



Traditional Ecological Knowledge and Environmental Conservation: An Anthropological Study of Environmental Practices in Rwanda

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Abstract: Traditional Ecological Knowledge (TEK) represents an important cultural resource for understanding and conserving the environment. In Rwanda, traditional practices concerning soil, water, forests, biodiversity, agriculture, and natural resources have historically been transmitted across generations. However, modernization, urbanization, climate change, and changing lifestyles may contribute to the erosion of such knowledge among younger generations. This study asked: To what extent do ICT students at the Catholic University of Rwanda understand and value Traditional Ecological Knowledge for environmental conservation? It hypothesized that greater recognition of traditional ecological knowledge would be associated with stronger support for its integration into contemporary conservation. The objective was to assess students' knowledge, perceptions, and attitudes toward traditional environmental practices. A descriptive mixed-methods design was employed among 39 ICT students, using structured questionnaires and open-ended questions. Data were analyzed through descriptive statistics and thematic analysis. Findings indicated that 89.7% (35/39) considered traditional ecological knowledge important for environmental conservation, while 84.6% (33/39) recognized traditional soil and water conservation practices. Furthermore, 87.2% (34/39) supported integrating TEK into contemporary conservation programmes, and 92.3% (36/39) believed that younger generations should participate in preserving traditional environmental knowledge. The study concludes that TEK remains a valuable cultural resource for sustainable environmental stewardship and should be strengthened through education, community participation, and intergenerational knowledge transmission.

Keywords: Traditional Ecological Knowledge; Environmental Conservation; Environmental Anthropology; Cultural Heritage; Rwanda.

Acronyms and Abbreviations

1. **TEK:** Traditional Ecological Knowledge
2. **ICT:** Information and Communication Technology
3. **FAO:** Food and Agriculture Organization of the United Nations
4. **UNESCO:** United Nations Educational, Scientific and Cultural Organization.

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1. INTRODUCTION

Environmental degradation, biodiversity loss, soil erosion, water insecurity, and climate change constitute important challenges for sustainable development in Rwanda. Although contemporary conservation increasingly relies on scientific knowledge, environmental policies, and technological innovations, Rwandan communities have historically developed knowledge and practices for managing soil, water, forests, wetlands, agriculture, livestock, and biodiversity. Traditional Ecological Knowledge (TEK) refers to the cumulative knowledge, practices, beliefs, and values developed through long-term interaction between communities and their environments (Berkes, 2012; Hakizimana L.; et al. 2023). It therefore represents not only cultural heritage but also a potential resource for environmental conservation and sustainable development.

The rationale for this study lies in the need to examine how traditional knowledge can complement contemporary scientific approaches to environmental management. From an anthropological perspective, human relationships with nature are shaped by cultural values, social institutions, and everyday practices (Ingold, 2000). TEK can provide locally adapted approaches to soil conservation, water management, agroforestry, biodiversity protection, and climate adaptation (Folke, 2004). Integrating such knowledge with scientific knowledge may consequently contribute to more participatory and culturally appropriate conservation strategies.

However, a significant problematic emerges from the transformation of Rwandan society. Modernization, urbanization, population pressure, changing lifestyles, formal education, and technological development may reduce younger generations' direct contact with traditional environmental practices. Climate change may further challenge knowledge developed under earlier ecological conditions. Consequently, valuable ecological knowledge may gradually disappear or become disconnected from the communities that developed it (Maffi, 2005). At the same time, traditional knowledge is not always adequately incorporated into formal environmental policies and conservation programmes.

This study therefore examines 39 ICT students at the Catholic University of Rwanda to assess their knowledge, perceptions, and attitudes toward TEK and environmental conservation. It asks: To what extent do ICT students understand and value Traditional Ecological Knowledge for environmental conservation in Rwanda? The study hypothesizes that greater recognition of TEK is associated with stronger support for its integration into contemporary conservation. It ultimately explores how culture, ecological knowledge, environmental stewardship, and modern

technology can be brought into constructive dialogue for sustainable environmental conservation in Rwanda.

2. METHODOLOGY

This study employed a descriptive mixed-methods research design to examine the role of Traditional Ecological Knowledge (TEK) in environmental conservation among students at the Catholic University of Rwanda (CUR). The mixed-methods approach was appropriate because the study combined quantitative evidence concerning students' knowledge, perceptions, and attitudes with qualitative information concerning traditional environmental practices, cultural values, and intergenerational transmission. TEK is understood as a dynamic system that integrates ecological knowledge, practices, beliefs, and social institutions developed through long-term interactions between communities and their environments (Berkes, 2012; Folke, 2004; Maffi, 2005; Ingold, 2000).

The study involved 39 ICT students at the Catholic University of Rwanda. Because the accessible population was relatively small, a census sampling approach was used, allowing all 39 students to participate. The respondents were considered relevant because they represent a younger, technologically oriented generation whose perspectives can contribute to understanding the preservation, transformation, and contemporary application of traditional ecological knowledge.

Data were collected using a structured questionnaire and open-ended questions. The questionnaire examined students' knowledge and perceptions of traditional environmental practices, cultural values and beliefs, environmental stewardship, intergenerational transmission, knowledge loss, and the integration of TEK into contemporary conservation. Open-ended questions allowed respondents to explain their perspectives in greater depth. The research instruments were informed by literature on traditional ecological knowledge, social-ecological systems, cultural diversity, and community-based natural-resource management (Berkes, 2012; Gadgil et al., 1993; Ostrom, 1990; Pretty, 2003).

Quantitative data were coded and analyzed using descriptive statistics, particularly frequencies and percentages. The results were presented in graphs to facilitate interpretation. Qualitative responses were analyzed thematically, focusing on recurring themes related to cultural beliefs, traditional environmental practices, collective responsibility, intergenerational knowledge transmission, modernization, and collaboration between communities and institutions. Ethical principles, including voluntary participation, informed consent, confidentiality, and respect for cultural knowledge, were observed throughout the study. Given the limited sample and the focus on one university, the findings

are interpreted within the study context and are not intended to represent all Rwandan youth.

3. TRADITIONAL ECOLOGICAL KNOWLEDGE AND ENVIRONMENTAL CONSERVATION

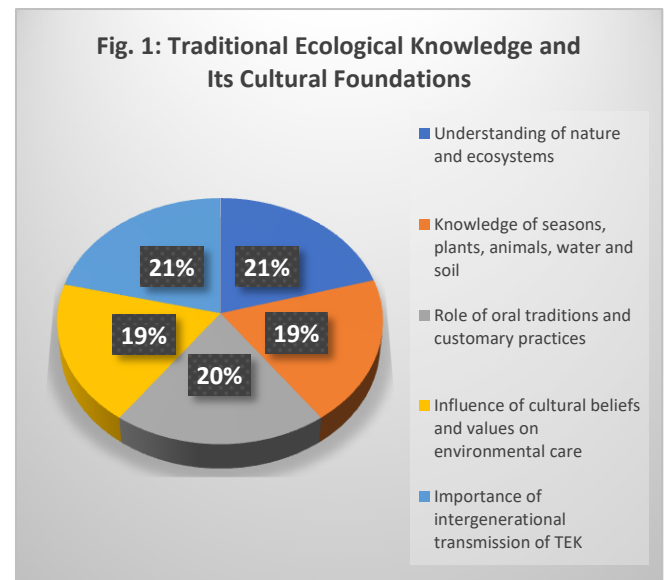
Traditional Ecological Knowledge (TEK) represents accumulated knowledge, practices, beliefs, and values developed by communities through long-term interaction with their natural environment. In Rwanda, such knowledge has historically informed the management of soil, water, forests, agriculture, livestock, and biodiversity. However, modernization, urbanization, climate change, and changing lifestyles increasingly challenge its transmission and preservation. Understanding how younger generations perceive TEK is therefore important for strengthening culturally appropriate environmental conservation and exploring complementarities between traditional knowledge, scientific approaches, and contemporary environmental policies.

3.1. Traditional Ecological Knowledge and Its Cultural Foundations

Traditional Ecological Knowledge (TEK) refers to the cumulative knowledge, practices, beliefs, and values developed by communities through long-term interaction with their natural environment. It encompasses people's understanding of ecosystems, seasons, plants, animals, water, soil, and the relationships between human beings and nature. Berkes (2012) argues that TEK is not simply a collection of environmental information but an integrated system linking knowledge, practice, and belief. From an anthropological perspective, Ingold (2000) emphasizes that environmental knowledge develops through people's practical engagement with their surroundings. Similarly, UNESCO (2003) recognizes knowledge concerning nature and the universe as an important component of intangible cultural heritage, while Olson (2013) highlights the contribution of traditional ecological knowledge to understanding resource use and conservation. In Rwanda, such knowledge has historically been embedded in agricultural practices, medicinal plant use, livestock management, water management, biodiversity protection, and customary relationships with particular landscapes and natural resources (Irakiza et al., 2016; Hakizimana L.; et al. 2017).

The findings of the present study indicate that Traditional Ecological Knowledge remains relevant among the 39 ICT students at the Catholic University of Rwanda. As shown in graph 1, 89.7% (35/39) of respondents demonstrated recognition of the importance of understanding nature and ecosystems through traditional knowledge. Furthermore, 84.6% (33/39) recognized traditional knowledge concerning seasons, plants, animals, water, and soil. These findings

suggest that students perceive traditional environmental knowledge as a meaningful source of ecological understanding rather than merely as knowledge belonging to the past. This is consistent with Berkes (2012), who describes TEK as a dynamic system capable of adapting to environmental change. Ingold (2012) similarly emphasizes that human knowledge emerges through practical engagement with materials and environments, while UNESCO (2003) stresses the importance of maintaining cultural knowledge associated with people's relationships with nature. From an environmental perspective, such knowledge can contribute to locally appropriate approaches to sustainable resource management.



The cultural foundations of TEK are particularly visible through oral traditions, customary practices, beliefs, and values. In the present study, 87.2% (34/39) of respondents recognized the role of oral traditions and customary practices in transmitting environmental knowledge, while 82.1% (32/39) acknowledged the influence of cultural beliefs and values on environmental care. These results indicate that environmental knowledge is not separated from social and cultural life (Hakizimana, L., 2025). Rather, it is communicated through stories, observations, proverbs, practices, family instruction, community participation, and culturally defined norms concerning the use and protection of natural resources. UNESCO (2003) identifies oral traditions and expressions as important vehicles for transmitting knowledge and collective memory. Ingold (1997) similarly conceptualizes learning as a process through which knowledge is acquired through participation and attention to the practices of previous generations. Berkes (2012) further explains that traditional ecological systems combine ecological observations with social institutions and cultural beliefs. In Rwanda, research on the Buhanga Sacred Forest demonstrates how cultural beliefs and traditional practices have historically influenced

relationships with plant species and contributed to biodiversity conservation (Irakiza et al., 2016).

The strongest result concerned intergenerational transmission: 92.3% (36/39) of students considered the involvement of younger generations important for preserving traditional ecological knowledge. This finding is particularly significant because TEK survives when knowledge is continuously transmitted, practiced, adapted, and interpreted by succeeding generations. If younger people become disconnected from traditional practices as a consequence of modernization, urbanization, technological change, or changing lifestyles, important ecological knowledge may gradually disappear. Berkes (2012) argues that TEK is cumulative and transmitted across generations while remaining adaptable to changing circumstances. Ingold (2000) similarly views knowledge as something learned through practical participation rather than simply through the transfer of abstract information. UNESCO (2003) also emphasizes the importance of safeguarding living heritage through continued practice and transmission. From a sociological perspective, intergenerational transmission contributes to cultural continuity by connecting individual knowledge with collective memory and community identity.

The findings further indicate that traditional ecological knowledge can contribute to contemporary environmental conservation. The high levels of recognition among respondents suggest that young university students do not necessarily view traditional knowledge and scientific knowledge as contradictory. Instead, the two can potentially complement one another. 89.7% (35/39) recognized the importance of understanding nature and ecosystems through TEK, while 84.6% (33/39) recognized specific traditional knowledge concerning environmental resources. This provides a basis for incorporating culturally grounded knowledge into environmental education and conservation initiatives. Berkes (2012) argues that local and scientific knowledge can be complementary in addressing complex ecological problems. Olson (2013) similarly demonstrates the relevance of TEK for conservation research, while UNESCO (2003) highlights the contribution of cultural heritage to sustainable relationships with the natural environment. In Rwanda, strengthening dialogue between communities, universities, environmental institutions, and younger generations could therefore help preserve valuable ecological knowledge while adapting it to contemporary environmental challenges.

Overall, the findings demonstrate that Traditional Ecological Knowledge has both ecological and cultural dimensions. It provides knowledge about nature while simultaneously expressing beliefs, values, social practices, collective memory, and relationships between generations. The high proportion of students recognizing its importance—

particularly 92.3% (36/39) for intergenerational transmission—suggests that TEK remains relevant among educated young people. Its future, however, depends on creating mechanisms through which traditional knowledge can be documented, critically examined, transmitted, and integrated with appropriate scientific knowledge (Hakizimana, L., 2024). Such an approach would contribute not only to environmental conservation but also to the preservation of Rwanda's cultural heritage and community identity.

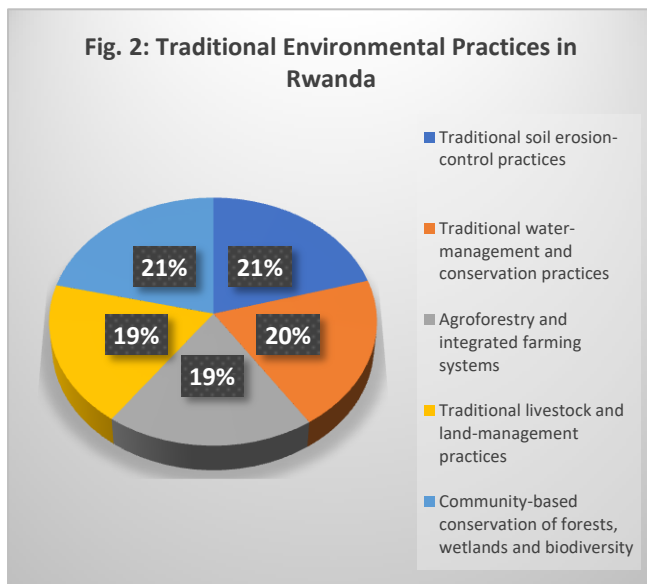
3.2. Traditional Environmental Practices in Rwanda

Traditional environmental practices in Rwanda represent practical ways through which communities have historically managed land, water, vegetation, livestock, forests, wetlands, and biodiversity. Unlike traditional ecological knowledge, which primarily concerns understanding and transmitting knowledge about nature, environmental practices refer to the concrete actions through which such knowledge is applied in everyday resource management. Agroecological scholars emphasize that locally developed practices can contribute to soil fertility, erosion control, biodiversity and agricultural resilience (Altieri, 2004; Berkes, 2012). From an anthropological perspective, these practices emerge from prolonged interaction between communities and their environments, while sociological approaches emphasize collective institutions and community cooperation in managing common resources (Ostrom, 1990; Pretty, 2003). In Rwanda, traditional environmental management has included soil-conservation techniques, water management, agroforestry, integrated farming, livestock management, and community protection of natural resources.

The first important dimension is traditional soil erosion-control practices. Rwanda's mountainous terrain makes soil erosion a major environmental concern, particularly where agricultural land is cultivated on steep slopes. Historically, farmers developed practices such as terracing, contour cultivation, planting grasses and hedges, mulching, maintaining vegetation cover, and incorporating organic materials into soils. Ndayizigiye (2005) documented several traditional soil-management techniques used to reduce erosion and maintain soil productivity. König (1992) similarly demonstrated the potential of agroforestry and vegetative measures for erosion control in Rwanda. Berkes (2012) explains that such practices reflect accumulated ecological experience, while Altieri (2004) considers locally adapted agricultural techniques important components of sustainable agroecosystems. In the present study, 84.6% (33/39) of ICT students recognized traditional soil erosion-control practices as relevant to environmental conservation.

The second dimension concerns traditional water-management and conservation practices. Communities have historically developed ways of protecting springs,

controlling runoff, maintaining vegetation around water sources, and managing water for domestic and agricultural purposes. Such practices are particularly important in a country where agricultural productivity depends heavily on rainfall and where wetlands and rivers provide essential ecosystem services. Berkes (2012) argues that community-based ecological knowledge can support sustainable water-resource management, while Ostrom (1990) demonstrates the importance of collective rules for managing shared natural resources. Pretty (2003) further emphasizes that cooperation and social capital can strengthen collective environmental management. In this study, 82.1% (32/39) of respondents recognized traditional water-management and conservation practices.



A third important dimension is agroforestry and integrated farming systems. Traditional Rwandan farming has often combined trees, crops and livestock within the same landscape. Trees can provide shade, fuelwood, fodder, fruits, organic matter and protection against erosion, while livestock can contribute manure that improves soil fertility. König (1992) identified agroforestry as an important component of traditional land-management systems in Rwanda. Altieri (2004) similarly argues that diversified farming systems can strengthen ecological resilience by combining biological and agricultural functions. More recent research also emphasizes the contribution of agroforestry to soil fertility, moisture retention and sustainable agricultural production (Quandt et al., 2023). Among the respondents, 79.5% (31/39) recognized agroforestry and integrated farming as traditional environmental practices with conservation value.

The fourth dimension involves traditional livestock and land-management practices. Livestock have traditionally been integrated into agricultural systems through the use of animal manure, grazing arrangements, fodder production and the recycling of agricultural residues. Such integration

creates relationships between crop production, soil fertility and livestock management. FAO (2018) emphasizes the importance of integrated crop–livestock systems for sustainable agricultural landscapes, while Berkes (2012) notes that traditional resource-management systems frequently connect different ecological components rather than treating them separately. In the present study, 76.9% (30/39) of respondents recognized the relevance of traditional livestock and land-management practices to environmental conservation. This relatively high proportion suggests that students recognize the ecological connections between agriculture, livestock and land management.

The fifth dimension concerns community-based conservation of forests, wetlands and biodiversity. Traditional conservation was not necessarily based on formal environmental legislation; communities could regulate resource use through collective norms, restrictions, sacred sites and shared responsibilities. The case of Buhanga Sacred Forest demonstrates the relationship between cultural institutions and biodiversity conservation in Rwanda. Irakiza et al. (2016) found that traditional beliefs and practices contributed to the protection of important plant species within the forest. Ostrom (1990) shows that communities can develop effective institutions for managing common resources, while Gadgil et al. (1993) emphasize the contribution of indigenous knowledge to biodiversity conservation. In the present study, 87.2% (34/39) of respondents recognized community-based conservation of forests, wetlands and biodiversity as important.

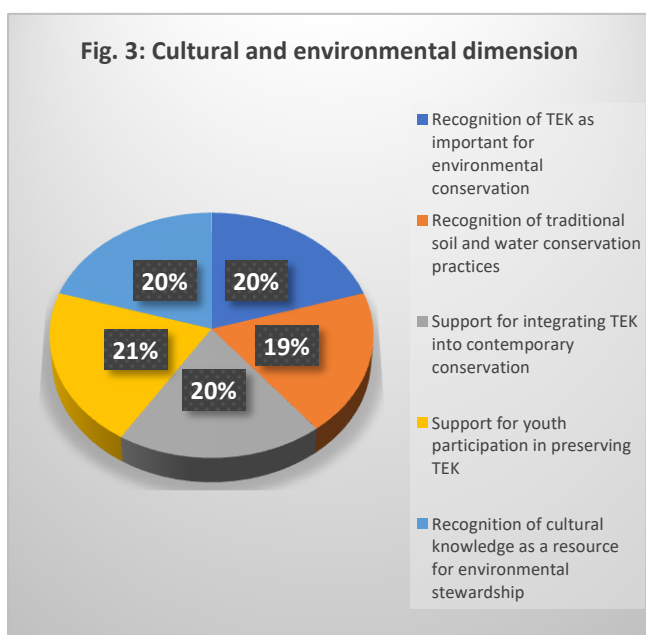
Overall, the findings demonstrate that traditional environmental practices in Rwanda extend beyond cultural memory to include practical systems of soil, water, agricultural, livestock and biodiversity management. The relatively high recognition of these practices among ICT students suggests that traditional approaches remain relevant to contemporary environmental thinking. Nevertheless, their integration into modern conservation should not involve simply reproducing the past. Instead, traditional practices should be documented, scientifically evaluated where appropriate, adapted to current environmental conditions, and combined with contemporary ecological knowledge. Such an approach could strengthen Rwanda's environmental conservation while preserving valuable elements of its cultural and ecological heritage.

3.3. Cultural Values, Beliefs, and Environmental Stewardship

Cultural values, beliefs, norms, taboos, rituals, and community institutions constitute an important dimension of Traditional Ecological Knowledge (TEK). Environmental stewardship is therefore not only a technical or ecological activity but also a cultural practice through which communities define appropriate relationships with nature. Berkes (2012) describes TEK as a knowledge–practice–

belief complex in which ecological understanding is connected to social institutions and cultural values. From an anthropological perspective, Ingold (2000) argues that human relationships with the environment develop through lived experience and cultural practices, while Gadgil et al. (1993) emphasize the contribution of local institutions and cultural knowledge to biodiversity conservation. Ostrom (1990), from a sociological and institutional perspective, demonstrates that shared norms and community rules can regulate the use of common natural resources. In Rwanda, this relationship between culture and nature is particularly visible in traditional practices surrounding forests, plants, animals and sacred places.

The findings of the present study among 39 ICT students at the Catholic University of Rwanda demonstrate a strong recognition of the cultural dimension of environmental conservation. 89.7% (35/39) of respondents considered Traditional Ecological Knowledge important for environmental conservation. This suggests that students recognize that environmental stewardship can be rooted in cultural knowledge and values rather than depending exclusively on modern scientific approaches. In addition, 84.6% (33/39) recognized traditional soil and water conservation practices, indicating that cultural knowledge can be connected to practical environmental management (Hakizimana, L., 2017). These findings correspond with Berkes (2012), who argues that ecological knowledge is inseparable from the cultural systems within which it develops, and with Folke (2004), who highlights the role of local knowledge in building resilience in social-ecological systems. Pretty (2003) further emphasizes the importance of social capital and collective action in natural-resource management, while Maffi (2005) demonstrates the close relationship between biological and cultural diversity.



Cultural norms and taboos can function as informal mechanisms of environmental protection. In traditional societies, certain trees, animals, forests or places may be considered sacred or subject to restrictions concerning access, harvesting or destruction. In Rwanda, research conducted in the Buhanga Sacred Forest found that cultural norms and values associated with the forest contributed to its non-exploitation. The researchers documented 45 botanical taxa belonging to 28 families, demonstrating the ecological importance of the area and the role of cultural beliefs in protecting particular species (Irakiza et al., 2016, Hakizimana L, et al. 2025). The study also reports that cutting certain tree species and killing particular indigenous animals were traditionally regarded as taboos. Such practices illustrate what Berkes (2012) calls the integration of ecological knowledge with cultural beliefs and institutions. Gadgil et al. (1993) similarly demonstrate that customary rules can contribute to biodiversity conservation, while Pretty (2003) emphasizes that social norms can facilitate collective environmental action.

Rituals and sacred places also contribute to the cultural construction of environmental responsibility. In Rwanda, forests and particular landscapes have historically been associated with oral traditions, ancestral memories, rituals, traditional medicine, songs, dances and community gatherings. Irakiza et al. (2016) note that Rwandan cultural relationships with forests included rites, customs, taboos and traditional knowledge concerning plants and animals. These cultural meanings could discourage destructive activities and encourage respect for particular natural sites. From a broader anthropological perspective, Ingold (2000) emphasizes that landscapes are not simply physical spaces but places inhabited, interpreted and given meaning by human communities. UNESCO (2003) similarly recognizes the importance of living cultural heritage in maintaining relationships between communities and their environment. Berkes (2012) argues that sacred and spiritual dimensions can form part of ecological management systems rather than existing separately from them.

The concept of collective responsibility is particularly important for understanding environmental stewardship. Natural resources such as forests, wetlands, rivers and biodiversity are not exclusively individual possessions; their degradation can affect the entire community. Consequently, traditional systems could establish shared expectations concerning access, use and protection. In the present study, 87.2% (34/39) of respondents supported integrating TEK into contemporary conservation programmes. This indicates strong recognition of the potential contribution of community-based knowledge to environmental management. Ostrom (1990) demonstrates that communities can establish collective institutions for managing common-pool resources, while Pretty (2003) links successful

collective environmental action to trust, cooperation and social capital. Berkes (2012) similarly emphasizes the importance of community institutions within traditional resource-management systems, and Folke (2004) shows that local institutions and ecological knowledge can strengthen resilience in social-ecological systems.

The study also highlights the importance of intergenerational collective responsibility. A particularly high proportion, 92.3% (36/39), believed that younger generations should participate in preserving traditional environmental knowledge. This finding is important because cultural norms, beliefs and environmental practices can survive only when they are transmitted, practiced and adapted by successive generations. If young people become disconnected from community knowledge, the cultural mechanisms that historically supported environmental stewardship may weaken. Maffi (2005) links cultural diversity with biodiversity, while Berkes (2012) emphasizes cultural transmission as a fundamental characteristic of TEK. Ingold (1997) understands learning as a process of developing knowledge through participation and attention, while UNESCO (2003) stresses the importance of safeguarding living heritage through continued transmission and practice.

Overall, the findings indicate that environmental stewardship in Rwanda has an important cultural and collective dimension. Cultural norms, taboos, beliefs, rituals and community values can shape how people perceive and use natural resources, while collective responsibility can encourage their protection. The high proportion of respondents recognizing TEK (89.7%, 35/39) and supporting its integration into contemporary conservation (87.2%, 34/39) demonstrates the continuing relevance of these cultural dimensions among young university students. The particularly strong support for youth participation (92.3%, 36/39) suggests that strengthening intergenerational transmission could help connect Rwanda's cultural heritage with contemporary environmental conservation. TEK should therefore be approached not as a static remnant of the past but as a living cultural resource that can complement scientific knowledge and contribute to sustainable environmental stewardship.

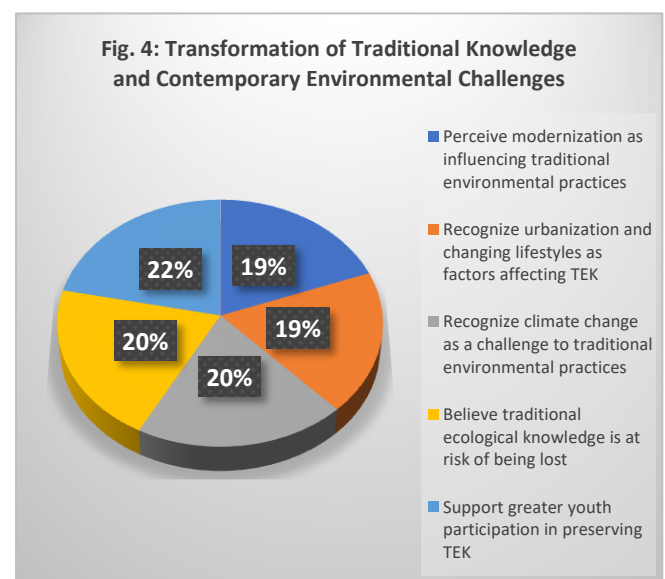
3.4. Transformation of Traditional Knowledge and Contemporary Environmental Challenges

Traditional Ecological Knowledge (TEK) is dynamic rather than static; it changes as communities experience demographic, economic, technological, environmental, and cultural transformations. In Rwanda, modernization, urbanization, population growth, changing livelihoods, and climate change are transforming the relationship between younger generations and traditional environmental practices. Berkes (2012) argues that TEK evolves through continuous interaction between communities and their environments,

while Folke (2004) emphasizes the importance of local knowledge for resilience in social-ecological systems. From an anthropological perspective, Ingold (2000) shows that ecological knowledge is acquired through practical engagement with particular environments, whereas Maffi (2005) highlights the close relationship between cultural diversity and biological diversity. Consequently, when social and cultural practices change rapidly, the knowledge associated with them may also be transformed or weakened.

Modernization and urbanization have particularly important implications for the transmission of traditional ecological knowledge (Hakizimana, L., 2026). As young people increasingly move toward urban areas for education, employment, and new economic opportunities, they may have fewer opportunities to participate in agricultural activities, livestock management, forest use, and other practices through which TEK was traditionally acquired. Rwanda's rapid demographic growth and land pressure have also contributed to significant changes in rural livelihoods and natural-resource management. According to the World Bank (2024), Rwanda has experienced substantial urbanization and continuing demographic pressure. These processes can weaken everyday contact between younger generations and the environments in which traditional knowledge developed (Hakizimana, L. 2026). Pretty (2003) emphasizes that social relationships and community participation are important for collective resource management, while Ostrom (1990) demonstrates that changes in community institutions can affect the management of common resources.

The present study among 39 ICT students provides evidence of both continuity and transformation. Although respondents generally valued TEK, their responses also suggest the need to actively preserve it. The following graph summarizes selected indicators related to the transformation and future transmission of traditional ecological knowledge.



Climate change represents another major factor transforming traditional ecological knowledge. Changes in rainfall patterns, increasing temperatures, droughts, floods, soil degradation, and changing agricultural seasons can make some traditional environmental practices less predictable or less effective. At the same time, local ecological knowledge can provide communities with observations concerning changing seasons, water availability, crops, and environmental conditions. Adger et al. (2003) emphasize the importance of social and institutional dimensions in adaptation to environmental change, while Berkes and Jolly (2001) demonstrate how Indigenous communities can adapt traditional practices to changing climatic conditions. Folke (2004) similarly argues that social–ecological resilience depends partly on the capacity of communities to learn and adapt. In the present study, 84.6% (33/39) of respondents recognized climate change as a challenge to traditional environmental practices.

The interaction between population pressure and environmental degradation is also important. Rwanda's high population density has intensified demand for agricultural land, fuelwood, water, and other natural resources. This can transform traditional systems of land use and reduce the ecological spaces in which traditional knowledge is practiced. However, population pressure does not automatically lead to the disappearance of TEK; communities may adapt their practices to changing resource conditions. Turner et al. (2003) demonstrate that local ecological knowledge can contribute to landscape management under conditions of environmental pressure. Berkes (2012) likewise emphasizes the adaptive character of TEK, while Ostrom (1990) shows that collective institutions can facilitate sustainable management even when resources are under pressure. The challenge is therefore not simply to preserve traditional practices unchanged but to identify which elements remain ecologically and culturally relevant.

The issue of knowledge loss and the changing role of younger generations is particularly significant. The study found that 87.2% (34/39) of respondents believed that traditional ecological knowledge is at risk of being lost. At the same time, 92.3% (36/39) believed that younger generations should participate in preserving TEK. This apparent tension is important: young people may recognize the value of traditional knowledge while having fewer opportunities to acquire it through everyday experience. Ingold (1997) argues that knowledge is learned through participation and attention rather than simply through the transmission of information. UNESCO (2003) similarly emphasizes that intangible cultural heritage survives through continued practice and transmission. Maffi (2005) further connects cultural continuity with ecological diversity, while Reyes-García et al. (2019) emphasize the importance of

intergenerational transmission for maintaining local ecological knowledge.

The findings therefore suggest that young people should not be viewed simply as passive recipients of traditional knowledge but as active agents in its transformation and preservation. The fact that 92.3% (36/39) support youth participation provides an important opportunity for universities and environmental institutions. ICT students, for example, could contribute to documenting traditional environmental knowledge through digital archives, interviews, mobile applications, geographic information systems, and other technologies. Such approaches could connect modern technological skills with local ecological knowledge. This would be consistent with the view of Berkes (2012) that TEK is a living and adaptive system rather than a fixed body of information.

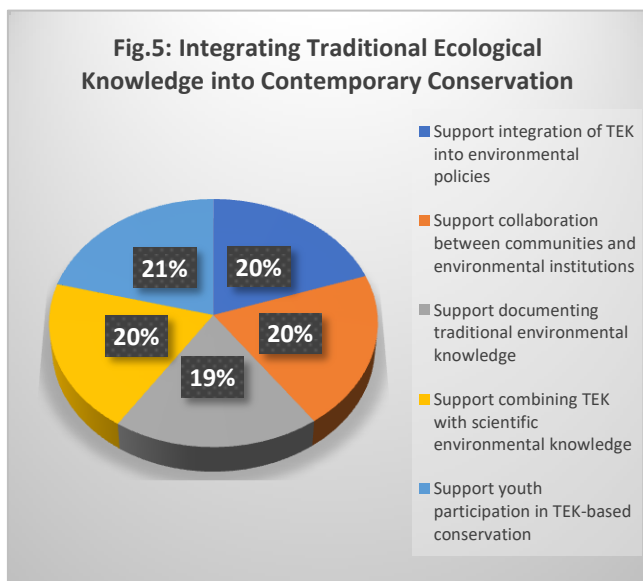
Overall, the findings demonstrate that modernization, urbanization, population pressure, climate change, and changing lifestyles create both risks and opportunities for traditional ecological knowledge in Rwanda. While 87.2% (34/39) perceived a risk of knowledge loss, the strong support for youth participation (92.3%, 36/39) indicates considerable potential for revitalization. The future of TEK therefore depends not on isolating traditional knowledge from modern society but on creating meaningful connections between traditional ecological knowledge, scientific knowledge, digital technologies, formal education, and younger generations.

3.5. Integrating Traditional Ecological Knowledge into Contemporary Conservation

Integrating Traditional Ecological Knowledge (TEK) into contemporary environmental conservation offers an important opportunity to connect local experience with scientific research, public policy, and institutional environmental management. TEK can provide detailed knowledge of local ecosystems, species, agricultural practices, water resources, and environmental change that has accumulated through generations. Berkes (2012) conceptualizes TEK as a dynamic knowledge–practice–belief system, while Folke (2004) emphasizes its contribution to resilience within social–ecological systems. From an anthropological perspective, Maffi (2005) demonstrates the close relationship between cultural and biological diversity, while Ostrom (1990) shows how community institutions can contribute to sustainable management of common resources. In Rwanda, this integration is particularly relevant because the country's biodiversity policy explicitly recognizes the importance of generating, managing, and applying traditional knowledge to biodiversity conservation.

The findings of the present study indicate substantial support for this approach among the 39 ICT students at the

Catholic University of Rwanda. 87.2% (34/39) of respondents supported integrating TEK into contemporary conservation programmes. This finding suggests that students perceive traditional knowledge as potentially complementary to scientific environmental knowledge rather than as an obsolete system. Such integration could include documenting traditional soil and water conservation practices, incorporating local ecological observations into environmental education, and involving communities in biodiversity monitoring (Hakizimana, L., et al. 2024). UNESCO emphasizes that meaningful collaboration between Indigenous and local knowledge holders, scientists, and policymakers can contribute to addressing biodiversity loss, although such collaboration must be respectful and carefully structured.



An important opportunity is therefore the existing policy environment in Rwanda. The country's biodiversity framework has already recognized traditional knowledge and community participation as relevant to biodiversity conservation. Rwanda's biodiversity policy calls for partnerships, knowledge management, and the application of traditional knowledge to conservation, while the National Biodiversity Strategy and Action Plan has included the integration of traditional knowledge and practices into biodiversity policy and implementation. The current National Biodiversity Strategy and Action Plan 2025–2030 further emphasizes inclusive conservation, ecosystem restoration, research, data, innovation, and community benefits. These policy commitments create a favourable institutional foundation for bringing local ecological knowledge into contemporary conservation programmes.

Nevertheless, several challenges must be considered. Traditional knowledge may be fragmented, orally transmitted, insufficiently documented, or vulnerable to disappearance as younger generations become increasingly influenced by modernization and urbanization (Hakizimana,

L., 2025). There is also a danger of extracting knowledge from communities without recognizing their ownership or providing appropriate benefits. Rwanda's Law on the Preservation of Cultural Heritage and Traditional Knowledge recognizes traditional knowledge as knowledge generated, preserved, and transmitted in an intergenerational context and associated with the cultural identity of particular communities (Hakizimana, L., 2025). It also protects holders against exploitation without prior informed consent. Consequently, researchers and conservation organizations should not simply collect local knowledge as research data; they should establish ethical mechanisms for consent, attribution, protection, and benefit sharing. Berkes (2012), Maffi (2005), UNESCO (2003), and Ostrom (1990) similarly emphasize the importance of cultural context, community institutions, and collective rights in knowledge-based environmental management.

The findings also highlight the importance of collaboration among local communities, government institutions, universities, researchers, and conservation organizations. The strongest result was the support for youth participation: 92.3% (36/39) of respondents believed that younger generations should participate in preserving TEK. This creates an opportunity for universities to serve as bridges between community knowledge and scientific research. ICT students, for example, could contribute to the digital documentation of traditional environmental practices through databases, geographic information systems, digital archives, mobile applications, and audiovisual documentation. Such initiatives could involve communities as knowledge holders, researchers as facilitators, government agencies as policy actors, and conservation organizations as technical partners. UNESCO stresses that combining local knowledge with scientific knowledge requires respectful and productive collaboration between knowledge holders, scientists, and policymakers.

The Rwandan environmental legal framework also provides a basis for collective action. The Law on Environment establishes the principle of cooperation and requires government authorities, national and international organizations, associations, and private individuals to cooperate in environmental protection. It also recognizes the right of people to participate in environmental conservation activities. This institutional framework can facilitate participatory conservation programmes in which communities are not merely beneficiaries but active partners in decision-making, monitoring, implementation, and evaluation. Ostrom (1990) and Pretty (2003) demonstrate that collective institutions, trust, participation, and social capital can strengthen natural-resource governance, while Berkes (2012) emphasizes the importance of combining ecological knowledge with appropriate community institutions.

Overall, the findings indicate that integrating TEK into contemporary conservation represents both an opportunity and a responsibility. The strong support among respondents—87.2% (34/39) for integration, 89.7% (35/39) for community–institutional collaboration, and 92.3% (36/39) for youth participation—suggests considerable potential for developing a more inclusive conservation model in Rwanda. Such integration should not replace scientific knowledge with traditional knowledge; rather, it should establish a dialogue between different knowledge systems. Rwanda can strengthen this approach by documenting community knowledge, protecting knowledge holders' rights, supporting intergenerational transmission, encouraging university–community research, and creating institutional mechanisms through which local knowledge can inform environmental policy and conservation practice.

4. CONCLUSION AND RECOMMENDATIONS

This study examined the role of Traditional Ecological Knowledge (TEK) in environmental conservation in Rwanda, with particular attention to ICT students at the Catholic University of Rwanda. The findings demonstrate that TEK remains an important cultural and environmental resource despite the transformations associated with modernization, urbanization, climate change, population pressure, and changing lifestyles. Students recognized the relevance of traditional knowledge for understanding and managing soil, water, agriculture, forests, biodiversity, and other natural resources. The study also highlights the importance of cultural values, community practices, and intergenerational transmission in sustaining environmental stewardship. However, the changing relationship between younger generations and traditional practices presents a risk of knowledge loss. The findings suggest that TEK should not be regarded simply as knowledge belonging to the past, but as a dynamic knowledge system that can complement scientific knowledge and contribute to contemporary environmental conservation. Its future relevance will depend on its documentation, adaptation, ethical protection, and integration into education, research, environmental policies, and conservation programmes.

The study makes the following recommendations. First, TEK should be integrated into environmental education at schools and universities to strengthen awareness of locally appropriate conservation practices. Second, intergenerational knowledge transmission should be strengthened by creating opportunities for elders, community leaders, researchers, and young people to exchange ecological knowledge and experiences. Third, government institutions, universities, conservation organizations, and local communities should collaborate in documenting, evaluating, and applying relevant traditional environmental practices. Fourth, ICT and digital technologies should be used to create ethical digital

archives, databases, mapping systems, and educational platforms for preserving and disseminating TEK. Finally, the integration of TEK should respect community ownership, informed consent, cultural rights, and benefit-sharing, ensuring that traditional knowledge holders remain active partners in environmental conservation.

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