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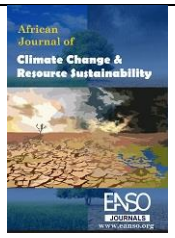

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Original Article

A Review of Exploring the Role of Indigenous Knowledge in Environmental Governance: A Case Study of Lake Mburo and Bwindi Impenetrable National Parks in Uganda

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Indigenous Knowledge, Environmental Governance, Community Participation, Biodiversity Conservation.

ABSTRACT

This article highlights the essential role of indigenous knowledge in natural resource management, particularly in countries such as Uganda with high biodiversity, but faces ecological threats like deforestation, overgrazing, poaching, and climate change. In Uganda, local communities' contributions to conservation are often overlooked, despite their valuable knowledge of ecosystems. The article systematically examines the integration of indigenous knowledge into environmental governance within Lake Mburo and Bwindi Impenetrable National Parks over the past 20 years, analysing peer-reviewed articles, reports, and case studies. The findings confirm that indigenous knowledge has significantly contributed to conservation by providing deep insights into local ecosystems and resource management practices. Community involvement in setting up local conservation agreements promotes ownership and stewardship, which enhances the effectiveness of conservation efforts. The integration of indigenous knowledge into governance frameworks improves decision-making and policy implementation. However, challenges remain in fully recognising indigenous knowledge at policy and operational levels, primarily due to socio-economic barriers that hinder its effective application. To address these challenges, the article recommends the creation of inclusive policies that empower local communities and integrate their knowledge into national conservation strategies. Recognising and incorporating indigenous knowledge into environmental governance can lead to more advanced biodiversity conservation and sustainability, benefiting both local communities and ecosystems.

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INTRODUCTION

Uganda is highly reputed for its rich biodiversity, with ecosystems that range from tropical forests and wetlands to savanna grassland and mountainous regions. These ecosystems provide a habitat for a wide array of species, globally important and mainly endemic (Pomeroy et al., 2002; Mwanjalolo et al., 2018). Presently, Uganda has over 1,000 bird species, several mammal species that are big herbivorous animals like elephants and buffalos, and numerous reptiles and amphibians, as well as a vast variety of plant species (Briggs, 2007; Wheatley, 2014; Briggs & Van Zandbergen, 2024). The most iconic of these protected areas are Lake Mburo National Park (LMNP) and Bwindi Impenetrable National Park (BINP) situated in South-Western Uganda.

LMNP was gazetted as a national park in 1983 and is described as a mosaic of savanna grasslands, woodland, and wetland ecosystems (Abdel-Meguid, 2017; Averbeck et al., 2009; Pomeroy et al., 2002). The park has various wildlife such as zebras, impalas, elands, and diverse birds that make it of primary concern for conservation efforts (Ochieng, 2011; Atuhaire, 2018; Mbuya et al., 2023). However, agricultural expansion, habitat encroachment, and increasing climate variability threaten the park's ecological integrity by intensifying human-wildlife conflicts and poaching (Berkes & Jolly, 2002; Adano et al., 2012; Weiskopf et al., 2020).

BINP was officially recognized as a national park in 1991 and was also declared a UNESCO World Heritage site in 1994. It is globally recognized for its role in conserving the endangered mountain gorillas (Byaruhanga, 2008; Kidd, 2014). This ancient montane forest is one of the most biologically diverse in East Africa, housing over 120 mammal species, more than 200 butterfly species, and a plethora of unique plant species (Briggs & Van Zandbergen, 2024; Marchant, 2022). Bwindi is also a critical destination for ecotourism, particularly for gorilla tracking, which has been a major driver of Uganda's tourism industry and local livelihoods (Sandbrook, 2006; Laudati, 2010; Ampumuza & Dzriessen, 2021). However, despite its ecological importance, Bwindi faces challenges such as deforestation, illegal hunting, and increasing pressure from surrounding human settlements (Laudati, 2010; Moses, 2015; Schulze, 2022). Moreover, growing Park popularity necessitates balancing conservation, community development, and managing environmental impacts to ensure long-term ecological health and success.

Uganda's national parks are governed by the Uganda Wildlife Authority (UWA) using a centralised, top-down model focused on wildlife conservation and tourism revenue generation (Petursson & Vedeld, 2017; Musinguzi & Muzaale, 2019; Twinamatsiko et al., 2022b). Though effective in protecting biodiversity and boosting tourism, Uganda's park governance poses socio-economic and cultural challenges for nearby indigenous and local communities (Ochieng, 2011; Vedeld et al., 2016; Foster, 2021; Satyal et al., 2021). One major consequence of this centralized system is the socio-economic exclusion of communities that historically relied on these lands for their livelihoods (Nampindo & Plumptre, 2005; Tiwari et al., 2018; Poelina,

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2021). For example, the Batwa people in BINP were displaced from their ancestral lands, disrupting their resource access and eroding their cultural identity and heritage (Ampumuza, 2021; Schulze, 2022). The Batwa and similar communities face poverty, landlessness, and cultural marginalisation, with their indigenous knowledge excluded from conservation strategies, sidelining sustainable practices (Mukasa, 2014; Nsibambi, 2018; Satyal et al., 2021).

Indigenous knowledge, developed over centuries, provides critical insights into ecosystems, species behaviour, and sustainable resource use through practices like land management, species monitoring, and conservation rituals (Boven & Morohashi, 2002; Fritz-Vietta et al., 2017; Kalra et al., 2024). However, its exclusion in formal governance frameworks has led to a disconnect between conservation policies and the lived realities of local communities (Watson, 2013; Reid et al., 2021; Arney et al., 2023). For example, the Batwa's understanding of the Bwindi Forest ecosystem, which includes knowledge about gorilla habitats, plant species, and forest dynamics, remains underutilised in the management of the park. The Batwa possess an intricate knowledge of the mountain gorilla's behaviour, movement patterns, and preferred habitats, which they acquired over centuries of coexisting with these animals. This expertise could be invaluable in tracking gorillas for conservation and ecotourism purposes, yet it is rarely integrated into park management practices. The Batwa also have an extensive understanding of the forest's plant species, including their medicinal and ecological functions. For example, they can identify plants critical for gorilla diets or those essential for maintaining forest health. This knowledge could be applied to habitat restoration efforts and biodiversity conservation strategies, but it remains largely overlooked by conservation authorities. (Mehta & Katee, 2012; Bitariho, 2013; Lubogo, 2024b). Similarly, communities around LMNP, known for their rotational grazing systems and conflict mitigation strategies with wildlife, are often excluded from decision-making processes (Mengistu, 2005; Babaasa et al., 2013; Nebbo, 2015; Atuhaire, 2018).

Recent literature emphasises the importance of moving beyond these exclusionary, top-down governance models toward more inclusive and participatory frameworks (Silver et al., 2010; Doerfel & Gibbs, 2020; Furholt et al., 2020). Community-based governance models that incorporate indigenous knowledge can significantly enhance conservation outcomes while addressing socio-economic inequities (Brooks et al., 2013; Calfucura, 2018). Indeed, indigenous communities hold intricate ecological knowledge that is invaluable for effective natural resource management (Walsh et al., 2013; Fleischman & Briske, 2016; Hoagland, 2017; Al-Mansoori & Hamdan, 2023). For instance, their ability to track wildlife movements, identify changes in ecosystem health, and implement sustainable harvesting techniques can complement scientific conservation methods (Moller et al., 2004; Dowsley, 2009; Peacock et al., 2020). However, Uganda’s conservation policies offer limited recognition of indigenous knowledge, often prioritizing external scientific approaches over socio-cultural dynamics, leading to strategies misaligned with local realities (Barugahare, 2008; Bwambale, 2021; Obiero et al., 2023; Alule et al., 2023). This lack of recognition undermines the potential contributions of indigenous communities and perpetuates their marginalization.

This study aims to explore how Indigenous Knowledge (IK) can be integrated into environmental governance and conservation strategies in Uganda’s Lake Mburo and Bwindi Impenetrable National Parks. Through a systematic review of literature, the study investigates the contributions of IK to biodiversity conservation, the extent of its recognition in policy and management frameworks, and the barriers hindering its full integration. The goal is to inform more inclusive, culturally grounded, and sustainable conservation approaches.

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Indigenous Knowledge

Indigenous knowledge (IK) refers to collective skills, understandings, and philosophies developed by indigenous communities through long-term interaction with their environments (Bohensky & Maru, 2011; Sillitoe, 2016; Whyte, 2017). It is place-based, orally transmitted, and encompasses ecological and cultural insights such as knowledge of species, habitats, climate patterns, and ecosystem dynamics. IK is holistic, blending cultural, spiritual, and practical elements, with a strong emphasis on sustainability and stewardship (Nelson, 2014; Berkes, 2017; Flick, 2021). Unlike modern scientific approaches, which seek universal principles, IK is context-specific and culturally embedded (McElwee, 2021). Indigenous knowledge offers adaptable solutions to challenges like climate change and biodiversity loss but faces threats from modernization and marginalization (Dehm, 2016; Puig, 2021; Habibi, 2024), despite global recognition in frameworks like the Convention on Biological Diversity (CBD) and the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). It evolves over time, providing adaptable, localised solutions to challenges such as climate change and biodiversity loss. Preserving and integrating IK into contemporary strategies is vital for sustainable development and ecological resilience.

Components of Indigenous Knowledge

Traditional Ecological Knowledge

Traditional Ecological Knowledge (TEK) is a rich, dynamic body of knowledge that indigenous communities have developed over generations, rooted in their close connection with the environment. It involves not only understanding the behaviour of specific species but also recognising complex interrelationships within ecosystems and the cyclical nature of ecological processes (Martinez, 2014; Nelson & Shilling, 2018; Rai et al., 2024). Indigenous knowledge is vital for ecological balance and sustainable resource use. In Uganda's Bwindi and Lake Mburo National Parks, communities like the Batwa use TEK to understand wildlife behaviour, such as gorilla migration, enabling coexistence while preserving traditional livelihoods through storytelling, rituals, and practices (Byaruhanga, 2008; Dowie, 2011; Schulze, 2022).

Similarly, in Lake Mburo, pastoralist communities such as the Bahima and Bakiga have long relied on TEK to manage grazing lands within the park's savanna ecosystem. These communities have developed intricate knowledge of seasonal patterns, the movement of grazing herds, and the regeneration cycles of vegetation. By observing these patterns, they are able to rotate grazing areas, prevent overgrazing, and ensure that the ecological health of the savanna is maintained (Mengistu, 2005; Ochieng, 2011; Apio et al., 2015). Integrating TEK into conservation strategies enhances resource management by providing complementary insights, requiring its preservation, documentation, and respect, while involving indigenous communities in decision-making to foster sustainable and inclusive solutions.

Cultural Practices

Cultural beliefs and practices are key to indigenous knowledge systems, fostering sustainable environmental interactions through sacred views of natural elements, such as forests and rivers, and embedding conservation principles in rituals and taboos (Senanayake, 2006; Magni, 2017; Mazzocchi, 2020). Indigenous communities view natural elements as sacred, embedding conservation in taboos and rituals that restrict resource use to prevent overexploitation and maintain ecological balance (Bernard & Kumalo, 2013; Zeleke, 2019). Ceremonial activities, like the Batwa people's forest rituals in Bwindi, emphasise respect for nature and contribute to biodiversity conservation. An example of the Batwa people's forest rituals in Bwindi is their ritual offerings and prayers at sacred sites, which are intended to honour the spirits of the forest. These ceremonies emphasise the sustainable use of resources by discouraging overexploitation and promoting practices that maintain the ecological balance, indirectly contributing to biodiversity

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conservation (Zeleke, 2019; Shein & Sukinarhimi, 2022). Sacred groves and seasonal restrictions often function as informal conservation zones. Among the Batwa at Bwindi, sacred groves are areas within the forest considered spiritually significant, where hunting, tree cutting, or other disruptive activities are strictly prohibited. For example, specific sections of the forest regarded as sacred burial sites or spiritual meeting places are left undisturbed, which helps preserve biodiversity in those areas. Similarly, seasonal restrictions are observed during certain times of the year, such as the breeding season for wildlife, to allow the ecosystem to regenerate naturally. However, these practices face threats from modernization and land-use changes (Khan et al., 2008; Jaryan et al., 2010; Parthasarathy & Naveen Babu, 2020). Recognizing and integrating them into contemporary frameworks can enhance conservation efforts while preserving cultural heritage.

Sustainable Resource Management Techniques

Indigenous communities use time-tested resource management techniques tailored to local environments, ensuring ecological balance and sustainability (Nelson & Shilling, 2018; Al-Mansoori & Hamdan, 2023). Practices include rotational farming and grazing, which prevent soil degradation and overuse, as seen around Lake Mburo, where pastoralists practice rotational grazing to maintain grasslands (Mengistu, 2005). Agroforestry, common in regions like Bwindi, integrates trees into agriculture to conserve biodiversity, improve soil health, and enhance food security. Other methods include floodplain management and traditional water conservation, such as rainwater harvesting and controlled flooding, which sustain ecosystems and manage water resources (Bitariho, 2013). These practices are increasingly recognized by the government (UWA) and NGOs such as Bwindi Mghahinga Conservation Trust, for their relevance in addressing modern challenges like deforestation and climate change. However, they face threats from land-use changes and undervaluation in policymaking (Twongyirwe, 2015; Gerald, 2021). Integrating these techniques into conservation and development programs can provide sustainable solutions while respecting indigenous knowledge and cultural heritage**.**

Medicinal Knowledge

Indigenous communities, especially in biodiversity-rich areas like Bwindi and Lake Mburo in Uganda, possess valuable knowledge about the medicinal properties of plants and animals, which is often passed down through generations. In Bwindi, indigenous Batwa communities possess knowledge about the medicinal properties of various plants, such as the bark of the Prunus africana tree, which they traditionally used to treat ailments like fevers and stomach pains. This knowledge, passed down through generations, holds significant potential for modern medicine and biodiversity conservation, but is often overlooked in formal healthcare and conservation strategies. In the Lake Mburo National Park region, indigenous communities possess knowledge about medicinal plants like the Aloe species, traditionally used to treat skin conditions and wounds. Additionally, they understand the therapeutic properties of certain animal products, such as using honey from wild bees for its antibacterial and healing qualities. This traditional knowledge passed down through generations, remains an untapped resource for health and conservation efforts (Barakagira, 2018; Katamigwa, 2023).

In remote regions where access to modern healthcare is limited, this traditional knowledge serves as a vital resource for addressing health challenges, offering an alternative or complement to modern medical treatments (Wanzala et al., 2005; Gurib-Fakim, 2006; Balick & Cox, 2020). The preservation of indigenous medicinal knowledge is not only essential for the health and well-being of these communities but also plays a crucial role in biodiversity conservation and pharmaceutical research for example on cancer and corona. The preservation of indigenous medicinal knowledge, such as the Batwa people's use of the Prunus africana tree bark for treating fevers and prostate ailments, highlights its dual importance. Protecting this knowledge not only

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supports the health of the community but also promotes the conservation of the Prunus africana tree, a species threatened by overharvesting for global pharmaceutical demand. By safeguarding such practices, both cultural heritage and biodiversity are preserved, while offering potential insights for modern medicine. Many of the species in these areas, particularly endemic plants and animals, possess unique properties that could lead to the development of new medicines and therapeutic treatments (Heywood, 2011; Pushpangadan et al., 2018). However, preserving and utilizing indigenous knowledge in healthcare and research requires respecting indigenous rights, preventing biopiracy, and integrating traditional knowledge with scientific research to improve health outcomes and support biodiversity conservation.

Significance of Indigenous Knowledge in Conservation

Indigenous knowledge plays a vital role in conservation by providing localised, context-specific solutions that are often more sustainable and effective in managing biodiversity compared to purely scientific approaches (Karki & Adhikari, 2015; Yu & Mu, 2023). In Uganda's Bwindi and Lake Mburo National Parks, community-based initiatives leveraging IK have proven effective in biodiversity management. The Batwa Cultural Experience in Bwindi is a community-based initiative that incorporates indigenous knowledge to promote biodiversity management. Through this program, the Batwa share their deep understanding of the forest, including sustainable resource use and gorilla habitats, while earning income from ecotourism. This initiative fosters conservation awareness among visitors and provides alternative livelihoods for the Batwa, reducing pressure on forest resources. The Ankole Longhorn Cattle Grazing Program in Lake Mburo is a collaborative effort between the park authorities and local pastoralist communities. By integrating traditional grazing practices that align with indigenous knowledge of ecosystem balance, this initiative prevents overgrazing, controls bush encroachment, and maintains the savanna grassland habitat critical for wildlife. Local communities, with generations of ecological expertise, employ sustainable practices like traditional farming, water management, and harvesting to maintain ecological balance. Despite these successes, challenges persist in formally recognizing IK within conservation policies. It is often undervalued compared to scientific knowledge, resulting in weak legal protections for IK and indigenous rights. Furthermore, indigenous communities face barriers to participating in governance, limiting their influence on conservation decisions and impacting their resources and livelihoods (Berkhoudt, 2012; Bose, 2024). Inclusive approaches are needed to integrate IK into conservation strategies, protect community rights, and balance biodiversity protection with sustainable livelihoods.

Rationale of Indigenous Knowledge

Despite the increasing recognition of IK as a critical component in biodiversity conservation and environmental governance, there remains a significant gap in the systematic integration of IK into formal governance frameworks within Uganda’s protected areas (Mugambiwa, 2020; Bwambale, 2021; Leal Filho et al., 2022). Much of the existing literature emphasizes the role of IK in local community practices, such as sustainable agriculture, medicinal knowledge, and resource management (Santos, 2009; Mphephu, 2017). However, there is limited research focusing specifically on how IK is formally recognised, valued, and incorporated into decision-making processes, especially in Uganda’s national parks like Lake Mburo and Bwindi Impenetrable National Parks (Namara, 2006; Omoding et al., 2020; Muhumuza et al., 2022).

A major gap lies in the lack of formal frameworks that integrate IK into the management strategies of protected areas. While IK is acknowledged informally, national park management plans often remain dominated by top-down, scientific approaches that do not adequately incorporate local communities' knowledge systems (Tran et al., 2020). This oversight can lead to the marginalisation of indigenous communities, limiting their participation in decision-making

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processes regarding the land and natural resources they have traditionally managed for generations. An example of this gap can be seen in Bwindi Impenetrable National Park, where the Batwa community's traditional knowledge of forest management, such as sustainable hunting practices and plant medicine, is often excluded from formal park management strategies. Despite their deep connection to the land, the Batwa have been marginalised in decision-making processes about the management of Bwindi Impenetrable National Park, with conservation policies largely shaped by top-down, state-led scientific approaches. Institutions such as the Uganda Wildlife Authority (UWA), guided by frameworks like the 1996 Uganda Wildlife Statute and subsequent Wildlife Act of 2019, have emphasized fortress conservation, which prioritizes biodiversity protection over local community rights. International conservation NGOs, such as the World Wide Fund for Nature (WWF) and the International Gorilla Conservation Programme (IGCP), while instrumental in funding and technical support, have also been critiqued for aligning with exclusionary models of conservation that insufficiently integrate Indigenous Knowledge (IK). This institutional exclusion limits the Batwa's participation in managing the very ecosystems they have historically conserved, contributing to their disempowerment and the erosion of traditional ecological knowledge. The absence of IK in governance structures undermines the effectiveness of conservation strategies by disregarding localized expertise that is essential for sustainable resource use and conflict resolution, particularly in managing human-wildlife conflict or responding to environmental changes (Davies et al., 2013; Ens et al., 2021; Zhang et al., 2023).

This study addressed the gap by conducting a systematic review of existing literature on the role of IK in the governance and management of LMNP and BINP. Both parks represent key biodiversity hotspots in Uganda, with Lake Mburo known for its savanna ecosystems and Bwindi being home to endangered mountain gorillas (Sandbrook et al., 2018; Briggs & Van Zandbergen, 2024). In these areas, indigenous communities have long relied on IK to sustainably manage resources and mitigate human-wildlife conflicts. However, the role of IK in formal governance structures has been under-researched, limiting the understanding of how traditional practices can complement modern conservation efforts (Whyte, 2017; Dorji et al., 2024; Petzold et al., 2020). Recent global conservation policies, such as the Post-2020 Global Biodiversity Framework, highlighting the importance of integrating traditional knowledge into biodiversity governance (Armitage et al., 2020; Priyadarshini et al., 2022; Secretariat, 2023) make this study particularly timely. Yet, in Uganda, there is a clear need for more empirical evidence on how IK can be integrated into existing legal, institutional, and management frameworks to improve conservation outcomes (Nkonya et al., 2005: Laird, 2010; Malmer et al., 2020). Additionally, as Uganda faces increasing pressure from climate change, human encroachment, and biodiversity loss, understanding how indigenous knowledge can contribute to adaptive governance is essential for creating resilient conservation strategies that are inclusive and effective (Oba, 2009; Cavanagh, 2012; Sliuzas et al., 2023).

By focusing on the governance practices of LMNP and BINP, this study explored how IK can be formally integrated into park management strategies, helping to bridge the gap between local practices and national or international conservation goals. This integration could not only enhance biodiversity protection but also empower indigenous communities, ensuring their cultural and ecological contributions are recognised and sustained (Kefitile, 2018). By doing so this study fills a crucial gap in the research on the integration of indigenous knowledge into governance structures for conservation in Uganda's protected areas. In addition, by systematically reviewing the available literature on Lake Mburo and Bwindi National Parks, the research aims to highlight the potential benefits of formally recognizing IK in governance frameworks. It also intends to identify

Article DOI : https://doi.org/10.37284/ajccrs.4.1.3109

the challenges and opportunities in doing so, thereby contributing to a more inclusive and effective approach to biodiversity conservation in Uganda.

METHODOLOGY

Study area

The research examines Uganda's Lake Mburo National Park (370 km²) in the cattle corridor, managed by the Uganda Wildlife Authority (Figure 1). Hosting diverse wildlife, the park is vital for local pastoralists and farming communities. Established as a controlled hunting area in 1933 and designated a national park in 1983, LMNP has faced many conflicts with communities over resource access restrictions (Atuhaire, 2018). The study highlights the coexistence of wildlife and humans, with 60% of wildlife found outside park boundaries, emphasising the need for conservation efforts (Ochieng, 2011).

It also examines Bwindi Impenetrable National Park (Figure 2), home to endangered mountain gorillas, where conservation efforts face challenges from community discontent over resource-use restrictions, highlighting the tension between ecological protection and local livelihoods in a poverty-stricken region (Twinamatsiko, 2015). Lake Mburo National Park has great eco-tourism opportunities as it can ensure biodiversity conservation (Okello, 2004; Rono, 2016; Mkonyi, 2021), while Bwindi is important for the conservation of endangered mountain gorillas (Robbins et al., 2009; Amusa et al., 2021). Both parks are struggling with, and stand to gain from, the integration of conservation and community livelihoods through community-based tourism and revenue-sharing of gorilla trekking to fuel local development and conservation processes (Ahebwa et al., 2012; Amony, 2021; Authority & Plus, 2021).

Figure 1: Location of Lake Mburo National Park

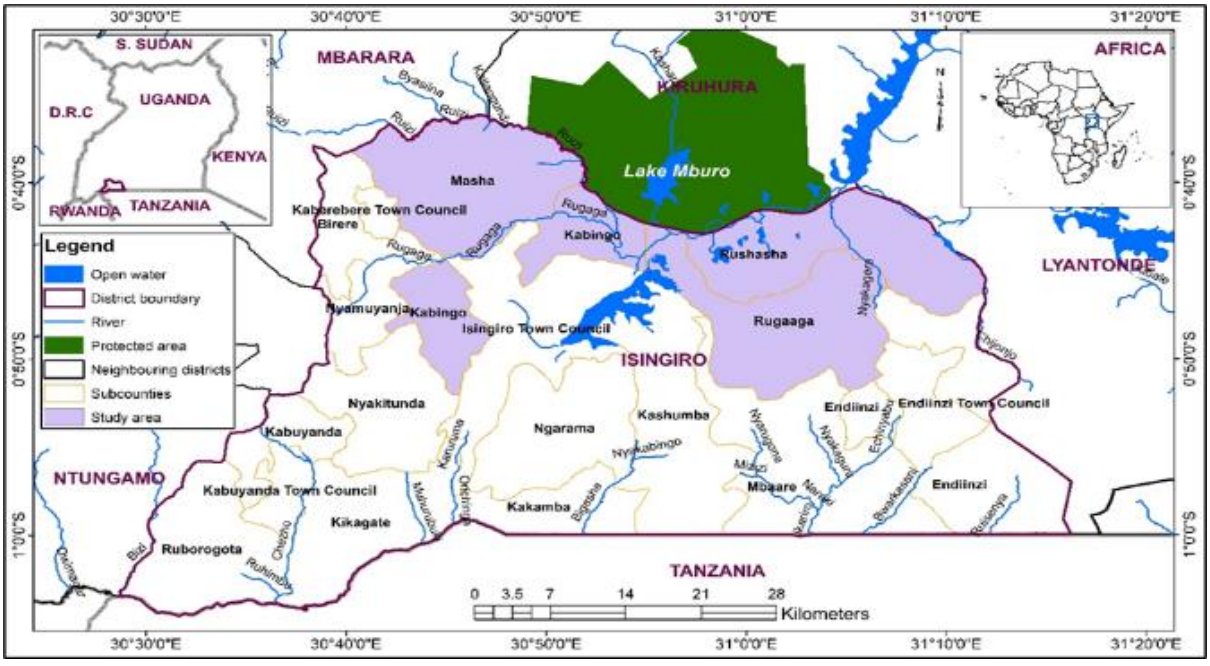

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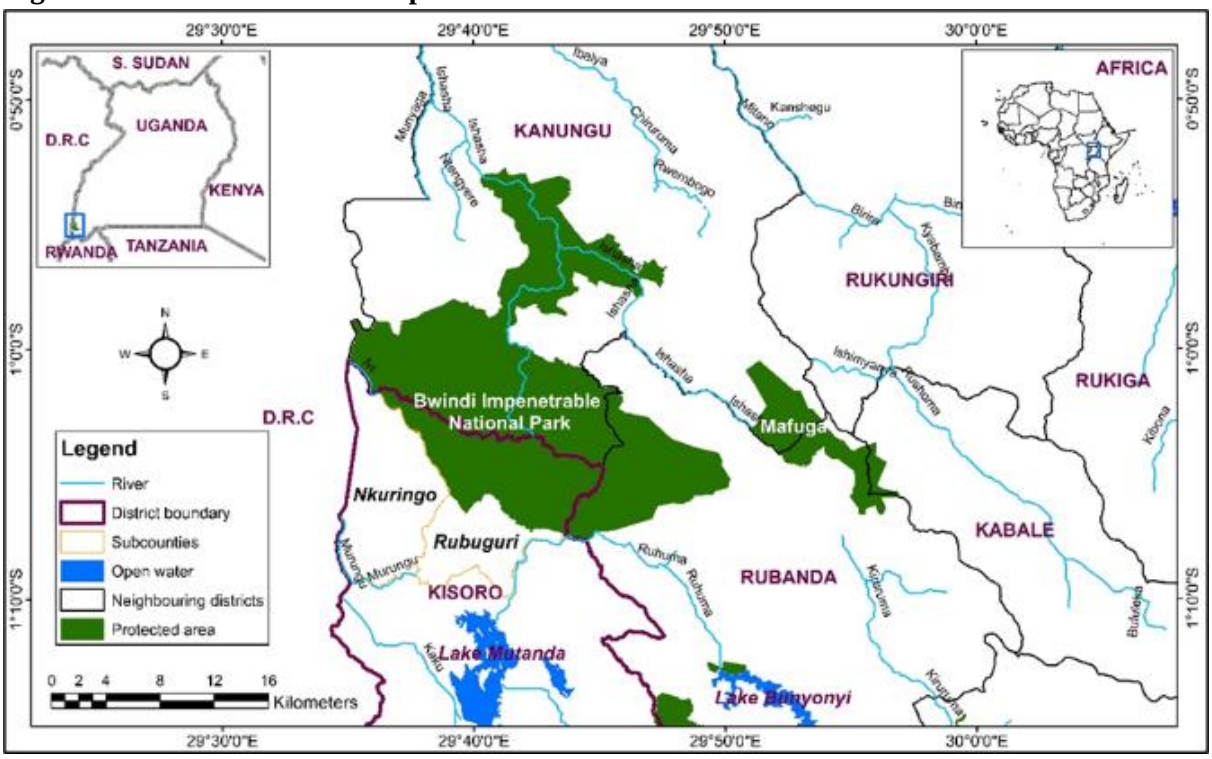
Figure 2: Location of Bwindi Impenetrable National Park



Overview of the Search Criteria

Search Strategy

The systematic review employed a rigorous search strategy to identify studies on integrating indigenous knowledge into environmental governance in Uganda's Lake Mburo and Bwindi Impenetrable National Parks. Academic databases like Google Scholar, JSTOR, Scopus, and Web of Science, along with Ugandan research repositories, were utilised. Targeted keywords and Boolean operators ensured comprehensive coverage of relevant topics. The review prioritised peer-reviewed articles and reputable reports from the last 20 years, focusing on studies emphasising IK's role in governance, community participation, and biodiversity conservation outcomes. A three-stage screening process title, abstract, and full-text review, filtered materials based on relevance. Additional searches included grey literature from intergovernmental organisations, like the United Nations Environment Programme (UNEP) and non-governmental organisations, such as the Worldwide Fund (WWF) and bibliographies from key studies. The strategy emphasised practical examples and empirical evidence, ensuring a thorough understanding of how IK contributes to governance and conservation in these protected areas.

Table 1: Criteria for Choosing Articles

Screening stage	Number of records
Initial search results	312
After title screening	290
After abstract screening	270
After full-text review	214

Inclusion and Exclusion Criteria

The systematic review applied clear inclusion and exclusion criteria to ensure focus and quality. Studies were included if they addressed indigenous knowledge in environmental governance, specifically within Uganda's Lake Mburo and Bwindi National Parks and the study topic. They had to be peer-reviewed, published in

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the last 20 years, provide empirical evidence, and be written in English. Reputable reports and case studies emphasising IK integration and conservation strategies were prioritised. Excluded were studies unrelated to the study topic, those lacking empirical data, those focused solely on Western scientific approaches, or those written in non-English languages. These criteria ensured the review captured relevant, credible literature highlighting the role of IK in conservation and governance.

Data Extraction and Analysis

The data extraction and analysis process systematically collected key insights on indigenous knowledge, focusing on its role in biodiversity conservation, community participation, and integration challenges. Through thematic analysis, the findings were synthesised into three major themes: (1) Indigenous Knowledge's (IK) contributions to sustainable management and species protection, (2) its role in engaging communities and bridging traditional and modern governance approaches, and (3) the barriers to its integration, such as policy gaps and institutional exclusion. Thematic development followed Braun and Clarke's six-phase approach, beginning with familiarisation through repeated reading of selected texts. Codes were then generated to capture recurrent patterns, such as references to traditional ecological practices, community engagement frameworks, and policy-related challenges. These codes were grouped into broader categories based on semantic and latent content, from which the final three themes emerged. This analytical process allowed for the identification of cross-cutting issues and context-specific dynamics, producing actionable insights for enhancing conservation strategies in Uganda's protected areas, particularly Lake Mburo and Bwindi Impenetrable National Parks.

RESULTS

Overview of Selected Studies

A total of 214 studies were included in the final analysis, representing a diverse range of perspectives and methodologies on the integration of indigenous knowledge into environmental governance frameworks. These studies primarily examined the interactions between local communities and the management of protected areas, with a particular focus on Uganda's Lake Mburo and Bwindi Impenetrable National Parks. The studies reviewed focused on the relationship between local communities and park management, highlighting the importance of community participation and indigenous practices in conservation. They also examined indigenous governance structures and their role in complementing formal policies for sustainable resource management. Case studies demonstrated the successful integration of indigenous knowledge in managing biodiversity and human-wildlife conflicts. However, challenges in aligning IK with formal governance, such as power imbalances and policy gaps, were identified. The review emphasised the need for policies that support the inclusion of IK in conservation strategies, particularly in Uganda's protected areas.

The Role of Indigenous Knowledge in Lake Mburo National Park

Indigenous knowledge plays a significant role in the management and conservation of Lake Mburo National Park, where local communities' traditional practices complement modern conservation efforts (Infield & Mugisha, 2018; Muhumuza et al., 2022; Bose, 2024). These practices, grounded in a deep understanding of the environment, foster sustainable interactions between people and wildlife. Local communities in the Lake Mburo region rely on traditional grazing patterns and seasonal migrations that align with the natural ecological cycles of the park (Mengistu, 2005; Anthony, 2006; Griffin, 2012; Scoon, 2022). These practices are not only culturally significant but also contribute to maintaining a balance between wildlife and livestock populations, preventing overgrazing, and promoting biodiversity (Dorrough et al., 2004; Metera et al., 2010; Ingty, 2021; Teague & Kreuter, 2020). The seasonal movements ensure that grazing pressure is distributed evenly across

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the landscape, allowing the environment to regenerate and minimise human-wildlife conflicts.

Community-led initiatives often integrate traditional ecological knowledge (TEK) for sustainable resource management. For example, in water conservation, practices such as protecting sacred water sources as communal assets reinforced by cultural rituals and taboos help maintain water quality and availability while preventing over-extraction and pollution. One notable example is the Rwenzori Mountains Sacred Sites Initiative, which collaborates with local custodians to safeguard culturally significant water sources and forest patches. Through community stewardship, the initiative blends TEK with contemporary conservation methods, ensuring ecological integrity while preserving Indigenous cultural heritage. Such initiatives illustrate the potential of hybrid governance approaches that respect local worldviews and promote environmental sustainability (Wali et al., 2017; Fabre et al., 2021; Kayamba-Phiri & Abbott, 2023). Indigenous techniques for constructing natural water catchments effectively harvest and store rainwater in arid regions, aligning with local hydrological patterns and minimizing ecosystem disruption. Traditional water filtration methods using plants like reeds and water hyacinths serve as natural biofilters, removing pollutants and enhancing water quality for human and wildlife needs, often integrated into modern conservation efforts (Finn & Jackson, 2011; Altieri & Nicholls, 2017). Beyond water management, these community-led efforts often foster stronger stewardship of natural resources. By integrating TEK with scientific conservation methods, projects can achieve enhanced ecological outcomes while respecting and preserving cultural heritage. This fusion not only benefits environmental conservation but also empowers communities by validating their knowledge and role in resource management, promoting social equity and resilience.

The integration of indigenous knowledge into the park's management strategies has fostered stronger cooperation between park authorities and local communities (Vodouhê et al., 2010; Andrade & Rhodes, 2012; Moreto & Charlton, 2021). For instance, when community members are involved in crafting policies around access to natural resources or mitigating human-wildlife conflicts, they are more likely to support and uphold these initiatives. The inclusion of community members in decision-making processes has led to improved relations and collaborative efforts in park management (Ochieng, 2011; Twinamatsiko et al., 2022a; Bonye et al., 2023). By respecting and valuing IK, authorities have facilitated more inclusive governance structures that enhance the effectiveness of conservation strategies. This collaboration has been key in resolving conflicts, such as those related to resource use and human-wildlife interactions, and ensuring that the interests of local communities are considered in park management plans (Ochieng, 2011; Macura, 2015; UWA & Plus, 2021).

The integration of IK into governance and management plans at Lake Mburo has not only improved conservation outcomes but has also empowered local communities. The recognition and incorporation of traditional practices promote sustainable land use and resource management while enhancing community ownership of conservation efforts (Infield & Mugisha, 2018; Ochieng, 2019; Twinamatsiko et al., 2022b). This collaborative approach has proven essential in preserving both biodiversity and the livelihoods of those living near the park. Indigenous knowledge is a vital component of sustainable management in Lake Mburo National Park, facilitating a balanced coexistence between local communities, livestock, wildlife, and park authorities (Ochieng, 2011; Gambay, 2014; Hariohay & Gambay, 2020). The recognition of indigenous knowledge as a vital component of sustainable park management has ensured a harmonious coexistence between local communities, livestock, wildlife, and park authorities. This approach exemplifies the potential for conservation frameworks to uphold biodiversity while respecting cultural heritage and supporting community livelihoods. The community-based gorilla tourism initiative in Bwindi Impenetrable National Park involves local Batwa and Bakiga

Article DOI : https://doi.org/10.37284/ajccrs.4.1.3109

communities in the management and monitoring of gorilla populations. By integrating the Batwa's traditional knowledge of gorilla behaviour and habitat, the initiative creates a sustainable model where both wildlife and communities benefit. The Batwa gain employment, while the park authorities achieve better conservation outcomes, all while respecting cultural heritage and supporting livelihoods through a combination of indigenous knowledge and scientific management.

The Role of Indigenous Knowledge in Bwindi National Park

Indigenous knowledge plays a crucial role in the conservation of Bwindi Impenetrable National Park, particularly in the protection of endangered species like the mountain gorillas (Sandbrook, 2006; Byaruhanga, 2008; Ampumuza, 2021). Local Batwa communities have long coexisted with the forest, using their traditional ecological knowledge to contribute to sustainable conservation efforts and minimise human-wildlife conflict (Twinamatsiko et al., 2014; Jóhannesson et al., 2015; Tumusiime et al., 2018). The Batwa people play an active role in gorilla conservation by participating in gorilla tracking and tourism activities. They apply traditional knowledge of the forest, such as understanding animal behaviour, forest pathways, and seasonal movements, which enhances conservation efforts and minimises disturbances to the gorillas (Hodosi, 2010; Ampumuza, 2021; Muresherwa et al., 2020). For instance, Batwa trackers use their knowledge of the terrain and animal habits to guide tourists safely through the park, ensuring minimal impact on the gorillas and their habitat. Additionally, their involvement in gorilla monitoring and anti-poaching activities has contributed to a reduction in illegal hunting and encroachment, benefiting both the local community and the park's biodiversity (Briggs, 2007; Hodosi, 2010; Amony, 2021).

Local communities have also formed associations and community-based organisations aimed at managing natural resources sustainably. These groups combine traditional governance systems with modern conservation practices, creating collaborative models that improve resource management while fostering community ownership (Bitariho, 2013; Buntaine et al., 2018; Kesande, 2023). For example, local community members use their traditional knowledge to manage buffer zones around the park, where they practice sustainable farming and grazing. They also engage in forest protection activities, such as tree planting and conservation education programs, integrating cultural values with conservation goals (Namara, 2006; Carius & Job, 2021; Twinamatsiko, 2015). The formation of community-based organisations that integrate traditional and modern conservation practices highlights the transformative potential of community-led resource management. These initiatives not only improve ecological outcomes but also empower communities by fostering a sense of ownership and enhancing their livelihoods, creating a sustainable and inclusive model for conservation.

Despite the successful integration of indigenous knowledge in conservation, there are several challenges that hinder its full potential. IK is often not formally recognised in the governance frameworks of Bwindi National Park. Authorities sometimes fail to acknowledge the value of traditional knowledge in decision-making processes, limiting its integration into official park management plans (Kidd, 2014; Twinamatsiko et al., 2014; Ampumuza et al., 2020a, 2020b). Land tenure remains a significant challenge in the park's surrounding communities. Many indigenous groups, particularly the Batwa, face land ownership and access issues, which complicate their ability to manage resources sustainably (Cernea & Schmidt-Soltau, 2006; Hansen & DeFries, 2007; Burkholder, 2012; Pimbert & Pretty, 2013; Baró et al., 2016). Displacement from traditional lands and lack of legal recognition of land rights limit their participation in long-term conservation efforts. The Batwa, who were historically forest dwellers, face cultural marginalisation as their traditional way of life has been disrupted by conservation efforts. The Batwa were culturally marginalised after being

Article DOI : https://doi.org/10.37284/ajccrs.4.1.3109

forcibly relocated from Bwindi Impenetrable National Park in 1991, losing their traditional forest-based lifestyle. Displaced without adequate compensation or alternative livelihoods, they were excluded from decision-making processes related to the park, hindering their ability to maintain cultural practices and access essential forest resources. While their knowledge is invaluable for conservation, they are sometimes excluded from the formal decision-making processes that affect their lives and the land they have traditionally managed (Hodosi, 2010; Kidd, 2014; Nsibambi, 2018; Schulze, 2022).

The integration of indigenous knowledge into Bwindi National Park's conservation strategies has shown positive results in reducing human-wildlife conflict, especially with gorillas, and fostering sustainable resource management. However, addressing the barriers to formal recognition of IK and land tenure issues is crucial to enhancing the effectiveness and inclusivity of conservation efforts (Baker et al., 2013; Twinamatsiko et al., 2014; Ampumuza, 2022). Efforts to bridge traditional and modern governance structures are essential for creating a more holistic approach to conservation that respects the rights and contributions of indigenous communities (Lockwood, 2010; Ross et al., 2016; Dawson et al., 2021; Foyet & Mupeta-Muyanwa, 2023). Additionally, securing land rights and integrating indigenous perspectives into policy and governance can further empower local communities, ensuring that they continue to play a key role in the long-term sustainability of Bwindi's biodiversity (Hodosi, 2010; Bitariho, 2013; Twinamatsiko, 2015; Kesande, 2023). Indigenous Knowledge is integral to the success of conservation efforts in Bwindi National Park, but for its full potential to be realized, challenges related to recognition, land rights, and cultural inclusion must be addressed.

Comparative Analysis

The management strategies of Lake Mburo and Bwindi Impenetrable National Parks highlight the integration of indigenous knowledge and community involvement for sustainable conservation. Both parks engage local communities through co-management, benefit-sharing, and traditional ecological practices, fostering ownership, reducing conflicts, and promoting coexistence between people and wildlife. Lake Mburo National Park integrates indigenous knowledge and community involvement through co-management, benefit-sharing, and traditional ecological practices, enabling local pastoralists to participate in park management, share in eco-tourism profits, and apply sustainable grazing methods, which fosters conservation, reduces conflicts, and promotes coexistence between people and wildlife. The community-based gorilla tourism initiative in Bwindi Impenetrable National Park integrates indigenous knowledge and community involvement through co-management, benefit-sharing, and traditional ecological practices, creating a sustainable conservation model. Local Batwa and Bakiga communities actively participate in park management by guiding tourists and monitoring gorilla populations, utilising their traditional knowledge of the forest and gorilla behaviour (Ochieng, 2011; Twinamatsiko et al., 2014; Nthenge, 2019; Ndayisaba, 2020; UWA & Plus, 2021). Moreover, both parks adopt a multi-stakeholder approach to governance, involving government agencies, local leaders, NGOs, and researchers in decision-making.

Both Lake Mburo and Bwindi Impenetrable National Parks employ a multi-stakeholder governance model involving the Uganda Wildlife Authority (UWA), local communities, local government authorities, NGOs, and researchers to sustainably manage park resources, protect wildlife, and promote community development. In Lake Mburo, stakeholders collaborate on sustainable grazing practices, wildlife protection, and tourism revenue-sharing, while in Bwindi, the Gorilla Tourism Program integrates community participation in eco-tourism, wildlife monitoring, and conservation efforts, with NGOs like the Wildlife Conservation Society and International Gorilla Conservation Programme providing technical expertise and funding. Both parks aim to

Article DOI : https://doi.org/10.37284/ajccrs.4.1.3109

balance conservation goals with local needs, ensuring long-term sustainability and coexistence between people and wildlife. This inclusive framework ensures that conservation strategies are socially equitable and ecologically sound (Ullah & Kim, 2020; Authority & Plus, 2021; Momen, 2021; Bonye et al., 2023; Bose, 2024; Lubogo, 2024a). Additionally, eco-friendly livelihoods, such as beekeeping (I have honey from Bwindi branded as forest honey) and handicrafts, are promoted in both regions to reduce dependency on natural resources from the parks (Tancau, 2011; Ahebwa et al., 2018; Atuhaire, 2018; Esposito et al., 2020; Gowreesunkar et al., 2022).

Despite these similarities, the parks differ significantly in their management priorities and strategies due to their distinct ecological characteristics and conservation challenges. Lake Mburo National Park places significant emphasis on livestock management. The park is located in a savannah ecosystem where livestock rearing is a dominant livelihood (Ochieng, 2011; Isreal, 2015; Atuhaire, 2018). This approach not only addresses the needs of local communities but also ensures the ecological health of the savannah (Ayorekire et al., 2011; Mbuya et al., 2015). In contrast, Bwindi Impenetrable National Park is renowned for its primate conservation efforts, particularly for mountain gorillas, which are critically endangered. Conservation strategies here focus on habitat preservation, anti-poaching measures, and scientific monitoring to ensure the survival of these iconic species (Nellemann et al., 2010; Sandbrook & Roe, 2010 Lubogo, 2024b). The differing management priorities of Lake Mburo and Bwindi Impenetrable National Parks highlight how tailored strategies, focusing on livestock integration in savannahs and primate conservation in rainforests, effectively balance ecological preservation with local community needs.

Bwindi has a well-developed ecotourism sector centred on gorilla trekking, which is a major source of revenue for both conservation and community development. In 2020, Bwindi Impenetrable National Park received approximately 36,000 tourists, primarily for gorilla trekking activities (Dani, 2023). The park's management emphasises maintaining strict regulations on tourism activities to minimise ecological disturbance while maximising economic benefits for local communities (Mehta & Katee, 2012; Maekawa et al., 2015; Ndayisaba, 2020). Lake Mburo National Park offers a diversified tourism portfolio, including game drives, birdwatching, nature walks, and cultural experiences. Unlike Bwindi, which focuses on gorilla trekking, Lake Mburo's tourism strategy is based on a variety of attractions, making tourism a balanced and significant revenue source for the park (Emerton et al., 2006; Nindi et al., 2014). Instead, the park seeks to provide a broad range of experiences that appeal to diverse visitor interests while fostering local community involvement and economic participation.

Lake Mburo's semi-arid ecosystem faces threats from invasive species like the lantana camara and the dichrostachys cinerea, drought, and overgrazing. These challenges degrade habitats, reduce forage availability, and strain water resources, impacting both wildlife and nearby pastoral communities. Overgrazing, driven by high livestock densities, further exacerbates land degradation and resource competition (Chidumayo, 2011; Isreal, 2015; Nagasha & Ocaido, 2024). Conservation efforts here must balance biodiversity protection with the needs of pastoral communities. Bwindi's dense montane forest ecosystem presents challenges such as limited land for agriculture, human encroachment, and the need for extensive forest management to maintain habitat connectivity for wildlife (Bitariho, 2013; Belfiore et al., 2015). By analysing these similarities and differences, it becomes evident that conservation strategies must be tailored to the unique ecological, social, and economic contexts of each park. While both parks benefit from community involvement and IK integration, their distinct focuses highlight the importance of context-specific approaches in achieving sustainable conservation goals.

DISCUSSION

The study highlights the vital role of IK in biodiversity conservation, emphasising its

Article DOI : https://doi.org/10.37284/ajccrs.4.1.3109

integration into community-led initiatives. Rooted in generations of experience, IK offers sustainable solutions by aligning local practices with broader conservation goals (Hens, 2006; Laird, 2010; Bohensky & Maru, 2011; Brondízio et al., 2021). Traditional land-use systems, such as rotational grazing or agroforestry, often align with modern principles of sustainability, minimizing ecological degradation while supporting livelihoods (van Noordwijk et al., 2020; Chappa et al., 2024). For example, in Lake Mburo National Park, the integration of traditional livestock management practices with park regulations has successfully reduced human-wildlife conflicts, illustrating how local knowledge systems can complement formal conservation strategies (Ochieng, 2011; Babaasa et al., 2013; Atuhaire, 2018; Ochieng, 2018). In Bwindi Impenetrable National Park, IK has played a key role in promoting coexistence between communities and wildlife, with practices like controlled forest resource use and cultural taboos against hunting certain species helping preserve biodiversity (van der Duim et al., 2014; Ampumuza, 2021). These practices are particularly relevant in the conservation of endangered species like mountain gorillas, where habitat integrity is crucial.

Community engagement is essential for successful and sustainable conservation, fostering strong relationships between local populations and protected areas. Local communities, often the first to observe ecological changes like shifts in animal behaviour, play a vital role in monitoring and maintaining ecosystem health (Helm et al., 2013; Fitchett et al., 2015; Hatfield et al., 2018). Engaging communities in monitoring ecological indicators allows them to act as an early warning system, helping park managers address issues like water pollution and human-wildlife conflicts early. Involving communities in decision-making fosters ownership, leading to greater adherence to conservation regulations, increased reporting of illegal activities, and proactive environmental protection (Cetas & Yasué, 2017; Newman et al., 2017; Gurung & Thapa, 2023). Community engagement in conservation is cost-effective and this leads to innovative, locally relevant solutions, enhances social and economic benefits for local populations, and strengthens the resilience and success of conservation efforts by integrating traditional knowledge with modern practices.

The findings emphasise the potential of IK to complement scientific approaches, creating holistic conservation strategies. Integrating IK with scientific methods, such as combining GIS technology with local knowledge in participatory mapping, enhances the identification of critical habitats and resource use patterns (Puri, 2007; Hodbod et al., 2019; Yanou et al., 2023). The success of these initiatives relies on the equitable inclusion of local communities in governance structures. Ensuring communities benefit from conservation through revenue-sharing, employment, or resource access is essential for maintaining their support and participation (Tumusiime & Vedeld, 2012; Twinamatsiko et al., 2015; Carius & Job, 2021; Spenceley et al., 2021). Indigenous Knowledge and community engagement are vital for biodiversity conservation, improving ecological understanding, promoting sustainability, and ensuring local relevance. Utilizing these strengths results in more inclusive and resilient conservation outcomes.

POLICY IMPLICATIONS

The findings of this study reveal critical policy implications for biodiversity conservation, emphasising the need for frameworks that formally recognise and integrate IK into conservation strategies. By doing so, policymakers can address conservation challenges more effectively while fostering social equity and sustainability.

RECOMMENDATIONS

Policymakers should develop and institutionalise frameworks that formally acknowledge IK as a valuable component of conservation strategies. Such frameworks could include guidelines for incorporating traditional ecological knowledge into national and regional conservation policies. Recognising IK not only validates the contributions of local communities but also

Article DOI : https://doi.org/10.37284/ajccrs.4.1.3109

ensures that their knowledge is utilised in ways that align with conservation objectives.

Conservation policies should prioritise participatory governance models that actively involve local communities in decision-making processes. This includes establishing platforms where indigenous and local voices are integral to planning, implementation, and monitoring efforts. For example, co-management agreements that define shared responsibilities between conservation authorities and communities can enhance both biodiversity outcomes and community welfare.

Policymakers should provide legal recognition to traditional practices that contribute to conservation, such as rotational grazing, sacred groves, and other culturally significant land-use practices. Additionally, financial incentives, such as payment for ecosystem services or community-based conservation funds, can further motivate local participation and ensure that conservation does not come at a cost to livelihoods.

Empowering communities with technical training and resources is essential for bridging gaps between IK and formal conservation approaches. Programs that provide education on biodiversity monitoring, sustainable agriculture, and alternative livelihoods can enhance community capacities to manage natural resources sustainably.

Strengthening partnerships between indigenous communities, conservation NGOs, and government agencies can lead to more effective resource management. By pooling resources and expertise, these stakeholders can develop integrated approaches that address ecological, social, and economic dimensions of conservation. For instance, NGOs can provide technical support, government agencies can facilitate policy implementation, and communities can contribute to localised knowledge and labour.

Partnerships must include mechanisms for equitable benefit sharing to ensure that communities derive tangible benefits from conservation efforts. Revenue-sharing schemes from tourism, such as those implemented in Bwindi Impenetrable National Park, can serve as a model. Such arrangements ensure that local communities are direct beneficiaries of conservation success, thereby fostering long-term commitment and compliance.

Conservation often intersects with complex socio-economic issues, such as land use, resource access, and human-wildlife conflicts. Strengthened partnerships can facilitate the creation of conflict resolution mechanisms that address these challenges through dialogue and mutual understanding. Mediating platforms that include all stakeholders' government bodies, NGOs, and communities can be instrumental in resolving disputes while ensuring the sustainability of conservation programs.

Partnerships can also facilitate knowledge exchange between scientific and indigenous perspectives. For example, conservation NGOs and research institutions can work with communities to combine IK with technologies like GIS, remote sensing, and biodiversity databases. This integration can enhance resource mapping, wildlife monitoring, and land-use planning.

Policymakers must adopt a holistic approach that integrates IK and strengthens partnerships across all levels of conservation governance. Formalising the role of IK, empowering local communities through participatory governance, and fostering collaborative resource management can create a more inclusive and sustainable framework for biodiversity conservation. These efforts are not only essential for ecological resilience but also for ensuring that conservation serves the interests of both people and the planet.

Future Research Directions

This review highlights the importance of IK in conservation but identifies several areas for further research. Future studies should explore the long-term sustainability of integrating IK into governance frameworks, examining how IK adapts to changing ecological, social, and political contexts. Research should also investigate how gender dynamics influence IK use, conservation

Article DOI : https://doi.org/10.37284/ajccrs.4.1.3109

practices, and community participation in decision-making. Additionally, understanding how IK evolves in response to climate change is crucial for adaptive conservation strategies. Exploring the intersection of economic factors, such as tourism revenue, with IK-based conservation and examining the role of policies in supporting or hindering IK integration are also important areas for future research**.**

CONCLUSION

This study underscores the indispensable role of IK in enhancing biodiversity conservation and fostering inclusive environmental governance. Drawing insights from Lake Mburo and Bwindi Impenetrable National Parks, it is evident that IK, rooted in the lived experiences and cultural practices of local communities, provides sustainable and context-specific solutions to conservation challenges. The integration of IK into governance frameworks has facilitated community engagement, reduced human-wildlife conflicts, and supported the preservation of critical ecosystems, including the habitats of endangered species such as the mountain gorilla. While the contributions of IK are evident, challenges such as socio-economic exclusion, lack of formal recognition, and insufficient integration into national policies persist. Bridging these gaps requires participatory governance models, equitable benefit-sharing mechanisms, and enhanced collaboration between local communities, conservation authorities, and other stakeholders. Addressing these barriers will not only strengthen conservation outcomes but also empower indigenous communities, ensuring their active role in sustainable resource management. Future research should focus on the long-term impacts of integrating IK, the influence of gender dynamics, adaptation to climate change, and the interplay between economic factors and conservation. By advancing the recognition and incorporation of IK, Uganda can create a more resilient and inclusive framework for managing its rich biodiversity and fostering socio-economic sustainability.

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