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ARTICLE

RESEARCH ARTICLE

Research trends related to tropical timber species for the last four decades through scientometric analyses

Tendencias de investigación relacionadas con especies tropicales maderables durante las últimas cuatro décadas a través de análisis cienciométricos

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Abstract: *Aim of study*: Dialogue among stakeholders is key for implementing sustainable forest management in tropical forests. However, in such multi-actor processes, the role and interest of a key stakeholder such as scientists is often overlooked. Hence, the aim of this work was to analyse the topics that forest scientists have related the most to the concept of "tropical timber species" during the last four decades. *Area of study*: World´s tropical forests. *Material and methods*: Scientometric analyses (co-word analysis), using *Bibliometrix* and *Biblioshiny* R packages with Web of Science (WoS) and Scopus databases. *Main results*: A total of 35,204 documents were identified that used the "tropical timber species" concept. Scientific productivity grew from one occurrence in 1980 to 31,457 occurrences by 2023, with 40% of all relevant scientific productivity generated in the 2018-2023 period. Dominant research themes were related to basic science on ecological structure (topics such as *taxonomy* and *biodiversity,* with 4,682 and 4,359 occurrences, respectively). However, *climate change* is quickly growing in importance (575 occurrences in 2018-2023). In fact, *climate change* has become a basic research topic, while applied themes such as *ecosystem fragmentation, deforestation, forest management* and *remote sensing* have become the themes more prevalent (as niche, motor or basic themes) in the last two years studied (2022-2023). *Research highlights*: Scientists are increasingly showing interest in applied topics related to management of tropical timber species. However, forest scientists are also mostly interested in research related to biodiversity, conservation and climate change when studying tropical timber species. Hence, such issues should be taken into account in multi-actor dialogues on sustainable tropical forest management.

Keywords: co-word analysis; forest actors; research trends; stakeholders' dialogue; tropical forests.

Resumen: *Objetivo del estudio:* El diálogo entre actores es clave para implementar la gestión forestal sostenible en los bosques tropicales. Sin embargo, en estos procesos en los que intervienen múltiples actores, a menudo se pasa por alto el papel y el interés de una parte interesada clave, como son los científicos. Por ello, el objetivo de este trabajo fue analizar los temas que los científicos forestales han relacionado más con el concepto de "especies maderables tropicales" durante las últimas cuatro décadas. *Área de estudio*: Bosques tropicales del mundo. *Material y métodos:* Análisis cienciométricos (análisis de palabras conjuntas), utilizando los paquetes de R *Bibliometrix* y *Biblioshiny* en las bases de datos Web of Science (WoS) y Scopus. *Resultados principales:* Se identificaron 35.204 documentos que utilizaban el concepto "especies maderables tropicales". La productividad científica ha crecido desde un documento en 1980 hasta 31.457 documentos en 2023, con el 40% de toda la productividad científica generado solamente en el período 2018-2023. Los temas de investigación dominantes han estado relacionados con las ciencias básicas sobre la estructura ecológica (temas como *taxonomía*, y *biodiversidad*, con 4.682 y 4.359 ocurrencias, respectivamente). Sin embargo, el *cambio climático* (575 ocurrencias en 2018-2023) está ganando importancia rápidamente. De hecho, el cambio climático se ha convertido en un tema básico de investigación, mientras que temas aplicados como *fragmentación de ecosistemas*, *deforestación*, *anatomía de la madera*, *mortalidad*, *gestión forestal* y *teledetección* se han convertido en los temas más prevalentes (como temas de nicho, motores o básicos) en los últimos dos años estudiados (2022-2023). *Aspectos destacados de la investigación:* Los científicos muestran cada vez más interés en temas aplicados relacionados con la gestión de especies tropicales maderables. Sin embargo, los científicos forestales están interesados principalmente en la investigación relacionada con la biodiversidad, la conservación y el cambio climático cuando estudian las especies de madera tropicales. Por eso, tales cuestiones deberían considerarse en los diálogos entre múltiples actores sobre la gestión sostenible de los bosques tropicales.

Palabras clave: actores forestales; análisis de palabras; bosques tropicales; diálogo de partes interesadas; tendencias de investigación.

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Supplementary information ↓

1. INTRODUCTION

Despite the importance of tropical forests for the global functioning of Earth´s ecosystems, deforestation is still a major threat to their stability, occurring due to the local and global demand for commodities. It is well known that logging is an indirect driver of tropical deforestation, and a direct driver of forest degradation, affecting biodiversity hotspots in tropical regions such as Southeast Asia, Central Africa, Central America and the Amazon basin (Zhou et al., 2013; Hoang & Kanemoto, 2021; Feurer et al., 2025). It is recognized that key actors in tropical forests management are local and national authorities, which in turn monitor other actors such as local communities and logging companies, and keep track of the national and international flows of timber and other forest goods. Another important actor in tropical forests are scientists. For example, scientists have studied drivers of tropical forest loss extensively, identifying causes and effects and generating information that can be used to manage such phenomena (i.e. Brown & Pearce, 1994; Laso Bayas et al., 2022). Nevertheless, the important role of scientists as relevant actors in tropical forest management is usually not recognized, or it is misunderstood (Ramírez & Belcher, 2019). In fact, a lack of mutual communication among different and well-separated categories of actors has been identified as a

barrier in participatory processes in forestry (Blanc et al., 2018). Even more, such lack of interaction among tropical forest stakeholders has also been identified as an indirect driver of tropical forest loss (Kainer et al., 2009; Armenteras et al., 2023).

This situation indicates that understanding how forest scientists approach the study of tropical forests is of great importance, as researchers are the information providers in a science-based forest management (Racelis & Barsimantov, 2013). Such information is later used in different processes to define management, trade and conservation policies, using concepts or definitions based on scientific works. How forest scientists contribute to debates on forest management, conservation and trade in tropical forests depends on what topics are keeping scientists most engaged and interested nowadays, making the analysis presented here particularly important and timely.

However, little is known about the classical and latest research trends on tropical forests, specifically related to tropical timber species (Herrera-Alvarez, 2024). It is also clear that research interests in managed tropical forests have not been static but have evolved over time. Most of the early research questions were mainly related to timber inventories and wood production connected to the interests of colonial powers and post-colonial projects (ForestPlots.net et al., 2021). These research questions were evident in the historical conflict between the objectives of high-intensity silvicultural practices focused on productivity, and practices focused on conservation strategies (Burivalova et al., 2017). Although these two seemingly opposite management goals were initially separated, it is known that over time a better integration of ecological and conservation information has been needed for sustainable forest management. Such convergence has aligned silvicultural interventions with the preservation of biodiversity and the key ecosystem services prioritized within a forest management unit, while also securing economic viability for the concerned stakeholders (Lee, 2000; Petrokofsky et al., 2015).

Hence, it is important to understand the evolution of forest researchers´ interests over time, as such interests are the basis for dialogues in which they participate (Ducarme et al., 2021). Successfully transferring such information is a frequent limitation to transition towards sustainable forest management (Zafra-Calvo et al., 2024). In addition, it has been highlighted that actors with more relationships and success in interchanging knowledge have the power to trigger more significant changes (Borgatti & Cross, 2003). Therefore, to reach a fruitful dialogue among forest actors based on current scientific knowledge, it is important to know how research trends have evolved over time and what topics are now considered more relevant and are attracting more attention in research actions.

This situation indicates the need to analyze the scientific discourse surrounding tropical timber species forest management and, as this is the common point with other stakeholders (i.e. administrations, local communities, forest owners, forest industries). An indirect way to understand how scientist could contribute to multi-actor dialogues is by understanding which topics scientists focus on when studying tropical timber species. A convenient approach to understand such focus are scientometric studies. They are a powerful tool to understand how research fields are structured and to highlight trends and dynamics using large datasets of academic publications. In fact, scientometric studies are becoming increasingly common in forest sciences to understand how disciplines are interconnected (e.g. Lucas et al., 2023).

Based on the above, our general objective was to quantify trends in research in managed tropical forests to support multi-actor dialogue on the sustainable management of tropical forests by providing a quantitative analysis of the terms most frequently used by forest scientists when working on managed tropical forests. To do so, we carried out a scientometric analysis of the scientific literature in which the term “tropical timber species” is mentioned. This term was used to limit the analysis to works related to forest management at operational, local or species scale, as it is one of the key concepts supporting multi-actor dialogue in tropical forests (Herrera-Alvarez et al., 2025). Our research questions were: 1) Are there specific scientific topics and disciplines related to tropical timber tree species?; 2) Have such scientific topics changed over time?; 3) What have been the main research trends related to tropical timber species during the last four decades? Such questions are of key importance to support successful science-based, multi-actor sustainable forest science in the tropics (Zafra-Calvo et al., 2024).

Our initial hypotheses were that: 1) knowledge on tropical timber species has been accumulated for several decades and continues to expand, as tropical forestry has also been transitioning from opportunistic to a more advanced science-based management (Herrera-Alvarez, 2024); and

2) main scientific topics reflected in academic literature have also evolved as ecology has moved from describing to explaining tropical biodiversity. To answer these questions and test the initial hypotheses, the specific objective of this study was to identify the current emerging topics and disciplines in academic research related to tropical timber species.

2. MATERIAL AND METHODS

2.1. Selection of relevant studies during the 1983-2023 period

Multiple queries using the Web of Science (including the Core Collection, the Book Citation Index, MEDLINE, CAB abstracts, ScIELO Citation Index and Korean Citation Index, https://www.webofscience.com/wos), and the Scopus databases (https://www.scopus.com) were carried out for the period from 1983 to 2023. Access to both databases was obtained via the national license for Spanish institutions managed by the Spanish Foundation for Science and Technology (FECYT: https://www.recursoscientificos.fecyt.es/). The year 1983 was selected due to the establishment of the International Tropical Timber Organization that year (ITTO, 2009), while 2023 was the last year with full records in both databases at the time of carrying out this work in early 2025. For both databases, we used the term "concept" and its synonymous or closely related words as defined by Cambridge´s (https://dictionary.cambridge.org/thesaurus/) and Oxford´s Thesaurus (https://www.oed.com/) (i.e. "definition", "concept", "description", "notion", "criteria", "characteristic", "trait", "feature", "conception"). These terms were combined using the Boolean operator AND with the term "timber species" and its synonymous (i.e. "commercial timber", "commercial tree", "forest products") and with the term "tropical". Alternative spellings in title and keywords were accounted for. Complete queries can be found in the Supplementary material Appendix 1.

Our analysis was done in five phases. In Phase 1, we identified 30,782 documents in the Web of Science (WoS) database. Next, further refinement was applied to limit documents to those included in the categories Ecology, Forestry, Plant Sciences, Environmental Sciences and Biodiversity Conservation. The 1,770 documents that did not fit these criteria were excluded (Figure 1). In addition, 30,241 documents were identified in the Scopus database, being these records also only in English (see query in the Suppl. Appendix 1). As in the WoS search, document types were limited to articles, reviews, book chapters, books, data papers, notes, and letters. However, only 20,000 documents could be exported due to the Scopus´s technical maximum export limit. Consequently, items were ranked by relevance before exporting. In Scopus, relevance is calculated for each document as a score composed of factors such as the number of times that the search term is found in the document, frequency, position in the document of the searched term, proximity of searched terms in the document and the completeness of the full query in the documents if several terms are searched (following methods defined by Spärck Jones, 1972). Hence, documents ranked below the 20,000 position were discarded. Out of the first 20,000 ranked, a total of 19,801 were successfully exported and converted into text files for further analysis with R Studio (version 4.1.3) (Figure 1).

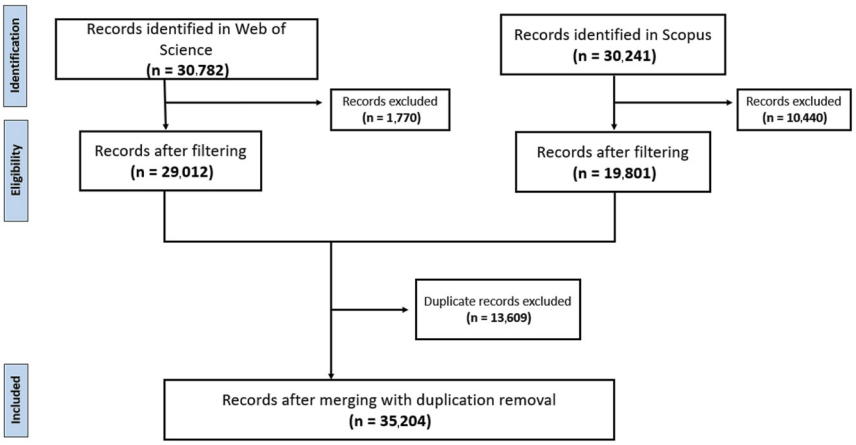

Figure 1. Flowchart of the process followed to compile the records of the four-decade (1983–2023) historical trends related to the use of the "tropical timber species" concept in the Web of Science and Scopus databases.

In Phase 2, the exported records from both databases were converted to the same data frame using the *Bibliometrix* R package (Aria & Cuccurullo, 2017) in R Studio version 4.1.3. In addition, the *mergeDbSources* function was used to merge both databases, identifying and excluding 13,609 duplicated records (68.7% of the total documents exported from Scopus). In Phase 3, the total unique records identified after this phase were 35,204 (Figure 1). These records were exported into. *csv* format with R Studio for further processing.

2.2. Selection of relevant studies from 2018 to 2023

In Phase 4 to provide a general view of the latest research trends, the same queries for Phase 1 to 3 were repeated but restricting the search period to the years from 2018 to 2023 (see Suppl. Appendix 1). The same search terms and inclusion and exclusion criteria were used as in the previous phase. Following the same procedure to combine and detect duplicates, a total of 13,424 unique records were identified for this period (Figure 2), creating another.*csv* file with R Studio as in the previous phase. The analysis of the trends from 2018 to 2023 was carried out as a new query and creating a new database to ensure that all relevant documents were included, reducing the potential effect caused by the technical export limitation in Scopus mentioned above. In Phase 5, to identify the currently active trends, we filtered the records for the most recent years (2022–2023) within the 2018–2023 dataset generated in Phase 4 to generate a third scientometric analysis, comprising 4,284 unique documents.

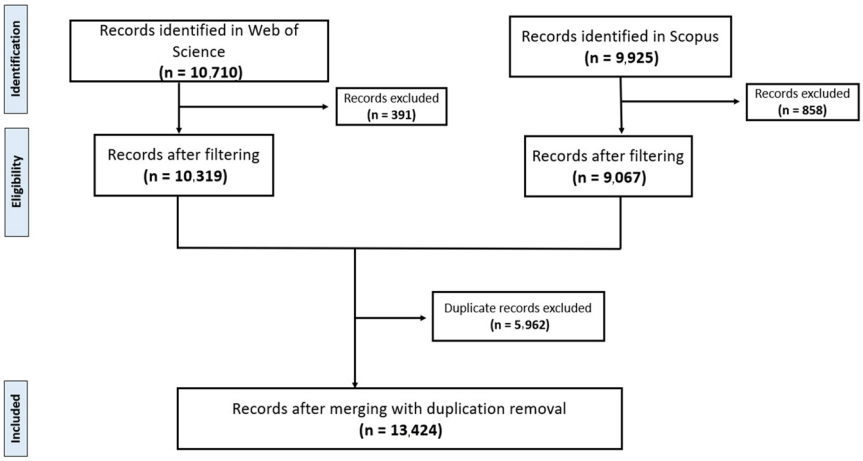

Figure 2. Flowchart of the process followed to compile the records of the trends related to the use of the “tropical timber species” concept for the period 2018-2023 in the Web of Science and Scopus databases.

2.3. Scientometric analyses

The *Biblioshiny* app of the *bibliometrix* R package was used to conduct a co-word network analyses (Aria et al., 2017; https://www.bibliometrix.org/home/index.php). The *Biblioshiny* software identifies the most common keywords and the main topics for each period. This software first creates the field *Author Keywords* by extracting authors’ own keywords from each document, indicating if such keywords are indexed from the original article and are searchable. In addition, the field *Keywords plus* is created by using the keywords associated to the manuscript by Scopus and Web of Knowledge databases. The *Keyword plus* field can also use words and phrases harvested from the titles of the cited articles (Aria et al., 2017), being the main difference with the previous field that such terms were not deliberately used by the original authors to classify their own work.

Once both fields are created, the bibliometric analyses included in this study were: 1) Most frequent words (using the field Keywords plus), 2) Words frequency over time (also in the field Keywords plus); and 3) Thematic evolution (using the field Author keywords) for both periods through word cluster analyses. In addition, as the analysis of research topics over time is based on co-word network analysis and clustering (Cobo et al., 2011), it allows identifying the type of themes in the research field. The thematic evolution analysis represents keywords in a two-dimension graph (Callon et al., 1991).

3. RESULTS

3.1. Long-term trends in research themes (1983-2023)

The most mentioned topics in the *Keywords plus* field for the identified documents can be arranged in four groups in order of total occurrence (Figure 3). In the first group, the most relevant words (with more than 4,000 occurrences in all cases) were *diversity*, *tropical forest*, and *biodiversity*. In the second group (2,500 to 4,000 occurrences), the most relevant words were *rainforest*, *patterns*, *forest*, *tree*, and *conservation*. In the third group (1,500 to 2,500 occurrences), the most relevant words were *growth*, *dynamics*, *species richness*, *vegetation*, and *ecology*. Finally, in the fourth group (less than 1,500 occurrences) the most relevant words were *abundance*, *tropical rain forest*, *communities*, *biomass, evolution, climate-change*, and *ecosystem*.

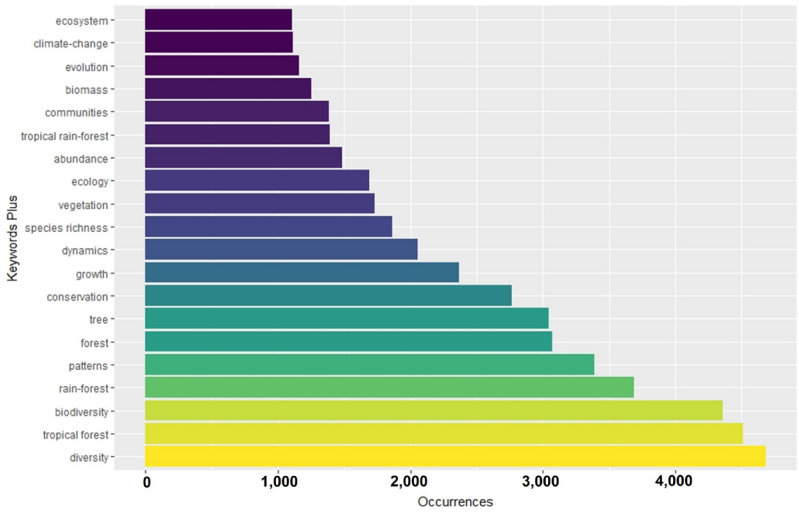

Figure 3. Terms with the highest occurrence in the *Keyword plus* field for the period 1983-2023 in the Web of Science and Scopus databases.

Regarding the terms' frequency over time in this period, occurrences of all keywords started to sharply rise from the year 2000. The terms with higher growth rates in this period were *tropical forest, rain forest, species richness, biodiversity, diversity, dynamics,* and *growth*. In addition, the terms *species richness, conservation,* and *forest* also showed an increase in frequency in the last decade between 2012 and 2023 (Figure 4).

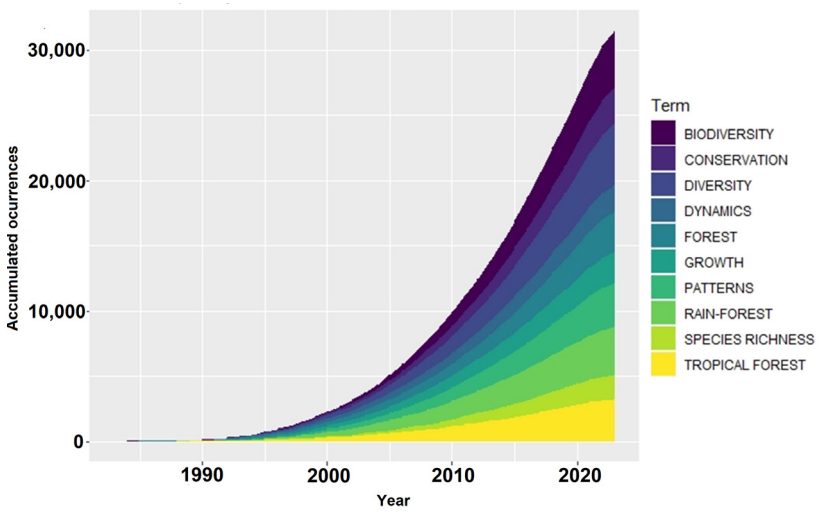

Figure 4. Frequency of the most common terms in the *Keyword plus* field over the period 1983-2023 in the Web of Science and Scopus databases.

As for the thematic evolution analysis, the terms *tropical forest* and *climate change* were in an intermediate position between being niche and motor themes. Similarly, themes such as *biodiversity, conservation*, and *diversity* were within the limits of being considered as both motor and basic themes. Finally, the themes *taxonomy, phylogeny* and *new species* were in the quadrant of emerging and declining topics (Figure 5).

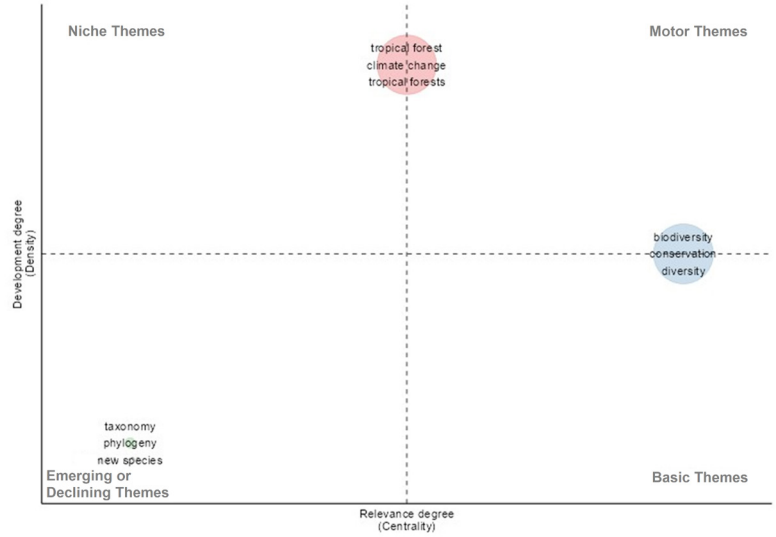

Figure 5. Thematic evolution analysis of the *Author´s keyword* field for the period 1983-2023. The size of the circles is proportional to the occurrence of the terms. Quadrants are denoted as *Niche themes*: well-developed themes but isolated (niches) from other themes; *Motor themes*: most discussed themes in the field; *Basic themes*: themes considered basic and transversal, with low levels of development but high levels of centrality and relevancy to the literature; *Emerging or Declining themes*: themes that have a clear temporal trend either negative (declining) or positive (emerging).

3.2. Modern (2018-2023) and current (2022-2023) trends in research

The most relevant words in the field *Keywords plus* could be found in a group of words with more than 1,500 occurrences: *biodiversity, diversity*, and *tropical forest*. In a second group, the most relevant words were forest, patterns, conservation, rain forest and tree (750 to 1,500 occurrences). A third group included words with 500 to 750 occurrences, such as *species richness, growth, dynamics, vegetation, climate-change, ecology*, and *communities*. Finally, in the last group (less than 500 occurrences) relevant words were *ecosystem, abundance, biomass, evolution,* and *climate* (Figure 6).

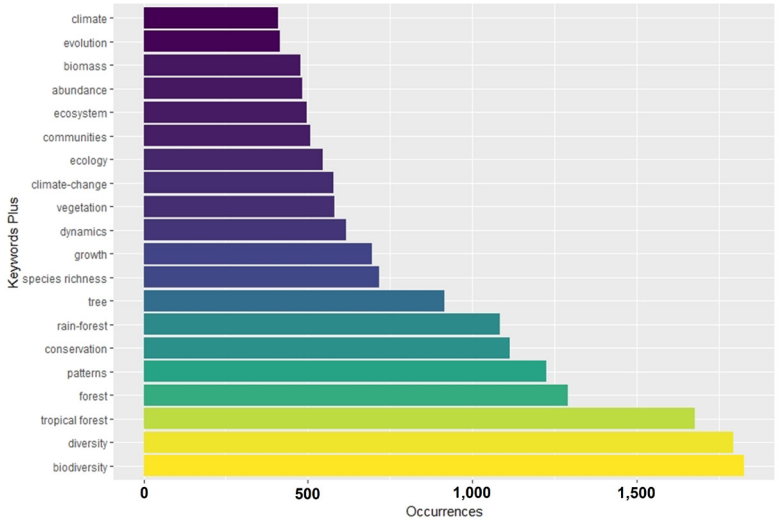

Figure 6. Terms with the highest occurrence in the *Keyword plus* field for the period 2018-2023 in the Web of Science and Scopus databases.

A steady increase in research productivity over this time was observed. The most frequent terms during the last five years were *biodiversity, conservation, diversity, forest*, *rain forest,* and *tropical forest.* However, during this period other terms such as *patterns, species richness*, *dynamics* and *growth* have also been present (Figure 4).

The thematic evolution analysis indicated that *tropical forest(s)* and *climate change* themes persisted and in an intermediate position between niche and motor themes. Similarly, *biodiversity, diversity* and *conservation* were in between motor and basic themes, indicating the importance of such topics in the whole research landscape related to the use of the "tropical timber species" concept. However, the themes *taxonomy, biogeography* and *Neotropics* were present in the quadrant of emerging or declining topics (Figure 7).

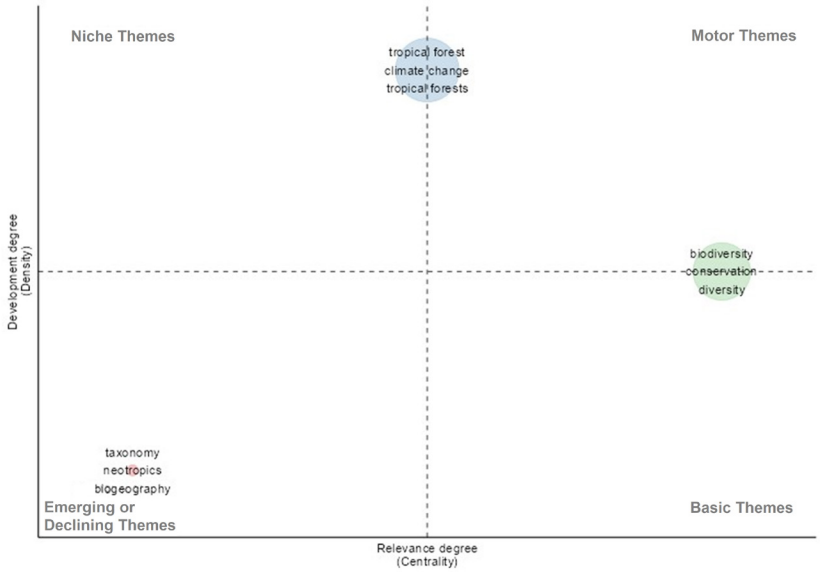

Figure 7**.** Thematic evolution analysis of the *Author´s keyword* field for the period 2018-2023. The size of the circles is proportional to the occurrence of the terms. Quadrants are denoted as *Niche themes*: well-developed themes but isolated (niches) from other themes; *Motor themes*: most discussed themes in the field; *Basic themes*: themes considered basic and transversal, with low levels of development but high levels of centrality and relevancy to the literature; *Emerging or Declining themes*: themes that have a clear temporal trend either negative (declining) or positive (emerging).

When limiting the thematic evolution analysis to the last two years (2022-2023) to highlight the presently active themes attracting the attention of forest scientist, some additional short-term patterns were found. As basic themes, we again identified *tropical forest* and *climate change*. However, themes such as *fragmentation, Atlantic forest* and *deforestation* were present in intermediate position between declining and basic themes. *Taxonomy, phylogeny*, and *new species* were also present as emerging or declining themes. *Wood anatomy* and *mortality* also were identified as niche themes. On the other hand, *remote sensing, forest management* and *random forest* were present as motor themes. Finally, *biodiversity, conservation* and *diversity* were in intermediate position between basic and motor themes (Figure 8).

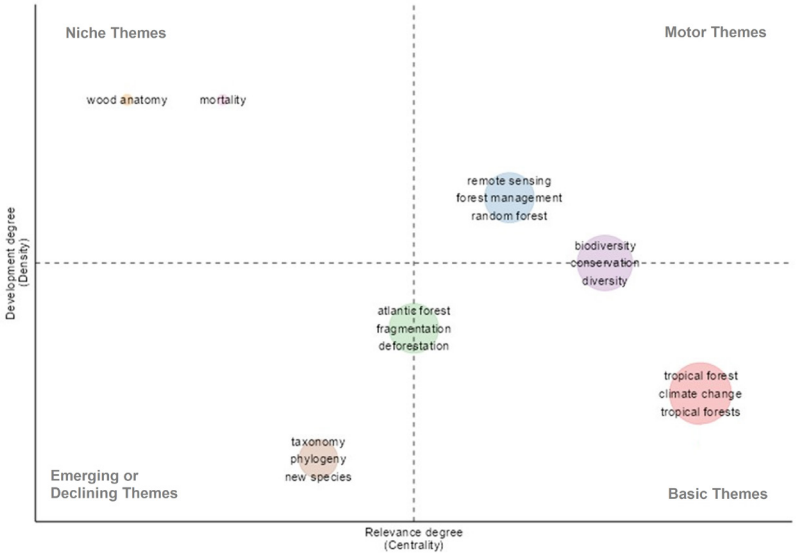

Figure 8. Thematic evolution analysis of the *Author´s keyword* field for the period 2022-2023. The size of the circles is proportional to the occurrence of the terms. Quadrants are denoted as *Niche themes*: well-developed themes but isolated (niches) from other themes; *Motor themes*: most discussed themes in the field; *Basic themes*: themes considered basic and transversal, with low levels of development but high levels of centrality and relevancy to the literature; *Emerging or Declining themes*: themes that have a clear temporal trend either negative (declining) or positive (emerging).

4. DISCUSSION

4.1. Historical trends in research themes

In a general perspective, it is noteworthy that the most productive research topics during the last 40 years (1983-2023) have been mainly focused on ecosystem structure and the presence and composition of species, populations, and communities, in agreement with similar trends found for the ecology field in the 1980-2000 period (Carmel et al., 2013). Although preserving tropical forest biodiversity under active management is not a new issue, it is still a popular topic (Gardner et al., 2009). In truth, actively managed forests are the most needed to improve knowledge on conservation status of different plant and animal species (Venter et al., 2016), and the need to preserve tropical forest biodiversity (du Toit et al., 2004). Both facts are likely behind the strong increasing trend over time in number of relevant documents identified.

Most frequent research themes (motor themes as defined by Callon et al., 1991) for the 40-year period were *biodiversity, conservation* and *climate change,* with the first two terms being also basic themes supporting a large part of the research literature, while *climate change* also being classified in a niche position. Climate change has been recognized as a key issue in tropical forests for more than 15 years (Singh & Sharma, 2009). For instance, some seminal papers are related to the role of tropical forests in mitigating and adapting to climate change (Mitchard, 2018; Ameray et al., 2021). This fact could also be related to the increase in relevance on climate change issues after the 2015 Paris Agreement (UNFCCC 2016), an influence that has also been found in other fields of forest ecology (Blanco & Lo, 2023). For example, the study of the potential impacts of different climate change scenarios is highlighted in recent research on Amazonian timber species (Lidskog & Sundqvist, 2022; Herrera-Alvarez et al., 2023).

Our analysis partially supported the initial hypotheses, as changes in scientific interest towards some of the most pressing issues in forest management have been detected. In addition, it is interesting to notice that the terms *taxonomy*, and *phylogeny* are mapped in the quadrant for emerging or declining topics. This fact indicates that the activity around those topics is relatively low and weakly linked to

other clusters, and may be increasingly declining topics, coinciding with a generalized declining interest in taxonomic studies and even careers in taxonomy (Löbl et al., 2023). However, the reappearance of the term *new species* among the emerging topics in the latest period (2022-2023) also indicates that there is a renovated interest in identifying new species. This evolution is not surprising, as the discovery of new species has been a major driver for research in tropical forests with active management of timber species (de Lacerda & Nimmo, 2010). In fact, the current biodiversity crisis is likely pushing for a renovated interest in identifying new species before they disappear (Liu et al., 2022). Hence, taxonomy, biodiversity and new species identification have again become an important topic related to tropical timber species (Damasco et al., 2021).

4.2. Modern trends in research themes

Almost 40% of all research related to tropical timber species since 1983 has been published during the 2018-2023 period. This is in line with global growth rates in scientific productivity (Oliveira et al. 2022), but it could also be due to the need for reliable information to apply science-based management in tropical forests (Borthakur & Singh, 2018; Mataveli et al., 2022). The main research topics in the latest five years were similar to the full period studied, which indicates that gathering basic knowledge on the structure and composition of tropical forests remains as a driver for research nowadays. Similarly, *climate change* is highlighted in both periods, likely due to already observed ecological changes, given the recent major drought events occurring in the Amazonia and other regions (Mitchard, 2018; Ameray et al., 2021; Ottoni et al., 2023). Nevertheless, *forest management* has lately become a motor theme together with *remote sensing, conservation* and *biodiversity*, indicating a rapid transitioning towards applied topics (De Almeida et al., 2021; Terryn et al., 2022). In fact, the presence of other emerging themes such as *deforestation* and *fragmentation* indicate that understanding the impacts of anthropogenic disturbances is becoming increasingly important (Phillips, 2023). As examples of these themes, the work by Poorter et al. (2021) relates recovery in secondary tropical forests to multidimensional features of soil, physiology and ecology. Interestingly, only one specific tropical region (the Brazilian Atlantic forest) was identified in the topic cluster analysis, likely reflecting the importance in number of academic and technical documents generated by topics related with both management and conservation in this megadiverse environment (Marques & Grelle, 2021).

Niche themes seem to be also linked to timber quality (as in works mentioning wood anatomy*)* or management under stress conditions (as in works mentioning mortality*)* as exemplified by the work by Levionnois et al. (2021). Only lately the theme *forest management* has appeared among the most relevant topics. This is likely due to both the increase in the socio-economic interest on better tropical forest management, but also because of the recognition by forest scientists of the high challenges that such forests are facing and need for research on them (Mitchard, 2018).

4.3. Methodological limitations

The *Biblioshiny* software is unable to merge similar keywords (such as *tropical forest* and *tropical forests*). Assuming this, we decided against manually modifying the data on keywords due to the large number of records (more than 30,000) and to preserve the integrity of such records. Therefore, we think a better approach is needed, in which scientific databases should include tools for identifying synonymous, plural forms and similar forms of the same keyword to be added to the ones selected by the authors (Ghanbarpour & Naderi, 2019). Another related issue is the use by authors of terms that can have double meanings as they are used in different disciplines. For example, the term *random forest* appears as a motor topic in the last two years, but it is clearly related to the statistical procedure and not to actual forests. This issue could get worse if terms used in ecology are also used in different fields, which could create misunderstandings among stakeholders (Hodges, 2008). It will also be difficult for future statistical word analyses to do a proper work, increasing the refinements needed when selecting records.

In addition, limiting the queries to documents in English could introduce language bias and reduce the presence of topics of interest for national or regional forest authorities (Chowdhury et al., 2022; Amano et al., 2023). However, works carried out in collaboration with academic partners or international institutions had likely generated scientific literature in English, which would be included in the databases. In addition, most of these documents, together with graduate student thesis (MSc, PhD), or events such as conferences, congresses or workshops, are commonly reported in the scientific databases with their titles, abstracts and keywords in both English and non-English versions. We estimate that such requirements would have allowed the designed query to capture most of the regional scientific productivity in the search results.

Another potential limitation is research not reported or included in WoS or Scopus, such as books prior to 2004 in Scopus and prior to 2011 in Web of Science (which included references to books since 2005), as the databases did not include books before those years. However, a preliminary analysis of book-related documents indicated that a maximum of 61 book-related documents were reported in 2011, compared to 11,278 term occurrences detected for that year. Such differences in magnitudes and the absence of abrupt changes in the temporal trends observed in Figure 4 indicate that book contributions are minor, and therefore potential bias was likely small. Similarly, in the case of "grey literature" works, such as graduate students´ thesis (MSc or PhD) or technical reports, WoS and Scopus do not include these documents. Although some of this literature could have been found by using secondary documents in the databases (as sources cited in the primary documents), a preliminary search showed that such documents usually did not have complete records that could later by processed by *Biblioshiny* during the cluster analysis. As cleaning up thousands of such records was considered impractical and a potential way to alter database records, incomplete documents were left out of the analysis. Finally, other important documents, such as patents, market studies, trade journals, economic reports or similar were left out by our query (even if Scopus does record patents), as they are in nature not academic research, and therefore not relevant for this study.

5. CONCLUSIONS

Our analysis of the last 40 years on research topics related linked to tropical timber species indicates that scientific productivity started to rise notably since the turn of the millennium, most likely due to the increasing interest in the role of tropical forests. In addition, most of the early basic themes such as *taxonomy, phylogeny, biodiversity, biogeography*, and *conservation*, persist nowadays, but *climate change* has already established as a strong basic research theme. It was also possible to identify that due to the increasing anthropogenic influence in world's tropical forests, especially during the most recent years with full data available (2022 and 2023), applied themes such as *fragmentation, deforestation, mortality, forest management* and *remote sensing* began to be more common among the scientific documents published. In conclusion, when using the term "tropical timber species", researchers are lately mostly focused on research related to *climate change* and different aspects of *forest management*, but also to *taxonomy* and *biodiversity*. Therefore, those four topics must be part of any multi-stakeholder dialogue for science-based tropical forest management in which forest scientist could be involved.

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Supplementary material

(Appendix I): accompanies the paper on the Forest Systems´ website.

Data availability

Data that support the findings of this study can be found in WoS or Scopus databases. See Supplementary material (Appendix I)

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Authorship contribution statement

Ximena Herrera-Alvarez: Conceptualization, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing, Funding acquisition, Formal analysis.

Gonzalo Rivas-Torres: Conceptualization, Supervision, Writing – review & editing.

Oliver L. Phillips: Conceptualization, Investigation, Writing – review & editing, Supervision, Funding acquisition.

Vicente Guadalupe: Conceptualization, Writing – review & editing.

Juan A. Blanco: Conceptualization, Methodology, Resources, Writing – review & editing, project administration, Funding acquisition, Supervision.

Competing interests

The authors have declared that no competing interests exist.

Statement on the use of Artificial Intelligence

Not applicable.

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