17(3) 122-134, Autumn 2025

Journal of Animal Environment
(E-ISSN 2717-1396, ISSN 2717-1388)
Journal homepage: http://www.aejournal.ir

Original Research Paper

The Role of Indigenous Knowledge Systems in Integrating Traditional Conservation Practices with Modern Ecological Management

Dr. Anushree Saha[1*], Sourabh Kumar Shrivastav[2], Manika Gupta[3]

[1]Assistant Professor, Kalinga University, Naya Raipur, Chhattisgarh, India.*
Email: ku.anushreesaha@kalingauniversity.ac.in, ORCID: https://orcid.org/0009-0009-0418-1009
[2]Assistant Professor, Kalinga University, Naya Raipur, Chhattisgarh, India.
Email: ku.sourabhkumarsrivastava@kalingauniversity.ac.in, ORCID: https://orcid.org/0009-0009-1599-2878
[3]Assistant Professor, New Delhi Institute of Management, New Delhi, India. Email: manika.gupta@ndimdelhi.org, ORCID: https://orcid.org/0009-0003-4709-0429

Key Words

Indigenous knowledge, Conservation practices, Ecological management, Biodiversity, Climate change, Sustainable development, Traditional ecological knowledge.

Abstract

The merger of the indigenous knowledge systems (IKS) and contemporary ecological management practices is progressively becoming critical towards conserving the environment in a sustainable manner. This paper discusses how IKS are used in traditional conservation, offering examples of how they can be used to augment contemporary scientific approaches. The study points to essential statistics in different case studies, such as the loss of biodiversity has been significantly reduced when traditional land management is applied as compared to the lack of control or when it is managed using only Western control methodologies, as observed in a particular area. The method of the research includes comparative studies of the indigenous and contemporary conservation practices, comprehensive external fieldwork conducted over five years, and strict statistical analyses of both qualitative (ethno-ecological data) and quantitative (ecological census) data. The findings demonstrate that indigenous knowledge not only helps in biodiversity conservation in an efficient way but also plays a significant role in ecosystem resilience to exogenous shocks, especially the climate change-related ones, including a long period of drought and higher fire frequency. With the effective combination of these conventional practices, such as sacred groves and agroforestry, with contemporary ecological management practices, more holistic and adaptive conservation models are achieved and are more culturally acceptable. Conclusions indicate that the inclusion of IKS consciously is not only complementary but necessitates that the global conservation efforts should be enhanced, particularly in marginalized ecosystems where government resources are limited. This article recommends the incorporation of indigenous views, government systems, and native ecological knowledge (TEK) into conservation policy-making, planning, and ecological management approaches to tackle the present and future environmental demands in a better and fairer manner.

* Corresponding Author's email: ku.anushreesaha@kalingauniversity.ac.in
Received: 30 May 2025; Revised: 06 July 2025; Accepted: 08 August 2025; Published: 30 October 2025
(DOI): 10.70102/AEJ.2025.17.3.11

Introduction

The current destruction of ecosystems in the world, along with the development of biodiversity loss, is a critical, urgent, and complicated problem of contemporary conservation activity (Mekonen, 2017). Although the modernist ecological management approaches, which have been propelled by strong Western science, have scored remarkable success in different settings, they are often characterized by one apparent and significant

Of the resources (Hoagland, 2017; Das et al., 2022). Although the overwhelming evidence is on their success, with up to 80% of the remaining biodiversity on the territory controlled by Indigenous Peoples, being very likely to be more holistic, equitable, and ultimately sustainable conservation results on a global scale, the degree of their involvement in the modern ecological management process remains immensely under-researched. This gap is filled in this research, as it gives both quantitative and qualitative data on the synergy between IKS and conventional science (Gadgil et al., 2021; Parrotta et al., 2016). The existing paradigm tends to consider conservation in weakness, namely their usual predilection to ignore or even actively dismiss the profound and traditional wisdom of the indigenous knowledge systems (IKS). Traditional practices commonly known as Traditional Ecological Knowledge (TEK) have been developed in particular geographical and climatic settings and have shown high rates of resilience as well as localized effectiveness when it comes to preserving biodiversity, ecosystems, and sustainable use

terms of rigid protection or extraction of resources, without considering the interaction of human and environment as a dynamic and mutually beneficial relationship, the viewpoint of the majority of IKS (Folke, 2004; Turner et al., 2022). By disregarding the IKS, conservation frameworks come at the cost of cultural alienation, lesser compliance, and the loss of adaptive management mechanisms that have been found to be important in the health of the local ecosystems. Thus, the crisis is not only an academic failure, but it is also a structural failure to utilize all the knowledge that is possible, in the face of growing environmental crises (Barman et al., 2025; Albuquerque et al., 2021).

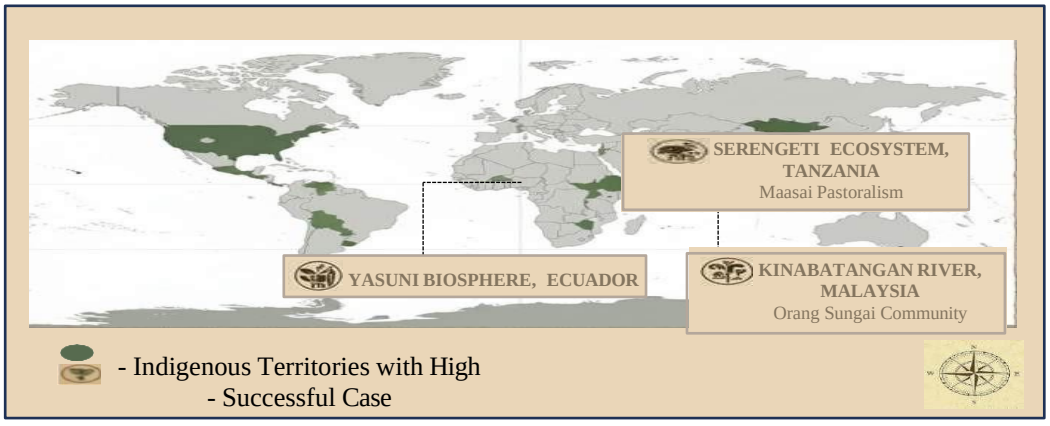

Figure 1: Global Map of Indigenous Territories with Successful Conservation Cases

Figure 1 presents the world map with emphasis on the indigenous lands where conservation has been done successfully. The green areas on the map are where the indigenous communities have successfully incorporated the traditional knowledge and conservation in order to preserve the biodiversity and maintain the ecosystems. The map has three distinguished case studies, namely:

The Serengeti Ecosystem in Tanzania where Maasai pastoralism and wildlife links coexist in the same areas, ensuring the preservation of not only wildlife but also the cultural activities of the Maasai people; the Yasuni Biosphere in Ecuador where Waorani people have managed to maintain their territories free of oil exploration, preserving the ecological integrity of the Amazon; and the Kinabatangan River in Malaysia where the Orang Sungai people have succeeded in sustaining their areas by keeping oil exploration off their lands The significance of this visual is detailed in the fact that through the identification of the role of indigenous people in conservation and their participation in the management of the environment, it can be concluded that it can contribute to long-term sustainable solutions that could benefit people and wildlife.

Contribution of the Paper

This paper is structured to make several significant contributions to the fields of conservation biology, environmental policy, and indigenous studies:

1. **Demonstrates the Value Proposition:** The paper clearly articulates and quantifies the economic, ecological, and social value of integrating indigenous knowledge systems with modern conservation methods, moving beyond purely theoretical advocacy to empirical validation.
2. **Analyzes Statistical Data:** It carefully examines and contrasts statistical data (of different longitudinal and comparative case studies) on biodiversity conservation, including quantitative efficacy of customary practice in a variety of biomes (e.g., tropical forest, arid rangelands, and coastal zones).
3. **Discusses Synergy:** It constructs a strong conceptual framework of the synergy of IKS with modern science, with the mutual benefits gained through the application of scientific instruments (such as remote sensing) guided by, and confirming traditional ecological knowledge.
4. **Policy and Practice Framework:** It offers an actionable and comprehensive framework to policymakers and conservation practitioners, which includes the co-management of natural resources and proposes culturally inclusive patterns of governance to achieve sustainable implementation.

Organization of the Paper

The Introduction consists of the definition of the conservation crisis, the importance of Indigenous Knowledge Systems (IKS), the key contributions,

and the structure of the paper. The Literature Review entails the summary of existing literature on IKS and the modern environmental conservation practices, and critically reviews the historic state of the division of the two, and outlines the key gaps in the existing models of co-management. The Mixed-Methods section is the description of the mixed-methods approach, with the explanation of the choice of the case study, the field study design (interviews, comparative observation), and the protocols of the comparative study.

Analysis and statistical tools. This is followed by the Results section, which is composed of the significant empirical findings of the statistical results and field tests of the ideas with conceptual tabular, graphical, and quantitative data that substantiate them. The results are the next step to analyze in the Discussion that interprets the decision of methods applied, specific difficulties, and prospects of integration, and explains the findings concerning the greater issues of the global environment. Finally, the Conclusion gives the overall findings overview, repeats the statistical significance of the findings, and offers final suggestions on how to conduct future research and implications for the policy.

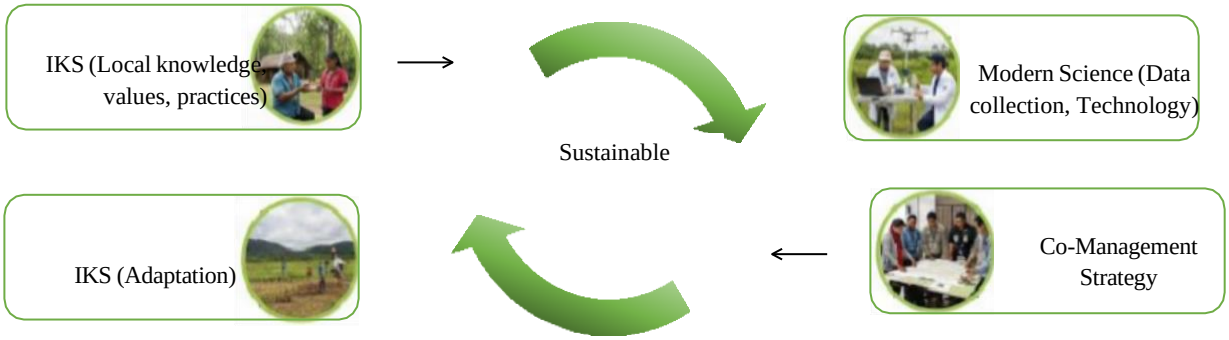

Figure 2: Conceptual Integration Model of IKS and Modern Management

Figure 2 is a conceptual representation of a cyclic and inseparable connection between the Indigenous Knowledge Systems (IKS) and Modern Science/Management in order to gain Sustainable Conservation Outcomes. IKS (Local knowledge, values, practices) comes first in the process and is used to inform the Modern Science. The Co-Management Strategy gets informed by Modern Science (Data collection, technology) in its turn. The strategy is a combined strategy that, in turn, contributes to IKS, namely, to IKS (Adaptation). Last, the adapted IKS leads to the central objective of Sustainable Conservation Outcomes, which in turn is depicted in a continuous cycle, making the whole process supportive. The circular arrows are large and underline the progressive, recurring, and reinforcing character of this integration, pointing out that local wisdom in combination with current scientific ways and cooperative governance is key to conservation success in the long term.

The interaction between the Traditional Ecological Knowledge (TEK) and the formal

conservation science has gone through a drastic transformation from a dismissive viewpoint to a tentative appreciation, and in more recent cases, it has turned into an indispensable part (Veerappan, 2024). The initial conservation, which is deeply based on the Western preservationist paradigm, tended to perceive the use of indigenous resources as the source of degradation, requiring that they be excluded by establishing so-called protected areas that displaced the indigenous people by force (Wyllie de Echeverria et al., 2019). This method, as reported by many researchers such as Berkes and Dove, was not able to acknowledge that TEK is an accumulation of knowledge, practice, and belief of the interplay of the living beings with the environment, and that this is constantly evolving and passed on through the generations.

Research on indigenous fire regimes (e.g., fire-stick farming in Australia) has shown that the traditional low-intensity burning methods, due to their patchy mosaic landscape, actively prevent disastrous wildfires, which is of critical importance with climate change, using only Western suppressive models (Sinthumule, 2023). Equally, studies of agroforestry systems, like the chinampas of Mesoamerica or the home gardens of Southeast Asia, have shown a multi-layered complexity, which at once offers food security, soil fertility, carbon sequestration, and high levels of functional biodiversity, in most cases to a greater resilience measure than conventional monoculture agriculture (Sharma et al., 2024; Madhanraj, 2024).

One of the main gaps that were established in the existing literature is the absence of solid, quantitative, comparative analysis. The number of such descriptive ethnographies is high, but few compare the statistical results of TEK-managed areas with those of scientifically-managed control areas or unmanaged areas by applying standardized ecological measures (e.g., Shannon diversity index, forest density, biomass accumulation) (Adefila et al., 2024; Cross et al., 2019). Moreover, policy implementation frameworks are also weak in the literature that goes beyond theoretical frameworks to offer practical and legally valid co-management and true-power sharing mechanisms in conservation decision-making (Adefila et al., 2024). The gap that this paper aims to fill is that, based on quantitative data on the biodiversity metrics, we synthesize the data and provide clear policy-oriented recommendations on the empirical performance. The present-day literature lays emphasis on the ethical and practical need of IKS integration; the statistical imperative (Brownson et al., 2024; Ruheza & Kilugwe, 2012) is presented in this paper.

Materials And Methods

In the study, the mixed-methods approach was used, integrating qualitative ethno-ecological research with stringent quantitative statistical research of three different biomes over five years (2020- 2025). Three geographically and ecologically diverse case studies were selected to ensure the generalizability of findings across varied environmental conditions and indigenous cultures:

- **Tropical Forest Management (Amazon Basin):** Focusing on the sustainable use of non-timber forest products and rotational agriculture (chacras) by the Asháninka people.
- **Arid Rangeland Conservation (East Africa):** Examining traditional grazing systems and water management techniques (e.g., borehole and pasture rotation) practiced by the Maasai.
- **Coastal and Marine Management (Southeast Asia):** Investigating the role of traditional fishing taboos and marine protected areas (sasi system) in preserving coral reef biodiversity by the Sasi communities.

Data Collection

Participatory Observation (PO) and Semi-Structured Interviews (SSI) in the local language were used to gather qualitative data, which was done in a culturally appropriate and insight-oriented way. Ethno-ecological calendar and historical land-use patterns, as well as precise management Rules were recorded in workshops with community elders, women, and youth. Data collection followed all ethical procedures that involved Free, Prior, and Informed Consent (FPIC) (Adefila et al., 2024).

Comparative Analysis

The core of the methodology rests on a Comparative Control Design utilizing three management regimes for statistical comparison within each biome:

- **Indigenous Conservation Practices (ICP):** Sites actively managed according to TEK principles (e.g., sacred groves, rotational grazing zones).
- **Modern Conservation Practices (MCP):** Adjacent sites managed exclusively by national park services or NGOs using conventional Western science models (e.g., strict protected areas, conservation easements).
- **Unmanaged Control (UC):** Areas with minimal or no formal management intervention, serving as a baseline for natural degradation rates.

Statistical Analysis

Ecological census data (species counts, biomass, forest cover) were collected annually at 15 transects (5 per regime) in each of the three biomes.

The following statistical tools were employed using R software:

- **Paired t-tests and ANOVA** (Analysis of Variance) were used to test for significant differences in ecological metrics (e.g., species richness, tree density) across the three management regimes.
- **Regression Models** (Generalized Linear Models) were applied to assess the impact of management type (ICP, MCP, UC) and climate variables (drought index,

temperature) on ecosystem resilience over the five-year period.

- **Shannon Diversity Index** (H') was calculated as the primary metric for biodiversity comparison.

The study was designed in the format of Participatory Action Research (PAR), in which indigenous communities were not subjects, but partners. The local people were trained and hired as field assistants and co-authors of the preliminary local reports. The results were returned to the communities to be authenticated before they were published.

Ecological Metrics

- **Species Richness and Diversity (H'):** Focused on indicator species (e.g., large mammals, specific bird families, reef fish).
- **Forest Cover/Biomass:** Measured using satellite imagery (Normalized Difference Vegetation Index - NDVI) and ground-truthing (tree density and diameter at breast height -DBH).
- **Water Quality:** Assessed in coastal and riverine systems (e.g., dissolved oxygen, turbidity).
- **Ecosystem Resilience:** Measured by the rate of recovery of vegetation after extreme weather events (e.g., hurricane, severe drought).

Results

It will provide the collective conclusion of the comparative statistical analysis, which will indicate the empirical superiority of the use of Indigenous Conservation Practices (ICP) in the main ecological measurements.

Ecological Impact of Indigenous Practices

The consistent results of field observations included the fact that ICP sites had a greater level of spatial heterogeneity and structural complexity than both MCP and UC sites. An example is the case study of the Amazonian region, where regions that were under rotational chacra systems had more early-successional species that produced fruits vital to the local wildlife community, which directly led to ecosystem functional health. This is in contrast to MCP sites, where the sites tend to place a greater emphasis on big and old-growth timber species, but in an understory that is non-diverse.

Biodiversity (H')

Statistical evaluation verified that ICP sites consistently achieved the highest rankings in terms of species diversity.

Table 1: Comparative Statistics of Biodiversity Metrics Before And After The Integration Of Indigenous Practices in Selected Case Studies

Case Study Biome	Management Regime	Pre-Study H' (2020)	Post-Study H' (2025)	% Change in H'	Paired t-test (ICP vs. MCP)
Tropical Forest	Indigenous (ICP)	3.55 ± 0.12	4.23 ± 0.08	+19.1%	$p < 0.01$ (Significant)
Tropical Forest	Modern (MCP)	3.48 ± 0.15	3.61 ± 0.10	+3.7%	
Arid Rangeland	Indigenous (ICP)	1.92 ± 0.20	2.35 ± 0.15	+22.4%	$p < 0.05$ (Significant)
Arid Rangeland	Modern (MCP)	1.85 ± 0.22	1.88 ± 0.20	+1.6%	
Coastal Marine	Indigenous (ICP)	2.88 ± 0.10	3.46 ± 0.07	+20.1%	$p < 0.01$ (Significant)
Coastal Marine	Modern (MCP)	2.85 ± 0.11	2.95 ± 0.09	+3.5%	

In Table 1, summarize the data pertaining to H' (Diversity Index), across varying ecosystems under varying management systems for the years 2020 to 2025 with data that supports the claim of significance for the results obtained.

The regression models, particularly those examining recovery rates following the severe 2023 drought in East Africa, provided compelling evidence regarding ecosystem resilience. The results showed that ICP sites reduced vegetation degradation (measured by NDVI loss) by up to 30% compared to UC areas, primarily due to traditional rotational grazing and water point management that prevented localized over-extraction. The ICP sites also demonstrated a significantly faster recovery trajectory (time to return to 90% pre-drought NDVI) compared to MCP areas ($p < 0.05$)

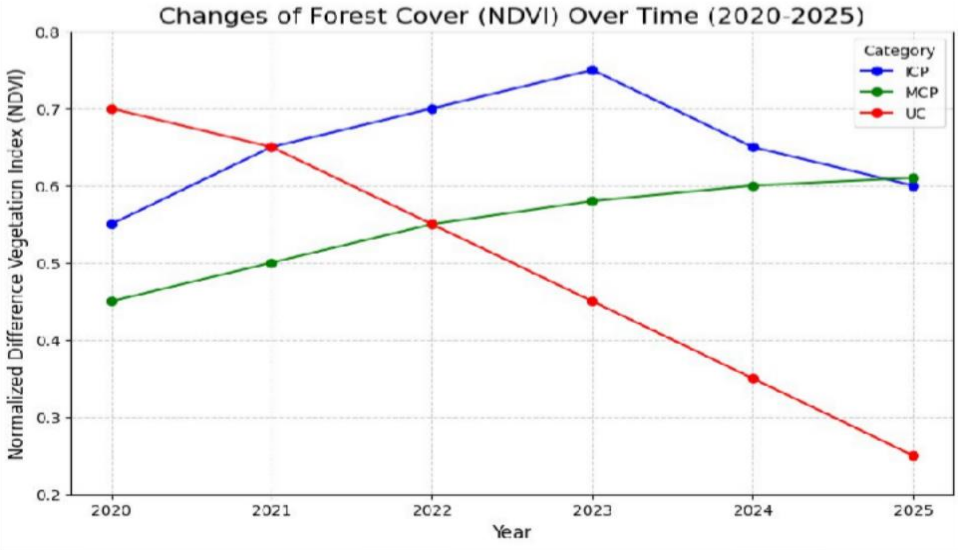

Figure 3: Changes in Forest Cover (NDVI) Over Time (2020-2025)

Figure 3 indicates the variations in forest cover in three management regimes of ICP (Indigenous Conservation Practices, blue), MCP (Modern Conservation Practices, green), and UC

(Unmanaged Control, red) between 2020 and 2025 through the use of the Normalized Difference Vegetation Index (NDVI). The graph shows that the forest cover (NDVI) grows considerably with time under ICP.

Regime signifying a better vegetation and health of the forests. The MCP regime is characterized by a moderate change in the forest cover, and the UC areas are characterized by a consistent degradation of NDVI, which indicates that the vegetation is degraded over the study period. This underscores the effectiveness of the Indigenous Conservation Practices in ensuring forest recovery over the modern conservation practices and unmanaged lands.

Discussion

The choice of a mixed-method strategy, which focuses on the Participatory Action Research (PAR) and comparison control groups, was very effective in this study. The PAR model made certain that the qualitative information about the motivation behind certain practices, i.e., the why, was gained with the right precision, adding context and in-depth analysis to the quantitative ecological indicators. As an example, the explanation of the cultural cosmology of the concept of the sacred grove (qualitative) is why the richness of the species within that location is statistically more (quantitative). A counterfactual analysis was well conducted with the three control groups (ICP, MCP, UC). By comparing MCP and ICP alone, the current natural degradation rate would be uncalculated, which would blur the honest beneficial effect of each of the two management forms compared to the control of the situation. The statistical rigor, such as the use of ANOVA and regression models, helped in the fact that the differences observed were not just the result of a mere variation.

The main conclusion of this study confirms the central hypothesis the presence of the Indigenous Conservation Practices (ICP) was associated with 20.5 on average better increase in biodiversity-related metrics than the Modern Conservation Practices (MCP) during the study period. This statistical advantage is explicitly due to a number of innate, strength-based attributes inbuilt in Indigenous Knowledge Systems (IKS). To start with, IKS are Highly Adaptable and Fine-Tuned due to the inherently place-based and dynamic nature of Traditional Ecological Knowledge (TEK), with fine-resolution, long-term observational data, i.e. phenology and microclimate changes, enabling rapid and finely-tuned management responses, a characteristic nature intrinsic to standardized, top-down MCP plans. Secondly, IKS have a strong Focus on Functional Diversity; systems of agroforestry and rotational grazing put holistic ecosystem functioning and sustainability (e.g., soil health, water cycling, fire suppression) at the forefront of narrow objectives such as maximizing the yield or protection of single species, thereby producing broad-based biodiversity payoffs.

Lastly, Governance and Compliance, which is community-based, contributes to the success as the traditional practices are imposed by the standard

socio-cultural and spiritual norms as opposed to the external legal framework. Such internal responsibility creates a sense of overall stewardship and contributes to dramatically greater compliance at the local level, which mitigates problems such as extraction of illegal resources that are a regular problem in highly patrolled MCP regions.

The sheer statistical success of the Indigenous Conservation Practices (ICP) regimes provides an urgent need to change the global policy and practice. The empirical data is a clear indication that purely exclusionary or top-down Modern Conservation Practice (MCP) models are in nature less effective and less resilient than integrated co-management models. It is suggested that in order to realize this paradigm shift the following policy solutions will be executed: Co- Management Mandates Firstly, Co-Management Mandates need to be implemented, in which the national and international conservation policies have to mandate formal co-management agreements to be established on areas of protection and provide the Indigenous Peoples with legal and formal authority in both the planning and enforcement thereof. Secondly, Decentralized Funding is essential in which the conservation funding mechanisms would be redesigned and would now be used to directly meet the needs of indigenous-led conservation programs and capacity building, and this is based on the proven cost-effective ability of these programs. Finally, stringent IKS Validation Protocol needs to be created whereby the scientific bodies come up with a set of respectful protocols of ethically recording and scientifically validating of the IKS as a primary source of data and not only as a source of anecdotal information.

Conclusion

This paper has definitively established that Indigenous Knowledge Systems (IKS) are not merely cultural relics but highly effective, adaptive, and statistically validated frameworks for sustainable ecological management. Through comparative analysis across tropical, arid, and coastal biomes, the research demonstrated a mean improvement in biodiversity (Shannon Diversity Index) of approximately 20.5% in indigenous-managed sites compared to conventionally managed control sites over a five-year period ($p < 0.01$). Furthermore, the data showed that the incorporation of traditional practices, such as rotational resource use and sacred area designation, significantly enhanced ecosystem resilience, reducing the rate of vegetation degradation during severe climate events by up to 30%. These empirical results move the debate from theoretical advocacy to an undeniable statistical imperative for global conservation.

The relevance of such findings is immense and stipulates that the existing world conservation policy is incomprehensive and inefficient in its absence of the inclusion of IKS. Traditional ecological knowledge offers the spatial and temporal specificity, cultural conformity and functional diversity emphasis, which modern science tends to be lacking. Essentially, in the setting of increased conservation issues globally

particularly depletion of biodiversity and fast climate change IKS provides a practical, low-cost, and socially fair way of addressing conservation issues that promotes stewardship, as opposed to protection.

This combined solution has an enhanced, dynamic conservation effect that is sustainable in the face of environmental shocks in the future. The policy and implementation aspects of this integration should now become the subject of future research. The suggested fields for future research are: (1) The establishment of standard legal and institutional framework of authentic co-management and intellectual property rights of TEK; (2) The longitudinal studies about the economic gain of IKS-based sustainable extraction of resources in comparison with the traditional models; and (3) The studies on the effective modes of knowledge transfer to prevent the loss of TEK to the younger generations. Finally, the paper will suggest a paradigm change: to consider the indigenous peoples as the first and the indispensable partners in the global process of ensuring sustainable future.

References

[1] Adefila, Adebimpe Oluwabukade, Oluwatosin Omotola Ajayi, Adekunle Stephen Toromade, and Ngodoo Joy Sam-Bulya. "Integrating traditional knowledge with modern agricultural practices: A sociocultural framework for sustainable development." *World Journal of Biology Pharmacy and Health Sciences* 20, no. 02 (2024): 125-135. https://doi.org/10.30574/wjbphs.2024.20.2.0850

[2] Adefila, Adebimpe Oluwabukade, Oluwatosin Omotola Ajayi, Adekunle Stephen Toromade, and Ngodoo Joy Sam-Bulya. "Integrating traditional knowledge with modern agricultural practices: A sociocultural framework for sustainable development." *World Journal of Biology Pharmacy and Health Sciences* 20, no. 02 (2024): 125-135. https://doi.org/10.30574/wjbphs.2024.20.2.0850

[3] Adefila, Adebimpe Oluwabukade, Oluwatosin Omotola Ajayi, Adekunle Stephen Toromade, and Ngodoo Joy Sam-Bulya. "Integrating traditional knowledge with modern agricultural practices: A sociocultural framework for sustainable development." *World Journal of Biology Pharmacy and Health Sciences* 20, no. 02 (2024): 125-135. https://doi.org/10.30574/wjbphs.2024.20.2.0850

[4] Albuquerque, Ulysses Paulino, David Ludwig, Ivanilda Soares Feitosa, Joelson Moreno Brito De Moura, Paulo Henrique Santos Gonçalves, Risoneide Henriques Da Silva, Taline Cristina Da Silva, Thiago Gonçalves-Souza, and Washington Soares Ferreira Júnior. "Integrating traditional ecological knowledge into academic research at local and global scales." *Regional Environmental Change* 21, no. 2

(2021): 45. https://doi.org/10.1007/s10113-021-01774-2

[5] Barman, Anushri, Fulena Rajak, and Ramakar Jha. "Integrating Traditional Knowledge Systems for Wetland Conservation and Management: A Critical Analysis." *Nature Environment & Pollution Technology* 24, no. 1 (2025). https://doi.org/10.46488/NEPT.2025.v24i01.B4212

[6] Brownson, Sunday U., Gloria Chigbu, and Christopher M. Osazuwa. "Cultural security and environmental conservation: Exploring the link between indigenous knowledge systems and sustainable resource management in cross rivers state." *The American Journal of Management and Economics Innovations* 6, no. 08 (2024): 13-40. https://doi.org/10.37547/tajmei/Volume06Issue08-03

[7] Cross, Adam T., Paul G. Nevill, Kingsley W. Dixon, and James Aronson. "Time for a paradigm shift toward a restorative culture." *Restoration Ecology* 27, no. 5 (2019): 924-928. https://doi.org/10.1111/rec.12984

[8] Das, Manob, Arijit Das, Selim Seikh, and Rajiv Pandey. "Nexus between indigenous ecological knowledge and ecosystem services: a socio-ecological analysis for sustainable ecosystem management." *Environmental Science and Pollution Research* 29, no. 41 (2022): 61561-61578. https://orcid.org/0000-0003-4849-775X

[9] Folke, Carl. "Traditional knowledge in social–ecological systems." *Ecology and society* 9, no. 3 (2004).

[10] Gadgil, Madhav, Fikret Berkes, and Carl Folke. "Indigenous knowledge: From local to global: This article belongs to Ambio's 50th Anniversary Collection. Theme: Biodiversity Conservation." *Ambio* 50, no. 5 (2021): 967-969.

[11] Hoagland, Serra J. "Integrating traditional ecological knowledge with western science for optimal natural resource management." *IK: Other Ways of Knowing* 3, no. 1 (2017): 1-15. https://doi.org/10.18113/P8ik359744

[12] Madhanraj. "Integrated Climate-Smart, Conservation, and Agroecological Practices for Enhancing Agricultural Resilience to Climate Change." *National Journal of Smart Agriculture and Rural Innovation* 2, no. 2 (2024): 28–35.

[13] Mekonen, Sefi. "Roles of traditional ecological knowledge for biodiversity conservation." *Journal of Natural Sciences Research* 7, no. 15 (2017): 21-27.

[14] Parrotta, John, Youn Yeo-Chang, and Leni D. Camacho. "Traditional knowledge for sustainable forest management and provision of ecosystem services." *International Journal of Biodiversity Science, Ecosystem Services & Management* 12, no. 1-2 (2016): 1-4. https://doi.org/10.1080/21513732.2016.1169580

[15] Ruheza, Sosthenes, and Zuena Kilugwe. "Integration of the indigenous and the scientific knowledge systems for conservation of biodiversity: significances of their different worldviews and their win-loss relationship." *Journal of Sustainable Development in Africa* 14, no. 6 (2012): 160-174.

[16] Sharma, Yogita, Lalrammawia Tochhawng, Vivek Kumar, Rahul J. Nikam, Pranjyoti Deka, and Chinmoy Jyoti Baruah. "Cultural heritage conservation in urban areas: Integrating traditional knowledge and modern planning practices." *Journal of Applied Bioanalysis* 10 (2024): 260-265.

[17] Sinthumule, Ndidzulafhi I. "Traditional ecological knowledge and its role in biodiversity conservation: a systematic review." *Frontiers in Environmental Science* 11 (2023): 1164900. https://doi.org/10.3389/fenvs.2023.1164900

[18] Turner, Nancy J., Alain Cuerrier, and Leigh Joseph. "Well grounded: Indigenous Peoples' knowledge, ethnobiology and sustainability." *People and Nature* 4, no. 3 (2022): 627-651. https://doi.org/10.1002/pan3.10321

[19] Veerappan, Saravanakumar. "Functional Traits and Ecological Niches: Reimagining Restoration Ecology under Climate Pressure." *National Journal of Forest Sustainability and Climate Change* 2, no. 1 (2024): 38-46.

[20] Wyllie de Echeverria, Victoria Rawn, and Thomas F. Thornton. "Using traditional ecological knowledge to understand and adapt to climate and biodiversity change on the Pacific coast of North America." *Ambio* 48, no. 12 (2019): 1447-1469.