



# REVITALISING INDIGENOUS KNOWLEDGE TO SUPPORT SUSTAINABLE MANAGEMENT OF RAMSAR WETLANDS IN KILOMBERO VALLEY, TANZANIA

Silvia Francis Materu<sup>1\*</sup>, Jilisa Kilanso Mwalilino<sup>2</sup>, Elly Josephat Ligate<sup>1</sup>

\* Corresponding author: [smateru@sua.ac.tz](mailto:smateru@sua.ac.tz)

<sup>1</sup>Department of Biosciences, College of Natural and Applied Sciences, Sokoine University of Agriculture, P.O. Box 3038-Morogoro, Tanzania.

<sup>2</sup>Department of Geography and Environmental Studies, College of Natural and Applied Sciences, Sokoine University of Agriculture, P.O. Box 3038-Morogoro, Tanzania.

## ABSTRACT

The Kilombero Valley Ramsar Site supports 1.5 million livelihoods through wetland ecosystem services historically stewarded by Indigenous Peoples. This study documented Indigenous knowledge practices, identified continuity barriers, and assessed integration potential across 11 villages using 93 key informant interviews, 22 gender-disaggregated focus groups, 59 household interviews, and communication, education and public awareness programmes (n = 796 participants). Clan governance through escalating penalties (fishing bans, goat fines, grain confiscation) and sacred site protection sustained fisheries and forest cover pre-1990s. However, its 95 per cent abandonment over 30–50 years, driven by immigration of many tribes including Sukuma people (~ 70 per cent), science-only curricula (~ 80 per cent youth scepticism), religion, globalisation and unenforceable village by-laws, have triggered pollution (~ 80 per cent waterbodies), destructive fishing, and forest conversion. CEPA training revealed strong support for hybrid governance: 85 per cent adult trainees favoured joint patrols of traditional healers (*mbui*) and rangers; and improved sacred site recognition among pupils (n = 490). Formal governance failures (remote enforcement gaps, absent legitimacy) underpin community demands for Indigenous knowledge systems reintegration. Kilombero Valley Ramsar site demonstrates the urgent need for hybrid conservation approaches that draw on surviving surviving clan authority to achieve Ramsar wise use principles where top-down approaches have failed.

**Key words:** Indigenous knowledge systems; Natural resources management; Ramsar site; Ramsar Convention; Community based conservation

## INTRODUCTION

Indigenous knowledge systems (IKS) are embedded in spiritual beliefs and oral traditions that are unique to specific cultures. They are descriptive, place-based and rarely written, relying on intergenerational transmission for continuity. This dependence on memory renders IKS vulnerable, as knowledge may be lost or transformed when younger generations fail to fully inherit traditions from elders (Sillitoe & Marzano, 2009). The absence of systematic documentation further heightens the risk of erosion and extinction. Wetlands are among the world's most productive ecosystems, providing water purification, flood regulation, biodiversity support, and livelihoods for millions, services that IKS have sustained for millennia (Bell et al., 2025; IPBES, 2023; Millennium

Ecosystem Assessment, 2005; Ramsar Convention Secretariat, 2016a). The Ramsar Convention, ratified by Tanzania in 2000, explicitly recognises culture and Indigenous knowledge in wetland conservation through Article 3.1 and subsequent resolutions, including Resolution VII.8 (1999) on cultural values, Resolution X.3 (2008) on traditional knowledge and management practices, and Resolution XII.11 (2015) on synergies with the Convention on Biological Diversity (Ramsar Convention Secretariat, 2023). Together, these instruments promote the integration of Indigenous and Local Knowledge (ILK) into the Convention's 'wise use' principle, which aims to maintain ecological character while supporting human well-being (Finlayson et al., 2011; Ramsar Convention Secretariat, 2010).

Globally, IKS/ILK are defined as place-based, experiential systems co-evolved by Indigenous Peoples and local communities (IPLCs), integrating empirical observation, spiritual values, and adaptive practices for ecosystem stewardship (Pascual et al., 2022; Tengö et al., 2014). This framing aligns with the Kunming–Montreal Global Biodiversity Framework Target 3, which mandates the integration of IPLCs' knowledge into biodiversity strategies by 2030 (CBD, 2022), and with IUCN Best Practice Guideline No. 20, which advocates participatory co-production in protected areas (Borrini-Feyerabend & Hill, 2013). In the Kilombero Valley Ramsar Site (KQRS), IKS manifest as clan-regulated taboos, rituals and customary rules (Emmanuel & Kweka, 2024) that are directly relevant for addressing governance gaps in community-led wise use. Historically, such systems have embedded ecological understanding within cultural and spiritual practice, guiding wetland management through oral traditions and customary law (Diawuo & Issifu, 2015; Hill et al., 2020; UNESCO, 2013).

The KQRS, designated in 2002 (Ramsar Convention Secretariat, 2002), is Tanzania's largest freshwater wetland, covering over 796,000 ha in the Rufiji River Basin and contributing more than 60 per cent of basin freshwater to sustain fisheries, wildlife and livelihoods under seasonal flooding (MNRT, 2004a; MNRT, 2018; URT, 2002). Its current Integrated Management Plan relies largely on top-down enforcement and faces low compliance, particularly in relation to encroachment (MNRT, 2018). Integrating IKS, through clan governance and sacred sites, offers a pathway to intercultural 'wise use', consistent with Ramsar Resolution XII.11 and Strategic Plan Target 12 (Ramsar Convention Secretariat, 2016b). Indigenous groups, including the Pogoro and Ndamba, and clans of the Bena, Hehe and Ngoni, have long applied intergenerational ecological knowledge of species behaviour, seasonal cycles, and hydrological dynamics to manage KQRS resources. Across Africa, sacred landscapes regulated by clan institutions have contributed to biodiversity conservation and ecosystem resilience (Diawuo & Issifu, 2015; Udgaonkar, 2002). ILK promotes sustainable resource use (Bell et al., 2025; Cameron, 2020) by embedding spiritual sanctions within community governance, enabling collective compliance without external enforcement (Berkes, 2017; Tengö et al., 2014). These systems are increasingly disrupted by immigration, monoculture expansion, infrastructure-driven deforestation, and global commodity chains (IPBES, 2023; Kangalawe & Liwenga, 2005; Msoffe et al., 2019; Wilson et al., 2024), threatening the ecological integrity of Ramsar sites.

Despite their significance, ILK and cultural heritage remain poorly documented in Tanzanian wetlands. This

study addresses this gap by: (i) documenting ILK in KQRS; (ii) identifying challenges to intergenerational continuity; and (iii) exploring pathways for integration with formal governance frameworks, including Ramsar and IUCN mechanisms. The study contributes to intercultural governance by strengthening community well-being, sustainability and the operationalisation of Ramsar's wise use principles and associated resolutions.

## METHODS

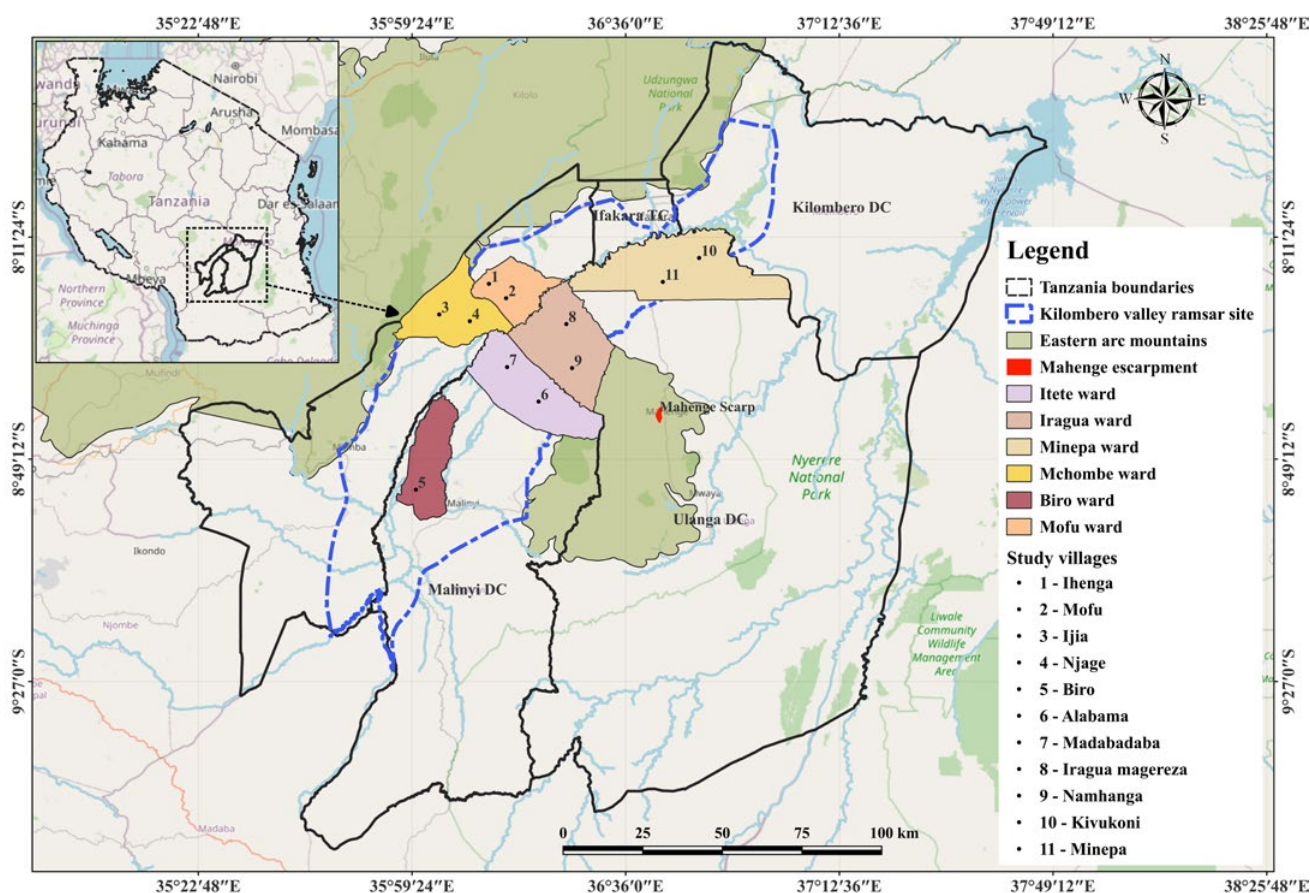
### Study area

This study was conducted in 11 villages within the KQRS, East Africa's largest low-altitude freshwater wetland located in the region's founding countries (Tanzania, Kenya and Uganda) (MNRT, 2004b). Designated in 2002, the KQRS lies at approximately 8°40'S, 36°10'E, covering about 796,735 ha with a catchment of roughly 40,000 km<sup>2</sup> (Materu et al., 2019; Ramsar Convention Secretariat, 2002). It is bounded by the Eastern Arc Mountains, including the Udzungwa catchment to the northwest and the Mahenge escarpment to the southeast (Materu et al., 2021; Ramsar Convention Secretariat, 2002). The valley is characterised by permanent and seasonal rivers that supply freshwater and support diverse livelihoods such as farming, fishing and livestock keeping (Materu et al., 2021). The climate is sub-humid, with average annual temperatures around 26 °C. Rainfall is bimodal, with short rains from December to February and long rains from March to June, producing about 1,600 mm annually (Bakengesa et al., 2011).

According to the 2022 Population and Housing Census, the KQRS supports ~1.5 million people across Kilombero (1,000,000), Malinyi (225,126) and Ulanga (232,895) districts (NBS, 2023). With an annual growth rate of 3.2 per cent, populations are projected to rise markedly by 2050, increasing pressure on wetland resources, highlighting the urgency of sustainable management aligned with Tanzania's Vision 2050 and the SDGs, particularly SDG 6 on water, SDG 15 on ecosystems, and SDG 13 on climate action. Indigenous Pogoro and Ndamba (fishing communities) coexist with immigrant Sukuma pastoralists, creating diverse governance systems. Native clans historically managed sacred sites through taboos and rituals, while pastoral influx since the 1990s drives rice expansion and wetland conversion (Kangalawe & Liwenga, 2005).

### Data collection

Traditional, Indigenous and local knowledge, innovations and practices of managing natural resources in the KQRS were assessed and documented through social surveys and CEPA (Communication, Education



**Figure 1.** A map of Tanzania showing the location of the Kilombero Valley Ramsar Site and the study villages

and Public Awareness) programmes, a widely used approach in environmental conservation, climate action, biodiversity management, and sustainable development to influence people's knowledge, attitudes and behaviours. Based on the socio-ecological gradient of the study area (riparian fishers, pastoralists community and mixed farming clans; Online Supplementary Table S1), this study was conducted in 11 villages, namely; Biro, Alabama and Madabadaba (Malinyi District); Iragua-Magereza, Namhanga, Minepa and Kivukoni (Ulanga District); and Ijia, Njage, Mofu and Ihenga (Mlimba District) (Figure 1).

**Key informant interviews (KIIs):** A heterogeneous purposive sample of 93 key informants (Online Supplementary Table S2) was systematically selected across district, ward and village administrative levels from seven sectors, strategically designed to capture the complete IKS transmission continuum (Palinkas et al., 2015; Tongco, 2007). This well-established non-probability approach targets information-rich respondents whose positional expertise spans knowledge custodians, transmission disruptors, and governance implementers.

Traditional healers (*mbui*,  $n = 9$ ) and village elders (*mzee maarufu*,  $n = 11$ ) provided oral histories of clan governance, taboos and rituals, complemented by religious leaders ( $n = 19$ ) preserving spiritual foundations of resource stewardship (Tongco, 2007). Education officers ( $n = 14$ ) and ward extension officers ( $n = 6$ ) represented institutional forces driving generational knowledge displacement through science-centric curricula and formalisation policies.

KIIs with forest officers ( $n = 3$ ), livestock and fisheries officers ( $n = 6$ ), village executive officers ( $n = 11$ ) and community development officers ( $n = 3$ ) offered critical insights into formal governance capacity for hybrid IKS integration (Palinkas et al., 2015).

**Focus group discussions (FGDs):** FGDs comprised two gender-disaggregated sessions per village (one male, one female) across all 11 study villages (Online Supplementary Table S2), yielding 22 groups strategically designed to capture the socio-cultural dynamics of Indigenous knowledge transmission (Krueger & Casey, 2015).

**Household interviews (HHIs):** Household interviews ( $n = 59$ ) employed participatory resource mapping to document generational continuity barriers and integration potential, spatially representing clan-

owned waterbodies, sacred forests, and regulated resource harvesting practices and any gendered access restrictions or spiritual prohibition / protocols.

**CEPA training programmes:** Communication, education and public awareness training programmes test community receptivity to integrating IKS into formal governance while generating evidence on generational knowledge gaps and scalability constraints. Adult training (n = 306; 162 males, 144 females) across nine villages evaluated integration feasibility between clan governance and statutory mechanisms. Participants, including hamlet representatives, environmental committees, executive officers, extension officers and teachers, received Kiswahili manuals covering wetland ecology, Ramsar designation, threats, and wise use principles. Field visits contrasted conserved sacred sites with degraded zones like rice conversion, complemented by cultural events and 18 seminars (nine villages, nine schools). The information obtained from KIIs and FGDs specifically probed community-government officers' collaboration models and wise-use education scalability.

Pupil training (n = 490; grades 2–6) quantified IKS transmission across generations, targeting environmental club members. Pre/post-tests measured recognition of sacred sites and ILK practices. These interventions produced baseline metrics for knowledge recovery potential while identifying youth scepticism towards spiritual foundations.

### Ethical consideration

Research permits were obtained from Sokoine University of Agriculture (DPRTC/R/126/SMCOSE/2/2019) and the Regional Administrative Authority (SUA/SM-CoSE/RS/01). Informed photo release and participation consent were secured, ensuring voluntary participation, withdrawal rights and participant confidentiality. To address the sensitivity of Indigenous knowledge, cultural norms were respected and potential harm minimised. Training materials were provided in Kiswahili to ensure accessibility. The study adhered to principles of transparency, respect and reciprocity, with findings shared with community stakeholders to strengthen empowerment and sustainable resource management.

## RESULTS

### Documented IKS and ILK practices

Clan-based IKS and ILK historically governed wetland and forest resource use across the KQRS through customary rules, taboos, rituals and clan justice mechanisms. KIIs with village elders (*mzee maarufu*) and traditional healers (*mbui*) revealed that offences such as poison fishing, harvesting fingerlings, cutting



Photo 1: A traditional healer's 'mbui' hut in a sacred forest, visited only for rituals, where tree cutting is strictly prohibited © S. F. Materu

sacred trees or burning wetlands were addressed through clan council hearings. Penalties followed an escalating structure, beginning with temporary fishing bans, followed by ritual fines such as goat sacrifices and, in cases of repeated violations, confiscation of grain stores until cleansing rituals were performed. As one elder explained, "Every youth attended these hearings to learn why swamps must rest during the dry season" [Male elder FGD, Kivukoni].

Community compliance relied primarily on shared spiritual beliefs rather than formal enforcement. HHIs across fisher, farmer and pastoralist households consistently indicated communal vigilance over wetlands and forests, "No one needed armed guards; everyone watched each other because the swamp belonged to all clans" [Fisher HHI, Namhanga]. Spiritual sanctions were widely regarded as effective deterrents, with respondents frequently citing fear of ancestral punishment. A farmer in Mofu noted, "Burning sacred grass during the dry season calls lightning from the ancestors, our grandparents witnessed this" [HHI, Mofu]. Despite increasing pressures, a few sacred sites remain actively protected. Traditional healers reported restricted access to sacred forests areas such as Magombero and ritual swamps including Kibasila and Ngapemba, where entry and resource extraction are prohibited except during specific ceremonies (Photo 1). These sites were consistently identified during FGDs as critical dry-season refugia for birds and other wetland species (Photo 2).



Photo 2. Foraging water birds in the wetlands, highlighting the rich biodiversity of endemic and migratory bird species © S. F. Materu



Photo 3. A fallen tree and fire illustrate the process of clearing forest land for new farms; including tree cutting, charcoal production, and removal of remaining logs in preparation for the planting season © E. J. Ligate

Clan-owned waterbodies were governed by strict harvesting regulations designed to sustain fish populations. Ponds such as Luvili, Lusongo and Ndawihachi permitted only the capture of mature fish using traditional fishing gear, including *ndanga*, scoop nets and *mgono* traps. Harvesting of fingerlings was prohibited, and seasonal fishing restrictions were enforced. Gendered access rules excluded women from entering certain ponds, based on spiritual protocols intended to prevent contamination of waterbodies. “Small fish stay to grow; women never enter these ponds because washing angers the fish spirits” [KII, Njage]. Folklore and ritual narratives reinforced compliance, linking violations to ecological consequences, such as the drying of ponds following unauthorised harvesting. “One boy took fingerlings from Lusongo; next day the pond turned to mud. He brought a goat and performed the cleansing dance” (Njage FGD).

Indigenous fire management practices reflected ecological awareness embedded in spiritual norms. Taboos prohibited burning green grasslands, wetlands and sacred areas, with fire associated with ancestral punishment and ecological imbalance. KIIs with *mbui* healers from Madabadaba, Ijia and Iragua-Magereza emphasised that ritual trees and sacred groves historically functioned as fire refuges within the landscape. Although agricultural expansion, charcoal production and land clearing have increased fire incidence in recent decades (Photo 3), some ritual trees and sacred forest patches remain protected due to continued respect for spiritual authority.

### Barriers to IKS continuity

A substantial erosion of IKS and ILK was consistently reported across all data collection methods. KIIs, FGDs and HHIs indicated that approximately 95 per cent of traditional taboos, rituals and customary rules governing wetland and forest use had been abandoned over the past 30–50 years. As one religious leader noted, “All rules are gone except Magombero forest, no one fears ancestors anymore” [KII, Itete]. FGDs among fishing communities similarly estimated that more than 80 per cent of traditional fishing regulations were no longer observed, with youth increasingly using destructive fishing techniques.

Demographic change and cultural mixing emerged as a primary barrier to IKS continuity. Respondents across villages consistently linked the erosion of clan authority to the influx of Sukuma pastoralists since the 1990s, which fragmented Indigenous governance structures. Women’s FGDs in Biro, Mofu and Itete emphasised that clan-based fishing and wetland rules were no longer respected by immigrant groups, “Our Ndamba rules mean nothing to cattle herders, they graze everywhere” [Women’s FGD]. Key informants estimated that approximately 70 per cent of IKS erosion in the KVRS could be attributed to demographic shifts and the weakening of clan-based social cohesion.

Formal education systems were repeatedly identified as undermining intergenerational transmission of IKS. KIIs with education officers and school leaders reported that science-oriented curricula diminished the legitimacy of elders’ knowledge and spiritual explanations of ecological processes. A primary school headteacher stated,



Photo 4. A newly established settlement in the Kilombero Valley  
© S. F. Materu

“Children learn that trees have no spirits and laugh at elders’ stories” [KII, Iragua-Magereza]. About 80 per cent of pupils in CEPA training initially expressed scepticism towards oral traditions and spiritual taboos, citing weak intergenerational knowledge transfer at household level.

Replacement of customary governance by formal institutions emerged as a key barrier. Over two-thirds of respondents said policies and by-laws replaced clan rules for wetland and forest management, yet enforcement was weak. Officers described by-laws as nominal, while HHIs and FGDs reported encroachment (Photo 4), including cultivation in Namwai and Madabadaba forests.

The erosion of IKS was linked to ecological impacts across the KVRS. Respondents reported destructive fishing, including poison fishing (*utupa*), mosquito nets, and small-mesh wires (*kokoro*), causing declining fish stocks. Fisheries officers estimated 80 per cent of waterbodies were polluted, while forest degradation increased due to fires, charcoal production and settlement expansion.

Religious transformation further accelerated IKS erosion. Interviews with Christian and Muslim leaders showed that about 98 per cent rejected the spiritual basis of Indigenous taboos, reframing environmental stewardship within religious doctrines. Leaders cited Quranic guidance against Earth’s corruption (Quran 7:56), Biblical teachings on caring for creation (Genesis 2:15), and Islamic tree-planting traditions. However, elders reported that this shift weakened clan-based ecological authority [KII-imam Ulanga].



Photo 5. Adult training on the Ramsar concept of wise use, with discussions on integrating IKS to strengthen community-based wetland conservation © S. F. Materu

### Community attitudes towards IKS revival

Community attitudes towards the revival of IKS and ILK were assessed through CEPA training programmes, FGDs and HHIs. Overall, adult participants demonstrated strong support for reintegrating IKS into formal wetland governance. Across nine villages, 85 per cent of adult trainees (Photo 5) expressed preference for hybrid governance arrangements that combine clan-based authority with statutory enforcement. During FGDs, participants consistently contrasted the effectiveness of customary rules with formal enforcement mechanisms, noting that clan sanctions were perceived as more legitimate and difficult to evade. “Clan rules worked better than armed guards – bring back councils with our own forest officers” [Men’s FGD, Alabama and Ijia].

HHIs reinforced this perspective; with respondents indicating that fear of spiritual sanctions associated with *mbui* authority persisted despite declining public adherence to rituals. “People may say they no longer believe, but everyone still fears *mbui* curses” [HHI, Njage]. FGDs further indicated that adult support for IKS revival was conditional on integration with government structures rather than a full return to exclusive clan control, reflecting concerns about inclusivity in ethnically mixed villages.

Youth attitudes towards IKS differed from those of adults but showed measurable improvement following CEPA interventions. Pre-training discussions revealed that most pupils had limited awareness of sacred sites and fishing taboos and were sceptical of spiritual explanations for environmental regulation. Following



Photo 6. Pupils on an educational excursion to a protected forest.  
© S. F. Materu

training sessions and field excursions (Photo 6), pupils demonstrated improved recognition of culturally protected sites and increased understanding of taboo restrictions. Pupils frequently emphasised the value of combining traditional narratives with scientific explanations, “Sacred grove stories may help, but we also need science to explain rainfall patterns” [Pupil FGD, Kivukoni].

Across adult and youth groups, discussions revealed community-led proposals for IKS revival. FGDs and HHIs suggested collaboration between traditional healers and forest officers to map sacred zones, integrating elders’ knowledge into school activities, and joint patrols with rangers in remote wetlands, framed as complementary to statutory governance.

## DISCUSSION

### Strengths of documented IKS and ILK practices

Documented IKS and ILK practices in the KVRs align with global community-based management and Ramsar wise-use principles by integrating spiritual beliefs, customary law and ecological knowledge to ensure high compliance without formal enforcement. Similar governance arrangements have been reported elsewhere in wetlands and forested landscapes, where spiritually anchored norms function as effective regulatory mechanisms for resource use (Aniah et al., 2014; Hill et al., 2020).

Practices such as restrictions on harvesting fingerlings, seasonal access to waterbodies, and prohibitions on burning wetlands reflect adaptive strategies consistent with contemporary ecosystem-based approaches. Embedding ecological limits within cultural norms reduced enforcement costs while enhancing ecosystem resilience, a feature similarly documented in sacred groves in India, floodplain wetlands in West Africa, and small-scale fisheries in the Pacific Islands (UNESCO, 2013).

Clan-based governance further strengthened these systems through collective responsibility and social accountability. The persistence of sacred forests and ritual wetlands within the KVRs mirrors global evidence that culturally protected sites often function as biodiversity refugia within increasingly modified landscapes (Hill et al., 2020). Such systems align closely with the Ramsar Convention’s principle of wise use, which emphasises local stewardship, social legitimacy and long-term ecological sustainability.

This study also demonstrates the adaptability of IKS and ILK within hybrid governance frameworks. Community preferences for integrating customary institutions with statutory mechanisms reflect a growing global consensus that pluralistic governance enhances effectiveness and legitimacy in complex socio-ecological systems. Comparable hybrid arrangements have been documented in Ramsar Sites and Indigenous Territories elsewhere, where Indigenous governance complements formal conservation structures (IPBES, 2019).

### Barriers to IKS continuity and global erosion trends

Despite their strengths, IKS and ILK in the KVRs have experienced substantial erosion, reflecting broader global trends in Indigenous knowledge loss. The findings align with international evidence that demographic change, cultural mixing, and weakening of customary authority undermine Indigenous governance systems, particularly in rapidly transforming wetland landscapes (Diawuo & Issifu, 2015; IPBES, 2019). In the KVRs, the influx of pastoralist communities and the resulting fragmentation of clan-based governance structures significantly reduced compliance with traditional rules.

Formal education systems further contributed to IKS erosion by prioritising scientific knowledge while marginalising oral traditions and spiritual explanations of ecological processes. Globalisation further disrupts IKS continuity whereby media promotes Western lifestyles over traditional life, undermining intergenerational transmission. Similar patterns have been documented globally, where school curricula and modernisation narratives weaken intergenerational transmission of Indigenous knowledge (Hill et al., 2020; UNESCO, 2013). In the KVRs, this shift diminished the legitimacy of elders’ authority and reduced youth engagement with customary environmental practices. The replacement of customary governance by statutory institutions also mirrors global conservation challenges. While formal policies and by-laws have expanded across Ramsar Sites worldwide, enforcement gaps and limited local legitimacy frequently constrain their effectiveness

(IPBES, 2019). In the KQRS, respondents consistently reported that statutory mechanisms failed to regulate remote wetlands previously governed through spiritually enforced norms, resulting in increased resource degradation.

Religious transformation represents an additional driver of IKS erosion, as belief systems that reject ancestral spiritual authority weaken culturally embedded environmental sanctions. This trend has been widely observed across Africa and Asia, where shifts towards organised religions reframe environmental stewardship in moral rather than customary terms, often without equivalent enforcement mechanisms (UNESCO, 2013).

### **Community attitudes towards IKS revival and potential pathways**

Community attitudes towards IKS revival were shaped by social heterogeneity, historical coexistence of multiple ethnic groups, and contemporary governance arrangements. While Ndamba and Pogoro clans are Indigenous to the floodplain, the landscape is now shared with Sukuma pastoralists, Hehe and other migrant communities, resulting in diverse value systems and varying levels of attachment to customary institutions. This plurality strongly influenced perceptions of IKS revival across villages.

Adult participants generally expressed support for reviving IKS, particularly where customary rules were perceived to have regulated resource use more effectively than current statutory mechanisms. However, this support was frequently conditional. Respondents favoured hybrid governance arrangements, combining clan-based norms with formal by-laws, to ensure inclusivity in ethnically mixed settlements. This reflects broader evidence that IKS revival is more socially acceptable where it accommodates multiple identities rather than reinstating exclusive clan authority (Hill et al., 2020; IPBES, 2019).

Farming and fishing communities demonstrated stronger support for restoring customary wetland rules, citing declining fish stocks and increased flooding as consequences of weakened governance. In contrast, pastoralist groups were more cautious, particularly where revived taboos were perceived as restricting grazing access to wetlands during dry seasons. These dynamics highlight the need for negotiated revival pathways that balance historical IKS with contemporary livelihood realities, rather than attempting full restoration of pre-existing systems.

Youth attitudes towards IKS were more ambivalent but showed potential for positive change. Consistent with

global findings, younger participants were less familiar with spiritual narratives and customary sanctions, reflecting weakened intergenerational transmission and the influence of formal education systems (UNESCO, 2013). However, CEPA activities demonstrated that combining Indigenous narratives with scientific explanations improved youth engagement and acceptance of culturally grounded conservation principles. This suggests that IKS revival is most viable when framed as complementary to scientific knowledge. Participants identified adaptive pathways, including recognition of sacred sites in village land-use plans, collaboration among traditional elders, *mbui* and government officers, and integration of local histories into school education. Such approaches align with evidence favouring inclusive, flexible systems over rigid customary restoration (Diawuo & Issifu, 2015; IPBES, 2019).

Overall, community attitudes in the KQRS indicate cautious but meaningful support for IKS and ILK revival, provided that revival efforts acknowledge ethnic diversity, contemporary livelihoods, and the need for hybrid governance structures. These findings reinforce the argument that IKS persistence depends less on cultural preservation alone and more on negotiated integration within modern conservation frameworks.

### **Implications for Ramsar governance and policy integration**

Our findings highlight that effective Ramsar governance requires more than statutory regulation alone. The decline of IKS and ILK coincides with rising wetland pressures, showing that excluding culturally embedded practices weakens conservation. Historically, clan-based institutions enforced access, harvesting and fire norms with minimal external oversight, but their erosion has reduced compliance. Integrating IKS into Ramsar tools, through recognition of sacred sites, customary fishing zones, and ritual wetlands in management plans and land-use frameworks, can strengthen protection while enhancing community legitimacy. The KQRS case illustrates that IKS cannot be restored in its original form, as contemporary social heterogeneity, religious transformations and changing livelihood strategies necessitate flexible, context-sensitive governance approaches. Therefore, Ramsar frameworks should support co-management that negotiates among stakeholders, combining customary practices with statutory oversight rather than paper or symbolic recognition alone.

## RECOMMENDATIONS

Based on our results, we recommend school-based elder knowledge sessions, joint clan–ranger patrols in remote wetlands, and low-cost, community-led documentation of sacred sites, oral histories and customary rules using village registers, maps and audio recordings to support planning, enforcement and intergenerational knowledge transfer. Complementary measures include mandating at least two clan elders on Village Environmental Committees and formally gazetted sacred zones in District Land Use Plans. Traditional clan sanctions can be adapted through co-drafted village by-laws aligned with Ramsar Resolution X.3. Future research should track knowledge retention among pupils, compare compliance under co-produced versus top-down enforcement, and evaluate any locally held documentation's impact on resource governance, embedding IKS within formal management.

## ABOUT THE AUTHORS

**Silvia Francis Materu** is a Senior Lecturer at Sokoine University of Agriculture (SUA), Tanzania. Her research explores the science–policy interface, focusing on soil and water conservation, natural resource management, biodiversity, and Indigenous knowledge systems. She also engages in teaching, community outreach and policy advocacy. ORCID: 0000-0002-4990-6693.

**Elly Josephat Ligate**, Senior Lecturer at Sokoine University of Agriculture (SUA), Tanzania, has over 20 years' experience in biodiversity management, conservation, and ecosystem restoration. His work spans climate change, agro-ecology, ecosystem services, IUCN assessments, and IFC-aligned impact studies. ORCID: 0000-0001-6607-2419.

**Jilisa Kilanso Mwalilino** is a Senior Lecturer at Sokoine University of Agriculture (SUA), Tanzania, in the Department of Geography and Environmental Studies. With over 20 years' experience in teaching and research, his work spans environmental conservation, pollution control, toxicology, radiology, and interdisciplinary environmental sciences. ORCID: 0009-0000-1362-9746.

## ACKNOWLEDGEMENTS

The authors thank the local communities, village leaders and government officials for their invaluable cooperation and support. We thank the heads of schools, teachers and pupils whose participation and insights enriched this work, as well as all key informants, focus group participants and trainees for their contributions. We thank the institutions and individuals who provided technical and logistical assistance during field

excursions. We acknowledge the financial support of the Ramsar Small Grants Fund for Wetland Conservation and Wise Use, provided under the close supervision of the Regional Secretariat and Dr Deogratius E. P. Nyangu, national focal person, on behalf of the Tanzanian Ramsar Administrative Authority in the Vice President's Office of the United Republic of Tanzania.

We thank two anonymous reviewers for their constructive comments, which improved the clarity and quality of our work.

## REFERENCES

- Aniah, P., Aasoglenang, A. T., & Bonye, S. Z. (2014). Behind the myth: Indigenous knowledge and belief systems in natural resource conservation in North East Ghana. *International Journal of Environmental Protection and Policy*, 2(3), 104–112. <https://doi.org/10.116488/j.ijep.20140203.11>
- Bakengesa, S., Munishi, P. K. T., & Ngaga, Y. (2011). Insights into wetland-related income, investments, biodiversity and other values in relation to settlement pattern in selected villages in Kilombero Ramsar Site, Tanzania. In *Proceedings of the 7th TAWIRI Scientific Conference, Morogoro, Tanzania*. [https://tafori.or.tz/dfpr/?utm\\_source=chatgpt.com](https://tafori.or.tz/dfpr/?utm_source=chatgpt.com)
- Bell, E., Tremblay, C., Carodenuto, S., Downie, B., Dearden, P., Ole Kileli, E., & McDougall, S. (2025). Indigenous knowledge-bridging to support ecological stewardship in Canada and Tanzania. *People and Nature*, 7(5), 1139–1150. <https://doi.org/10.1002/pan3.70034>
- Berkes, F. (2017). *Sacred ecology* (4th ed.). Routledge. <https://doi.org/10.4324/9781315114644>
- Borrini-Feyerabend, G., & Hill, R. (2013). *Governance of protected areas: From understanding to action*. Best Practice Protected Area Guidelines Series No. 20. IUCN. <https://portals.iucn.org/library/sites/library/files/documents/PAG-020.pdf>
- Cameron, L. (2020). Healthy Country, Healthy People: Indigenous knowledge, ecological relationships, and human wellbeing. *International Journal of Ecopsychology*, 1(1), Article 3. <https://digitalcommons.humboldt.edu/ije/vol1/iss1/3>
- Convention on Biological Diversity (CBD). (2022). Kunming-Montreal *Global Biodiversity Framework*. <https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf>
- Diawuo, F., & Issifu, A. K. (2015). Traditional African belief systems in natural resource conservation and management in Ghana. *The Journal of Pan African Studies*, 8(9), 45–64. [https://www.iccaconsortium.org/wp-content/uploads/2017/11/Exploring\\_the\\_African\\_Traditional\\_Belief.pdf](https://www.iccaconsortium.org/wp-content/uploads/2017/11/Exploring_the_African_Traditional_Belief.pdf)
- Emmanuel, O., & Kweka, O. (2024). Challenges of using indigenous and local knowledges in management of the Malagarasi-Muyovozi Wetland resources. *Journal of the Geographical Association of Tanzania*, 44(2), 1–17. <https://doi.org/10.56279/jgat.v44i2.305%20>
- Finlayson, C. M., Davidson, N., Pritchard, D., Milton, G. R., & Mackay, H. (2011). The Ramsar Convention and ecosystem-based approaches to the wise use and sustainable development of wetlands. *Journal of International Wildlife Law & Policy*, 14(3–4), 176–198. <https://doi.org/10.1080/13880292.2011.626704>
- Hill, R., Adem, Ç., Alangui, W. V., Molnár, Z., Aumeeruddy-Thomas, Y., Bridgewater, P., Tengö, M., Thaman, R., Adou Yao, C. Y., ... Xue, D. (2020). Working with indigenous, local and scientific knowledge in assessments of nature and nature's linkages with people. *Current Opinion in Environmental Sustainability*, 43, 8–20. <https://doi.org/10.1016/j.cosust.2019.12.006>

- IPBES, W. (2019). *Summary for policy makers of the global assessment report on biodiversity and ecosystem services of the intergovernmental science-policy platform on biodiversity and ecosystem services*. IPBES Secretariat, Bonn, Germany
- IPBES. (2023). *First Indigenous and Local Knowledge Dialogue Workshop Report*. IPBES Technical Support Unit. [https://files.ipbes.net/ipbes-web-prod-public-files/2023-02/IPBES\\_SusUse\\_1stILKDialogue\\_Report\\_final\\_forWeb.pdf](https://files.ipbes.net/ipbes-web-prod-public-files/2023-02/IPBES_SusUse_1stILKDialogue_Report_final_forWeb.pdf)
- Kangalawe, R. Y. M., & Liwenga, E. T. (2005). Livelihoods in the wetlands of Kilombero Valley in Tanzania: Opportunities and challenges to integrated water resource management. *Physics and Chemistry of the Earth, Parts A/B/C*, 30(11–16), 968–975. <https://doi.org/10.1016/j.pce.2005.08.044>
- Krueger, R. A., & Casey, M. A. (2015). *Focus groups: A practical guide for applied research* (5th ed.). SAGE Publications. <https://us.sagepub.com/en-us/nam/focus-groups/book243860> [web:103]
- Materu, S. F., & Heise, S., (2019). Eco-toxicity of water, soil, and sediment from agricultural areas of Kilombero Valley Ramsar wetlands, Tanzania. *Ecosystem Health & Sustainability*, 5(11), Article e01281. <https://doi.org/10.1080/20964129.2019.1695545>
- Materu, S. F., Heise, S., & Urban, B. (2021). Seasonal and spatial detection of pesticide residues under various weather conditions of agricultural areas of the Kilombero Valley Ramsar Site, Tanzania. *Frontiers in Environmental Science*, 9, 599814. <https://doi.org/10.3389/fenvs.2021.599814>
- Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: Wetlands and water*, Synthesis. World Resources Institute, Washington, DC. <https://www.millenniumassessment.org/documents/document.358.aspx.pdf>
- Ministry of Natural Resources and Tourism (MNRT). (2004a). *Kilombero Valley Ramsar Site: Foundation Report (Integrated Management Plan)*. Dar es Salaam.
- Ministry of Natural Resources and Tourism (MNRT). (2004b). *The Development and Implementation of an Integrated Management Plan of Kilombero Valley Flood Plain- Ramsar Site Identification Report*, Dar es Salaam, Tanzania, 160.
- Ministry of Natural Resources and Tourism (MNRT). (2018). *Kilombero Valley Ramsar Site – Integrated Management Plan – Foundation Document* (p. 13). United Republic of Tanzania. [https://kilomberovalley.files.wordpress.com/2019/02/kvrs-imp\\_foundation-2018-09.pdf](https://kilomberovalley.files.wordpress.com/2019/02/kvrs-imp_foundation-2018-09.pdf)
- Msoffe, N. K., Sheng, L., & Lyimo, J. (2019). Land use change trends and their driving forces in the Kilombero Valley Floodplain, Southeastern Tanzania. *Sustainability*, 11(2), 505. <https://doi.org/10.3390/su11020505>
- National Bureau of Statistics (NBS). (2023). *2022 Population and Housing Census: Administrative Units Population Distribution Report*. Government of the United Republic of Tanzania. [https://www.nbs.go.tz/nbs/takwimu/Census2022/Administrative\\_units\\_Population\\_Distribution\\_Report\\_Tanzania\\_volume1a.pdf?utm\\_source=chatgpt.com](https://www.nbs.go.tz/nbs/takwimu/Census2022/Administrative_units_Population_Distribution_Report_Tanzania_volume1a.pdf?utm_source=chatgpt.com)
- Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research*, 42(5), 533–544. <https://doi.org/10.1007/s10488-013-0528-y>
- Pascual, U., Balvanere Levy, P., Christie, M., & Baptiste, B. (2022). *Summary for policymakers of the methodological assessment of the diverse values and valuation of nature of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)*. IPBES Secretariat. <https://doi.org/10.5281/zenodo.6522392>
- Quran. (n.d.). *The Quran, Surah Al-A'raf (7:56)*. (Translation: Sahih International). <https://quran.com/7/56>
- Ramsar Convention Secretariat. (2002). *Kilombero Valley Ramsar Site, United Republic of Tanzania, Advisory Mission Report*. [https://www.ramsar.org/sites/default/files/documents/library/ram83\\_kilombero\\_valley\\_tanzania\\_2016\\_e.pdf](https://www.ramsar.org/sites/default/files/documents/library/ram83_kilombero_valley_tanzania_2016_e.pdf)
- Ramsar Convention Secretariat. (2010). *Wise use of wetlands: Concepts and approaches for the wise use of wetlands*. Ramsar Convention Secretariat. [https://www.ramsar.org/sites/default/files/documents/library/key\\_2e\\_revised\\_oct\\_2010.pdf](https://www.ramsar.org/sites/default/files/documents/library/key_2e_revised_oct_2010.pdf)
- Ramsar Convention Secretariat. (2016a). *An Introduction to the Ramsar Convention on Wetlands* (5th ed.). Ramsar Convention Secretariat. [https://www.ramsar.org/sites/default/files/documents/library/handbook1\\_5ed\\_introductiontoconvention\\_final\\_e.pdf](https://www.ramsar.org/sites/default/files/documents/library/handbook1_5ed_introductiontoconvention_final_e.pdf)
- Ramsar Convention Secretariat. (2016b). *The Ramsar Convention's Programme on communication, capacity building, education, participation and awareness* (CEPA) 2016–2024. [https://www.ramsar.org/sites/default/files/documents/library/cepa\\_programme\\_2016\\_2024\\_e.pdf](https://www.ramsar.org/sites/default/files/documents/library/cepa_programme_2016_2024_e.pdf)
- Ramsar Convention Secretariat. (2023). *List of resolutions and recommendations of the Conference of the Contracting Parties, CoP 14-2022*. [https://www.ramsar.org/sites/default/files/2023-07/list\\_resolutions\\_recommendations\\_e\\_1.pdf](https://www.ramsar.org/sites/default/files/2023-07/list_resolutions_recommendations_e_1.pdf)
- Sillitoe, P., & Marzano, M. (2009). Failure of indigenous knowledge research in development. *Futures*, 41, 13–23. <https://doi.org/10.1016/j.futures.2008.07.004>
- Tengö, M., Brondizio, E. S., Elmqvist, T., Malmer, P., & Spierenburg, M. (2014). Connecting diverse knowledge systems for enhanced ecosystem governance: The multiple evidence base approach. *Ambio*, 43(5), 579–591. <https://doi.org/10.1007/s13280-014-0501-3>
- The Holy Bible, New International Version (NIV). (1984). *Genesis* 2:15. <https://www.biblegateway.com/passage/?search=Genesis+2%3A15&version=NIV>
- Tongco, M. D. C. (2007). Purposive sampling as a tool for informant selection. *Ethnobotany Research and Applications*, 5, 147–158. <https://ethnobotanyjournal.org/index.php/era/article/view/126>
- Udgaonkar, S. (2002). The recording of traditional knowledge: Will it prevent “bio-piracy”? *Current Science*, 82, 413–419. <https://www.jstor.org/stable/24106653>
- UNESCO. (2013). *The contribution of indigenous and local knowledge systems to IPBES*. UNESCO/UNU. Expert Meeting Report, Paris. <https://unesdoc.unesco.org/ark:/48223/pf0000225242>
- United Republic of Tanzania (URT) (2002). Ministry of Natural Resources and Tourism, Wildlife Division. (2002, May 2). *Information Sheet on Ramsar Wetland (RIS) – The Kilombero Valley Floodplain (Site No. 1173)*. Ramsar Convention Secretariat. <https://rsis.ramsar.org/RISapp/files/RISrep/TZ1173RIS.pdf>
- Wilson, E., Emmanuel, O., & Daconto, G. (2024). Challenges of using indigenous and local knowledge in wetland management: The Tanzanian experience. *Journal of Geography and Environmental Studies*, 44(2). <https://doi.org/10.56279/jgat.v44i2.305>

## RESUMEN

El sitio Ramsar del valle de Kilombero sustenta los medios de vida de 1,5 millones de personas gracias a los servicios ecosistémicos de los humedales, gestionados históricamente por los pueblos indígenas. Este estudio documentó las prácticas de conocimiento indígena, identificó las barreras que impiden la continuidad y evaluó el potencial de integración en 11 aldeas mediante 93 entrevistas a informantes clave, 22 grupos focales desglosados por género, 59 entrevistas a hogares y programas de comunicación, educación y sensibilización pública (n = 796 participantes).

La gobernanza de los clanes mediante sanciones cada vez más severas (prohibiciones de pesca, multas por cabras, confiscación de cereales) y la protección de los lugares sagrados mantuvieron la pesca y la cobertura forestal antes de la década de 1990. Sin embargo, su abandono en un 95 % durante 30-50 años, impulsado por la inmigración del pueblo sukuma (~ 70 %), los planes de estudio exclusivamente científicos (~ 80 % de escepticismo entre los jóvenes), la religión, la globalización y las ordenanzas municipales inaplicables, ha provocado contaminación (~ 80 % de las masas de agua), pesca destructiva y conversión de bosques. La formación en CECF reveló un fuerte apoyo a la gobernanza híbrida: el 85 % de los alumnos adultos se mostraron a favor de las patrullas conjuntas de curanderos tradicionales (*mbui*) y guardabosques, y se mejoró el reconocimiento de los lugares sagrados entre los alumnos (n = 490). Los fallos de la gobernanza formal (lagunas en la aplicación de la ley en zonas remotas, falta de legitimidad) sustentan las demandas de la comunidad para la reintegración de los sistemas de conocimiento indígenas. El sitio Ramsar del valle de Kilombero demuestra la urgente necesidad de una conservación híbrida que aproveche la autoridad tribal sobreviviente para lograr los principios de uso racional de Ramsar, allí donde han fracasado los enfoques descendentes.

## RÉSUMÉ

Le site Ramsar de la vallée de Kilombero assure la subsistance de 1,5 million de personnes grâce aux services écosystémiques des zones humides, historiquement gérés par les peuples autochtones. Cette étude a documenté les pratiques traditionnelles, identifié les obstacles à la continuité et évalué le potentiel d'intégration dans 11 villages à l'aide de 93 entretiens avec des informateurs clés, 22 groupes de discussion ventilés par sexe, 59 entretiens avec des ménages et des programmes de communication, d'éducation et de sensibilisation du public (n = 796 participants). La gouvernance clanique, qui prévoyait des sanctions de plus en plus sévères (interdiction de pêcher, amendes pour les chèvres, confiscation des céréales) et la protection des sites sacrés ont permis de préserver les pêcheries et le couvert forestier avant les années 1990. Cependant, son abandon à 95 % en 30 à 50 ans, dû à l'immigration du peuple Sukuma (~ 70 %), aux programmes scolaires exclusivement scientifiques (~ 80 % de scepticisme chez les jeunes), à la religion, à la mondialisation et à des règlements villageois inapplicables, a entraîné une pollution (~ 80 % des plans d'eau), une pêche destructrice et la conversion des forêts. La formation CEPA a révélé un fort soutien en faveur d'une gouvernance hybride : 85 % des adultes formés étaient favorables à des patrouilles conjointes des guérisseurs traditionnels (*mbui*) et des gardes forestiers, et à une meilleure reconnaissance des sites sacrés parmi les élèves (n = 490). Les défaillances de la gouvernance formelle (lacunes dans l'application des lois dans les régions reculées, absence de légitimité) sous-tendent les demandes de la communauté en faveur de la réintégration des systèmes de connaissances autochtones. Le site Ramsar de la vallée du Kilombero démontre l'urgence d'une conservation hybride s'appuyant sur l'autorité clanique survivante pour mettre en œuvre les principes d'utilisation rationnelle de Ramsar là où les approches descendantes ont échoué.