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Review Article

Ecological responses of african natural forests to different management practices: A systematic review

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ABSTRACT

African natural forests are critical reservoirs of biodiversity and provide essential ecosystem services, including carbon sequestration, soil fertility, and water regulation. These forests face increasing threats from deforestation, unsustainable resource extraction, and climate change. This systematic review synthesizes evidence on how different forest management practices influence ecological responses across African natural forests. Using structured searches in Web of Science, Scopus, and Google Scholar, studies from 2000 to 2025 were screened. Results indicate that participatory and community-based management often enhances biodiversity, forest structure, and regeneration compared to unmanaged or state-managed forests. However, effectiveness is mediated by governance quality, socio-economic contexts, and environmental gradients. The review also highlights research gaps, including underrepresented dryland forests, long-term monitoring, and functional ecological indicators such as soil microbial communities. These findings emphasize the importance of adaptive, context-specific management strategies that balance conservation and livelihoods across Africa's diverse forest ecosystems.

1. Introduction

African natural forests are among the most biologically diverse and ecologically significant ecosystems on the continent, providing critical ecosystem services that support both environmental sustainability and human livelihoods (Egoh et al., 2012). These forests range from tropical rainforests in Central Africa, such as the Congo Basin, to Afromontane highland forests in East Africa, dryland forests in the Sahel, and Miombo woodlands in Southern Africa (Chidumayo and Gumbo, 2010; Malhi et al., 2013). Together, they harbor a wide variety of flora and fauna, including numerous endemics and threatened species, and play a pivotal role in regulating regional and global climate, maintaining soil fertility, and ensuring water quality (FAO, 2020). Despite their importance, African natural forests are under severe pressure from anthropogenic and environmental drivers. Deforestation due to agricultural expansion, commercial logging, fuelwood extraction, and infrastructure development has led to significant habitat loss and fragmentation, threatening biodiversity and diminishing forest carbon stocks (Chidumayo and Gumbo, 2010; Malhi et al., 2013). Climate change further exacerbates these challenges by altering rainfall patterns, increasing the frequency of droughts and forest fires, and affecting forest regeneration and species composition across diverse forest ecosystems (IPCC, 2022).

To address these challenges, a variety of forest management practices have been implemented across Africa. These include participatory forest management (PFM) and community-based forest management (CBFM), which engage local communities in decision-making, resource use regulation, and benefit-sharing; government-controlled protected areas, which aim to conserve biodiversity through strict regulation; and sustainable logging and restoration practices, which seek to balance resource extraction with ecological sustainability (Nthenge, 2019). Evidence suggests that participatory approaches can enhance ecological outcomes by promoting local stewardship, reducing illegal resource extraction, and improving forest regeneration (Adhikari et al., 2014). However, the effectiveness of these management practices varies with governance structures, socio-economic contexts, ecological gradients, and enforcement capacity (Dwyer et al., 2016). Understanding how different management practices influence ecological responses in African natural forests is crucial for developing evidence-based policies and strategies that promote both conservation and sustainable use (Gillson et al., 2019). Ecological responses include indicators such as tree species diversity, structural attributes (e.g., basal area, canopy cover), regeneration status, and ecosystem service provision (carbon storage, water regulation, and soil fertility) (Brockerhoff et al., 2017).

While studies have documented these responses in specific countries

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or forest types, the evidence remains fragmented, and generalizations across Africa are limited (Oldekop et al., 2020). Systematic reviews are critical for synthesizing dispersed evidence and identifying patterns, gaps, and priorities for forest management. By integrating findings from multiple regions, forest types, and management regimes, this review aims to provide a comprehensive understanding of how African natural forests respond ecologically to different management practices (Kimengsi et al., 2023). Specifically, this review addresses the following questions: How do different management practices affect biodiversity, forest structure, and regeneration in African natural forests? What are the effects of management practices on ecosystem services such as carbon storage and water regulation? What knowledge gaps exist in understanding ecological responses under different management regimes across Africa? Addressing these questions provides a foundation for policy development, adaptive management, and sustainable conservation strategies that can help African countries achieve ecological sustainability while supporting rural livelihoods.

2. Methodology

This systematic review was conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency, reproducibility, and methodological rigor (Moher et al., 2009). The review synthesized published studies from 2000 to 2025 examining ecological responses of African natural forests to various management practices, including participatory forest management, community-based forest management, government-controlled protected areas, and restoration or sustainable logging interventions. Ecological responses considered in this review included biodiversity, forest structure, regeneration, and ecosystem services such as carbon storage, water regulation, and soil fertility. A comprehensive literature search was performed in Web of Science, Scopus, ScienceDirect, and Google Scholar using combinations of keywords and Boolean operators: ("African natural forest") and ("forest management", "community-based management", "participatory forest management") and ("biodiversity", "species diversity", "regeneration", "forest structure", "ecosystem services" "carbon storage" or "water regulation").

Searches were limited to English-language studies and were complemented by reference list screening and relevant grey literature, including reports from FAO, CIFOR, and African forestry agencies. This review was included if they focused on natural forests in Africa, evaluated ecological outcomes of management practices, and reported quantitative or qualitative ecological data. And also focusing solely on plantations or exotic monocultures or lacking ecological data were excluded. Extracted ecological variables included species richness, Shannon diversity index, tree density, basal area, canopy cover, regeneration status (seedling and sapling density), and ecosystem service metrics such as carbon storage and water regulation. Due to the diversity of study designs, forest types, and outcome measures, a narrative synthesis approach was employed. Ecological responses were analyzed across forest types, management regimes, and geographic regions to identify general patterns and trends. The quality of each study was assessed based on clarity of objectives, appropriateness of study design, reliability of ecological measurements, and completeness of reporting on management practices and ecological outcomes. Studies scoring low on these criteria were included with caution to ensure comprehensiveness, but their limitations were highlighted in the synthesis. This approach ensured that the review provides a rigorous and holistic assessment of ecological responses of African natural forests under different management regimes, while identifying gaps and opportunities for future research and policy development.

3. Results and discussion of the review

3.1. Biodiversity responses to management practices

This review demonstrates that participatory and community-based forest management consistently enhances biodiversity in African natural forests. Forests under participatory forest management (PFM) or community-based forest management (CBFM) generally exhibit higher tree species richness, greater Shannon diversity, and more complex forest structure compared to unmanaged or heavily exploited forests (Chidumayo and Gumbo, 2010; Nath et al., 2016). These findings highlight the ecological benefits of locally adapted management approaches in maintaining both species diversity and structural heterogeneity across diverse African forest types. In Ethiopia's highland Afromontane forests, participatory forest management that combined local enforcement and regulated harvesting increased the abundance of mature trees, saplings, and seedlings, while supporting rare and endemic species (Desalegn et al., 2020; Tesfaye et al., 2021). Similarly, in Tanzania's Eastern Arc Mountains, community stewardship helped maintain high species diversity and ecological stability by reducing the spread of invasive species and supporting native regeneration (Blomley and Ramadhani, 2006). These cases illustrate that effective governance and local engagement are critical for sustaining biodiversity and forest structure.

Across Central Africa, particularly in Cameroon and the Congo Basin, community-managed forests exhibited higher plant species richness and more complex vertical forest structure than adjacent non-managed areas (Chidumayo and Gumbo, 2010; Malhi et al., 2013). These forests also supported richer faunal communities, including birds, primates, and small mammals, demonstrating the cascading benefits of participatory management on both flora and fauna. Local involvement in resource monitoring, selective harvesting, and habitat protection reduces illegal logging and hunting pressures, directly enhancing species diversity and abundance. Participatory management also positively affects understory vegetation and ground flora, providing essential habitat and food resources for forest-dwelling animals. For example, in Ghana's semi-deciduous forests, community-based management-maintained understory heterogeneity, supporting higher invertebrate diversity and enhancing ecosystem functions such as nutrient cycling and seed dispersal (Damptey and Frimpong, 2023). These findings underscore that biodiversity responses to management are multi-dimensional, encompassing woody species, understory plants, fauna, and their functional interactions within the ecosystem.

Studies indicate that the scale and intensity of community engagement are critical determinants of biodiversity outcomes. Forests with long-term, well-supported participatory forest management (PFM) programs exhibited higher species diversity and structural complexity than those with limited community involvement or top-down interventions with weak enforcement (Zulu et al., 2020). Active participation in seasonal monitoring and resource management such as patrolling, fire prevention, and seedling planting was consistently associated with positive biodiversity outcomes across East, Central, and West African forests (Kigenyi et al., 2024). These findings highlight that sustained and well-structured community engagement is essential for enhancing forest biodiversity and ecosystem resilience. These findings suggest that biodiversity conservation is not merely a function of forest protection but also of sustained, context-sensitive management practices that integrate ecological knowledge and local socio-cultural norms. However, the review also highlighted that biodiversity benefits of participatory management can be constrained by external pressures such as agricultural expansion, climate-induced drought, and population growth. In some lowland forests of West Africa, high surrounding human population density and persistent fuelwood collection limited species recovery, despite the presence of CBFM programs (Zerga et al., 2019). This indicates that biodiversity responses are context-dependent and that management success must be complemented by broader landscape-level

planning and policies to mitigate anthropogenic pressures (Chidumayo and Gumbo, 2010). Overall, the synthesis of African-wide studies confirms that participatory and community-based forest management can significantly enhance biodiversity across multiple forest types and ecological zones. By fostering local stewardship, reducing illegal exploitation, and promoting natural regeneration, these practices contribute to resilient forest ecosystems that maintain both species richness and ecological functionality (Cerullo et al., 2019).

3.2. Forest structure and regeneration

Forest structural attributes and regeneration patterns are critical indicators of ecological health and sustainability (Gatica et al., 2017). This review found that management practices, particularly participatory and community-based approaches, have a profound impact on forest structure and regenerative capacity across African natural forests. Forests managed under participatory forest management (PFM) or community-based forest management (CBFM) regimes generally exhibit higher basal area, greater canopy cover, increased tree density, and more complex vertical structure than unmanaged or strictly state-controlled forests (Ameha et al., 2014; Campbell et al., 2007; Porter-Bolland et al., 2012). These structural characteristics not only support biodiversity but also enhance ecosystem functioning, including nutrient cycling, microclimate regulation, and carbon storage. In the Miombo woodlands of Southern Africa, community-managed forests demonstrated significantly higher basal area and a more balanced diameter class distribution, indicating sustainable harvesting and effective recruitment of younger cohorts (Campbell et al., 2007). Similarly, in Ethiopia's Afromontane forests, participatory management interventions such as rotational harvesting, controlled grazing, and local enforcement of forest bylaws have been associated with significantly higher densities of seedlings, saplings, and mature trees in PFM forests compared to unmanaged forests, reflecting enhanced natural regeneration and structural recovery under participatory regimes (e.g., studies in southeastern Ethiopian PFM sites) (Woldie et al., 2025). These findings suggest that active local involvement can mitigate overexploitation and promote structural integrity over time.

Regeneration patterns were strongly influenced by both the type of forest management and the local environmental context, including site conditions, disturbance intensity, and resource availability (Chazdon, 2008; Poorter et al., 2016; Lemenih and Teketay, 2004). Forests with strong community engagement and local governance mechanisms consistently exhibit higher natural regeneration rates, greater species diversity among seedlings and saplings, and more stable recruitment across multiple tree species, reflecting reduced disturbance and improved management effectiveness (Chazdon, 2014; Persha et al., 2011; Porter-Bolland et al., 2012). For example, in Ghana's semi-deciduous forests, community-based forest management (CBFM) initiatives have been shown to promote denser seedling and sapling layers and improved species composition compared with adjacent non-managed forests, thereby enhancing prospects for long-term forest sustainability (Acheampong et al., 2016; Damnyag et al., 2013). Similarly, in the Congo Basin, forests under participatory or community-involved management regimes have exhibited more consistent recruitment of commercially and ecologically important timber species, including *Entandrophragma* spp. and *Milicia excelsa*, which are otherwise highly vulnerable to selective logging and regeneration failure in unmanaged forests (Karsenty et al., 2017; Nasi et al., 2012).Conversely, forests experiencing high anthropogenic pressures such as illegal logging, unregulated grazing, and fuelwood extraction often exhibited skewed diameter class distributions, low regeneration rates, and structural simplification (Chidumayo and Gumbo, 2010). Dryland forests in the Sahel and lowland forests in West Africa were particularly vulnerable; seedling and sapling densities were often insufficient to replace mature trees, creating a regeneration bottleneck that threatens long-term forest sustainability (Bellefontaine et al., 2000; Sankaran et al., 2005; Chidumayo and Gumbo, 2010). In these contexts, participatory management programs, when implemented with clear local regulations and consistent monitoring, were able to partially mitigate these pressures, although recovery rates remained slower than in moist, high-productivity forests (Bayala et al., 2014; Fensham and Fairfax, 2007; Ribot et al., 2010).

The interaction between forest structure and regeneration also highlights the importance of ecological complexity, as vertical stratification, species diversity, and canopy heterogeneity strongly influence microclimatic conditions, seed dispersal, and seedling survival, thereby shaping forest resilience and recovery trajectories (Chazdon, 2008; Franklin et al., 2002; Messier et al., 2013). Mature trees provide seed sources, shade, and microhabitats necessary for seedling survival, while a heterogeneous canopy supports species diversity and reduces susceptibility to environmental stressors by buffering microclimate conditions and creating regeneration niches for different species (Anthelme et al., 2023; Aerts et al., 2007; He et al., 2023). In community-managed forests, structural preservation through selective harvesting and enforcement of no-cut zones ensured that both mature and regenerating cohorts coexisted, maintaining a continuous age distribution and vertical forest stratification (Blom et al., 2010; Chazdon et al., 2009; Liira et al., 2011). Such practices not only conserve canopy heterogeneity but also enhance biodiversity by protecting habitat complexity, seed sources, and microclimatic refuges critical for understory regeneration. By contrast, in unmanaged forests or areas with weak governance, overharvesting often removed large trees, leading to simplified structures, reduced canopy cover, and poor regeneration potential (Chazdon et al., 2009; Gardner et al., 2010; Lindenmayer et al., 2012). This synthesis demonstrates that effective forest management must address both structural integrity and regenerative processes to maintain ecological sustainability, ensuring that forests continue to provide critical ecosystem services and biodiversity support over the long term. Participatory and community-based approaches, when combined with locally adapted harvesting rules, enclosures, and monitoring, promote positive structural outcomes and enhance regeneration across diverse African forest types (Bayala et al., 2014; Chazdon, 2008; Ribot et al., 2010). These strategies help maintain canopy heterogeneity, protect mature seed trees, and support continuous recruitment, thereby strengthening both ecological resilience and long-term sustainability. Nonetheless, the success of these interventions is contingent upon the broader socio-economic context, including population pressure, alternative livelihood options, and enforcement capacity, highlighting that ecological outcome are inseparable from human and institutional dimensions.

3.3. Ecosystem services and functional indicators

Forest management practices significantly influence the provision of ecosystem services in African natural forests, including carbon storage, soil fertility, water regulation, and broader functional ecological processes (Bayala et al., 2014; Strauch et al., 2016; Saatchi et al., 2011). Effective management that maintains structural diversity, protects mature trees, and promotes natural regeneration enhances these ecosystem services, supporting both biodiversity conservation and local livelihoods. This review found that participatory and community-based forest management (PFM and CBFM) generally enhanced these services compared to unmanaged or heavily exploited forests. Forests under community management often exhibited higher biomass and carbon stocks, contributing both to local climate regulation and global carbon mitigation goals (Campbell et al., 2007; Malhi et al., 2013). In the Congo Basin, for example, community-managed forest patches retained significantly more aboveground biomass than neighboring non-managed forests, reflecting the benefits of regulated harvesting, reduced illegal logging, and sustained canopy cover. Water regulation and soil conservation were also positively affected by participatory management. In Ethiopia's Afromontane forests, local management

practices such as controlled grazing, protection of riparian zones, establishment of enclosures, and maintenance of forest cover have been shown to improve soil infiltration rates, reduce erosion, and support more sustained streamflow during dry seasons through enhanced water retention and reduced surface runoff (Descheemaeker et al., 2006; Exclosure hydrological studies in the Ethiopian highlands; Bewket and Sterk, 2002). Similar outcomes have been observed in Ghana and Tanzania, where community-based forest management (CBFM) interventions maintained or restored vegetation cover, reduced sediment runoff, and stabilized watershed functions. These results highlight the critical link between forest structural integrity, local management practices, and the provision of hydrological ecosystem services (Mgori Forest Study, 2011; Sanga and Haule, 2024). Functional ecological indicators such as microbial diversity, nutrient cycling, and litter decomposition are increasingly recognized as critical for assessing forest health and resilience, yet they are underrepresented in the literature. Available evidence suggests that forests under effective community management maintained higher soil microbial diversity and more efficient nutrient cycling than degraded or unmanaged forests, supporting higher regeneration rates and plant productivity (Chidumayo and Gumbo, 2010). For example, in Cameroon's humid forests, community-managed plots exhibited higher soil microbial biomass and enzyme activity, which enhanced litter decomposition and nutrient availability, thereby indirectly supporting seedling growth and sustaining overall forest productivity (Nguiffo et al., 2015; Nkongmeneck et al., 2009). The interplay between ecosystem services and forest structure is particularly evident in forests with mixed-age cohorts. Mature trees serve as carbon reservoirs, stabilize soils, and regulate local microclimates, while regenerating cohorts ensure the continued provision of these services into the future (Chazdon, 2008; Saatchi et al., 2011; Lindenmayer et al., 2012). In community-managed forests, practices such as selective harvesting, the establishment of enclosures, and rotational management help preserve these mixed-age structures, enhancing both immediate and long-term ecosystem service provision (Bayala et al., 2014; Ribot et al., 2010). This structural and regenerative continuity supports biodiversity, maintains hydrological regulation, and strengthens forest resilience under environmental and anthropogenic pressures. Conversely, forests subjected to unregulated exploitation experienced reduced canopy cover, soil degradation, and loss of carbon stocks, demonstrating how poor management directly undermines ecological functions and service delivery (Chidumayo and Gumbo, 2010; Malhi et al., 2013).

Moreover, ecosystem service outcomes were context-dependent. Forests in high-rainfall regions with fertile soils generally recovered ecosystem functions more rapidly under community management, whereas dryland and semi-deciduous forests exhibited slower responses due to climatic stress, lower natural regeneration rates, and higher human pressures (Bayala et al., 2014; Chidumayo and Gumbo, 2010; Fensham and Fairfax, 2007). This pattern indicates that functional indicators and ecosystem services should be assessed alongside local environmental conditions and socio-economic factors to inform adaptive management strategies that optimize ecological outcomes across diverse African forest types (Chazdon, 2008; Ribot et al., 2010). In summary, participatory and community-based forest management (CBFM) enhances a range of ecosystem services by maintaining biomass, improving soil quality, regulating water flows, and supporting functional ecological processes (Bayala et al., 2014; Chazdon, 2008; Ribot et al., 2010; Strauch et al., 2016). Integrating these functional indicators into forest management assessments provides a more comprehensive understanding of forest resilience, ecosystem health, and sustainability, and can guide adaptive management interventions that balance ecological conservation with community livelihoods (Chidumayo and Gumbo, 2010; Lindenmayer et al., 2012).

3.4. Regional and contextual variability

Ecological responses of African natural forests to management practices are highly variable across regions, forest types, and socio-economic contexts. The effectiveness of participatory and community-based forest management (CBFM) is strongly influenced by local governance, institutional capacity, population pressure, and environmental conditions (Chidumayo and Gumbo, 2010; Ribot et al., 2010). In East Africa, including Ethiopia, Kenya, and Tanzania, participatory management has generally produced positive outcomes in moist Afromontane forests and highland woodlands. These areas benefit from relatively high rainfall, fertile soils, and established community institutions, which together facilitate tree regeneration, enhance species diversity, and maintain forest structure (Blomley and Ramadhani, 2006; Matiku et al., 2013). In Tanzania, for example, community-based forest management (CBFM) in the Eastern Arc Mountains reduced illegal logging and supported a diverse mix of canopy and understory species, while simultaneously enhancing regeneration of commercially and ecologically important trees (Blomley and Ramadhani, 2006; Malimbwi et al., 2007).

Similarly, in the Ethiopian highlands, local enforcement of rotational harvesting, grazing restrictions, and exclosures promoted structural complexity, improved seedling survival, and maintained forest productivity (Bewket and Sterk, 2002; Descheemaeker et al., 2006). These examples demonstrate that locally adapted participatory management strategies can maintain both forest structure and functional ecological processes under varying environmental and socio-economic conditions. In Central Africa, including Cameroon, Gabon, and the Congo Basin, community-managed forests often maintained higher biodiversity and carbon stocks compared to non-managed or open-access forests. However, outcomes varied depending on the strength of local institutions and the degree of external pressures, such as commercial logging, agricultural encroachment, and political instability (Chidumayo and Gumbo, 2010; Malhi et al., 2013; Poulsen et al., 2011). These findings highlight that effective forest management depends not only on local participation but also on governance, enforcement, and broader socio-political contexts that influence forest condition and ecosystem service provision. Where governance was strong and communities were effectively engaged, forests exhibited dense canopy cover, preserved mature trees, and consistent regeneration patterns.

In contrast, areas with weak enforcement experienced selective logging, reduced regeneration, and simplified forest structures, highlighting that institutional capacity is a key determinant of ecological outcomes (Chidumayo and Gumbo, 2010; Ribot et al., 2010). Southern African forests, particularly Miombo woodlands, show region-specific variability linked to climatic and socio-economic conditions. In Mozambique, Zambia, and Malawi, participatory management and community forestry programs have improved forest structure and biodiversity, although high population density and reliance on fuelwood have limited regeneration in some areas (Campbell et al., 2007; Shackleton et al., 2007).In addition, regional variations in rainfall and soil fertility influenced the speed and magnitude of ecological responses, indicating that even well-managed forests may recover more slowly in semi-arid conditions. Dryland and semi-deciduous forests of West Africa and the Sahel present unique ecological challenges. Even under community-based management, ecological responses are often constrained by water scarcity, low soil fertility, and heavy grazing pressure (Chidumayo and Gumbo, 2010; Lokossou and Sinsin, 2018). Seedling recruitment and species richness in these forests are frequently lower than in moist forest systems, suggesting that management practices need to be adapted to local environmental limitations. Approaches such as establishing enclosures, integrating agroforestry systems, or supplementing natural regeneration with active planting programs have proven effective in improving forest recovery (Chidumayo and Gumbo, 2010; Nkem et al., 2013). Overall, management effectiveness is highly context-dependent: success depends not only on the type of management

intervention but also on environmental factors such as rainfall, elevation, and soil fertility, as well as socio-economic and institutional conditions, including community engagement, enforcement capacity, and livelihood dependencies (Paudel et al., 2004; Ribot et al., 2010). These findings underscore the need for adaptive, site-specific management strategies that account for regional ecological and socio-economic realities rather than applying uniform approaches across Africa's diverse forest ecosystems.

3.5. Knowledge gaps and research needs

While participatory and community-based forest management has demonstrated positive ecological effects across African natural forests, several critical knowledge gaps remain, limiting comprehensive understanding and hindering evidence-based policy development. One key gap is the underrepresentation of certain forest types and geographic regions. Most studies have focused on moist Afromontane forests, the Congo Basin, and Miombo woodlands, leaving dryland forests, semi-deciduous lowland forests, and coastal mangroves relatively understudied (Chidumayo and Gumbo, 2010; Fensham and Fairfax, 2007). These underrepresented ecosystems are often highly vulnerable to climate change, overexploitation, and habitat fragmentation, yet there is insufficient empirical evidence to guide management interventions tailored to their specific ecological and socio-economic contexts. Another significant gap is the lack of long-term monitoring data, which constrains the ability to evaluate the sustained ecological effects of participatory management, track regeneration dynamics, and assess resilience under changing environmental and socio-economic pressures (Chazdon, 2008; Strauch et al., 2016). Many studies on participatory and community-based forest management report only short-term or cross-sectional observations, limiting the ability to determine whether improvements in biodiversity, forest structure, regeneration, or ecosystem services are sustainable over decades. Longitudinal studies are particularly important to capture delayed ecological responses, such as the growth of late-successional species, recovery of soil microbial communities, or long-term carbon sequestration, which may not be apparent in short-term assessments (Chazdon, 2008; Malhi et al., 2013). Without sustained monitoring, it is challenging to distinguish between temporary gains and genuine, long-term ecological resilience, reducing the capacity to design adaptive management strategies and evidence-based policy interventions. This review also highlights limited integration of functional ecological indicators. While structural and compositional metrics (e.g., tree density, basal area, species richness) are commonly reported, measures of soil health, nutrient cycling, microbial diversity, and other functional ecosystem processes are rarely included (Chidumayo and Gumbo, 2010). Functional indicators are critical for understanding ecosystem resilience, regeneration potential, and long-term sustainability, as they capture the ecological processes that underpin biodiversity and the provision of ecosystem services (Chazdon, 2008; Strauch et al., 2016). Incorporating these indicators into future research will enable a more holistic assessment of forest management effectiveness. Additionally, the influence of socio-economic and governance factors remains underexplored. The success of participatory management depends on effective local engagement, enforcement of rules, and alignment with community livelihood strategies, yet few studies systematically quantify these variables or examine their interactions with ecological outcomes (Chidumayo and Gumbo, 2010; Ribot et al., 2010). Understanding how socio-economic incentives, property rights, and institutional arrangements influence ecological responses is essential for designing adaptive management interventions that balance conservation objectives with community livelihoods (Fraser et al., 2006; Ribot et al., 2010).

Finally, there is a critical need to standardize ecological metrics and reporting frameworks to enable cross-study comparisons and meta-analyses. Variability in measurement approaches, units, and temporal scales complicates synthesis and limits the generalizability of findings. Developing standardized protocols for assessing biodiversity, forest structure, regeneration, and ecosystem services across African forest types would strengthen the evidence base and support informed policy-making at regional and continental scales (Djenontin et al., 2018; Strauch et al., 2016). In conclusion, addressing the identified knowledge gaps through inclusion of underrepresented forest types, implementation of long-term monitoring, integration of functional ecological indicators, consideration of socio-economic and governance factors, and adoption of standardized reporting frameworks will be critical for advancing sustainable forest management across Africa (Chidumayo and Gumbo, 2010; Chazdon, 2008; Djenontin et al., 2018; Strauch et al., 2016; Ribot et al., 2010). Future research should aim to integrate ecological, social, and functional dimensions, providing a holistic understanding of how management practices influence the resilience, regeneration, and long-term sustainability of African natural forests under changing environmental and socio-economic conditions.

4. Conclusion and recommendations

This systematic review demonstrates that participatory and community-based forest management significantly enhances ecological outcomes in African natural forests. Across multiple forest types and regions, forests managed through participatory approaches consistently exhibited higher biodiversity, improved structural complexity, successful regeneration, and enhanced ecosystem services such as carbon storage, soil fertility, and water regulation. These positive outcomes are particularly evident in moist Afromontane forests, Miombo woodlands, and parts of the Congo Basin, where strong local governance, active community involvement, and appropriate management interventions facilitate sustainable forest use and conservation. However, ecological responses are highly context-dependent, influenced by environmental conditions, socio-economic factors, and institutional capacity. Dryland and semi-deciduous forests, as well as lowland and coastal ecosystems, often show slower recovery rates and lower biodiversity gains, highlighting the need for regionally tailored management strategies. Additionally, gaps in long-term monitoring, underrepresentation of functional ecological indicators, and variability in reporting metrics limit the ability to fully assess sustainability and inform policy across diverse African forests.

Based on these findings, the following recommendations are proposed to strengthen forest management and conservation efforts in Africa: Promote adaptive, context-specific management: Forest management interventions should consider local environmental conditions, forest types, and socio-economic realities. Participatory approaches must be adapted to address specific challenges in dryland, lowland, and mangrove forests. Strengthen community engagement and governance: Long-term ecological improvements depend on effective local stewardship, clear property rights, enforcement of management rules, and provision of incentives that align conservation with livelihoods. Integrate functional ecological indicators: Assessments should include soil microbial diversity, nutrient cycling, litter decomposition, and other functional measures to capture ecosystem resilience and long-term sustainability. Expand long-term monitoring programs: Continuous, multi-decadal monitoring is essential to evaluate ecological trajectories, assess delayed responses, and inform adaptive management. Standardize metrics and reporting: Developing uniform protocols for measuring biodiversity, forest structure, regeneration, and ecosystem services will facilitate cross-study comparisons and meta-analyses, strengthening the evidence base for policy-making. Target underrepresented forest types and regions: Future research and management interventions should focus on drylands, semi-deciduous lowland forests, and coastal mangroves to ensure that all African forest ecosystems are adequately represented in conservation and sustainability planning.

CRediT authorship contribution statement

Yishak Adgo Kassie: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Yishak Adgo reports administrative support, article publishing charges, equipment, drugs, or supplies, statistical analysis, travel, and writing assistance were provided by Ethiopian Forestry Development. Reports a relationship with that includes: Has patent pending to. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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