Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Social Fencing and Sacred Landscapes: Traditional Ecological Knowledge and Common-Pool Resource Governance on the Tibetan Plateau

tazong ji

18115725610qq.com

Minzu University of China

tazong ji

Minzu University of China

Research Article

Keywords: Traditional Ecological Knowledge (TEK), Common-Pool Resources (CPR), Social fencing, Sacred landscapes, Transhumance, Polycentric governance, Socio-ecological systems (SES)

Posted Date: June 19th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9987871/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Additional Declarations: No competing interests reported.

Abstract

The Tibetan Plateau, a globally critical socio-ecological system, faces severe vulnerabilities under modern top-down rangeland fencing policies. While physical fencing aims to curb ecological degradation by privatizing land-use rights, it frequently fragments pastoral landscapes and disrupts the traditional transhumance mobility vital for alpine ecosystem resilience, creating a profound "fencing paradox". This study addresses a critical empirical and theoretical gap regarding how indigenous communities utilize Traditional Ecological Knowledge (TEK) as an endogenous "social fence" to govern common-pool resources (CPRs). Integrating a textual hermeneutics analysis of classical Tibetan codices (14th–17th centuries) with ethnographic fieldwork ($N = 32$) across Nagqu City, we analyze the institutional mechanisms of seasonal landscape sealing (*ri rgya klu rgya*). Findings indicate that traditional governance operates via cognitive-ontological sacralization, institutional spatial zoning, and performative ritual enforcement. Empirical cases—including female-led aquatic stewardship at Lake Dangra Yumtso, myth-enforced terrestrial conservation at the Gyang shod cypress forest, and spatial zoning at the Maedika Wetland—demonstrate how cultural boundaries successfully manage pastures and watersheds with near-zero transaction and monitoring costs. However, rapid market integration from the Cordyceps economy and rigid administrative boundaries pose severe risks to TEK transmission. This paper contributes to human ecology and CPR governance by demonstrating how incorporating indigenous "social fences" into contemporary co-management frameworks extends Elinor Ostrom’s design principles, facilitates local institutional legitimacy, and enhances polycentric socio-ecological resilience.

1. Introduction

1.1 The Global Ecological Significance of the Third Pole The Tibetan Plateau, conceptualized within global environmental scientific discourse as the "Third Pole," represents one of the most fragile, climatically sensitive, and ecologically significant high-altitude biomes on Earth (Qiu 2008). Spanning an immense geographic expanse, the plateau profoundly influences hemispheric atmospheric circulation and serves as the primary hydrological source for major Asian river systems, including the Yangtze, Salween (Nu), and Mekong, earning it the moniker "Asia's Water Tower" (Yao et al. 2012). In the Nagqu region specifically, which covers approximately 353,000 square kilometers with an average elevation exceeding 4,500 meters, ecosystems are fundamentally constrained by severe biophysical limitations. These include extreme cold, pervasive hypoxia, and a drastically compressed vegetative growing season that lasts merely four months. Despite these formidable environmental constraints, human populations have not only survived but thrived in this biome. Archaeological evidence from the Paleolithic Ni'adi site confirms continuous human habitation and environmental adaptation on the plateau dating back 30,000 to 40,000 years. Consequently, the Tibetan Plateau is not merely a pristine wilderness; it is a highly evolved socio-ecological system (SES) where human well-being and ecological health have been inextricably linked over millennia (Folke 2006). Understanding the dynamics of human-environment interactions in this extreme setting is therefore a critical imperative for the discipline of human ecology and global sustainability studies.

1.2 Human Ecology and Traditional Ecological Knowledge (TEK)

Within the broader framework of human ecology, Traditional Ecological Knowledge (TEK) has emerged over the past three decades as a vital lens for understanding how indigenous and local communities manage ecosystems sustainably. TEK is generally defined as a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, concerning the relationship of living beings with one another and with their environment (Berkes 1999; Berkes 2012). Globally, TEK is increasingly recognized by interdisciplinary scholars as a crucial component of biodiversity conservation, adaptive management, and climate change resilience (Gómez-Baggethun et al. 2013).

Tibetan TEK represents a highly unique and complex subset of global indigenous knowledge systems. It is characterized by a profound fusion of pre-Buddhist animistic ontologies, highly formalized Buddhist ecological ethics, and the pragmatic, empirical necessities of nomadic pastoralism (Salick and Byg 2007). This knowledge system does not compartmentalize

the "natural" and the "social" into a Western dualism; rather, it conceptualizes a unified socio-ecological continuum where environmental degradation is viewed simultaneously as a biophysical crisis and a moral transgression. While international science-policy frameworks increasingly acknowledge the value of TEK in broad terms, the specific institutional, legal, and operational mechanisms through which Tibetan ecological ethics regulate resource extraction—moving beyond mere belief into functional governance—remain severely under-theorized in contemporary human ecology literature.

1.3 Common-Pool Resource (CPR) Theory and the "Fencing Paradox"

The governance of the Tibetan Plateau's vast rangelands, forests, and watersheds is fundamentally a problem of managing Common-Pool Resources (CPRs). According to Elinor Ostrom's seminal CPR theory, these are resources characterized by high subtractability (one person's use diminishes availability for others) and difficult excludability (it is costly to prevent users from accessing the resource) (Ostrom 1990). Ostrom and subsequent scholars (Agrawal 2001; Dietz et al. 2003) famously challenged the deterministic "Tragedy of the Commons" paradigm (Hardin 1968), demonstrating with robust empirical evidence that local communities can and frequently do design self-governing institutions to manage CPRs sustainably without requiring top-down state privatization or rigid centralized control.

However, modern conservation science and state administrative policies on the Tibetan Plateau have frequently defaulted to an exogenous, technocratic approach inspired by privatization models. Since the 1990s, administrative bodies have deployed physical rangeland fencing extensively across the Changtang grasslands to combat perceived overgrazing, demarcate land-use rights, and enclose protected areas (Yeh 2005; Bauer 2005). Viewed through a socio-ecological lens, this rigid physical enclosure generates a profound "fencing paradox" (Richard et al. 2006). Landscape ecology demonstrates that barbed-wire fencing causes severe habitat fragmentation. It violently severs the natural migration corridors of native wildlife, such as the Tibetan antelope, and critically impedes the flexible, mobile transhumance strategies that are absolutely essential for pastoral survival. During severe winter snowstorms, physical fences trap livestock, preventing them from accessing emergency grazing refugia, while simultaneously disrupting the cyclical human-grass-livestock equilibrium required for alpine vegetation recovery.

1.4 Research Gap and Objectives

To resolve this fencing paradox, human ecologists and institutional scholars must turn to alternative governance models that rely on "social fencing"—informal, culturally embedded institutions that establish spatial, temporal, and psychological boundaries around resources without requiring physical barriers. In traditional Tibetan systems, social fences are operationalized through *ri rgya klu rgya* (the seasonal sealing of mountains and waters), a governance mechanism rooted in ancient cosmological taboos and later institutionalized via historical legal codices.

Despite the theoretical promise of social fencing, there is a distinct research gap in the literature: most existing studies treat indigenous Tibetan conservation either as static historical folklore or as an unstructured, generalized religious sentiment, failing to analyze it as a rigorous, functioning CPR governance institution. Furthermore, there is a lack of empirical grounding on how historical textual jurisprudence translates into lived, modern socio-ecological practices in the face of state interventions and rapid market integration.

This paper contributes to the fields of human ecology and CPR governance by systematically demonstrating how ancient Tibetan ecological wisdom operates as a highly adaptive, institutionalized "social fence." By triangulating a diachronic textual analysis of primary Tibetan historical codices with rich ethnographic fieldwork in Nagqu, this study aims to evaluate how traditional social fences function as resilient resource management tools. Specifically, we investigate how cognitive-ontological sacralization, institutional zoning, and performative ritual enforcement dialogue with Ostrom's CPR design principles, and how these endogenous systems navigate friction with modern administrative policies and market pressures.

2. Methods

To comprehensively analyze the complex intersection of historical ecological jurisprudence and contemporary CPR management on the Tibetan Plateau, this study employs a qualitative, mixed-methods research design (Creswell and Clark 2017). This epistemological approach effectively bridges historical hermeneutics with empirical, ground-level ethnography, allowing for an analytical triangulation that traces how structural principles embedded within classical texts manifest in lived, modern conservation practices.

2.1 Textual Hermeneutics and Historical Analysis The historical and theoretical foundation of this research derives from a rigorous textual analysis of classical Tibetan literature spanning the 14th to 17th centuries. The objective of this textual hermeneutics was to establish the historical baseline of local ecological ethics, identifying the formal codification of CPR rules prior to modern state interventions. Primary sources were purposively selected to provide a diachronic view of Tibetan ecological thought and were categorized into three distinct institutional genres:

Cosmological and Ritual Texts

We examined ancient, rare Bon handwritten manuscripts documenting early indigenous animistic ontologies. The analysis focused specifically on texts detailing the tripartite spatial boundaries of the *Lha* (celestial), *Klu* (subterranean and aquatic), and *Gnyn* (terrestrial surface) realms, and their associated behavioral taboos.

Secular Codices and Administrative Decrees

To trace the institutionalization of TEK into state policy, we analyzed key legal texts. These included the 14th-century *Tasi byang chub rgyal mtshan gyi bka' chems* (The Last Teachings of Tasi Byang Chub Rgyal Mtshan), the 16th-century *Khrims yig zhal lce bcu drug* (Sixteen-Article Code), and the 17th-century code of the Fifth Dalai Lama (*Khrims yig zhal lce bco sum*). These texts were coded for explicit administrative rules regarding forestry quotas, temporal hunting bans, and the legal codification of *ri rgya klu rgya*.

Monastic Constitutions (Bca' yig)

Localized environmental common law records from major monasteries, including Bri gung byang chub gling, Smrin grol gling, and 'Bras spungs, were analyzed to understand how broad state and religious ethics were translated into strictly enforceable local spatial policy.

2.2 Ethnographic Field Sites and Data Collection

To evaluate the contemporary survival, transformation, and practical efficacy of these textual institutions, extensive ethnographic fieldwork was conducted between November 2022 and October 2023 across diverse ecological biomes in Nagqu City (Fig. 1).[1]

Utilizing principles of "thick description" (Geertz 1973), specific study sites were purposively selected based on their diverse socio-ecological characteristics:

Nyima County (Wenbu South Village): Located on the shores of the internationally recognized Lake Dangra Yumtso. This site was selected to investigate aquatic TEK, the endurance of sacred hydrology, and the gendered dimensions of ritual resource protection.

Nagchu County (Gyang shod Village) and Biru County (Yangxiu Township): Characterized by terrestrial alpine forest biomes. These sites were selected to study the communal management of vital biodiversity refugia (specifically the Gyang shod cypress forest), the mechanics of oral history transmission (the Sapu mountain myth), and modern conflicts regarding rangeland fencing and the Cordyceps economy.

Lhari County (Maedika, Smi ti, and Aza Townships): Chosen for their direct proximity to the hydrological headwaters of the Lhasa River. These sites provided critical insights into watershed protection, spatial zoning strategies, and the complex intersection of traditional Bla mtsho (Life Lakes) boundaries with the contemporary Maedika National Wetland Park.

Primary empirical data were collected through a combination of participant observation, Focus Group Discussions (FGDs), and semi-structured key informant interviews ($N = 32$). The informant sample encompassed a diverse, purposive cross-section of local stakeholders to ensure multi-vocal perspectives (Fig. 2).[2]

This included pastoral herders and villagers ($n = 20$), monastic practitioners ($n = 3$), local government officials and village leaders ($n = 4$), as well as other community stakeholders such as local enterprise staff, medical practitioners, and students ($n = 5$). Interviews were conducted in Tibetan and Chinese, focusing on traditional nature taboos, seasonal transhumance routes, local enforcement mechanisms for resource protection, grassroots responses to state rangeland fencing policies, human-wildlife conflicts, and the socio-economic transformations driven by the Cordyceps market economy.

2.3 Data Analysis and Ethical Protocols

Interview audio recordings and extensive field notes were transcribed verbatim and subsequently translated from Tibetan and Chinese into English. Given the ethnographic and exploratory nature of this study, a manual thematic analysis approach was employed (Braun and Clarke 2006). The qualitative data corpus was iteratively reviewed and subjected to an inductive-deductive coding process. Initial open coding identified recurrent experiential concepts directly from the informants' narratives (e.g., "divine retribution," "water pollution taboos," "pasture fragmentation," "outsider intrusion," "loss of mobility"). These initial codes were subsequently categorized into higher-order analytical themes corresponding to Ostrom's CPR design principles (boundary definition, monitoring, graduated sanctions) and the socio-ecological impacts of modern administrative policies (TEK erosion, market integration).

Ethics Statement

All field research adhered strictly to ethical protocols for ethnographic social science research. Prior to each interview and focus group, participants were provided with a detailed explanation of the research objectives. Verbal informed consent was secured to accommodate local literacy contexts and respect cultural sensitivities regarding formal documentation. To ensure strict confidentiality and protect informant privacy amid local policy sensitivities, all participant identities have been fully anonymized. Specific personal identifiers have been replaced with alphanumeric codes (e.g., Interviewee ZX, Herder CW, Villager B) or general descriptors throughout the text.

3. Results

The integration of historical textual analysis with contemporary ethnographic data reveals a highly sophisticated socio-ecological system. The results are structured to first outline the historical legal and ontological foundations of Tibetan TEK, followed by deep ethnographic analyses of how these institutions function as "social fences" in modern aquatic and terrestrial biomes, and concluding with an examination of the modern drivers eroding these traditional systems.

3.1 Textual Foundations of *Ri rgya klu rgya* and Ecological Jurisprudence

The theoretical foundation of traditional Tibetan ecological ethics is deeply embedded in its religious ontologies, which fundamentally conceptualize the natural environment not as inert matter intended for human extraction, but as a living, socially integrated, and highly responsive metaphysical system. Early Bon manuscripts reveal a complex spatial ontology that divided the universe into a symbiosis of three distinct realms: *Lha* (celestial), *Klu*(subterranean and aquatic), and *Gnyn* (terrestrial surface). The *Klu* were regarded as the supreme guardians of forests, lakes, and vital water sources. Ancient

manuscripts explicitly document strict ecological taboos, linking human environmental degradation directly to spiritual and physical retribution. The texts state: "In all places where there is ‘Klu’, ploughing of the land, cutting of wood and trees, leaking of contaminated water into the fields, burning of impure things will cause ‘Klu’ to become disconnected from the reality, hence provoking emotions like anger and hatred" (Tsaring Tnar Ngawang Gyatsa 2016, p. 145). This demonstrates an advanced, systemic recognition of ecological connectivity between terrestrial land-use practices and aquatic health, establishing an early form of watershed management.

By the 14th century, as administrative structures centralized, these decentralized animistic taboos were formalized into state-mandated secular policy. The *Tasi byang chub rgyal mtshan gyi bka’ chems* transformed passive ecological stewardship into a quantifiable administrative duty, mandating rigorous forestry management: "On our territory, more than 200,000 trees are planted every year... Except as a last resort, these trees should not be used indiscriminately in the construction of monasteries [or] houses" (Tasi Byang Chub Rgyal Mtshan 2015, pp. 216–217).

The most structurally complex contribution to CPR governance is the statute of *ri rgya klu rgya* (the sealing of mountains and waters). The 14th-century text *Rab brtan kun bzang ’phags kyi rnam thar* outlines strict temporal management, effectively closing the landscape to human extraction during critical biological periods: "The usual period of “raising mountains” is the eighth, fifteenth, and thirtieth days of each month... and the first to fifteenth day of the first, third, fourth, and eighth months... during which it is forbidden to kill... hound hunters should not harm the animals in the mountains" (Jigs med grags pa 1987). This temporal zoning strategically coincided with the vulnerable spring breeding seasons of wildlife and the germination phases of alpine flora, effectively institutionalizing a biological rest period for the ecosystem.

3.2 Aquatic Stewardship: Sacred Hydrology and Gender Dynamics at Lake Dangra Yumtso

Contemporary ethnographic fieldwork forcefully demonstrates that these ancient textual doctrines remain deeply embedded in daily spatial conservation behaviors. In Wenbu South Village, located in the vast expanses of Nyima County, the annual *Klu* worship ritual at the sacred Lake Dangra Yumtso serves as a profound example of enduring aquatic TEK.

The ritual translates abstract cosmology into highly specific ecological governance. During fieldwork, a female villager detailed the socio-ecological rules: "Every year on the 15th of the 6th month in the Tibetan calendar, all the women in our village dress in grand attire and gather by the lake of Dangra Yumtso to sacrifice to the 'Klu'... It is said that whoever pollutes the water source will suffer from skin diseases that pass down through generations. On the day of the ritual, women are absolutely forbidden to wear clothing made of animal skins or consume pungent foods; they must be strictly vegetarian" (Interviewee CDJ).

The underlying mechanism operating here is the transformation of a metaphysical pollution taboo into a rigorous, biophysical self-enforcement system. The deep-seated belief that offending the *Klu* triggers hereditary dermatological ailments functions as a low-cost, ubiquitous monitoring mechanism. Because the threat of divine retribution is omnipresent, the community polices its own behavior without requiring external state agents or formal fines. This generates tangible conservation outcomes; for instance, during the harsh winter months when the lake freezes, inhabitants endure immense physical hardship to carry urine pots over long distances across the ice, actively avoiding the deposition of biological waste on the sacred surface.

Furthermore, this governance system is distinctly gendered. Women serve as the primary protagonists, organizers, and ultimate custodians of this aquatic ecological ritual. In a broader administrative landscape frequently dominated by patriarchal state institutions, the women of Wenbu South Village exercise profound authority over the localized CPR, utilizing ritual to assert communal stewardship. This endogenous authority was mobilized in 2012–2013 when local pastoralists fiercely protested and physically blocked a foreign survey team from operating motorized boats on the lake, successfully using the cultural taboo against mechanical disturbance to repel exogenous intervention. This case

demonstrates how gendered ritual practices operationalize cognitive taboos into highly effective, self-monitoring aquatic CPR governance.

3.3 Terrestrial Conservation: Myth, Behavior, and Outcomes at Gyang shod Cypress Forest

Field research in Gyang shod Village, Nagchu County, provides critical empirical evidence regarding the efficacy of traditional social fencing in terrestrial biomes. The village is situated adjacent to a visually distinct mountain characterized by an unusually dense, old-growth forest of cypress trees. This lush, biodiverse canopy stands in stark contrast to the surrounding heavily utilized and comparatively arid alpine landscape.

In-depth interviews revealed that this forest functions as a perfectly preserved biodiversity refugium entirely due to the unbroken transmission of oral traditions and historical tribal mandates. A senior herder recounted the socio-ecological history: "When I was a child, I heard my grandfather say that the chief of our tribe... made it a rule that no herdsman should cut down any cypress trees on this mountain. In the past, there was an old grandfather... who took the trunk of a tree from the back of the mountain to burn. Soon after, all the sheep in his family got sick. The local Living Buddha told him it was divine retribution for using the sacred wood as firewood. This story has been passed down to this day. As a result, no local villagers have cut down the trees here, so it looks extraordinarily lush compared to other mountains" (Interviewee GT).

This narrative precisely illustrates the causal chain underpinning a "social fencing system." It begins with a *myth* (the sacredness of the mountain and the historical tribal decree), which generates a deeply held communal *belief* in imminent divine punishment (the sickness of the grandfather's sheep acting as a cautionary precedent). This belief directly regulates human *behavior* by replacing formal guards with internalized psychological deterrence, leading directly to the *ecological outcome* of an intact, old-growth forest canopy. The mechanism's longevity relies heavily on intergenerational transmission; elders recounting the consequences of transgression to children ensures the social fence remains robust across decades, entirely bypassing the need for high-cost formal enforcement. This case demonstrates how mythically enforced social fencing creates a self-sustaining institutional mechanism that effectively preserves critical terrestrial biodiversity without formal state intervention.

3.4 Spatial Zoning: State vs. Local Interaction at Maedika Wetland

In Lhari County, the fragile hydrological source of the Lhasa River and the Maedika Wetland represent critical areas where traditional boundaries interact with modern state conservation zones. To protect the innermost source lake, *Phug mtsho*, the local indigenous population actively restricts mass human access, utilizing a traditional religious spatial zoning strategy.

A local villager and guide detailed this approach: "In June of the Tibetan calendar each year, we hang prayer flags here, but we will not hold large religious rituals here; those are held at our local *mtsho rwa mtsho*. This area is virtually uninhabited because it is all within the boundaries of the Maedika National Wetland Park, so no roads or bridges can be built" (Interviewee DW). Similarly, the three major lakes in Lhari County are venerated by locals as the "Life Lakes" (*Bla mtsho*). Grand sacrificial ceremonies are intentionally held at designated, less ecologically sensitive camps to pray for rainfall and healthy livestock, thereby concentrating human impact away from the most vulnerable riparian zones.

The analytical mechanism here involves the superposition of local religious zoning and state conservation boundaries. State boundaries are often binary—an area is either strictly protected inside a park or open for use outside it. In contrast, local restrictions are highly nuanced, governing *how* and *when* humans interact with specific micro-ecologies through concentric circles of sacredness. By displacing large rituals away from the immediate source waters, the community minimizes trampling and pollution precisely where the ecosystem is most vulnerable. When the state superimposed the Maedika National Wetland Park over this area, it effectively codified an existing indigenous spatial logic. This case demonstrates that integrating nuanced local religious zoning with macro-level state conservation boundaries creates a highly effective, polycentric approach to watershed governance.

3.5 The Fencing Paradox and Mobility Disruption

Despite the efficacy of endogenous systems, modern administrative policies frequently clash with traditional pastoral survival strategies. A prime example is the "Special Remediation Action for Illegal Land Occupation" launched in Biru County, which mandated the demolition of pastoralists' seasonal homes to combat perceived grassland degradation, enforcing a rigid "One Household One House" policy.

The mechanism of failure here lies in the deployment of physical fencing, which triggers severe ecological fragmentation and disrupts the fundamental logic of non-equilibrium pastoralism. Pastoralists expressed deep frustration regarding this spatial confinement: "The government requires us to dismantle our pastoral housing based on agricultural land-use policies. This completely disregards our nomadic lifestyle. We have lived on these pastures, shifting between seasons, since the 1980s. When they tear down our homes and fence the land, it doesn't protect the grass—it destroys the traditional order of our grazing cycle" (Herder CW).

Physical fencing violently interrupts the spatial and temporal flexibility required in highly variable alpine environments. Livestock mobility is thwarted, leading to localized overgrazing within artificially constrained fenced parcels, while rendering herds highly vulnerable to starvation during unpredictable snowstorms (dzud) because they cannot access emergency forage. Furthermore, wildlife migration routes are physically blocked by the wire, causing genetic isolation and mortality for species like the Tibetan antelope. Unlike social fencing, which regulates access and limits specific extractive behaviors while preserving landscape connectivity, physical fencing imposes a rigid, sedentary agricultural logic onto a dynamic nomadic system. This case demonstrates that exogenous physical fencing is fundamentally incompatible with the biophysical realities of alpine pastoralism, actively degrading the socio-ecological resilience it intends to protect.

3.6 The Cordyceps Economy: Market Integration and TEK Erosion

Simultaneously, traditional ecological boundaries are being severely tested by rapid market integration, specifically the booming cash economy for *Yarsagunbu* (Ophiocordyceps sinensis). The massive influx of outsiders and commercial vehicles during the brief May-June harvesting season has led to severe grassland trampling and vehicular degradation in eastern Nagqu counties.

The underlying mechanism is a profound shift in human-environment relations triggered by marketization. The traditional system relied on a "sacred ecology" where the landscape was a spiritual entity demanding restraint. However, as the economic value of Cordyceps skyrockets, this paradigm is rapidly being replaced by "economic rationality," wherein the landscape is viewed strictly as a commodified resource for immediate wealth accumulation. Younger generations, increasingly exposed to the cash economy and modern consumption patterns, are abandoning the sacred cosmology that previously restricted over-harvesting.

The traditional *ri rgya* seasonal closures, which historically protected the landscape during the highly vulnerable spring germination period, are frequently ignored in the rush for profit. The spiritual sanctions (divine retribution) that once functioned as a flawless monitoring system lose their deterrent power against the immediate, massive financial rewards of the Cordyceps harvest. When CPRs are rapidly integrated into global markets without the concurrent adaptation of local institutional safeguards, traditional monitoring systems inevitably collapse. This case demonstrates how rapid market integration and the triumph of economic rationality over sacred ecology trigger a profound mechanism of TEK erosion, exposing CPRs to acute over-exploitation.

4. Discussion

4.1 TEK vs. State Governance: Ontological Clashes and Legitimacy Acquisition

The empirical findings from Nagqu highlight a profound ontological and institutional divergence between traditional Tibetan ecological knowledge (TEK) and exogenous state environmental governance. State governance models applied to the Tibetan Plateau generally rely on a Western, technocratic epistemology that views land as a quantifiable, compartmentalized state asset. Conservation is achieved through a "fences and fines" paradigm—top-down privatization of land-use rights, rigid sedentary boundaries, and bureaucratic enforcement.

Conversely, TEK conceptualizes the landscape as a unified socio-ecological continuum, a sacred trust shared among human, biological, and metaphysical entities (Lha, Klu, Gnyn). The clash between these two systems is not merely administrative; it is fundamentally ontological (Berkes 2012). When the state enforces sedentarization and physical fencing, it attempts to impose agricultural stability onto an alpine ecosystem defined by extreme climatic variability. As demonstrated by the pastoralists' frustration in Biru County, prioritizing static property boundaries over dynamic transhumance mobility destroys the very mechanism—cyclical rest and recovery—that makes pastoralism viable on the Third Pole. This finding is consistent with the growing consensus in human ecology and critical agrarian studies that state interventions which ignore or criminalize local socio-ecological contexts often accelerate, rather than mitigate, environmental degradation (Scott 1998; Yeh 2005).

A critical dimension of this ontological divergence lies in the process of legitimacy acquisition for environmental governance institutions, where state-imposed physical fencing and sedentarization frequently trigger a profound legitimacy deficit among local pastoralists because these policies fundamentally contradict the lived, empirical realities of surviving on the plateau. By overriding indigenous spatial logic with rigid agricultural boundaries, the state dismantles the cognitive and moral foundations that historically validated environmental rules within the community. This top-down replacement forces pastoralists to abandon self-enforced normative compliance in favor of behavioral resistance, as the new regulations offer no pragmatic survival value in a highly variable climate. From the perspective of institutional theory, this failure illustrates that sustainable governance cannot be achieved through mere coercive mandates, but requires a continuous, culturally embedded process of legitimacy acquisition where policies must secure moral and cognitive resonance with the governed population to endure.

In the context of the Cordyceps economy, the rapid influx of market-driven harvesters further complicates this governance landscape by introducing external actors who operate entirely outside the traditional socio-ecological boundaries. The rapid commodification of the landscape disrupts the traditional feedback loop where local spiritual taboos previously translated directly into low-cost, high-efficiency resource monitoring. Without the internalized fear of divine retribution, the economic incentives of the market rapidly outpace the state's limited bureaucratic capacity to patrol these vast, rugged territories, leading to unchecked ecological degradation. This dynamic validates Ostrom's assertion that CPR governance regimes are highly vulnerable to exogenous market shocks unless the community retains the institutional autonomy to continuously adapt and renegotiate their rule-making legitimacy.

Conversely, traditional social fencing circumvents these enforcement failures by utilizing myth and ritual to define invisible but impenetrable boundaries across the alpine biome. Instead of relying on barbed wire, these mechanisms rely on intergenerational storytelling and communal ceremonies to embed ecological limits directly into the psychological identity of the resource users. When compliance becomes a measure of one's cultural and spiritual integrity rather than a legal obligation, the transaction costs of monitoring and sanctioning drop to near zero. Consequently, extending CPR theory necessitates recognizing that effective polycentric governance hinges on harnessing these endogenous processes of legitimacy acquisition, thereby transforming local ecological knowledge from a marginalized cultural artifact into a central pillar of state environmental policy.

4.2 Social Fencing vs. Physical Fencing: The Costs of Exclusion

The most critical theoretical insight derived from the fieldwork is the stark functional contrast between exogenous "physical fencing" and endogenous "social fencing," where state-mandated wire enclosures are deployed with massive infrastructural costs to demarcate rigid property lines. By imposing static boundaries onto a highly stochastic alpine environment, these

physical barriers artificially truncate the vital transhumance corridors that herds require to access emergency forage during unpredictable severe weather events, inevitably causing severe ecological fragmentation. Concurrently, the erection of state-owned fences shifts the locus of environmental responsibility away from the community, dismantling the sacred, collectively acquired community obligation and replacing it with a heavily resented, externally imposed government mandate that actively erodes local stewardship. This empirical trajectory is consistent with broader socio-ecological systems (SES) literature, which has shown that similar privatization and enclosure schemes in African and Mongolian non-equilibrium pastoral systems lead to parallel outcomes of heightened socio-economic vulnerability and ecological decline (Humphrey and Sneath 1999; Reid et al. 2014).

In stark contrast, "social fences" rely on embedded cultural institutions, anthropomorphic myths, and religious taboos to establish robust, invisible boundaries without the use of physical wire, as explicitly demonstrated by the conservation outcomes at the Gyang shod cypress forest and Lake Dangra Yumtso. These traditional frameworks operate with near-zero transaction and monitoring costs because the overarching enforcement mechanism is entirely internalized within the psychological and spiritual consciousness of the community through continuous intergenerational storytelling. Consequently, a pastoralist refrains from cutting a sacred cypress tree or polluting a venerated lake not because a physical barrier impedes access, but because the culturally transmitted narrative of divine retribution transforms the extractive act into a cognitive impossibility and a socially unacceptable moral violation. This endogenous regulatory success fundamentally challenges the dominant policy assumption that physical barriers and top-down state privatization are the only, or most effective, means of enclosing and protecting CPRs in vast, remote landscapes where continuous bureaucratic monitoring remains logistically unfeasible.

4.3 Extending Ostrom's CPR Theory via Tibetan TEK

This paper contributes to the theoretical advancement of CPR governance by demonstrating how Tibetan TEK successfully operationalizes Elinor Ostrom’s core design principles for stable, long-term resource management (Ostrom 1990). By embedding governance rules within a profound cosmological framework, indigenous communities transform environmental stewardship from a calculated economic tradeoff into an absolute moral imperative. This ontological fusion ensures that conservation behaviors are sustained not by the continuous calculation of individual utility, but by the deeply internalized spiritual duty to maintain universal harmony between humans and non-human entities. Consequently, this extends CPR theory by illustrating how these foundational principles can be robustly fulfilled through deeply cultural and religious mechanisms, effectively challenging the reliance on purely secular, rational-choice institutions often presumed in standard economic models.

Clearly Defined Boundaries: Regarding clearly defined boundaries, Tibetan TEK establishes territorial limits not through physical wire or secular cadastral surveys, but through the deeply entrenched mapping of sacred geography. The conceptual boundaries surrounding the *Klu* in aquatic zones and the *Bla mtsho* (Life Lakes) function as invisible cartography that strictly demarcates restricted CPRs by linking physical spaces to specific divine custodians. By mapping spiritual domains onto physical landscapes, communities internalize geographical limits as non-negotiable zones of reverence, effectively curtailing human encroachment without the need for constructed barriers. This finding supports Ostrom's principle that successful CPRs require clearly defined limits, while simultaneously expanding her framework to recognize that metaphysical mapping can fulfill this requirement just as effectively as formal state-sanctioned property lines.

Congruence between Appropriation Rules and Local Conditions: To achieve congruence between appropriation rules and local conditions, the historical jurisprudence of *ri rgya klu rgya* strategically aligns temporal hunting and gathering bans, known as "raising the mountains," with the highly vulnerable spring breeding and germination seasons of the alpine biome. By legally and ritually sealing off the landscape during these critical biological windows, the institution creates an artificial, undisturbed sanctuary that prevents human extraction during the ecosystem's most fragile regenerative phases. This synchronization ensures that the rhythm of human consumption is strictly subordinated to the biophysical carrying capacity

of the environment, thereby preventing the irreversible depletion of slow-growing highland flora and fauna. Therefore, this endogenous legal structure perfectly embodies Ostrom's requirement that extraction rules must fit local ecological conditions, demonstrating how religious jurisprudence can operationalize socio-ecological congruence to maintain long-term resource sustainability (Agrawal 2001).

Monitoring and Graduated Sanctions: In the Tibetan context, the fulfillment of Ostrom's criteria for monitoring and graduated sanctions relies on a ubiquitous, supernatural surveillance system where the community itself acts as the primary monitor through performative rituals, such as the women-led *Klu* worship. The profound belief that offending environmental guardians inevitably triggers direct physical or economic retribution—such as skin diseases from polluting water or livestock mortality from cutting sacred cypress—functions as a highly deterrent, culturally enforced sanctioning mechanism. Because the threat of divine punishment is internalized by every community member, the system achieves pervasive self-policing, entirely bypassing the substantial financial and logistical burdens associated with deploying formal state patrol units. This dynamic significantly extends Ostrom's theory by illustrating that when ecological monitoring is deeply embedded within a shared metaphysical cosmology, communities can achieve robust compliance and administer potent sanctions through shared belief rather than reliance on formal secular policing.

4.4 The Vulnerability of TEK to Market Integration

While TEK provides robust mechanisms for CPR governance under traditional subsistence conditions, the ethnographic data regarding the Cordyceps economy highlights a significant vulnerability when indigenous systems are subjected to sudden, massive integration into global capitalist markets. This economic transition shifts the primary value of the landscape from a sacred, shared trust to a highly commodified resource, fundamentally altering the perceived utility of traditional restrictive norms. Consequently, the immense financial incentives for Cordyceps extraction begin to vastly outweigh the once-potent spiritual sanctions, creating a systemic breakdown where younger generations increasingly bypass traditional *ri rgya* seasonal closures in pursuit of short-term wealth. This finding is consistent with global literature on commons management, which frequently cites market integration and demographic pressures as primary drivers of institutional collapse in traditional societies (Dietz et al. 2003; Gómez-Baggethun et al. 2013).

The structural erosion of TEK occurs primarily because marketization introduces an exogenous logic of "economic rationality" that directly competes with the endogenous "sacred ecology" governing local resource use. As the market value of caterpillar fungus escalates, the traditional social fences—previously reinforced by communal observation and the threat of supernatural retribution—lose their regulatory efficacy because the immediate material gains of defiance become more tangible than the deferred spiritual consequences. This collapse is further accelerated by the increased mobility of harvesters and the influx of external market actors who operate entirely outside the community's moral jurisdiction, effectively neutralizing the social pressure required to sustain communal compliance. This dynamic underscores that TEK is not a static panacea for resource management, but a highly dynamic system that requires adaptive co-management strategies to navigate the dual, compounding pressures of intrusive state intervention and the transformative force of globalized markets.

5. Conclusion

Looking back into its far-reaching and deeply complex history, Tibetan society developed an advanced, empirically grounded ecological consciousness as a strict, unavoidable practical necessity for surviving the extreme climatic and biophysical challenges of the Third Pole. From the cosmological spatial taboos documenting the vulnerable habitats of the *Lha, Klu*, and *Gnyn* in ancient Bon manuscripts, to the state-institutionalized afforestation quotas and temporal wildlife protection laws (*ri rgya klu rgya*) enacted between the 14th and 17th centuries, the ecological ethics of the Tibetan Plateau represent a profound, highly functional synthesis of spiritual reverence and pragmatic CPR governance.

Contemporary ethnographic fieldwork across Nagqu confirms that these ancient textual doctrines are not mere historical artifacts. Instead, they operate as dynamic "social fences" embedded in the daily lives, organizational rituals, structural

gender dynamics, and spatial conservation behaviors of modern Tibetan communities. However, the imposition of rigid physical fencing, non-contextual sedentary land remediation policies, and the rapid commodification of the landscape via the Cordyceps economy threaten to disrupt this ancient socio-ecological balance by ignoring the absolute necessity of pastoral mobility and eroding the cultural boundaries that have historically prevented the tragedy of the commons.

Theoretical Significance and Policy Implications

This study demonstrates that endogenous social fences provide a robust, low-cost, and culturally resonant alternative to the ecologically disruptive "fencing paradox" of exogenous state management. Policymakers must recognize that pastoralists are not the inherent enemies of the grassland; rather, their transhumance strategies and TEK are vital components of ecosystem resilience. Future environmental policies and National Park planning on the Tibetan Plateau must transition toward genuine polycentric co-management. This requires moving beyond coercive enforcement toward processes of legitimacy acquisition, legally recognizing and formally integrating traditional spatial zoning, seasonal mobility patterns, and sacred site protections into administrative blueprints, as successfully modeled at the Maedika Wetland.

Future Research Directions:

Future research in human ecology should focus on longitudinal studies tracking how climate change and shifting phenological baselines impact the reliability of traditional weather prediction and seasonal *ri rgya*closures. Additionally, quantitative biophysical assessments comparing the biodiversity metrics and vegetation cover of areas protected by "social fences" (like the Gyang shod cypress forest) versus state-managed physical enclosures would further validate the ecological efficacy of TEK. By systematically excavating and theoretically integrating these culturally endogenous social fences, we can ensure that the resilient wisdom of harmonious coexistence continues to actively safeguard the fragile, globally critical ecosystems of the Third Pole for generations to come.

Declarations

Funding

Not applicable.

Ethics approval

Not applicable.

Consent to participate

Verbal informed consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Clinical trial number

Not applicable.

Author Contribution

G.A. conceived the study, conducted fieldwork, performed data analysis, and wrote the manuscript.

References

1. Agrawal A. Common property institutions and sustainable governance of resources. World Dev. 2001;29(10):1649–72.
2. Bauer K. Development and the enclosure movement in pastoral Tibet since the 1980s. Nomadic Peoples. 2005;9(1/2):53–81.
3. Berkes F. Sacred Ecology: Traditional Ecological Knowledge and Resource Management. Philadelphia: Taylor & Francis; 1999.
4. Berkes F. Sacred Ecology. 3rd ed. New York: Routledge; 2012.
5. Bhagwat SA, Rutte C. Sacred groves: potential for biodiversity management. Front Ecol Environ. 2006;4(10):519–24.
6. Braun V, Clarke V. Using thematic analysis in psychology. Qualitative Res Psychol. 2006;3(2):77–101.
7. Bsdos nams tshe ring. *Snga rabs bod kyi srid khrims* [Ancient Tibetan political laws]. Beijing: Mi rigs dpe skrun khang (Nationalities Publishing House; 2004.
8. Chab spel tse brten phun tshogs. *Bod kyi snga rabs khri mys srol yig cha bdams bsdigs* [A collection of ancient Tibetan legal documents]. Lhasa: Bod ljongs bod yig dpe rnying dpe skrun khang. Tibet Tibetan Ancient Books Publishing House; 1989.
9. Chab spel tse brten phun tshogs. *Bod kyi snga rabs khri mys srol yig cha bdams bsdigs* [A collection of ancient Tibetan legal documents]. Lhasa: Bod ljongs bod yig dpe rnying dpe skrun khang. Tibet Tibetan Ancient Books Publishing House; 2012.
10. Creswell JW, Clark VLP. Designing and conducting mixed methods research. Thousand Oaks: Sage; 2017.
11. Dietz T, Ostrom E, Stern PC. The struggle to govern the commons. Science. 2003;302(5652):1907–12.
12. Folke C. Resilience: The emergence of a perspective for social–ecological systems analyses. Glob Environ Change. 2006;14(3):253–67.
13. Geertz C. The Interpretation of Cultures: Selected Essays. New York: Basic Books; 1973.
14. Gómez-Baggethun E, Corbera E, Reyes-García V. (2013). Traditional ecological knowledge and global environmental change: Research findings and policy implications. Ecol Soc, 18(4).
15. Hardin G. The tragedy of the commons. Science. 1968;162(3859):1243–8.
16. Humphrey C, Sneath D. The end of nomadism? Society, state, and the environment in Inner Asia. Durham: Duke University Press; 1999.
17. Jigs med grags pa. *Rgyal rtse chos rgyal gyi rnam par thar pa dad pa'i lo thog dngos grub kyi char 'bebs zhes bya ba bzhugs so* [Biography of the Dharma King of Gyantse]. Lhasa: Bod ljongs mi dmangs dpe skrun khang (Tibet People's Publishing House); 1987.
18. Karma rgyan mtshan. (2005). Ecological views in traditional Tibetan culture. J Dar rtse mdo mi rigs Teachers Coll, (2): 45–51.
19. Niamir-Fuller M, editor. Managing mobility in African rangelands: the legitimization of transhumance. London: Intermediate Technology; 1999.
20. Ostrom E. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge: Cambridge University Press; 1990.
21. Qiu J. China: The third pole. Nature. 2008;454(7203):393–6.
22. Reid RS, Fernández-Giménez ME, Galvin KA. Dynamics and resilience of rangelands and pastoral peoples around the globe. Annu Rev Environ Resour. 2014;39:217–42.
23. Richard C, Yan Z, Du G. (2006). The paradox of the individual household responsibility system in the grasslands of the Tibetan Plateau, China. *USDA Forest Service Proceedings RMRS-P-39*.

24. Rocheleau D, Thomas-Slayter B, Wangari E, editors. Feminist political ecology: Global issues and local experiences. New York: Routledge; 2006.
25. Salick J, Byg A. Indigenous peoples and climate change. Oxford: Tyndall Centre for Climate Change Research; 2007.
26. Scott JC. Seeing like a state: How certain schemes to improve the human condition have failed. New Haven: Yale University Press; 1998.
27. Su ra bsdos nams tshe ring. *Khrims yig zhal lc'e bcu drug gi bshus yig dang 'bru 'grel bzhugs so*[Annotations on the Sixteen-Article Code]. Beijing: Mi rigs dpe skrun khang (Nationalities Publishing House; 2020.
28. Tasi byang chub rgyal mtshan. *Tasi byang chub rgyal mtshan gyi bka' chems* [The last teachings of Tasi Byang Chub Rgyal Mtshan]. Lhasa: Bod ljongs mi dmangs dpe skrun khang. Tibet People's Publishing House); 2015.
29. Tsaring Tnar Ngawang Gyatsa. *Ancient and Rare Tibetan Manuscripts of the Bon Tradition*. Xining: Mtso sngon mi rigs dpe skrun khang. Qinghai Nationalities Publishing House; 2016.
30. Tsonapa Shes rbs. dzngs po (n.d.). *'dul b'I rnm bshd* [Commentary on the Vinaya]. Shing par, dpe ring.
31. Winkler D. Yartsa Gunbu (Cordyceps sinensis) and the fungal commodification of Tibet's rural economy. Econ Bot. 2008;62(3):291–305.
32. Yao T, Thompson LG, Mosbrugger V, Zhang F, Ma Y, Luo T, Joswiak D. Third pole environment (TPE). Environ Dev. 2012;3:52–64.
33. Yeh ET. Green pastoralism: Chinese state-building and the enclosing of Tibetan rangelands. Hum Ecol. 2005;33(1):9–33.

Tables

Table Questionnaire Survey Instrument Structure

Domain	Variables / Items
Socio-demographic characteristics	Age; education level; household income
Livelihood and resource use	Size of pastureland; livelihood type; dependence on natural resources
Environmental perceptions	Perceived level of grassland degradation; drivers; observed ecological changes
Evaluation of ecological policies	Perceived effectiveness; transparency; adequacy; preferred support
Behavioral and institutional responses	Compliance; attitudes toward protection; perceptions of governance legitimacy

This table summarizes the sections, domains, and items of the structured questionnaire used in the study to capture socio-demographic characteristics, livelihood patterns, environmental perceptions, evaluation of ecological policies, and behavioral/institutional responses.

Footnotes

1. The map is a schematic representation showing the approximate locations of fieldwork sites.
2. The table summarizes the composition of participants involved in the study. Percentages are calculated based on the total sample size (N = 32). The "Other stakeholders" category includes enterprise staff, medical personnel, and students.

Figures

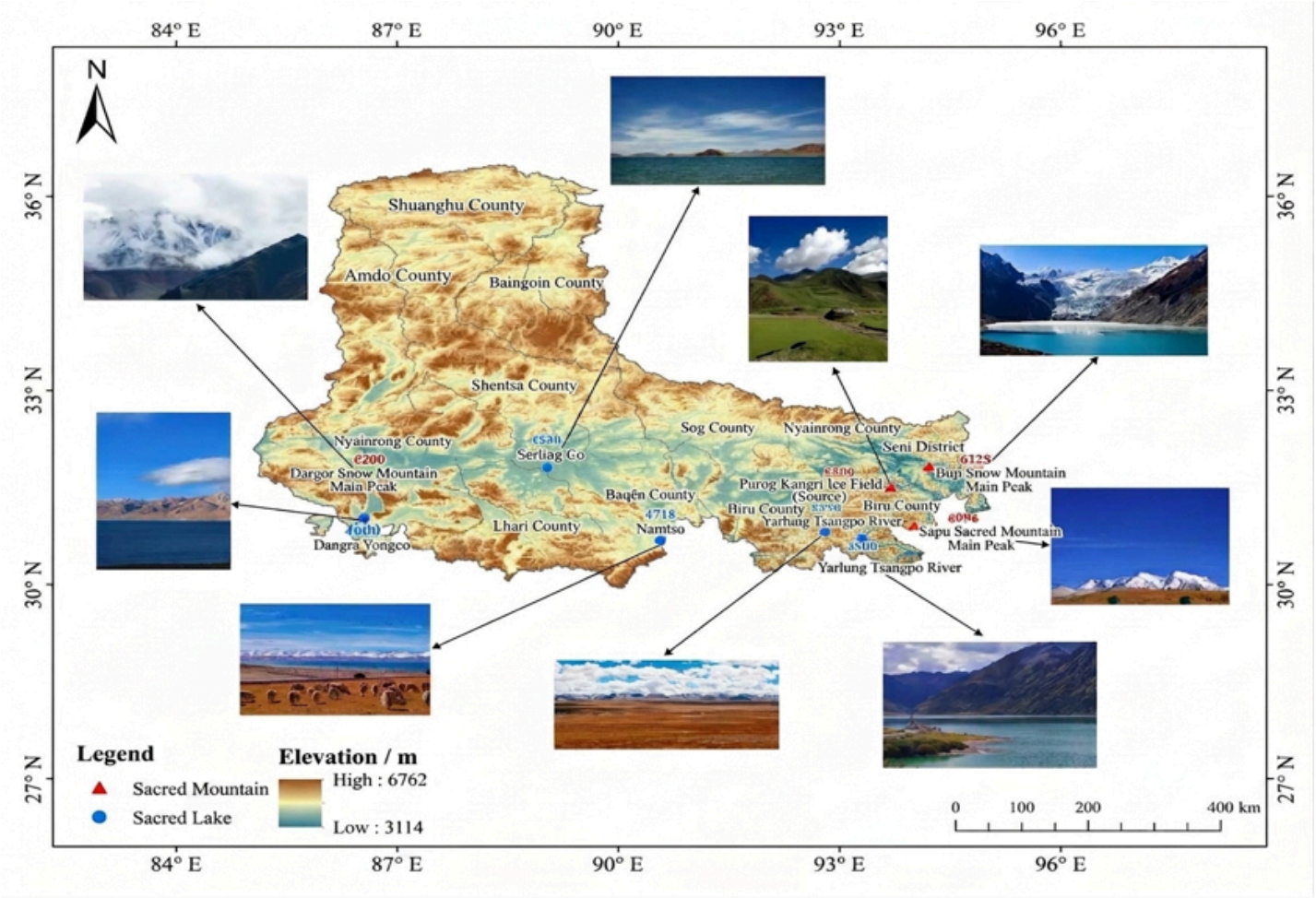


Figure 1

Fieldwork locations in Nagchu Prefecture.

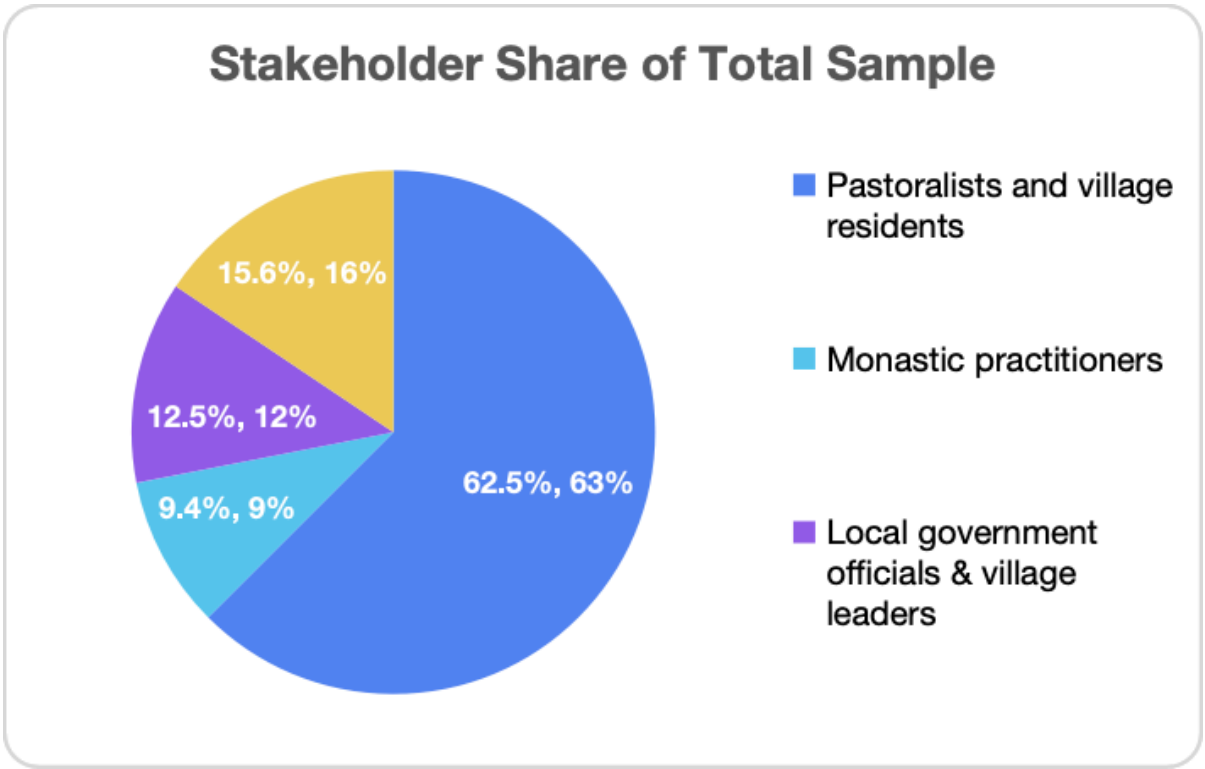


Figure 2

Stakeholder Share of Total Sample