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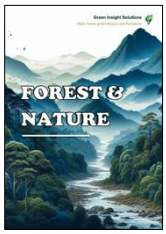

RESEARCH ARTICLE

Navigating the Forest: A Bibliometric Analysis of FSC Certification Research with Implications for Indonesia

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ABSTRACT

Forest Stewardship Council (FSC) certification is one of the most influential voluntary instruments for promoting sustainable forest management worldwide, yet limited bibliometric and structured reviews have systematically examined how scientific interest in this topic has evolved. This study maps the structure, growth, and thematic development of FSC certification research, assesses Indonesia's position within the global research network, and identifies implications for future studies. A bibliometric analysis was conducted using 752 publications indexed in the Scopus database from 1996 to 2026. Metadata normalization was performed using OpenRefine; quantitative indicators were calculated with Bibliomagika®, and collaboration patterns and keyword networks were visualized using VOSviewer. The dataset comprised contributions from 2,415 authors, with 642 publications generating 17,961 citations, resulting in an h-index of 64 and a g-index of 103. Peer-reviewed journal articles dominated the literature (76.06%), indicating strong academic consolidation. Keyword co-occurrence analysis revealed major research clusters focused on forest management, sustainability, certification, ecosystem services, and deforestation. Collaboration networks analysis showed that North American and European institutions play dominant roles, whereas countries with extensive FSC implementation, such as Indonesia, remain weakly connected to the global research network. One key finding is the limited academic attention to recent governance innovations within the FSC, notably the Regional Forest Stewardship Standards for Smallholders (RFSS) and the Remedy Framework, despite Indonesia being a key implementation context. This study concludes that FSC certification research has developed into a robust, multidisciplinary field, yet important gaps persist. Addressing these gaps, particularly through empirical studies on new FSC policies in tropical forest regions, represents a significant opportunity for future research. Indonesia holds a unique position and should capitalize on it to contribute empirical evidence on the outcomes of these new FSC policies.

1. Introduction

Sustainable forest management (SFM) has become a key part of addressing global environmental problems, such as climate change, biodiversity loss, and rural instability. In this context, voluntary sustainability standards have become an important instrument for encouraging responsible production and consumption in the supply chains of forest products worldwide. The Forest Stewardship Council (FSC) is one of the most important and trusted voluntary-based certification systems available in the market. The FSC certification is used as a tool to ensure that forest products come from responsibly managed forests (Malovrh et al., 2019). It has been shown that certification has improved forest management and governance, as well as SFM compliance, across a variety of ecosystems and geo-governance arrangements in the last 30 years (Charnley et al., 2022; Miteva et al., 2015; Savilaakso et

al., 2016). Furthermore, social and environmental benefits such as improved living conditions for local communities, lower deforestation rates, and the integration of sustainability principles into policy-making have also been linked to FSC certification. The uneven adoption rate across regions, the high cost of certification, and limited macro-level effectiveness in halting global deforestation, on the other hand, continue to influence the debate over long-term impacts (Bösch, 2025).

Various methods can be used to identify research topic patterns, develop discussions, and identify significant contributors to a topic. One such method is bibliometric analysis (Donthu et al., 2021; Passas, 2024). The method uses metadata obtained from publications in a database. This analysis includes publication growth, influential authors, citation relationships, and thematic clusters within publication metadata to uncover research developments that are difficult to capture through narrative reviews. Since the FSC standard was first implemented in 1994, FSC certification has played a significant role in influencing global forest management. However, FSC certification faces ongoing challenges, such as uneven adoption of standards across regions, high certification costs, and the FSC's limited ability to effectively halt the effects of global deforestation (Bösch, 2025; Marx and Cuypers, 2010).

Bibliometric methods can provide insight into the evolution of FSC certification. Several related studies, for example, on sustainability, policy, and consumer behavior, have shown that this method can yield insights into underexplored topics that warrant further research (Priya and Alur, 2023; Sun et al., 2022). However, when it comes to FSC certification itself, dedicated bibliometric studies are still quite limited. As a result, we still lack a clear picture of how FSC certification research has grown, who the key contributors are, and which themes have shaped the field over the years.

Indonesia is one of the world's most heavily forested countries, making its role in regulating the climate and protecting biodiversity difficult to overstate. However, Indonesia still faces complex issues related to forest and land use management. These issues include deforestation, conversion of primary forests, and the use of forest products that do not comply with sustainable principles (Ningsih et al., 2020). Thus, the Indonesian government and the forest management industrial sector have adopted several policy instruments, including sustainable forest management certification (Pratiwi et al., 2015). There are some sustainable forest management certification schemes in Indonesia, including *Pengelolaan Hutan Produksi Lestari* (PHPL) certification for the mandatory scheme and the FSC for the voluntary scheme. However, studies on sustainable forest management under the FSC scheme or critical reviews of FSC governance itself in Indonesia are still limited, especially when compared to global research patterns.

Even though the literature on forest certification and sustainability standards is expanding, most studies have focused on FSC certification in relation to broader debates about market-based instruments, forest governance, or sustainability transitions. Thus, there remains a lack of systematic knowledge about the evolution of FSC certification in the literature. This is also related to the publication dynamics, influenced contributors, collaboration structure, and changes in the thematic over time. This gap is important given FSC's significant role in forest governance worldwide, especially in tropical countries like Indonesia. It is difficult to see whose perspective actually guides the discussion and which unexplored topics remain without a systematic, organized review. To address this gap, the study implements a bibliometric analysis to provide a visual overview of the structure, growth, and thematic evolution of FSC certification research.

2. Materials and Methods

2.1. Data Collection

This study uses quantitative bibliometric methods to analyse the development of research on FSC certification globally and to understand Indonesia's position in the discussion. The bibliometric data used in this study were obtained from the Scopus database, which is widely recognized as a comprehensive, reliable database that supports various bibliometric analysis platforms (Donthu et al., 2021; Passas, 2024). Compared to other databases such as Web of Science or Google Scholar, Scopus contains relatively consistent key information for trend analysis and bibliometric visualization, including author affiliations, citation counts, abstracts, and keywords (Stefanis et al., 2025).

The keywords used in this study are as follows.

TITLE-ABS-KEY ("FSC Certification" OR "Forest Stewardship Council")

To maintain accuracy and relevance, this study focused on publications that clearly reference the Forest Stewardship Council as an organization or certification scheme. Thus, the keywords above were used to identify terms in the title, abstract, and keywords. Broader search terms regarding forest certification were also tested in the initial search, but it was found that too many publications were not related to the subject being analyzed.

The above keywords were used to obtain all publications that explicitly discuss FSC certification across various themes. Themes can include sustainable forest management, forest governance, forest product trade, environmental services, or forest policy. The search returned 1,012 documents. From these collected documents, the authors manually excluded documents that discussed or used the term FSC but were not related to the FSC referred to in this discussion, namely, Forest Stewardship Council Certification. For example, the authors manually screened records using title, abstract, and keyword reviews to exclude records that mentioned FSC but were not relevant to the Forest Stewardship Council or did not discuss forest certification. Once it was done, a total of 260 documents were found to be irrelevant for this analysis and were excluded. Thus, the total number of documents used in the analysis was 752. These documents were published between 1996 and 2026, which aligns with the existing reality, as the FSC was founded in 1994 as a voluntary certification for sustainable forestry.

2.2. Data Cleaning and Harmonization

After searching the Scopus database using the keywords described above, the dataset was exported in CSV format, containing all available information, including authors, titles, publication year, affiliations, abstracts, keywords, and citation counts. After excluding datasets irrelevant to this analysis, data harmonization was performed using complementary tools, namely OpenRefine and Bibliomagika® (Ahmi, 2023).

OpenRefine is used to maintain data consistency. This tool is primarily used to correct variations in available bibliometric data, including common formatting and spelling errors (Passas, 2024). This process includes:

1. Standardizing author and affiliation spelling, for example, from “Univ. Gadjah Mada” to “Universitas Gadjah Mada”.
2. Normalizing keywords and combining keywords with similar terms, such as “forest certification”, “timber certification”, and “forest management certification”.

After the dataset was cleaned, Bibliomagika®, a bibliometric computing software developed for advanced quantitative analysis, was used for statistical processing and indicator calculation. Bibliomagika® generated key bibliometric indicators, including:

- Total publications (TP) – number of documents analyzed.
- Number of contributing authors (NCA).
- Number of cited papers (NCP).
- Citations per paper (C/P).
- Citations per cited paper (C/CP).
- Citations per author (C/A).
- h-index (h), g-index (g), and m-index (m) for evaluating author and journal productivity and impact.

This combination of OpenRefine and Bibliomagika® allows for high-level data normalization and computational accuracy, consistent with recent methodological innovations in bibliometric research that emphasize AI-assisted data filtering and normalization (Stefanis et al., 2025).

2.3. Bibliometric Analysis Techniques

Following data cleaning and harmonization, the bibliometric and network analyses were conducted using VOSviewer (Version 1.6.20), a specialized software for constructing and visualizing bibliometric networks. VOSviewer was selected for its ability to generate intuitive visual maps that illustrate relationships among authors, institutions, countries, and keywords through co-authorship, co-citation, and co-occurrence analyses (Mondal, 2025; Sun et al., 2022).

Three main analytical approaches were applied:

1. Performance analysis: This examined publication and citation trends over time, as well as the leading journals, countries, and authors contributing to FSC certification research. This step provided a macro-level understanding of research productivity and influence (Donthu et al., 2021).
2. Science mapping: VOSviewer's visualization functions were used to map co-authorship networks (to identify collaboration clusters), co-citation networks (to highlight intellectual linkages among key studies), and keyword co-occurrence networks (to reveal thematic structures and emerging topics) (Hu et al., 2025).
3. Thematic change analysis: Using the temporal overlay visualization menu in VOSviewer, we analyzed thematic trends to identify changes in the main research themes from the early studies to those developed over the past few years (Boubacar and Sissoko, 2025; Priya and Alur, 2023).

Quantitative analysis and interpretation of research topic patterns and trends on FSC certification can be performed by combining the Bibliomagika® and VOSviewer tools. This multi-tool use is consistent with bibliometric methodologies widely used in recent years, which prioritize complementary software to enrich analysis and deepen interpretation (Mondal, 2025; Stefanis et al., 2025).

3. Results and Discussion

3.1. Overview of the FSC Certification Research Landscape

Basic bibliometric indicators provide general information regarding research related to FSC certification (**Table 1**). The cleaned and harmonized dataset covers publications from 1996 to 2026. This shows that FSC certification has become a research topic in academia. During this period, 752 publications were published by 2,415 contributing authors, indicating that a significant number of people were interested in the topic. Of these, 642 papers have been cited, indicating that most studies have become part of the larger scientific discussion. The citation profile is 17,961 total citations, 23.88 citations per paper, and 27.98 citations per cited paper. It indicates that the field is well-known among scholars, with an h-index of 64 and a g-index of 103, both of which are relatively high, suggesting a clear core of important publications. One of the earliest studies that shaped the discussion regarding FSC certification was an article published in 1997 titled "Informing the Green Consumer: The Debate Over the Use and Abuse of Environmental Labels", by James Salzman. The study analyses how the environment was used as an information-based governance tool. It was discussed regarding their potential to influence consumers and their limitations in understanding forest products sourced in the absence of institutional oversight (Salzman, 1997). It was one of the key issues for the next discussion on third-party forest certification, including FSC. These conclusions align with previous studies indicating that FSC, as a governance instrument, has obtained substantial academic focus due to its influence on the development of environmental authority and policy frameworks (Cashore et al., 2004; Marx and Cuypers, 2010).

Table 1. Main information of the selected papers

Basic information	Data
Start year	1996
End year	2026
Total publications	752
Number of contributing authors	2415
Number of cited papers	642
Total citations	17.961
Citation per paper	23,88
Citation per cited paper	27,98
Citation per author	7,44
Citation sum within h-core	16.131
Citable year	30
h-index	64
g-index	103

Table 2 shows that FSC certification research is both mature and still very dynamic, with 76.06% of all publications being peer-reviewed articles. This shows that the topic is based on both theoretical and practical research published in well-known scientific journals. There is also a significant proportion of book chapters (9.84%) and review articles (7.31%), suggesting that researchers continue to consolidate findings, re-examine previous concepts, and integrate different perspectives as the topic becomes more complex over time (Donthu et al., 2021). These indications suggest that the topic is not only well-established but also open to different ways of knowledge.

Table 2. Document type.

Document type	Number of publications	%
Article	572	76.06
Book chapter	74	9.84
Review	55	7.30
Conference paper	36	4.70
Book	7	0.93
Short survey	4	0.53
Note	2	0.27
Erratum	1	0.13
Letter	1	0.13

3.2. Publication Dynamics and Document-Type Patterns

The growth of publications on FSC certification from 1996 to 2026 shows that this area of research has developed steadily and become much more mature over time (**Fig. 1**). The available publications generally follow a quadratic curve, with an R^2 value of 0.9929. This indicates that the research topic is not only growing but also growing at a significant rate. At the beginning of this research, around 1996 and the early 2000s, there appeared to be little research being conducted. It was not until later in the period that research related to FSC certification began to grow rapidly. This indicates that research attention began to increase during that time.

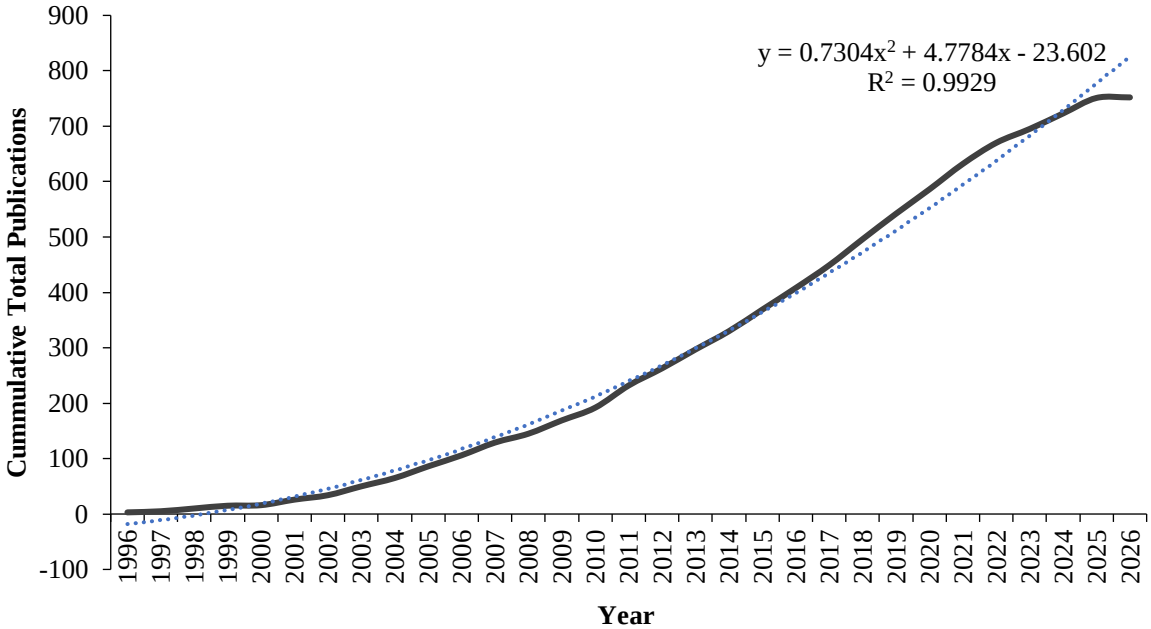

Fig. 1. Cumulative growth of publications over time (1997−2026).

The graph of total publications and total citations by year shows a more interesting dynamic (**Fig. 2**). The number of publications increased sharply between 2008 and 2016. This coincided with the development of global issues related to deforestation, illegal logging, and the emergence of timber

legality assurance systems. In Indonesia, for example, the government issued Ministerial Regulation Number P.38/Menhut-II/2009, which mandated timber legality assurance systems, called SVLK (Timber Legality Verification System), led to a discussion on the relationship between timber legality assurance systems and the FSC. However, since 2017, publications have shown an irregular pattern, with slight declines. This trend may indicate a consolidation phase in which basic concepts have been established, but the research focus may expand to other related sustainability tools. The significant decline in annual publications related to FSC certification from 2023 to the present could be due to several reasons, such as researchers shifting their focus to other sustainable forest management instruments, such as carbon trading and REDD^{+}, or simply an indexing lag, as many activities in various countries gradually recovered after COVID-19 in 2023.

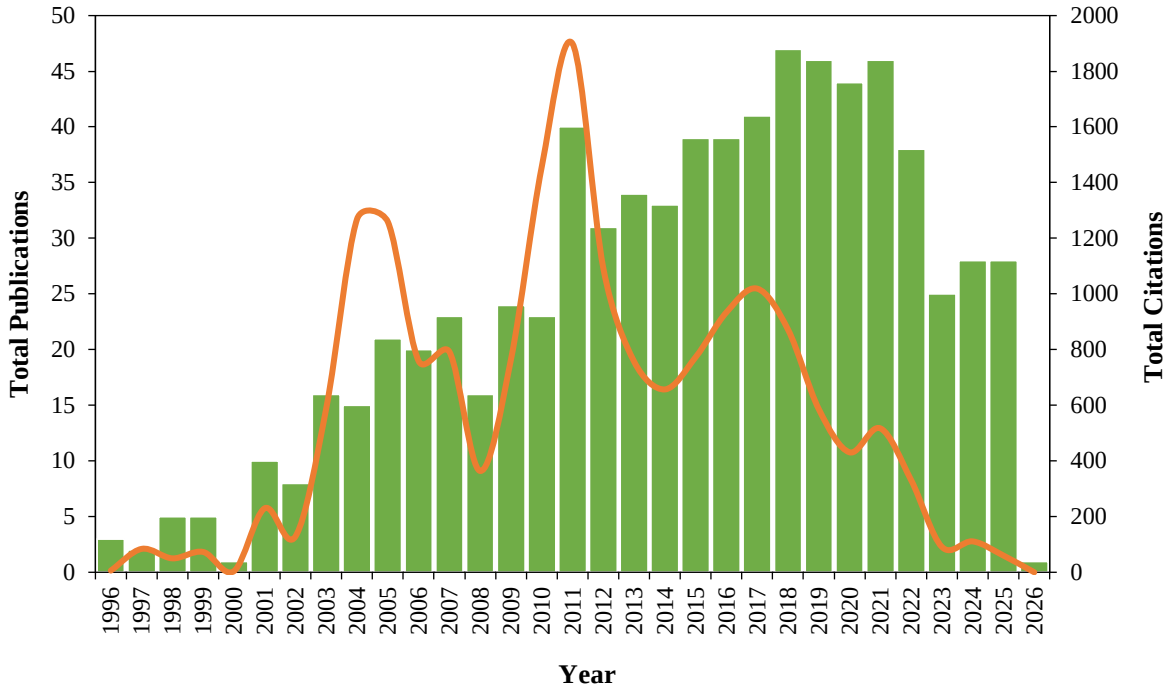

Fig. 2. Total publications and total citations by year.

3.3. Most Influential Source and Leading Authors

The analysis of the most influential publication sources (**Fig. 3**) shows an intellectual landscape dominated by a small group of highly recognized journals that have become central homes for FSC-related scholarship. Forest Policy and Economics emerged as the most influential journal, with 1,748 citations. This indicates that the journal dominates the discussion of these topics and exerts the strongest influence on evolution and dynamics in FSC certification research. The journal also reaffirms its focus on current environmental policy issues, sustainable forest management, and market policy. The dominance of the journal Forest Policy and Economics demonstrates the strong focus of FSC certification research on policy analysis and governance frameworks. Early study and many influential topics from the journal shaped the view of FSC certification research. The most influential publication in the journal concluded that FSC is a non-state governance mechanism that is market-oriented and can change authority dynamics, legitimacy, and compliance beyond formal regulation (Cashore et al., 2004). The literature views the certification as a governance tool rather than merely a technical standard, thereby providing an analytical foundation for future empirical and comparative research.

Other influential journals include Geoforum, Conservation Biology, and Biomass and Bioenergy, demonstrating the field's relatedness to many others. Geoforum articles frequently examine certification through the lenses of political ecology, power dynamics, and social and environmental justice. Research published in Geoforum analyzed certification within a neoliberal governance network, highlighting the conflict between market-oriented solutions, social equality, and local conditions in forestry and tropical environments (Klooster, 2009). The study helps explain why FSC certification outcomes may vary across regions. Studies published in Conservation Biology, for example, highlight conservation impacts,

biodiversity and ecological certification standards. The study systematically assessed empirical evidence on the environmental and socio-economic benefits of FSC and related schemes. Despite positive results, the evidence is uneven and methodologically constrained (Blackman and Rivera, 2011). Biomass and Bioenergy also contribute to including FSC in broader conversations about renewable resources, as seen in a paper that emphasizes the interactions among FSC standards, energy policy, forestry regulations, and bioenergy expansion. It shows the role of certification in balancing environmental protection with conflicting resource use objectives (Stupak et al., 2007). With the range of these publication venues, it can be concluded that FSC certification has become a key issue affecting ecology, forestry, governance, development economics, and sustainability transitions.

Table 3 shows the influential authors who have a quantitative impact on FSC certification research. At the top of the ranking is Francis E. Putz, the most important author according to the dataset, as measured by the h-index. In total, he has 12 publications, 289 total citations, and a citation-per-paper ratio of 32.11. His high g-index and the most cited papers (9 papers) demonstrate that he is not only productive but also has a consistent impact. In second place is Graeme Auld, with 10 publications and 103 citations. Although his citation-per-paper ratio is not as high as that of the top-ranked author, Graeme Auld still demonstrates that his research remains above average in terms of reference and consistently influential.

Citation-based influence reflects both scholarly quality and global knowledge production structure. North American and European institutions with English-language publishing, long-established academic networks, and access to high-impact journals host highly cited authors, including Putz, Auld, Cashore, and Cubbage. Cashore et al. (2004) established one of the first and most prominent theoretical frameworks for defining FSC as non-state market-driven governance, which policy-oriented publications have widely referenced. Putz and colleagues' empirical, impact-oriented studies on the environmental and management effects of tropical forest certification have also garnered citations (Burivalova et al., 2016). Cubbage et al. (2010) provided firm-level evidence on the implications of certification in Latin America, while Auld and colleagues advanced comparative political analyses of certification legitimacy and authority. These contributions are important; however, the Scopus database and language biases tend not to recognize research from the Global South. Research in the area was often published in local journals or policy reports, despite its practical relevance.

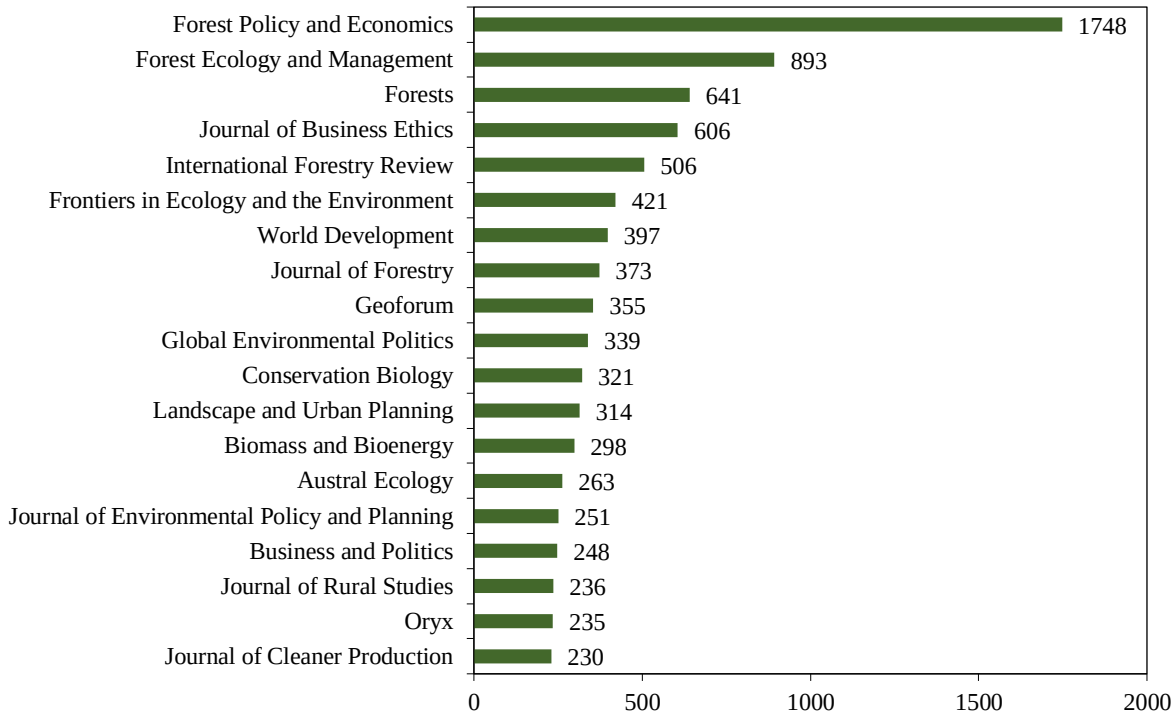

Fig. 3. Top 20 most influential source titles by total citations.

Table 3. Most influential authors

Full Name	TP	NCP	TC	C/P	C/CP	h	g	m
Putz, Francis E.	12	9	289	32.11	32.11	7	12	0.241
Auld, Graeme	10	6	103	17.17	17.17	5	10	0.217
Cubbage, Frederick W.	11	4	140	28.00	35.00	4	11	0.174
Cashore, Benjamin W.	8	5	44	7.33	8.80	4	6	0.182
Johansson, Johanna	6	4	120	30.00	30.00	4	6	0.235
Eden, Sally E.	4	3	140	46.67	46.67	3	4	0.167
Boström, Magnus	3	3	52	17.33	17.33	3	3	0.130
Blackman, Allen	3	3	59	19.67	19.67	3	3	0.200
Gulbrandsen, Lars H.	8	4	108	27.00	27.00	3	8	0.143
Rickenbach, Mark G.	4	4	81	20.25	2025	3	4	0.125
Pattberg, Philipp H.	3	3	49	16.33	16.33	3	3	0.143
McDermott, Constance L.	9	4	76	15.20	19.00	3	8	0.167
Cerutti, Paolo Omar	6	3	51	17.00	17.00	3	6	0.200
Elbakidze, Marine M.	6	3	63	21.00	21.00	3	6	0.200
Newsom, Deanna	3	3	25	8.33	8.33	3	3	0.136
Overdevest, Christine Ann	3	3	22	7.33	7.33	3	3	0.150
Bugalho, Miguel N.	5	3	54	18.00	18.00	3	5	0.200
Tysiachniouk, Maria S.	10	3	78	26.00	26.00	3	8	0.176
Paluš, Hubert J.	5	3	142	47.33	47.33	3	5	0.333
Ranius, Thomas	4	3	103	25.75	34.33	3	4	0.130
Ellis, Peter Woods	5	3	127	31.75	42.33	3	5	0.250
Serrão, José Eduardo	3	2	11	5.50	5.50	2	3	0.200
Marchetti, Marco	4	2	19	9.50	9.50	2	4	0.154
Tritsch, Isabelle	2	2	22	11.00	11.00	2	2	0.200
Zanuncio, J. C.	6	2	39	19.50	19.50	2	6	0.200

Notes: TP = total number of publications; NCA = number of contributing authors; NCP = number of cited publications; TC = total citations; C/P = average citations per publication; C/CP = average citations per cited publication; h = h-index; g = g-index; m = m-index.

Other authors who have contributed significantly are Frederick W. Cubbage and Benjamin Cashore, ranked third and fourth, respectively. Some authors who have published fewer papers can still stand out because they are highly cited. For example, Sally Eden and Hubert J. Paluš. Although their publication count is below average to medium, they are considered authors with the highest citation-per-paper ratios, above 40. This indicates their high effectiveness in shaping discussions on FSC certification research. Furthermore, authors like Johanna Johansson, Maria Tysiachniouk, and Marine Elbakidze have a similar h-index but more balanced productivity and citation profiles.

In general, based on **Table 3**, we can see that the research area exhibits different publication strategies and citation behavior. The research was constructed not only by selective high-impact authors but also by regular authors. This indicates that this topic is supported by a mix of top-tier authors and a broader group of mid-level contributors. Together, they make FSC certification research a dynamic, interdisciplinary field.

3.4. Collaboration Network

Fig. 4 provides a visual network map of co-authorship in research on FSC certification. This visualization can provide important insights into how knowledge about FSC certification is formed, shared, and published across different fields. **Fig. 4** shows that topics in this field are both fragmented and convergent. The co-authorship network among individual researchers demonstrates that this field is both fragmented and convergent. The network comprises 10 separate clusters, connected by a few key researchers who serve as bridges, linking FSC certification research across different fields. Graeme Auld, Benjamin Cashore, Paolo Cerutti, Sini Savilaakso, and Raphaël Tsanga are some of the main authors who linked these clusters. The fact that they are present suggests that some scholars are important in shaping conversations between regions and bringing together ideas from different fields. The clustering also shows regional research communities, especially those focused on debates about

European governance and on the effects of certification in tropical forest countries. These communities rarely overlap, indicating a form of scholarly path dependence in the field.

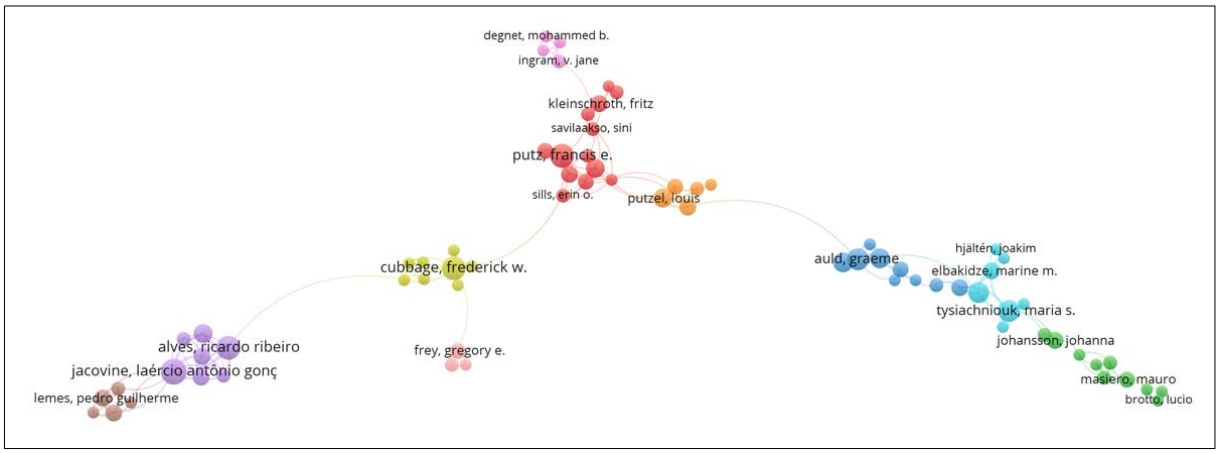

Fig. 4. Network visualization map of the co-author by authorship.

The network visualization map of co-authors by organization highlights the dominance of institutions from the Global North (**Fig. 5**). Universities with strong forestry and environmental governance programs, such as the University of British Columbia, the University of Florida, and Wageningen University, occupy central positions in the network. These institutions usually serve as academic anchors for large-scale comparative research, method development, and theoretical work on sustainability governance. The visualization also indicates that they not only produce a high volume of FSC-related publications but also maintain extensive international partnerships with research institutions in Europe, North America, and, occasionally, Africa and Asia. It is opposite to the organizations from tropical countries such as Indonesia, which appear at the periphery of the network. Research bodies such as CIFOR and certain Southeast Asian universities still contribute to the studies, but they are less integrated into global collaborative clusters. This trend confirmed the previous literature finding that global environmental governance research and certification scholarship remain dominated and shaped by Northern academic structures (Cashore et al., 2004; Schepers, 2009).

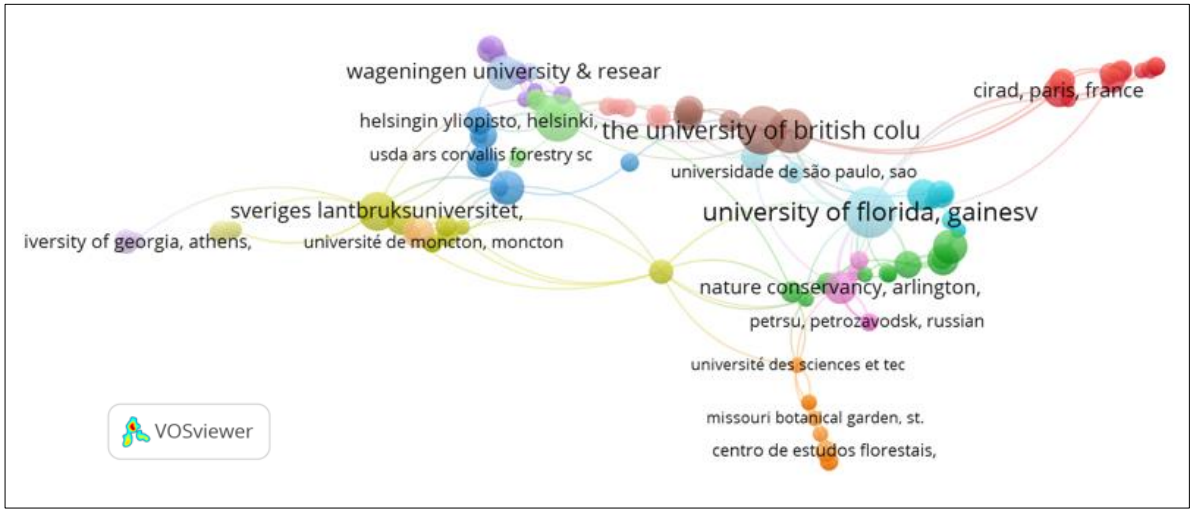

Fig. 5. Network visualization map of the co-author by organization.

The network visualization map of co-authorship by country further illustrates these patterns (**Fig. 6**). It shows that the United States is the most significant contributor at the centre. It is also demonstrating strong connections with Canada, Germany, France, and Brazil. These connections are based on a long-standing tradition of collaboration in forestry research, environmental policy, and sustainability science. Brazil also appears in the internal network visualization, demonstrating its deep involvement in certification discussions in Latin America, where FSC-certified forests cover a large area. Sweden, the

United Kingdom, the Netherlands, and Finland are other highly connected European countries. This is consistent with the fact that these regions share many important institutions.

Again, it is shown that the involvement of tropical countries is generally weak and limited to the studies. Indonesia, Vietnam, and Malaysia appear in the network visualization, but mostly connect through countries such as Australia, Japan, and the United States rather than among themselves. This means that while these countries play a significant role as research sites, they are less significant in generating cross-border academic contributions in this area. In practical terms, this means that most research on FSC certification in the tropics is heavily influenced externally rather than locally, a dynamic that points to broader challenges in the global distribution of scientific authority in sustainability governance.

However, collaborative networks across countries are showing very interesting developments, with authors from different countries increasingly interacting with each other. The existence of multi-country research projects, particularly on the impact of certification in tropical regions, for example, demonstrates a growing recognition of transnational learning. This cross-border, learning-oriented collaboration is particularly relevant in Indonesia, as certification is closely linked to complex governance changes, local social processes, and verification systems for legality, such as the SVLK. Collaboration at the regional and South-South levels could be a worthy pursuit to enrich discussions on global FSC certification. It is hoped that this will lead to research with diverse perspectives that reflect the realities of on-the-ground forest management, particularly outside developed countries.

Several factors could explain the limitations of integrating organizations from tropical countries into the FSC certification research network. Research funding for this study, especially for large-scale research, is usually concentrated in the Global North, where the forest and environment governance program has provided institutional ongoing support for research with a publication orientation (Cashore et al., 2004). On the other hand, research organizations in countries like Indonesia usually operate under project-based or donor-driven funding that prioritizes implementation rather than academic publication. Language is also a significant factor, as English-language publications indexed by Scopus tend to be more receptive to institutions with stronger publishing infrastructure and familiar editorial practices, which can limit the visibility of locally produced knowledge (Schepers, 2009). These variables will undoubtedly shape who participates in these discussions and whose perspectives are most frequently cited, even in research fields empirically studied in the Global South.

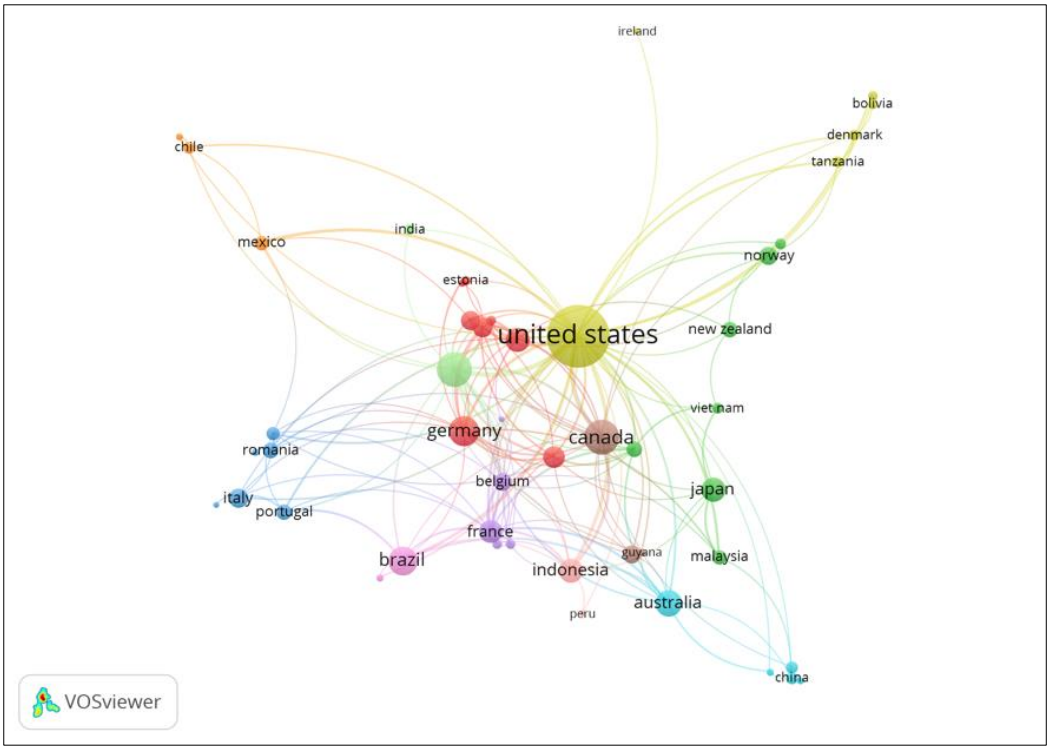

Fig. 6. Network visualization map of co-authors by country.

3.5. Thematic Structure of FSC Certification Research

Based on the keyword co-occurrence network visualizations in **Fig. 7** and the temporal visualization in **Fig. 8**, we can see that FSC certification research has evolved into several critical themes. We can see that FSC certification research has evolved into several critical themes. The four main clusters correspond to four dominant core areas of concern in the literature, which can be observed in **Fig. 7**. The largest, most important cluster is around the themes of forest management, certification, sustainable forest management, and the Forest Stewardship Council. This indicates that much of the research is still limited to the practical and institutional roles of FSC in forest governance. This is consistent with prior studies that have indicated the role of certification as a governance instrument, linking policy, management, and market incentives (Cashore et al., 2004). For example, Cashore et al. (2004) is the most cited paper in this area because it provided a seminal explanation of the FSC as a market-driven, non-state governance system. It is a system in which legitimacy and authority are established through standards, audits, and market acceptance, rather than solely through government regulation. This foundational knowledge has often been used in subsequent FSC certification research.

The second major theme is biodiversity, ecosystem services, tropical forests, deforestation, and conservation. These all occupy a dense area of an ecological cluster. These keywords are mostly related to research investigating the environmental impacts of FSC, particularly in biodiversity-rich areas such as Indonesia and the wider tropics, with an emphasis on impact evaluations and ecological assessments of certification (Charnley et al., 2022; Ningsih et al., 2020). A concrete example is Sollmann et al. (2017), who evaluated biodiversity outcomes in FSC-certified tropical forests using camera-trap data and community-occupancy modeling. Their results showed higher estimates of species richness in certified sites, particularly for endangered mammals. This type of study is representative of the biodiversity and conservation landscape because it goes beyond general claims and applies a field-based monitoring approach to assess whether FSC-certified forest management is associated with resulting ecological benefits.

The temporal overlay map gives us more information about how these themes have changed over time. The first keywords, mostly used between the late 1990s and the middle of the 2000s, focused on industrial processes and their environmental impacts. Examples include “pulp and paper”, “pollution”, and “sawmills”. This indicates that early research on FSC certification focused primarily on environmental management in the industrial sector. A practical example of this industry-facing theme is Espinoza and Buehlmann (2012), which discusses forest certification and chain-of-custody in relation to market requirements and downstream standards such as green building, based on survey evidence from the U.S. hardwood sector. This shows how early FSC-related scholarship not only intersected with forest management principles but also with production systems, market access, and demand-side requirements.

From the mid-2000s to the early 2010s, the primary focus of research themes shifted to global governance, legitimacy, and policy integration. Since around 2015, relatively new terms such as “carbon”, ”ecosystem services”, and “deforestation” have emerged as topics of discussion in the FSC certification keyword landscape. This development is evident in studies that explicitly link certification to ecosystem services. For example, research by Paluš et al. (2021) discusses certification as a tool that can support sustainable forest management goals. Certification is seen as contributing to ecosystem service functions such as erosion control, soil-related functions, and biodiversity and ecosystem diversity. This is because forests are now seen as more valuable for their role in combating climate change.

The temporal overlay map provides a clearer picture of how these themes have evolved. Early research on FSC certification (represented by the dark blue nodes) focused primarily on industrial processes and their environmental impacts, including pulp and paper production, sawmills, and pollution. This suggests that in the early days of FSC certification research, many topics intersected with environmental management in industry. Only around 2008 to 2012 (green nodes) did this focus shift to issues of governance, legitimacy, standards, and institutional interactions. This aligns with the general rise of private environmental governance in academic studies (Marx and Cuypers, 2010). The visualization also shows that in the most recent period (yellow nodes), there has been a greater focus on topics related to ecosystem services, carbon, deforestation, and conservation. This is because forests have now become part of the global climate and sustainability agenda.

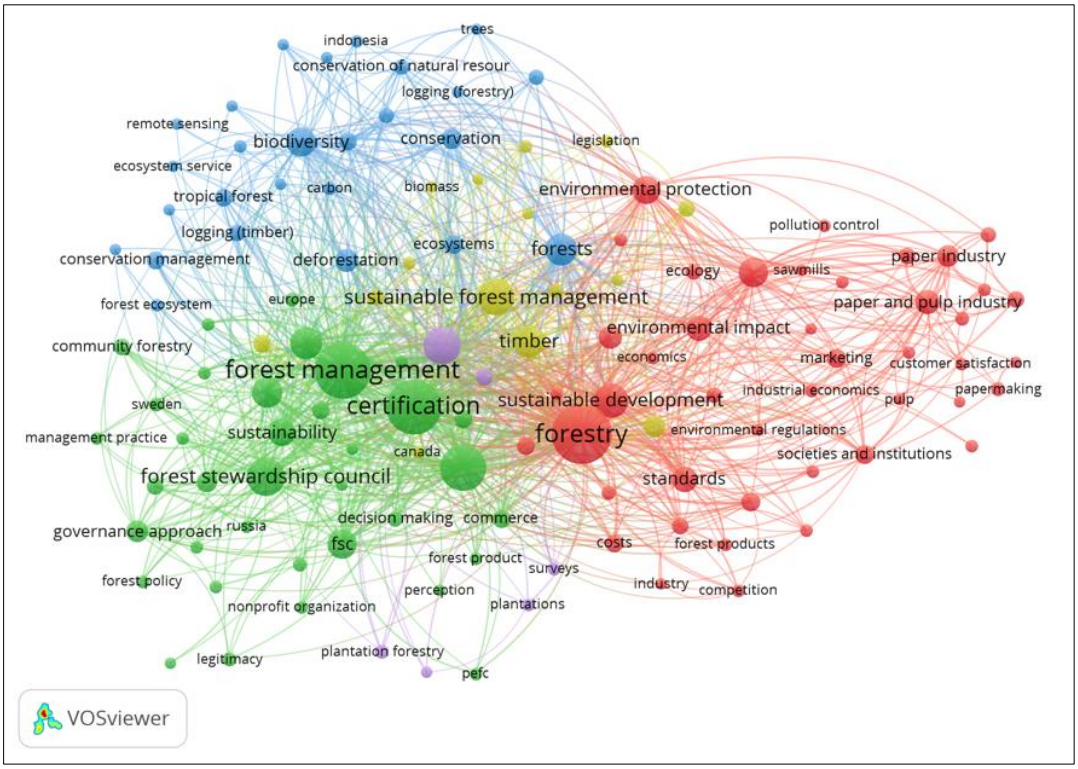

Fig. 7. Network visualization map of the occurrence of all keywords.

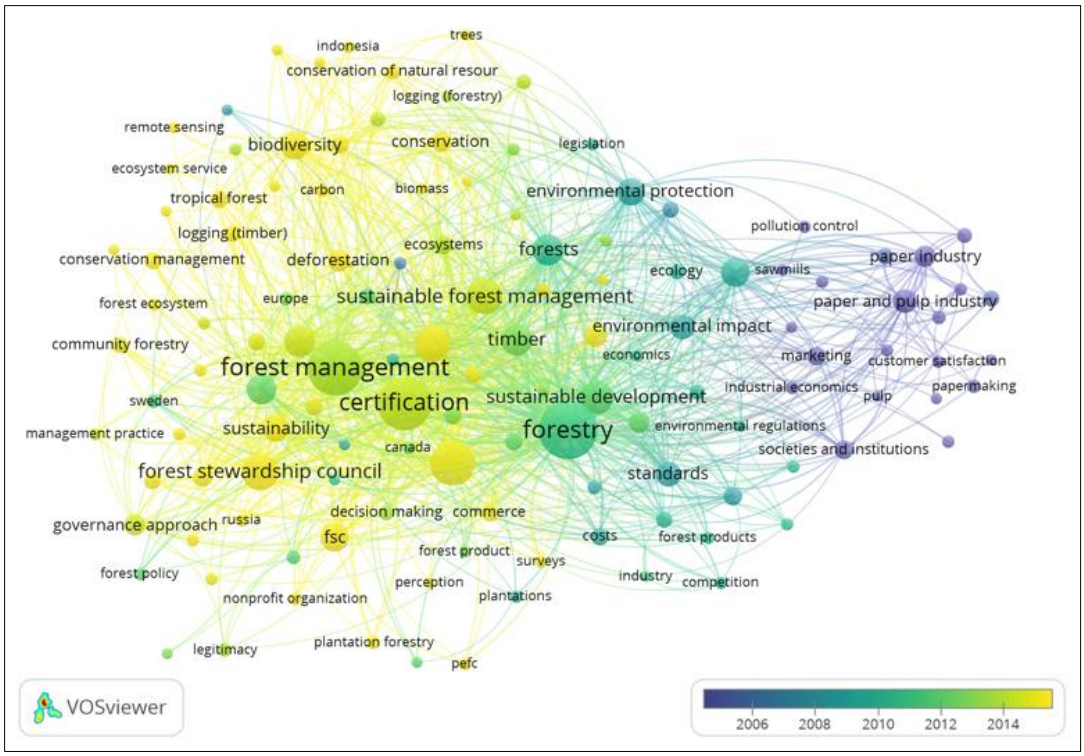

Fig. 8. Temporal overlay map of the occurrence of all keywords.

Overall, the keyword map shows that the field of FSC certification has evolved significantly in academia, from simple discussions of industry issues and environmental impacts to more complex ones of governance, ecology, and economics. This theme is diverse, and evolution reflects trends identified in other research on sustainability standards, where inquiry progresses in tandem with policy discussions

and the challenges of implementation (Donthu et al., 2021). However, issues such as equity, rights, smallholder inclusion, and locally grounded perspectives remain relatively little discussed. The maps also show that there are no new FSC topics, such as the Remedy Framework and the Regional Forest Stewardship Standard (RFSS), a standard specifically designed for smallholders. This suggests clear avenues for future research. Section 3.7 provides more detail on these gaps.

3.6. Research Gaps Revealed by Bibliometric Patterns

The bibliometric maps make several research gaps more evident. The co-authorship network shows that most collaboration is concentrated among a small group of well-connected scholars in North America and Europe. Authors from the tropical forest region, including Indonesia, appear only on the edges of the map or do not form strong clusters, even though FSC is widely implemented in these countries. This shows that much of the intellectual work in FSC certification research is still concentrated in Western institutions.

The same pattern appears in the organizational and country collaboration maps. Major universities such as the University of British Columbia, Wageningen University, and the University of Florida occupy central positions, while institutions from Indonesia and Southeast Asia are either weakly connected or absent. Countries such as the United States, Canada, and Germany dominate the network, occupying the center of the visualization and appearing as large nodes, while Southeast Asian countries like Indonesia, Vietnam, and Malaysia appear as smaller nodes with fewer international links.

The keyword co-occurrence visualization map also reveals some thematic gaps. Mainstream research topics in the FSC certification subject, such as forest management, sustainability, certification, ecosystem services, and deforestation, are most frequently discussed. However, new concepts or developments within the FSC itself, such as the FSC Framework for Improvement and Regional Forest Management Standards (RFSS), are completely absent. However, keywords regarding social conflicts, indigenous peoples' rights, or smallholder-managed forests are rarely discussed. This suggests that FSC certification research is well established, but its focus is on legacy themes and has not yet integrated with recent policy innovations.

3.7. Emerging Frontiers: RFSS and the FSC Remedy Framework as New Governance Directions

Based on the previously presented, keywords related to the Regional Forest Stewardship Standard (RFSS) and the FSC Remedy Framework in the bibliometric map indicate a significant research gap that the academic community has not yet addressed. This finding is consistent with the previous study, as both topics are relatively new within the FSC itself. Scientific literature usually lags several years behind policy developments (Donthu et al., 2021; Stefanis et al., 2025). This also indicates that the dominance of FSC certification studies by countries in the Northern Hemisphere means that topics such as the RFSS and the Remedy Framework are not always discussed, as they are more relevant to developing countries such as Indonesia, Vietnam, Thailand, and India.

The Remedy Framework and the RFSS both represent paradigm shifts within the FSC. The RFSS introduced a standard focused on smallholders, which was recently announced as a regular standard alongside the NFSS (National Forest Stewardship Standard) in mid-2025, after approximately 3 years of piloting in Indonesia, Vietnam, Thailand, and India, countries where FSC certification has historically been difficult for smallholder forests. The Remedy Framework is FSC's first formal initiative for restorative action. The initiative requires companies to address past social and environmental harms before they are eligible to enter the certification process or reassociate with the FSC. The Remedy Framework initiative was launched in 2022, following the adoption of Motion 37 by its members at the FSC General Assembly in Bali. This shift takes the FSC beyond performance audits and toward a governance model more focused on rights and social and environmental issues.

Because this framework is still relatively new, there are still many opportunities for researchers to explore, and many fundamental questions remain unanswered in the literature. For example, how can the RFSS help smallholders in various social and economic situations to get certified? Will the Remedy Framework be implemented on the ground? Moreover, how will these new FSC tools work with national regulatory systems, such as Indonesia's SVLK? These questions make the RFSS and the Remedy Framework two of the most promising areas for future FSC certification research. The absence of these topics in the bibliometric landscape presents an opportunity to develop research on FSC certification

further. Countries like Indonesia, which are significantly involved in both initiatives, are ideally positioned to become key players and provide new perspectives on the evolving role of FSC certification in global forest governance.

3.8. Implications of FSC Certification Research for Indonesia

Indonesia is a key country in the implementation of the FSC standard. With its vast tropical forest area and complex standards implementation challenges, Indonesia faces challenges in representing knowledge development in this field. This study highlights the weakness of collaborative networks and the limited number of Indonesian authors and institutions discussing FSC certification. Much of the research on FSC certification in Indonesia is developed and influenced by external perspectives or by regions that dominate the research, particularly in the Global North.

The bibliometric results also have implications for understanding governance development regarding FSC certification in Indonesia. No occurrence of subject-related terms for new FSC policies or initiatives, such as RFSS and the FSC Remedy Framework, in keyword and co-citation networks indicates that these initiatives have not been addressed by academic research. This is important given that Indonesia is actively involved in piloting and implementing both initiatives. The FSC specifically designed the RFSS to accommodate forest management practices by smallholders in four countries: Indonesia, Vietnam, Thailand, and India. Regarding policies related to the FSC Remedy Framework, Indonesia has become a significant discussion arena, as it is home to several world-class forestry companies relevant to these policies. This lack of academic attention indicates a growing gap between policy implementation and academic analysis, which can limit evidence-based learning and informed policy discussions.

These findings suggest that Indonesia has a strategic opportunity to contribute more actively to the development of FSC certification research. Future research could pay closer attention to emerging topics such as RFSS, the implementation of the FSC Remedy Framework, and possibly connecting it to local instruments such as SVLK and forest management mandatory certification. Contributions from Indonesia and regional collaboration would significantly increase the representation of local experiences and enrich FSC studies with specific perspectives from tropical developing countries.

4. Conclusion

A bibliometric study was conducted using three analytical tools. OpenRefine was used for metadata normalization, Bibliomagika® for calculating quantitative indicators, and VOSviewer for generating collaboration visualizations and keyword networks. The collected dataset consisted of 752 publications produced between 1996 and 2026. The publications were supported by 2,415 contributing authors. Key metrics included 642 cited papers with 17,961 total citations. Strong h-index of 64 and g-index of 103. The results showed that scientific publications are dominated by peer-reviewed journal articles, accounting for around 76.06%. Keyword analysis revealed that research clusters on this subject focused more on forest management, sustainability, certification, ecosystem services, and deforestation. Collaboration networks also indicated that North American and European institutions and organizations were the main players in this subject, while countries with significant FSC implementation, such as Indonesia, were less connected to the global network. One key finding is the absence of two major recent governance innovations within the FSC itself: the FSC Regional Forest Stewardship Standards for Smallholders (RFSS) and the Remedy Framework, as indicated by the keyword and co-citation networks. One key finding is the absence of two major recent governance innovations within the FSC itself, which are the FSC Regional Forest Stewardship Standards for Smallholders (RFSS) and the Remedy Framework, which further confirms that efforts to implement these new initiatives in Indonesia and Indonesia as one of the centers for the implementation of these initiatives, have not received academic attention. This study concludes that FSC certification research has developed into a robust, multidisciplinary field, but several important gaps remain. The lack of discussion on the new FSC policies implemented in recent years presents a significant opportunity for future FSC certification research, particularly in tropical forest regions in developing countries. Indonesia holds a unique position and should capitalize on it to contribute empirical evidence on the outcomes of these new FSC policies. Overall, these findings provide a foundation for the next generation of FSC research to move toward more inclusive and policy-relevant themes.

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