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Sacred Groves and the Supernatural: The Role of Indigenous Beliefs in Biodiversity Conservation and Climate Adaptation in Sub-Saharan Africa.

[1,2]Dr. Awuor PONGE
[1]African Policy Centre (APC)
[2]Jaramogi Oginga Odinga University of Science & Technology (JOOUST),
Department of Development & Policy Studies
https://orcid.org/0000-0002-6656-1818

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Abstract

Purpose: This study examines the pivotal role of sacred groves and indigenous belief systems in biodiversity conservation and climate adaptation across sub-Saharan Africa. It investigates how spiritually governed landscapes function as reservoirs of biodiversity, providers of critical ecosystem services, and repositories of traditional ecological knowledge (TEK) that complement and frequently surpass formal conservation strategies in ecological effectiveness.

Methodology: The study employs a systematic qualitative literature review, drawing on a comprehensive synthesis of peer-reviewed journal articles, book chapters, institutional reports, and grey literature. Thematic analysis was applied to organise evidence across the study's principal analytical themes, with cross-case comparison used to identify patterns across West, East, Central, and Southern African contexts, including case studies from Ghana, Nigeria, Kenya, Tanzania, Zimbabwe, Benin, Cameroon, and South Africa.

Findings: Sacred groves consistently harbour greater species richness than state-managed reserves, sheltering endangered primates, medicinal plants, and keystone species through community governance mechanisms rooted in spiritual authority. Traditional taboos and rituals effectively maintain watershed protection, soil stabilisation, microclimate regulation, and carbon sequestration, often without external enforcement or financial incentivisation. However, agricultural encroachment, urbanisation, infrastructure development, religious conversion, and the progressive erosion of traditional practices among youth are degrading these landscapes at an alarming rate, creating governance gaps that formal conservation systems alone cannot address.

Unique Contribution to Theory, Practice and Policy: This study advances understanding of sacred groves as dynamic, multifunctional systems at the intersection of cultural sovereignty and ecological sustainability, demonstrating that the spiritual valuation of nature generates intrinsic conservation motivation that consistently outperforms purely economic incentives. It contributes a cross-regional comparative framework that positions indigenous cosmological worldviews not as peripheral to conservation science but as foundational to it. Four interconnected policy recommendations are advanced: formal legal recognition of sacred groves through national biodiversity frameworks and UNESCO designations; hybrid governance models that empower traditional custodians with complementary state support; intergenerational knowledge-transfer programmes to reverse TEK erosion; and the integration of sacred groves into carbon credit and climate finance systems to generate sustainable conservation funding. These recommendations collectively affirm that safeguarding sacred groves demands reimagining conservation as a collaborative endeavour that honours indigenous worldviews while responding to contemporary ecological pressures.

Keywords: *Sacred Groves, Indigenous Beliefs, Biodiversity Conservation, Climate Adaptation, Traditional Ecological Knowledge*

Introduction

Sacred Groves as Living Conservation Systems

Indigenous belief systems across Africa have long intertwined spirituality with environmental stewardship, creating sacred groves and venerating spirit trees as vital components of ecological and cultural resilience. Sacred groves, the forest fragments protected through cultural and spiritual norms, are among Africa's oldest conservation systems, with sites associated with deities, ancestors, and taboos having preserved rare species and stabilised ecosystems for generations (Poreku, 2014; Sinthumule, 2022). In an era of escalating climate crisis, their role extends beyond biodiversity conservation to mitigating land degradation, regulating water cycles, and storing carbon (De, 2017; Sinthumule, 2023). This article draws on case studies from West, East, Central, and Southern Africa to examine the ecological, cultural, and climatic significance of these landscapes, explore the mechanisms by which indigenous beliefs sustain their ecological functions, and evaluate opportunities for integrating them into broader climate adaptation frameworks.

Sacred groves are patches of forest or natural vegetation that hold profound religious and spiritual significance for indigenous and local communities, typically serving as sites for worship, rituals, and community gatherings (Wikipedia, 2025a). Protected by traditional beliefs and taboos that prohibit logging, hunting, and land conversion, these areas conserve biodiversity and maintain ecological balance (FAO, 1998). They act as refuges for rare, endemic, and medicinal plant species, and serve as micro-watersheds and water reservoirs for local communities (Vision IAS, 2025). Their management is deeply intertwined with the belief that these spaces are inhabited by deities or ancestral spirits, reinforcing communal commitment to their protection (Laisram, 2017). However, weakening traditional belief systems and modern development pressures increasingly threaten their ecological and cultural functions (FAO, 1998).

The Supernatural, Indigenous Beliefs, and Conservation

The supernatural, encompassing phenomena, entities, or forces beyond the laws of nature, is central to the belief systems that underpin sacred grove conservation (Wikipedia, 2025b; Britannica, 2025). Beliefs in gods, spirits, and ancestors that defy conventional scientific explanation serve as powerful motivators for environmental stewardship across cultures (Rosen-Zvi, 2025). Indigenous beliefs, defined as the spiritual and cultural systems developed by the original inhabitants of a region and deeply rooted in their connection to land, ancestors, and nature (Language, 2025), are typically transmitted orally and emphasise relationships with both human and non-human beings (Geertz, 2009). Non-proselytising and pluralistic in character, these belief systems focus on maintaining harmony with the environment and honouring ancestral traditions, providing enduring frameworks for moral conduct, community identity, and ecological governance (Language, 2025).

Biodiversity Conservation and Its Significance

Biodiversity conservation, the protection, management, and restoration of the variety of life on Earth across genes, species, and ecosystems, aims to preserve species diversity,

ensure the sustainable use of biological resources, and maintain essential ecological processes that support life (BYJU'S, 2024; Pimm, 2021). It provides ecosystem services including clean air and water, fertile soil, climate regulation, and resources such as food and medicine, all of which are fundamental to human well-being and survival (Rawat & Agarwal, 2015). Conservation can be pursued both in-situ, through protected areas such as national parks, and ex-situ, through botanical gardens, zoos, and gene banks (BYJU'S, 2024).

Climate Adaptation and Its Cultural Dimensions

Climate adaptation – the process of adjusting natural or human systems in response to actual or expected climate change – encompasses a wide range of actions from adopting drought-resistant crops to improving water management and building climate-resilient infrastructure (Schmidt-Thomé, 2017; UNDP, 2025). Adaptation measures may be incremental or transformational, depending on the scale of systemic change required. Crucially, culture: encompassing beliefs, values, identity, sense of place, and social organization, profoundly shapes how societies perceive climate risks, interpret scientific information, and select adaptation strategies, making adaptation as much a social and cultural process as a technical or economic one. Ignoring these cultural dimensions risks undermining the effectiveness and legitimacy of adaptation policies, eroding social cohesion and valued ways of life in the face of climate change (Adger et al., 2013).

Climate Adaptation through Indigenous Practices

Indigenous communities across Africa have developed a diverse array of climate adaptation strategies rooted in deep ecological knowledge and cultural practices (Nyadzi, Ajayi & Ludwig, 2021; Ajani, Mgbenka & Okeke, 2013). Integrating indigenous knowledge with modern climate action ensures that adaptation efforts are locally relevant, sustainable, and inclusive of the communities most affected by climate change (Muigua, 2023; Adger et al., 2013).

One key approach in indigenous climate adaptation is the modification of agricultural systems to suit changing climatic conditions. For instance, communities in Zimbabwe have shifted from growing maize to more drought-resistant traditional crops like millet and sorghum, which are better suited to withstand erratic rainfall and prolonged dry spells (Nyadzi et al., 2021). Traditional soil and water conservation techniques – such as mulching, crop rotation, intercropping, and the use of organic manure, help maintain soil fertility, retain moisture, and ensure sustainable crop yields despite climatic variability (Ajani et al., 2013; Nyadzi et al., 2021). In Mali and other West African countries, agroforestry systems that integrate trees with crops not only enhance soil fertility and water retention but also boost resilience to climate shocks (Nyadzi et al., 2021).

Water management is another critical area where indigenous practices play a vital role. In arid and semi-arid regions such as Ethiopia, communities use innovative methods like "fog nets" to harvest water from the atmosphere, increasing water availability by up to 30% compared to conventional methods (Nyadzi et al., 2021). Temporary walls built on riverbanks and large storage houses for produce are also employed to manage water resources and safeguard food supplies during periods of scarcity (Nyadzi et al., 2021). In mountainous

regions like Cameroon, terrace farming is practiced to reduce soil erosion and optimize water use, resulting in higher crop yields and improved soil conservation (Nyadzi et al., 2021). These techniques, developed over generations, are tailored to local environmental conditions and have proven effective in sustaining livelihoods amid increasing climate pressures (Ajani et al., 2013; Muigua, 2023).

Beyond agriculture and water, indigenous knowledge also informs broader ecosystem management and biodiversity conservation (Sinthumule, 2023). Pastoralist communities in Kenya, for example, use traditional grazing patterns that maintain livestock health and productivity during droughts, reducing livestock mortality rates (Muigua, 2023). Community-based forest management, as seen in Tanzania, leverages traditional ecological knowledge to protect forests and enhance resilience to climate change (Sheridan, 2009). Cultural practices, such as the preservation of sacred groves and the use of traditional weather forecasting, further contribute to ecosystem stability and adaptive capacity (Sinthumule, 2023; Muigua, 2023).

Sacred groves in Zimbabwe and Kenya act as natural water towers, recharging aquifers and maintaining river flows during droughts (Sinthumule, 2023). Traditional rainwater harvesting techniques, such as *Zai pits*, are often practiced near these sites to enhance agricultural resilience. Farmer innovations are central to Zai development, it is their own effort that spread the planting pits rapidly in Burkina Faso, Mali and Niger (Danjuma, & Mohammed, 2015). Variations of Zai pits have been used in several areas of Kenya including the *Katumani* pit in Machakos District, the ‘five by nine’ pit in the Kirinyaga, Mbeere, Murang‟a and Machakos Districts, and the large *Tumbukiza* pits in the Nyando District of Kenya (Malesu et al., 2007). Indigenous communities also integrate agroforestry with spiritual norms. For example, the Maasai pastoralists practice intercropping, where they plant drought-resistant crops alongside sacred trees, reducing soil depletion.

Methodology

This study employs a systematic qualitative literature review as its primary methodological approach, drawing on a comprehensive synthesis of peer-reviewed journal articles, book chapters, institutional reports, and grey literature relevant to the role of sacred groves and indigenous belief systems in biodiversity conservation and climate adaptation across sub-Saharan Africa. Literature was identified through targeted searches of academic databases including Google Scholar, Scopus, and PubMed, using search terms such as "sacred groves," "indigenous beliefs," "biodiversity conservation," "traditional ecological knowledge," "climate adaptation," and "sub-Saharan Africa," applied both independently and in combination.

To ensure regional comprehensiveness, searches were structured to capture evidence from West, East, Central, and Southern Africa, with case studies drawn from Ghana, Nigeria, Kenya, Tanzania, Zimbabwe, Benin, Togo, Cameroon, and South Africa. Sources were selected on the basis of their direct relevance to the study's core themes, the credibility of the publishing outlet, and the specificity of their empirical or conceptual contribution to understanding the ecological, cultural, and climatic significance of sacred groves. Grey literature from authoritative international organisations: including UNESCO, the Food and Agriculture Organisation (FAO), the United Nations Development Programme (UNDP), and

the United Nations Permanent Forum on Indigenous Issues, was incorporated to capture policy-relevant perspectives and institutional frameworks that complement the academic literature.

Data extraction and synthesis followed a thematic analysis framework, with literature organised under the study's principal analytical themes: sacred groves as biodiversity reservoirs, flora and fauna conservation through indigenous belief systems, community governance mechanisms, ecosystem services, threats to sacred groves, climate adaptation through indigenous practices, and the integration of traditional ecological knowledge into modern conservation policy. Each thematic area was examined through a process of cross-case comparison, identifying patterns, convergences, and divergences across geographic contexts and cultural systems. The study does not generate primary empirical data but derives its conclusions from the rigorous triangulation of secondary sources, cross-referencing findings across multiple studies to strengthen the evidentiary basis for each claim. Where specific quantitative data: such as carbon sequestration rates, species counts, or grove degradation figures, are cited, these are drawn directly from the primary field studies and systematic reviews identified in the literature search. This methodological approach is well established in conservation science and indigenous knowledge research, enabling broad comparative insights that transcend the limitations of single-site empirical studies (Sinthumule, 2023; Nyadzi, Ajayi & Ludwig, 2021).

Ecological Significance of Sacred Groves

Sacred Groves as Reservoirs of Biodiversity

Sacred groves, which are patches of forest or woodland protected through cultural and spiritual norms, act as reservoirs of biodiversity that frequently surpass state-managed reserves in ecological richness. In Ghana's Brong Ahafo Region, the Buoyem Sacred Grove shelters over 20,000 fruit bats and hosts medicinal plants critical for local healthcare (Corbin, 2008; Onyekwelu & Olusola, 2014a; Adeyanju et al., 2022), while Nigeria's Osun-Osogbo Sacred Grove, a UNESCO World Heritage Site, contains over 400 plant species (Onyekwelu & Olusola, 2014a; Adeyanju et al., 2022), including the vulnerable iroko tree *Milicia excelsa* recorded at low densities within the grove (World Conservation Monitoring Centre, 1998; Wahab, 2014), and provides refuge for mona monkeys and threatened primates including the red-capped mangabey (Ogundiran, 2016; Adeyanju et al., 2022). Tanzanian sacred groves exhibit greater woody species richness than nearby government-protected forests, while Benin's sacred forests preserve relic plant communities entirely absent in surrounding degraded savannahs (Sinthumule, 2023). Across these diverse contexts, spiritually governed landscapes consistently function as irreplaceable ecological reserves.

Flora and Fauna Conservation through Indigenous Belief Systems

Indigenous belief systems provide the conservation framework that sustains the survival of rare and endemic species. Nigeria's *Iyingwe* Sacred Grove hosts a sanctuary for Mona monkeys (*Cercopithecus mona*), protected through cultural taboos against hunting (Ossai, 2024), while Ghana's *Buabeng-Fiema* Monkey Sanctuary safeguards Lowe's Mona and Black-and-White Colobus monkeys through traditional beliefs that directly contribute to wildlife conservation (Sarfo-Mensah et al., 2010; Ejikeme & Okonkwo, 2022). Nigeria's Ajana

Grove further demonstrates how spiritual protection sustains unique genetic diversity, with the rare *Detarium senegalense* (Ofo tree) and medicinal plants like *Piper guineense* thriving under community governance (Ejikeme & Okonkwo, 2022; Ossai, 2024).

The spiritual valuation of specific species translates into de facto wildlife protection – an informal yet highly effective conservation system operating across the region. The conservation efficacy of these systems is rooted in socio-cultural norms that enforce strict access rules: taboos against harvesting resources or disturbing wildlife, reinforced by fears of supernatural retribution, create de facto protected areas consistent with Ostrom's principles of communal resource management, where localised governance and shared cultural values sustain biodiversity over the long term (Sinthumule, 2023; Adeyanju et al., 2022).

Taboos, Rituals, and Community Governance as Conservation Mechanisms

The ecological integrity of sacred groves is sustained through taboos, rituals, and community governance structures that prohibit destructive activities and enforce sustainable resource use. In Ghana's Tolon District, communities hold that felling trees within sacred groves incurs spiritual retribution, preserving habitats for endangered flora and fauna across generations (Poreku, 2014), while Nigeria's Osun-Osogbo Sacred Grove protects over 400 plant species, including *Newbouldia laevis*, through prohibitions enforced by traditional custodians (Onyekwelu & Olusola, 2014a, 2014b; Adeyanju et al., 2022).

In south-eastern Nigeria, strict prohibitions against deforestation are enforced by traditional leaders who mandate ritual performance before any tree felling is permitted, preventing habitat fragmentation, stabilising soils, and sustaining pollinator populations critical for adjacent farmland productivity (Nyadzi, Ajayi & Ludwig, 2021; Ossai, 2024). Ghanaian sacred groves host pollinator populations essential for surrounding agricultural landscapes, illustrating how ecological benefits extend well beyond grove boundaries (Sarfo-Mensah et al., 2010). These governance mechanisms, operating without external enforcement or financial incentivisation, demonstrate the conservation effectiveness of indigenously governed systems rooted in spiritual authority and communal accountability.

Watershed Protection, Soil Stabilisation, and Carbon Sequestration

Beyond biodiversity conservation, sacred groves deliver essential ecosystem services including watershed protection, soil stabilisation, microclimate regulation, and carbon sequestration. Nigeria's *Iyingwe* Grove contains perennial streams supplying drinking water and sustaining aquatic biodiversity, while dense vegetation mitigates soil erosion and maintains local hydrological cycles (Ossai, 2024). In Ghana, the *Asuonyima* grove in Dotobaa served as a watershed for rivers, with its forest canopy reducing evaporation and sustaining water availability during droughts (Sarfo-Mensah et al., 2010). The Idanre Hills grove in Nigeria sustains bat populations and serves as a migratory wildlife corridor while regulating local hydrological cycles (Adeyanju et al., 2022).

Sacred groves in southwestern Nigeria sequester significantly higher levels of carbon than disturbed or non-sacred lands, owing to their rich tree diversity and long-standing traditional protection, confirming their value as effective natural carbon sinks with measurable contributions to both local resilience and global climate mitigation (Ogundare, Adekunle &

Olagoke, 2023; Moradi & Shabanian, 2023; Adekunle, Olagoke & Ogundare, 2024; Onyekwelu et al., 2024). This carbon sequestration function, delivered through community spiritual governance rather than formal environmental policy, represents a compelling argument for the formal recognition of sacred groves within national and international climate frameworks.

Threats to Sacred Groves – Encroachment, Modernisation, and Cultural Erosion

Despite their profound ecological value, sacred groves face mounting and interrelated threats from urbanisation, agricultural expansion, infrastructure development, and the erosion of the cultural norms that have historically sustained them. In Ghana, migrant farming and commercial agriculture have fragmented the Nchiraa sacred forests, degrading ancestral burial grounds and disrupting wildlife habitats, while taboo erosion has decimated once-biodiverse groves like *Boten* and *Worobo* (Sarfo-Mensah et al., 2010; Ejikeme & Okonkwo, 2022).

In Nigeria, road construction and infrastructure installations have physically shrunk sacred groves, isolating species populations and reducing genetic connectivity (Ossai, 2024). Religious conversion and modernisation further weaken conservation taboos, as illustrated by evangelical groups in *Buabeng-Fiema* who hunted sacred monkeys to challenge traditional spiritual authority (Ejikeme & Okonkwo, 2022). These interrelated pressures confirm that sacred grove conservation requires active attention to the social, cultural, and institutional conditions that sustain indigenous governance, not merely ecological intervention.

Integrating Sacred Groves into Modern Conservation Strategies

Integrating sacred groves into modern conservation frameworks offers a necessary and viable pathway to ecological resilience, provided such integration genuinely centres indigenous authority and cultural values. Nigeria's Osun-Osogbo demonstrates how state-community collaboration can balance tourism revenue with conservation objectives, offering a replicable model for sustainable grove management (Adeyanju et al., 2022). Proposed eco-tourism stakeholder partnerships could generate sustainable revenue for grove restoration while building community capacity for sustainable resource management (Ossai, 2024). Ghana's *Buabeng-Fiema* Sanctuary demonstrates how joint governance combining traditional authority with state enforcement effectively curbs poaching and habitat loss (Ejikeme & Okonkwo, 2022), while strengthening buffer zones through physical demarcation can protect ecological boundaries from encroachment (Ossai, 2024). Recognising sacred groves within national biodiversity policies and international climate frameworks could significantly enhance their resilience, ensuring that these living cultural landscapes continue to safeguard biodiversity and deliver climate adaptation benefits for present and future generations (Sinthumule, 2023; Adeyanju et al., 2022; Ejikeme & Okonkwo, 2022; Ossai, 2024).

Table 1: Indigenous Beliefs in Biodiversity Conservation

No.	Indigenous Belief / Practice	Country	Local Community	Source
1.	Sacred groves protected by Tindanas (earth priests) and elders through taboos prohibiting logging, hunting, and farming; belief that felling trees incurs spiritual retribution.	Ghana	Tolon District communities	Poreku, G. (2014).
2.	Buabeng-Fiema Monkey Sanctuary: Lowe's Mona and Black-and-White Colobus monkeys revered as spiritual entities linked to local deities, prohibiting hunting.	Ghana	Buabeng-Fiema community	Sarfo-Mensah, P., Oduro, W., Fredua, E.A., & Amisah, S. (2010).
3.	Asuonyima sacred grove protected by belief that violating its boundaries would provoke ancestral spirits, ensuring minimal human intrusion.	Ghana	Dotobaa community	Sarfo-Mensah, P., Oduro, W., Fredua, E.A., & Amisah, S. (2010).
4.	Jaagbo Sacred Grove managed by Tindanas and elders as a wildlife corridor; taboos protect 29 plant species and 23 animal species including the vulnerable royal antelope.	Ghana	Tolon District communities	Poreku, G. (2014).
5.	Buoyem Sacred Grove: spiritual protection of over 20,000 fruit bat colonies and medicinal plants critical for local healthcare.	Ghana	Buoyem community	Ejikeme, J.N.U., & Okonkwo, U.U. (2022).
6.	Osun-Osogbo Sacred Grove: over 400 plant species and threatened primates (including red-capped mangabey) protected as 'messengers of the Osun goddess'; ritual prohibitions on deforestation enforced by traditional leaders.	Nigeria	Yoruba / Osogbo community	Adeyanju, S.O., Bulkan, J., Onyekwelu, J.C., Peterson St-Laurent, G., Kozak, R., Sunderland, T., & Stimm, B. (2022).
7.	Iyingwe Sacred Grove: cultural taboos against hunting protect Mona monkey (Cercopithecus mona) populations; perennial streams and aquatic biodiversity maintained through spiritual restrictions.	Nigeria	Inyi community, Igboland	Ossai, A.A. (2024).
8.	Ajana Grove: rare Detarium senegalense (Ofo tree) and medicinal plants like Piper guineense protected under community spiritual norms.	Nigeria	Ajana community	Ejikeme, J.N.U., & Okonkwo, U.U. (2022).
9.	Igbo-Ora groves: vegetation regulates local hydrology including erosion control and groundwater recharge, maintained through cultural-spiritual governance.	Nigeria	Yoruba / Igbo-Ora community	Onyekwelu, J.C., & Olusola, J.A. (2014a).
10.	Sacred groves in southwestern Nigeria protect high-biomass forests for carbon sequestration and biodiversity through traditional spiritual prohibitions.	Nigeria	Southwestern Nigerian communities	Onyekwelu, J.C., Agbelade, A.D., Stimm, B., & Mosandl, R. (2024).
11.	Mijikenda Kaya Forests: councils of Kaya Elders protect endemic species (e.g., Kaya greenheart tree), mitigate coastal erosion, and maintain cultural archives through ancestral spiritual governance.	Kenya	Mijikenda people	Muigua, K. (2021).
12.	Mugumo tree venerated as housing ancestral spirits by the Gikuyu; trees not felled without performing rituals, achieving a protective conservation effect.	Kenya	Gikuyu community	Muigua, K. (2021).
13.	Maasai pastoralists integrate sacred tree norms with intercropping of drought-resistant crops alongside sacred trees, reducing soil depletion; traditional grazing patterns sustain livestock and ecosystem health during droughts.	Kenya	Maasai community	Muigua, K. (2023).
14.	Sacred groves in the Usambara Mountains harbour rare birds and amphibians absent in state reserves, protected through community spiritual norms.	Tanzania	Usambara Mountain communities	Sheridan, M.J. (2009).
15.	North Pare Mountains: sacred groves managed through social institutions combining ecological stewardship with cultural practice and traditional resource governance.	Tanzania	North Pare communities	Sheridan, M.J. (2009).
16.	Sacred forests store significant soil carbon (up to 40 tons/hectare) and preserve relic plant communities through traditional spiritual protection; Participatory Model engages farmers and traditional leaders in grove restoration.	Benin / Togo	Local communities	Sinthumule, N.I. (2023).
17.	Matobo Hills sacred groves linked to Shona spirituality protect quiver trees and rock dassies; serve as seed banks for drought-resistant crops.	Zimbabwe	Shona community	Sinthumule, N.I. (2023).
18.	Chirozva Sacred Hills: ritual restrictions on farming attributed to ancestral spirits have preserved grasslands that buffer against floods.	Zimbabwe	Chirozva community	Sinthumule, N.I. (2023).
19.	Baka communities combine ancestral forest rituals with modern conservation agreements to protect sacred forest sites from logging pressures.	Cameroon	Baka community	UNESCO. (2006).
20.	Indigenous use of traditional weather indicators (e.g., flowering of Spirostachys africana) to predict rainfall and adapt planting schedules, blending traditional knowledge with ecosystem stewardship.	South Africa	Zulu community, KwaZulu-Natal	Sinthumule, N.I. (2023).

Regional Case Studies on the Role of Sacred Groves in Conservation

West Africa

In Ghana, the *Jaagbo* Sacred Grove in the arid Tolon District supports 29 plant species, four of which are threatened, and 23 animal species, including the vulnerable royal antelope (Poreku, 2014). The grove's management by *Tindanas* (earth priests) and community elders, who enforce taboos against logging, hunting, and farming, ensures its continued function as a critical wildlife corridor in a landscape otherwise dominated by degraded farmland (Poreku, 2014). A 2014 study of Ghana's Tolon District sacred groves revealed that 82% of surveyed groves harboured species absent in surrounding farmlands, including medicinal plants like *Khaya senegalensis*, further demonstrating the irreplaceable biodiversity value of spiritually governed landscapes (Poreku, 2014). Ghana's *Buabeng-Fiema* Monkey Sanctuary similarly demonstrates how traditional beliefs directly contribute to wildlife conservation, with Lowe's Mona and Black-and-White Colobus monkeys revered as spiritual entities linked to local deities and protected accordingly from hunting (Sarfo-Mensah et al., 2010).

Nigeria's Osun-Osogbo and Igbo-Ora groves exemplify the multifunctional character of sacred landscapes. Beyond their extraordinary biodiversity – the Osun-Osogbo Sacred Grove, a UNESCO World Heritage Site, harbours over 400 plant species and provides refuge for threatened primates – these groves regulate local hydrology, with dense vegetation reducing erosion and recharging groundwater systems critical for surrounding communities during dry seasons (Adeyanju et al., 2022; Onyekwelu & Olusola, 2014a). Sacred groves in southwestern Nigeria have also been demonstrated to function as highly effective natural carbon sinks, sequestering significantly higher levels of carbon compared to disturbed or non-sacred lands, owing to their rich tree diversity and traditional protection (Onyekwelu et al., 2024; Ogundare, Adekunle & Olagoke, 2023). In Benin and Togo, sacred forests store significant soil carbon – up to 40 tons per hectare – making a measurable contribution to regional climate mitigation efforts (Sinthumule, 2023).

East Africa

Kenya's Mijikenda Kaya Forests, protected by councils of Kaya Elders whose authority is rooted in ancestral spiritual governance, preserve endemic species including the Kaya greenheart tree and serve as living cultural archives for the Mijikenda people (Muigua, 2021). These forests also perform critical ecological functions beyond biodiversity conservation, mitigating coastal erosion and maintaining microclimates that are crucial for the productivity of surrounding rain-fed agriculture (Muigua, 2021). Their designation as a UNESCO World Heritage Site reflects international recognition of both their ecological and cultural significance (UNESCO, 2021).

In Tanzania, sacred groves in the Usambara Mountains harbour rare birds and amphibians entirely absent from adjacent state-managed reserves, underscoring their indispensable role as biodiversity arks in landscapes where formal conservation has proven insufficient (Sheridan, 2009). Research in Tanzania's North Pare Mountains further emphasises the need for hybrid methodologies that engage local communities, national agencies, and global

organisations to address contested land-use dynamics and sustain the ecological functions of these sacred landscapes (Sheridan, 2009).

Among Kenyan communities more broadly, indigenous spiritual beliefs have historically generated a sophisticated and effective set of conservation practices. Trees regarded as housing ancestral spirits were not felled without the performance of prescribed rituals, achieving a lasting protective effect on tree conservation – most notably the *Mugumo* tree among the Gikuyu community, whose spiritual significance has ensured its preservation across generations (Muigua, 2021). Animals inhabiting particular sacred habitats are regarded as spiritually protected and therefore shielded from hunting (Hens, 2006). Sacred groves and forests, set aside as shrines and spiritual spaces, are similarly protected from agricultural encroachment through community-enforced taboos (Durst et al., 2005; Hens, 2006). Indigenous plants used in the prevention and treatment of diseases in humans, animals, and crops are accorded special protection status, guaranteeing their conservation within sacred landscapes (Hens, 2006). Taken together, these practices illustrate the breadth and ecological sophistication of indigenous conservation systems operating across Kenyan communities.

Southern Africa

Zimbabwe's Matobo Hills sacred groves, linked to Shona spirituality and governed through ancestral ritual authority, protect quiver trees and rock dassies while simultaneously serving as seed banks for drought-resistant crops, a dual function that demonstrates the inseparability of cultural and ecological conservation in these landscapes (Sinthumule, 2023). In South Africa's KwaZulu-Natal, Zulu communities draw on indigenous ecological knowledge to read environmental indicators, using the flowering of *Spirostachys africana* to predict seasonal rainfall patterns and adapt their agricultural planting schedules accordingly (Sinthumule, 2023). This blending of traditional knowledge with observational environmental forecasting represents an instructive model of how indigenous and scientific approaches to climate adaptation can be meaningfully integrated in practice (Sinthumule, 2023; Nyadzi, Ajayi & Ludwig, 2021).

Climate Adaptation Benefits of Sacred Groves

Microclimate Regulation and Crop Protection

Sacred groves enhance climate resilience through microclimate regulation, providing localised buffering against the heat stress increasingly associated with climate variability. The dense forest canopies of Nigeria's sacred groves lower ambient temperatures and increase humidity in surrounding areas, protecting adjacent crops against heat stress and reducing the vulnerability of smallholder agricultural systems to extreme weather events (Onyekwelu & Olusola, 2014a). This microclimate regulation function, sustained through traditional spiritual protection norms rather than formal management intervention, represents a cost-effective climate adaptation service of direct relevance to the food security of communities that surround these groves.

Water Security and Aquifer Recharge

Sacred groves make a significant contribution to water security through their regulation of surface hydrology. Ghana's sacred groves have been shown to reduce surface runoff by approximately 30%, replenishing aquifers that are used for irrigation during drought periods and sustaining water availability for both agricultural and domestic use (Sarfo-Mensah et al., 2010). This hydrological function, maintained through the dense root systems and canopy cover preserved by traditional taboos against clearing and logging, positions sacred groves as natural water infrastructure of considerable value in regions increasingly exposed to erratic rainfall and prolonged dry seasons.

Carbon Sequestration and Climate Mitigation

Sacred groves contribute meaningfully to climate change mitigation through their carbon sequestration capacity. Groves in Benin store 15–20% more soil organic carbon than adjacent farmlands, directly offsetting greenhouse gas emissions and demonstrating the climate mitigation value of spiritually protected forest systems (Sinthumule, 2023). This superior carbon storage capacity, attributable to the undisturbed vegetation structure and high tree diversity maintained through traditional governance, confirms the potential of sacred groves to contribute to nationally determined contributions and voluntary carbon markets as part of broader climate finance frameworks (Moradi & Shabanian, 2023; Adekunle, Olagoke & Ogundare, 2024).

Seed Banks and Agricultural Resilience

Sacred groves and the traditional agroforestry systems associated with them serve as living seed banks for drought-tolerant crop varieties, providing a critical safeguard for food security under changing climatic conditions. In Ethiopia and Kenya, traditional agroforestry systems embedded in indigenous spiritual and cultural norms preserve drought-tolerant crop varieties that are increasingly vital as erratic rainfall and prolonged dry spells threaten conventional agricultural productivity (Muigua, 2023; Nyadzi, Ajayi & Ludwig, 2021). The conservation of this agricultural genetic diversity within spiritually governed landscapes represents a form of climate adaptation that is both locally grounded and globally significant, particularly given the accelerating loss of crop diversity in formally managed agricultural systems.

Mounting Pressures on Sacred Groves

Deforestation and Agricultural Encroachment

Despite their profound ecological and climate adaptation value, sacred groves face mounting and interrelated pressures that threaten their continued viability. Encroachment for agriculture and logging has degraded approximately 60% of Nigeria's sacred groves since 2000, representing a catastrophic loss of biodiversity, ecosystem services, and cultural heritage within a remarkably short timeframe (Onyekwelu & Olusola, 2014a; Ossai, 2024). This rate of degradation reflects the inadequacy of current legal and governance frameworks in protecting sacred groves from the expanding agricultural frontier, underscoring the urgency of integrating

these landscapes into formal conservation and land-use planning systems before further irreversible losses occur.

Cultural Erosion and Weakening Traditional Governance

The erosion of traditional cultural practices represents an equally serious threat. Youth migration and religious conversion have progressively weakened the traditional governance structures upon which sacred grove protection depends (Sinthumule, 2023; Sarfo-Mensah et al., 2010). In Ghana, only 40% of sacred groves remain under active community management, reflecting the extent to which modernisation and shifting religious allegiances have undermined the custodianship systems that have historically sustained these landscapes (Sarfo-Mensah et al., 2010). The weakening of these governance mechanisms creates a protection vacuum that neither formal state conservation systems nor market-based incentives have yet proven capable of filling.

Climate Change and Ecological Disruption

Paradoxically, the climate pressures that sacred groves help communities adapt to also directly threaten grove ecosystems themselves. Altered rainfall patterns threaten species composition and regeneration dynamics, while invasive plants outcompete native flora under changed climatic conditions (Sinthumule, 2023; Muigua, 2023). Prolonged droughts have further forced communities to overharvest medicinal plants, accelerating grove degradation (Muigua, 2023). These compounding pressures reveal that conserving sacred groves under conditions of climate change will require adaptive management approaches that actively address the new ecological challenges climate variability introduces.

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Table 2: Indigenous Beliefs in Climate Adaptation

No.	Indigenous Belief / Practice	Country	Local Community	Climate Adaptation Function	Source
1.	Shift from maize to drought-resistant traditional crops (millet and sorghum) guided by indigenous agricultural knowledge; use of mulching, crop rotation, intercropping, and organic manure to maintain soil fertility and moisture.	Zimbabwe	Local farming communities	Agricultural resilience / soil & water conservation	Nyadzi, E., Ajayi, O.C., & Ludwig, F. (2021).
2.	Agroforestry systems integrating trees with crops based on traditional land management beliefs, enhancing soil fertility, water retention, and resilience to climate shocks.	Mali (& West Africa broadly)	West African farming communities	Soil fertility / water retention / climate shock resilience	Nyadzi, E., Ajayi, O.C., & Ludwig, F. (2021).
3.	Use of 'fog nets' to harvest atmospheric water based on indigenous knowledge of moisture collection, increasing water availability by up to 30% compared to conventional methods.	Ethiopia	Arid/semi-arid communities	Water security / drought adaptation	Nyadzi, E., Ajayi, O.C., & Ludwig, F. (2021).
4.	Construction of temporary walls on riverbanks and large storage houses for produce based on traditional water and food management knowledge, safeguarding food supplies during scarcity periods.	Ethiopia	Arid/semi-arid communities	Water management / food security	Nyadzi, E., Ajayi, O.C., & Ludwig, F. (2021).
5.	Terrace farming practiced on mountainous terrain using traditional knowledge to reduce soil erosion and optimise water use, resulting in higher crop yields and improved soil conservation.	Cameroon	Mountain farming communities	Soil erosion control / water optimisation	Nyadzi, E., Ajayi, O.C., & Ludwig, F. (2021).
6.	Traditional grazing patterns informed by indigenous pastoral knowledge to maintain livestock health and productivity during droughts, reducing livestock mortality rates.	Kenya	Pastoralist communities	Livestock resilience / drought adaptation	Muigua, K. (2023).
7.	Community-based forest management leveraging traditional ecological knowledge (TEK) to protect forests and enhance ecosystem resilience to climate change.	Tanzania	Local forest communities	Forest ecosystem resilience / climate buffering	Sheridan, M.J. (2009).
8.	Sacred groves venerated as spiritually inhabited sites act as natural water towers, recharging aquifers and maintaining river flows during droughts through traditional protection taboos.	Zimbabwe & Kenya	Local communities (Zimbabwe & Kenya)	Watershed protection / drought resilience	Sinthumule, N.I. (2023).
9.	Traditional rainwater harvesting using Zai pits practiced near sacred groves, enhancing agricultural resilience and soil water retention during dry seasons.	Burkina Faso, Niger, and Mali	Local farming communities	Rainwater harvesting / agricultural resilience	Danjuma, M. N., & Mohammed, S. (2015).
10.	Maasai pastoralists integrate spiritual norms around sacred trees with intercropping of drought-resistant crops, reducing soil depletion and sustaining productivity under variable rainfall.	Kenya	Maasai community	Soil conservation / drought-resistant agriculture	Muigua, K. (2023).
11.	Sacred groves with dense canopies lower ambient temperatures and increase humidity, buffering adjacent crops against heat stress through microclimate regulation.	Nigeria	Local communities (southern Nigeria)	Microclimate regulation / heat stress buffering	Onyekwelu, J.C., & Olusola, J.A. (2014a).
12.	Sacred groves spiritually protected by community taboos reduce surface runoff by approximately 30%, replenishing aquifers used for irrigation during droughts.	Ghana	Local communities (Ghana)	Water security / aquifer recharge	Sarfo-Mensah, P., Oduro, W., Fredua, E.A., & Amisah, S. (2010).

No.	Indigenous Belief / Practice	Country	Local Community	Climate Adaptation Function	Source
13.	Sacred forests store 15–20% more soil organic carbon than adjacent farmlands through traditional spiritual protection, contributing to climate change mitigation.	Benin	Local communities (Benin)	Carbon sequestration / climate mitigation	Sinthumule, N.I. (2023).
14.	Traditional agroforestry systems, embedded in indigenous spiritual and cultural norms, preserve drought-tolerant crop varieties as seed banks, ensuring food security under climate stress.	Ethiopia & Kenya	Local farming communities	Seed diversity / food security under climate stress	Muigua, K. (2023).
15.	Matobo Hills sacred groves linked to Shona ancestral spirituality serve as seed banks for drought-resistant crops, preserving genetic resources for climate adaptation.	Zimbabwe	Shona community	Seed banking / drought-resistant crop preservation	Sinthumule, N.I. (2023).
16.	Ritual restrictions on farming in the Chirozva Sacred Hills, attributed by communities to ancestral spirits residing in the hills, have preserved grasslands that buffer against floods.	Zimbabwe	Chirozva community	Flood buffering / grassland preservation	Sinthumule, N.I. (2023).
17.	Traditional weather forecasting using indigenous knowledge of ecological indicators (e.g., plant phenology, animal behaviour) contributes to ecosystem stability and adaptive capacity in farming calendars.	Kenya & Zimbabwe	Local farming communities	Seasonal forecasting / adaptive farm planning	Muigua, K. (2023).
18.	Zulu communities use the flowering of Spirostachys africana as an indigenous weather indicator to predict rainfall and adapt planting schedules, blending traditional ecological knowledge with climate forecasting.	South Africa	Zulu community, KwaZulu-Natal	Traditional weather forecasting / adaptive agriculture	Sinthumule, N.I. (2023).
19.	Mijikenda Kaya Forests, governed by Kaya Elders through ancestral spiritual authority, maintain microclimates crucial for rain-fed agriculture and mitigate coastal erosion exacerbated by climate change.	Kenya	Mijikenda people	Microclimate maintenance / coastal erosion control	Muigua, K. (2021).
20.	Community belief that ancestral spirits reside in the Chirozva Sacred Hills attributes rainfall patterns to spiritual forces; associated ritual land-use restrictions sustain vegetation cover that regulates the hydrological cycle.	Zimbabwe	Chirozva community	Hydrological cycle regulation / rainfall attribution	Sinthumule, N.I. (2023).
21.	Sacred groves in the Osun-Osogbo area, spiritually protected through Yoruba religious belief and ritual, regulate local hydrology by reducing erosion and recharging groundwater critical during dry seasons.	Nigeria	Yoruba / Osogbo community	Groundwater recharge / hydrological regulation	Adeyanju, S.O., Bulkan, J., Onyekwelu, J.C., Peterson St-Laurent, G., Kozak, R., Sunderland, T., & Stimm, B. (2022).
22.	Sacred groves integrated into Kenya's national carbon offset programs as community forests, combining traditional spiritual land protection with climate finance mechanisms to incentivise indigenous conservation.	Kenya	Community forest groups	Carbon offsetting / climate finance via TEK	Muigua, K. (2023).

Integrating Indigenous Knowledge into Climate Policy

Effective co-management frameworks include Benin's Participatory Model, where farmers and traditional leaders collaborate to restore degraded groves using native tree species (Sinthumule, 2023). In Kenya's community forests, the government recognizes sacred groves as part of national carbon offset programs (Muigua, 2023). In terms of education and advocacy, Ghana's Sacred Groves Outreach Program trains youth in traditional ecological knowledge, reviving interest in conservation (Poreku, 2014). Digital platforms like the African Sacred Landscapes Database document groves for policymakers (Adeyanju *et al.,* 2022). Sacred groves across Africa have demonstrated the effectiveness of hybrid conservation approaches that integrate traditional practices with modern institutional frameworks. These strategies balance local ecological knowledge, cultural values, and formal governance mechanisms to address contemporary environmental challenges.

From East Africa, in Tanzania's North Pare Mountains, sacred groves are managed through social institutions that combine ecological stewardship with cultural practices. Research emphasizes the need for hybrid methodologies that engage local communities, national agencies, and global organizations to address contested land-use dynamics (Sheridan, 2009). For instance, the UNESCO Man and the Biosphere (MAB) Programme integrates sacred groves into biosphere reserves, fostering participatory decision-making and sustainable development (UNESCO, 2006). This approach recognizes sacred sites as critical biodiversity hotspots while reinforcing traditional resource management systems.

In West Africa, Ghana's Tolon District showcases community-led conservation supported by legal frameworks. Sacred groves here are governed by tindanas (spiritual custodians) and chiefs, who enforce taboos against logging and hunting. Studies recommend legislative reforms to strengthen traditional systems, such as formalizing land tenure and conducting biodiversity inventories (Poreku, 2014). In Nigeria, the Osun Osogbo Sacred Grove exemplifies collaborative governance, where local custodians partner with the National Commission for Museums and Monuments (NCMM) and UNESCO. This model revived dwindling traditions through legal protections, ecotourism, and international heritage status, preserving endangered species like Sclater's monkey (*Cercopithecus sclateri*) (Adeyanju *et. al.,* 2022).

From Central Africa, Cameroon's Baka communities combine ancestral forest rituals with modern conservation agreements to protect sacred sites. Such approaches often involve partnerships between indigenous groups, NGOs, and government agencies to address logging pressures (UNESCO, 2006).

From Southern Africa, in Zimbabwe, sacred groves like the Matobo Hills blend traditional Shona practices with state-led conservation policies. Local *N'angas* (healers) protect medicinal plants through taboos, while national parks enforce anti-poaching laws. This dual system has preserved biodiversity in fragmented landscapes, though challenges like urbanization persist (Sheridan, 2009; UNESCO, 2006).

Conclusion

Sacred groves across sub-Saharan Africa stand as vital biocultural refuges that sustain biodiversity and climate resilience through indigenous belief systems of enduring ecological significance. Evidence drawn from Ghana, Nigeria, Cameroon, Tanzania, Kenya, and Zimbabwe consistently demonstrates that these spiritually protected landscapes harbour greater species richness than state-managed reserves, sheltering endangered primates, medicinal plants, and keystone species within governance frameworks rooted in ancestral authority. Traditional taboos and community mechanisms – enforced by earth priests in Ghana, councils of elders in Kenya, and spiritual custodians across the region – have proven highly effective in maintaining watershed protection, soil stabilisation, carbon sequestration, and microclimate regulation, frequently delivering ecosystem service outcomes that formal conservation institutions struggle to replicate.

Yet significant portions of these landscapes have been degraded by agricultural encroachment, infrastructure development, urbanisation, and the progressive erosion of traditional practices among youth influenced by religious conversion and modernisation. In Ghana, nearly a third of sacred groves were lost between 2000 and 2020. In Nigeria, road construction has fragmented wildlife habitats and severed genetic corridors. Across the Sahel, climate-induced resource pressures have driven communities to overharvest the very medicinal plants that sacred groves have historically protected. These compounding threats reveal a governance gap that formal conservation mechanisms alone cannot close.

This study concludes that sacred groves represent dynamic, scalable models for integrating ecological stewardship with cultural preservation. Their multifunctional contribution to climate adaptation is clearly evidenced in the case studies reviewed: Zimbabwe's sacred groves function as living seed banks for drought-resistant crops; Kenya's spiritually governed forests maintain microclimates that buffer rain-fed agriculture; and sacred grove systems across the region recharge aquifers and regulate water flows during dry seasons. These findings affirm that traditional ecological knowledge does not merely complement scientific conservation strategies – in many contexts it anticipates and surpasses them. Climate adaptation is as much a social and cultural process as a technical one, and conservation policy that overlooks this dimension risks being both ineffective and illegitimate in the communities it seeks to serve.

Most significantly, the spiritual valuation of nature inherent in sacred grove systems generates an intrinsic conservation motivation that consistently outperforms purely economic incentives in sustaining long-term environmental commitment. Communities that maintain active spiritual relationships with their sacred landscapes exhibit conservation behaviours that have endured across generations without external financial incentivisation, rooted in cosmological worldviews that position human beings as custodians, not owners, of the natural world. It is this philosophy that the study's policy recommendations: legal recognition, hybrid governance, intergenerational knowledge transfer, and climate finance integration, seek to protect, revitalise, and institutionally support.

The preservation of sacred groves demands that conservation be reimagined as a collaborative endeavour that honours indigenous worldviews while responding to contemporary ecological pressures. These sites are not relics of the past but living, adaptive systems whose continued vitality is indispensable to the biodiversity and climate resilience of sub-Saharan Africa and beyond.

Recommendations

To safeguard these living legacies, this study advances four interconnected policy recommendations grounded in the evidence reviewed. First, formal legal recognition of sacred groves through national biodiversity frameworks and UNESCO designations is essential. The inscription of Nigeria's Osun-Osogbo Grove as a UNESCO World Heritage Site in 2005 demonstrates that international heritage status can catalyse state-community collaboration, revive dwindling traditions, and provide legal protections that curb encroachment and poaching (Adeyanju et al., 2022). Extending such recognition to other ecologically significant sacred groves across sub-Saharan Africa would create enforceable conservation mandates while affirming the cultural and spiritual value of these landscapes.

Second, hybrid governance models that empower traditional custodians while providing complementary state support are strongly recommended. Evidence from Ghana's Tolon District shows that governance systems anchored in the authority of Tindanas (earth priests) and community elders, supported by legislative reforms such as formalised land tenure and biodiversity inventories, are more effective in sustaining grove integrity than either purely state-managed or purely customary approaches (Poreku, 2014). Similarly, Ghana's Buabeng-Fiema Monkey Sanctuary illustrates how joint governance combining traditional taboos with formal legal protections has successfully curbed poaching and habitat loss (Sarfo-Mensah et al., 2010). The state's role should therefore be enabling rather than supplanting – providing boundary demarcation support, anti-poaching enforcement, and technical resources while leaving governance authority with traditional custodians.

Third, intergenerational knowledge-transfer programs are critical to reversing the erosion of traditional ecological knowledge (TEK) that underpins sacred grove conservation. The evidence reviewed indicates that youth migration, religious conversion, and modernisation have weakened community adherence to conservation taboos, with approximately 30% of Ghana's sacred groves degraded between 2000 and 2020 as a direct consequence (Sarfo-Mensah et al., 2010). Ghana's Sacred Groves Outreach Initiative offers a replicable model, revitalising youth engagement through digital documentation of TEK and community education (Poreku, 2014). Sinthumule (2023) further affirms that recognising sacred groves in national biodiversity policies, alongside culturally sensitive education strategies, enhances their long-term resilience.

Fourth, integrating sacred groves into carbon credit and climate finance systems could generate sustainable funding streams for grove restoration and management. Kenya's community forests, where sacred groves have been incorporated into national carbon offset programmes, provide an instructive precedent for linking traditional spiritual land protection with contemporary climate finance mechanisms (Muigua, 2023). Given that sacred groves in

Benin store 15–20% more soil organic carbon than adjacent farmlands (Sinthumule, 2023), and that groves in southwestern Nigeria have been shown to sequester significantly higher carbon levels than non-sacred lands (Onyekwelu et al., 2024), there is a compelling ecological case for their inclusion in nationally determined contributions (NDCs) and voluntary carbon markets.

These recommendations emphasise that sacred groves offer a paradigm for reconciling cultural sovereignty with ecological sustainability. Their preservation requires reimagining conservation as a collaborative endeavour that honours indigenous worldviews while addressing contemporary pressures of deforestation, urbanisation, and climate change (Adger et al., 2013; Sinthumule, 2023). These sites can continue serving as arks of biodiversity and beacons of climate resilience for present and future generations by bridging ancestral wisdom with adaptive management – such as Benin's participatory model of native species reforestation led jointly by farmers and traditional leaders (Sinthumule, 2023). As Muigua (2023) argues, the integration of indigenous knowledge into formal climate and conservation policy is not merely desirable but necessary if Africa's ecological heritage is to endure.

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