

Integrating indigenous knowledge and culture in sustainable forest management via global environmental policies

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Abstract: This research investigates the intricate connection between indigenous knowledge and sustainable forest management, with two main objectives. It seeks to explore and outline indigenous knowledge, elements, and practices that support sustainable forest management (SFM). It aims to uncover the invaluable traditional insights and practices that have helped preserve and ensure the responsible use of forest ecosystems. Also, it investigated global environmental policies that support indigenous knowledge since the inception of the Convention on Biological Diversity (CBD). A narrative review method was employed to review and analyse peer-reviewed contents and reports to deduce ancestral or traditional wisdom, knowledge, practices, and beliefs from existing studies. The paper extracted data from existing literature from scholarly peer-reviewed journals. It aims to provide useful information for policy-makers, forest managers, and indigenous communities, to promote SFM and the sustainable development goals related to a sustainable environment. The study found that indigenous knowledge (IK) which includes ethnobotanical knowledge and plant selection, mixed land use, seed banks, and cultural beliefs such as sacred groves and taboos are some traditional practices, beliefs, and cultural knowledge that support SFM and can be integrated into international and national environmental management policies which the two-eyed seeing framework (TESF) seeks to promote. The framework highlights the potential of implementing IK into SFM. Also, the Akwé: Kon Guidelines, the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), are some global environment policies that recognise traditional people and indigenous knowledge since the commencement of the CBD in the nineties. The paper recommends, for a future study, investigating the applicability of the Akwé: Kon Guidelines in international and national projects and programs that impact traditional sacred lands, forests and rivers, and indigenous people. Also, the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement need to fully acknowledge the supporting role of indigenous knowledge and people in climate change mitigation and adaptation solutions, especially in Africa, since the majority of the world's population constitutes indigenous people who inhabit healthy standing forests and ecosystems.

Keywords: ecological knowledge; ecosystem services; environmental management; forestry; human well-being

Forests are significant ecosystems that provide countless benefits and essential resources to support biodiversity (Kok et al. 2017; Verkerk et al. 2022; Guegan et al. 2023) and help in climate change mitigation and adaptation strategies. They also enable the interplay between biodiversity and the health of indigenous peoples (Robinson et al. 2024). Studies show that a substantial portion of the Earth's terrestrials is made up of forests and that they contribute to global ecological balance and human well-being all over the Earth (Boles Fassler 2017; Soe, Yeo-Chang 2019; Cimatti et al. 2023; Dong, Huang 2023).

The complex ecosystems provide ecological services which include e.g. biodiversity conservation, carbon sequestration (Verkerk et al. 2020), and clean water while supporting community livelihoods, especially at the local level (Anderegg et al. 2020; Heilmayr et al. 2020; De Frenne 2021). Forests also provide indigenous people with cultural and spiritual values and non-timber forest amenities (e.g. biodiversity, wildlife harvests for meat and fur, berries, etc.), whose values can be satisfied by maintaining a certain amount of mature, old-growth tree stands (van Kooten et al. 2019; Moloise et al. 2024). However, these ecosystems face multiple challenges, such as deforestation, habitat degradation, and climate-related problems (Tong et al. 2020; Dubale et al. 2023). Knowing the values and priceless advantages of forests and the numerous environmental complexities threatening the existence of forests and other natural resources, there is a dire need for policy-makers, research, science, and practices to consider traditional forest management knowledge, wisdom, and cultural belief systems that support, promote and ensure sustainable forest management (SFM). The recent enormous loss of plant non-wood timber forest products (NWFPs), especially in developing countries, coupled with the erosion of indigenous forest management practices that can be used to manage them sustainably, increases the need to find ways to stimulate, preserve, or improve indigenous management practices (Chukwuone et al. 2020).

Traditional local knowledge forest management (TLKFM) has garnered high recognition over the years for its inherent sustainability and harmonious coexistence with nature (Rakatama, Pandit 2020; Moloise et al. 2024). Indigenous knowledge, ingrained in the collective wisdom of local communities, encompasses a profound understanding of forest ecosystems, ecological dynamics, season-

al variations, and the intricate relationships that connect humanity with mother nature (Messer-schmidt 2019; Wangchuk et al. 2021). This wisdom and knowledge are embedded in culture, norms, and belief systems that are deeply interwoven with cultural practices and passed down from one generation to another generation over time; which indicates the need to incorporate this ancient forest management knowledge and wisdom into current strategies, measures, policies, and regulations toward the creation of sustainable forests and forest resources. In this sense, there has been a recognition of the invaluable role that indigenous knowledge can play in contemporary forest management efforts (Ludwig, El-Hani 2020; Alule et al. 2023).

While indigenous forest management practices may not conform to the conventional model of scientific forestry, they have been used effectively by local people in managing forests and conserving forest resources for many years. They are used in both communally owned and family/individually owned forests. Indigenous people often modify and adjust these practices in such a way as to adapt to changes they observe in their forests (Chukwuone et al. 2020).

The integration of local knowledge into mainstream conservation policies, decisions, and practices is seen as a promising avenue to improve the sustainability of forest ecosystems (Lazdinis et al. 2019; Mansourian et al. 2020) by coupling traditional knowledge and wisdom with modern science and conservation strategies, to bolster the resilience of forests, promote biodiversity conservation, and enhance climate change mitigation initiatives. Aside the ensuring sustainable forest management, it also touches on cultural preservation, community empowerment, and the recognition of indigenous locals' rights (Ludwig, El-Hani 2020; Mansourian et al. 2020).

SFM is a global interest that demands the involvement of diverse stakeholders, including indigenous communities who often possess rich indigenous knowledge systems related to forest ecosystems.

Despite the potential of integrating traditional knowledge and practices into policies, there remains the need to identify these indigenous practices and cultural belief systems which this paper aims to address by exploring and outlining the indigenous knowledge, its elements and practices that support SFM in Africa, in order to uncover the invaluable traditional insights and practices

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that have helped preserve and ensure the responsible use of forest ecosystems. The study also investigates the global environmental policies that support indigenous knowledge since the inception of the Convention on Biological Diversity (CBD).

Primary objectives. The primary objectives of this paper are: (i) To explore and outline the indigenous knowledge, elements, and practices that support SFM in Africa and other developing regions; (ii) to identify the global environmental policies that support indigenous knowledge since the inception of the Convention on Biological Diversity (CBD); and (iii) to identify the possibilities of innovative implementation of indigenous knowledge into traditional European SFM planning.

This paper contributes to the growing body of knowledge on the importance of indigenous people and traditional knowledge in SFM and presents some cultural beliefs and insights into traditional practices that can be incorporated into international and national sustainable environmental policies, strategies, and measures by policy-makers, experts, and international organisations as well as in the European Union or European countries. The article also demonstrates the potential of indigenous knowledge and modern science working together to address environmental issues.

Local knowledge (Gómez-Baggethun 2022, Hallberg-Sramek et al. 2023) is described as a 'cumulative body of knowledge, practice, and belief handed down through generations by cultural transmission'. In European countries with traditional, developed forest management and forest economic planning, this local knowledge is often incorporated into national principles of economic planning. Or, if the results of this local knowledge did not correspond to economic goals, it is reflected either in nature protection or at least in research activities in the protection and promotion of biodiversity. However, in developing countries, including Africa, forest management planning is in its infancy or completely absent. This greatly complicates the implementation of traditional indigenous knowledge into sustainable forest management. In Europe, for a change, indigenous knowledge is not usually discussed in connection with forest management, although there are exceptions, e.g. Hallberg-Sramek et al. (2023). Nevertheless, there may be insights into the use and management of forests according to indigenous knowledge in developing countries useful in formulating SFM planning principles.

LITERATURE REVIEW

Overview of sustainable forest management.

The concept of sustainability in forestry has gained global recognition due to its enormous contributions to addressing environmental problems. The idea of sustainable forest management has a long history. Early methods of managing forests were primarily concerned with preserving biodiversity, water supplies, and local inhabitants' rights and needs. There is no universally agreed definition for SFM, but various definitions share keywords and phrases such as sustainable ecological conservation of ecosystems, responsible forest resources management, sustainable biodiversity preservation and conservation, and forest stewardship. SFM is the sustainability aspect of managing forests to ensure that both present and future generations benefit from the eco-services of forests. Jhariya et al. (2019) defined SFM as an integrated approach to sustainable management and conservation of natural resources. Angelstam et al. (2019) explained that SFM is an agreed international explicit grand policy vision for the sustainable use and governance of forest resources such as landscapes' goods, services, and values. Similarly, Innes (2016) also posited the deliberate and responsible management of forests for the provision of goods and services. It seeks to reconcile trade-offs between the economic benefit of forest resources and the conservation of biodiversity (Laakkonen et al. 2019).

In a nutshell, SFM is a comprehensive strategy to foster and promote forest stewardship to create a balance between social, economic, and environmental goals. Forests offer a range of ecological functions and resources necessary for human well-being. The major products of forests for human survival have been food, fuel, and plant medicines, among others, over the years and the present and will be in the future. When environmental concerns became more prevalent in the late 20th century, SFM began to take off. From being primarily concerned with production, forestry has expanded to include wider ecological and social objectives. The 1992 Earth Summit, the adoption of the Rio Declaration, and Agenda 21 are all significant turning points of SFM.

Importance of indigenous ecological knowledge (IEK) or traditional ecological knowledge (TEK). According to Ford et al. (2020) 'indigenous

knowledge' refers to the knowledge, abilities, and ideologies developed by communities with a long history of interacting with society and nature. It encompasses the understandings and competencies that people have acquired in relation to their location. Berkes et al. (2000) also defined TEK as a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and their environment. Tiu (2007) explained further that IEK is the relationship of indigenous people with their landscape and the way they are cared for and connected to the landscape. Minahan continued to elucidate that IEK does not create segregation and silos of ecology like some other areas of science.

IEK is place-based knowledge and differs between each tribe and geographical location. It refers to place-based knowledge generated over the years within myriad specific cultural contexts (Richmond 2021). It is different from science, and citizen science in that it goes beyond direct observation and interaction with plants, animals, and ecosystems but entails a broad spectrum of cultural and spiritual knowledge and values that underpin human-environment relationships (Berkes et al. 2000). IEK is often augmented with contemporary observations and experiences that refine accumulated knowledge and allow for flexibility and adaptability in the context of environmental and social change. It is accumulated and modified by generations, not static or outmoded as perceived (Asselin 2015; Richmond 2021). In other words, before the introduction of scientific or Western knowledge, communities had the wisdom and strategies to manage and preserve the ecology and ecosystems for survival and well-being. The keywords running through the various scholarly definitions of IEK include geographically specific, or place-based, transfer from generation to generation, locally developed over the years, and timely tested and proven effective. Local adages make relevant and timely contributions to inform the restoration and conservation of forests. This knowledge and wisdom were not only ecologically driven but spiritually and culturally developed.

Daniel (2022) opined that IEK is a body of observations, oral and written knowledge, innovations, practices, and beliefs that promote sustainability and the responsible stewardship of cultural and

natural resources through relationships between humans and their landscapes. Indigenous knowledge cannot be separated from the people inextricably connected to that knowledge.

In a time of serious environmental problems, indigenous knowledge becomes paramount in adaptation strategies and policies developed to address existing environmental complexities, including the conservation of forests (Alule et al. 2023; Kakiso 2023; Moloise et al. 2024). For instance, forestry plays a very significant role in climate change mitigation. A study conducted by IPCC (2022) indicates that indigenous and local knowledge shapes how climate change risk is understood and experienced, and therefore helps in developing place-based climate change solutions and governance systems that match the expectations of various stakeholders.

In Asselin's (2015) study titled 'Indigenous Knowledge' the contributions of IEK to forest management were discussed extensively. To mention but a few of IEK's roles in forest management, they include providing biological information and ecological insight, offering alternative management practices, promoting biodiversity conservation and environmental ethics principles, and ensuring environmental monitoring and assessment for social development. Studies have revealed forest indigenous knowledge provides detailed biological and ecological information that would be hard to reach using quantitative scientific research methods.

Due to the significant role indigenous people play in sustaining forests and ecosystems (Kakiso 2023), the Forest Steward Council (FSC) recognises and respects indigenous people's rights and encourages and advocates for forest agencies and organisations to do the same (FSC 1996). However, even the FSC is proof that indigenous knowledge is undervalued in Europe or largely has no justification at the moment. For example, the Czech National FSC Standard states that 'According to the definition by the United Nations, there are no indigenous people in the Czech Republic that would feel or define themselves as such. Therefore, the principle in this form is not applicable' (FSC 2024).

Two-eyed seeing framework (TESF). The study is grounded by the two-eyed seeing framework (TESF), developed by Elder Albert Marshall (Marshall, Bartlett 2004). The framework explains the need to consider and value indigenous and scientific knowledge and integrate it into solving societal

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problems holistically. TESH seeks to focus one eye on the indigenous perspective while the other eye views reality through a Western lens to embrace a diverse understanding (Arsenault et al. 2018).

Mullen (2022) applied this framework to investigate what it means to develop and designate Indigenous Protected and Conserved Areas (IPCAs) in Canada and identified common challenges. Mullen found that the success or failure of IPCA development and designation depends on collaboration between government, industries, and indigenous communities.

Arsenault et al. (2018) also used the TESH to examine the significance of utilising indigenous research methodologies to address current water issues affecting First Nations in Canada. Similarly, Wright et al. (2019) evaluated how the two-eyed seeing framework can be used in an integrative approach to indigenous research.

Mckee (2012) also employed the TESH as an integrative framework to argue that current key ideas in environmental education, such as systems theory, ecological literacy, biophilia, and place-based education, can benefit from and connect with foundational values of indigenous education. The framework underscores the cultural relevance of knowledge and acknowledges that indigenous wisdom and practices are deeply rooted in the cultural, spiritual, and historical context of local geographical areas.

This framework is suitable for this paper as it promotes and combines both IEK and scientific knowledge in sustainable forestry management. This integration provides a comprehensive understanding of forest ecosystems and supports community well-being. It allows for a holistic approach to forest management for sustainable development. In a nutshell, the two-eyed seeing framework provides a valuable guiding philosophy for this study, emphasising the importance of integrating indigenous wisdom, respecting cultural context, and promoting sustainability and community well-being.

MATERIAL AND METHODS

A qualitative method was employed for the study relying on secondary data only. The narrative review methodology was employed to review and analyse a range of materials (academic papers, reports, policy documents, articles, and any other written materials related to the study objectives)

gathered from search engines such as Google Scholar, ProQuest, PubMed, ScienceDirect, Emerald Insight, Research Gate, and Google. Besides the academic literature, other official documents such as indigenous community records, historical records, and other written materials relevant to the objectives and providing insights into indigenous knowledge and its integration into forest management were also reviewed to obtain data for the study. Various contents in relation to the phenomenon under study were analysed with content analysis methodology to allow the researcher to review secondary data to discover indigenous practices and beliefs and to gain a deeper understanding of how indigenous wisdom contributes to sustainable forest management and community well-being.

The two-eyed seeing framework was used to justify the need for the integration of IEK into scientific and policy solutions toward sustainable ecological management. The data obtained from the secondary source were grouped or categorised into key themes according to the study objectives, analysed, and discussed in relation to the two-eyed seeing framework. The findings confirmed the need for integrating traditional knowledge into existing scientific knowledge, as the two-eyed seeing indicates to ensure effective collaboration and effective implementation of SFM policies. The next methodological step was a review of global environmental policies that have supported local knowledge since the time of the Convention on Biological Diversity.

RESULTS AND DISCUSSION

Just as in other countries, Africa has rich cultural beliefs, knowledge, and practices that promote sustainable forestry which should be recognised and promoted. The discussion was categorised into sub-themes according to the study objectives.

Indigenous or traditional practices that promote SFM in Africa

Indigenous or traditional practices that promote SFM in Africa, as examples of developing regions with low levels of forestry planning, include a wide range of activities, depending on the natural conditions, level of technological development of communities or regions, and level of traditional knowledge about local natural sources of ecosystem services. Traditions also have a strong social

character; however, they are not purely economic or management activities. These practices are:

- mixed land use;
- hunting or game management;
- using raw materials;
- ethnobotanical knowledge and plant selection;
- seed banks;
- cultural values and beliefs;
- sacred groves and taboos.

This list is not all-inclusive. There are no written records of many traditional activities, and therefore they are very little researched. An example is the natural regeneration dynamics (MacFarlane et al. 2015) of the coastal dry forest Zanzibar-Inhambane, managed by local communities. Along with climate change, African traditional knowledge of environmental change is also gaining importance. Based on the perceived vulnerability of indigenous communities, many scholars tend to argue generically for the integration of indigenous knowledge into climate change policies and implementation (Makondo, Thomas 2018). A wealth of studies has documented how traditional ecological knowledge has contributed to forest conservation (e.g. Boafo et al. 2016; Osei-Tutu 2017; Mavhura, Mushure 2019; Sinthumule, Mashau 2020; Alule et al. 2023; Dubale et al. 2023). Chukwuone et al. (2020) found out that some indigenous practices like controlled harvesting, selective weeding, enrichment planting, indigenous protective mechanisms, and fire breaks complement each other and are also useful in the management of some non-wood forest products (NWFPs).

Mixed land use. Indigenous people practice mixed land use where a piece of land is used for different purposes simultaneously, which helps provide food, maintain tree cover, and livestock rearing, which also enhances soil fertility with livestock dung. Instead of clearing forests to create space for other activities, forests are reserved, and available spaces are managed efficiently for multiple purposes. It is common in African countries like Ghana, Nigeria, Ethiopia, and Kenya among several other countries.

For instance, the Nashua (a conservation reserve in Masi Mara, Kenya) integrates people and wildlife into the same ecosystem. Humans and wildlife live together in the same space to protect their landscape and ecosystems for the Nashua community and wildlife (Muriithi 2022; UNDP 2021). They build fences to prevent aggressive and unfriendly

wildlife from attacking the community. These ecosystems are being driven and led by the community itself. Also, in Kericho County, the 47th county in Kenya, and Ghana, mixed land use is practised among farmers. This practice goes beyond the reservation of forests but concerns the entire ecosystem at large. Local people are also interested in protecting their ecosystems to pass them on to the next generation; integrating these people in decisions will help to develop community-owned policies that will be easy to implement.

Traditional hunting and gaming (Pattiselanno et al. 2011; Bongmba, Talla 2020). Traditional hunting and gaming have been used as a method of ecological management by traditional societies and indigenous communities over centuries (Krause 2019). It is deeply embedded in local cultures and has ecological benefits when practised appropriately and effectively. Hunting and gaming practices are typically sustainable and promote environmental stewardship. For instance, indigenous hunting practices promote biodiversity conservation. Instead of targeting a single species, they rotate their focus to different species of animals over time, allowing some species to recover while keeping others in check. It is also used to control certain species through selective hunting of specific animals, which helps to control overpopulation that may lead to habitat degradation and depletion of resources. By hunting certain species, indigenous communities can help maintain the balance within ecosystems. For example, predation on herbivores can prevent overgrazing and habitat destruction.

This practice has cultural and spiritual significance where local communities have rituals and traditions associated with hunting and gaming, which instil a sense of environmental responsibility and virtues in people. Just to mention but a few African countries that practise hunting and gaming, let us name Ghana, Zimbabwe, Namibia, Tanzania, Zambia, Botswana, and South Africa. Gaming and hunting are also practised in some parts of Europe even till the present day, e.g. in the Czech Republic, England, and Austria, among several others.

Despite the significance of this practice, it is crucial to note that the ecological benefits of hunting and gaming practices depend on responsible and sustainable management as over-hunting, habitat destruction, and illegal or unsustainable practices may cause ecological harm.

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Integrating traditional hunting and gaming into ecological knowledge with contemporary conservation and management efforts and policies is critical to sustainable forestry; this integrative approach is termed 'biocultural conservation'. It seeks to combine the strengths of traditional and scientific knowledge for more effective ecological management and conservation.

Ethnobotanical knowledge and plant selection (Shrestha, Medley 2017; Ahoyo et al. 2024). In Africa, the use of plant species for medicinal (herbalism, phytomedicine, or phytotherapy) purposes is very common. Most indigenous communities possess detailed knowledge of plant species used for medicine, food, nutrition security (Olowo et al. 2022; Dubale et al. 2023; Tamene et al. 2023), and rituals. For example, indigenous people with ethnobotanical knowledge are called 'abibiduro' in Ghana; South Africans call it 'sangoma' or 'inyanga'; in Tanzania, it is 'shaman' or 'mugwenu'; 'nga.nga' or 'godobor' in Zambia; 'shaman' or 'laibon' in Kenya, and 'tilizat', 'dibia', or 'boka' in Nigeria.

Examples of these medicinal plants in Africa include but are not limited to bitter leaf (*Vernonia amygdalina*), *Moringa oleifera*, scent leaf (*Ocimum gratissimum*), bitter kola (*Garcinia kola*), *Prunus africana*, cashew (*Anacardium occidentale*), African bush mango (*Irvingia gabonensis*), yellow yam (*Dioscorea bulbifera*), baobab (*Adansonia digitata*), and *Hibiscus sabdariffa* (zobolo). This knowledge guides sustainable harvesting, ensuring that valuable plant resources are not depleted. Some communities only depend on and believe strongly in the effectiveness of herbals hence preserving such plants and ecosystems by ensuring the continuity of such species for other generational benefits. The plant selection is done by identifying and using specific tree species for various purposes, such as medicinal plants, food, and construction materials.

Ethnobotanical indigenous knowledge is very important not only for local communities but also for the geopolitical North as a knowledge pool for the pharmaceutical industry and as an alternative source of medicine. Therefore, as the two-eyed seeing framework suggests, integrating ethnobotanical knowledge into policies and science will encourage local people to accept and support such policies since they are in line with their traditions, fundamental practices, and sources of their health.

Seed banks. Traditional communities have long practised seed saving and traditional seed banks,

preserving native tree species and promoting reforestation efforts. These types of indigenous knowledge and wisdom vary across different African regions and communities. They highlight the holistic and sustainable approaches that indigenous peoples have developed over generations to manage and conserve their forested environments. Recognising and integrating these practices into modern forestry management can contribute significantly to sustainable forest conservation in Africa.

Cultural values and beliefs. African beliefs and cultures have rich traditions of forest conservation rituals that mirror their deep spiritual and cultural connections to the natural worldview. Many indigenous cultures have deep-rooted spiritual and cultural connections to the land and forests. These values often lead to practices that promote the preservation and conservation of ecosystems. These rituals are mostly performed to seek blessings and protection and ensure the enforcement of sustainable resource management. Some of these include sacred groves and taboos.

Sacred groves and taboos. In Africa, some indigenous or traditional people designate certain forests as sacred groves, where access and resource use or harvesting are restricted. These forests are associated with diverse taboos to prevent people from going into these forests. The main purpose of the taboos associated with these areas is to help conserve biodiversity and maintain ecosystem integrity.

These sacred groves can be found in India, Asia, Latin and North America, Canada, Europe, Germany, and several parts of the world (Jaryan et al. 2010), but Africa is the focus of this study. In Africa, these groves can be found in Zimbabwe, Kenya, Ivory Coast, Sierra Leone, Benin, Nigeria, and Ghana. For instance, groves in Ghana include Boaben-Fiema and Tafi, Esukwakwa Forest Reserve and its Anweam sacred grove, Ntwokom sacred grove, Tafi Atome sacred grove, Asantemanso and Nananom Mpow. It is forbidden to enter the sacred forests of these communities. These forests are said to be the abode of ancestral spirits and gods and, therefore, must be protected by the community chief and leaders. Chiefs are also buried in these sacred forests as part of the community's spiritual reincarnation belief systems, where it is believed that the spirit of the departed will continue to live in these forests. With this, special sacrifices are performed before anyone can enter such a forest

to bury another deceased. Following this practice, forests and rivers in these areas remain untouched and the ecosystem is protected because no one is allowed to tamper with such reserves.

Local communities have positive attitudes toward the conservation of the local sacred forests. They do not harvest fuel wood or hunt in them because they show respect for these groves and fear being punished by the gods, chiefs, and other significant elders of the communities (Sinthumule, Mashau 2020).

Most of these forests are very thick; people do not go into these forests to engage in thoughtless deforestation and illegal activities, and no hunting or logging of trees is allowed here. At times, some part of the forest or the entire forest is dedicated to some spirits or some deities. These sacred groves or landscapes are practically worshipped. Nobody enters these forests except ritual men, chiefs, and leaders who visit the forest to perform sacrifices as and when there is a need. Sacred forests, rivers, and lands are forms of African ancient forest conservation methods or strategies. Aside from the sacred groves, there are also evil forests, where evil people are buried, or community outcasts are sent.

Typical examples of sacred forest ritual and worship include the Bakas in Congo's Central African rainforests, who perform rituals that seek harmony with the forest and its spirits. They believe that pacifying and honouring the forest spirits through music, dance, and offerings ensures a bountiful harvest and sustainable hunting and gathering. Like the Baka indigenous people, the Bagyeli people from Southern Cameroon areas adjacent to Gabon and Equatorial Guinea celebrate the guardian of their forest called the 'Ekila' spirit. During such celebrations, they offer food, drinks, and dances to show gratitude and request protection and abundance from the forest for years ahead and to also ensure sustainable harvest. The Yoruba culture in Nigeria is deeply connected to nature, and rituals. These involve appeasing forest deities, such as 'Osun,' the goddess of water and fertility, and 'Ogun,' the god of iron and the forest. Offerings are made to these deities to ensure the well-being of the forest and its resources. The San people of Southern Africa from Basarwa communicate with ancestral spirits and gain insight into hunting and gathering strategies through dancing.

In addition to the above, the Aka people of the Congo Basin maintain balance in their forest

through rituals, believing that proper rituals and ceremonies are critical in preserving forest spirits. The Samburu celebrate the 'Nganyiet tree' believing it to be the protector of their cattle. These rituals underscore the importance of tree and forest conservation in their pastoral needs. The 'Gule Wamkulu' ceremony of the Chewa people of Malawi involves masked dancers who embody spirits representing different aspects of nature and the interconnectedness of humans and the environment. The Tamberma people of Togo celebrate the 'Damba' festival to honour the spirits of their forest and ancestors through offerings and prayers to protect the environment and ensure the continuity of their belief system, traditions, and practices.

Finally, the Yaka people of the Democratic Republic of Congo also celebrate 'Kanhungwe,' a ceremony dedicated to the spirits of the forest. They believe that these spirits influence the success of their agricultural and hunting activities.

These rituals and beliefs in Africa reinforce the importance of sustainable forestry and resource management. They demonstrate the profound respect and reverence that many African cultures have for the natural world and emphasise the importance of maintaining harmony with the environment and preserving the forest's resources for future generations. These beliefs have proven to be effective in forest management in the sense that most standing and healthy forests today are inhabited by local people. The present generation is benefiting from the works of indigenous people which need to be transferred to future generations.

Indigenous or traditional practices implemented in SFM in Central Europe

All the above-mentioned practices of traditional ecological knowledge are part of the utilisation of forest resources even in Central Europe. The extent of some is limited to negligible (sacred groves and taboos). Others are now an integral part of landscape management through legislation (mixed land use, seed banks, traditional hunting and gaming, cultural values and beliefs). Ethnobotanical knowledge and plant selection have their societal potential. For example, in the Czech Republic, besides traditional mushroom picking, the gathering and use of wild garlic (*Allium ursinum* L.) by the public is increasingly expanding. Traditional ecological knowledge also includes care for forest springs. For example, as part of the forest Slavín in the territo-

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ry of the School Forest Enterprise Masaryk Forest Křtiny, managed by the Mendel University in Brno.

The two-eyed seeing framework

The two-eyed seeing framework, as mentioned, advocates the need for scientific knowledge to be mainstreamed or blended with these kinds of local strategies and methods to develop ecosystem management policies and decisions for the benefit of all stakeholders. The reason is to ensure that SFM policies are developed with the inclusion of all stakeholders and also to enable local people to own these policies and support their implementation – only then can a sustainable environment be achieved successfully around the globe. Besides, studies show that indigenous people own a larger part of existing forests today. To integrate the traditional beliefs and practices, traditional communities need to be given a fair hearing and an environment where they can form SFM policy decisions from their own local or geographical context, knowledge, and experience. Only then will indigenous people reflect scientific knowledge and support the sustainable environment course of action (Hallberg-Sramek 2023). There is a need to also value indigenous practices such as those discussed, to promote environmental stewardship and to instil environmental virtues in individuals, communities, and the world at large.

Also, indigenous people constitute many societies in Africa, and so achieving a sustainable forest and environment largely depends on them. Science, policy-makers, and international organisations need their support in SFM decision-making, policy formulations, and implementation; without them, there is the possibility of policy failure.

Paradoxically, a similar problem exists to a certain extent with the implementation of indigenous knowledge into forest management planning in Central Europe. Although forest management plans or forest management certifications commonly address cultural ecosystem services or local community values, greater integration into forest cultivation practices is still lacking. In particular, it is necessary to mention the potential that indigenous knowledge has in increasing the resilience of forest stands and human society to climate change. However, to redirect the attention of forestry professionals in this direction, it is necessary to scientifically demonstrate the effectiveness of this implementation of indigenous knowledge

into sustainable forest management (SFM) and also its economic profitability.

Examples of global international policies and conventions, describing traditional indigenous knowledge as a tool for sustainable forest management

Global environmental policies in support of local knowledge since the inception of the Convention on Biological Diversity (CBD). In 1992, the United Nations Convention on Biological Diversity (a legally binding treaty) was opened for signature at the United Nations Conference on Environment and Development in Rio de Janeiro and entered into force in 1993. The three main objectives of the treaty are biodiversity or biological diversity conservation, sustainable use of biodiversity components, and fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. The state parties to the multilateral treaty are to implement decisions made by the Conference of the Parties (COP). Article 8(j) of the CBD recognises the importance of traditional knowledge, innovations, and practices of indigenous and local communities. The study reviewed the literature to identify the global environmental policies that conform with Article 8(j) of the CBD.

The review shows that some sustainable environment global policies have acknowledged the critical role of local knowledge in biodiversity conservation, sustainable resource management, and environmental protection since the establishment of the CBD. These policies include the Akwé: Kon Guidelines, the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the Sendai Framework for Disaster Risk Reduction, the United Nations Development Programme (UNDP), the World Bank and Indigenous Peoples' Programs, and Global Environmental Facility (GEF) Indigenous Peoples' Program (Recio, Hestad 2022).

Similarly, Aichi Targets (Target 18) recognised indigenous communities all over the world, their traditional ecological knowledge, and their immense contributions to achieving the strategic plan for biodiversity 2011–2020 (Sinthumule, Mashau 2020).

Akwé: Kon Guidelines. As indicated earlier about sacred groves, the Akwé: Kon Voluntary Guidelines is a framework used to conduct environmental, cultural, and social impact assessments towards developmental proposed projects

and activities that are meant to be undertaken or are likely to impact sacred sites or groves [such as lands and waters traditionally occupied and used by indigenous and local communities (Secretariat of the Convention on Biological Diversity 2004)]. It was adopted by the Conferences of Parties (COP) to the CBD treaty in their seventh meeting in 2000. The Akwé: Kon provides ten steps to guide governments, policy-makers, and parties on how to involve indigenous people in existing and future assessment procedures. The main aim of these guidelines is to encourage stakeholders to incorporate cultural, environmental, biodiversity-related, and social considerations of indigenous and local communities into new or existing impact-assessment procedures, and to also inform indigenous people of the impact of development proposed on their lands, forests, and rivers as well as the impact on the people. The guidelines present ten steps to follow in conducting the social, environmental, and cultural assessment to inform development initiatives in local communities.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), introduced in 2012, assesses the state of the earth's biodiversity and ecosystems and their benefits to humans. It recognises the role of indigenous and local knowledge in the assessments and promotes the inclusion of traditional knowledge holders in its processes and initiatives (Löfmarck, Lidskog 2017).

Nagoya Protocol on Access and Benefit-Sharing (a supplementary to the CBD) supports the CBD objective three (3). In 2010, the Nagoya Protocol adopted part of the CBD, which aims at addressing the fair and equitable sharing of benefits arising from the utilisation of genetic resources. It supports and promotes the role of indigenous knowledge in the conservation and sustainable use of biological diversity (Schabus 2017; Recio, Hestad 2022).

The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) stresses the need to obtain free, prior, and informed consent from indigenous people for projects that affect their lands and resources. It was adopted in 2007 to acknowledge indigenous people's rights, which include the right to maintain, control, protect, and develop their cultural heritage, traditional knowledge, and traditional cultural practices and belief systems (UNDRIP 2007).

Sendai Framework for Disaster Risk Reduction (2015–2030), which also supports the role of indigenous knowledge in disaster risk reduction and management. It recognises the value of traditional practices and local wisdom in building resilience.

United Nations Development Programme (UNDP). The UNDP supports various projects and initiatives that involve the documentation and integration of local and indigenous knowledge into sustainable development and environmental management programs (UNDP 2015).

World Bank and Indigenous Peoples' Programs. The World Bank has policies and programs that recognise the vital role of indigenous knowledge and the rights of indigenous peoples. It supports programs and projects that involve indigenous communities and local knowledge in sustainable development (Davis 2021).

Although indigenous people are already widely acknowledged as the most vulnerable to the impacts of climate change, their unique knowledge and experience remain largely under-utilised by interventions that aim to reduce vulnerability or increase adaptation to new circumstances. Intergovernmental Panel on Climate Change (IPCC) Working Groups do realise the importance of indigenous knowledge and make attempts to include this knowledge (Makondo, Thomas 2018).

Global Environmental Facility (GEF) Indigenous Peoples' Program. Finally, the GEF Indigenous Peoples' Program is a financial mechanism of the CBD. It established the Indigenous Peoples' Program to advance indigenous peoples and local communities' participation in projects related to biodiversity conservation, climate change, and sustainable land management.

These global policies and programs, among others, are in support of indigenous knowledge and acknowledge the paramount role of indigenous people in sustainable forestry and ecosystem management. However, it was interesting to know that the United Nations Framework Convention on Climate Change (UNFCCC) marginalises indigenous knowledge in climate discussions (Comberti et al. 2016). Also, the 2015 Paris Agreement does not fully recognise the need to further integrate indigenous peoples' knowledge and practices in climate change mitigation and adaptation. Meanwhile, indigenous lands constitute 80% of the world's biodiversity – they occupy most of the standing forest in developing coun-

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Table 1. Activities needed to implement indigenous knowledge or traditional ecological knowledge into sustainable forest management in Europe and to promote indigenous knowledge through sustainable forest management in Africa

Type of action	Africa	Europe
IK → SFM	–	Identification and definition of 'traditional ecological knowledge' in the use of forest resources.
IK → SFM	–	The inclusion of 'traditional ecological knowledge' among the principles of using target forest ecosystem services, especially as a part of adaptation measures, supporting the resilience of society.
IK → SFM	–	Support of small traditional craft production, based on the use of forest resources.
SFM → IK	Scientific and professional EU–African cooperation in the implementation of forest management planning and sharing of good forestry practices.	–
SFM → IK	Use international programs, such as forest certification systems or REDD, to support forest management planning.	–
SFM → IK	Categorisation of forest stands according to the degree of anthropogenic influence, ecological stability, and target ecosystem services (including indigenous knowledge).	–
SFM → IK	Classification and use of forestry technologies in terms of suitability for indigenous knowledge.	–
SFM → IK	Acceptance of forest management planning as a part of national forestry policies and legislation.	–

IK → SFM – integration of indigenous knowledge into sustainable forest management; SFM → IK – support of indigenous knowledge through sustainable forest management; REDD – Reducing Emission from Deforestation and Forest Degradation in Development Countries

tries, especially in Africa (Frechette et al. 2016). Table 1 lists the activities required for the implementation of indigenous knowledge or traditional ecological knowledge into sustainable forest management in Europe. Indigenous people have unique knowledge systems and practices that promote sustainable resource management including forestry, which plays a very critical role in climate change mitigation. A guardian accented at the COP26 conference that indigenous people have done more than any government in the climate space but international and national policies and laws do not recognise and support their collective rights (Tauli-Corpuz et al. 2020).

CONCLUSION

The study highlighted the significant role of indigenous people in sustainable forest management, indicating some traditional knowledge and practices such as mixed land use, seed banks, hunting and gaming, ethnobotanical knowledge, and cultural beliefs like sacred graves and taboos that promote sustainable ecosystem management. Some global policies towards sustainable environment management since the inception of the CBD were reviewed. It was discovered that UNFCCC and the Paris Agreement policies do not fully recognise the role and usefulness of indigenous knowledge

in climate mitigation and adaptation policies and efforts. Studies also show that the environmental policies in Africa are yet to consider the integration of indigenous traditional knowledge into environmental policies (FAO/FAOLEX 1995; Boafo et al. 2016; Antwi 2020).

Indigenous knowledge (or perhaps in this case better 'traditional ecological knowledge') can be inspiring even for sustainable forest managers in Europe. This has three necessary conditions: the identification of adequate traditional ecological knowledge, its implementation in forest economic planning through ecosystem services, and a framework for public education and education of forest managers on this topic.

The implementation of indigenous knowledge into sustainable forestry management does not mean a change in scientifically and for many decades practically proven forest cultivation practices. However, it expands existing practices towards more diverse production and utilisation of ecosystem services. In Central European conditions, this could, for example, entail the preservation of the associated (middle) forest or the current exploration of possibilities offered by agroforestry. Indigenous knowledge is also part of a set of approaches that support, through the extensive use of forest ecosystems, not only their inner resilience but primarily societal resilience to climate change. However, in this area, there is still a lack of sufficiently significant and replicable examples.

RECOMMENDATION

The study recommends future research to examine how the Akwé: Kon Voluntary Guidelines are employed by international and national organisations to implement development projects that impact sacred land, forests and rivers in Africa. Secondly, parties, governments, and international and national organisations need to recognise and respect indigenous people's knowledge and best practices that promote sustainable development, and incorporate this knowledge in policies, strategies, and measures meant to address environmental problems around the globe. Also, indigenous people constitute a majority of the African population and inhabit vast land and rich forests. Hence, their support in addressing climate change is not replaceable or cannot be overemphasised. The UNFCCC, the Paris Agreement and other or-

ganisations need to treat indigenous participation as significant as other key stakeholders.

This study based on the two-eyed seeing framework requests that the Convention on Biological Diversity, Forest Stewardship Council, UNEP (United Nations Environment Programme), and other international organisations consider the culture and beliefs of indigenous people in local communities and find out how sustainable environmental policy frameworks, regulations, strategies, and measures can be integrated with IEK or TEK to achieve sustainable development holistically. African countries need to revise their environmental policies to integrate traditional ecological knowledge, practices, and beliefs to develop holistic environmental policies with all significant stakeholders included.

In addition, national environmental policies and legislation should integrate IEK into the implementation. It is important to implement the forest management planning (FMP) tool for a successful linking of traditional ecological knowledge and SFM. Forest management planning is a crucial tool for effective long-term SFM. Therefore, the study recommends SFM planning, which is common in Europe but not in the developing world, especially in Africa. Forest management certifications (e.g. FSC) support principles of forest management planning. The FMP in African countries might not be as comprehensive as in Europe, where it is built on decades of forestry research and forest management records. However, this would help in the long-term coordination of forest care, which would correspond to the long-term life cycle of forests and forest management. Institutions responsible for forest management should be strengthened to plan and monitor SFM and to also ensure enforcement of laws to protect forest reserves in Africa.

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