Proceedings Citation Index - Science (CPCI-S), and Conference Proceedings Citation Index - Social Science & Humanities (CPCI-SSH). This comprehensive coverage ensured that relevant publications from various disciplines and publication types were included in the dataset.

To ensure the most up-to-date and relevant results, the search was limited to publications from 2001 to May 2023, the specified time period for the analysis. The time frame for the study spanned publications from 2001 to 2023. The year 2001 was chosen as the starting point to capture the evolution of green insurance research over the past two decades, coinciding with the growing global emphasis on sustainability following the Kyoto Protocol (Bohringer,2003). The cut-off year, 2023, ensures the inclusion of the most recent contributions to the field. This comprehensive temporal coverage allows for an analysis of both historical trends and emerging research themes, as highlighted by recent bibliometric studies on sustainability. The search results were then exported from the WOS database, including all necessary bibliographic information, such as authors, affiliations, publication titles, abstracts, keywords, citations, and reference lists. This data formed the basis for the subsequent bibliometric analysis, which involved various techniques and analyses to understand the research landscape, collaboration patterns, and emerging trends in the field of green insurance.



Prisma flowchart

3.2 Bibliometric Analysis Tools

RStudio, an integrated environment for R programming, was employed for bibliometric analysis and visualization in this study, leveraging its powerful capabilities for processing and interpreting large bibliographic datasets (Guleria & Kaur, 2021; Dervis, *2019*). The primary tool used was the *bibliometrix* package, as developed by Aria and Cuccurullo (2017), which offers a comprehensive framework for bibliometric analysis, including data importing, preprocessing, and advanced science mapping techniques. Key features include citation analysis, keyword co-occurrence mapping, and thematic evolution studies, making it highly suitable for exploring research trends in green insurance (Aria & Cuccurullo, 2017).

In addition to *bibliometrix*, its graphical user interface, *biblioshiny*, was utilized to enhance the accessibility and efficiency of data visualizations. *Biblioshiny* allows for the interactive exploration of bibliometric data, facilitating the creation of visual outputs such as collaboration networks, thematic maps, and co-citation graphs without requiring extensive programming skills (Aria *et al.*, 2020). These tools enable researchers to produce insightful and high-quality visualizations, making RStudio an indispensable platform for bibliometric analysis in this domain.

4. Results and Discussion

In table 1, The bibliometric analysis of research on green insurance from 2002 to 2023 provides comprehensive insights into the academic progression and collaboration in this field. Over this period, 78 documents were published across 45 distinct sources, including journals, books, and conference proceedings. The annual growth rate of publications stands at 10.22%, reflecting a consistent increase in scholarly interest, driven by the global focus on sustainability and climate risk management. The average age of the documents is approximately five years, indicating a relatively recent surge in research activities, aligning with the rising prominence of environmental, social, and governance (ESG) considerations in the insurance industry. The

average number of citations per document is 18.69, showcasing the moderate academic impact and relevance of these publications. The dataset contains 3,517 references, demonstrating a robust foundation of literature underpinning this field. The analysis identifies 259 unique "Keywords Plus" and 248 "Author's Keywords," which suggest a diverse and multidisciplinary approach to green insurance research. This highlights the field's intersection with related topics such as climate risk, renewable energy, and sustainable practices in the insurance sector. Authorship data reveals contributions from 204 authors, with 10 single-authored documents. On average, there are 2.9 co-authors per document, reflecting the collaborative nature of research in this domain. Additionally, international co-authorship accounts for 20.51% of the total, emphasizing the global interest and cross-border collaboration on issues pertaining to climate risks and green insurance.

In terms of document types, the majority are journal articles (69), with a smaller number of articles listed as early access (7) or proceedings papers (2). This distribution indicates that journal publications are the primary medium for disseminating research findings in this area. Overall, these findings underscore the growing academic interest in green insurance, driven by its critical role in addressing sustainability challenges and fostering resilience against climate-related risks.

Table 1: Main information about Data

Timespan	**2002:2023**
Sources (Journals, Books, etc.)	45
Documents	78
Annual Growth Rate %	10.22
Document Average Age	5.01
Average citations per doc	18.69
References	3517
DOCUMENT CONTENTS	
Keywords Plus (ID)	259
Author's Keywords (DE)	248
AUTHORS	
Authors	204
Authors of single-authored docs	10
AUTHORS COLLABORATION	
Single-authored docs	10
Co-Authors per Doc	2.9
International co-authorships %	20.51
DOCUMENT TYPES	
article	69
article; early access	7
article; proceedings paper	2

Descriptive Analysis: Author, Source, and Countries

Figure 1. shows the analysis of the most relevant authors in the field of green insurance highlights key contributors who have significantly advanced research in this domain. Among them, W. J. W. Botzen emerges as the most prolific author, contributing six articles with a fractionalized contribution score of 2.53. Botzen's work likely focuses on the intersection of climate risk, insurance mechanisms, and sustainability, reflecting a substantial influence on the field. Following closely, J. C. J. M. Van Den Bergh has contributed four articles with a fractionalized contribution score of 1.83. Van Den Bergh's research likely spans sustainability economics and policy implications, emphasizing the role of green insurance in mitigating environmental risks and supporting climate resilience. J. H. Lin is the third most relevant author, with three articles and a fractionalized score of 0.92. Lin's contributions may delve into technical aspects of green insurance, such as renewable energy insurance or financial modelling for climate risks. S. Chen and N. Gatzert follow with two articles each, with fractionalized scores of 0.58 and 1.00, respectively. Their work likely contributes insights into the practical and theoretical aspects of green insurance, including corporate responsibility, ESG integration, and innovative insurance solutions. The diverse contributions of these authors reflect the interdisciplinary nature of green insurance research, encompassing fields such as environmental economics, risk management, financial modelling, and sustainability policy. Their collective efforts have shaped the academic discourse and practical applications in this emerging domain, paving the way for further advancements in addressing climate risks through innovative insurance mechanisms.

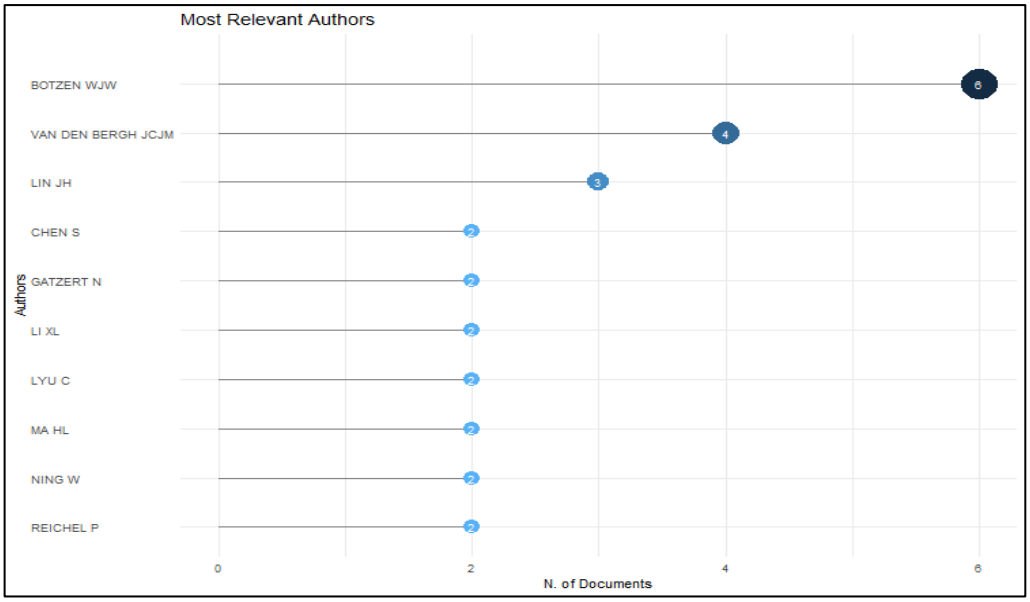


Figure1: Most relevant authors

Collaboration Networks

In figure 2. An analysis of collaboration and network patterns in green insurance research reveals the critical role of international partnerships in advancing the field. The data on multi-country publications (MCP) highlights countries like the Netherlands, which exhibits a 100% MCP ratio, indicating its strong emphasis on cross-border research collaborations. This high level of international engagement reflects the Netherlands' proactive approach to addressing global sustainability challenges by leveraging diverse perspectives and expertise. In contrast, countries like China, with a relatively low MCP ratio of 11.4%, demonstrate a predominant focus on domestically driven research. This pattern suggests opportunities for enhancing global impact through increased international partnerships, particularly in regions with high publication volumes but limited cross-border collaboration.

Collaborative networks have a demonstrable influence on the quality and impact of green insurance research. Studies originating from countries with high MCP ratios, such as the Netherlands and Germany, tend to achieve higher citation rates, signifying their academic relevance and influence. This can be attributed to the diversity of ideas and methodologies that arise from international collaboration, as well as the broader dissemination of findings across global academic and industry audiences. For instance, research involving institutions from multiple countries often addresses universally relevant themes, such as ESG integration or climate risk insurance, which resonate with both developed and developing economies.

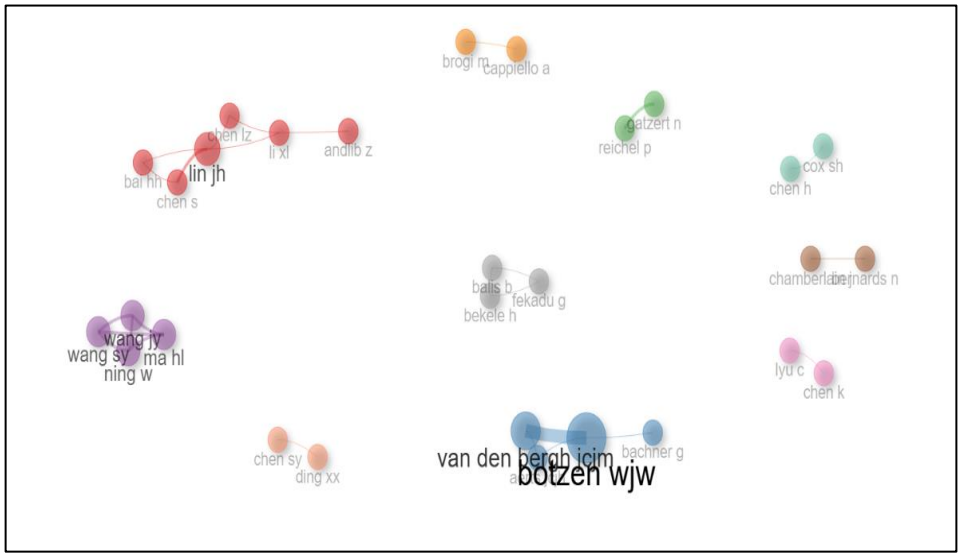


Figure 2: Collaboration Networks

Annual scientific production

Figure 3 shows, the annual scientific production graph illustrates the progression of academic publications in the domain of green insurance over the timespan from 2002 to 2023. The data reveals a modest but consistent output during the initial years, with relatively few publications per year up to around 2016. This period reflects

the nascent stage of research in green insurance, where interest was likely emerging but not yet widespread. From 2016 onwards, a noticeable upward trend begins to emerge, coinciding with increased global attention on sustainability, climate risk, and environmental, social, and governance (ESG) practices. Notably, from 2020, the field experiences a sharp rise in scientific output, with the number of publications escalating significantly through to 2023. This surge is likely influenced by heightened awareness of climate change impacts, advancements in ESG-driven insurance solutions, and the adoption of international policies, such as the Paris Agreement and its implications for industries, including insurance. The sharp increase post-2020 may also be attributed to the global prioritization of resilience against climate-related risks, the integration of technology in green insurance solutions, and a broader acceptance of sustainability as a critical business driver. This trend underscores the growing recognition of green insurance as a pivotal area of academic inquiry, reflecting its relevance in addressing contemporary global challenges. The data highlights the dynamic and evolving nature of this research domain, with significant growth suggesting that the field will likely continue to expand in importance and influence in the years ahead.

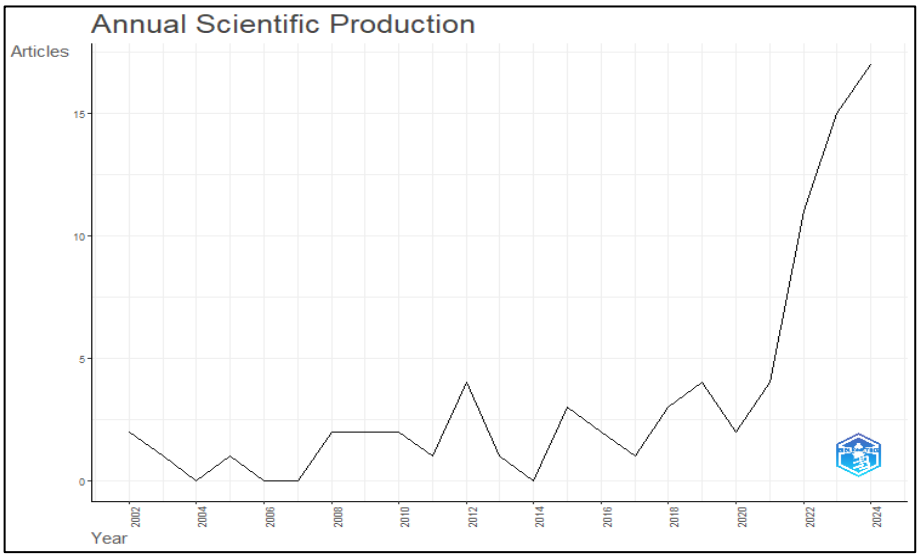


Figure3: Annual scientific production

Figure 4, shows, the analysis of the most relevant sources indicates that the "Geneva Papers on Risk and Insurance-Issues and Practice" is the leading journal, contributing 11 articles to the body of research on green insurance. This journal's prominence reflects its focus on risk management and insurance issues, aligning with the research's core themes of sustainability and environmental risk mitigation. Following this, "Energy Economics" has contributed 6 articles, underscoring the critical intersection of green insurance with energy economics, particularly regarding renewable energy and climate risk management. "Finance Research Letters" ranks next with 4 articles, highlighting the financial dimensions of green insurance, such as ESG integration and the economic impact of sustainable practices. Additionally, "Applied Economics Letters" and "Corporate Social Responsibility and Environmental Management" each contribute 3 articles. These journals demonstrate the interdisciplinary nature of the research, linking economic and corporate responsibility perspectives with the broader goal of environmental sustainability.

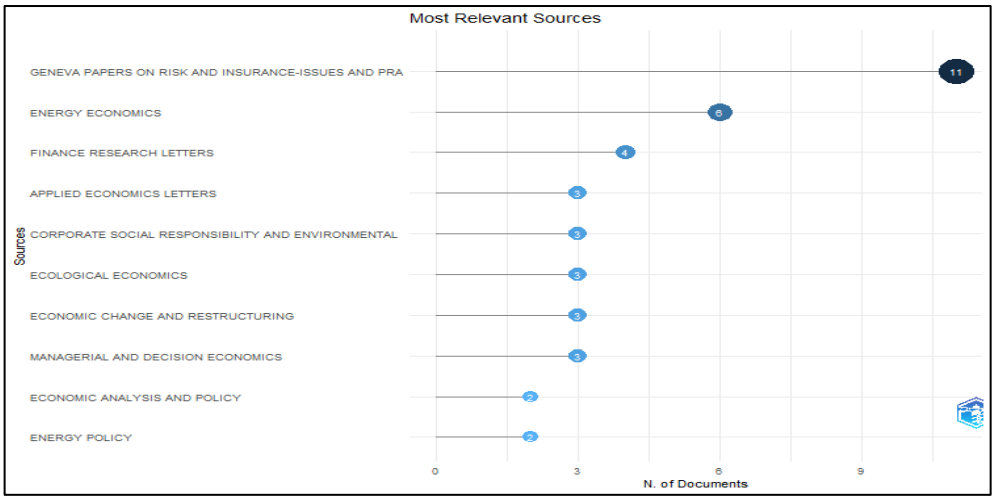


Figure 4: Most relevant sources

Corresponding author Countries:

Figure 5 shows Fostering new collaborations between leading authors and institutions presents significant opportunities to enrich the field. Strengthening ties between prolific contributors, such as authors from China, the United States, and the Netherlands, could enhance the scope and applicability of green insurance research. Collaborative projects that integrate the technical expertise of Chinese researchers, the innovative methodologies of Dutch scholars, and the policy-driven focus of American institutions can yield comprehensive insights into pressing sustainability issues. Additionally, expanding collaboration with underrepresented regions, particularly in Africa and South Asia, could address critical gaps in the literature and support the development of region-specific green insurance solutions.

To facilitate these collaborations, international conferences, joint research initiatives, and funding opportunities through global organizations can play a pivotal role. Platforms like the United Nations Framework Convention on Climate Change (UNFCCC) and industry consortia focused on sustainable finance could serve as catalysts for cross-border partnerships. By leveraging the strengths of collaborative networks, green insurance research can achieve greater academic impact and practical relevance, contributing to the development of innovative solutions for global sustainability challenges.

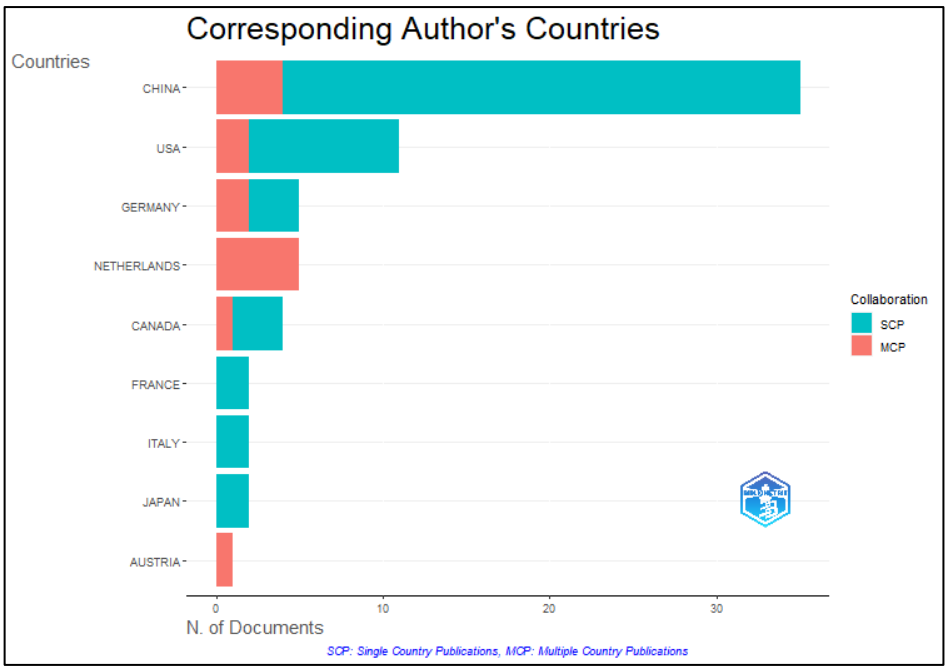


Figure 5: Corresponding author's countries

The analysis of corresponding author countries reveals that China leads in contributions to green insurance research, with 35 articles representing 44.87% of the total. Among these, 31 articles were single-country publications (SCP), while 4 were multi-country publications (MCP). This dominance underscores China's active engagement in sustainability and environmental risk research, likely driven by its policies on renewable energy and carbon emissions management. The MCP ratio of 0.11 indicates limited international collaboration, suggesting a primary focus on domestically driven research initiatives. The United States ranks second with 11 articles, accounting for 14.10% of the total. Of these, 9 are SCP, and 2 are MCP, resulting in an MCP ratio of 0.18. This reflects a moderate level of international collaboration, consistent with the US's global leadership in environmental and economic research. The contributions from the US likely focus on ESG integration, risk modelling, and policy frameworks for green insurance. Germany and the Netherlands each contributed 5 articles, representing 6.41% each. However, their collaboration patterns differ significantly. Germany has an MCP ratio of 0.40, indicating a balanced mix of domestic and international collaborations. In contrast, the Netherlands exhibits a 100% MCP ratio, highlighting its strong emphasis on cross-border research partnerships. This suggests that Dutch contributions may focus on global perspectives of green insurance, including multinational policy coordination and collaborative sustainability projects. Canada, with 4 articles (5.13%), also demonstrates a mix of SCP (3) and MCP (1), resulting in an MCP ratio of 0.25. Canadian research likely addresses renewable energy insurance and climate resilience in the context of its vast natural resources and environmental policies.

Overall, the geographical distribution of corresponding author countries highlights a global interest in green insurance, with China and the US as primary contributors, while European countries like Germany and the Netherlands play a significant role in fostering international collaboration. This distribution reflects the diverse regional priorities and approaches to integrating insurance solutions with sustainability goals.

Country Scientific Production

In table 2, the analysis of country scientific production reveals that China leads as the most prolific contributor to green insurance research, with 98 publications. This dominance underscores China's significant focus on addressing climate risks, carbon emissions, and renewable energy through academic research. China's position reflects its active role in global sustainability initiatives, supported by its ambitious environmental policies and economic strategies. The United States follows as the second-largest contributor, with 28 publications. This reflects the country's leadership in sustainability-related financial research, ESG frameworks, and innovative insurance mechanisms. The US's substantial academic output highlights its focus on addressing global climate challenges through multidisciplinary approaches. The Netherlands, with 11 publications, demonstrates its active participation in global green insurance research, despite being a smaller country. The Netherlands is known for its strong emphasis on environmental sustainability and collaborative research, which likely contributes to its notable output in this domain.

Table 2: Country Scientific Production

Countries Name	Frequency
CHINA	98
USA	28
NETHERLANDS	11
SPAIN	10
GERMANY	8
CANADA	5
ITALY	5
ICELAND	3
PAKISTAN	3
AUSTRIA	2

Spain, contributing 10 publications, also showcases its growing involvement in green insurance research. This reflects the country's interest in renewable energy insurance and climate resilience, supported by its commitments to sustainability and innovation in risk management. This distribution highlights the global nature of green insurance research, with contributions spanning both developed and developing regions. While China and the US dominate in volume, European countries such as the Netherlands and Spain play critical roles in advancing collaborative and innovative approaches to sustainable insurance practices. The data reflects the growing global recognition of green insurance as a pivotal tool for mitigating climate risks and fostering sustainability.

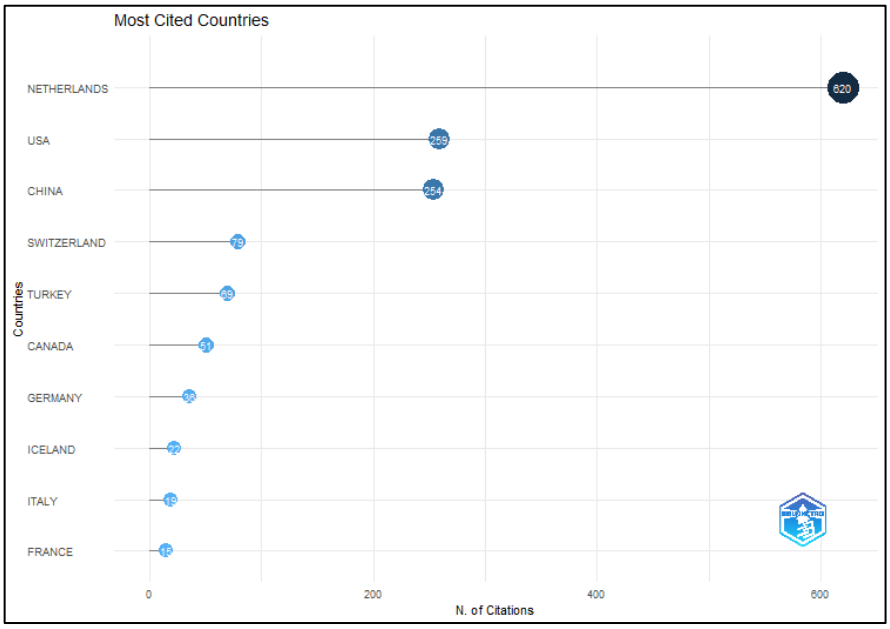


Figure 6: Most cited countries

Figure 6 shows the analysis of the most cited countries in green insurance research provides insights into the academic influence and impact of their contributions. The Netherlands emerges as the most highly cited country, with a total of 620 citations and an impressive average of 124 citations per article. This indicates the Netherlands' research is not only prolific but also highly impactful, likely due to its emphasis on cross-

disciplinary collaborations and innovative approaches to sustainable insurance practices. The United States follows with 259 citations and an average of 23.5 citations per article. While the US ranks second in total citations, the lower average compared to the Netherlands reflects a broader range of research outputs, with some articles achieving substantial influence. The US's contributions likely focus on the intersection of ESG frameworks, climate risk modelling, and practical applications in insurance. China has received 254 total citations, with an average of 7.3 citations per article. While China is a leader in terms of the volume of publications, the lower average citation count suggests that its research is still gaining global academic recognition. This may reflect the relatively recent growth of China's green insurance research and its focus on domestic sustainability challenges. Switzerland and Turkey have high average citation counts of 79 and 69 per article, respectively, despite contributing fewer publications. This indicates that their research is particularly specialized or foundational, addressing key theoretical or policy-related aspects of green insurance that resonate strongly within the academic community. Overall, this distribution highlights the varying levels of influence among countries, with the Netherlands and the United States leading in terms of global academic impact. China's contributions reflect the growing importance of its research, while Switzerland and Turkey demonstrate the value of specialized, high-impact studies in advancing the discourse on green insurance

Word Cloud

Figure 7 shows the word cloud analysis highlights the most frequently occurring terms in the literature on green insurance, providing insights into the key themes and focus areas of the research. The term "impact" appears most frequently, reflecting the central concern of this field in assessing the implications of green insurance on environmental sustainability, economic stability, and societal well-being. This term encapsulates the overarching goal of creating measurable and meaningful outcomes through sustainable insurance practices. The word "risk" is another prominent term, underscoring the critical role of green insurance in managing and mitigating risks associated with climate change, renewable energy, and environmental challenges. The frequent use of this term indicates the field's emphasis on risk assessment frameworks and insurance mechanisms tailored to address these emerging threats.

Figure 7: word cloud

The term "management" also features prominently, reflecting the strategic focus of the research on managing climate-related risks through innovative policies, corporate strategies, and operational practices. It highlights the multidisciplinary nature of the field, combining insights from risk management, sustainability, and insurance. Other significant terms include "corporate social responsibility" and "growth," which indicate the alignment of green insurance with broader business goals such as ESG integration, fostering sustainable development, and supporting organizational growth in an environmentally responsible manner.

The recurring presence of these terms illustrates the thematic emphasis on sustainability, risk mitigation, and the strategic management of resources in the context of green insurance. This word cloud analysis provides a comprehensive overview of the research priorities in the field and highlights its alignment with global sustainability goals.

Thematic Analysis:

Figure 8 shows, Thematic analysis in bibliometrix involves systematically identifying and interpreting patterns within bibliometric data to understand research trends and intellectual structures across various fields. This approach not only highlights key themes but also reveals connections and gaps in the literature, guiding future research directions.

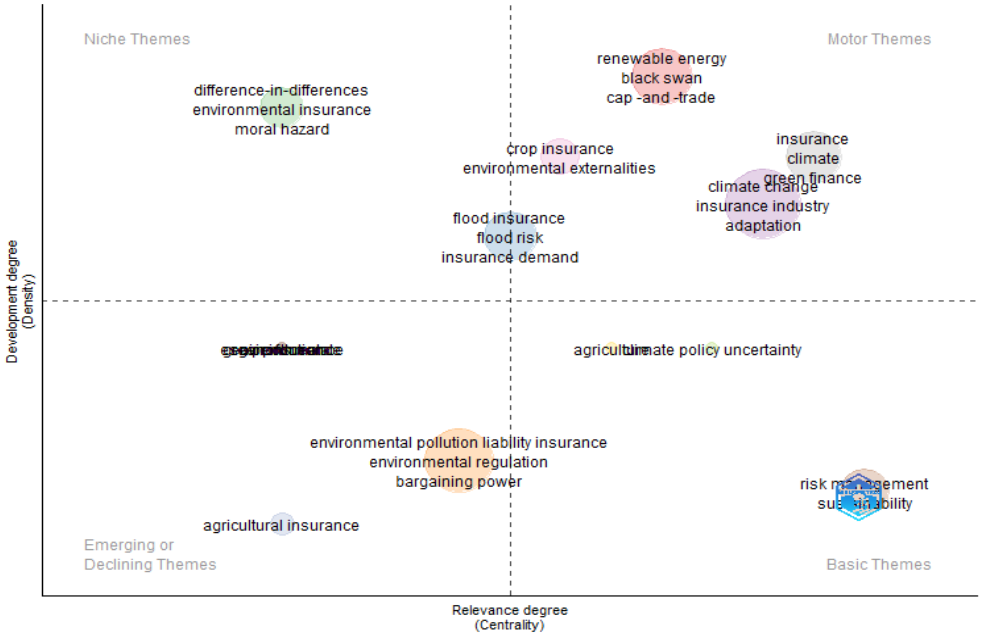


Figure 8: Thematic analysis

A thematic analysis of the research on green insurance reveals several major themes and subtopics that dominate the academic discourse. Based on the keyword analysis and word cloud, the recurring themes include **climate risk management**, **ESG integration**, **renewable energy insurance**, **corporate social responsibility (CSR)**, and the broader impact of green insurance on **sustainable growth**. These themes highlight the interdisciplinary nature of the field, bridging environmental science, finance, and corporate governance. For example, climate risk management focuses on mitigating risks associated with climate change through innovative insurance solutions, such as disaster risk insurance and policies tailored to renewable energy projects. Similarly, ESG integration emphasizes incorporating environmental, social, and governance principles into insurance frameworks to support sustainable business practices and reduce environmental harm.

To deepen the understanding of these themes, a systematic review of the most cited papers was conducted. The review identified key findings that underscore the practical and theoretical significance of green insurance. Highly cited studies often focus on the role of insurance in addressing climate-related risks, such as flooding and extreme weather events, while exploring the potential for financial instruments like carbon credit insurance to promote sustainability. Methodologically, these studies employ advanced risk modelling techniques, case studies, and empirical analyses to evaluate the effectiveness of green insurance solutions. For instance, some papers use quantitative risk assessment models to assess the economic benefits of green insurance, while others adopt a qualitative approach to explore its role in fostering corporate accountability.

Despite these advancements, the systematic review also highlights several gaps in the existing literature. One notable gap is the lack of comprehensive studies on the consumer behavior and market dynamics influencing the adoption of green insurance products. Additionally, while many studies address the theoretical aspects of ESG integration, there is limited empirical evidence on its long-term impact on corporate performance and environmental outcomes. The review also reveals an underrepresentation of research focused on developing economies, which are often the most vulnerable to climate risks but lack the resources and infrastructure to implement green insurance solutions effectively.

In summary, the thematic analysis and systematic review provide a holistic understanding of the current state of research on green insurance. While significant progress has been made in understanding its role in climate risk management and ESG integration, further studies are needed to address the identified gaps, particularly in consumer behavior, empirical evaluations, and the unique challenges faced by developing countries. This analysis serves as a foundation for advancing the academic discourse and practical implementation of green insurance in addressing global sustainability challenges.

Conclusion

This bibliometric analysis provides a detailed exploration of the academic development and thematic evolution of green insurance research from 2002 to 2023, uncovering its critical role in addressing climate risks and promoting sustainable development. The study, based on publications indexed in the Web of Science database, highlights the rapid growth in scholarly interest, with an annual growth rate of 10.22%, reflecting the increasing recognition of green insurance as a vital tool in achieving global sustainability goals. Through systematic analysis, the research identifies key trends, influential contributors, and emerging themes that define the field, offering valuable insights for academics, policymakers, and practitioners.

The findings demonstrate that green insurance has evolved as a multi-faceted domain, bridging environmental science, risk management, finance, and policy. Key themes such as climate risk management, renewable energy insurance, ESG integration, and carbon credit mechanisms underline the field's interdisciplinary nature. These themes not only address immediate environmental challenges but also align with broader global objectives such as the United Nations Sustainable Development Goals (SDGs), particularly SDG 13 (Climate Action) and SDG 11 (Sustainable Cities and Communities). The focus on impact, risk, and management, as evidenced by keyword and thematic analyses, reinforces the practical relevance of green insurance in mitigating climate vulnerabilities while fostering economic resilience.

The study also highlights the significant contributions of various regions, with China leading in publication volume and the Netherlands demonstrating the highest impact through international collaborations. The Netherlands' 100% Multi-Country Publication (MCP) ratio exemplifies the value of cross-border research partnerships, while China's predominantly domestic focus points to opportunities for expanding its global influence. Similarly, the United States emerges as a key contributor, leveraging its strong academic base to address ESG frameworks and develop innovative insurance solutions. These regional patterns underline the importance of fostering international collaboration to address diverse environmental challenges and share best practices.

Technological advancements such as blockchain integration and AI-driven risk modelling are identified as emerging trends that hold transformative potential for green insurance. Blockchain offers transparency and security in claims processing, while AI enables predictive risk analysis, ensuring more precise underwriting and loss prevention. These innovations highlight the adaptability of green insurance to dynamic environmental and economic contexts, paving the way for innovative solutions that meet the evolving needs of businesses and communities.

Despite these advancements, the study identifies several gaps that warrant further exploration. These include limited research on consumer behavior and market dynamics influencing the adoption of green insurance, underrepresentation of studies focused on developing economies, and a lack of empirical evaluations of policy impacts. Addressing these gaps is essential to enhance the adoption and effectiveness of green insurance products. Future research should focus on sector-specific applications, such as agriculture and transportation, and explore region-specific challenges in developing countries. Empirical studies assessing the long-term impacts of ESG integration on corporate performance and environmental outcomes will provide valuable evidence for scaling green insurance solutions.

In conclusion, this bibliometric analysis serves as a foundational contribution to the understanding of green insurance, offering a roadmap for future research and practical innovations. By addressing identified gaps, leveraging emerging technologies, and fostering international collaborations, green insurance can evolve as a cornerstone of global climate adaptation and sustainability strategies. This study underscores the transformative potential of green insurance in bridging financial systems and sustainability imperatives, contributing to a resilient and sustainable future.

Practical Implications

The findings of this bibliometric study have significant practical implications for various stakeholders, including policymakers, insurers, businesses, and researchers. For policymakers, the study highlights the critical role of green insurance in advancing sustainability goals and mitigating climate risks. Policymakers can use these insights to develop supportive frameworks, such as subsidies, tax incentives, and regulatory mandates, to encourage the adoption of green insurance products. The study underscores the need for international collaboration, suggesting that countries with robust global partnerships, like the Netherlands, can serve as models for fostering cross-border initiatives and knowledge sharing.

For insurance companies, the research identifies emerging trends, such as blockchain integration, AI-driven risk modelling, and carbon credit insurance, which can guide the development of innovative products and services. These advancements not only improve operational efficiency and transparency but also enhance insurers' ability to assess and mitigate risks associated with climate change. Businesses, on the other hand, can leverage green insurance as a strategic tool to align with ESG principles, manage climate-related risks, and demonstrate their commitment to sustainability.

Additionally, the study provides actionable insights into the importance of consumer-centric approaches, such as offering incentives for sustainable practices and designing sector-specific products tailored to industries like agriculture, construction, and renewable energy. Researchers can use the study as a foundation to explore underrepresented areas, such as consumer behavior, policy impacts, and the role of green insurance in

developing economies. Collectively, these practical applications underscore the transformative potential of green insurance in fostering resilience and driving global progress towards a sustainable future.

limitation

Despite its contributions, this study has several limitations. First, the reliance on the Web of Science database may exclude relevant publications from other indexing services, potentially limiting the comprehensiveness of the analysis. Second, the focus on English-language publications may overlook critical research conducted in non-English-speaking regions, thereby introducing a linguistic bias. Lastly, while the study identifies emerging trends and influential contributors, it does not delve deeply into sector-specific applications or the consumer behavior influencing the adoption of green insurance products.

Future Directions.

To address the identified gaps and build upon the findings of the current research, future studies should consider several key directions. First, expanding the scope of data sources by incorporating additional databases, such as Scopus and Google Scholar, would significantly enhance the comprehensiveness of bibliometric analyses, providing a more robust foundation for understanding the field. Furthermore, it is essential to conduct region-specific and sector-specific studies, particularly focusing on underrepresented regions like developing countries. These studies could explore the unique challenges and opportunities for green insurance in these contexts, offering valuable insights into how these regions can effectively integrate sustainable practices into their insurance models. Additionally, empirical evaluations are needed to assess the long-term impact of Environmental, Social, and Governance (ESG) integration on both corporate performance and environmental outcomes. Such studies would offer evidence-based recommendations for scaling green insurance solutions and ensuring their broader implementation. Investigating consumer behavior is another critical area for future research, as understanding consumer attitudes and barriers to adopting green insurance products will enable insurers to develop targeted marketing strategies and educational campaigns. Finally, the integration of emerging technologies such as blockchain and artificial intelligence (AI) holds significant potential for transforming green insurance practices. Exploring these technologies in terms of efficiency, transparency, and automation could drive innovation within the industry and facilitate the growth of sustainable insurance solutions.

References:

1. He, Q., & Faure, M. (2023). Mitigation of Long-Term Risks and the Role of Insurance: A Behavioural Law and Economics Perspective. *European Journal of Risk Regulation*, *14*(4), 779-792.
2. Hochrainer-Stigler, S., & Reiter, K. (2021). Risk-layering for indirect effects. *International Journal of Disaster Risk Science*, *12*, 770-778.
3. World Economic Forum. 2023. The global risks report 2023: 18th edn. Geneva: World Economic Forum https://www.weforum.org/publications/global-risks-report-2023/
4. Chen, T. L., Kim, H., Pan, S. Y., Tseng, P. C., Lin, Y. P., & Chiang, P. C. (2020). Implementation of green chemistry principles in circular economy system towards sustainable development goals: Challenges and perspectives. *Science of the Total Environment*, *716*, 136998.
5. El-Hermisy, H. (2021). The economic effects of environmental and climatic changes on the economic sector. *International Journal of Modern Agriculture and Environment*, *1*(1), 51-78.
6. Gatzert, N., Reichel, P., & Zitzmann, A. (2020). Sustainability risks & opportunities in the insurance industry. *Zeitschrift für die gesamte Versicherungswissenschaft*, *109*, 311-331.
7. Matthews, H. D., & Wynes, S. (2022). Current global efforts are insufficient to limit warming to 1.5 C. *Science*, *376*(6600), 1404-1409.
8. Botzen, W. W. (2021). Economics of insurance against natural disaster risks. In *Oxford Research Encyclopedia of Environmental Science*.
9. Babuna, P., Yang, X., Gyilbag, A., Awudi, D. A., Ngmenbelle, D., & Bian, D. (2020). The impact of Covid-19 on the insurance industry. *International journal of environmental research and public health*, *17*(16), 5766.
10. Lukić, M., Ćosić, M., & Prodanović, B. (2022). Impact of climate changes on the insurance market. *International Review*, (3-4), 111-117.
11. Nobanee, H., Dilshad, M. N., Abu Lamdi, O., Ballool, B., Al Dhaheri, S., AlMheiri, N., ... & Alhemeiri, S. S. (2022). Insurance for climate change and environmental risk: a bibliometric review. *International Journal of Climate Change Strategies and Management*, *14*(5), 440-461.
12. Stricker, L., Pugnetti, C., Wagner, J., & Zeier Röschmann, A. (2022). Green insurance: a roadmap for executive management. *Journal of Risk and Financial Management*, *15*(5), 221.
13. Semieniuk, G., Campiglio, E., Mercure, J. F., Volz, U., & Edwards, N. R. (2021). Low-carbon transition risks for finance. *Wiley Interdisciplinary Reviews: Climate Change*, *12*(1), e678.
14. Debrah, C., Chan, A. P. C., & Darko, A. (2022). Green finance gap in green buildings: A scoping review and future research needs. *Building and Environment*, *207*, 108443.

15. Brogi, M., Cappiello, A., Lagasio, V., & Santoboni, F. (2022). Determinants of insurance companies' environmental, social, and governance awareness. *Corporate Social Responsibility and Environmental Management*, *29*(5), 1357-1369.
16. Xuan, D., Ma, X., & Shang, Y. (2020). Can China's policy of carbon emission trading promote carbon emission reduction? *Journal of cleaner production*, *270*, 122383.
17. Kenyon, C., Berrahoui, M., & Macrina, A. (2022). Transparency principle for carbon emissions drives sustainable finance. *arXiv preprint arXiv:2202.07689*.
18. Steuer, S., & Tröger, T. H. (2022). The role of disclosure in green finance. *Journal of Financial Regulation*, *8*(1), 1-50.
19. Braun, A., Utz, S., & Xu, J. (2019). Are insurance balance sheets carbon-neutral? Harnessing asset pricing for climate change policy. *The Geneva Papers on Risk and Insurance-Issues and Practice*, *44*, 549-568.
20. Johannsdottir, L., & McInerney, C. (2018). Developing and using a Five C framework for implementing environmental sustainability strategies: A case study of Nordic insurers. *Journal of Cleaner Production*, *183*, 1252-1264.
21. Gomez-Echeverri, L. (2018). Climate and development: enhancing impact through stronger linkages in the implementation of the Paris Agreement and the Sustainable Development Goals (SDGs). *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *376*(2119), 20160444.
22. Kawamoto, M., & Kanie, N. (2020). Engaging business: the UN sustainable development goals and climate change. *International Development and the Environment: Social Consensus and Cooperative Measures for Sustainability*, 47-54.
23. Gatzert, N., Reichel, P., & Zitzmann, A. (2020). Sustainability risks & opportunities in the insurance industry. *Zeitschrift für die gesamte Versicherungswissenschaft*, *109*, 311-331.
24. Jóhannsdóttir, L., Wallace, J., & Jones, A. (2012). The primary insurance industry's role in managing climate change risks and opportunities. In *Managing Climate Change Business Risks and Consequences: Leadership for Global Sustainability: Leadership for Global Sustainability* (pp. 51-79). New York: Palgrave Macmillan US.
25. Journeault, M., Perron, A., & Vallières, L. (2021). The collaborative roles of stakeholders in supporting the adoption of sustainability in SMEs. *Journal of environmental management*, *287*, 112349.
26. Pedersen, E. R. G., Lüdeke-Freund, F., Henriques, I., & Seitanidi, M. M. (2021). Toward collaborative cross-sector business models for sustainability. *Business & Society*, *60*(5), 1039-1058.
27. Oliveira-Duarte, L., Reis, D. A., Fleury, A. L., Vasques, R. A., Fonseca Filho, H., Koria, M., & Baruque-Ramos, J. (2021). Innovation Ecosystem framework directed to Sustainable Development Goal# 17 partnerships implementation. *Sustainable Development*, *29*(5), 1018-1036.
28. Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of informetrics*, *11*(4), 959-975.
29. Aria, M., Misuraca, M., & Spano, M. (2020). Mapping the evolution of social research and data science on 30 years of social indicators research. *Social indicators research*, *149*, 803-831.
30. Mills, E. (2009). A global review of insurance industry responses to climate change. *The Geneva Papers on Risk and Insurance-Issues and Practice*, *34*, 323-359.
31. Brogi, M., Cappiello, A., Lagasio, V., & Santoboni, F. (2022). Determinants of insurance companies' environmental, social, and governance awareness. *Corporate Social Responsibility and Environmental Management*, *29*(5), 1357-1369.
32. Xing, L., Li, J., & Yu, Z. (2022). Green finance strategies for the zero-carbon mechanism: Public spending as new determinants of sustainable development. *Frontiers in Environmental Science*, *10*, 925678.
33. He, L., & Chen, L. (2021). The incentive effects of different government subsidy policies on green buildings. *Renewable and Sustainable Energy Reviews*, *135*, 110123.
34. Schäfer, L., Warner, K., & Kreft, S. (2019). Exploring and managing adaptation frontiers with climate risk insurance. *Loss and damage from climate change: Concepts, methods and policy options*, 317-341.
35. Yu, L., & Aleksandrova, M. (2021). *Weather index insurance: Promises and challenges of promoting social and ecological resilience to climate change* (No. 14/2021). Briefing Paper.
36. Pugnetti, C., Gebert, T., Hürster, M., Huizenga, E., Moor, M., Stricker, L., ... & Zeier Röschmann, A. (2022). Leading the green insurance revolution.
37. Khovrak, I. (2020). ESG-driven approach to managing insurance companies' sustainable development. *Insurance Markets and Companies*, *11*(1), 42-52.
38. Yang, R., & Zhang, R. (2022). Environmental pollution liability insurance and corporate performance: Evidence from China in the perspective of green development. *International Journal of Environmental Research and Public Health*, *19*(19), 12089.
39. Dawson, C., Dargusch, P., & Hill, G. (2022). Assessing how big insurance firms report and manage carbon emissions: a case study of Allianz. *Sustainability*, *14*(4), 2476.
40. Ameli, N., Drummond, P., Bisaro, A., Grubb, M., & Chenet, H. (2020). Climate finance and disclosure for institutional investors: why transparency is not enough. *Climatic Change*, *160*(4), 565-589.
41. Pranckutė, R. (2021). Web of Science (WoS) and Scopus: The titans of bibliographic information in today's academic world. *Publications*, *9*(1), 12.

42. Aria, M., Cuccurullo, C., & Aria, M. M. (2022, February). *Package 'bibliometrix'*.
43. Lyubchich, V., Newlands, N. K., Ghahari, A., Mahdi, T., & Gel, Y. R. (2019). Insurance risk assessment in the face of climate change: Integrating data science and statistics. *Wiley Interdisciplinary Reviews: Computational Statistics*, *11*(4), e1462.
44. Green, J. F. (2021). Does carbon pricing reduce emissions? A review of ex-post analyses. *Environmental Research Letters*, *16*(4), 043004.
45. Birkle, C., Pendlebury, D. A., Schnell, J., & Adams, J. (2020). Web of Science as a data source for research on scientific and scholarly activity. *Quantitative Science Studies*, *1*(1), 363-376.
46. Belousova, V., Bondarenko, O., Chichkanov, N., Lebedev, D., & Miles, I. (2022). Coping with greenhouse gas emissions: Insights from digital business services. *Energies*, *15*(8), 2745.
47. Liao, S. C., Chang, S. C., & Cheng, T. C. (2022). Index-based renewable energy insurance for Taiwan Solar Photovoltaic Power Plants. Risk Management and Insurance Review, 25(2), 145-172.
48. Böhringer, C. (2003). The Kyoto protocol: a review and perspectives. *Oxford Review of Economic Policy*, *19*(3), 451-466.
49. Derviş, H. (2019). Bibliometric analysis using bibliometrix an R package. *Journal of scientometric research*, *8*(3), 156-160.
50. Guleria, D., & Kaur, G. (2021). Bibliometric analysis of ecopreneurship using VOSviewer and RStudio Bibliometrix, 1989–2019. *Library Hi Tech*, *39*(4), 1001-1024.