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The Role of Customary Forests in Climate Change Mitigation: An Analysis of Traditional Conservation Practices

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Abstract
Customary forests managed by indigenous communities are increasingly recognized as critical assets for climate change mitigation, yet they face dual threats from environmental degradation and rigid conservation policies. This study aims to analyze the effectiveness of traditional conservation practices in customary forests and their specific contribution to climate resilience and carbon mitigation. A systematic literature review was conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Data were retrieved from the Scopus database, limiting the scope to English-language articles published between 2020 and 2026. Out of 194 initial records, 24 studies met the eligibility criteria and were subjected to thematic analysis. The review identified three key findings: (1) Indigenous stewardship often sustains higher functional diversity and resilience than strict state-controlled protected areas; (2) Rapid climate velocity is rendering static "preservationist" models obsolete, necessitating the adoption of adaptive frameworks like "Resist-Accept-Direct" (RAD); and (3) Effective mitigation requires a hybrid approach that integrates Traditional Ecological Knowledge (TEK) with modern technologies, such as DNA barcoding and predictive climate modeling. The study concludes that achieving global climate goals requires a paradigm shift from "fortress conservation" to active, rights-based stewardship that legally empowers indigenous communities as primary ecosystem engineers..

Keywords: Climate Change, Customary Forests, Traditional Forest Conservation, Local Wisdom

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1. Introduction

Climate change affects future forest conditions by altering forest processes and biodiversity. Increasing concentrations of CO_2 in the atmosphere are predicted to be the primary cause of climate change, gradually warming the Earth. Approximately one quarter of the increase in atmospheric CO_2 originates from deforestation, which significantly influences the global climate. In recent years, species responses to climate change have become a major focus of attention at local, regional, and global levels. Wang and Myint (2016) explain that biodiversity is often affected by the impacts of climate change, such as changes in temperature, precipitation, evaporation, solar radiation, carbon emissions, and the frequency of extreme climate events.

Forests play a crucial role in mitigating and adapting to climate change. They are essential for absorbing carbon from the atmosphere and storing it over long periods. Conversely, deforestation contributes approximately 6–17% of total global anthropogenic CO_2 emissions. Forest ecosystems are therefore vital for humanity in addressing both current and future climate change. This includes customary forests, which play an important role in climate change mitigation processes. In reality, many customary forests face the threat of displacement or conversion for development projects or agricultural expansion. Customary forests are material assets owned by indigenous law communities and cannot be arbitrarily transferred through their reclassification as state forests (Malhi et al., 2020).

Customary forests are generally inhabited by indigenous communities who live in and around forest areas. Many indigenous peoples depend on customary forests for their daily livelihoods. These forests are protected because they provide multiple benefits: serving as sources of livelihood for indigenous communities, maintaining natural ecosystems, and supporting the role of forests in regulating climate change. According to Rahden and Abdon (2003), there are three fundamental principles in the management of indigenous forests. First, management follows ecosystem mechanisms that have evolved alongside human societies, maintaining harmony as part of the ecosystem. Second, there is an established knowledge system and institutional structure (customary governance) that enables communities to address issues related to forest resource use. Third, there is a system of distribution and enforcement of customary law to ensure that forest resources are protected both from internal misuse and external exploitation.

Within customary forests, ecosystems remain relatively intact because indigenous communities regard forests as partners in life rather than mere resources. They do not exploit forests excessively, allowing forest ecosystems to function naturally. Across Indonesia, indigenous communities practicing traditional or customary forest management employ various techniques for sustainable natural resource management. These communities possess a deep understanding of forest ecosystems and are well positioned to maintain ecological balance through traditional practices such as managing shifting cultivation, protecting water sources, and utilizing medicinal plants.

Customary forests are not merely green spaces; they are symbols of sustainability, resilience, and local wisdom. In addressing the global climate crisis, valuable lessons can be drawn from the ways indigenous communities manage customary forests—living in harmony with nature while preserving environmental heritage for future generations. Local wisdom is one of the most important keys in global efforts to combat climate change and maintain ecological balance. Keraf (2010) emphasizes that indigenous communities possess their own rules to ensure the sustainability of customary forests, particularly through local wisdom practices (Qordriyatun, 2015).

Based on the discussion above, it is necessary to further examine the conservation practices implemented by indigenous communities in managing customary forests, ensuring that forest ecosystems remain intact and continue to function effectively. As previously noted, Indonesia is home to a significant number of customary forests. Currently, 131 customary forests have been officially recognized by the government. All of these forests are utilized and protected by local indigenous communities to ensure that forest functions are preserved and maintained sustainably.

2. Materials and Methods

2.1 Research Design

This study employs a systematic literature review aimed at comprehensively analyzing traditional conservation practices in the management of customary forests and their impact on climate change mitigation. By adopting a descriptive qualitative approach, this research synthesizes existing evidence to provide a holistic understanding of how indigenous knowledge systems contribute to ecological stability. The review process was structured to ensure reproducibility and minimize bias, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. This framework ensures a transparent and rigorous selection of studies, allowing for a systematic evaluation of the available literature.

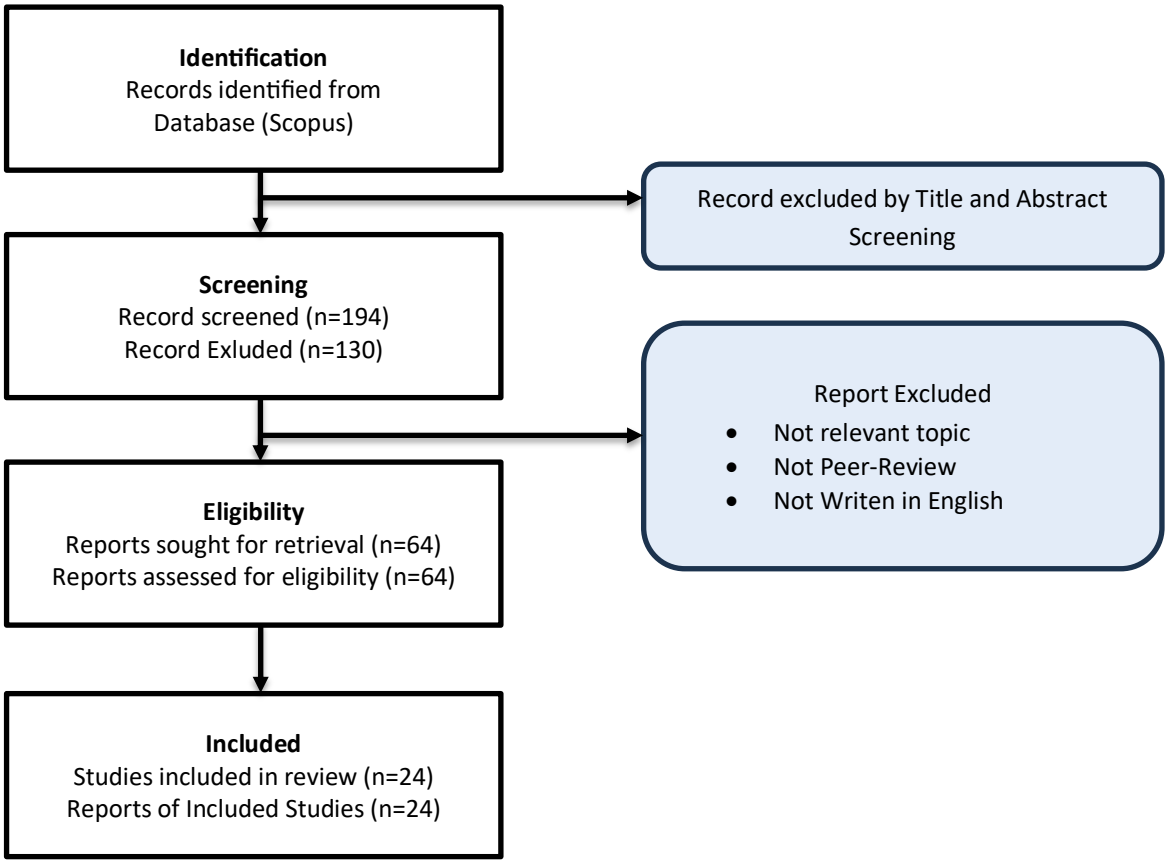

Figure 1. PRISMA Flowchart

2.2 Eligibility Criteria

To ensure the review focused on high-quality and relevant evidence, strict eligibility criteria were established. The review included scientific articles that presented primary data sources, ensuring the analysis was grounded in empirical evidence rather than theoretical speculation. To maintain linguistic consistency and accessibility, the accepted publication language was limited to English. To capture the most recent developments and current state of customary forest management in the context of rapidly evolving climate science, the publication year range was restricted to the period between 2020 and 2026. Explicit exclusion criteria were applied to filter out studies that were not peer-reviewed, such as conference proceedings without full papers, editorials, and gray literature. Furthermore, studies that were deemed irrelevant—specifically those that did not explicitly discuss the intersection of customary forests, traditional conservation, and climate change—were excluded from the final synthesis.

2.3 Information Source

The electronic database Scopus was selected as the primary information source for this review. Scopus was chosen due to its status as one of the largest and most comprehensive abstract and citation databases of peer-reviewed literature. It offers extensive coverage in the fields of environmental science, agricultural studies, and social sciences, which are the core disciplines intersecting in this research. The database's rigorous indexing standards ensure that the articles retrieved are of high academic quality, thereby supporting the validity of this review's findings.

2.4 Search Strategy

A systematic search strategy was developed to identify relevant literature. The search string was constructed using Boolean operators to combine key terms related to the study's objectives. The full search string used was: TITLE-ABS-KEY (("customary forest" OR "indigenous forest" OR "traditional forest management") AND ("climate change" OR "carbon mitigation" OR "carbon sequestration") AND ("conservation" OR "local wisdom")). This strategy was developed and refined through an iterative process. Initial scoping searches were conducted to identify common keywords used in relevant high-impact journals. The string was then tested and adjusted to ensure it captured a broad range of relevant studies without retrieving an excessive number of unrelated articles.

2.5 Study Selection Process

The study selection process was conducted in two stages. First, all retrieved records were screened by title and abstract to remove duplicates and clearly irrelevant studies based on the inclusion criteria. Second, the full texts of the remaining articles were retrieved and assessed for final eligibility. This screening process was conducted by two independent reviewers to reduce selection bias. Any discrepancies between the reviewers regarding the inclusion or exclusion of a specific study were resolved through discussion until a consensus was reached. If a consensus could not be achieved, a third reviewer was consulted to make the final decision.

2.6 Data Extraction

Data extraction was performed using a standardized extraction form to ensure consistency. For each included study, the following information was extracted: author(s), year of publication, study objectives, methodology, and key findings regarding traditional conservation practices and climate mitigation outcomes. This structured approach facilitated the comparison of findings across different geographic locations and cultural contexts.

2.7 Quality Assessment

To ensure the reliability of the findings, the methodological quality of the included studies was assessed using the Newcastle-Ottawa Scale (NOS), adapted for cross-sectional and qualitative studies. This tool allowed for the evaluation of the selection of study groups, the comparability of the groups, and the ascertainment of the exposure or outcome of interest. The assessment was conducted by two experts in agricultural science education. The results of this quality assessment were used to weight the evidence during the synthesis; studies identified as having a high risk of bias were treated with caution, and the synthesis primarily relied on studies demonstrating robust methodological quality.

2.8 Data Synthesis

Given the heterogeneity of the included studies in terms of methods and cultural contexts, a meta-analysis was not feasible. Instead, data were analyzed using thematic analysis. This involved identifying recurring patterns and themes across the extracted data, such as specific local wisdom practices, mechanisms of carbon storage, and social institutional structures. These themes were then synthesized narratively to provide a comprehensive answer to the research objectives, ensuring a coherent and logical flow of information that highlights the collective impact of customary forests on climate change mitigation.

3. Results and Discussions

3.1 Overview of Included Studies

The systematic review process resulted in the final inclusion of 24 articles published between 2021 and 2026. The selected studies encompass a diverse range of geographic regions, including the Tropical Andes, Sub-Saharan Africa, Southeast Asia (specifically Indonesia and Myanmar), and North America, highlighting the global relevance of integrating traditional and customary practices into climate mitigation strategies. The methodologies employed vary from systematic reviews and policy analyses to field experiments and predictive modelling (e.g., Species Distribution Models). Table 1 presents a summary of the included studies, detailing the authors, methods, and key findings relevant to this research.

Table 1. Summary of Included Studies

Author (Year)	Method	Key Findings
Hämäläinen et al. (2026)	Systematic Review	Traditional conservation practices often align with climate adaptation, but novel climate-specific recommendations are less frequent.
Nienaber & Imrie-Kuzu (2025)	Systematic Review	Transformative change requires governance innovation and behavioral shifts; traditional approaches alone are insufficient for systemic drivers.
Gunasena et al. (2025)	Review	Integrating modern biotechnology (tissue culture/DNA barcoding) with traditional conservation addresses challenges like seed recalcitrance.
Steel et al. (2025)	Empirical Study (Field)	Historical-centric conservation (restoring past fire regimes) may not maximize future biodiversity; managing for pyrodiversity is crucial.
Rather et al. (2025)	Review	Traditional methods (habitat conservation, legal policies) lack scalability for *Dalbergia*; AI and tech-driven solutions are needed.
Rosales-Ramos et al. (2025)	Spatial Analysis (SDM)	Existing Protected Areas (traditional tool) leave critical conservation gaps for *Opuntia* species; high richness areas are underprotected.
Johnson et al. (2025)	Modeling (BRT)	Climate shifts challenge traditional static conservation strategies for North Atlantic right whales; predictive foraging models are needed.
Gardner & Bullock (2025)	Conceptual Analysis	"Assisted colonization" is necessary to maintain ecosystem function, moving beyond the traditional goal of preserving species "in place."
Keller et al. (2025)	Modeling/Decision Framework	Proposes a "Resist-Accept-Direct" (RAD) framework; traditional goals of maintaining historic states are increasingly impractical for invasive species.
Ayoumbissi Keugmeni et al. (2025)	Field Experiment	Integrating traditional soil conservation (*Zaï*, *Half-moon*) with controlled irrigation significantly improves food security and yields in the Sahel.
Gerstner & Zarnetske (2025)	Spatial Analysis	Community-managed lands often have higher functional diversity than strict protected areas; Indigenous lands are critical for conservation.
Perry et al. (2024)	Review	Proposes a resilience-based framework for riverine systems, criticizing traditional opportunistic/reactionary conservation.
Bowen-Jones (2024)	Conceptual/Review	Traditional approaches cannot rebuild dynamic ecosystems alone; need "ecosystem engineers" (human and non-human) to re-animate landscapes.
Bratu et al. (2024)	Literature Review/Case Study	Voluntary Payment for Ecosystem Services (PES) schemes show promise in Romania, supplementing mandatory legislation.
Mulwanda et al. (2024)	Survey/Focus Groups	Smallholder farmers possess traditional knowledge for pollinator conservation, but adoption is hindered by lack of support/enforcement.
Dyring et al. (2024)	Policy Analysis	Coastal groundwater-dependent ecosystems fall through policy gaps; traditional protected areas often fail to protect underlying groundwater systems.
Wilkening et al. (2023)	Framework Application	Applies the RAD framework; traditional practice of preserving species in place is challenged by ecosystem transformation.
Germano et al. (2023)	Species Distribution Modeling	Traditional in-situ methods are insufficient for frogs in NZ under climate change; assisted migration is required.
Schlaepfer & Lawler (2023)	Review/Perspective	Conservation must shift priorities from maintaining historical states to fostering biodiversity changes and human well-being.
Harwood et al. (2022)	Modeling (Spatial Resilience)	Developed a Spatial Resilience Index to measure landscape capacity to retain biodiversity; highlights areas for adaptive management.
Balmford et al. (2021)	Review	Conservation relies too heavily on traditional education/regulation; needs to integrate behavioral science for more effective interventions.
Dar et al. (2021)	Machine Learning (Modelling)	Climate change threatens Himalayan brown bear habitat significantly; traditional in-situ conservation will not be sufficient without mitigation.

Musundire et al. (2021)	Literature/Policy Review	Stewardship of edible insects in Africa requires preserving traditional harvesting practices supported by robust policy frameworks.
Gaitan-Espitia & Hobday (2021)	Review	Rapid climate change necessitates a shift from passive (traditional) interventions to active evolutionary and genetic management.

3.1 Interpretation of Key Findings

The synthesis of the 24 articles reveals three dominant themes regarding the role of customary and traditional conservation in the era of climate change.

3.1.1 The Resilience of Indigenous and Community-Based Stewardship

A critical analysis of recent literature fundamentally challenges the "fortress conservation" model, which historically prioritized strict, state-controlled protected areas over inhabited landscapes. The findings from Gerstner & Zarnetske (2025) provide compelling empirical evidence that community-managed lands in the Tropical Andes do not merely coexist with biodiversity but actively sustain higher levels of functional diversity (FD) than many strict protected areas (PAs). This suggests that the "exclusionary" approach to conservation may be flawed, particularly in regions where indigenous stewardship has shaped ecological functions over millennia. By maintaining specific guilds of frugivorous birds and mammals essential for seed dispersal, customary forests serve as dynamic reservoirs of ecosystem services rather than static museums of nature. This finding is significant because it shifts the theoretical framework from viewing human presence as an inherent threat to viewing specific types of human stewardship—namely, indigenous customary management—as a prerequisite for ecological integrity.

The resilience of these traditional systems is further underscored by their practical adaptability to extreme climate stressors. For instance, research by Ayoumbissi Keugmeni et al. (2025) in the Sahel region demonstrates that traditional soil conservation techniques, such as Zaï (planting pits) and Half-moon structures, when integrated with controlled irrigation, significantly outperform conventional flat tillage in terms of crop yield and soil health. This indicates that "local wisdom" is not merely a cultural artifact but a rigorous, empirically valid set of technologies adapted to resource scarcity. Unlike modern industrial monocultures that are often brittle in the face of drought, these customary practices enhance soil water retention and nutrient cycling, thereby acting as a buffer against the climatic volatility predicted for the coming decades.

However, the literature also warns against romanticizing indigenous stewardship without analyzing the specific mechanisms that make it effective. It is not the mere presence of indigenous communities that guarantees conservation, but the specific application of their governance structures and ecological knowledge. The success of the systems described by Gerstner & Zarnetske (2025) and Ayoumbissi Keugmeni et al. (2025) relies on active, regulated interaction with the environment—what Bowen-Jones (2024) refers to as being "ecosystem engineers." This implies that the value of customary forests lies in the processes of interaction they preserve (e.g., selective logging, rotational farming, spiritual prohibitions) rather than just the land tenure itself. Therefore, climate mitigation strategies must focus on protecting these specific traditional management practices, rather than just drawing boundaries around indigenous territories without empowering the governance systems that sustain them.

3.1.2 The Limitations of Static "Traditional" Conservation vs. Adaptive Management

A major conceptual tension identified in this review is the divergence between "traditional conservation" as defined by Western science (maintaining historical baselines) and "traditional conservation" as practiced by indigenous groups (adaptive stewardship). Several studies (Steel et al., 2025; Johnson et al., 2025; Wilkening et al., 2023) argue that the Western scientific reliance on historical baselines—attempting to keep ecosystems exactly as they were in the past—is becoming increasingly untenable due to rapid climate velocity. Steel et al. (2025) explicitly found that restoring historical fire regimes in the Sierra Nevada might fail to maximize future biodiversity, suggesting that a rigid adherence to "how things used to be" can be maladaptive. This critique is pivotal, as it suggests that state-sanctioned conservation policies that enforce static preservation may ironically be less effective than dynamic customary systems that are comfortable with cyclical change and patch dynamics.

In response to these limitations, the literature increasingly advocates for a "Resist-Accept-Direct" (RAD) framework, as proposed by Keller et al. (2025) and Wilkening et al. (2023). This framework acknowledges that ecosystem transformation is inevitable and that managers must decide whether to resist change, accept a new ecological state, or direct the system toward a novel but functional condition. Indigenous management systems have arguably been practicing a form of "Directing" for centuries—modifying landscapes to favor useful species (like fruit trees or medicinal plants) while maintaining overall canopy cover. This aligns with the findings of Gardner & Bullock (2025), who argue that "assisted colonization" and active translocation of species will be necessary to prevent ecosystem collapse. The implication is that Customary Forests, which are often managed as "forest gardens," may be better pre-adapted to this active management paradigm than strict nature reserves designed to be untouched wilderness.

Furthermore, the concept of "re-animating" landscapes proposed by Bowen-Jones (2024) suggests that passive protection is insufficient for climate mitigation. The study argues that we need "ecosystem engineers"—both human and non-human—to actively rebuild natural complexity. This challenges the passive bias of many international climate schemes (like early iterations of REDD+), which viewed forests simply as carbon stocks to be fenced off. Instead, the literature suggests that the most effective carbon sinks are those that are actively managed for complexity and resilience, a characteristic typical of many customary forest regimes. Thus, the finding is that "preservation" is dead; "adaptive stewardship" is the only viable path forward, and customary forests offer a working model of what that stewardship can look like when it is grounded in deep local knowledge.

3.1.3 Technological and Governance Pathways for Integration

Despite the demonstrated value of customary conservation, the literature reveals a critical implementation gap characterized by a lack of political and financial support. Mulwanda et al. (2024) highlight a recurring tragedy: while smallholder farmers in Zambia possess sophisticated traditional knowledge regarding pollinator conservation, their ability to implement this knowledge is crippled by financial constraints and a lack of enforcement mechanisms. This finding points to a systemic failure in global climate governance, where resources are often funneled to high-level bureaucratic fixes rather than the grassroots communities actually managing the land. The disconnect between having the knowledge and having the power to use it is a primary barrier preventing customary forests from reaching their full mitigation potential.

However, a promising counter-trend identified in the review is the potential for integrating traditional wisdom with advanced technology to bridge this gap. Studies by Gunasena et al. (2025) and Rather et al. (2025) describe how modern biotechnologies—such as DNA barcoding, tissue culture, and AI-driven monitoring—can be deployed to support traditional conservation goals. For example, DNA barcoding can be used to scientifically validate indigenous claims about species diversity, protecting customary lands from illegal logging or biopiracy. This "technological validation" does not replace local wisdom but acts as a shield, giving it the empirical weight needed to survive in a court of law or international climate treaty. This synthesis of ancient knowledge and futuristic tech offers a powerful new narrative for conservation, moving beyond the binary of "primitive vs. modern."

Finally, the review emphasizes that technology alone is insufficient without governance innovation. Nienaber & Imrie-Kuzu (2025) and Dyring et al. (2024) argue that transformative change requires restructuring social-ecological governance. They identify "policy gaps" where critical ecosystems (like groundwater-dependent coastal zones) fall through the cracks of fragmented government agencies. The solution proposed is not just "more government" but "polycentric governance," where customary institutions are formally recognized as partners with equal standing to the state. This implies that the most critical "technology" for climate mitigation is not a machine, but a legal innovation: the formal recognition of Customary Rights as a primary vehicle for global climate security. Without this governance shift, the ecological resilience of customary forests will likely be eroded by external economic pressures, regardless of how effective their traditional practices might be.

3.2 Implications

3.2.1 Practical and Theoretical Implications

Theoretically, this review shifts the discourse from "protecting nature from people" to "protecting nature *through* people." The superior performance of community-managed lands in some contexts (Gerstner & Zarnetske, 2025) provides empirical backing for Rights-Based Conservation. Practically, this implies that climate funding (e.g., REDD+) should be directly channeled to Indigenous institutions rather than just central governments, as these communities are proven stewards of carbon-rich functional ecosystems.

3.2.2 Policy and Practice

Policymakers must move beyond the "Protected Area" designation as the sole conservation tool, as it often leaves gaps (Rosales-Ramos et al., 2025; Dyring et al., 2024). Instead, policies should legally recognize Customary Forests and support them with "active" management resources—such as assisted migration technologies or drought-resistant agriculture—rather than imposing static preservation rules that may no longer fit a changing climate (Schlaepfer & Lawler, 2023).

3.3 Strengths and Limitations of the Literature Review

This review utilized the PRISMA guidelines to ensure a transparent and replicable selection process. The use of Scopus ensured that only high-quality, peer-reviewed literature was analyzed, and the inclusion of recent papers (up to 2026) provides a cutting-edge perspective on the field. The restriction to English-language publications may have excluded relevant studies on customary forests published in local languages (e.g., Bahasa Indonesia, Spanish). Additionally, while Scopus is comprehensive, it may miss smaller, regional journals where indigenous scholarship is often published. The high heterogeneity of the studies prevented a statistical meta-analysis, relying instead on qualitative thematic synthesis.

3.4 Future Research Directions

Based on the identified gaps, future research should focus on:

1. **Hybrid Management Models:** Investigating how specific traditional practices (like *Zaï* or shifting cultivation) can be formally integrated with technical climate adaptation strategies (e.g., predictive climate modeling).
2. **Longitudinal Effectiveness:** Few studies track the long-term carbon sequestration outcomes of customary forests compared to state forests; more quantitative, longitudinal data is needed.
3. **Governance of Transformation:** How can customary laws evolve to address *new* climate threats (e.g., invasive species, novel fire regimes) without losing their cultural integrity? Research using the RAD framework in indigenous contexts would be valuable.

4. Conclusions

Based on the discussion from the background through the systematic analysis of 24 recent studies, it can be concluded that traditional conservation practices carried out by indigenous communities play a significant and often superior role in preserving forest ecosystems and biodiversity compared to static, top-down models. The review highlights that community-managed lands are critical reservoirs of functional diversity (Gerstner & Zarnetske, 2025) and that local wisdom, when supported by modern tools and policy, offers resilient pathways for climate mitigation (Ayoumbissi Keugmeni et al., 2025). However, the "traditional" goal of preserving historical ecological states is increasingly untenable due to rapid climate change (Steel et al., 2025; Wilkening et al., 2023). Therefore, the future of customary forests lies not in isolation but in active stewardship empowering indigenous communities with the rights, technologies, and adaptive governance frameworks needed to manage ecosystem transformation. Uncontrolled exploitation must be replaced by this hybrid, rights-based approach to ensure global climate stability.

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