



# A Bibliometric Review of the Impacts of Logging in Forests in Semi-Arid Zones

Mamoudou Amadou Tina <sup>a\*</sup>, Issoufou Bagnian <sup>a,b</sup>,  
Ali Mahamane <sup>c</sup> and Adam Toudou <sup>d</sup>

<sup>a</sup> *Laboratory of Ecology and Management of Sahelo-Saharan Biodiversity, André Salifou University of Zinder, Niger.*

<sup>b</sup> *Department of Natural Resources and Environment, Faculty of Agricultural Sciences (FSA), Djibo Hamani University of Tahoua, Niger.*

<sup>c</sup> *Faculty of Science and Technology, Abdou Moumouni University of Niamey, Niger.*

<sup>d</sup> *Faculty of Agronomy, Abdou Moumouni University of Niamey, Niger.*

## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

## **Article Information**

DOI: <https://doi.org/10.9734/ijpss/2024/v36i105070>

## **Open Peer Review History:**

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/123626>

**Review Article**

**Received: 01/08/2024**  
**Accepted: 03/10/2024**  
**Published: 09/10/2024**

## **ABSTRACT**

Forest massifs in semi-arid zones play an essential role in maintaining ecological balances and the livelihood of local communities. However, unsustainable logging in these regions can have devastating ecological, and socio-economic consequences. This bibliometric review aims to synthesize the available evidence regarding the impacts of logging in semi-arid ecosystem. Analysis of publication trends reveals a significant increase in research from 2008, reflecting a growing awareness of the issues related to sustainable forest management. The United States, Canada, Australia and China the most prominent countries in this field. The bibliometric analysis of the highlights major concerns related to climate change, clear-cutting, interactions with demographic

\*Corresponding author: E-mail: [amadoutinam@gmail.com](mailto:amadoutinam@gmail.com);

dynamics and biogeochemical cycles. However, gaps remain, including a lack of data specific to semi-arid areas, limited understanding of the complex interactions between different dimensions of impacts, and insufficient integration of local perspectives and traditional knowledge. This review highlights the need to continue interdisciplinary and collaborative research efforts to ensure sustainable management of semi-arid forests in the face of current and future environmental challenges.

*Keywords: Bibliometric analysis; logging; semi-arid zones; social impacts; sustainable forest management.*

## 1. INTRODUCTION

Forests in semi-arid zones, characterized by irregular rainfall and low levels of productivity, play an essential role in maintaining ecological balances and the livelihood of local communities [1,2]. These fragile ecosystems provide a multitude of ecosystem services, including the regulation of the hydrological cycle, the preservation of biodiversity, carbon sequestration and the production of woody and non-woody resources [3,4]. However, unsustainable logging in these regions can have devastating ecological, and socio economic consequences. Numerous studies have highlighted the ecological impacts of this overexploitation, including land degradation, loss of biodiversity, soil erosion and disruption of biogeochemical cycles [3,4]. Socio-economically, the depletion of forest resources undermines the viability of local livelihoods, exacerbates poverty and can lead to land use conflicts [5,6]. Additionally, the impacts of logging on the structure and composition of semi-arid forests may compromise their resilience to future climate change [3]. Economically, although the exploitation of wood and non-wood forest products constitutes an important source of income for local populations [7], unsustainable management of these resources can lead to their depletion and the loss of these long-term benefits [5]. Additionally, forest degradation can negatively impact other economic sectors such as agriculture and tourism [8]. Finally, the social impacts of logging in semi-arid areas are often overlooked but can be considerable. Reduced access to forest resources can affect the livelihoods and food security of local communities, thereby exacerbating poverty and inequality [6]. Furthermore, conflicts over the use and ownership of forest resources can be exacerbated by unsustainable exploitation [9].

Although many studies have addressed these impacts in isolation, little work has attempted to comprehensively and systematically synthesize the available evidence regarding the ecological,

economic and social effects of logging in semi-arid areas. Some reviews have focused on specific aspects such as land degradation [10] or impacts on biodiversity [11], while others have taken a broader perspective but without examining specifically the context of semi-arid zones [12,13].

A recent bibliometric review by Adebowale et al. [14] mapped research trends on the environmental impacts of logging, highlighting the importance of this topic but not comprehensively covering the socio-economic all dimensions. Additionally, the review discussed the challenges of the aridity and vulnerability of the semi-arid zones to climate change on a limited scale, Thewhich present unique challenges due to their aridity and vulnerability to climate change. Thus, despite these previous synthesis efforts, there remains a lack of comprehensive and integrated understanding of the multiple impacts of logging in semi-arid ecosystems. A bibliometric and systematic review aimed at filling this gap would help guide sustainable management strategies in these vulnerable areas. By mapping trends, assessing available evidence and identifying knowledge gaps, this review is expected to make a significant contribution to the sector of bibliometric analysis.

This study aims to (i) analyze research trends related to the impacts of logging, (ii) analyze the major emerging themes linked to the impacts of logging, and (iii) identify knowledge gaps and future research needs on the impacts of logging in semi-arid forest areas.

## 2. METHODS

### 2.1 Data Collection

A search strategy that included search terms from a data source to collect the most relevant references was carried out. The first step consists of defining a search string taking into

**Table 1. Element PIO**

<b>Elements</b>	<b>Keywords</b>	<b>Synonyms</b>	<b>Syntaxe</b>
Population (P)	Forest massif	Forest ecosystems, semi-arid forest	Forest ecosystems or Semi-arid forests
Intervention (I)	Lumbering	Logging, Woodcutting,	Forest exploitation or Timber harvesting or Tree felling
Outcome (Outcome)	Effect	Effects, impacts, consequences	Impacts or Consequences or Effectors Outcomes

account the keywords and terms linked to the PICO (Population, Interventions, Comparator and Outcome) elements [15]. The Scopus database (<http://www.scopus.com/search/>) was chosen it includes a wide range of high-impact international academic journals [16] and mainly records scientific articles, reviews, and books, reports, and conferences.

The Keywords and terms for searches in the main bibliographic databases were derived from the POS elements detailed in Table 1.

Each element was compared by the Boolean operators OR [15,17] and their combinations by the Boolean operator AND. The terms made it possible to establish the search chain (Search by titles, keyword summary) as follows:

(TITLE-ABS-KEY ("Massif Forestier" OR "Forest massif" OR "Forest ecosystems" "Semi-arid forests") AND TITLE-ABS-KEY ("Forest exploitation" OR "Timber harvesting" OR "Tree felling") AND TITLE-ABS-KEY ("Impacts" OR "Consequences" OR "Effects" OR influence)

## 2.2 Data Analysis

A total of 313 documents were retained from the Scopus data source. These documents were exported respectively to CSV formats, and then submitted to R software to carry out bibliometric analyses. Bibliometric analysis is a rigorous and objective approach to literature analysis that allows the identification, evaluation and interpretation of all available studies relevant to a research question in a specific or related area of study. to a specific problem of interest. Thus, the publication trend analysis, the analysis of countries or regions having a strong contribution in the field was carried out using bibliometrix R-Tool via the bibliophagy interface [18], a recent R package that facilitates more comprehensive bibliometric analysis by employing specific tools for quantitative bibliometric and scientometric research. Also, the analysis of the contents of the

documents was carried out with the VOSviewer software.

A descriptive bibliometric analysis was carried out, involving the examination of publications and citations over time, the assessment of the quality of the publications and the impact of the authors on the subject studied.

Using biblioshiny, a thematic analysis was carried out to highlight the major thematic groups as well as their evolution over time. The level of importance of the themes was assessed using Callon's centrality index, while their degree of development was assessed by Callon's density, according to the methodology of [19]. These two indicators were used to construct the strategic diagram illustrated in Fig. 2, thus making it possible to assess the temporal performance of the identified themes.

## 3. RESULTS AND DISCUSSION

### 3.1 Analyze Research Trends Related to the Impacts of Logging

Analysis of the trends in studies on the impacts of logging between 1979 and 2023 (Fig. 1) reveals a dynamic in two distinct phases. The first, extending from 1979 to 2008, is characterized by modest scientific output and from 2008 to 2023. The two distinct phases observed in the evolution of research on the impacts of logging reflect changes in priorities and the concerns of the scientific community over time. The modest scientific output during the first phase (1979-2008) can be attributed to several factors.

First, the issue of the impacts of logging may not have been seen as an urgent priority at that time, with environmental concerns more focused on other issues such as industrial pollution or the conservation of iconic biodiversity.

Second, the methodologies and analytical tools needed to comprehensively study the impacts of

logging, including remote sensing and ecological modelling techniques, may have been less developed or accessible during this period.

However, it is important to note that this initial phase laid the foundations for future research, allowing pioneers in the field to explore new avenues and raise key questions which were then explored further.

From 2008 onwards, the significant increase in scientific production and the influence of published articles can be attributed to several concomitant factors. On the one hand, the growing awareness of the issues linked to deforestation and forest degradation, amplified by concerns linked to climate change, has probably stimulated the interest of the scientific community in this subject. On the other hand, improved Earth observation technologies and modelling capabilities have allowed researchers to study the impacts of logging more thoroughly and precisely. Finally, repeated calls from international bodies and policymakers for sustainable forest management have likely prompted researchers to become more engaged in this area, to provide sound scientific information to inform policies and management practices.

The slow but steady evolution observed during this second phase suggests that the impacts of logging have become a major and lasting concern for the scientific community, reflecting the growing importance given to the preservation of forest ecosystems and sustainable management of these valuable resources.

### 3.2 Distribution of Publications between Countries/Regions of the World

The number of publications and citations per country on a topic reflects the country's interest in the topic and the influence of its work on current scientific developments. In all of the 333 publications obtained, the impact of exploitation in forest areas has generated more research interest in the USA, Canada, Australia and China (Fig. 2.). The USA comes first with a frequency of 450 publications followed by Canada (150 publications) and Australia (125 publications) (Fig. 2). Although some African countries have shown interest in the subject, publication efforts are still weak across the continent. In Africa, the countries that have sparked this interest are Niger, Benin, Nigeria, Ivory Coast and South Africa (Fig. 2).

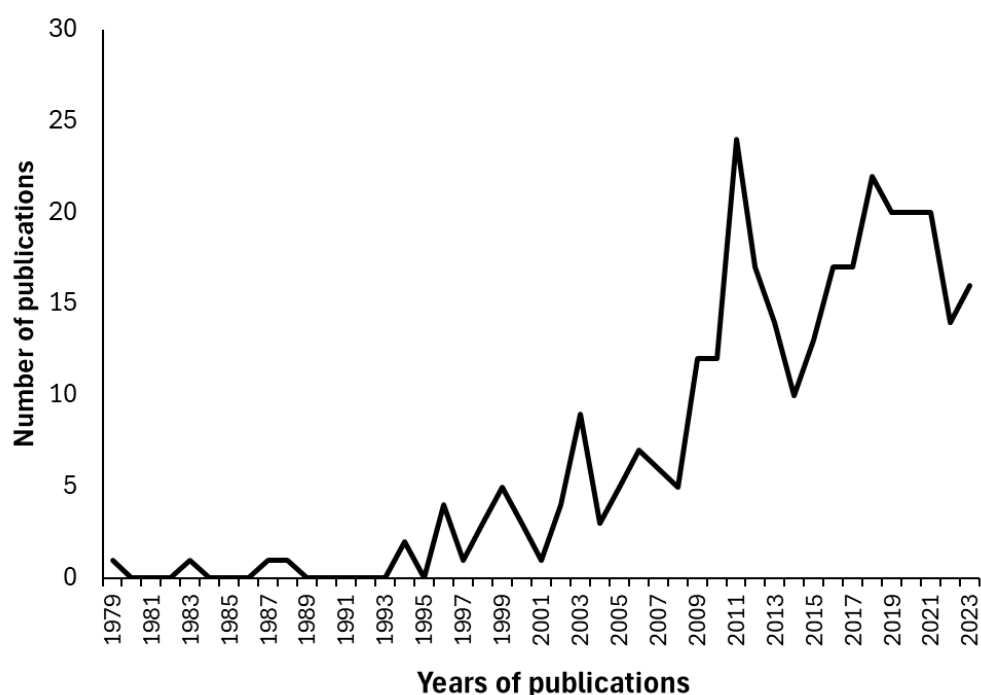
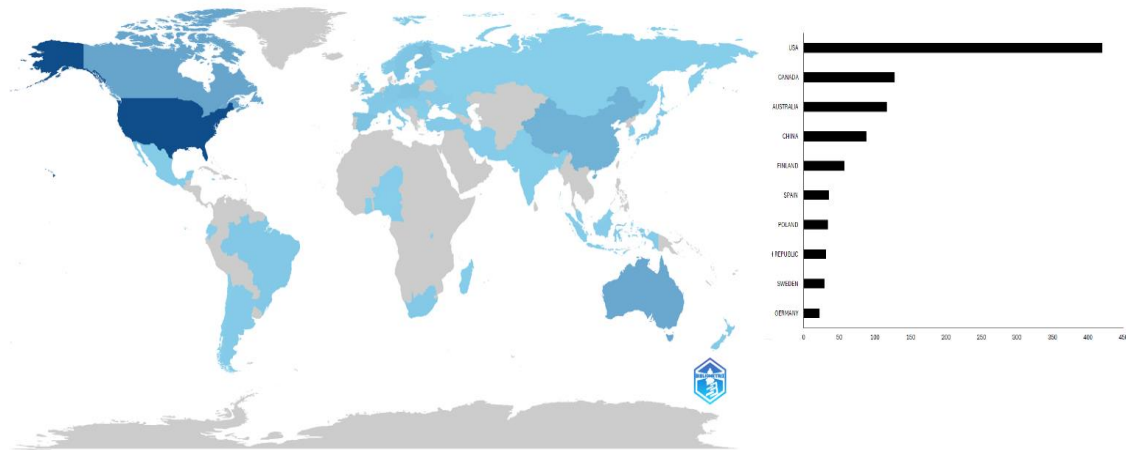


Fig. 1. Publication trend on the theme



**Fig. 2. Spatial distribution of publications on wetland ecosystems from the period 1979 to 2023**

The geographical distribution of publications and citations reflects both the research capacities of different countries, and the priorities and specific challenges they face in terms of management of forests and forest areas. Countries that occupy the top positions, such as the United States, Canada, Australia and China, generally have strong research infrastructures, substantial funding and recognized expertise in the field of forestry and ecology. However, beyond these research capacities, the preponderance of publications from these countries may also reflect the importance of the issues linked to forest exploitation on their territories. The United States, Canada, and Australia are home to large areas of forests, some of which are under significant logging pressures. Similarly, China, facing increasing demand for forest resources and reforestation challenges, has likely intensified its research efforts in this area. On the other hand, the relatively low number of publications from African countries can be explained by several factors. First, research capacities in these countries are often limited by constraints in funding, infrastructure and researcher training. Second, some African countries may place a lower priority on logging research due to other, more pressing social, economic or environmental issues. However, it is encouraging to note that some African countries, such as Niger, Benin, Nigeria, Ivory Coast and South Africa, are starting to become more involved in this area of research. This reflects the growing awareness of the importance of sustainable forest management on the African continent, rich in biodiversity and facing major environmental challenges. To strengthen research capacities and promote more sustainable management of forests in Africa, it

will be essential to encourage international collaborations, the transfer of knowledge and technologies, as well as the financing of local research projects. A better understanding of the impacts of logging in these regions will make it possible to better guide policies and management practices adapted to the specific contexts of African countries.

### 3.3 Scientific Impact of the Authors

By jointly analyzing bibliometric indicators such as the number of publications, citations, as well as the H and G indices, three authors stand out as the most influential in the field of research on the impacts of logging in forest massifs: WILLIAMS MR, CHEN J., and LINDENMAYER DB. During the period studied, WILLIAMS MR emerges as the most prolific and cited author on this subject, with 6 publications, 67 citations, and H indices (5) and G (6) the highest (Table 2). However, it is important to note that its contribution seems to have been one-off, concentrated around the year 2011 (Fig. 3). CHEN J. and LINDENMAYER DB also stand out as influential authors, with high publication and citation counts, as well as respectable H and G indices, reflecting their substantial and lasting contribution to this area of research.

This bibliometric analysis highlights the importance of considering not only the number of publications, but also citations and H and G indices to identify the most influential authors. Although WILLIAMS MR was the most prolific author during the period studied, his impact appears to have been limited over time, unlike CHEN J. and LINDENMAYER DB, who appear to have had a more lasting influence. It is

interesting to note that these three authors come from different countries (United States, China and Australia), which reflects the international interest in this research topic and the possible collaborations between researchers from different regions of the world. However, it is important to emphasize that these results should not be interpreted as an absolute measure of the influence or quality of these authors' work. Bibliometric indicators have their limits and only reflect part of the real impact of research. Factors such as the quality of the journals in which the articles are published, the influence of the work on policy and management practice, and the impact on the training of new researchers must also be taken into account.

Nevertheless, this study provides valuable insight into the structure and dynamics of research on the impacts of logging in forest ranges, highlighting key authors and emerging trends. This information can be useful in identifying

potential experts, fostering collaborations and guiding future research efforts in this crucial area for the sustainable management of forest resources.

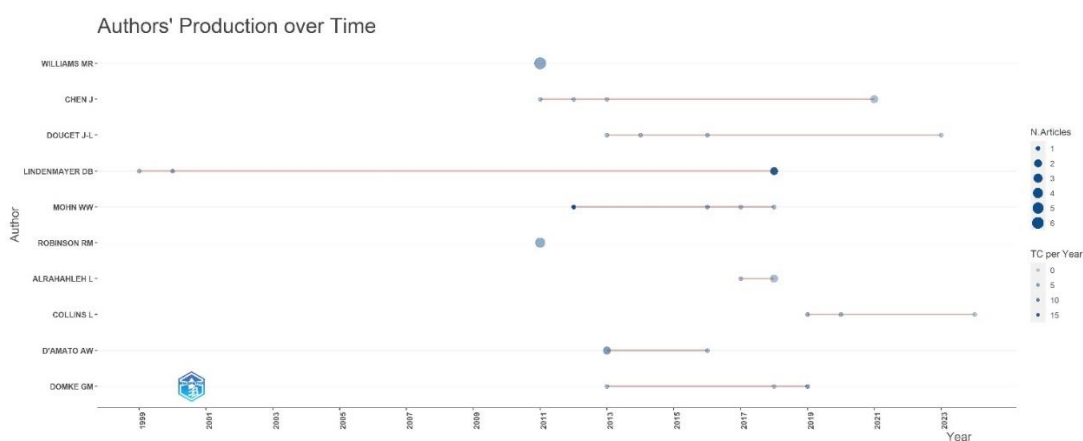
### 3.4 Emerging Thematic Groups Related to the Impacts of Logging

The analysis of 313 documents revealed eight major thematic groups related to the impacts of forestry exploitation, with climate change and clear-cutting emerging as the primary "driving" themes (Fig. 4).

Research in Africa has confirmed the significance of these themes. Studies in the Congo Basin have demonstrated that deforestation significantly affects local climate, emphasizing the critical role of tropical forest preservation in climate change mitigation [20]. The complex interplay between logging, biodiversity, and carbon storage in Central

**Table 2. H index, G index, total number of citations and number of top ten publications**

Element	h_index	g_index	m_index	TC	NP	Year of start of publication
WILLIAMS MR	5	6	0.357	67	6	2011
CHEN J	4	5	0.286	49	5	2011
LINDENMAYER DB	4	4	0.154	272	4	1999
MOHN WW	4	4	0.308	301	4	2012
ROBINSON RM	4	4	0.286	56	4	2011
ALRAHAHLEH L	3	3	0.375	26	3	2017
D'AMATO AW	3	3	0.25	90	3	2013
DOMKE GM	3	3	0.25	64	3	2013
DOUCET JL	3	4	0.25	49	4	2013
EVANS SA	3	3	0.115	244	3	1999



**Fig. 3. Evolution of the number of publications and citations of authors. The width of the circle in the figure is proportional to the number of publications and the intensity of the color to the number of citations**

African forests highlights the challenges in balancing conservation and economic development [21].

Population density emerged as a key theme, underscoring the intricate relationship between logging activities and local demographic dynamics. This is particularly relevant in the African context, where research has shown strong links between population growth and forest degradation [22].

Soil carbon has been identified as an emerging theme of increasing interest. African researchers have contributed significantly to this field, investigating the impacts of forest degradation on soil carbon stocks in tropical African forests [23].

The analysis also highlighted the importance of "basic" themes related to silviculture and timber harvesting. These operational aspects of forestry are crucial in the African context, with studies focusing on reduced-impact logging practices in Central Africa [24].

While this thematic distribution reflects the diversity of research approaches, it's important to note that it may not capture all the complexities of the interactions between these themes. An integrated, interdisciplinary approach is essential for a comprehensive understanding of logging

impacts, as demonstrated by research on forest management in sub-Saharan Africa [25].

The emergence of new themes, such as soil carbon, underscores the need for continuous adaptation in forestry research. Recent studies on the impact of climate change on Southern African forests exemplify this necessity for ongoing research evolution to address emerging challenges [26].

The results of this study highlight the complexity of the impacts of forestry exploitation in semi-arid zones, revealing multifaceted effects on both ecological and socio-economic levels (Table 3).

Intensive forestry exploitation in semi-arid regions can lead to a significant reduction in biodiversity. Research conducted in Burkina Faso has identified the main factors responsible for land degradation and deforestation, emphasizing the urgency of understanding these dynamics for sustainable forest management [27]. However, under certain conditions, controlled forestry exploitation could promote species diversity. This observation is corroborated by studies in Benin, which have shown how biodiversity and socio-economic factors influence farmers' choices regarding wild edible trees in agroforestry systems [28].

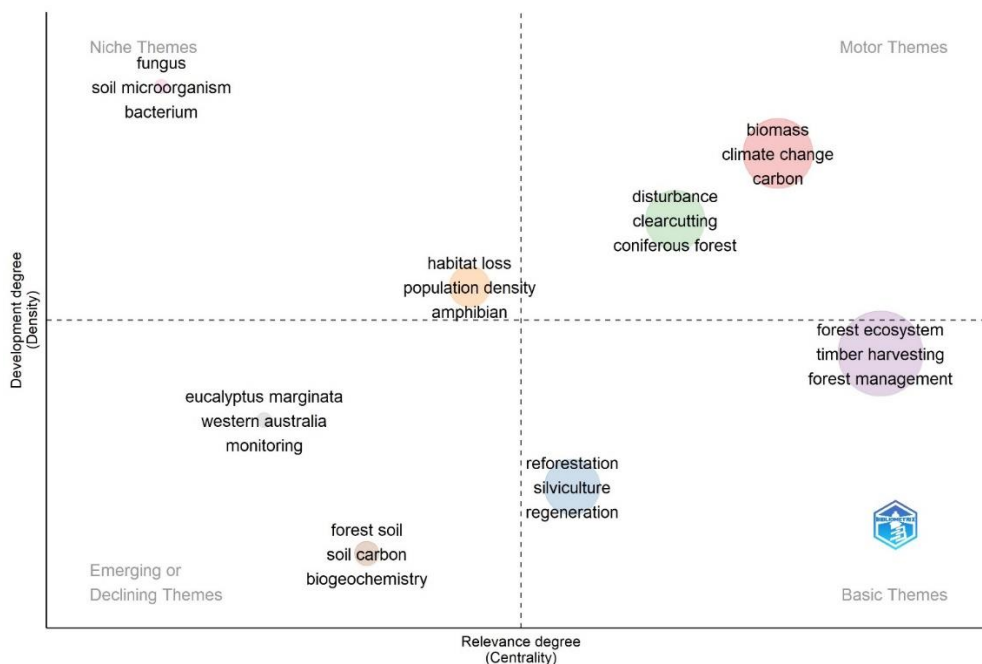


Fig. 4. Thematic map on the impact of logging in forest areas

Changes in forest cover in arid and semi-arid zones have significant repercussions on water resources and population dynamics. Studies in Burkina Faso have highlighted the complex links between land use, population growth, and natural resources [29] (Ouedraogo et al., 2010).

**Table 3. Matrix of logging impacts in semi-arid forests**

<b>Aspect</b>	<b>Positive Impacts</b>	<b>Negative Impacts</b>
Ecological/Environmental	- Enhancement of natural regeneration processes	- Reduction in biodiversity (flora and fauna)
	- Creation of novel ecological niches	- Habitat fragmentation and loss of ecosystem connectivity
	- Improved stand structure (under sustainable management)	- Accelerated soil erosion and potential desertification
	- Mitigation of wildfire risk (with appropriate management)	- Alteration of local hydrological cycles
	- Potential increase in climate change resilience (through diversification)	- Short-term increase in carbon emissions and reduction in carbon sequestration capacity
	- Opportunities for ecological research and monitoring	- Increased susceptibility to invasive species colonization
Socio-economic	- Potential for selective breeding and genetic improvement of tree species	- Disruption of nutrient cycling and soil microbial communities
	- Generation of local employment (direct and indirect)	- Potential loss of traditional livelihoods and non-timber forest products (NTFPs)
	- Revenue generation for local communities	- Land-use conflicts (e.g., forestry vs. agriculture)
	- Development of local infrastructure (roads, schools, health centers)	- Risk of resource overexploitation and unsustainable harvest rates
	- Diversification of income sources (timber and non-timber forest products)	- Economic vulnerability due to timber market fluctuations
	- Enhancement of local forestry skills and knowledge	- Disruption of forest-dependent cultural practices
	- Potential for development of ecotourism and recreational activities	- Risk of inequitable distribution of benefits
Ecological-Socioeconomic Nexus	- Potential improvement in food security (through integrated forest management)	- Loss of ecosystem services (e.g., medicinal plants, water regulation)
	- Economic valuation of conservation (payments for ecosystem services)	- Landscape degradation affecting both ecology and aesthetic/tourism value
	- Increased awareness of forest ecosystem services and values	- Intensification of human-wildlife conflicts due to habitat reduction
	- Development of locally-adapted sustainable forestry practices	- Risk of overexploitation of water resources, impacting both ecology and livelihoods
	- Opportunities for agroforestry systems, benefiting both environment and local economy	- Alterations in local microclimates affecting both biodiversity and agricultural practices
	- Potential for integration of traditional ecological knowledge with scientific forestry practices	- Shifts in ecosystem services provision, impacting both ecological functions and community benefits



From a socio-economic perspective, sustainable forestry exploitation can create essential economic opportunities for rural communities. Research in Senegal has demonstrated the considerable socio-economic value of trees for local communities, underscoring the importance of forest resources for their livelihoods [30]. Nevertheless, the potential disappearance of traditional livelihoods raises crucial questions about the equity and sustainability of these practices. Studies in Burkina Faso have explored local perceptions of dry forest decline, highlighting the challenges faced by communities dependent on these resources [31,32].

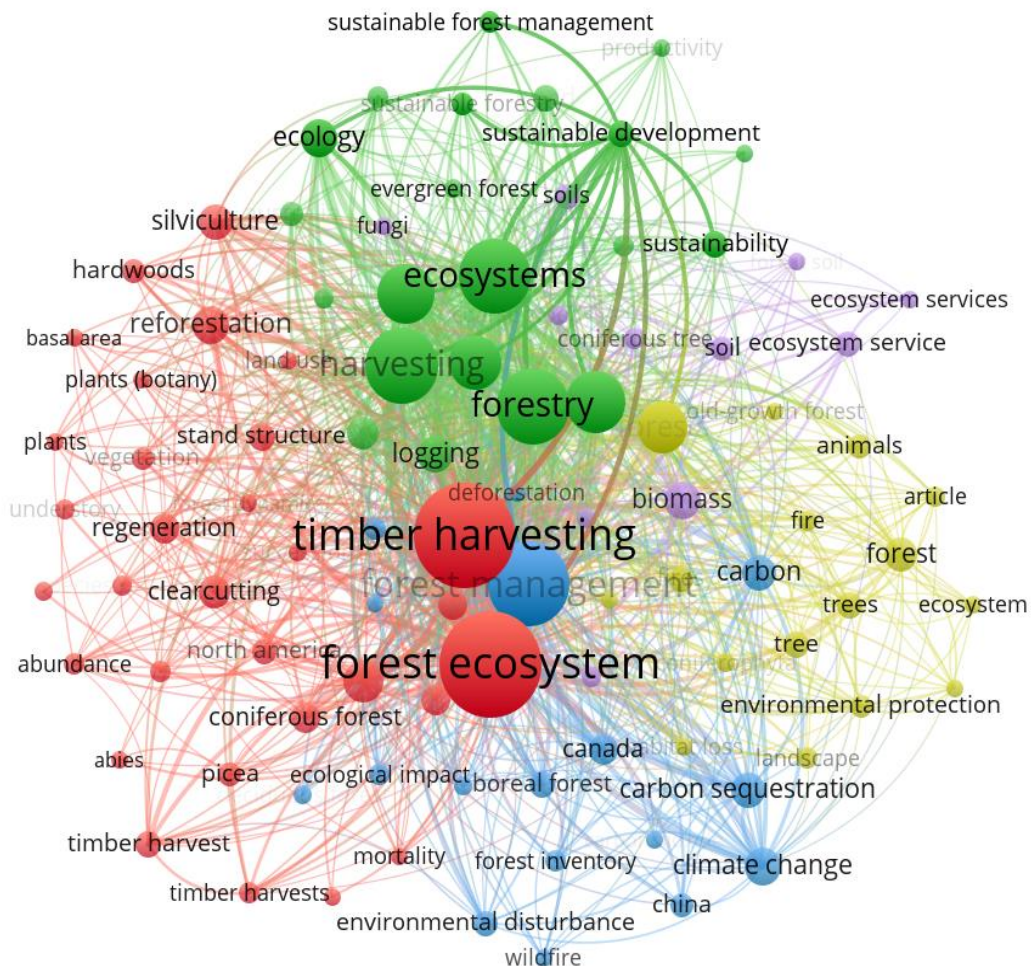
The interaction between ecological and socio-economic aspects is manifested notably by the increase in human-wildlife conflicts, illustrating how ecological changes can have direct repercussions on human communities.

### 3.5 Content Analysis

The analysis of keyword co-occurrences made it possible to identify five major thematic clusters associated with the impacts of logging in scientific publications (Fig. 5).

The first cluster, represented in green, focuses on concepts related to forest ecosystems, such as biodiversity, forest structure, as well as ecological processes. This cluster reflects the importance given by researchers to the effects of exploitation on the integrity and functioning of forest ecosystems.

The second cluster, in red, is associated with silviculture concepts, encompassing forest stand management techniques and harvesting methods. This thematic group highlights the attention paid to the operational and technical aspects of logging.



**Fig. 5. Cluster of factors studied in scientific publications**

The third cluster, in blue, is defined by forest management in a broader sense, including policies, strategies and approaches to sustainable forest management. This cluster highlights the importance of an integrated and long-term vision to ensure responsible forestry.

The fourth cluster, in yellow, is characterized by factors influencing forests, such as climate change and natural disturbances. This thematic group highlights the need to consider the multiple factors that interact with logging and shape ecosystem dynamics.

Finally, the fifth cluster, in purple, is linked to ecosystem services from forests, encompassing the economic, social and environmental benefits that these ecosystems provide. This cluster highlights the importance of taking into account the multiple values and functions of forests in exploitation strategies.

This distribution into thematic clusters reflects the multidimensional and interdisciplinary nature of research on the impacts of logging. Researchers have approached this issue from different angles, ranging from fundamental ecological aspects to socio-economic and management considerations.

However, it is important to note that these clusters are not isolated silos, but rather interconnected areas that overlap and interact. A holistic and integrated approach, taking into account the complex links between these different aspects, is essential for a thorough understanding of the impacts of logging and for developing effective sustainable management strategies.

Furthermore, the emergence of new challenges, such as climate change and increasing demographic pressure, highlights the need to stay abreast of scientific developments and adapt to new, constantly evolving realities in this crucial area.

### **3.6 Knowledge Gaps and Future Research Needs on the Impacts of Logging in Semi-Arid Forests**

Although this study has identified broad trends and key areas of research on the impacts of logging in semi-arid zones, several gaps remain and pave the way for future in-depth investigations.

First, there is a distinct lack of data specific to semi-arid ecosystems. While many studies have addressed the impacts of logging in a general context, few have focused specifically on semi-arid zones, which nevertheless present unique characteristics in terms of aridity, biodiversity and vulnerability to climate change. Targeted research on these particular regions is essential for an in-depth understanding of the issues specific to these environments and for the development of truly adapted management strategies.

Furthermore, despite the efforts of this review to highlight the different facets of impacts (ecological, economic and social), the complex interactions between these dimensions remain insufficiently explored. A truly interdisciplinary and integrated approach, capable of understanding these interconnections in all their complexity, is sorely lacking. Only such a holistic approach will make it possible to propose sustainable solutions taking into account all the issues linked to logging in semi-arid zones.

In addition, the impacts of this exploitation on the resilience of semi-arid ecosystems to future climate change deserve particular attention. In-depth research on adaptation and resilience-building strategies is essential to ensure the sustainability of these fragile ecosystems in a context of major environmental upheavals.

Another aspect that is too often overlooked concerns local perspectives and traditional knowledge. Indeed, existing studies mainly focus on scientific and technical aspects, but neglect the knowledge and expertise of indigenous communities in the sustainable exploitation of semi-arid forests. The integration of this ancestral knowledge into research could, however, greatly enrich our understanding of the impacts and management strategies best suited to the realities on the ground.

Finally, a thorough assessment of the effectiveness of current policies and regulatory frameworks in semi-arid areas is required. Although some studies address aspects of forest management and policies, few of them rigorously analyze the relevance and real impact of the measures in force. However, such an assessment would be crucial to guide future reforms and promote truly sustainable exploitation of forest resources in these regions.

These significant gaps strongly underline the need to actively pursue research efforts in this

crucial area, by adopting innovative interdisciplinary approaches, promoting indigenous knowledge and strengthening collaboration between researchers, policy makers and local communities. Sustained investments in research and development of new methodologies and technologies adapted to the specificities of semi-arid zones are also essential to meet the complex challenges of sustainable management of forest areas in these vulnerable regions.

#### 4. CONCLUSION

This bibliometric review made it possible to explore in depth the current state of knowledge on the impacts of logging in forests in semi-arid zones. While the results obtained highlight the growing awareness of the scientific community regarding these crucial issues, numerous gaps persist. Additional research, adopting resolutely interdisciplinary approaches and integrating indigenous knowledge, is essential. Only a holistic understanding of the ecological, economic and social impacts of logging, as well as a rigorous evaluation of the regulatory frameworks in force, will make it possible to develop truly sustainable management strategies adapted to the specific context of semi-arid zones. Faced with current and future environmental challenges, the sustainability of these fragile ecosystems depends on it.

#### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Boufaraâ A. Ecological characterization and economic valuation of provisioning ecosystem services in the semi-arid forests of eastern Morocco. *Ecological Indicators*. 2022;134:108469.
2. Negi VS, Kamboj SK, Aggarwal NK, Raveendran M, Pandey AK, Firdous SM. An assessment of the resource potential of gum, resin and wood in the semi-arid region of Bundelkhand, India. *Natural Resources Forum*. 2019;43(1):3-14.
3. Biederman JA, Somor AJ, Harpold AA, Gutmann, ED, Breshears, DD, Troch, PA, Brooks, PD. Drought supersedes species richness in semi-arid forests as the critical determinant of woody productivity. *Nature Ecology & Evolution*. 2021;5(7): 967-976.
4. Ouédraogo A, Lykke AM, Langanuck T, Djalón A. Socioeconomic importance of woodland resources for the rural population of the Ouové valley in Benin. *Forest Policy and Economics* 2018;88:49-58.
5. Naughton-Treves L, Kammen, DM, Chapman C. Trade in non-timber forestry products - a conservation tool? *Land-use and livelihoods*. 2005;2:1-9.
6. Newton AC, Cantarello E, Tejedor N, Myers G. Dynamics of forest values in agroforestry and natural forest systems in the UK. *Agroforestry Systems*. 2016;90(5):821-828.
7. Angelsen A, Jagger P, Babigumira R, Belcher B, Hogarth NJ, Bauch S, Wunder S. Environmental income and rural livelihoods: a global-comparative analysis. *World Development* 2014;64: S12-S28.
8. Chidumayo EN, Gumbo DJ. The environmental impacts of charcoal production in tropical ecosystems of the world: a synthesis. *Energy for Sustainable Development*. 2013;17(2):86-94.
9. Mamo G, Sjaastad E, Vedeld P. Economic dependence on forest resources: A case from Dendi District, Ethiopia. *Forest Policy and Economics*. 2007;9(8):916-927.
10. Kimiti DW, Wasonga OV, Muwat M, Bussmann RW. Dryland forestry research: A synthesis of reforestation and afforestation in Kenya. *Journal of Sustainable Forestry*. 2017;36(8):825-846.
11. Murphy PG, Lugo AE. Ecology of tropical dry forests. *Annual review of ecology and systematics* 1986;17(1):67-88.
12. Katila P, Ardiansyah M, Porrás I, Shrivastava S. Forests and sustainable rural development: A socio-economic perspective. *Forests and Sustainable Rural Development*. 2020;1-21.
13. Das N. Environmental impacts of fuelwood production from traditional forestry practices in the semi-arid region of West Bengal. *Environment, Development and Sustainability*. 2012;14(1): 47-62.

14. Adebowale K, Oluwade B, Dada O, Ojo E, Adedokun S. A bibliometric analysis of environmental impacts of forest exploitation. *Environmental Science and Pollution Research* 2021;28(37):51706-51720.
15. Petrokofsky G, Sist P, Blanc L, Doucet JL, Finegan B, Gourlet-Fleury S, Healey JR, Livoreil B, Nasi R, Peña-Claros M, Putz FE, Zhou W. Comparative effectiveness of silvicultural interventions for increasing timber production and sustaining conservation values in natural tropical production forests. A systematic review protocol. *Environmental Evidence*. 2015;4:8. DOI:10.1186/s13750-015-0034-7
16. Cavaggioli F, Ughetto E. A bibliometric analysis of the research dealing with the impact of additive manufacturing on industry, business and society. *The International Journal of Production Economics*. February 2019;208:254-268, Available:https://doi.org/10.1016/j.ijpe.2018.11.02
17. Garcia-Yi J, Lapikanonth T, Vionita H, Vu H, Yang S, Zhong Y, Li Y, Nagelschneider V, Schlindwein B, Wesseler J. What are the socio-economic impacts of genetically modified crops worldwide? A systematic map protocol. *Environmental Evidence*. 2014;3:24  
DOI:10.1186/2047-2382-3-24.  
Available:http://www.environmentalevidenc  
ejournal.org/content/3/1/24
18. Aria M, Cuccurullo C. Bibliometrix: An R-tool for comprehensive science mapping analysis  
*Journal of Informetrics*. 2017;11(4):959-975.  
Available:https://doi.org/10.1016/j.joi.2017.08.007
20. Callon M, Courtial JP, Laville F. Co-Word Analysis as a Tool for describing the network of interactions between basic and technological research: The Case of Polymer Chemistry. *Scientometrics*. 1991;22:155-205.  
Available:https://doi.org/10.1007/BF02019280
21. Sahoo SK, Abhishek A, Khare N, Singh SP. Impact of deforestation on regional climate over the Congo basin. *Global and Planetary Change*. 2021;205:103524.
22. Eba'a Atyi R, Lescuyer G, Ngouhou Poufoun J, Moulende Fouda T. Étude de l'importance économique et sociale du secteur forestier et faunique au Cameroun. CIFOR; 2016.
23. Ouedraogo I, Nacoulma BMI, Hahn K, Thiombiano A. Assessing ecosystem services based on indigenous knowledge in south-eastern Burkina Faso (West Africa). *International Journal of Biodiversity Science, Ecosystem Services & Management*. 2017;13(1):332-347.
24. Chiti T, Perugini L, Vespertino D, Valentini R. Effect of selective logging on soil organic carbon dynamics in tropical forests in central and western Africa. *Plant and Soil*. 2018;427(1):105-119.
25. Nasi R, Billand A, van Vliet N. Managing for timber and biodiversity in the Congo Basin. *Forest Ecology and Management*. 2012;268:103-111.
26. Sills EO, de Sassi C, Jagger P, Lawlor K, Miteva DA, Pattanayak SK, Sunderlin WD. Building the evidence base for REDD+: Study design and methods for evaluating the impacts of conservation interventions on local well-being. *Global Environmental Change*. 2020;61:102001.
27. Gondwe MF, Cho MA, Chirwa PW, Geldenhuys CJ. Impacts of climate change on the biodiversity and ecosystem services of miombo woodlands in southern Africa: A review. *Forest Ecology and Management*. 2022;505:119912.
28. Dimobe K, Ouédraogo A, Soma S, Goetze D, Porembski S, Thiombiano A. Identification of driving factors of land degradation and deforestation in the Wildlife Reserve of Bontioli (Burkina Faso, West Africa). *Global Ecology and Conservation*. 2015;4:559-571.
29. Assogbadjo AE, Glèlè Kakaï R, Vodouhé FG, Djagoun CAMS, Codjia JTC, Sinsin B. Biodiversity and socioeconomic factors supporting farmers' choice of wild edible trees in the agroforestry systems of Benin (West Africa). *Forest Policy and Economics*. 2012;14(1):41-49.
30. Ouedraogo I, Tigabu M, Savadogo P, Compaoré H, Odén PC, Ouadba JM. Land cover change and its relation with population dynamics in Burkina Faso, West Africa. *Land Degradation & Development*. 2010;21(5):453-462.
31. Gning ON, Sarr O, Gueye M, Akpo LE, Ndiaye PM. Valeur socio-économique de l'arbre en milieu malinké (Khossanto, Sénégal). *Journal of Applied Biosciences*. 2013;70(1):5617-5631.

32. Paré S, Savadogo P, Tigabu M, Ouadba JM, Odén PC. Consumptive values and local perception of dry forest decline in Burkina Faso, West Africa. *Environment, Development and Sustainability*. 2010; 12(2):277-295.

**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*

*The peer review history for this paper can be accessed here:*

<https://www.sdiarticle5.com/review-history/123626>