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REVIEW

What are the Main Concerns for Global Mangrove Management Research? Systematic Literature Review and Bibliometric Analysis

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ABSTRACT

Mangroves are crucial ecosystems that provide significant ecological, economic, and social benefits, including coastal protection, carbon sequestration, and biodiversity support. However, their long-term survival is increasingly threatened by human activities, climate change, and ineffective governance. This study aims to identify major trends, thematic clusters, influential publications, and emerging issues in mangrove research. Through PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach, a total of 210 published between 1190 and 2025 peer-reviewed articles was retrieved from the Scopus database and analyzed using bibliometric methods to uncover research patterns and gaps. Visualization tools such as VOSViewer and the Biblioshiny R package were employed to map key concerns in mangrove management. The results indicate a steady increase in mangrove-related research, driven by the growing urgency of climate change and environmental degradation. Research is largely dominated by institutions and countries with extensive mangrove distributions. Eight primary research clusters were identified, including Coastal Zone Management, Environmental Policy, Degradation, Remote Sensing, Co-Management, and Community

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Participation. The findings underscore the urgent need for coordinated, multidisciplinary approaches to mangrove management that integrate ecological conservation with socio-economic dimensions. This study offers a comprehensive roadmap for future research, emphasizing areas such as socio-ecological resilience, innovative governance models, and the integration of local knowledge into policy-making.

Keywords: Mangrove Management; Mangrove Ecosystem; Global Research; Systematic Literature Review; Bibliometric Analysis

1. Introduction

Environmental damage in coastal areas is threatening the ecosystems with further effects on the socio-economic aspects [1,2]. This is possible due to the ability of climate and weather changes to trigger tides. The occurrence of storms, tsunamis, or tidal waves can lead to soil erosion and structural damage with subsequent impact on the balance of coastal ecosystems [3]. The minimization of these threats can be achieved through the adoption of mangroves as an effective alternative solution [4,5]. Mangroves are an important component of coastal ecosystem that offers several key ecosystem services such as carbon sequestration, coastal protection, and provision of habitat for different flora and fauna [6,7]. However, this unique ecosystem is threatened by some anthropogenic pressures, including deforestation, aquaculture expansion, and urban development [8].

Mangrove management is a subject of significant concern in the global discourse on environmental sustainability. This is due to the importance of the ecosystems in climate change mitigation in addition to the protection and economic sustainability of coastal communities [9,10]. Mangroves also play a critical role in maintaining the sustainability of coastal environment. However, certain challenges are associated with the management process because mangroves are terrestrial and marine plants that often cross regional or national boundaries and are valued differently by local stakeholders compared to national and international players [11,12]. The World Mangroves by the Food and Agriculture Organization (FAO) of the United Nations reported that the area of mangroves in the world reached 14.8 million hectares in 2020. A total of 677,000 hectares were lost between 2000 and 2020 but the rate decreased by approximately 23% in the second decade. Currently, the total mangrove forests in the world are estimated at 16,530,000 hectares, including 7,441,000 in Asia, 3,258,000 in Africa, and 5,831,000 in the Americas [13]. The spread is across 118 countries [14] but covers less than 1% of the global tropical forest area. Mangrove forests serve as protective green belts and provide an essential ecosystem for goods and services required by an estimated 2.4 billion people living in 100 km of coasts [15].

Coastal resilience is associated with the existence of adequate mangrove forests which are considered important ecosystems in tidal areas. This is because the loss of mangrove forests as vegetation and green belts can cause vulnerability and degrade the ability of nature to absorb blue carbon which worsens sedimentation conditions and climate change [16–18]. Mangrove forests also protect coast from erosion caused by rising sea levels and tsunamis. For example, the provision of 264.0 km of mangrove sea walls in Vietnam effectively provides security for Northern Delta region of the country identified as an abrasion-prone area [5]. The results of the research showed that mangrove forests were an effective solution to reduce greenhouse gas emissions and also acted as a biofilter for water pollution caused by heavy metal poisoning in coastal areas [19]. Moreover, mangrove forests contribute significantly to the welfare of coastal communities by providing goods and services [20]. Some of the benefits to be preserved include the provision of wood for charcoal, support for healthy fish and shrimp commodities, and improvement of biodiversity, such as the cultivation of herbal medicine and economically valuable fruits [21]. The trend shows that mangrove forests have indeed many functions and benefits for coastal areas.

Measurable actions are needed to support mangrove sustainability. As a basis for policymaking, it is important to analyze and formulate evidence-based insights on coastal protection sector to improve risk management and promote sustainable practices related to mangroves [22]. The United Nations Development Program (UNDP)

through Sustainable Development Goals (SDGs) designed global-scale sustainable development goals set at point 14. The focus of the point is to conserve marine biodiversity, ensure sustainable use of marine resources, and address marine environmental issues, as well as mangrove metrics such as tropical cyclone frequency and mangrove changes to represent the strong dependency between mangrove forests and SDGs [23]. The 2030 SDGs Agenda requires achievements in terms of mitigating the impacts of climate change and protecting biodiversity, which in the context of coastal management is implemented by mainstreaming mangrove forests and blue carbon ecosystems [24,25].

The efforts to address global climate change have motivated countries around the world to formulate several agreements in which mangrove forests are identified as part of the possible as solutions. Several international commitments have long recognized the importance of mangrove ecosystems in supporting biodiversity, coastal protection, and sustainable development. Through agreements such as the Ramsar Convention on Wetlands (1971) and the Convention on Biological Diversity (1992), the global community has demonstrated its commitment to conserving and restoring mangroves as vital components of both wetland and coastal ecosystem management [7,26]. Furthermore, the Global Mangrove Alliance (GMA) set an ambitious goal to expand global mangrove habitat by 20% by 2030 in order to restore lost mangrove habitat. This was designed to be coordinated through a partnership with the International Union for Conservation of Nature, the Nature Conservancy, the World Wildlife Fund, and Wetlands International [27].

In recent decades, countries in Southeast Asia as well as South America and Oceania have implemented several preventive policies to address environmental degradation in coastal areas based on SDGs. Marquez and Olavides [19] focused on mangrove restoration and rehabilitation in the Philippines. The research reported the usage of mangroves as ecosystem-based protection in the form of flood buffers to reduce the risk of disasters due to climate change. Another research showed that the Philippines contributed 50% of the 65 mangrove species worldwide [28]. Moreover, Indonesia is the country with the richest mangrove maritime in the world and has proposed the most ambitious and extensive rehabilitation target of 600,000 hectares to be fully achieved by 2024 as part of its commitment to global environmental conservation [29]. Mangrove management programs have also been established at the national and regional levels [30,31]. Another research showed that French Guiana in South America used mangroves as green belts to protect coast from erosion and promoted marine biodiversity patterns supported by silt sedimentation supplied by the Amazon River [32]. The efforts to maintain the viability and sustainability of mangrove forests in Panama and Brazil are achieved by increasing local awareness of the socio-ecological benefits and corporate support for the restoration process [26,33].

The review of mangrove research is not new considering the attempts made by previous scholars. For example, Simpson et al. [34] examined the influence of global change variables on organic matter decomposition in mangrove ecosystems. Bhowmik et al. [35] also analyzed the socio-ecological drivers of global mangrove deforestation. Lee et al. [36]focused on strengthening multi-stakeholder relationships in decision-making for mangrove management in order to break unsustainable practices. Arulnayagam et al. [37] historically reviewed a summary of key results from 70 research on the diversity, taxonomy, distribution, and ecological interactions of mangrove flora and fauna along coast of Sri Lanka. Pillodar et al. [38] also conducted Mangrove Resource Mapping in the Philippines, while Gerona-Daga and Salmo [39] reviewed mangrove restoration in Southeast Asia with a specific focus on challenges and opportunities. Another research by Hamza et al. [40] determined the global patterns of mangrove resource utilization, while Bimrah et al. [1] focused on mangrove ecosystem services. Furthermore, Bibliometric methods have also been applied as observed in the emphasis of Tasneem and Ahsan [41] on emerging trends and interests related to mangrove ecosystem services and Ho and Mukul [14] on mangrove forest performance and publication trends. While prior research has applied bibliometric analysis to mangrove ecosystems and others have examined mangrove restoration or ecosystem services through Systematic Literature Reviews (SLR), no study has explicitly combined SLR and bibliometric approaches to comprehensively map scientific progress, management priorities, and the trajectory of global mangrove research. Moreover, integrated assessments that compare publication trends, thematic clusters, topic evolution, and emerging research gaps in recent years

remain scarce.

This identifies the main focus of mangrove research globally by combining SLR and Bibliometric methods in order to provide relevant scientific contributions. Therefore, this study aims to (1) identify major research clusters in global mangrove studies; (2) map geographical publication patterns and thematic trends; (3) detect emerging issues and gaps in mangrove-related research; and (4) provide an integrated evidence base to support more effective and sustainable global mangrove management.

The novelty was a combination of SLR and Bibliometric analysis implemented to provide deeper insight into the direction of mangrove research in the future. Furthermore, conversations regarding worldwide mangrove management within the present review period are also lacking. This article will offer significant insights for scholars and practitioners engaged in mangrove management, utilising the Scopus database as a worldwide foundation. Practically, the results could be used by stakeholders in formulating more effective and sustainable mangrove management policies or strategies. This showed that the contribution extended beyond the scientific aspects to practical applications for the conservation and restoration of mangrove ecosystems globally.

2. Mangrove Management: A Global Challenge

Mangroves are coastal and riverside forests that grow in areas where land and sea meet in tropical and subtropical regions [42,43]. The existence has very important benefits for the ecosystem in the future, specifically because of the ability to absorb large amounts of carbon which is known as "blue carbon" [8,44]. The global presence is influenced by climate change and global warming [45]. However, deforestation and land conversion are serious threats to the sustainability of the mangrove ecosystem in the future [8,46]. The damage caused by climate change can also threaten human groups who depend on mangroves for livelihood. This shows the need for serious attention from all parties through active collaboration to implement effective mangrove management [47]. However, the implementation of effective mangrove management is not free from various complex and contextual challenges. These challenges differ between regions, but generally include pressure from land conversion, weak governance, and limited understanding and participation of stakeholders (**Table 1**).

Table 1. Global Mangrove Management Challenges.

Region	Main Issue	References
Afrika Timur (Kenya, Tanzania, Mozambique)	Increased tree felling for poles, charcoal, and firewood; reclamation for salt ponds, agriculture, and shrimp farming; inadequate enforcement of management measures against uncontrolled extractive exploitation.	Semesi; Zorini et al. [48,49]
Asia		
Bangladesh	Declining quality (growing stock) even though the forest area has not changed much; the need to balance conservation with the subsistence needs of local communities.	Iftekhar and Islam; Roy [50,51]
Brunei Darussalam, Hong Kong, Thailand	The need to assign a dollar value to the mangrove ecosystem highlights its economic importance. In Thailand, the sustainable management of the remaining 196,000 hectares of mangroves for various economic activities poses a challenge.	Maxwell; Chen et al. [52,53]
Tiongkok	Threats to upper and high tide habitat due to habitat changes; potential regional extinction of five mangrove species.	Zhang et al. [17]
Indonesia	High levels of mangrove destruction (severe and moderate); allocation and management of resources by multiple ministries; conversion into aquaculture ponds; restoration of damaged mangroves.	Damastuti et al. [54]; Soeprobowati et al. [12]; Feti [30]; Utami et al. [55]
Malaysia	Mangrove logging permitted under the National Forestry Law; the need to balance timber production with other ecosystem services;	Loh et al. [56]; Chen et al. [53]
Philippines	Encroachment and replacement of natural forests by locally planted mangrove plantations; cutting and clearing of plantation forests for fish farming and settlements.	Walters [57]
Latin America & Karibia		
Ecuador	A 16% decrease in mangrove area and a 27% increase in shrimp pond development between 1966 and 1982.	Terchunian et al. [58]
Eastern Tropical Pacific Region (Costa Rica, Panama, Colombia, Ecuador)	The continued decline in mangrove cover due to the expansion of human activities (agriculture, aquaculture, coastal development), even with laws in place that prohibit its logging.	López-Angarita et al.; Chamberland-Fontaine et al.; Walker et al. [59–61]

The implementation of mangrove management directly supports several United Nations SDGs, specifically Goal 2 on community welfare, especially in coastal areas; Goal 13 on climate action; Goal 14 on marine ecosystem protection; and Goal 15 on forest and biodiversity conservation. This is due to the ability of the process in strengthening climate resilience, integrating climate policies, protecting coastal ecosystems, and promoting sustainable forest management, including efforts to halt deforestation and restore degraded areas [5,9,62]. At the international level, several initiatives have been implemented for the conservation and sustainable use of mangrove ecosystems through different conventions, including CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), Convention on Biological Diversity (CBD), and the United Nations Framework Convention on Climate Change (UNFCCC). Mangrove protection is also supported by the Ramsar Convention, the Mangrove Charter by ISME, and the draft code of conduct for mangrove management by the World Bank and other partners [7]. However, policy fragmentation persists despite the existence of a strong international framework. This fragmentation arises because, mangrove management often involves different sectors, disciplines, and institutional structures, which can lead to overlapping and conflicting policies. For example, in Panama, despite several policies targeting wetlands and granting mangroves high conservation status, mangrove protection remains hampered by competing government agendas and disagreements over policy implementation [60]. In Senegal, differing views among local stakeholders regarding the effectiveness of mangrove management indicate the need for clear guidelines on the roles of government and other actors in decentralized resource management [11].The varying quality of national regulations affects the effectiveness of mangrove management policies. Countries with low-quality regulations tend to experience higher rates of mangrove loss even when protected areas exist. Countries with low regulatory quality tend to experience higher rates of mangrove loss even when protected areas exist [3].

Mangrove conservation and management depend on the policies of each country. This is based on the fact that the countries with the largest mangrove areas have complex challenges in protecting mangrove ecosystems. In addition to human activities, climate change is another serious threat to the sustainability of ecosystems in the future [42]. The challenges identified in several countries such as Papua New Guinea, Indonesia, and Vietnam are associated with the institutional, policy, and funding aspects [5,9,31,63]. Meanwhile, countries in the South Asian region such as Bangladesh, Sri Lanka, and India have legal and management issues. These lead to the need for changes in silvicultural systems, adoption of ecosystem management methods, revision of forestry laws, and regional cooperation to improve mangrove management. According to Golebie et al. [64], mangrove management methods applied in 39 countries were divided into three basic categories, including top down, bottom up, and comanaged. Alongside their benefits, these three methodologies exhibit shortcomings, encompassing institutional issues, resource limitations, and the intricacies of coordination among multiple actors. Some of the challenges identified in the Americas, such as Panama included the difficulties in the context of implementation and management plans and a lack of communication between stakeholders. The research conducted in Brazil [33] showed the need for a holistic method that focused on both the ecological aspects as well as the social and economic dynamics of communities depending on mangrove ecosystems.

The current global challenges to mangrove conservation efforts include several changes in land use, coastal tourism activities, and over-exploitation [65]. Moreover, the participation of local communities has been recognized as critical to the success of every mangrove management intervention, both past and present [66]. An important method considered effective in mangrove management is the application of a collaborative model including stakeholders from government elements, local communities, academics, the private sector, and non-governmental organizations. This model is considered important because the success of mangrove management extends beyond the ecological aspects to interrelated social, political, and economic dynamics [26,67]. The collaborative governance model is expected to be in the form of a Penta helix or quadruple helix for local, national, and international implementation.

3. Methods

A mixed-method was applied in this research by

combining SLR and Bibliometric analysis [68,69]. The purpose was to investigate key issues in global mangrove management research. The implementation of the method was to comprehensively evaluate current trends in mangrove research topics through Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) protocol [70]. This is because SLR is often used on a particular topic to rigorously synthesize previous topics in order to answer a research question [71–73]. Meanwhile, Bibliometric analysis is the assessment of quantitative and qualitative literature to analyze data in the form of characteristics, relationships, clusters, as well as the current and future trends in a particular area [74,75].

This research was conducted based on the three stages adopted from Xiao and Watson [76] and Batista et al. [73]. First, the process was initiated through planning which focused on determining the topic and unique origin as the main research question. At this stage, the search strategy was designed using certain keywords followed by the determination of the indexing to be used. Second, data analysis was conducted using the selected software. Third, research synthesis was applied quantitatively and qualitatively. These processes are comprehensively presented in the following **Figure 1**.

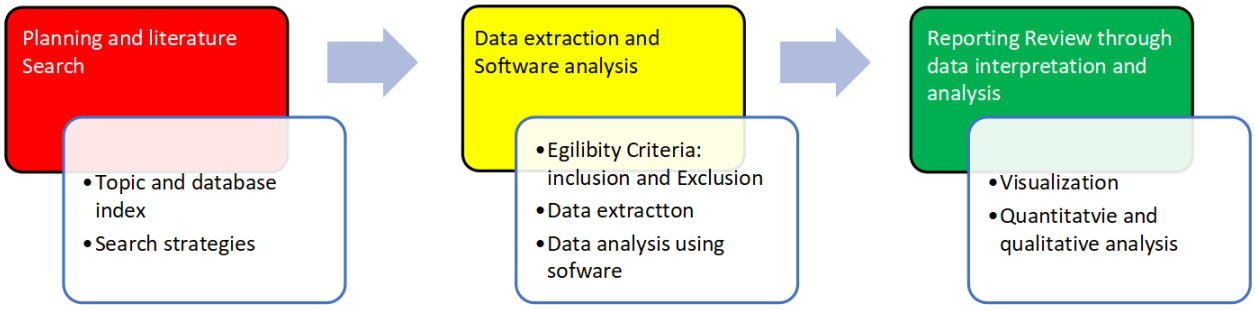

Figure 1. Stages of the Research.

The number of documents to be reviewed was determined by adopting PRISMA scheme described in **Figure 2**. Several criteria were applied to identify and retrieve relevant publications from a major academic database known as Scopus. A comprehensive search query was designed to capture the articles on mangrove management. The keywords used were "mangrove management" OR "mangrove governance" with a focus on the abstract and title in addition to the exclusion and inclusion criteria.

A total of 356 documents were initially identified from the database based on the eligibility criteria as presented in **Figure 2**. Articles related to social and environmental sciences as well as those published in the English language were included to ensure the focus was not limited to scientific publications while some published in 2025 were excluded. The year 2025 has been excluded since the data extraction from Scopus occurred in May, resulting in incomplete coverage of the month, which could introduce bias. This resulted in the recovery of 261 documents and the removal of 51 conference papers. However, several articles from 2025 were used in the discussion process due to their relevance and contribution to this research. Therefore, the total number of documents reviewed was 210 as presented in the comprehensive information in **Figure 2**. The articles were converted into CSV (Comma Separated Value) file for subsequent processing in the analysis software, including VOSViewer and Biblioshiny R. The two software were combined with aim of exploring their advantages and disadvantages. VOSviewer is highly advantageous for its powerful visualization capability. It is also relatively user-friendly and efficient in handling large datasets. However, its limitation lies in analytical flexibility, as it focuses mainly on visualization rather than advanced statistical or descriptive analyses. In contrast, Biblioshiny R—a web interface for the Bibliometrix R package—provides greater flexibility for statistical and descriptive bibliometric analysis, such as trend analysis and thematic evolution. Finally, the data processed were subsequently analyzed to answer the research questions.

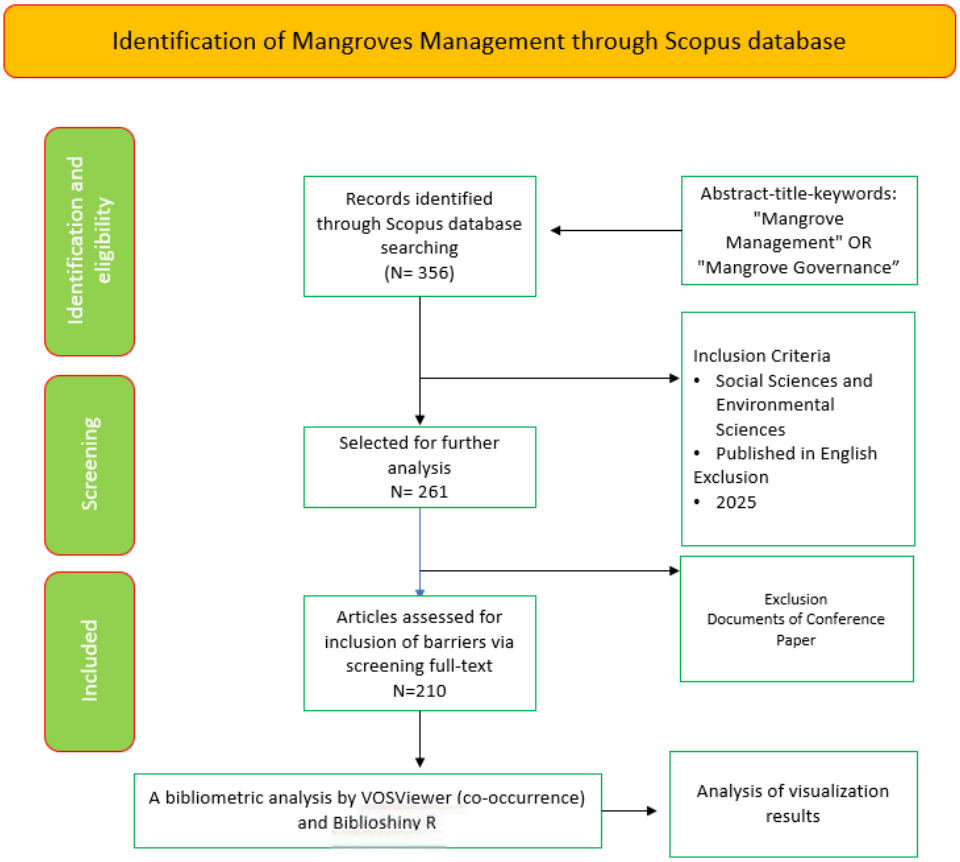

Figure 2. PRISMA Workflow.

Source: Author analysis.

4. Results and Discussion

4.1. Summary Information on Publication by Year

Since its inception in 1983, research on mangrove management has grown to involve authors from various research institutions around the world. **Figure 3** shows that the annual growth rate of publications is 7.23%. Mangrove management research also involves international co-authors, accounting for 35.71% of the total documents, meaning that a percentage of documents are written by authors from more than one country. This indicates a moderate level of global research networking in this field. Moreover, over more than four decades, the average number of documents per year reached 7.7, and the highest number of publications was recorded in 2024, see **Figure 4.** This trend showed that there was increasing academic attention and policy relevance on the topic.

The research on mangrove management has increased gradually over the past 3 decades, specifically since the early 2000s, as observed in **Figure 4**. The output was observed to be relatively limited in the early 1990s but experienced an increase which became more significant after 2010. This surge was possibly due to the increasing global awareness of climate change, biodiversity loss, and the inclusion of mangroves in international policy frameworks such as SDGs, the Paris Agreement, and the Ramsar Convention [23–25]. Several international agreements have also promoted mangrove management in different countries due to the benefits and positive impacts on the environment and disaster mitigation.

Figure 3. Summary information of reviewed articles.

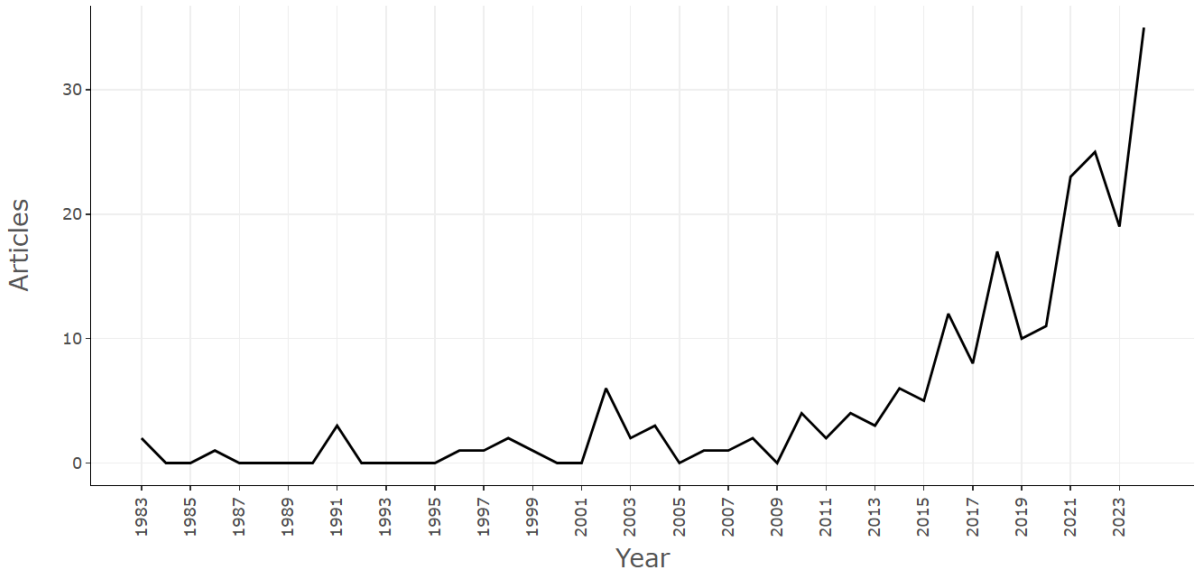

Figure 4. Publication by year.

The results showed there was generally a shift in focus from strictly ecological research to a more integrated method that included governance, community-based management, and climate adaptation. Mangrove management should emphasise the inclusive dimensions of climate change mitigation and the welfare of coastal populations [5,31,66]. Therefore, a community-based management approach to mangrove management could be a better alternative in the future [77]. Community participation is considered a key factor in environmentally sustainable projects [19]. At the same point, the increasing frequency of publications showed that mangrove management had become a significant research priority from an environmental perspective as well as in the aspects of public policy and sustainable development. Furthermore, the growing trend emphasized the need for collaborative and interdisciplinary research to solve the complex socio-ecological problems faced by mangrove ecosystems globally.

4.2. Most Cited Articles

Part of the methods to determine the influence of an article in the world of research is to assess the number of citations or quotations received. The identification of more citations shows a higher possibility of an article to be used as a reference by other scholars. This can be in the form of theoretical basis, methodological reference, or comparative material for research results. In relation to mangrove management, frequently cited articles discussed important issues such as community participation, ecosystem sustainability, and the challenges of climate change. The articles were considered important due to the new insights offered and the solutions provided to be applied in the field by scholars, practitioners, and policymakers. The list of the most cited articles presented in **Table 2** showed the research that was most often used as a reference and the main themes discussed in relation to mangrove management.

The article by Datta, D. et al. [78] had the most citations with a total of 182 and the focus was on how community-based mangrove management could support the sustainability of the ecosystem. The importance of the article was the comprehensive information provided on the role of local communities in maintaining and utilizing mangroves sustainably. In the second place, Glaser [33] discussed the relationship between mangrove ecosystems, local economies, and social sustainability in Brazil. The research showed that mangrove management depended on environmental aspects as well as the socio-economic conditions of the surrounding community. Furthermore, Iftekhar and Islam [50] offered an analysis of mangrove management strategies in Bangladesh. The research was considered important because it provided policy direction based on the local context.

Table 2. 10 Most Cited Articles in Mangrove Management Research.

No.	Name	Title	Source	Year	Cited
1.	Datta, D., Chattopadhyay, R.N., Guha, P. [78]	Community-based mangrove management: A review on status and sustainability	Journal of Environmental Management, 107, pp. 84–95	2012	182
2.	Glaser, M. [33]	Interrelations between mangrove ecosystem, local economy and social sustainability in Caeté Estuary, North Brazil	Wetlands Ecology and Management, 11(4), pp. 265–272	2003	157
3.	Iftekhar, M.S., Islam, M.R. [50]	Managing mangroves in Bangladesh: A strategy analysis	Journal of Coastal Conservation, 10(1–2), pp. 139–146	2004	130
4.	Machado, W., Moscatelli, M., Rezende, L.G., Lacerda, L.D. [79]	Mercury, zinc, and copper accumulation in mangrove sediments surrounding a large landfill in southeast Brazil	Environmental Pollution, 120(2), pp. 455–461	2002	125
5.	Walters, B.B. [57]	Local management of mangrove forests in the Philippines: Successful conservation or efficient resource exploitation?	Human Ecology, 32(2), pp. 177–195	2004	112
6.	Sasmito, S.D., Murdiyarso, D., Friess, D.A., Kurnianto, S. [80]	Can mangroves keep pace with contemporary sea level rise? A global data review	Wetlands Ecology and Management, 24(2), pp. 263–278	2016	109
7.	Luo, Y.Y., Not, C., Cannicci, S. [81]	Mangroves as unique but understudied traps for anthropogenic marine debris: A review of present information and the way forward	Environmental Pollution, 271, 116291	2021	103
8.	Sudtongkong, C., Webb, E.L. [82]	Outcomes of state- vs. community-based mangrove management in Southern Thailand	Ecology and Society, 13(2), 27	2008	94
9.	Chow, J. [42]	Mangrove management for climate change adaptation and sustainable development in coastal zones	Journal of Sustainable Forestry, 37(2), pp. 139–156	2018	87
10.	Sasmito, S.D., Basyuni, M., Kridalaksana, A., Sasmito, M.F.S., Lovelock, C.E., Murdiyarso, D. [29]	Challenges and opportunities for achieving Sustainable Development Goals through restoration of Indonesia's mangroves	Nature Ecology and Evolution, 7(1), pp. 62–70	2023	84

Source: Author analysis, 2025.

Machado et al. [79] discussed heavy metal pollution in mangrove areas near landfills in Brazil. The research was important because it warned about the risks of pollution to the health of mangrove ecosystems. Moreover, Walters [57] contributed interesting research related to local mangrove management in the Philippines by questioning whether conservation success was more due to community participation or efficient resource exploitation. Sasmito et al. [80] also discussed the ability of mangroves in adapting to sea level rise and showed that restoration efforts could be an important strategy in resolving the issues of climate change. The research showed that the attention to environmental factors, governance, and social impacts was becoming increasingly important in mangrove management.

More recent research pointed to new directions in mangrove management. For example, Luo et al. [81] discussed how mangroves could act as reservoirs for man-made marine debris and suggested the need for a more serious method for coastal pollution. Sudtongkong and Webb [82] also compared state-based and community-based management methods in Thailand. The research reported that community-based methods tended to be more effective in the long term. Furthermore, Chow [42] evaluated the potential for mangrove management as part of climate change adaptation and sustainable development strategies. Sasmito et al. [29] also emphasized the importance of mangrove restoration in Indonesia to support the achievement of SDGs. The articles generally provided a broad overview of the direction and focus of mangrove research which was observed to be increasingly associated with the environmental, social, and policy aspects.

4.3. Most Contribution Authors, Journals, Affiliations, and Countries

Mangrove management research has become an interesting topic for the global academic community as

observed from the participation of 812 authors from different institutions and countries. The list of the most productive authors presented in **Figure 5** shows that Farid Dahdouh-Guebas is in the top position with a total of 13 articles published. The activeness of Dahdouh-Guebas shows a very important role in developing scientific discourse related to coastal ecology, mangrove conservation, and sustainable socio-ecological management [83]. The works have an impact on the field of ecology and also assist in shaping an interdisciplinary method for coastal area management through cross-country and institutional collaboration. Jean Huge was listed as a very productive author with 11 papers that showed consistent participation in similar research. The focus of Huge often overlapped with the themes of sustainability and community participation in environmental conservation and this ensures the relevance of the works in developing a more holistic literature. Furthermore, Satyanarayana and Behara published seven papers as part of their continued contribution. The list also showed that Datta, Debajit, De Groot, Rudolf, and Ratsimbazafy, Hajaniaina A., contributed five articles each. This showed the important role of the authors in the development of literature in the area.

Table 3 describes the ten most contributing journals on mangrove management. The Ocean and Coastal Management was ranked first with 18 contributions and this made the journal the most dominant source in the field. Wetlands Ecology and Management was ranked second with 9 contributions and the Journal of Environmental Management was third with 7. Furthermore, AACL Bioflux Journal was in fourth place with six publications and each of Environment, Development and Sustainability, Forest Ecology and Management, Forest Policy and Economics, and *Jurnal Manajemen Hutan Tropika* had four publications. The journals were generally under reputable publishers including Elsevier and Springer. Coastal Research Library was under Springer which was discontinued in 2024.

This distribution shows the dominance of international journals in disseminating scientific research results on mangrove management worldwide with the majority covering the environment and coastal areas. The existence of cross-disciplinary attention to important issues such as coastal habitat conservation, ecosystem restoration, and mangrove-based ecosystem services was presented through the diversity of the sources. Furthermore, the publication pattern confirmed that international and interdisciplinary collaboration was important in addressing several challenges faced in sustainable mangrove forest management. This result strengthened the current understanding that research on mangrove management considered the ecological as well as the social, economic, and policy aspects.

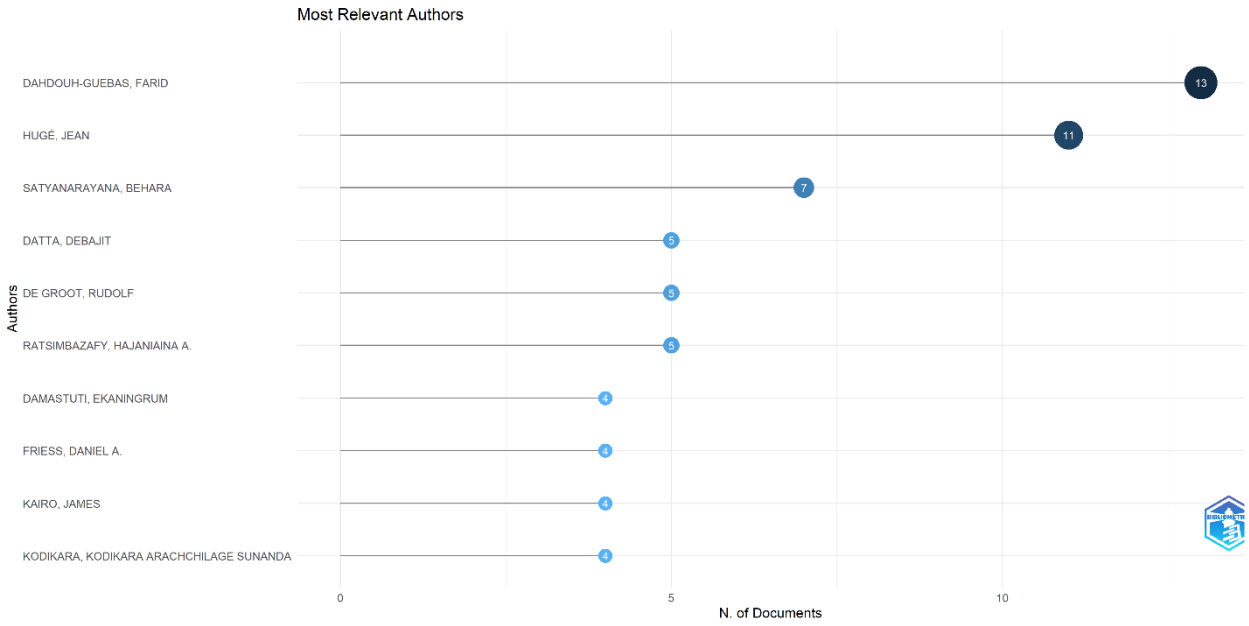

Figure 5. Authors with the most contribution.

Table 3. Leading Journals.

No	Journals	Scimagojr(2024)	Documents	Quartile	Publisher
1	Ocean and Coastal Management	1.245	18	Q1	Elsevier
2	Wetland Ecology and Management	0.507	9	Q2	Springer
3	Journal of Environmental Management	1.994	7	Q1	Academic Press
4	AACL Bioflux	0.223	6	Q4	Bioflux Publishing House
5	Coastal Research Library	discontinued	4	-	Springer International Publishing
6	Environment Development and Sustainability	0.958	4	Q1	Springer International Publishing
7	Forest Ecology and Management	1.319	4	Q1	Elsevier
8	Forest Policy and Economic	1.205	4	Q1	Elsevier
9	Journal Manajemen Hutan Tropika	0.226	4	Q3	Institut Pertanian Bogor, Department of Forest Management, Faculty of Forestry
10	Marine Policy	1.169	4	Q1	Elsevier

Source: Author analysis based on articles adopted from Scopus database, 2025.

Figure 6 shows the top ten most productive educational and research institutions in publishing scientific papers related to coastal management as well as mangrove ecosystems. The Free University of Brussels is in the top position with 14 publications followed by Université Libre de Bruxelles and IPB University which contribute 13 each. The others are Open Universiteit, Universiti Malaysia Terengganu, Zoological Society of London, and Universitas Gadjah Mada. This distribution shows that educational and research institutions from developed countries provide more results on mangrove management. However, institutions from developing countries also participated as observed in IPB University, Gadjah Mada University, and Universiti Malaysia Terengganu. The trend shows the increasing attention of tropical regions to the conservation of coastal habitats and mangrove ecosystems.

Figure 6. Institutions with the most contributions.

The diversity of institutions in **Figure 6** shows that attention to mangroves is beyond quantity due to the focus on cross-disciplinary and cross-geographic aspects. European institutions such as Vrije Universiteit Brussel and Université Libre de Bruxelles reflect strong research capacity and global collaboration networks. The inclusion of institutions from Southeast Asia and Africa, including IPB, UGM, UMT, as well as the Kenya Marine and Fish-

eries Research Institute showed that countries with extensive mangrove ecosystems were starting to take strategic positions in the flow of knowledge production. The data emphasized the importance of strengthening international collaboration, supporting access to quality scientific journals, and enhancing local capacity to ensure contributions to mangrove research and management were more inclusive and sustainable.

The countries with the highest contribution to mangrove management research are increasing in terms of both the quantity of publications and the diversity of institutions. In this analysis, all authors identified in the 210 evaluated papers. **Figure 7** shows that Indonesia is the country with the largest number of publications at 193, followed by China (117), the United States (61), Belgium (48), Malaysia (39), the United Kingdom (36), and India (30).

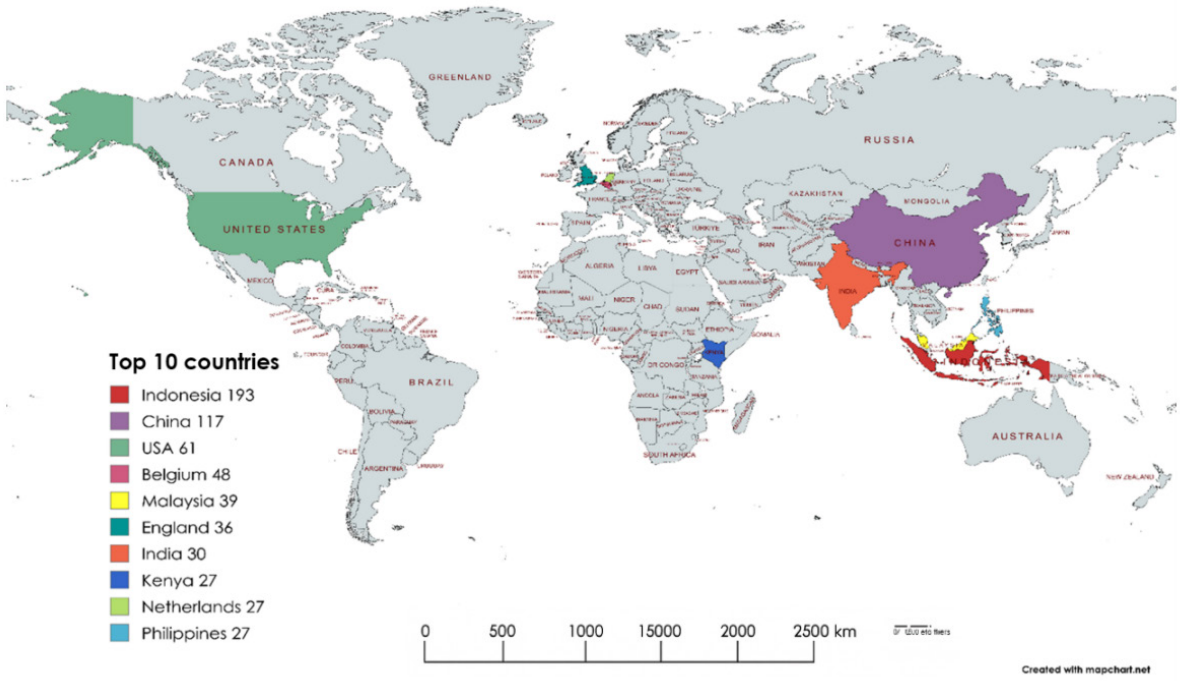

Figure 7. Top 10 countries on the global landscape of mangrove management research.

The dominance of Indonesia and other tropical countries such as Malaysia, the Philippines, and Kenya shows that the region has a significant mangrove ecosystem. This differs from developed countries such as England, Belgium, and the United States where several coastal areas have experienced large-scale land conversion into dense residential and industrial infrastructure [35,42]. Developing countries have the main locations for mangrove forests and also act as the last guardians of the ecosystem in the face of climate change and coastal development pressures [16,84]. This pattern confirms their status as objects of conservation and strategic actors in the management and restoration of mangrove forests globally. Therefore, international support through research collaboration, funding, and knowledge transfer is important to strengthen local capacity in countries with the greatest ecological potential.

4.4. Cluster Analysis and Thematic Evolution

The period of over 4 decades reviewed show that research on mangrove management was widely based on different perspectives, subjects, and disciplines. Therefore, clusters were provided to determine the present and future prospects of research in the field. The process was also necessary to consider the relevant topics in a particular cluster. Thematic evolution was applied to determine the trending themes and those considered to have the potential for further exploration in the future. The grouping of clusters was achieved using the Co-occurrence feature of VOSViewer and based on the keywords obtained from CSV files. It was observed that a minimum of two terms appeared together. The thematic evolution was conducted using Biblioshiny R package to provide degenerative visu-

alization of Scopus CSV data.

Figure 8 shows six research clusters related to mangrove management using different colors. The grouping was based on the preferences of authors with due consideration for the visualization results obtained through VOSViewer. Cluster 1 is focused on coastal area management and presented in green. The emphasis is on the importance of global attention to coastal area management as a complex ecosystem that includes mangroves in its main components. The concept is associated with the effort to preserve the ecosystem and is a strategic instrument in reducing disaster risks, increasing coastal area resilience to climate change, and maintaining the sustainability of natural resources for surrounding communities. The cluster offers a holistic perspective that the success of mangrove management cannot be separated from the overall governance of coastal areas [7,9]. The method promotes the combination of ecological aspects and socio-economic interests which are key to formulating sustainable mangrove management policies both at the global and local levels.

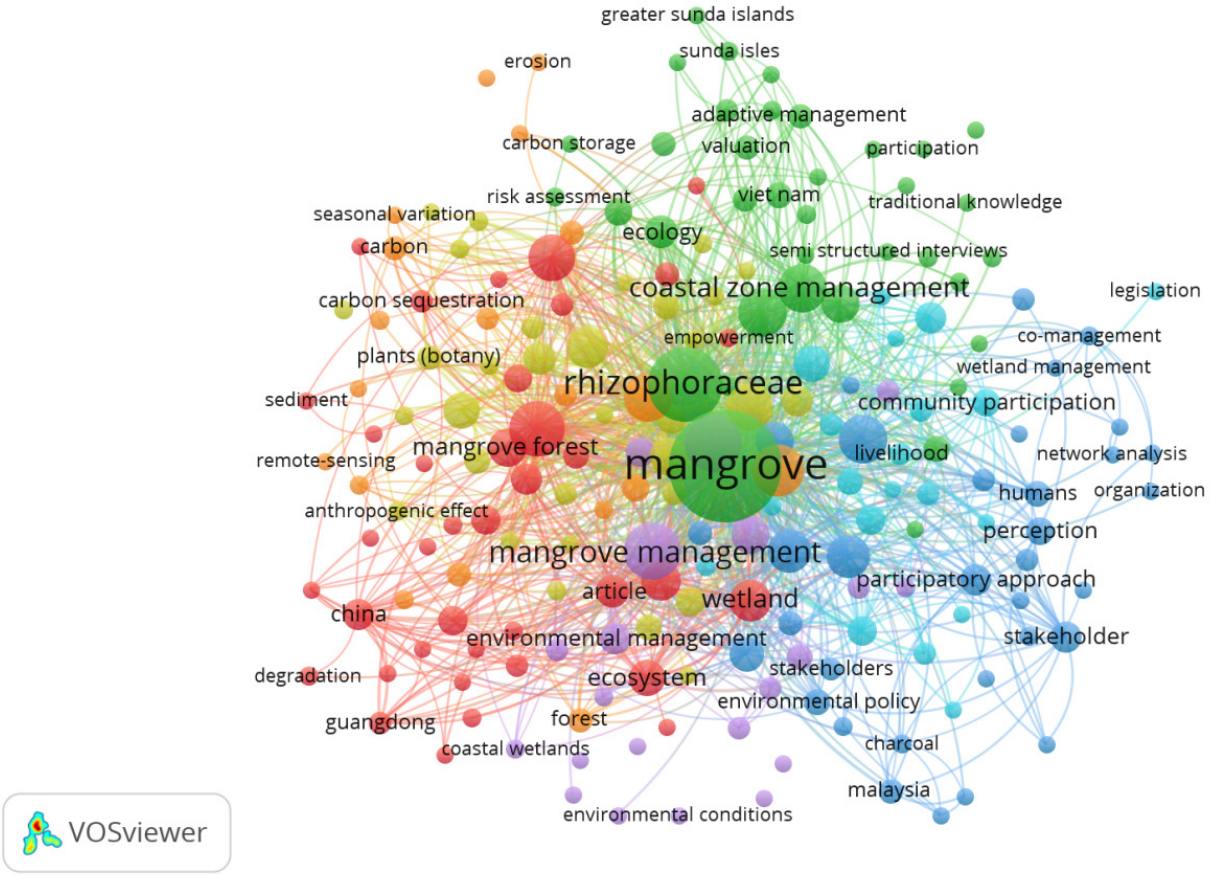

Figure 8. Cluster analysis network.

Cluster 2 is the environmental policy which is presented in purple colour. It reflects the important focus on the role of environmental policy in supporting the sustainability of mangrove management globally. The emphasis is on policies that are adaptive, responsive to environmental change, and able to bridge ecological interests with the socio-economic needs of coastal communities. The other issues often observed in the cluster include the importance of cross-sectoral policy harmonization, the need for economic incentives in mangrove conservation, and the urgency of data-based monitoring to support more accurate policy evaluation.

Cluster 3 is associated with degradation and is presented in red colour. The focus is on the serious threat of global mangrove management to the degradation of the ecosystem both due to human and natural activities. The reduction in mangrove areas in several countries is believed to be caused by both degradation as well as defor-

estation and restoration efforts [8]. It is also observed that extensive mangrove land degradation threatens the biological and socio-economic life of coastal communities [55]. Meanwhile, Cluster 4 on remote sensing is presented in orange and observed to be an important method in supporting efforts to monitor and manage mangroves more effectively and efficiently [16]. Research in the cluster reported the use of remote sensing technologies such as satellite and drone imagery, to map the distribution and changes in mangrove cover, detect areas of degradation, and monitor ecosystem dynamics at wide spatial and temporal scales [3,77,85,86]. The focus was also on the increasing application of advanced data processing methods such as machine learning and AI-based classification algorithms to improve the accuracy of mangrove mapping.

Cluster 5 on co-management is presented in blue colour and shows the importance of collaboration between government, local communities, academics, and other stakeholders in sustainable mangrove ecosystem management [87]. Previous research reported that the co-management method was considered a solution to overcome different challenges in mangrove management, such as the low effectiveness of top-down policies, limited government resources, and conflicts of interest between sectors [30,88]. Meanwhile, Cluster 6 on community participation is identified using Tosca color and considered an important factor in supporting the success of conservation, restoration, and sustainable use programs for mangrove ecosystems [54,77]. The important role of communities in mangrove conservation can also reduce vulnerability in the event of a crisis caused by natural disasters or a declining mangrove ecosystem [89].

Figure 9 shows that the trend of mangrove research in the last 5 years has shifted from pure conservation to a more integrative method such as ecosystem services, blue carbon, community-based restoration, and strengthening the role of local communities. Future research has the potential to provide information on the role of mangroves in climate change mitigation, disaster risk reduction, and improving the economy of coastal communities [90]. Moreover, the future of global mangrove management significantly depends on the partnerships formed based on equality between developed and developing countries. The aim is to appreciate the scientific and ecological contributions of tropical regions that are home to the largest mangrove forests in the world [41]. The participation of different stakeholders in mangrove management is also inevitable considering the complexity and socio-political methods currently trending. Therefore, investigations on socio-ecological resilience, innovative governance models, and the incorporation of local knowledge into policy formulation are expected to increase the chances of successful mangrove conservation for future life.

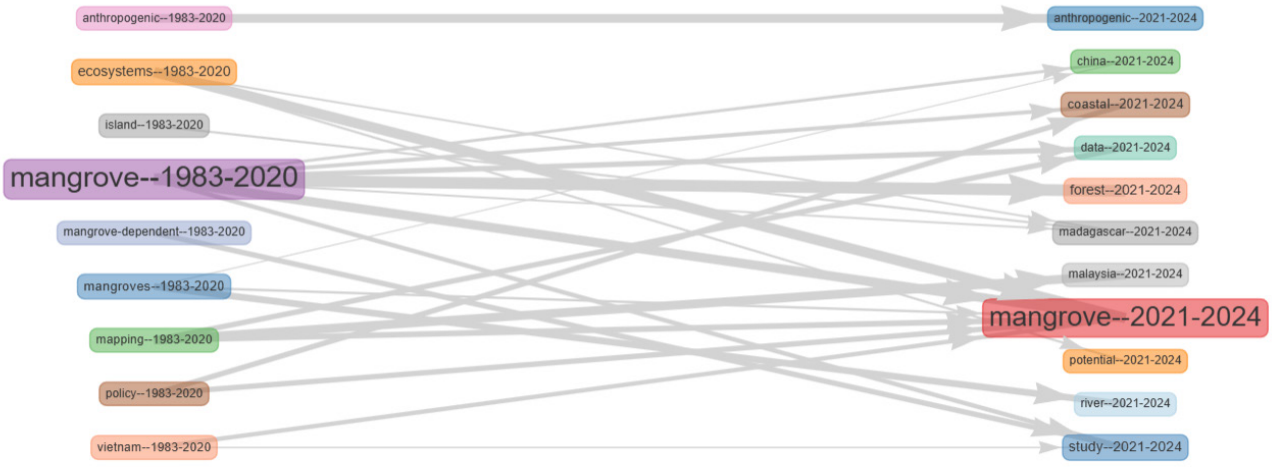

Figure 9. *Cont.*

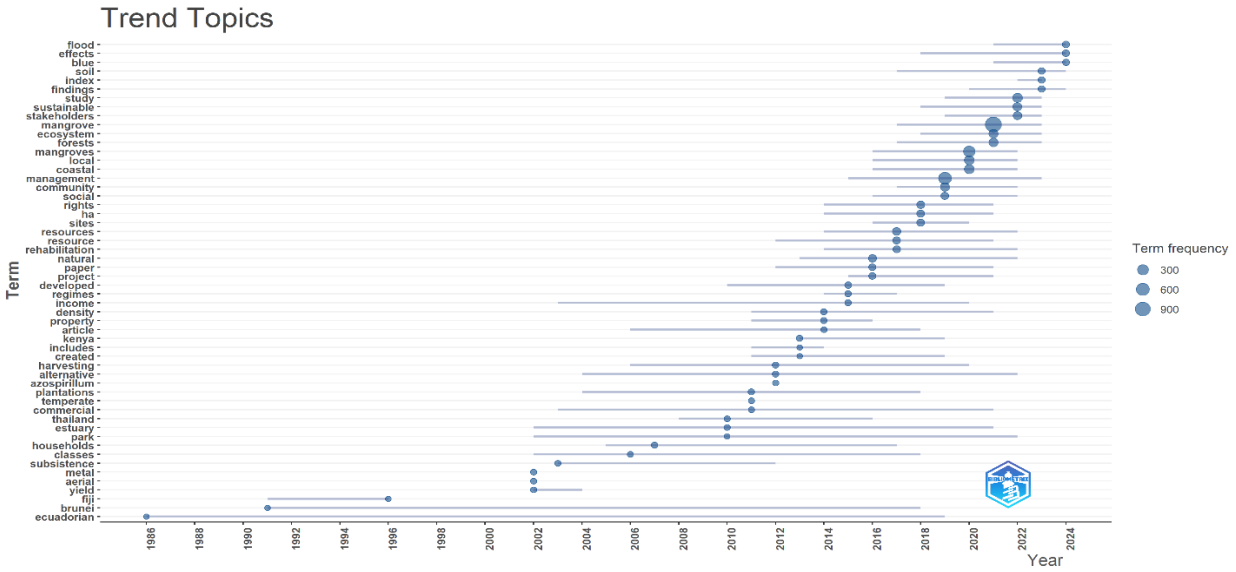

Figure 9. Thematic evolution.

4.5. Conceptual Model for Global Mangrove Research Direction

Figure 10 shows that the conceptual model for global manrgroves management for future direction. Analysis of ecosystem services conditions, research can be focused on analyzing the condition of ecosystem services provided by mangroves. This is important because the ecosystem services approach is increasingly developing in natural resource management and serves as an instrument connecting ecosystem functions with human well-being [91]. Socio-economic analysis and valuation, there are opportunities to conduct research related to the socio-economic analysis and valuation of mangroves. This includes how communities utilize mangroves and assign economic value to the various services provided by these ecosystems. System structure and prospective future strategies, future research can be directed at understanding the complex structure of mangrove systems and developing prospective strategies. These aspects pose challenges in developing dynamic and complex mangrove ecosystem management strategies in Indonesia to achieve sustainable management goals. Socio-political and institutional aspect, there is a limited number of studies concerning socio-political and institutional aspects, as well as the impacts of socio-cultural transformation due to globalization on Community Based Mangrove Management (CBMM). Therefore, research with a sharper focus on these aspects is highly recommended for better community management of these highly stressed mangrove forests [78]. Understanding the impact of urbanization, there is a significant gap in our understanding of how urban mangroves function. Although the responses of mangroves to urban environments have been documented for about 35 years, there is still no model that describes this system. Further research is needed to develop such a model, therefore future mangrove management along urbanizing coastlines can be more effective [92].

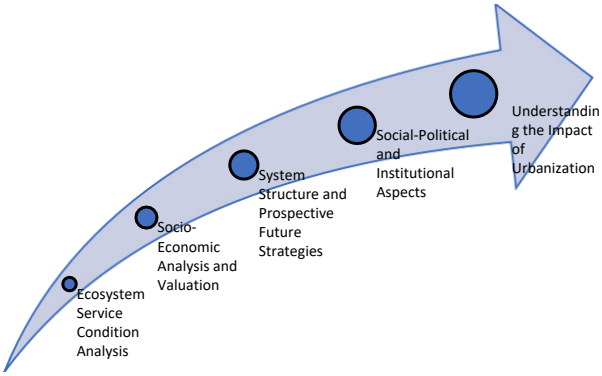

Figure 10. Conceptual Model for Global Mangrove.

5. Conclusion

In conclusion, research on mangrove management increased significantly due to the continuous threats of climate change and environmental degradation. Mangrove ecosystems provided important ecological services such as coastal protection, carbon sequestration or “blue carbon”,

and supported biodiversity to benefit billions of people worldwide. Most mangrove areas were observed to be located in developing countries that were playing strategic roles as guardians of the ecosystems but facing different challenges, including institutional overlap, weak law enforcement, and competing development pressures. The research clusters identified show some methods that covered multiple aspects of mangrove management, including coastal zone management, environmental policy, degradation, remote sensing, co-management, and community participation. The trend was an indication of a multidimensional method of mangrove management. Furthermore, socio-ecological resilience, innovative governance models, and integration of local knowledge into policy were observed to be the key themes. It was reported that successful mangrove management methods often required community participation and collaborative governance.

Conceptually, this research provided a comprehensive mapping of mangrove research landscape by combining SLR and Bibliometric analysis. This combined method offered deeper insights into the changes and clustering of research themes. The results enhanced the understanding of the interactions between environmental, social, and policy factors in mangrove management in order to advance the discussions associated with multiple disciplines. Policymakers and stakeholders were also informed about the development of targeted and sustainable management strategies with a focus on socio-economic considerations, governance innovations, and community engagement. Furthermore, the importance of international collaboration, knowledge exchange, and capacity building was emphasized specifically in developing countries.

This type of SLR and Bibliometric research had some limitations which included using only Scopus indexing database. In-depth inclusion and exclusion criteria were used but comprehensive empirical discussions should be introduced in the future. This research also identified a gap in fully integrating socio-ecological resilience and innovative governance into mangrove management framework. Future research should expand the results more deeply to each country with a large mangrove ecosystem. Governance models that effectively integrated local and indigenous knowledge into policymaking should also be developed in addition to the exploration of the socio-economic dimensions, including community participation in the entire mangrove management process. This should clearly explain the main conclusions of the article, highlighting its importance and relevance. This section is not mandatory but can be added to the manuscript if the discussion is unusually long or complex.

Author Contributions

Conceptualization, H.P. and A.R.; methodology, A.R.; software, A.R.; validation, A.R., N.A.R. and S.P.H.; formal analysis, H.P.; investigation, S.P.H., T.R.S.; resources, S.P.H.; data curation, T.R.S.; writing—original draft preparation, H.P.; writing—review and editing, A.R.; visualization, A.R.; supervision, S.P.H.; project administration, N.A.R.; funding acquisition, H.P. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement

Not applicable.

Data Availability Statement

Data will be available upon request to the corresponding author.

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Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Bimrah, K., Dasgupta, R., Hashimoto, S., et al., 2022. Ecosystem Services of Mangroves: A Systematic Review and Synthesis of Contemporary Scientific Literature. Sustainability. 14(19), 12051. DOI: https://doi.org/10.3390/su141912051

[2] Le Heron, R., Lundquist, C.J., Logie, J., et al., 2022. A Socio-Ecological Appraisal of Perceived Risks Associated with Mangrove (Mānawa) Management in Aotearoa New Zealand. New Zealand Journal of Marine and Freshwater Research. 56(3), 447–465. DOI: https://doi.org/10.1080/00288330.2022.2097270

[3] Turschwell, M.P., Tulloch, V.J.D., Sievers, M., et al., 2020. Multi-Scale Estimation of the Effects of Pressures and Drivers on Mangrove Forest Loss Globally. Biological Conservation. 247, 108637. DOI: https://doi.org/10.1016/j.biocon.2020.108637

[4] Quenum, I.A., Avocèvou-Ayisso, C., Idohou, R., et al., 2024. Restoration and Governance Approaches of Mangrove Ecosystems in Africa. Wetlands. 44(5), 54. DOI: https://doi.org/10.1007/s13157-024-01805-8

[5] Van Dat, T., Cuc, N.T.K., Diep, P.T., 2021. Governance of Mangrove Ecosystems in Northern Vietnam with Consideration of Impacts of Sea Level Rise and Climate Change: A Dynamic Approach. In Natural Resource Governance in Asia. Elsevier: London, UK. pp. 99–133. DOI: https://doi.org/10.1016/B978-0-323-85729-1.00007-4

[6] Friess, D.A., Rogers, K., Lovelock, C.E., et al., 2019. The State of the World's Mangrove Forests: Past, Present, and Future. Annual Review of Environment and Resources. 44(1), 89–115. DOI: https://doi.org/10.1146/annurev-environ-101718-033302

[7] Mohamed, M.K., Adam, E., Jackson, C.M., 2023. Policy Review and Regulatory Challenges and Strategies for the Sustainable Mangrove Management in Zanzibar. Sustainability. 15(2), 1557. DOI: https://doi.org/10.3390/su15021557

[8] Sharma, S., MacKenzie, R.A., Tieng, T., et al., 2020. The Impacts of Degradation, Deforestation and Restoration on Mangrove Ecosystem Carbon Stocks Across Cambodia. Science of The Total Environment. 706, 135416. DOI: https://doi.org/10.1016/j.scitotenv.2019.135416

[9] Sillanpää, M., Friess, D.A., Heatubun, C.D., et al., 2024. Mangrove Management Practices, Policies, and Impacts in New Guinea. Biological Conservation. 296, 110697. DOI: https://doi.org/10.1016/j.biocon.2024.110697

[10] Xu, M., Wang, Z., Liang, Y., et al., 2024. Analysis of Spatiotemporal Evolution Characteristics and Recovery Patterns of Mangrove Forests in China Since 1978. Ecological Indicators. 169, 112882. DOI: https://doi.org/10.1016/j.ecolind.2024.112882

[11] Arumugam, M., Niyomugabo, R., Dahdouh-Guebas, F., et al., 2021. The Perceptions of Stakeholders on Current Management of Mangroves in the Sine-Saloum Delta, Senegal. Estuarine, Coastal and Shelf Science. 248, 107160. DOI: https://doi.org/10.1016/j.ecss.2020.107160

[12] Soeprobowati, T.R., Anggoro, S., Puryono, S., et al., 2022. Species Composition and Distribution in the Mangrove Ecosystem in the City of Bengkulu, Indonesia. Water. 14(21), 3516. DOI: https://doi.org/10.3390/w14213516

[13] Food and Agriculture Organization (FAO), 2023. The World's Mangroves 2000–2020. FAO: Rome, Italy. Available from: https://openknowledge.fao.org/server/api/core/bitstreams/7f15adf1-2756-4e86-a6dd-77d0fc26d97c/content

[14] Ho, Y.-S., Mukul, S.A., 2021. Publication Performance and Trends in Mangrove Forests: A Bibliometric Analysis. Sustainability. 13(22), 12532. DOI: https://doi.org/10.3390/su132212532

[15] UN Environment Programme (UNEP), 2023. The Importance of Mangroves to People: A Call to Action. UNEP: Nairobi, Kenya. Available from: https://www.unep.org/resources/report/importance-mangroves-people-call-action

[16] Dutta Roy, A., Pitumpe Arachchige, P.S., Watt, M.S., et al., 2024. Remote Sensing-Based Mangrove Blue Carbon Assessment in the Asia-Pacific: A Systematic Review. Science of The Total Environment. 938, 173270. DOI: https://doi.org/10.1016/j.scitotenv.2024.173270

[17] Zhang, Y., Yan, S., Wang, W., et al., 2020. Habitat Use by Fish across Tidal Cycles in a Tropical Estuarine Mangrove Ecosystem (Dongzhaigang Bay, Hainan, China). Journal of Coastal Research. 37(1). DOI: https://doi.org/10.2112/JCOASTRES-D-20-00046.1

[18] Miller, M.A., Tonoto, P., 2023. Leveraging Plural Valuations of Mangroves for Climate Interventions in Indonesia. Sustainability Science. 18(3), 1533–1547. DOI: https://doi.org/10.1007/s11625-023-01297-1

[19] Marquez, G.P.B., Olavides, R.D., 2024. Integrating Science-Based and Local Ecological Knowledge: A

Case Study of Mangrove Restoration and Rehabilitation Projects in the Philippines. Disasters. 48(S1), e12630. DOI: https://doi.org/10.1111/disa.12630

[20] Analuddin, K., Helmi, M., Pribadi, R., et al., 2024. Mangrove Vulnerability and Blue Carbon Storage in the Coral Triangle Areas, Southeast Sulawesi, Indonesia. Frontiers in Ecology and Evolution. 12, 1420827. DOI: https://doi.org/10.3389/fevo.2024.1420827

[21] Trialfhianty, T.I., Muharram, F.W., Suadi, et al., 2022. Spatial Multi-Criteria Analysis to Capture Socio-Economic Factors in Mangrove Conservation. Marine Policy. 141, 105094. DOI: https://doi.org/10.1016/j.marpol.2022.105094

[22] Bhati, M., Goerlandt, F., Pelot, R., 2025. Digital Twin Development Towards Integration into Blue Economy: A Bibliometric Analysis. Ocean Engineering. 317, 119781. DOI: https://doi.org/10.1016/j.oceaneng.2024.119781

[23] Gong, M., Teller, N., Golebie, E.J., et al., 2024. Unveiling Complementarities Between Mangrove Restoration and Global Sustainable Development Goals. Journal of Cleaner Production. 474, 143524. DOI: https://doi.org/10.1016/j.jclepro.2024.143524

[24] Kairo, J., Mbatha, A., Murithi, M.M., et al., 2021. Total Ecosystem Carbon Stocks of Mangroves in Lamu, Kenya; and Their Potential Contributions to the Climate Change Agenda in the Country. Frontiers in Forests and Global Change. 4, 709227. DOI: https://doi.org/10.3389/ffgc.2021.709227

[25] Arfan, A., Sanusi, W., Rakib, M., et al., 2024. Mangrove Ecosystem Management Strategy to Support Sustainable Development Goal 14. Environmental Research, Engineering and Management. 80(1), 64–76. DOI: https://doi.org/10.5755/j01.erem.80.1.33887

[26] Chamberland-Fontaine, S., Thomas Estrada, G., Heckadon-Moreno, S., et al., 2022. Enhancing the Sustainable Management of Mangrove Forests: The Case of Punta Galeta, Panama. Trees, Forests and People. 8, 100274. DOI: https://doi.org/10.1016/j.tfp.2022.100274

[27] Slobodian, L., Vidal, A., 2023. Mangrove Law and Policy. Global Mangrove Alliance: Washington, DC, USA. Available from: https://nationalsecurity.law.georgetown.edu/publication/mangrove-law-and-policy/?utm_source=chatgpt.com

[28] Cayetano, C.B., Creencia, L.A., Sullivan, E., et al., 2023. Multi-Spatiotemporal Analysis of Changes in Mangrove Forests in Palawan, Philippines: Predicting Future Trends Using a Support Vector Machine Algorithm and the Markov Chain Model. UCL Open Environment. 5. DOI: https://doi.org/10.14324/111.444/ucloe.000057

[29] Sasmito, S.D., Basyuni, M., Kridalaksana, A., et al., 2023. Challenges and Opportunities for Achieving Sustainable Development Goals Through Restoration of Indonesia's Mangroves. Nature Ecology & Evolution. 7(1), 62–70. DOI: https://doi.org/10.1038/s41559-022-01926-5

[30] Feti, F., Hadi, S.P., Purnaweni, H., et al., 2020. Does the Intervention of Regional Authorities Contribute to Sustainable Mangrove Eotourism? Case Study on Mangrove Management at Karangsong, West Java, Indonesia. Ecological Questions. 31(3), 7. DOI: https://doi.org/10.12775/EQ.2020.017

[31] Mursyid, H., Daulay, M.H., Pratama, A.A., et al., 2021. Governance Issues Related to the Management and Conservation of Mangrove Ecosystems to Support Climate Change Mitigation Actions in Indonesia. Forest Policy and Economics. 133, 102622. DOI: https://doi.org/10.1016/j.forpol.2021.102622

[32] Michaud, E., Aschenbroich, A., Gauthier, O., et al., 2022. The Codevelopment of Mangroves and Infaunal Community Diversity in Response to the Natural Dynamics of Mud Deposition in French Guiana. Sustainability. 14(5), 2829. DOI: https://doi.org/10.3390/su14052829

[33] Glaser, M., 2003. Interrelations Between Mangrove Ecosystem, Local Economy and Social Sustainability in Caeté Estuary, North Brazil. Wetlands Ecology and Management. 11(4), 265–272. DOI: https://doi.org/10.1023/A:1025015600125

[34] Simpson, L.T., Chapman, S.K., Simpson, L.M., et al., 2023. Do Global Change Variables Alter Mangrove Decomposition? A Systematic Review. Global Ecology and Biogeography. 32(11), 1874–1892. DOI: https://doi.org/10.1111/geb.13743

[35] Bhowmik, A.K., Padmanaban, R., Cabral, P., et al., 2022. Global Mangrove Deforestation and Its Interacting Social-Ecological Drivers: A Systematic Review and Synthesis. Sustainability. 14(8), 4433. DOI: https://doi.org/10.3390/su14084433

[36] Lee, S.L., Then, A.Y.-H., Goh, H.C., et al., 2022. Strengthened Multi-Stakeholder Linkages in Valuation Studies Is Critical for Improved Decision Making Outcomes for Valuable Mangroves – The Malaysian Case Study. Frontiers in Marine Science. 9, 1033200. DOI: https://doi.org/10.3389/fmars.2022.1033200

[37] Arulnayagam, A., Khim, J.-S., Park, J., 2021. Floral and Faunal Diversity in Sri Lankan Mangrove Forests: A Systematic Review. Sustainability. 13(17), 9487. DOI: https://doi.org/10.3390/su13179487

[38] Pillodar, F., Suson, P., Aguilos, M., et al., 2023. Man-

grove Resource Mapping Using Remote Sensing in the Philippines: A Systematic Review and Meta-Analysis. Forests. 14(6), 1080. DOI: https://doi.org/10.3390/f14061080

[39] Gerona-Daga, M.E.B., Salmo, S.G., 2022. A Systematic Review of Mangrove Restoration Studies in Southeast Asia: Challenges and Opportunities for the United Nation's Decade on Ecosystem Restoration. Frontiers in Marine Science. 9, 987737. DOI: https://doi.org/10.3389/fmars.2022.987737

[40] Hamza, A.J., Esteves, L.S., Cvitanović, M., et al., 2024. Global Patterns of Mangrove Resource Utilization: A Systematic Review. Frontiers in Sustainable Resource Management. 3, 1395724. DOI: https://doi.org/10.3389/fsrma.2024.1395724

[41] Tasneem, S., Ahsan, Md.N., 2024. A Bibliometric Analysis on Mangrove Ecosystem Services: Past Trends and Emerging Interests. Ocean & Coastal Management. 256, 107276. DOI: https://doi.org/10.1016/j.ocecoaman.2024.107276

[42] Chow, J., 2018. Mangrove Management for Climate Change Adaptation and Sustainable Development in Coastal Zones. Journal of Sustainable Forestry. 37(2), 139–156. DOI: https://doi.org/10.1080/10549811.2017.1339615

[43] Veettil, B.K., Wickramasinghe, D., Amarakoon, V., 2023. Mangrove Forests in Sri Lanka: An Updated Review on Distribution, Diversity, Current State of Research and Future Perspectives. Regional Studies in Marine Science. 62, 102932. DOI: https://doi.org/10.1016/j.rsma.2023.102932

[44] Suryawan, I.W.K., Gunawan, V.D., Lee, C.-H., 2024. Assessing the Importance-Performance Analysis of Adaptive Capacity Programs for Sustainable Mangrove Conservation in the Taman Nasional Bali Barat Conservation Area. Ocean & Coastal Management. 257, 107345. DOI: https://doi.org/10.1016/j.ocecoaman.2024.107345

[45] Cui, L., DeAngelis, D.L., Berger, U., et al., 2024. Global Potential Distribution of Mangroves: Taking into Account Salt Marsh Interactions Along Latitudinal Gradients. Journal of Environmental Management. 351, 119892. DOI: https://doi.org/10.1016/j.jenvman.2023.119892

[46] Liang, S., Hu, W., Liu, J., et al., 2023. Mapping Mangrove Sustainability in the Face of Sea Level Rise and Land Use: A Case Study on Leizhou Peninsula, China. Journal of Environmental Management. 325, 116554. DOI: https://doi.org/10.1016/j.jenvman.2022.116554

[47] Sajriawati, Amir, A., Hiskya, H.J., et al., 2021. Collaboration of Government Policies and the Marind Tribe Communities on Mangrove Resources Management in the Payum Coastal Area of Merauke Regency in Papua. Review of International Geographical Education Online. 11(5). Available from: https://rigeo.org/menu-script/index.php/rigeo/article/view/770

[48] Semesi, A.K., 1998. Mangrove Management and Utilization in Eastern Africa. Ambio. 27(8), 620–626.

[49] Zorini, L.O., Contini, C., Jiddawi, N., et al., 2004. Participatory Appraisal for Potential Community-Based Mangrove Management in East Africa. Wetlands Ecology and Management. 12(2), 87–102. DOI: https://doi.org/10.1023/B:WETL.0000021672.15252.54

[50] Iftekhar, M.S., Islam, M.R., 2004. Managing Mangroves in Bangladesh: A Strategy Analysis. Journal of Coastal Conservation. 10(1), 139. DOI: https://doi.org/10.1652/1400-0350(2004)010%255B0139:MMIBAS%255D2.0.CO;2

[51] Roy, A.K.D., 2014. Determinants of Participation of Mangrove-Dependent Communities in Mangrove Conservation Practices. Ocean & Coastal Management. 98, 70–78. DOI: https://doi.org/10.1016/j.ocecoaman.2014.06.001

[52] Maxwell, G.S., 1991. Perspectives on Mangrove Management: Lessons from Brunei, Hong Kong and Thailand. Malaysian Journal of Tropical Geography. 22(1), 29–36.

[53] Chen, D., Satyanarayana, B., Wolswijk, G., et al., 2024. Historical Ecological Monitoring and Appraisal for Extractive Uses and Other Values in Malaysia Unveils Consequences of Regime Shifts in 120 Years of Mangrove Management. Journal for Nature Conservation. 79, 126582. DOI: https://doi.org/10.1016/j.jnc.2024.126582

[54] Damastuti, E., Van Wesenbeeck, B.K., Leemans, R., et al., 2023. Effectiveness of Community-Based Mangrove Management for Coastal Protection: A Case Study from Central Java, Indonesia. Ocean & Coastal Management. 238, 106498. DOI: https://doi.org/10.1016/j.ocecoaman.2023.106498

[55] Utami, W., Sugiyanto, C., Rahardjo, N., 2024. Mangrove Area Degradation and Management Strategies in Indonesia: A Review. Journal of Degraded and Mining Lands Management. 11(3), 6037–6047. DOI: https://doi.org/10.15243/jdmlm.2024.113.6037

[56] Loh, I.H., Chong, J.L., Baird, M.H., 2018. The Conservation of Coral Reefs Through Mangrove Management. Biodiversity. 1–6. DOI: https://doi.org/10.1080/14888386.2018.1473168

[57] Walters, B.B., 2004. Local Management of Mangrove Forests in the Philippines: Successful Conservation or Efficient Resource Exploitation? Human Ecolo-

gy. 32(2), 177–195. DOI: https://doi.org/10.1023/B:HUEC.0000019762.36361.48

[58] Terchunian, A., Klemas, V., Segovia, A., et al., 1986. Mangrove Mapping in Ecuador: The Impact of Shrimp Pond Construction. Environmental Management. 10(3), 345–350. DOI: https://doi.org/10.1007/BF01867258

[59] López-Angarita, J., Roberts, C.M., Tilley, A., et al., 2016. Mangroves and People: Lessons from a History of Use and Abuse in Four Latin American Countries. Forest Ecology and Management. 368, 151–162. DOI: https://doi.org/10.1016/j.foreco.2016.03.020

[60] Chamberland-Fontaine, S., Heckadon-Moreno, S., Hickey, G.M., 2022. Tangled Roots and Murky Waters: Piecing Together Panama's Mangrove Policy Puzzle. Frontiers in Forests and Global Change. 5, 818722. DOI: https://doi.org/10.3389/ffgc.2022.818722

[61] Walker, J.E., Ankersen, T., Barchiesi, S., et al., 2022. Governance and the Mangrove Commons: Advancing the Cross-Scale, Nested Framework for the Global Conservation and Wise Use of Mangroves. Journal of Environmental Management. 312, 114823. DOI: https://doi.org/10.1016/j.jenvman.2022.114823

[62] Ilamathi, P., Chidambaram, S., 2025. Integration of Hyperspectral Imaging and Deep Learning for Sustainable Mangrove Management and Sustainable Development Goals Assessment. Wetlands. 45(1), 9. DOI: https://doi.org/10.1007/s13157-024-01887-4

[63] Kustanti, A., 2019. Institutional Management on Mangrove Forest. A Case from Indonesia. International Journal of Conservation Science. 10(3), 555–564. Available from: https://ijcs.ro/public/IJCS-19-51_Kustanti.pdf

[64] Golebie, E.J., Aczel, M., Bukoski, J.J., et al., 2022. A Qualitative Systematic Review of Governance Principles for Mangrove Conservation. Conservation Biology. 36(1), e13850. DOI: https://doi.org/10.1111/cobi.13850

[65] Nyangoko, B.P., Shalli, M.S., Mangora, M.M., et al., 2022. Socioeconomic Determinants of Mangrove Exploitation and Management in the Pangani River Estuary, Tanzania. Ecology and Society. 27(2), art32. DOI: https://doi.org/10.5751/ES-13227-270232

[66] Song, A.M., Dressler, W.H., Satizábal, P., et al., 2021. From Conversion to Conservation to Carbon: The Changing Policy Discourse on Mangrove Governance and Use in the Philippines. Journal of Rural Studies. 82, 184–195. DOI: https://doi.org/10.1016/j.jrurstud.2021.01.008

[67] Martínez-Espinosa, C., Wolfs, P., Vande Velde, K., et al., 2020. Call for a Collaborative Management at Matang Mangrove Forest Reserve, Malaysia: An Assessment from Local Stakeholders' View Point. Forest Ecology and Management. 458, 117741. DOI: https://doi.org/10.1016/j.foreco.2019.117741

[68] Marzi, G., Balzano, M., Caputo, A., et al., 2025. Guidelines for Bibliometric-Systematic Literature Reviews: 10 Steps to Combine Analysis, Synthesis and Theory Development. International Journal of Management Reviews. 27(1), 81–103. DOI: https://doi.org/10.1111/ijmr.12381

[69] Donthu, N., Kumar, S., Mukherjee, D., et al., 2021. How to Conduct a Bibliometric Analysis: An Overview and Guidelines. Journal of Business Research. 133, 285–296. DOI: https://doi.org/10.1016/j.jbusres.2021.04.070

[70] Kumar, S., Pandey, N., Haldar, A., 2020. Twenty Years of Public Management Review (PMR): A Bibliometric Overview. Public Management Review. 22(12), 1876–1896. DOI: https://doi.org/10.1080/14719037.2020.1721122

[71] Wang, X., Noor, A.M., Mohd, K.A.M., 2025. Reviewing the Efficacy of Urban Landscape Design Strategies in China: A Systematic Review. Research in Ecology. 162–181. DOI: https://doi.org/10.30564/re.v7i3.9258

[72] Huang, Y., Li, N., Huang, G., et al., 2021. A Review of Research on Ecological Economics Based on Bibliometrics. Research in Ecology. 3(3), 28–36. DOI: https://doi.org/10.30564/re.v3i3.3685

[73] Batista, G.D.S., Rocha, E.G., De Lacerda, M.C., et al., 2025. Applications of Floating Treatment Wetlands for Remediation of Rainwater and Polluted Waters: A Systematic Review and Bibliometric Analysis. Wetlands Ecology and Management. 33(2), 27. DOI: https://doi.org/10.1007/s11273-025-10042-7

[74] Sulistyaningsih, T., Loilatu, M.J., Roziqin, A., 2024. Research Trends on Smart Urban Governance in Asia: A Bibliometric Analysis. Journal of Science and Technology Policy Management. 15(5), 997–1015. DOI: https://doi.org/10.1108/JSTPM-03-2022-0045

[75] Kismartini, K., Yusuf, I.M., Sabilla, K.R., et al., 2024. A Bibliometric Analysis of Maritime Security Policy: Research Trends and Future Agenda. Heliyon. 10(8), e28988. DOI: https://doi.org/10.1016/j.heliyon.2024.e28988

[76] Xiao, Y., Watson, M., 2019. Guidance on Conducting a Systematic Literature Review. Journal of Planning Education and Research. 39(1), 93–112. DOI: https://doi.org/10.1177/0739456X17723971

[77] Sathiyamoorthy, S., Sakurai, T., 2024. Effectiveness

of Community Participation in Mangrove Restoration: The Evidence from Northern Sri Lanka. Environmental Economics and Policy Studies. 26(4), 759–779. DOI: https://doi.org/10.1007/s10018-024-00397-1

[78] Datta, D., Chattopadhyay, R.N., Guha, P., 2012. Community Based Mangrove Management: A Review on Status and Sustainability. Journal of Environmental Management. 107, 84–95. DOI: https://doi.org/10.1016/j.jenvman.2012.04.013

[79] Machado, W., Moscatelli, M., Rezende, L.G., et al., 2002. Mercury, Zinc, and Copper Accumulation in Mangrove Sediments Surrounding a Large Landfill in Southeast Brazil. Environmental Pollution. 120(2), 455–461. DOI: https://doi.org/10.1016/S0269-7491(02)00108-2

[80] Sasmito, S.D., Murdiyarso, D., Friess, D.A., et al., 2016. Can Mangroves Keep Pace with Contemporary Sea Level Rise? A Global Data Review. Wetlands Ecology and Management. 24(2), 263–278. DOI: https://doi.org/10.1007/s11273-015-9466-7

[81] Luo, Y.Y., Not, C., Cannicci, S., 2021. Mangroves as Unique but Understudied Traps for Anthropogenic Marine Debris: A Review of Present Information and the Way Forward. Environmental Pollution. 271, 116291. DOI: https://doi.org/10.1016/j.envpol.2020.116291

[82] Sudtongkong, C., Webb, E.L., 2008. Outcomes of State- Vs. Community-Based Mangrove Management in Southern Thailand. Ecology and Society. 13(2), 27. DOI: https://doi.org/10.5751/ES-02531-130227

[83] Dahdouh-Guebas, F., Mafaziya Nijamdeen, T.W.G.F., Hugé, J., et al., 2022. The Mangal Play: A Serious Game to Experience Multi-Stakeholder Decision-Making in Complex Mangrove Social-Ecological Systems. Frontiers in Marine Science. 9, 909793. DOI: https://doi.org/10.3389/fmars.2022.909793

[84] Gevaña, D.T., Camacho, L.D., Pulhin, J.M., 2018. Conserving Mangroves for Their Blue Carbon: Insights and Prospects for Community-Based Mangrove Management in Southeast Asia. In: Makowski, C., Finkl, C.W. (Eds.). Threats to Mangrove Forests, Coastal Research Library. Springer International Publishing: Cham, Switzerland. pp. 579–588. DOI: https://doi.org/10.1007/978-3-319-73016-5_26

[85] Nguyen, H.-H., Tran, L.T.N., Le, A.T., et al., 2020. Monitoring Changes in Coastal Mangrove Extents Using Multi-Temporal Satellite Data in Selected Communes, Hai Phong City, Vietnam. Forest and Society. 4(1), 256. DOI: https://doi.org/10.24259/fs.v4i1.8486

[86] Castellanos-Galindo, G.A., Casella, E., Tavera, H., et al., 2021. Structural Characteristics of the Tallest Mangrove Forests of the American Continent: A Comparison of Ground-Based, Drone and Radar Measurements. Frontiers in Forests and Global Change. 4, 732468. DOI: https://doi.org/10.3389/ffgc.2021.732468

[87] Fathima Mafaziya Nijamdeen, T.W.G., Ratsimbazafy, H.A., Kodikara, K.A.S., et al., 2023. Mangrove Management in Sri Lanka and Stakeholder Collaboration: A Social Network Perspective. Journal of Environmental Management. 330, 117116. DOI: https://doi.org/10.1016/j.jenvman.2022.117116

[88] Mafaziya Nijamdeen, T.W.G.F., Hugé, J., Ratsimbazafy, H.A., et al., 2022. A Social Network Analysis of Mangrove Management Stakeholders in Sri Lanka's Northern Province. Ocean & Coastal Management. 228, 106308. DOI: https://doi.org/10.1016/j.ocecoaman.2022.106308

[89] Soanes, L.M., Pike, S., Armstrong, S., et al., 2021. Reducing the Vulnerability of Coastal Communities in the Caribbean Through Sustainable Mangrove Management. Ocean & Coastal Management. 210, 105702. DOI: https://doi.org/10.1016/j.ocecoaman.2021.105702

[90] Setiacahyandari, H.K., Hizbaron, D.R., 2024. Understanding Eco-DRR as a Sustainability Indicator for Mangrove Conservation in Urbanized Area of North Jakarta, Indonesia. Environmental and Sustainability Indicators. 24, 100494. DOI: https://doi.org/10.1016/j.indic.2024.100494

[91] Sofian, A., Kusmana, C., Fauzi, A., et al., 2019. Ecosystem Services-Based Mangrove Management Strategies in Indonesia: A Review. AACL Bioflux. 2(1), 151–166. Available from: https://bioflux.com.ro/docs/2019.151-166.pdf

[92] Branoff, B., 2018. Urban Mangrove Biology and Ecology: Emergent Patterns and Management Implications. In: Makowski, C., Finkl, C.W. (Eds.). Threats to Mangrove Forests, Coastal Research Library. Springer International Publishing: Cham, Switzerland. pp. 521–537. DOI: https://doi.org/10.1007/978-3-319-73016-5_23