The Synergy Mechanism of Indigenous Wisdom and External Collaboration: A Case Study of Grassland Desertification Control in Xiaman Town, Zoigê

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Abstract

The Ruoergai Prairie on the eastern edge of the Tibetan Plateau is an important water conservation area for both the Yangtze and Yellow River upper reaches. The effectiveness of its desertification control directly relates to the national ecological security strategy. This study focuses on Manzhen, a town in Ruoergai County, and uses qualitative research methods to track the over 20-year-long collaborative desertification control practice between the "Green Camel" volunteer organization and local herders. The study systematically explores the integration mechanism between local ecological wisdom and the professional capabilities of non-governmental organizations (NGOs). The results show that the local knowledge system developed by herders through their long-standing traditional nomadic life, including "seasonal sand fixation strategies" and "selection and use of local plants," complements the modern scientific technologies and external resource networks brought by NGOs. These two components are deeply integrated through three pathways: "culture-adaptive organizational structure building," "participatory technology co-development," and "community co-management systems." The collaboration has successfully restored over 400 acres of desertified land and significantly increased the grassland vegetation coverage by 12%. This study further illustrates that a collaborative mechanism that truly respects and integrates local knowledge can effectively promote ecological restoration, economic development, and social progress in cold regions, providing important theoretical support and practical models for the sustainable governance of similarly ecologically fragile areas.

Keywords

Desertification of grasslands, indigenous wisdom, NGO collaboration, Ruoergai, participatory governance.

1. Introduction

The Ruoergai Prairie, located on the eastern edge of the Tibetan Plateau, spans approximately 35,600 square kilometers. In the area where Manzhen Town is located, desertified land accounts for 31% of the county's total desertified area. According to the results of the fifth national desertification land monitoring, the desertified land in this area reaches 24,900 hectares and expands at a rate of 0.8% annually. As an important water conservation area in the upper reaches of the Yellow River, its ecological condition is directly related to the ecological security of the Yangtze and Yellow River basins, earning it the title of "ecological barrier of the Chinese Water Tower." Since the 1990s, desertification control has been the core focus of ecological protection in this region. However, the traditional "government-led" governance model, due to its insufficient consideration of local herders' livelihoods and indigenous knowledge, often falls into a vicious cycle of "governance-degradation" [1].

In 2002, the "Green Camel" volunteer organization settled in Wenge Village, Manzhen Town, initiating the practice of desertification control through collaboration between grassroots organizations and local herders. Unlike other external interventions, this organization has always adhered to the core principle of "respecting indigenous knowledge and fostering community capacity," establishing a unique "volunteer-herder" collaboration model. By 2025, the partnership had established three nurseries, cultivated over 200,000 local seedlings, and promoted 12 technical models of "highland willow sand barriers + shrub-grass compound planting," becoming a typical example of desertification control in Ruoergai. Today, the "Green Camel" NGO has only one member, Ge Yongxin (Hami), who remains in Manzhen Town. Every year, he persists in leading local herders to collect willow branches along the Yellow River, working with village leaders to mobilize herders to plant trees together.

2. Literature Review

International academic research on Indigenous Ecological Knowledge (IEK) began to develop systematically, clearly demonstrating that the unique knowledge systems formed by indigenous peoples through long-term interactions with their environments play an irreplaceable role in ecosystem maintenance and resource management [2].

In the field of grassland ecological governance, researchers have found that the traditional rotational grazing system practiced for generations by Mongolian herders is essentially a flexible management strategy based on grassland vegetation recovery cycles [3]. This practice represents a form of ecological wisdom that dynamically regulates grassland carrying capacity and continues to offer important insights and reference value for modern sustainable grassland management[4,5].

As important actors in the field of environmental governance, NGOs have been widely recognized by both academia and practitioners for their positive contributions [6]. In the Chinese literature, most studies have focused on the resource-integration functions of NGOs [7]. However, existing research has often overlooked the interactive processes between NGOs and indigenous knowledge within local communities. How these two forms of knowledge and capacity achieve effective integration through complementarity and co-construction, and how they jointly advance ecological governance, remain insufficiently and unsystematically explored. This gap limits the practical guidance value of existing theories for real-world ecological governance[8]. Existing studies on ecological governance in the Ruoergai region have mainly focused on two core dimensions. The first concerns investigations into the driving mechanisms of desertification [9].

However, most existing studies have concentrated on technical optimization and engineering practices within the natural sciences [10]. Relatively little attention has been paid to social mechanisms such as multi-actor collaboration and policy implementation in the governance process [11]. In particular, there is a notable lack of systematic analysis of the complementary and interactive relationships between local traditional ecological knowledge and modern scientific and technological approaches [12]. This gap limits a more comprehensive understanding of the socio-ecological dynamics underpinning sustainable governance in the Ruoergai region.

3. Research Methods

This article adopts a structure-process-outcome analytical framework, constructing a complete research trajectory that analyzes indigenous wisdom characteristics, develops NGO collaboration mechanisms, and evaluates integration outcomes. At the structural level, the analysis of indigenous wisdom focuses on the extensive traditional knowledge accumulated by herders in areas such as species identification, ecological timing judgment, and the sustainable

management of grassland resources.At the process level, the study emphasizes the bidirectional interaction mechanisms between NGOs and local communities in organizational coordination, technological alignment, and institutional innovation [13]. At the outcome level, the study conducts a systematic empirical examination of the actual integration effects of the collaborative model across three dimensions: ecological restoration indicators, economic performance assessment, and changes in social capital.

Document analysis: Relevant policy documents on desertification control in the Ruoergai region, archival materials of the Green Camel environmental organization (2002-2025), and related academic studies were systematically reviewed [14]. Through synthesis, comparison, and analytical interpretation, a solid theoretical foundation and a structured empirical context were established to support subsequent analysis.

In-depth interviews: Fieldwork was conducted in Wenge Village and Xicang Village of Manzhen Town from July to September 2024. Semi-structured interviews were carried out with three former and current leaders of the Green Camel organization, 27 herders involved in desertification control, and five local village officials. In total, 45 hours of valid interview recordings were collected and transcribed into approximately 120,000 words, providing rich first-hand data and diverse perspectives.

Participant observation involved the researcher residing in the study area during key phases of desertification control, specifically the seedling planting period (April-May) and the sand-stabilization period (September-October), directly participating in activities such as sand-barrier construction and seedling planting. Detailed observations were recorded to capture concrete interaction patterns and decision-making processes between the Green Camel organization and local herders.

Data analysis: SPSS 26.0 was used to systematically organize, compare, and analyze ecological indicators as well as socioeconomic data. This enabled the identification of internal relationships and temporal trends among key variables.

In order to establish the three-dimensional knowledge system of local ecological wisdom, this study will build the "local wisdom" into three latent variables/comprehensive indexes, which are cognitive dimension, technical dimension and practice dimension respectively, and the collected observable data will be processed in a standardized way to form the index form.

$$z_{ij}=\frac{x_{ij}-\min(x_j)}{\max(x_i)-\min(x_j)} \tag{1}$$

At the same time, it is integrated into the form of local structural wisdom index.

$$K_i=w_1K_i^{(cog)}+w_2K_i^{(tech)}+w_3K_i^{(prac)}, \sum w=1 \tag{2}$$

To accurately measure the process layer path, this study categorizes the process layer into three technical pathways: cultural adaptation, technological adaptation, and institutional adaptation, which are defined as process state variables as shown in Equation 3.

$$M_i=\lambda_1A_i^{cul}+\lambda_2A_i^{tec}+\lambda_3A_i^{ins} \tag{3}$$

Finally, the result vector is generated according to the three-dimensional results of ecological-economic-social capital and the integration effectiveness index, as shown in Equation 4.

$$Y_i=(E_i,R_i,S_i) \quad (4)$$

4. Results

As shown in Fig.1, the indigenous ecological wisdom can be precisely identified as an effective catalyst for social collaboration. This study empirically validates Berkes' theory of knowledge complementarity and further demonstrates that indigenous wisdom is not merely a simple aggregation of fragmented traditional experiences, but rather a coherent knowledge system encompassing three interrelated dimensions: cognition, technology, and practice. Its core strength lies in its deep contextual embeddedness within local ecological systems and cultural settings, which enables flexible and adaptive responses to complex and dynamic environmental conditions.

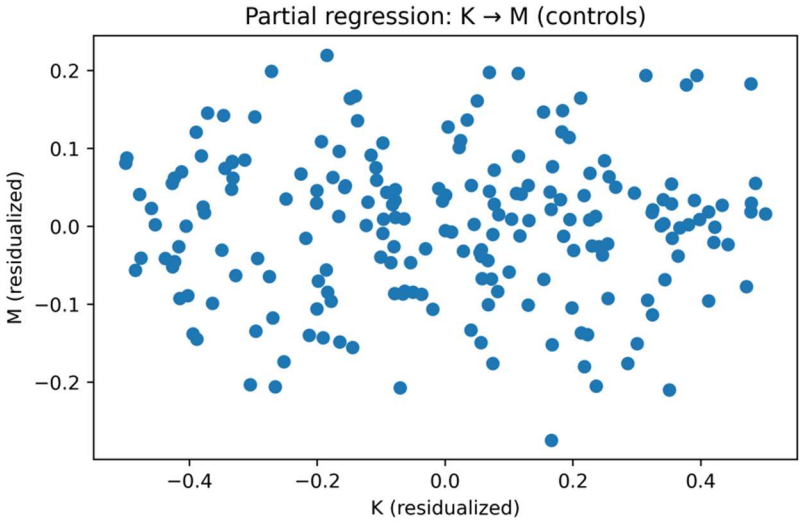

Fig. 1 Structure-process correlation scatter plot

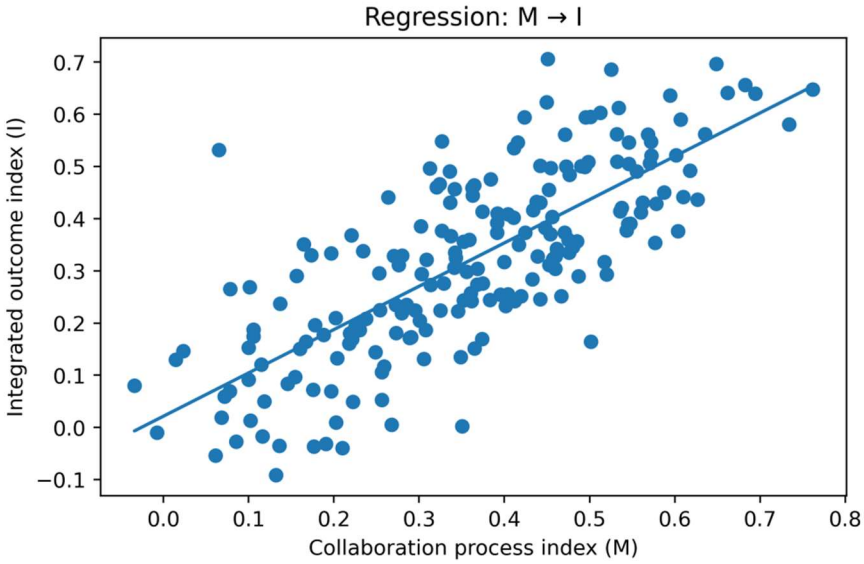

Fig. 2 Collaboration-Effect Relationship Diagram

As shown in Fig.2, the collaborative mechanism can be precisely observed to significantly translate into comprehensive outcomes.The case of the Green Camel project shows that

external actors and scientific technologies should not replace indigenous knowledge. Instead, they should activate and enhance its contemporary applicability through systematic and scientific approaches. This process ultimately generates an integrated model in which indigenous wisdom provides the foundational framework, while modern science and technology serve as functional instruments. Such an organic integration facilitates synergistic gains between tradition and modernity in the pursuit of sustainable development.

The successful collaboration between the two parties highlights a critical principle of "three-dimensional adaptation" in ecological governance. First, cultural adaptation requires external organizations to fully respect and actively integrate into local cultural traditions, rather than mechanically transplanting external models. Second, technological adaptation demands that introduced scientific and technical solutions be locally tailored, instead of being directly applied, so as to fit specific environmental conditions and community needs. Third, institutional adaptation implies that newly established governance mechanisms must align with existing community practices and social structures in order to ensure long-term sustainability [15].

This principle fundamentally revises the one-sided assumptions of traditional technological determinism by emphasizing that the effectiveness of technology is contingent upon its embeddedness in local socio-cultural and institutional contexts. It underscores the necessity of localized innovation in governance models that are grounded in place-specific realities.

5. Conclusion and Discussions

It is recommended to establish a tripartite collaborative mechanism involving the government, NGOs, and local communities, with clearly defined responsibilities and efficient coordination. The government should primarily provide policy support and financial guarantee, drawing on the stable funding inputs and institutional arrangements of the Nanhu-Ruoergai cooperation project to lay a solid foundation for project implementation. NGOs should fully leverage their advantages in technical expertise and resource linkages by undertaking responsibilities for technology transfer, personnel training, and community capacity building, thereby supporting long-term project sustainability. Local communities, as the core implementing actors, should actively mobilize resident participation and draw on their deep knowledge of local geographic and socio-cultural contexts to ensure that indigenous wisdom plays a central role in practice.

Through the complementary strengths and coordinated efforts of all three parties, a systematic, stable, and sustainable governance synergy can ultimately be established.

It is proposed to establish an indigenous ecological wisdom database to systematically document and archive herders' long-accumulated experiences in sand stabilization, as well as local knowledge related to the identification and utilization of native species. This would form a structured knowledge system for reference, transmission, and intergenerational learning. At the same time, an industry-academia-research-application collaborative innovation platform should be developed to integrate the capacities of research institutes, universities, and enterprises. Through this platform, empirically validated indigenous practices can be translated into standardized and scalable technical solutions, such as the formulation and implementation of technical guidelines for alpine willow sand-barrier systems. This process would facilitate technology deployment and enhance the overall capacity for regional ecological governance.

It is recommended to promote the innovative model of realizing the value of ecological products by developing diversified pathways such as ecotourism and the commercialization of distinctive agro-pastoral products, thereby enhancing the economic returns of ecological protection efforts. At the same time, a dual-incentive system combining ecological compensation and market-based revenues should be established. This system would not only

ensure stable financial compensation for herders participating in ecological governance, but also provide sustainable market-oriented income channels.

Such a combined incentive mechanism would help attract young herders to return to their communities and engage in desertification control and ecological restoration, thereby fostering a virtuous cycle between environmental protection and economic development.

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References

[1] Li T. Sustainable development and management of ecosystem in arid and semi-arid areas: A focus on the Qinghai-Tibet plateau and inner Mongolian grasslands[J]. 2024.

[2] Berkes, Fikret, Johan Colding, and Carl Folke. "Rediscovery of traditional ecological knowledge as adaptive management." Ecological applications 10.5 (2000): 1251-1262.

[3] Bum T. Pluralistic ecological governance: A comparative analysis of conservation practices among Tibetan communities of China[J]. Asia Pacific Viewpoint, 2024, 65(1): 71-83.

[4] Hao X. A Study of Policy, Economy, Environment, Technology, and Culture Synergies across the Sino-Mongolian Border for the Ecological Development of the Mongolian Steppe[J]. 2024.

[5] Kong Z H. Beyond the National Environmental Programmes (NEPs): environmental governance in drylands China[D]. University of York, 2024.

[6] Turnbull S, Poelina A. How Indigenous wisdom can sustain humanity[J]. Journal of Behavioural Economics and Social Systems, 2022, 4(1): 10-36.

[7] He W, Yue X. Collaborative Governance in Desertification Control in China: A Case Study of Hobq Desert[J]. Sustainability, 2023, 15(3): 1979.

[8] Yang S, Kuo B C H, Lin S. Wisdom, cultural synergy, and social change: A Taiwanese perspective[J]. New Ideas in Psychology, 2022, 64: 100917.

[9] Roland B, Rubens A, Akolgo-Azupogo H. Combining indigenous wisdom and academic knowledge to build sustainable future: An example from rural Africa[J]. 2018.

[10] Rist S, Dahdouh-Guebas F. Ethnosciences--A step towards the integration of scientific and indigenous forms of knowledge in the management of natural resources for the future[J]. Environment, Development and Sustainability, 2006, 8(4): 467-493.

[11] An H, Li Q L, Yan X, et al. Desertification control on soil inorganic and organic carbon accumulation in the topsoil of desert grassland in Ningxia, northwest China[J]. Ecological Engineering, 2019, 127: 348-355.

[12] Zhang Z, Huisingh D. Combating desertification in China: Monitoring, control, management and revegetation[J]. Journal of Cleaner Production, 2018, 182: 765-775.

[13] Li J, Wu W, Fu X, et al. Assessment of the effectiveness of sand-control and desertification in the Mu US desert, China[J]. Remote Sensing, 2022, 14(4): 837.

[14] Wang X, Ge Q, Geng X, et al. Unintended consequences of combating desertification in China[J]. Nature Communications, 2023, 14(1): 1139.

[15] Sang X, Sun C, Chai Z. Dynamic changes and prediction of land-use patterns in a typical area for rocky desertification control[J]. Frontiers in Ecology and Evolution, 2025, 13: 1542799.