


# Trends and Hotspots in Forest Conservation Research: A Bibliometric and Network Analysis from Scopus Data

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Article Info	ABSTRACT
<p><i>Article history:</i></p> <p>Received June, 2025 Revised June, 2025 Accepted June, 2025</p> <hr/> <p><i>Keywords:</i></p> <p>Forest Conservation Forest Management Bibliometric Analysis VOSviewer</p>	<p>This study presents a comprehensive bibliometric and network analysis of forest conservation research published between 2000 and 2024 using data retrieved from the Scopus database. By employing VOSviewer, the study explores co-authorship networks, country collaborations, keyword co-occurrence, thematic evolution, and research intensity. The findings reveal that forest conservation and forest management are the central pillars of the field, interconnected with emerging themes such as biodiversity, climate change, carbon sequestration, and environmental protection. The analysis highlights key contributors—including influential authors and globally active countries like the United States, Germany, China, and Brazil—while also identifying underrepresented regions in collaborative networks. Temporal overlay mapping shows a shift from traditional forest policy and resource management toward integrative themes aligned with global sustainability agendas. The study concludes that forest conservation research has matured into an interdisciplinary and globally relevant field, yet recommends greater attention to socio-cultural dimensions, equity issues, and increased engagement from scholars in the Global South to ensure inclusive and effective conservation strategies.</p> <p><i>This is an open access article under the <a href="#">CC BY-SA</a> license.</i></p> <div></div>

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<h2>1. INTRODUCTION</h2> <p>Forests represent one of the most vital ecosystems on Earth, playing a crucial role in maintaining biodiversity, mitigating climate change, preserving water cycles, and supporting the livelihoods of indigenous and local communities [1]–[3]. As the lungs of the planet, forests store vast amounts of carbon and house more than 80% of terrestrial species [4]. Over the past few decades, global attention toward forest conservation has significantly intensified due to the alarming rate of deforestation, forest degradation, and</p>	<p>biodiversity loss. With accelerating anthropogenic pressures and increasing demands for land and resources, the urgency to develop sustainable forest management and conservation strategies has never been greater [5].</p> <p>The scientific community has responded to these environmental challenges through a growing body of research focused on forest conservation [6]. This body of work spans across multiple disciplines, including ecology, environmental science, geography, policy studies, and remote sensing [7], [8]. The</p>
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proliferation of scholarly articles addressing forest conservation topics such as deforestation drivers, protected area management, community-based forestry, ecosystem services, and restoration ecology reflects the growing complexity and interdisciplinary nature of this research domain [9]. Moreover, advancements in geospatial technologies, data science, and modeling tools have opened new avenues for monitoring, managing, and analyzing forest ecosystems more effectively.

International frameworks and conventions such as the Convention on Biological Diversity (CBD), the United Nations Framework Convention on Climate Change (UNFCCC), and the Sustainable Development Goals (SDGs), particularly Goal 15 ("Life on Land"), have further catalyzed research in this field. The REDD+ initiative (Reducing Emissions from Deforestation and Forest Degradation), in particular, has stimulated a surge in policy-driven and implementation-oriented studies aimed at reconciling conservation goals with economic development and climate mitigation [10]. These global agendas have also fostered greater collaboration among stakeholders, including governments, NGOs, academic institutions, and local communities [11]–[13].

Despite the abundance of publications, the rapid expansion of literature in forest conservation makes it increasingly difficult to track thematic developments, emerging trends, and key contributors [14], [15]. This is where bibliometric analysis becomes essential. Bibliometrics provides a quantitative and systematic approach to map the intellectual structure of a scientific field by analyzing publication patterns, co-authorship networks, co-citation structures, and keyword co-occurrence [16]. These methods can help identify influential authors, institutions, journals, and research clusters that shape the evolution of the discipline. In turn, this aids in uncovering knowledge gaps and guiding future research directions.

Recent bibliometric studies in environmental science have demonstrated the value of such approaches. For instance,

analyses have been applied to topics such as climate change adaptation, ecosystem services, and biodiversity conservation. However, a comprehensive bibliometric and network analysis specifically focusing on forest conservation, using a broad and reliable database such as Scopus, remains limited. This leaves room for an in-depth synthesis that captures both historical trajectories and emerging hotspots in forest conservation research.

Given the vast and multidisciplinary nature of forest conservation literature, researchers, policymakers, and practitioners face difficulty in synthesizing the most influential themes, collaborations, and knowledge structures. Without a clear understanding of how the field has evolved—its dominant topics, intellectual foundations, and research frontiers—there is a risk of duplication, inefficiencies, and missed opportunities for interdisciplinary integration. Furthermore, the absence of an up-to-date scientometric mapping on forest conservation limits the ability to benchmark research progress, prioritize funding, and align scientific inquiry with policy needs. Thus, there is a critical need to systematically analyze the literature to detect trends, hotspots, and gaps that inform future directions in forest conservation research. This study aims to conduct a comprehensive bibliometric and network analysis of forest conservation research from Scopus-indexed publications.

## 2. METHODS

This study adopts a bibliometric and network analysis approach to systematically examine trends and research hotspots in forest conservation literature. The data were extracted from the Scopus database, chosen for its extensive coverage of peer-reviewed scientific publications across multiple disciplines. A search query was formulated to retrieve documents that contained the keywords "forest conservation", "forest protection", or "forest preservation" in the title, abstract, or keywords. The search was restricted to articles and review papers

published between 2000 and 2024 to capture contemporary developments while ensuring data manageability. The retrieved metadata included information such as authors, affiliations, publication year, journal source, citations, abstracts, and keywords.

Data preprocessing involved cleaning and standardizing the bibliographic information to ensure consistency in author names, institutional affiliations, and keyword terms. Duplicates, editorials, book chapters, and conference abstracts were excluded to maintain the quality and relevance of the dataset. After refinement, the final dataset was exported in CSV and RIS formats compatible with bibliometric software. The analysis was conducted using VOSviewer (version 1.6.x), a tool widely used for constructing and visualizing bibliometric networks. Three types of network analyses were performed: co-authorship analysis to identify collaboration networks among authors and institutions, co-citation analysis to map the intellectual structure of the field, and keyword co-occurrence analysis to detect thematic clusters and emerging topics.

The resulting maps and clusters were interpreted using both quantitative and qualitative insights. Bibliometric indicators such as total publications, citation counts, h-index, and centrality measures were used to assess productivity and influence. In the co-authorship network, nodes represented authors or institutions, while links indicated collaborative ties. The co-citation network illustrated the interconnectivity among highly cited works, helping to identify foundational literature. Keyword co-occurrence maps revealed dominant themes and shifts in research focus over time. To enhance interpretability, temporal overlay visualization was applied to highlight the evolution of research themes and identify emerging hotspots.

3. RESULTS AND DISCUSSION

Co-Authorshi Network Visualization

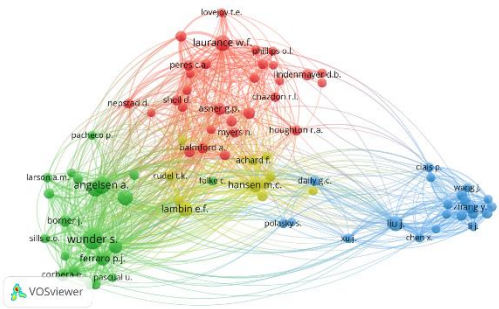


Figure 1. Author Visualization  
Source: Data Analysis

Figure 1 reveals the collaborative structure among influential researchers in forest conservation. Each node represents an author, while the size of the node indicates the number of publications or citations, and the links denote co-authorship relationships. The network is divided into four main clusters: the red cluster, led by Laurance W.F. and Peres C.A., emphasizes biodiversity conservation and tropical forest ecology; the green cluster, centered around Angelsen A. and Wunder S., focuses on policy-oriented research such as REDD+ and economic approaches to conservation; the yellow cluster, anchored by Lambin E.F. and Hansen M.C., integrates remote sensing, land-use change, and global monitoring efforts; and the blue cluster, dominated by Liu J., Zhang Y., and Wang J., represents a growing body of Chinese researchers contributing to sustainability science and coupled human–natural systems.

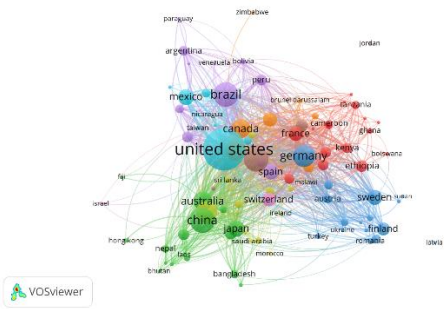
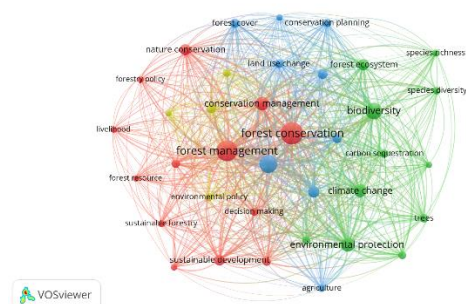


Figure 2. Country Visualization  
Source: Data Analysis

Figure 2 illustrates international collaboration in forest conservation research. The United States appears as the most prominent node, indicating its central role

and high publication volume, often serving as a key partner in global research efforts. Surrounding it are other major contributors such as Germany, France, Canada, China, Australia, and Brazil, each forming significant clusters that reflect strong regional and thematic partnerships. The red cluster, containing countries like Kenya, Ethiopia, and Tanzania, highlights collaborations within Africa, often tied to biodiversity and conservation fieldwork. The green cluster, with China, Japan, and Australia, reflects growing engagement from Asia-Pacific nations in forest monitoring and policy studies. European countries like Sweden, Finland, and Switzerland show tight interlinkages, often aligned with sustainability and climate policy research.

### Keyword Co-Occurrence Network Visualization



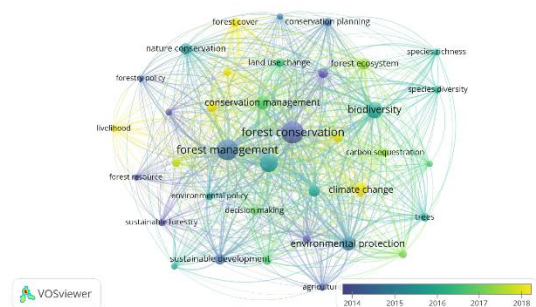
**Figure 3. Network Visualization**

Source: Data Analysis

Figure 3 highlights the thematic structure of forest conservation research. At the core of the map are two dominant and highly interconnected terms: “forest conservation” and “forest management,” indicating that these serve as central anchors in the field. These keywords form the nucleus around which other research themes are organized, suggesting that most scholarly discussions are grounded in efforts to balance conservation goals with effective forest governance strategies. The strong linkage between these terms and others like conservation management, environmental policy, and decision making indicates a research emphasis on institutional frameworks and implementation mechanisms. The red cluster consists of terms such as forest resource, forestry policy,

sustainable development, livelihood, and nature conservation, which collectively point toward a socio-political and policy-oriented dimension of forest conservation. This cluster emphasizes the importance of local communities, livelihoods, and governance structures, underscoring the socio-economic trade-offs involved in forest resource use. Research in this area often explores how forest conservation policies impact rural development and how participatory and inclusive governance models can lead to more equitable and sustainable outcomes.

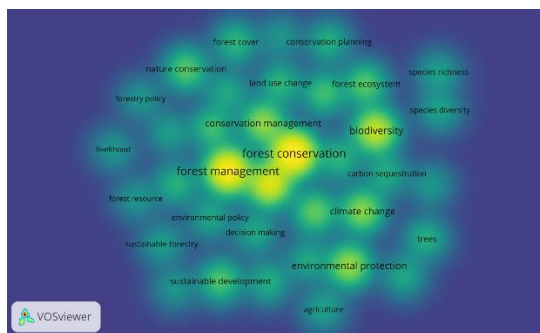
In contrast, the green cluster reflects the ecological and biodiversity-oriented themes, with prominent keywords like biodiversity, forest ecosystem, carbon sequestration, climate change, species richness, and trees. This suggests a strong focus on understanding forests as complex ecological systems and their role in addressing global environmental challenges such as climate regulation and biodiversity loss. The interconnection with climate change further indicates an increasing interest in synergizing forest conservation efforts with climate mitigation strategies such as REDD+ and ecosystem-based adaptation. The blue cluster represents the technical and planning aspects of forest conservation, with terms such as forest cover, land use change, conservation planning, and environmental protection. This thematic area is likely supported by advancements in geospatial analysis, remote sensing, and land-use modeling, which are critical for monitoring forest health, planning conservation zones, and predicting the outcomes of land-use decisions.



**Figure 4. Overlay Visualization**

Source: Data Analysis

Figure 4 provides temporal insights into how forest conservation research themes have evolved over time. In this network, colors represent the average publication year associated with each keyword, ranging from purple (older, ~2014) to yellow (more recent, ~2018). Core terms such as “forest conservation” and “forest management” appear in darker hues, indicating that these foundational topics have been central to the field for many years and continue to anchor most scholarly discussions. Emerging themes are evident in the yellow-highlighted keywords, which represent more recent research interests. Terms like “climate change”, “carbon sequestration”, “biodiversity”, and “species richness” have gained prominence in recent years, reflecting a shift toward ecosystem services, climate regulation, and biodiversity integration in forest policy and practice. These newer areas suggest increasing alignment with global sustainability agendas such as the Paris Agreement and the Sustainable Development Goals (SDGs), particularly SDG 13 (Climate Action) and SDG 15 (Life on Land). Meanwhile, keywords like “sustainable forestry”, “livelihood”, and “forest policy”, which appear in purplish tones, indicate earlier areas of focus that, while still relevant, may have experienced relatively less growth in publication frequency in recent years. This shift suggests a growing emphasis on interdisciplinary and climate-oriented forest research, leveraging ecological science, remote sensing, and environmental governance.



**Figure 5. Density Visualization**  
Source: Data Analysis

Figure 5 provides a heatmap-style representation of research intensity in the field of forest conservation. In this map, areas with brighter yellow hues represent higher frequency and centrality, indicating terms that appear most frequently and are most interconnected in the literature. The brightest zones surround the keywords “forest conservation” and “forest management,” affirming their position as the central focus of the research domain. These core topics serve as the conceptual backbone of forest-related studies, often linked with themes such as conservation management, environmental policy, and biodiversity. Surrounding these central concepts are moderately dense areas—depicted in green—such as “climate change,” “environmental protection,” and “carbon sequestration”, which signify growing yet slightly more specialized attention. On the outer edges, lower-density (blue-green) zones like livelihood, forestry policy, and agriculture indicate less frequently studied or more peripheral themes. This distribution suggests that while ecological and management-centered approaches dominate the discourse, there remains space to deepen integration of socio-economic dimensions and policy-specific studies, offering fertile ground for future interdisciplinary research.

## DISCUSSION

The findings of this bibliometric and network analysis offer valuable insights into the intellectual structure, research trends, and collaborative dynamics in forest conservation studies from 2000 to 2024. This section discusses the key outcomes derived from co-authorship networks, country-level collaborations, keyword co-occurrence patterns, temporal trends, and thematic densities, providing a comprehensive understanding of the evolution and current state of forest conservation research.

The co-authorship network analysis reveals a well-connected and collaborative research community, with distinct clusters reflecting thematic specialization and scholarly influence. The central position of authors like Laurance W.F., Peres C.A., Angelsen A., and Liu J. underscores their



intellectual leadership in different subfields. Laurance and Peres are strongly associated with tropical forest ecology and biodiversity conservation, Angelsen and Wunder with REDD+, forest economics, and policy, while Liu and colleagues represent the growing influence of sustainability science, particularly in the context of socio-ecological systems. The clustering of authors around specific themes suggests that forest conservation research has developed through both disciplinary consolidation and interdisciplinary integration. Notably, the co-authorship patterns also reflect a global research agenda where tropical and temperate forest systems are examined through lenses of ecology, policy, and socioeconomics.

At the country level, the United States dominates the collaborative landscape, as indicated by its centrality and linkages with numerous countries from both the Global North and South. Other highly active nations include Germany, China, Brazil, Australia, and Canada. The presence of China, Japan, and India in major clusters signifies the rising participation of Asia-Pacific countries in global forest conservation discourse, often involving technological applications such as remote sensing and ecosystem modeling. Meanwhile, Brazil, with its Amazonian forests, contributes significantly to biodiversity and deforestation studies. Interestingly, African countries like Kenya, Ethiopia, and Tanzania form a distinct collaboration group, often tied to biodiversity, community forestry, and sustainable development research, highlighting a growing but still emerging scholarly base in that region. These results point to a trend of increasing North–South cooperation, although disparities in research output and centrality still persist, suggesting the need for greater inclusion and capacity building in underrepresented regions.

The keyword co-occurrence analysis provides a structural map of research themes within the field. At the center of the network, “forest conservation” and “forest management” emerge as anchor concepts

around which other keywords are organized. Their high frequency and central location indicate that they remain the dominant framework through which forest-related challenges are studied. Surrounding themes such as biodiversity, conservation management, and environmental protection reflect the enduring relevance of ecological integrity in forest policy. Meanwhile, terms like climate change, carbon sequestration, and sustainable development reveal the increasing alignment of forest conservation with global environmental goals, particularly those related to climate mitigation, biodiversity targets, and the Sustainable Development Goals (SDGs).

A closer examination of the keyword clusters reveals thematic nuances. The red cluster focuses on policy and socio-economic aspects—such as sustainable forestry, livelihood, forestry policy, and environmental policy—emphasizing the human dimension of forest conservation. These themes are often associated with debates around forest governance, local participation, and the socio-political implications of conservation strategies. The green cluster contains ecological and climate-related terms such as biodiversity, carbon sequestration, and forest ecosystem, highlighting scientific inquiries into ecological processes and forest functions. The blue cluster, which includes keywords like forest cover, land use change, and conservation planning, points toward the increasing application of geospatial tools and landscape-level management approaches. These clusters suggest that forest conservation research has evolved from isolated ecological or policy studies into a more integrated domain that accommodates cross-cutting environmental, technical, and socio-political concerns.

Temporal overlay analysis offers further insights into the evolution of research priorities. Foundational keywords like forest management, forest conservation, and nature conservation appear in darker hues (e.g., ~2014), indicating their long-standing presence in the literature. However, newer research interests—represented by yellow

keywords such as climate change, carbon sequestration, and biodiversity—indicate a shift toward climate-responsive and biodiversity-focused agendas. This evolution mirrors broader trends in environmental governance and international policymaking, such as the Paris Agreement and the post-2020 Global Biodiversity Framework. Additionally, keywords like decision making, environmental policy, and sustainable development reflect the ongoing emphasis on evidence-based, policy-relevant research that informs conservation action at multiple scales.

The density visualization reinforces these observations by highlighting the most intensely studied areas. Topics like forest conservation, forest management, and biodiversity appear in high-density (yellow) zones, underscoring their prominence in scholarly discussions. Moderately dense areas include climate change, conservation planning, and environmental protection, suggesting that these are expanding fields with substantial momentum. On the periphery, lower-density terms such as livelihood, agriculture, and decision-making hint at underexplored but critical linkages, especially for research aiming to bridge ecological sustainability and social equity. These peripheral terms suggest opportunities for future research to delve deeper into interdisciplinary topics such as agroforestry, forest-agriculture trade-offs, and community-based adaptation strategies.

One notable finding from the combined analysis is the increasing interconnectivity between previously distinct research areas. The overlaps between ecological science and policy studies are more pronounced in recent years, indicating a growing recognition of the need for integrative approaches to forest governance. For example, the linkages between climate change, forest ecosystem, and environmental policy illustrate how climate-focused forest strategies are being mainstreamed into national and global policymaking. Similarly, the connectivity between livelihood, forest resource, and decision making reflects the rising importance of participatory and

inclusive forest governance models that acknowledge the rights and roles of indigenous peoples and local communities.

Despite these advances, the analysis also reveals several gaps and imbalances. For instance, while ecological and climate-related themes are well represented, socio-cultural and justice-oriented dimensions of forest conservation receive comparatively less attention. Topics such as gender, indigenous knowledge, and equity are notably absent or underrepresented in the visualizations, despite their critical importance in achieving effective and fair conservation outcomes. Similarly, while international collaboration is visible in high-income countries, lower-income regions in Africa, Asia, and Latin America appear less central, pointing to the need for enhanced research support, funding, and visibility for scholars in these areas.

#### 4. CONCLUSION

This study provides a comprehensive bibliometric and network analysis of forest conservation research from 2000 to 2024, highlighting the field's thematic evolution, collaborative structures, and emerging priorities. Core themes such as forest management, biodiversity, and climate change remain central, while newer topics like carbon sequestration and environmental protection signal an increasing alignment with global sustainability agendas. The findings reveal a well-connected scholarly network dominated by contributions from the United States, Europe, and emerging Asian countries, though regional disparities persist. Keyword clustering and temporal mapping show a shift toward integrative, interdisciplinary approaches that bridge ecological, policy, and socio-economic dimensions. Despite the growing complexity and connectivity in the literature, future research must address gaps related to equity, local participation, and knowledge inclusion from the Global South to ensure more holistic and just forest conservation outcomes.

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