

Research Paper: Bibliometric Analysis of and Their Role in Rural Development in the Period of 1978-2023

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ABSTRACT

Purpose: This study aims to provide a comprehensive overview of the structure and trends in natural resources literature from 1978 to 2023. By identifying the main thematic clusters, key terms, influential authors, and countries contributing to the field, this research offers valuable insights into the evolution of natural resources research and its implications for sustainable resource management, community participation, and the integration of socio-economic considerations.

Methods: A bibliometric analysis was conducted on 380 articles indexed in Scopus using VOSviewer software. The study period was divided into two sub-periods, 1978-2000 and 2001-2023, to examine the evolution of research themes over time. Co-occurrence analysis, citation analysis, and bibliographic coupling were employed to identify the main thematic clusters, influential authors, and countries contributing to the field.

Results: Five main thematic clusters were identified: natural resources, natural resource management, community-based natural resource management, sustainability, and rural economy. The research themes evolved from focusing on the government's role in natural resource management during 1978-2000 to the role of institutions and individuals in sustainable resource use and rural programs after 2000. The relationship between natural resources, climate change, and ecosystem services has recently gained prominence. The study also identified key terms such as sustainability, community-based management, rural development, and climate change, which have shaped the discourse in this field. Furthermore, influential authors and countries contributing significantly to the development of research on natural resources were highlighted.

Conclusion: Despite the limitations of bibliometric analysis, such as the exclusion of potentially influential documents not indexed in scientific databases, this study offers a comprehensive overview of the structure and trends in natural resources research. The findings emphasize the importance of sustainable resource management, community participation, and the integration of socio-economic considerations in addressing the challenges related to natural resources.

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1. Introduction

Natural resources are crucial in sustaining rural households and the environment (Ostrom, 1990; Pretty, 2003). However, the overexploitation of these resources has caused a significant decline in many developing countries, leading to a global challenge (Everard et al., 2021; Sharifi et al., 2021). Vulnerable segments of the impoverished population in these countries rely heavily on renewable natural resources for their subsistence and daily lives (Anantha et al., 2021). The challenge is to improve sustainable resource management and the welfare of the vulnerable population and create resilience against shocks (Tajima et al., 2022). With population growth, limited freshwater resources, and disappearing forests in most countries, the pressure on natural resources has increased (Ellegaard & Wallin, 2015; Nguyen et al., 2022). This pressure is due to the growing human population, which needs more resources to maintain their livelihoods. Environmental pressures such as climate change and changing precipitation patterns have further intensified this issue (Sharifi et al., 2021; Shisanya, 2018). The situation is often a version of the tragedy of the commons, where populations trapped in long-term underdevelopment have been forced to unsustainably extract various local natural resources (Roe et al., 2009; Sayer & Campbell, 2004). Although this may benefit individuals in the short term, it threatens the collective welfare of the broader society in the long term (Heffernan, 2022). Research shows that communities dependent on natural resources are more prone to material problems and economic stagnation than those dependent on production or other sectors (Mueller, 2021; Mueller & Tickamyer, 2020). Resource-rich countries like Nigeria, Angola, Sudan, Algeria, and Congo have little economic development, less democracy, low per capita income, and poor living standards. Agricultural performance in countries heavily dependent on resource rents has an inverse role (Li et al., 2023; Pretty, 2003). This may be because the agricultural sector in resource-rich countries cannot provide more job opportunities and better living standards than the oil and mineral sector (Azizi, 2020). Although extraction can reduce inequality, it is not associated with low poverty rates (Bierkamp et al., 2023). Simply put, growth cannot be solely attributed to natural resources. According to J. Tom Mueller (2021), natural resource development encompasses any economic activity that utilizes the local natural environment, including extractive and non-extractive industries. Mining, agriculture, oil and gas extraction, tourism, real estate, and outdoor recreation can contribute to rural development (Roe et

al., 2009; Sayer & Campbell, 2004). However, the extractive natural resource industry in countries like the United States has declined since the 1920s, with labor markets shifting towards natural amenity-based economies like second-home communities or rural tourism (Mueller, 2021). Despite this, natural resources remain vital for sustainable development, particularly in developing countries that are rapidly declining and posing significant threats (T. et al. et al., 2022).

The primary aim of this study is to offer an updated comprehension of the structure of the research knowledge on natural resources published in the last 40 years. Specific objectives include identifying the main thematic areas and their evolution over time, as well as recognizing key authors, sources, and countries that have significantly contributed to the development of this field. Additionally, identifying unexplored themes that warrant further research is also a goal. This study provides a periodic assessment of the field's progression by conducting a comprehensive bibliometric analysis that examines a substantial number of recently published articles. Given the critical importance of this research area, scholars can review the topics covered and analyze the salient themes to apply the findings practically. The insights gained from this study can inform future research directions and support evidence-based decision-making in natural resource management and rural development policies.

2. Literature Review

Throughout history, people have learned about natural resources and developed classifications for them (Pretty, 2003; Tajima et al., 2022; Tripathi & Bhattacharya, 2004). According to the Encyclopedia Britannica, resources are natural products humans can use, and the environmental elements that produce them are collectively referred to as resources (Maja & Ayano, 2021). UNESCO defines natural resources as materials derived from the natural environment and utilized by humans. The United Nations Environment Program states that natural resources can create economic value and provide natural factors and conditions for human well-being and future prosperity. These resources include land, water, minerals, biology, climate, and oceans (Deng et al., 2022).

Natural resource management policies encompass a set of principles countries and regions employ to safeguard their environment and natural resources as they strive towards rural development goals (Lurie & Brekken, 2019). Given the proven unsustainability of development, there is a growing movement towards preserving natural resources. Regional communities aim to expand the devel-

opment process while protecting the environment and valuable natural resources. Researchers are exploring various policy models to achieve more effective outcomes that ensure a higher degree of implementation (Karelakis et al., 2013; Lurie & Brekken, 2019).

Various countries have established public welfare initiatives, such as India's Integrated Watershed Management and Mahatma Gandhi National Rural Employment Guarantee Act, as well as Ethiopia's Sustainable Land Management Program (Bierkamp et al., 2023; Li et al., 2023; Ostrom, 1990; Ribot & Peluso, 2003; Scoones, 1998; Sikor & Lund, 2009). Mahatma Gandhi National Rural Employment Guarantee Act stands as one of the world's most extensive public welfare programs, having been implemented in India since 2005 (K. et al. et al., 2021). This expansive program tackles water harvesting, pasture, and orchard development. It prioritizes four primary areas of impact: 1) Public works about natural resource management, 2) Individual assets aimed at enhancing household productivity, 3) The enhancement of communal infrastructure to improve livelihoods, and 4) Rural infrastructure development to alleviate hardship by providing access to basic facilities (Anantha et al., 2021; Maja & Ayano, 2021).

Mueller suggests that rural natural resource dependence is an example of the core-periphery relationship. Rural and resource-rich labor markets depend on the global capitalist economy and the local natural environment (Lurie & Brekken, 2019; Mueller, 2021). Palomares argues that lands that are rich in natural resources have little impact on rural development due to various factors such as the lack of competent actors, access to financial resources, transportation or basic infrastructure, lack of education, and initiative (Ellegaard & Wallin, 2015; Hardin, 1968; Kessler, 1963). To improve the welfare of rural households and reduce the exploitation of natural resources, there is a need to improve non-agricultural opportunities and invest in infrastructure and communications (Calvo Palomares et al., 2020; Meaza et al., 2017). Meaza adds that marginal grabens are rich in blue and green waters and have fertile plains for irrigated agriculture. However, they can reach a closed and closed basin state in dry and semi-arid environments, threatening smallholder farmers' livelihoods (Ellegaard & Wallin, 2015; Hardin, 1968; Kessler, 1963; Shackleton et al., 2001; Shisanya, 2018). Proper river basin governance, integrated land management, and rational water allocation are necessary for optimizing land and water resources in rural development of marginal grabens in northern Ethiopia and other parts of the world with similar geographic settings (Meaza et al., 2017).

3. Methodology

This study employs a bibliometric analysis approach to investigate the structure and trends in the natural resources literature. Bibliometric analysis is a quantitative method that uses statistical techniques to analyze bibliographic data, such as publications, citations, and keywords, to uncover patterns and trends in a research field (Pritchard, 1969; Ellegaard & Wallin, 2015). This method has been widely used to assess the state of research in various disciplines, including environmental science, sustainability, and natural resource management (e.g., Sharifi et al., 2021; Aznar-Sánchez et al., 2018; Gaviria-Marin et al., 2019).

Data for this study were collected from Scopus, a comprehensive database of peer-reviewed literature, including scientific journals, books, and conference proceedings. Scopus was chosen as the primary data source due to its extensive coverage of social science research and its user-friendly features for tracking citations and identifying potential collaborations (Mongeon & Paul-Hus, 2016). A broad search string was used to retrieve relevant articles to ensure a comprehensive analysis. The search query included the following terms: TITLE ("natural resources") AND TITLE-ABS-KEY(rural) OR TITLE-ABS-KEY(village) AND (LIMIT-TO (SUBJAREA, "SOCP")).

The search was limited to articles published in social science journals to maintain a focused scope. The initial search yielded 380 articles spanning the period from 1978 to 2023. To examine the evolution of the research field over time, the dataset was divided into two sub-periods: 1978-2000 and 2001-2023. Although a more granular division of the dataset into multiple sub-periods would have been desirable, the low number of articles published before 2000 necessitated using only two sub-periods. The bibliographic data of the retrieved articles, including titles, abstracts, keywords, authors, affiliations, and citations, were exported from Scopus in CSV format. The data were then processed and analyzed using VOSviewer, a software tool for constructing and visualizing bibliometric networks (Van Eck & Waltman, 2010). VOSviewer was employed to conduct co-occurrence term analysis, citation analysis, and bibliographic coupling analysis.

Co-occurrence term analysis was performed to identify the main thematic areas in the natural resources literature. This analysis examines the frequency and co-occurrence of keywords in the dataset, revealing the key topics and their relationships (Callon et al., 1983).

The term list file was adjusted to account for plurals and synonyms, such as “natural resource” and “natural resources,” to prevent double-counting and ensure accurate results. Citation analysis was conducted to identify the field’s most influential articles, authors, and sources. This analysis measures the impact of a publication based on the number of times it has been cited by other publications (Garfield, 1972). Bibliographic coupling analysis was used to identify clusters of articles with standard references, indicating their thematic similarity (Kessler, 1963).

The results of the analyses are presented using network diagrams generated by VOSviewer. In these diagrams, nodes represent terms, authors, or publications, and links represent their co-occurrence, citation, or bibliographic coupling relationships. The size of a node indicates its frequency or importance, while the width of a link signifies the strength of the connection between nodes. The clustering of nodes reveals various thematic areas or subfields within the natural resources literature. This study provides a comprehensive overview of the structure and trends in the natural resources literature over the past four decades by employing a combination of co-occurrence term analysis, citation analysis, and bibliographic coupling analysis. The insights gained from this bibliometric analysis can inform future research directions and support evidence-based decision-making in natural resource management and rural development policies (Sharifi et al., 2021).

4. Findings

Publication trends

The chart in Figure 1 depicts the distribution of 381 documents, including books and articles, over the study period from 1978 to 2023. The data reveals an upward

trend in article publication, with significant growth observed between 1978 and 2015. However, this trend has been declining in the past eight years. Notably, before 2000, only 60 articles were published, with the remaining 321 articles accounting for approximately 85 percent of the documents in the database. The highest cumulative frequency was recorded for 2014-2010, with 2012 having the highest number of articles at 22. One of the reasons for the decrease in the number of articles between 2023 and 2020 is that this period covered three years, while the previous periods covered five years. This chart highlights the importance of natural resources management across different periods, with their widespread use necessitating proper management since 2000.

The following table categorizes articles published between 1978 and 2000. The keywords used in these articles are grouped into six clusters. It is evident that during this time frame, topics related to sustainability, poverty, and rural areas were explored in conjunction with keywords such as natural resources, resource management, and community-based management. This highlights the emphasis placed on the sustainable use of natural resources and their connection to rural areas while acknowledging the possibility of reducing poverty through utilizing these resources.

In the next step, we classified the articles after 2000 to the present (2023). The table below shows the clusters of keywords. In this section, we are faced with 4 clusters with the keywords natural resources, natural resource management, and sustainability in common with the years before 2000. What is noteworthy is the discussion related to livelihoods, which has allocated many articles to itself. Considering that the lives of many rural residents are directly dependent on natural resources, the degradation of these resources endangers their livelihoods.

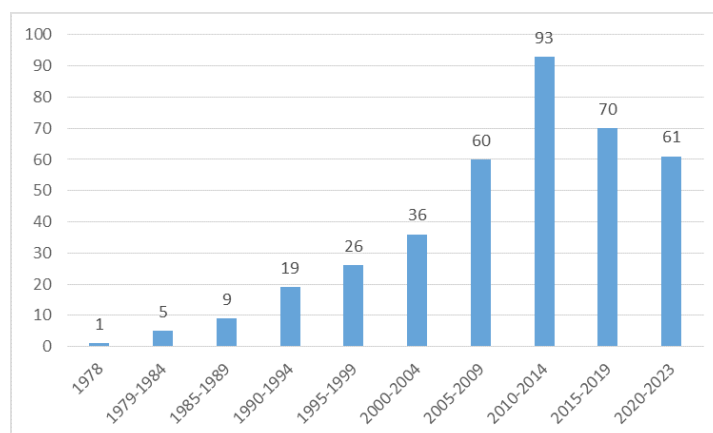


Figure 1. Distribution of articles over the study period 1978-2023

Table 1. Terminological co-occurrence analysis 1978-2000

label	cluster	item	weight<Links>
natural resources	1	13	55
natural resource management	5	11	54
rural areas	4	11	49
community-based natural resource management	6	9	45
sustainability	3	7	37
poverty	2	5	31



Table 2. Co-occurrence term analysis 2000-2023

label	cluster	item	weight<Links>
natural resources	1	13	47
natural resource management	4	9	46
sustainability	2	13	35
livelihood	3	13	29



The image below shows the time spectrum of keyword usage. According to the image, the purple and blue ranges belong to the years before 2000, which include words such as developing countries, environmental degradation, the role of government, rural sociology, etc. The middle range, i.e., the years 2015-2000, shows various topics. What is noteworthy are the topics that have gained more frequency after 2020. These keywords are ecosystem services and climate change.

Thematic clusters

Five main clusters can be identified from this figure: The concept of natural resource conservation is depicted

ed in yellow (11 items). 2- Natural resource management, shown in red (16 items). 3- In purple (4 items) is community-based natural resource management. 4- The concept of sustainability in green (15 items), and 5- The concept of rural economy, marked in blue (13 items). The thickness of the link between the nodes indicates the connection's strength, while the node's size is directly proportional to the frequency of the term. Therefore, as clearly shown in the diagram, the most dominant clusters are natural resources and natural resource management. The other three clusters have attracted relatively less attention.

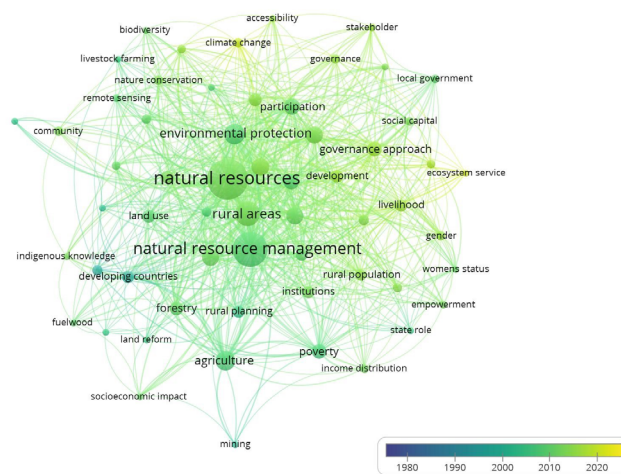


Figure 2. Time spectrum of keyword usage



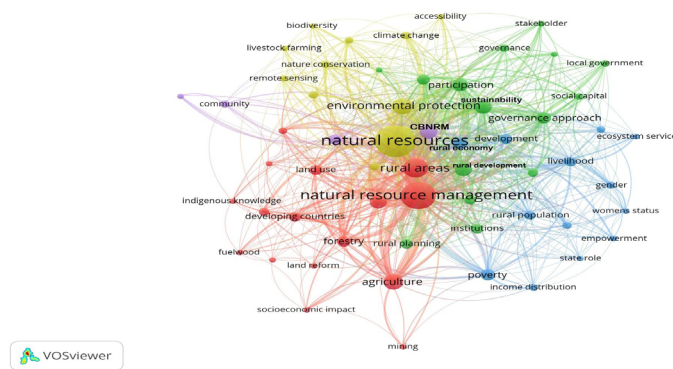


Figure 3. Output of co-occurrence term analysis for the whole period (2023-1978)

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Natural resource conservation thematic cluster

The first thematic cluster identified through co-occurrence analysis focuses on natural resource conservation. This cluster highlights the significant attention given to nature conservation as countries strive to balance preserving their environment and valuable resources with promoting sustainable change. The research within this cluster encompasses a range of topics, including climate change, biodiversity, and access to natural resources. Climate change emerges as a central issue within this cluster, emphasizing its far-reaching impact on economies and lives across the globe. The literature underscores the urgent need for action to mitigate the effects of climate change and adapt to its consequences. Studies have examined the global community's response to this pressing issue, such as the adoption of the Paris Agreement in 2016 and the commitment to reducing emissions from deforestation and forest degradation through the United Nations Convention on Climate Change (UNFCCC) in 2007 (Bayrak & Marafa, 2017). These international agreements reflect the recognition of the high costs associated with inaction on climate change, both in the present and for future generations.

Biodiversity conservation is another key focus within this cluster. Research has explored the importance of maintaining biodiversity for the resilience and functioning of ecosystems and the social and economic benefits derived from biodiversity (Cardinale et al., 2012). Studies have investigated various strategies for biodiversity conservation, such as protected areas, ecosystem-based management, and community-based conservation (Roe et al., 2015). The literature also addresses the challenges associated with biodiversity conservation, including habitat loss, overexploitation, and the impacts of climate change (Maxwell et al., 2016). Access to natural resources is a critical issue that has received attention within this cluster. Studies have examined the equity and sustain-

ability dimensions of resource access, highlighting the importance of ensuring that local communities can benefit from the resources they depend on (Ribot & Peluso, 2003). Research has explored the role of governance systems, property rights, and power relations in shaping access to natural resources (Sikor & Lund, 2009). Case studies have documented the experiences of communities in managing and conserving natural resources, highlighting the importance of local knowledge, institutions, and collective action (Ostrom, 1990).

The application of geospatial technologies, such as Geographic Information Systems (GIS) and remote sensing, has emerged as a valuable tool for natural resource conservation within this cluster. These technologies enable the storage, analysis, and visualization of large amounts of diverse data, facilitating the monitoring and assessment of natural resources (Ramaano, 2023). Studies have demonstrated the utility of GIS and remote sensing for predicting changes in natural resources and their status, providing crucial information for urban and rural planning (Rao et al., 2007). Integrating geospatial technologies with participatory approaches has also been explored, highlighting the potential for enhancing community engagement in natural resource management (Tripathi & Bhattarya, 2004).

Overall, the natural resource conservation thematic cluster reflects the growing recognition of preserving the environment and natural resources for sustainable development. The research within this cluster emphasizes the interconnectedness of climate change, biodiversity, and access to resources, underlining the need for holistic and integrated approaches to conservation. The application of geospatial technologies emerges as a promising tool for supporting conservation efforts, providing valuable insights for decision-making and planning. As the world continues to grapple with the challenges of environmental degradation and climate change, the findings from

this cluster can inform policies and practices aimed at promoting sustainable natural resource management and conservation.

Natural resource management thematic cluster

The second thematic cluster, depicted in red, revolves around natural resource management and its significance in the global context. This cluster reveals researchers' motivations for studying natural resource management practices worldwide. A prominent finding within this cluster is the strong relationship between natural resource management and rural areas. This connection can be attributed to the fact that villages are often located near natural resources such as forests, mountain slopes, and other landscapes. Consequently, the primary users of these natural resources are predominantly rural populations. Given that a significant portion of a country's land is typically rural, the protection and development of these areas are considered a priority and a key policy focus. Agriculture is a central theme within the natural resource management cluster, closely linked to sustainable development, forestry in developing countries, environmental degradation, and land use. Numerous studies in this cluster investigate the impact of agricultural practices on natural resource management. Researchers have found that improving agricultural efficiency can deter families from extracting natural resources (Nguyen et al., 2022). By enhancing agricultural productivity, households can reduce their reliance on forest products and instead opt for market goods. This shift in consumption patterns can alleviate pressure on natural resources and contribute to their conservation.

However, the relationship between agriculture and natural resource management is not always straightforward. Some researchers argue that increasing income and returns from agricultural activities can motivate farmers to convert forested areas into farmland (Angelsen & Kaimowitz, 2001). This land-use change can lead to deforestation and environmental degradation, undermining efforts to conserve natural resources. Furthermore, rural households may experience increased wealth as agricultural productivity rises, enabling them to access modern technologies that accelerate resource extraction activities (Bierkamp et al., 2023). This paradoxical outcome highlights the complex dynamics between agricultural development and natural resource management.

The literature within this cluster also explores the role of institutions, governance, and policy in shaping natural resource management practices. Studies emphasize the importance of effective governance structures and poli-

cies that promote sustainable resource use and conservation (Ostrom, 1990). Researchers have examined various approaches to natural resource management, such as community-based management, co-management, and market-based instruments (Agrawal, 2001). These approaches seek to engage local communities, stakeholders, and market forces in the sustainable management of natural resources, recognizing the importance of local knowledge, incentives, and participation. Case studies from different regions provide insights into the challenges and opportunities associated with natural resource management in rural contexts. For example, Southeast Asian research highlights the impact of agricultural intensification and land-use change on forest resources (Ziegler et al., 2009). Studies from sub-Saharan Africa demonstrate the potential of community-based natural resource management in promoting sustainable livelihoods and conservation outcomes (Roe et al., 2009). Research from Latin America explores the role of indigenous knowledge and practices in natural resource management (Berkes, 2012). These diverse case studies underscore the need for context-specific approaches that consider natural resource management's social, economic, and cultural dimensions.

The natural resource management thematic cluster also addresses the broader implications of resource management for sustainable development. Researchers recognize that effective natural resource management is crucial for achieving sustainable development goals, such as poverty alleviation, food security, and environmental sustainability (Sayer & Campbell, 2004). Studies highlight the potential synergies and trade-offs between natural resource management and other development objectives, emphasizing the need for integrated and holistic approaches (Sunderlin et al., 2005).

The natural resource management thematic cluster reveals the complex interplay between natural resources, rural livelihoods, agriculture, institutions, and sustainable development. The research within this cluster underscores the importance of understanding the motivations, challenges, and opportunities associated with natural resource management in rural contexts. Studies in this cluster contribute to the development of sustainable management practices and policies by examining the links between agriculture, land use, and resource conservation. The insights gained from this research can inform decision-making processes and support the design of effective interventions that promote the well-being of rural communities while safeguarding the natural resources they depend on. (Bierkamp et al., 2023; Nguyen et al., 2022).

Community-based Natural Resource Management Thematic Cluster

The community-based natural resource management (CBNRM) thematic cluster, highlighted in purple, may appear small with only four items, but it represents a crucial aspect of natural resources research. The cluster includes critical concepts such as “Community-based natural resource management,” “Community,” “Environmental management,” and “Rural sociology,” which collectively underscore the importance of community involvement and empowerment in the conservation and management of natural resources.

CBNRM has emerged as a promising approach to address conflicts between communities and nature conservation efforts. Over the past four decades, CBNRM has gained traction as a strategy to mitigate these conflicts and promote sustainable resource management, particularly in response to various environmental multilateral treaties (Li et al., 2023; Shisanya, 2017). The CBNRM framework has undergone significant development and revision, adapting to communities’ and conservation initiatives’ evolving needs and challenges. The relevance of CBNRM is particularly evident in developing countries, where it has the potential to provide sustainable livelihoods to indigenous rural communities living in or near protected areas. By actively empowering these communities to manage their local natural resources, CBNRM aims to strike a balance between conservation goals and the socio-economic well-being of local populations.

One notable program that embodies the principles of CBNRM is the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) in India. Implemented in 2005, MGNREGA is one of the world’s most extensive public welfare programs, focusing on water harvesting, pasture, orchard development, and other activities related to natural resource management (Anantha et al., 2021). The program’s four main categories of effects include:

- Public works related to natural resource management
- Individual assets aimed at improving the productivity of individual households
- Development of shared infrastructure to enhance livelihoods
- Development of rural infrastructure to facilitate access to basic facilities and reduce hardship

By creating at least 100 days of work for households with adult members willing to perform unskilled manual labor, MGNREGA aims to increase rural people’s livelihoods while simultaneously promoting sustainable resource management practices.

The CBNRM cluster is closely linked to the sustainability cluster, identified in green. Co-occurrence analysis reveals that sustainability is strongly associated with participation and rural development. The study highlights the crucial role of social factors, particularly public participation, in shaping natural resource policy actions and influencing policy implementation. Participatory decision-making in rural policy is emphasized as a critical driver of effective, impartial, and widely supported policies.

The research findings underscore the importance of decentralized policy-making and implementation for successful rural development. Close communication and participation in integrated resource management are essential for successfully implementing long-term policies and programs. This highlights the need for inclusive and collaborative approaches that engage local communities in the decision-making processes related to natural resource management. Social capital and rural planning are important factors linked to sustainable resource management within the sustainability cluster. The effective use of local natural resources, in close connection with human and social capital, is recognized as a means to improve the welfare of rural populations. The role of institutions and government in the decision-making process leading to policy formation is also highlighted (Karelakis et al., 2013), emphasizing the need for solid governance frameworks that support sustainable resource management.

The CBNRM thematic cluster, although small in terms of the number of items, represents a vital area of research within the natural resources domain. It underscores the importance of community empowerment, participatory approaches, and the integration of conservation goals with the socio-economic needs of local populations. The close links between CBNRM and sustainability highlight the interdependence of social, economic, and environmental factors in achieving sustainable resource management.

As the world continues to face pressing challenges related to natural resource conservation and rural development, the insights from the CBNRM cluster offer valuable guidance for policymakers, practitioners, and researchers. By fostering community participation,

strengthening local institutions, and promoting inclusive decision-making processes, CBNRM approaches can contribute to more effective and equitable natural resource management, ultimately leading to improved livelihoods and conservation outcomes.

Further research within the CBNRM cluster could explore the specific mechanisms and best practices for community engagement, the role of traditional knowledge in resource management, and the long-term impacts of CBNRM initiatives on biodiversity conservation and rural development. Additionally, comparative studies across different regions and contexts could provide valuable insights into the factors that influence the success or failure of CBNRM approaches, informing the design and implementation of future programs.

The community-based natural resource management thematic cluster, although small in size, represents a crucial area of research within the domain of natural resources. It highlights the importance of community empowerment, participatory approaches, and the integration of conservation goals with the socio-economic needs of local populations. The close links between CBNRM and sustainability underscore the interdependence of social, economic, and environmental factors in achieving sustainable resource management. As the world continues to grapple with the challenges of natural resource conservation and rural development, the insights from the CBNRM cluster offer valuable guidance for policymakers, practitioners, and researchers, emphasizing the need for inclusive, collaborative, and adaptive approaches to natural resource management.

Rural economic cluster

The blue cluster in the graph represents the rural economy, primarily focusing on poverty, rural population, and livelihood. This cluster highlights the critical role of natural resources in supporting the livelihoods of rural households, particularly in developing countries where vulnerable populations living in poverty rely on these resources for their survival and daily needs. The significance of natural resources in rural livelihoods cannot be overstated. In many developing countries, rural communities depend on natural resources such as forests, water bodies, and agricultural land for subsistence and income generation. These resources provide essential goods and services, including food, fuel, fodder, and medicinal plants, which form the backbone of rural economies (Tajima et al., 2022).

However, the relationship between natural resources and rural livelihoods is complex and multifaceted. While natural resources can provide a safety net for rural households, their overexploitation and degradation can also lead to increased vulnerability and poverty. Therefore, sustainable management of natural resources is crucial for ensuring the long-term well-being of rural communities and the environment.

The role of government in policy and decision-making processes related to natural resource management and rural development is another crucial aspect highlighted in this cluster. Effective policies and governance structures are essential for promoting sustainable resource use, protecting the rights of local communities, and fostering inclusive economic growth (Karelakis et al., 2013). Researchers emphasize the importance of participatory approaches that engage local stakeholders in decision-making processes, ensuring that the needs and priorities of rural communities are adequately addressed. Sustainable development emerges as a central theme within the rural economic cluster. Researchers underscore the importance of pursuing economic growth and development that does not compromise the environment's integrity or deplete valuable natural resources (Karelakis et al., 2013). This requires a balanced approach that considers sustainability's social, economic, and environmental dimensions.

The cluster also highlights the diverse forms of natural resource development that can contribute to rural economies. Both extractive activities, such as oil, gas, minerals, and mining, and non-extractive activities, including agriculture, tourism, real estate, and outdoor recreation, can generate income and employment opportunities in rural areas (Mueller, 2021). However, the relative importance of these activities may vary across different contexts and over time.

For example, natural resource extractive development has declined in the United States since the 1920s, with labor markets shifting towards amenity-based economies. This trend is characterized by the growth of second-home and bedroom communities and rural tourism, which capitalizes on the natural beauty and recreational opportunities of rural landscapes (Mueller, 2021). This shift reflects society's changing preferences and values, as well as the economic and technological transformations that have reshaped rural economies. Income inequality is another important theme within the rural economic cluster. Studies have shown that environmental income derived from natural resources can be crucial in mitigating income disparities, particularly among ethnic

minority households (Bierkamp et al., 2023). Access to and control over natural resources can provide a valuable source of income and subsistence for marginalized communities, helping to reduce poverty and promote social equity.

The concept of women's roles and experiences in rural economies is also explored within this cluster. Studies suggest that rural women often face exploitation on their lands due to the pressure of household reproduction, unpaid and unaccountable work, new work conditions, and fertility demands (Çelik, 2023). This exploitation is often rooted in patriarchal structures and the undervaluation of women's labor in both the productive and reproductive spheres. Researchers argue that capitalism has benefited from the patriarchal ideology of the homemaker, which has allowed for the appropriation and exploitation of women's invisible work (Çelik, 2023). This highlights the need for gender-sensitive approaches to natural resource management and rural development that recognize and value the contributions of women while also addressing the structural inequalities that perpetuate their marginalization. In conclusion, the rural economic cluster emphasizes the critical importance of natural resources in sustaining rural livelihoods, particularly in developing countries. It underscores the need for sustainable management practices that balance economic growth with environmental conservation and social equity. Government policies, participatory decision-making, and gender-sensitive approaches are highlighted as critical factors in promoting inclusive and sustainable rural development.

Participating countries

The analysis of participating countries in the natural resources literature reveals interesting collaboration and global leadership patterns. Figure 4 provides a visual representation of the collaborative networks among countries, highlighting the central role played by the United States in this research domain. The United States emerges as a critical player, collaborating with countries across all clusters, with the notable exceptions of Germany and India. This finding underscores the United States' significant influence and engagement in natural resources research on a global scale. The country's extensive collaborative efforts demonstrate its commitment to advancing knowledge and understanding in this field and its ability to forge partnerships with a wide range of nations.

However, it is intriguing that despite being part of the same cluster, the United States has not engaged in col-

laborative research with Zimbabwe and Peru. This lack of direct cooperation suggests potential gaps or untapped opportunities for knowledge exchange and joint research initiatives between these countries.

Peru, in particular, appears to have limited international collaborations, with its only connection being with the United Kingdom. This finding indicates that Peru may benefit from expanding its research partnerships and engaging with a broader range of countries to enhance its contributions to the natural resources literature. The United Kingdom, while connected to Peru, also exhibits limited cooperation with several other nations, including Canada, Brazil, Spain, and Sweden. This observation suggests that the United Kingdom's global research cooperation in the natural resources domain is relatively restricted compared to other leading countries. There may be scope for the United Kingdom to strengthen its collaborative ties with a more diverse set of partners to leverage international expertise and resources fully.

In contrast to the United States and the United Kingdom, Germany has established notable partnerships with East Asian countries such as Thailand, Vietnam, India, and South Africa. These collaborations highlight Germany's strategic engagement with the Asia-Pacific region and its efforts to foster research cooperation with emerging economies. Shared interests, complementary expertise, and the potential for mutual benefits in natural resources research may drive Germany's partnerships with these countries. The analysis also reveals that the United States is at the forefront of global leadership in natural resources research, mainly through its intense collaboration with Botswana. This partnership underscores the United States' commitment to engaging with African nations and supporting research initiatives that address natural resource challenges in the region. The United States' leadership role in this context may be attributed to its scientific capabilities, financial resources, and diplomatic influence.

On the other hand, Germany's position on the periphery of the collaborative network suggests that while it has established essential partnerships, its overall global engagement in natural resources research may be more targeted or specialized than the United States. Germany's collaborations with East Asian countries and South Africa indicate its strategic focus on specific regions and research areas. The patterns of collaboration and global leadership identified in this analysis have implications for disseminating knowledge, exchanging expertise, and developing research capacity in the natural resources field. Countries with extensive collaborative networks,

such as the United States, are well-positioned to drive research agendas, shape policy discussions, and contribute to the global knowledge base. However, the analysis also highlights the need for increased international cooperation and the inclusion of a broader range of countries to address complex natural resource challenges that transcend national borders.

Future research could explore the factors that facilitate or hinder international collaboration in natural resources research, such as funding mechanisms, institutional arrangements, and cultural differences. Additionally, investigating the impact of these collaborative networks on research outcomes, policy development, and on-the-ground conservation efforts would provide valuable insights into the effectiveness of international cooperation in this field. The analysis of participating countries in the natural resources literature reveals the central role of the United States in global research collaboration, the targeted partnerships of Germany with East Asian countries, and the potential for increased cooperation among other nations. These findings emphasize the importance of international collaboration in addressing shared natural resource challenges and highlight opportunities for strengthening global research networks to advance sustainable resource management practices worldwide.

Author Collaboration Networks

Analyzing author collaboration networks provides valuable insights into the intellectual structure and critical contributors to natural resources research. Figure 5 presents a visual representation of seven distinct author groups, each depicted in a different color, that have referenced one another's work. This network analysis reveals the patterns of scholarly communication and the influential authors shaping the discourse in this domain. At the heart of the network lies Elinor Ostrom, whose prominent position and larger node size underscore her significant contributions to developing natural resource-

es research. Ostrom's seminal work on the governance of common-pool resources has laid the foundation for much of the subsequent scholarship in this field (Ostrom, 1990). Her research has emphasized the importance of institutions, collective action, and community-based management in ensuring the sustainable use of natural resources (Ostrom, 2009). Ostrom's central location in the network suggests that her ideas have been widely referenced and built upon by other scholars, cementing her influence in shaping the intellectual landscape of natural resources research.

The red cluster emerges as the most prominent group, featuring renowned authors such as Agrawal, Berkes, and Ostrom. This cluster's strong connections to the green, yellow, and some of the purple clusters indicate the extensive scholarly dialogue and knowledge exchange among these groups. Agrawal's research has focused on the role of institutions and community-based conservation in natural resource management (Agrawal, 2001; Agrawal & Ostrom, 2001). Berkes has made significant contributions to understanding traditional ecological knowledge and its integration into natural resource management practices (Berkes, 2012). The close collaboration among these authors highlights their shared research interests and the complementary nature of their work. The green cluster, which includes authors such as Scoones, Shackleton, and Hardin, exhibits connections with some of the authors in the red and yellow clusters. Scoones' research has explored the links between livelihoods, institutions, and natural resource governance (Scoones, 1998). Shackleton's work has focused on the role of non-timber forest products in rural livelihoods and the implications for natural resource management (Shackleton et al., 2001). Hardin's influential article on the tragedy of the commons has sparked debates on the governance of shared resources (Hardin, 1968). The connections between the green cluster and other groups suggest the cross-pollination of ideas and the building upon each other's research.

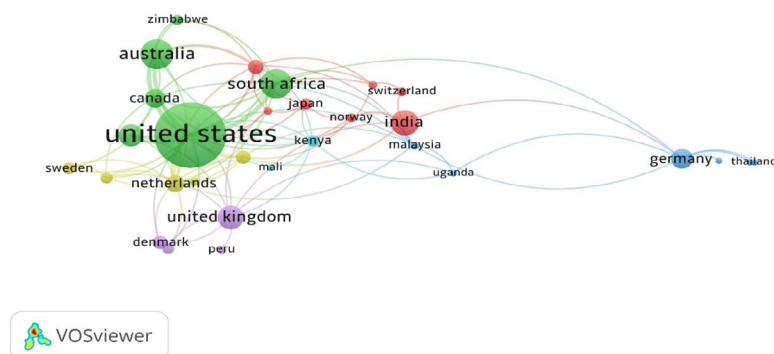


Figure 4. Output of participating countries

The yellow cluster, connected to red and green clusters, features notable authors such as Chambers, Mbatia, Pretty, and Blaiki. Chambers' work has advocated for participatory approaches and the inclusion of local knowledge in natural resource management (Chambers, 1994). Pretty has emphasized the importance of sustainable agriculture and the role of social capital in natural resource conservation (Pretty, 2003). Blaiki's research has explored the political ecology of resource use and the power dynamics involved in natural resource governance (Blaiki & Brookfield, 1987). The interconnectedness of the yellow cluster with other groups highlights the interdisciplinary nature of natural resources research and the integration of perspectives from various fields.

Notably, every cluster, except for the turquoise and orange ones, is connected to the red cluster. This observation underscores the central role played by the authors in the red cluster, particularly Ostrom, in shaping the intellectual discourse and serving as a bridge between different research communities. The lack of connections between the orange cluster and other groups suggests the presence of a more specialized or isolated research community within the natural resources domain. The analysis of author collaboration networks provides a glimpse into the social and intellectual structures that underlie the advancement of natural resources research. By identifying the key authors and their collaboration patterns, this analysis helps to understand the flow of knowledge, the formation of research communities, and the influential ideas that have shaped the field. Future research could delve deeper into the specific themes and topics addressed by each author cluster and the evolution of these collaboration networks over time. Moreover, the consistency between the author's and the country's collaboration networks suggests a strong link between scholarly communities and their respective national contexts. This finding highlights the importance of international collaboration and the role of leading countries in driving research agendas and facilitating knowledge exchange. Further investigation into the factors that enable or hinder cross-country collaboration, such as funding mecha-

nisms, institutional support, and cultural factors, could provide valuable insights for strengthening global research partnerships in the natural resources domain.

The analysis of author collaboration networks in the natural resources literature reveals the central role of Elinor Ostrom and the influential contributions of authors such as Agrawal, Berkes, Scoones, and Chambers. The interconnectedness of research clusters highlights the interdisciplinary nature of the field and the importance of scholarly dialogue in advancing knowledge. These findings provide a foundation for understanding the intellectual structure of natural resources research and offer avenues for future exploration of this critical domain's social and collaborative dimensions.

Bibliographic Coupling of Countries in Natural Resources Research

Figure 6 presents a bibliographic coupling analysis of countries based on their shared references in the natural resources literature. This analysis provides insights into different nations' intellectual proximity and research focus, revealing patterns of similarity and collaboration in the field.

The United States emerges as the most prominent country in this analysis, with the largest circle indicating its extensive use of standard references compared to other nations. This finding underscores the United States' significant influence and centrality in natural resources research, as it serves as a critical reference point for scholars worldwide. The United States' bibliographic solid coupling with South Africa, represented in the green cluster, highlights the intellectual linkages and potential for collaboration between these nations. Following the United States, Canada, the Netherlands, and Botswana exhibit strong bibliographic coupling, suggesting their shared research interests and intellectual foundations. The connection of this cluster with most other countries, except for Mali and Peru, indicates the broad relevance and applicability of the research emanating from these nations.

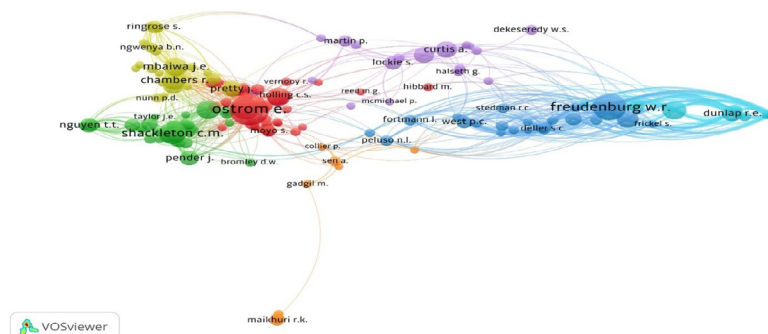


Figure 5. References of authors to each other

South Africa emerges as the most prominent country within the green cluster, showcasing its significant contributions to the natural resources literature. However, despite their presence in the same cluster, South Africa lacks direct bibliographic coupling with Japan and Indonesia. This observation suggests potential gaps in research collaboration or differences in research focus between these countries. Australia, ranking second in the green cluster, demonstrates extensive bibliographic coupling with other nations, highlighting its active engagement and intellectual connections within the research community.

The purple cluster features the United Kingdom, Denmark, China, and Peru as the most prominent countries. The bibliographic coupling of this cluster with most other nations, except for those on the periphery, indicates the wide-ranging impact and relevance of the research originating from these countries. This finding suggests that the knowledge generated by scholars in the purple cluster has been widely referenced and built upon by researchers across the globe. India is the most prominent country in the yellow cluster, exhibiting equal bibliographic coupling with other nations except those on the periphery. This observation highlights India's balanced and comprehensive engagement with the natural resources literature, drawing upon diverse intellectual influences. The presence of Switzerland, Ethiopia, Norway, and Finland in the yellow cluster suggests shared research interests and the potential for collaboration among these countries.

The blue cluster is characterized by the solid bibliographic coupling of Ghana, Vietnam, Malaysia, and Thailand with German articles. This finding indicates that researchers from these countries have extensively referenced and built upon the work of German scholars in the natural resources field. However, the marginalization of Germany itself suggests that while German research has been influential, it has not been as widely cited by articles from other clusters. This observation may reflect differences in research focus or the need for greater integration of German research into the broader international discourse. The marginalization of France and its limited bibliographic coupling (only with the United States and Botswana) is a noteworthy finding. This observation suggests that French research in natural resources may be more specialized or focused on specific topics, leading to fewer intellectual linkages with other countries. Further investigation into the reasons behind France's peripheral position could provide insights into natural resources research's unique characteristics or challenges in the French context.

It is important to note that the absence of direct collaboration among the authors, as mentioned in the analysis, could be attributed to the breadth and diversity of the natural resources field. The wide range of topics and disciplinary perspectives in this domain may lead to researchers working independently or in specialized sub-groups rather than engaging in extensive co-authorship networks. The bibliographic coupling analysis of countries in natural resources research provides a valuable perspective on the intellectual landscape of the field, highlighting the prominent nations, their shared intellectual foundations, and the potential for collaboration. This analysis complements the findings from other sections, such as the author's collaboration networks, to offer a comprehensive understanding of the social and intellectual structures shaping natural resources research.

Future research could delve deeper into the specific themes and topics that characterize the bibliographic coupling of different countries and the factors that facilitate or hinder international collaboration in this field. Additionally, exploring the evolution of these bibliographic coupling networks over time could shed light on the dynamic nature of research interests and the emergence of new intellectual connections among countries. The bibliographic coupling analysis of countries in natural resources research reveals the central role of the United States, the intellectual solid linkages within clusters, and the potential for increased collaboration among nations. These findings provide a foundation for understanding the global landscape of natural resources research and offer avenues for further investigation into this critical domain's social, intellectual, and collaborative dimensions.

5. Discussion

The field of natural resources has witnessed a remarkable evolution and growth in recent decades, attracting significant attention from researchers worldwide. Advancements in technology and communication have facilitated more accessible access to information and the ability to publish articles, resulting in a substantial increase in scientific literature related to natural resources. Specialized websites, scientific databases, and journals have further contributed to the proliferation of research in this field, making it easier and faster for scholars to disseminate their findings. This study aimed to comprehensively understand knowledge structure and trends in the natural resources literature by employing bibliometric analysis through VOSviewer. The analysis allowed for examining the field's performance and visualizing its knowledge domain. The findings reveal that while

the growth of natural resources research was relatively slow until the late 1990s, with only a limited number of publications since the late 1970s, the pace of article publishing has accelerated significantly since then. This increased attention towards natural resources can be attributed to various factors, including the global population growth since the 1960s, which has led to the overuse and unplanned exploitation of natural resources, as well as the escalation in food prices since the early 2000s, highlighting the need for sustainable resource management.

The study's co-occurrence analysis of terms for the entire study period (1978-2023) revealed five main thematic clusters within the natural resources literature: natural resources, natural resource management, community-based natural resource management, sustainability, and rural economy. These clusters encompass a wide range of topics, reflecting the multifaceted nature of natural resources research.

The natural resources cluster exhibited a balanced focus on topics such as protected areas, nature conservation, climate change, access, and biodiversity, with climate change emerging as a prominent and up-to-date subject of study. The natural resource management cluster primarily explored themes related to rural areas, agriculture, and sustainable development while delving into the relationships between natural resource management and land use, forests, developing countries, and environmental degradation. Community-based natural resource management (CBNRM) emerged as a distinct cluster, emphasizing the promotion of nature conservation through community empowerment. This cluster encompassed subsets such as environmental manage-

ment, society, and rural community, highlighting the importance of local participation in resource management. The sustainability cluster focused on critical topics such as participation, participatory approaches, governance, industry, and rural planning, underlining the need for inclusive and sustainable resource utilization.

Lastly, the rural economy cluster addressed poverty, development, livelihood, urbanization, and women's status, recognizing the intricate links between natural resources and socio-economic well-being. The emergence of ecosystem services as a relatively new topic within this cluster signifies the growing recognition of the benefits derived from healthy ecosystems. To further elucidate the evolution of natural resources research, the study period was divided into two sub-periods: 1978-2000 and 2001-2023. This temporal analysis provided valuable insights into the changing structure and trends of the field over time. Additionally, the study identified vital authors and countries that have significantly contributed to the development of natural resources research, offering readers, especially those new to the field, a better understanding of the intellectual landscape and guiding their future research endeavors.

While this study presents a comprehensive overview of the general structure of the natural resources literature, it also acknowledges the need for more specific analyses focusing on each of the five identified clusters. Such in-depth examinations could yield more accurate information on the evolution and nuances within these thematic areas.

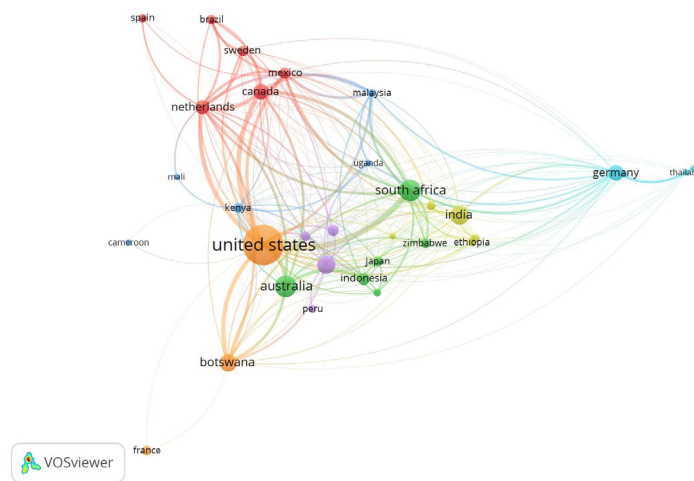


Figure 6. Authors' use of familiar sources

It is important to note that the bibliometric approach employed in this study is not without limitations. The existing software tools for bibliometric analysis are limited to processing data related to publications indexed in scientific databases such as Web of Science and Scopus. Consequently, potentially influential documents not indexed in these databases, such as gray literature, cannot be analyzed using these tools. Therefore, it is crucial to recognize that bibliometric analyses should be complemented by systematic reviews incorporating gray literature and peer-reviewed sources to provide a more comprehensive understanding of the field.

Moreover, the study highlights the need for more systematic reviews to obtain accurate information for addressing pressing social challenges, such as climate change, which has emerged as a critical topic within the natural resources literature. These reviews can help bridge the gap between research findings and practical applications, informing policy decisions and guiding sustainable resource management practices. This study provides a valuable contribution to understanding the structure and trends of the natural resources literature over the past four decades. By employing bibliometric analysis, the study has identified vital thematic clusters, influential authors, and countries that have shaped the field's development. The findings underscore the growing importance of sustainable resource management, community participation, and the integration of socioeconomic considerations in natural resources research.

As the world continues to grapple with the challenges posed by population growth, environmental degradation, and climate change, the insights gained from this study can inform future research directions and support evidence-based decision-making in natural resource management and policy formulation. By building upon the knowledge base established by this study and conducting more targeted analyses, researchers and practitioners can work towards developing sustainable solutions that balance the conservation of natural resources with the needs of communities and the broader society.

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Conflict of Interest

The authors declared no conflicts of interest.

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