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Mangrove Environmental Services, Participation, and Ecotourism: Mapping Global Research Trends Through Bibliometric Analysis

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Abstract

Challenges in mangrove ecosystem management arise from the polarization of values between local economic benefits (livelihoods) and global ecological concepts (Blue Carbon), as well as the critical issue of community participation. Through a bibliometric analysis of 300 documents (2021–2025) from the Scopus/Web of Science database, this study aims to map research trends and identify literature gaps related to mangrove ecosystem services, community participation, and ecotourism. Network analysis reveals a strong centrality to livelihoods, reflecting a research focus that is predominantly driven by economic benefits. In contrast, Blue Carbon is situated on the periphery of the network, highlighting the research focus gap. Recent research trends are shifting toward regulation and institutions (governance). This study's scientific contribution is to offer research priorities to bridge this value gap by internalizing ecological concepts into local practices as a fundamental strategy for enhancing sustainable participation and synchronizing local conservation with the global climate agenda.

Keywords: Mangrove ecosystem services; community participation; ecotourism

INTRODUCTION

The mangrove ecosystem plays a crucial role in supporting coastal sustainability, providing essential environmental services such as carbon storage, coastal protection from erosion, climate change mitigation, and vital habitats for marine life (Perdana et al., 2021; Suprapto et al., 2021; Mugilan et al., 2024). Additionally, mangroves offer direct and indirect socio-economic benefits, making them a sustainable asset for coastal communities (Kunjuraman, 2024; Ollong et al., 2025). Although Indonesia's extensive mangrove areas make them a strategic national asset, unfortunately, mangroves are experiencing severe degradation due to land conversion, urbanization, and pond expansion (Rahmadi et al., 2023; Kurniawansyah et al., 2023). Therefore, mangrove management must be integrated, considering environmental services and community involvement to maximize benefits and ensure sustainability.

Mangrove ecosystem services are categorized into four main groups: provisioning, regulating, supporting, and cultural (Gargaran et al., 2024). Ecologically, research confirms its role as a high carbon storage (blue carbon) and as a natural defense against erosion (Sribianti, 2021; Warningsih et al., 2021). From a socio-economic perspective, developing mangrove-based ecotourism and encouraging local community participation are key strategies to increase benefits while supporting conservation (Kunjuraman, 2022; Fistiningrum & Harini, 2021). Community-based practices highlight that effective management must blend environmental science, policy, and socio-economics (Lukman et al., 2025). Therefore, sustainable management now requires a deeper understanding of community perceptions and participation, especially in ecotourism. Despite consensus on these strategies, field implementation faces obstacles, including limited participation, with coastal communities often involved only in operational roles rather than in strategic decision-making (Hapzi & Untari, 2024). There is also a perception that non-economic functions, such as regulating services (climate mitigation) and cultural services, are undervalued (Iswandaru & Febryano, 2021; Plaimo & Wabang, 2022; Wakhidah, 2025). These challenges are compounded by institutional and regulatory barriers, with ecotourism management hampered by weak local institutional support and a lack of sectoral coordination (Mursyid et al., 2021; Mardianton et al., 2024; Budisusila et al., 2024). Given these issues, there is an urgent need to develop mechanisms that internalize the value of mangrove ecosystem services by integrating ecological values into community participation practices beyond mere economic valuation.

This research offers significant novelty by integrating three crucial aspects that are often treated separately in previous studies: the internalization of mangrove environmental service values, the community-

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based ecotourism context, and the analysis of community perceptions and participation patterns. Previous studies often treat ecological and social-institutional aspects separately (Jabbar et al., 2021; Nugraha et al., 2024). The main objectives of this study are: (1) to analyze coastal community perceptions of mangrove environmental services; (2) to identify their participation patterns in ecotourism activities; and (3) to formulate effective internalization strategies to strengthen sustainable mangrove resource management. The urgency of this research is very high because mangrove ecotourism has the potential to simultaneously improve the welfare of coastal communities while preserving ecological functions amid climate change pressures.

METHODS

Research Design

This study is a systematic literature review and bibliometric analysis that is non-field-based (in-silico). Data collection was conducted exclusively from two reputable scientific databases: Scopus and Web of Science (WoS). The selection of these two databases is important to ensure validity and broad journal coverage. The population includes all documents that simultaneously contain three main themes: mangrove ecosystem services, community participation or involvement, and ecotourism development. Topic criteria were applied using a specific query formula: "mangrove ecosystem services" AND ("community participation" OR "local involvement") AND ("ecotourism" OR "coastal management"). Additional criteria limited the document type to only Journal Articles, with a time frame set from 2020 to 2025. After the screening process, the final sample size analyzed was 300 relevant journal articles, which were processed using VOSviewer software.

Research Procedure

The research procedure is carried out in three main systematic stages (Zupic & Čater, 2015): first, Data Acquisition, which involves searching using Query formulas on Scopus and WoS for the period 2020–2025, resulting in 300 journal articles as the final sample. Second, Data Processing, where the extracted bibliometric metadata (including Keywords, Authors, Affiliations, Year of Publication, and Citations) is processed using VOSviewer software (Van Eck & Waltman, 2010; Waltman, van Eck, & Noyons, 2010). This processing aims to normalize and prepare variables for network analysis. Third, Analysis and Interpretation, which involves analyzing the processed data to map keyword co-occurrence networks, identify dominant thematic clusters, and analyze temporal trends, forming the basis for describing shifts in global research focus.

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Research Data Analysis

Analisis data dilakukan terutama melalui visualisasi jaringan menggunakan VOSviewer. Perangkat lunak ini berfungsi sebagai instrumen utama dalam melakukan analisis co-word (ko-kata kunci), yang merupakan fondasi pemetaan ilmiah (Callon et al., 1983). Dalam visualisasi jaringan: ukuran lingkaran (Node Size) menunjukkan frekuensi kemunculan kata kunci (relevansi), sementara jarak antar lingkaran (Link Distance) mengindikasikan kekuatan keterkaitan tematik. Selain itu, warna (Temporal Analysis) digunakan untuk memetakan evolusi riset, di mana warna dingin (biru atau hijau) mencerminkan topik yang lebih tua, dan warna hangat (kuning atau merah) mengidentifikasi tren penelitian terbaru. Analisis ini dilanjutkan dengan analisis klaster untuk mengidentifikasi dominasi kelompok topik dan analisis sentralitas untuk menentukan isu-isu strategis, yang kemudian digunakan untuk menarik kesimpulan yang valid mengenai struktur bidang penelitian.

RESULTS AND DISCUSSION

Results

Polarization and Shifts in Coastal Ecosystem Research Themes

As an integral step in mapping the knowledge structure and identifying trends in thematic evolution, Keyword Co-occurrence Network Bibliometric Analysis was conducted using VOSviewer software. Figure 1 displays a visualization of the keyword co-occurrence network with a temporal overlay. Each node (circle) represents a research concept, while the color indicates the average year of publication. Overall, the visualization results show a clear polarization between established themes, which tend to be dominated by older colors, and emerging trends, marked by warmer colors.

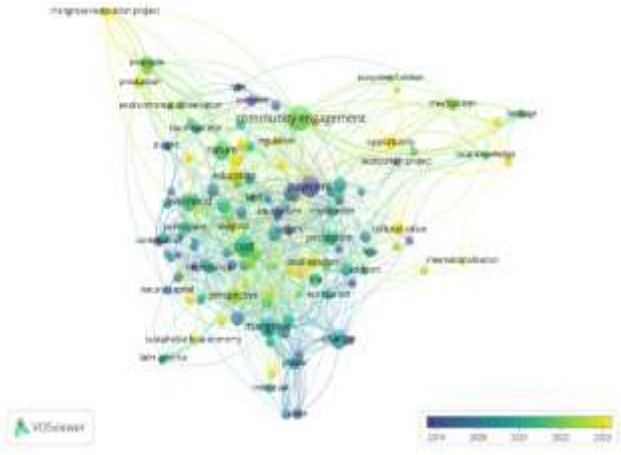

Figure 1. Visualization of Keyword Co-occurrence Network with Temporal Overlay (Bibliometric Analysis using VOSviewer)

The Gap Between Global Trends and Local Perceptions

This bibliometric analysis comprehensively reveals a significant polarization in the landscape of coastal ecosystem research. The Blue Carbon topic is identified as the most central and most recent research cluster, evidenced by visual markers (yellow/red clusters) on the VOSviewer

network. This finding reflects a growing global scientific emphasis on the importance of regulating ecosystem services, in line with international climate change mitigation priorities. Conversely, the long-standing thematic cluster (indicated by blue/green colors on the bibliometric map) continues to focus extensively on livelihood and ecotourism development (Fistiningrum & Harini, 2021). This indicates that, so far, practices and publications remain firmly rooted in socio-economic incentives and Provisioning/Cultural Services. This gap creates a theoretical-practical dilemma: cutting-edge global research is oriented toward abstract ecological values (Blue Carbon), while direct economic benefits dominate older research and local practices.

Table 1. Synthesis of Local Perception Polarization and Global Trends

Environmental Services Category	Relationship with Global Trends (Bibliometric Analysis)	Strategic Implications
Provisioning Service: Shows a high level of awareness of livelihoods and NTFPs.	As in the Old/Dominant Thematic Cluster (Green Color/Old), which focuses on livelihoods and the community's economy.	Becoming the main social capital and a solid entry point for participation, ensuring sustained commitment through incentives.
Cultural Service: Characterized by a high perception of ecotourism identity and local wisdom.	Connected with the cultural value cluster and local wisdom (Green/Old), which are part of the social conservation base.	Strengthen community-based ecotourism narratives as a local identity and a binding social commitment.
Regulating Service: Marked by Low Perception (Blue Carbon Conceptual Gap).	Contradicts the Central Cluster and the Newest (Bright Yellow Color/New 2022-2023), which focus on payment and carbon.	There is a knowledge transfer gap. Integration of carbon issues (global trends) into livelihood practices and community engagement (local basis) is needed to access climate funding.

The synthesis of this research concludes that there is a substantial knowledge transfer gap (Science-Practice Gap). This gap requires more adaptive and integrated management strategies. The strategic implication is that the Blue Carbon narrative must be effectively integrated into existing community-based ecotourism frameworks to bridge global conservation priorities with local development needs (Nugraha et al., 2024). The polarization identified within the global knowledge structure needs to be contextualized with value orientations at the local community level. To facilitate a structural understanding of this discrepancy, Table 1 presents a synthesis comparing local perceptions of mangrove ecosystem service values with trends and centrality of thematic clusters within bibliometric networks. This in-depth review explicitly highlights why integrating conceptual ecological values, particularly Blue Carbon, into the current socio-economic frameworks is an urgent imperative.

Central Theme Concentration in Mangrove Research

To complement the thematic co-occurrence analysis, Figure 2 displays a Network Density Visualization highlighting areas of high research concentration. This map shows the most mature topics, characterized by dense internal connections. The visualization illustrates the thematic density of keywords within the co-occurrence network, where bright yellow regions represent the highest levels of research focus. These areas often involve concepts such as community engagement, livelihood, payment, and mangrove, emphasizing the central clusters most frequently discussed and interconnected in the literature.

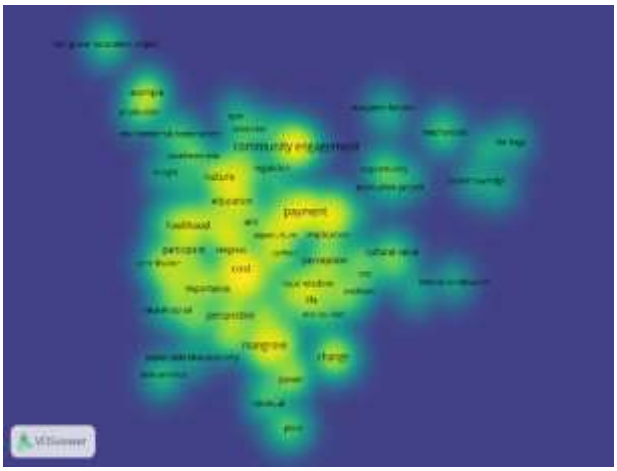

Figure 2. Network Density Visualization of Environmental Service Keywords for Mangroves (2015–2025).

Discussion

Convergence and Stability: Provision of Services and Cultural Services Analysis

Bibliometric analysis shows convergence and stability in the internalization of Provisioning Services values. These services have high community perception, making them the most effective sources of social capital and incentives for conservation (Dhungana et al., 2025). This alignment is empirically verified by bibliometric data,

which identify livelihood and community engagement clusters as established themes (stable, old clusters). These findings confirm that conservation strategies integrated directly with improving welfare and livelihoods have strong scientific validity and a powerful drive to mobilize community participation. Therefore, ensuring transparent and sustainable economic benefits from Provisioning Services should be the primary foundation to guarantee long-term community commitment.

Besides the economic aspect, Cultural Services also show a high level of stability and perception. The community internalizes these services as part of ecotourism identity, holds traditional values, and is enriched by local wisdom (Hapzi & Untari, 2024). Recognition of these non-economic values is crucial because they go beyond monetary incentives and create strong emotional and social bonds with the ecosystem. Strategically, Cultural Services serve as a multiplier of ethical and social commitments, lending legitimacy to local management rules. The combined stability of Provisioning and Cultural values creates a solid foundation for adaptive management. However, it also highlights the potential limitations of an understanding that focuses only on benefits within local community boundaries.

Contradiction: Arrangement Services and Knowledge Transfer Gaps

The sharpest polarization in the landscape of research and management practices lies in Regulating Services. Although the empirical function of mangroves as erosion barriers is well understood, the local community's perception of the conceptual ecological values, such as Blue Carbon and climate change mitigation, remains low (Wakhidah, 2025). This contradiction is explicitly confirmed by the VOSviewer analysis: local understanding is firmly rooted in the local-applied aspect, while the clusters of payment, carbon, and change become the Central and Most Recent Clusters (through 2024–2025). Global demands drive these recent clusters to finance Nature-Based Solutions and carbon finance schemes.

The contradiction between the global research agenda and local understanding clearly indicates a Science-Practice Gap. Global research focuses on carbon finance, while field beneficiaries lack the conceptual framework to understand and utilize these values. Therefore, the strategic implications of these findings are urgent. Education must be redesigned to transform ecotourism into an effective platform that directly integrates Blue Carbon narratives into livelihood practices and community engagement (King et al., 2024). This strategy is key to bridging the global agenda (Blue Carbon) with the local social-economic base, enabling optimal access to climate-funding opportunities.

Implications of Procedural Justice and Institutional Transformation

The gap in values is exacerbated by governance issues that create risks of Tokenistic Participation. Effective Operational Participation characterizes this phenomenon, but Strategic Participation (decision-making, fair profit sharing) tends to be centralized among elites (Mursyid et al., 2021). The lack of financial transparency and unresolved conflicts of interest are manifestations of governance failure. Although community engagement is central in global bibliometrics, the failure to realize procedural justice threatens the integrity of this pillar. Therefore, Institutional Transformation and Strengthening Procedural Justice become the most urgent solutions. These are fundamental conservation tools that foster a sustainable sense of communal ownership. Its implementation requires a mutually agreed-upon financial transparency system and the strengthening of soft managerial skills. Institutional Synchronization (the third pillar of the strategy) requires active assistance from local governments in drafting Village Regulations (Perdes) so that managing institutions (Pokdarwis) transform into inclusive entities capable of leveraging complex funding opportunities from the global payment cluster. Overall, the future of mangrove management depends on the capacity of local institutions to bridge the stability of Service Provision and Cultural services with the opportunities of Regulation Services/Blue Carbon through the strengthening of Procedural Justice.

CONCLUSION

A bibliometric analysis of global research on mangrove environmental services reveals a paradigmatic transformation characterized by a clear thematic polarization between 2020 and 2025. The main results show that established themes, such as livelihood and community engagement, form the foundation of research oriented towards local socio-economic benefits. In contrast, the latest research trends (emerging themes) have shifted significantly towards a global agenda, centered on the payment, carbon, and change clusters (dominated by bright yellow on the temporal map). This polarization creates a thematic gap in which the carbon cluster (conceptual Regulation Services) is not yet structurally integrated with the livelihood (Provisioning Services) and community engagement clusters. Therefore, the main conclusion is that future research should focus on bridging this gap, with studies that test the effectiveness of integrating the value of Regulatory Services into local conservation practices, and on strengthening the institutionalization and regulation dimensions to ensure fairness in the latest payment for ecosystem services (PES) mechanisms.

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