

A Study of Policy, Economy, Environment, Technology, and Culture Synergies across the Sino-Mongolian Border for the Ecological Development of the Mongolian Steppe

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Abstract: This study examines the synergies and differences in management policy, economic development, environmental protection, technological solutions, and cultural preservation between Inner Mongolia (China) and Mongolia, focusing on the ecological development of the Mongolian steppe. By analyzing how contrasting approaches to land management, grazing practices, and resource conservation impact the pastoral economy and the livelihoods of herders, the study reveals that Inner Mongolia's emphasis on privatized land use, rotational grazing, and technological interventions contrasts with Mongolia's traditional communal land management and mobile pastoralism. These differences present significant challenges for sustainable development and grassland restoration but also offer opportunities for cross-border collaboration. Through a comparative analysis of other grassland regions, such as the North American prairies and the Serengeti-Maasai ecosystem, the research highlights best practices that can guide coordinated efforts between China and Mongolia. The study underscores the need to balance economic growth, environmental sustainability, and cultural preservation in promoting high-quality ecological development of the Mongolian steppe. Recommendations for future collaboration focus on harmonizing policies, improving infrastructure, enhancing sustainable practices, and leveraging renewable energy potential.

1. Introduction

1.1 Background

The Mongolian steppe, which stretch across the Sino-Mongolian border, represent one of the most ecologically significant and culturally rich ecosystems in the world [1]. This vast steppe is home to nomadic herding communities whose livelihoods depend on the health and productivity of the grasslands. Spanning from China's Inner Mongolia Autonomous Region to the heart of Mongolia, the region encompasses millions of hectares of grassland essential for livestock farming—the primary economic activity of both areas. These grasslands also support significant biodiversity, including iconic species such as the Mongolian gazelle, wild Bactrian camel, and argali sheep.

While both China and Mongolia share a cultural and historical connection to the steppe, their policies and approaches to land management, economic development, and environmental protection differ significantly. In Inner Mongolia, policies have focused on grassland privatization, rotational grazing systems, and technological interventions to boost productivity while limiting overgrazing [2]. In contrast, Mongolia has retained a more traditional approach, emphasizing mobile pastoralism, communal land use, and community-based natural resource management (CBNRM) [3]. These differing strategies present both opportunities and challenges for cross-border management of the steppe.

1.2 Problems

The divergence in land management policies between China and Mongolia is central to understanding the current state of the Mongolian steppe. In Inner Mongolia, grassland management emphasizes state ownership with usage rights granted to individuals or collectives. Policies like the Grassland Law and grazing bans aim to balance productivity with ecological sustainability but have led to fragmentation of grasslands, limiting herders' mobility and sometimes exacerbating socioeconomic disparities. Technological interventions—such as artificial grass planting, water management infrastructure, and digital monitoring systems—have been employed to enhance productivity and combat degradation. However, unintended consequences like water depletion and disruption of traditional practices have occurred.

In contrast, Mongolia largely maintains traditional grazing practices, with herders moving seasonally to prevent overgrazing. After the privatization of livestock in the 1990s, herd sizes increased, intensifying pressure on grassland and leading to wealth disparities among herders. Mongolia relies more on traditional ecological practices, leveraging mobile pastoralism to mitigate climate variability, but faces challenges in sustainable management due to limited technological resources and increasing environmental pressures like desertification [4].

Both countries confront severe environmental challenges, particularly grassland degradation and desertification [5], but their differing approaches raise questions about long-term sustainability. Additionally, cultural preservation is a critical issue. Modernization, urbanization, and policy shifts have led to the erosion of traditional practices, especially in Inner Mongolia, where there is increased emphasis on Mandarin language use and sedentary lifestyles [6]. Mongolia maintains a stronger connection to its nomadic roots but is also affected by globalization and economic pressures that threaten cultural traditions. Balancing economic development, environmental sustainability, and cultural preservation remains a complex challenge for both nations.

1.3 Objectives

This study aims to provide a comprehensive analysis of the policies, economic, environmental, technological, and cultural synergies and differences across the Sino-Mongolian border, focusing on their impacts on the ecological development of the Mongolian steppe. Specifically, this research seeks to:

- 1) Examine the policy differences between China's Inner Mongolia and Mongolia regarding land management, grazing systems, and environmental protection.
- 2) Analyze the economic impacts of these policies on herder livelihoods, resource management, and regional development.
- 3) Assess environmental protection efforts and their implications for the sustainability of the grassland ecosystem.
- 4) Evaluate the effectiveness of technological solutions implemented in both regions to combat environmental degradation and promote sustainable pastoralism.
- 5) Explore the challenges of preserving traditional nomadic cultures in the face of modernization and policy shifts.
- 6) Provide recommendations for fostering cross-border cooperation between China and Mongolia in managing the steppe ecosystem while balancing economic growth, environmental sustainability, and cultural preservation.

2. Current Status and Impacts Analysis

2.1 Management Policy

2.1.1 Inner Mongolia

2.1.1.1 Main Policy Content

The management policies in Inner Mongolia's pastoral areas focus on transforming grassland ownership, usage rights, grazing practices, and overall management methods to promote sustainable

development and protect the grassland ecosystem. The core content includes:

1) Grassland Ownership and Use Rights: Establishing state ownership of grasslands while allocating usage rights to individuals or collectives. Legal frameworks like the Grassland Law regulate the protection, utilization, and management of grasslands. Herders are granted use rights, encouraging them to invest in land improvements and adopt sustainable practices [1].

2) Grazing Management: Implementing seasonal grazing regulations to prevent overgrazing and protect vegetation. Certain seasons are designated for grassland recovery, during which grazing is prohibited. Promoting rotational grazing systems encourages herders to mimic traditional nomadic migration patterns, preventing overuse of specific pastures [3].

3) Livestock Quantity Control: Introducing government incentives to encourage herders to reduce herd sizes and adopt more sustainable livestock practices, thereby reducing pressure on grasslands [4].

4) Sustainable Herding Training: Providing training on sustainable grazing techniques and alternative livelihoods to enhance herders' environmental awareness and skills [7].

2.1.1.2 Policy Evolution Process

The evolution of management policies has undergone several key stages:

- Land Reform Movement (1950s): The initial land reforms dismantled the feudal land ownership system, redistributing land to peasants and herders. This transition aimed to eliminate landlordism and promote equitable land distribution, marking a move from feudalism to collectivism [2].

- Collectivization under People's Communes (Late 1950s - Early 1980s): Land and livestock were collectivized, abolishing private ownership. Traditional nomadic practices were restricted as herders became part of collective units managing resources and production collectively [3].

- Household Responsibility System and Grassland Contract Responsibility System (1980s): Marking a shift towards decentralization, individual households were granted the right to use land and manage livestock. Grasslands were contracted to individual herder households to increase productivity and encourage sustainable land management [8].

- Grassland Law and Tenure Reforms (1985 onwards): The enactment of the Grassland Law provided a legal basis for grassland protection, utilization, and management. Reforms strengthened herders' tenure security by issuing certificates for grassland use rights, enhancing their ability to make long-term investments in land stewardship [4].

- Grazing Bans and Restrictions (2000s onwards): Implemented total and seasonal grazing bans in severely degraded areas to allow ecological recovery. These bans prohibited grazing during certain periods or entirely in specific regions. Promotion of rotational grazing systems encouraged herders to adopt practices that reduce pressure on any single area [9].

- Livestock Reduction Programs: Introduced financial incentives for herders who voluntarily reduced their herd sizes. Provided training on sustainable herding techniques and alternative livelihoods to help herders adapt to new production methods [1].

- Grassland Ecological Protection Subsidies (2011): Economic incentives were introduced to encourage herders to adopt sustainable practices and reduce livestock numbers. Subsidies and rewards aimed to balance economic development with ecological conservation by mitigating overgrazing and promoting grassland restoration [10].

This evolution reflects a governmental shift from passive management to active protection and sustainable development, aiming to balance ecological conservation with economic growth [11].

2.1.1.3 Policy Impacts (Positive Impacts, Negative Impacts)

The implementation of these management policies has had profound effects on Inner Mongolia's pastoral areas:

Positive Impacts:

- Increased Productivity and Enhanced Land Management: The household responsibility system motivated herders to improve productivity, as they directly benefited from their labor and investments. Secure land tenure encouraged investment in land improvements, adoption of

sustainable practices, and better care of the grasslands. This led to more efficient resource use, higher outputs, improved pasture quality, and long-term ecological benefits [12].

- **Environmental Recovery and Long-Term Sustainability:** Grazing bans and restrictions effectively reduced overgrazing, leading to the restoration of grassland vegetation and a decrease in the rate of desertification. By reducing pressure on ecosystems, these policies aim to ensure the viability of pastoralism for future generations, preserving valuable natural resources [13].

- **Legal Protection and Enhanced Environmental Awareness:** The Grassland Law provided mechanisms to protect herders' rights and the grassland ecosystem. Legal recognition of use rights increased herders' confidence in making long-term plans and investments. Herders received training in sustainable practices, increasing their environmental consciousness and contributing to the long-term development of their communities [14].

Negative Impacts:

- **Overgrazing and Land Degradation:** Individual land rights led some herders to increase livestock numbers to maximize income, resulting in overgrazing. This exacerbated land degradation and desertification, undermining the ecological balance [5].

- **Fragmentation of Pasturelands:** The division of communal lands disrupted traditional migratory patterns essential for sustainable nomadic herding. Fragmented pastures limited mobility, reduced access to diverse grazing areas, and affected the health of the grassland ecosystem [15].

- **Economic Hardship and Cultural Disruption:** The reduction in livestock numbers directly decreased herders' income, causing short-term economic hardship and affecting their livelihoods. Strict grazing restrictions conflicted with traditional nomadic lifestyles, leading to cultural and social tensions that affected community cohesion [16].

- **Socioeconomic Disparities and Implementation Challenges:** Wealthier herders were able to acquire more land and livestock, widening the economic gap between rich and poor. This led to increased socioeconomic disparities, social tension, and challenges to community cohesion. Difficulties in policy enforcement, such as insufficient supervision, herders' resistance, and lack of alternative income sources, limited the effectiveness of the policies [17].

These impacts highlight the complexities of policy implementation in pastoral regions. While economic incentives and legal frameworks have driven productivity and land stewardship, they have also introduced environmental challenges and social inequalities. Balancing economic development with ecological protection and social equity remains a critical task for policymakers in Inner Mongolia. Supporting herders through the transition with economic assistance and efforts to preserve cultural practices is essential to ensure the sustainable development of the pastoral areas [18].

2.1.2 Mongolia

Traditionally, Mongolian herders practiced communal land ownership and relied on nomadic lifestyles, migrating across vast grasslands in harmony with seasonal changes. These policies aim to improve land use efficiency, promote the development of the pastoral economy, protect the grassland ecological environment, and safeguard the rights and interests of herders while ensuring the sustainable development of pastoralism [15].

Mongolia's pastoral land remains largely under public access, and traditional nomadic mobility is central to its grazing systems. The government has initiated community-based natural resource management (CBNRM) projects to better manage pastureland. However, the privatization of livestock in the 1990s created wealth disparities and access issues, with increased pressure on pastureland due to rising livestock numbers [7].

2.2 Economic Development

2.2.1 Inner Mongolia

2.2.1.1 Core Content of Economic Development

Economic development in Inner Mongolia's pastoral areas has been significantly shaped by efforts to modernize the pastoral economy while ensuring ecological sustainability. The key

components of this development include:

- **Modernization of Pastoral Practices:** The integration of advanced technologies and scientific methods has transformed traditional herding practices. This includes the adoption of improved livestock breeds, artificial grass planting to enhance fodder supply, and the use of digital tools for efficient livestock and grassland management [19].
- **Sustainable Resource Management:** Emphasis on sustainable use of grassland resources has been crucial. Practices such as rotational grazing and seasonal grazing restrictions help prevent overgrazing, promoting the long-term viability of the grasslands which are essential for the pastoral economy [20].
- **Diversification of Income Sources:** To reduce reliance on traditional livestock grazing, herders are encouraged to engage in alternative economic activities. These include eco-tourism, renewable energy projects like wind and solar farms, and the production of handicrafts. This diversification enhances income stability and economic resilience [21].
- **Infrastructure Development:** Investments in infrastructure—such as roads, communication networks, and energy facilities—have improved access to markets, education, and healthcare. Enhanced infrastructure supports economic activities by facilitating the transportation of goods and services and connecting pastoral areas with broader markets [22].
- **Policy Support and Financial Incentives:** The government provides subsidies, training programs, and support services to herders. Financial incentives encourage the adoption of sustainable practices and technologies, mitigating the short-term economic impacts of policies like grazing restrictions [23].

2.2.1.2 Evolution Process of Economic Development

The economic development of Inner Mongolia's pastoral areas has evolved through several distinct stages:

- **Collectivization Era (1950s - Early 1980s):** During this period, the economy was organized around collective ownership under people's communes. While aimed at equitable resource distribution, this system often led to inefficiencies and limited personal incentives for productivity, hindering economic growth [24].
- **Introduction of Market Reforms (1980s):** The implementation of the Household Responsibility System granted individual households the rights to use land and manage livestock independently. This shift incentivized herders to increase productivity and efficiency, leading to significant economic growth and improved livelihoods [2].
- **Ecological Conservation Initiatives (2000s Onwards):** Recognizing the environmental degradation caused by overgrazing, the government implemented policies focused on ecological restoration. While these policies aimed to ensure long-term sustainability, they required herders to adjust economically, often reducing herd sizes and modifying traditional practices [25].
- **Technological Advancement and Integration (2010s Onwards):** The adoption of advanced technical solutions, such as information technology for monitoring grasslands, improved breeding techniques, and water resource management technologies, enhanced pastoral productivity. These advancements contributed to economic development by increasing efficiency and opening up new markets [10].

Emphasis on Sustainable Development (Recent Years): A growing focus on balancing economic growth with ecological protection has led to the promotion of green industries and sustainable practices. This includes renewable energy projects and sustainable tourism, aligning economic objectives with environmental stewardship [26].

2.2.1.3 Impacts of Economic Development

Positive Impacts:

- **Improved Livelihoods for Herders:** Increased productivity due to modernized practices and technologies has led to higher household incomes. Diversification into alternative income sources has reduced economic vulnerability and improved living standards [19].
- **Regional Economic Growth:** The modernization of the pastoral economy has contributed to

the overall economic growth of Inner Mongolia. Enhanced market integration and competitiveness have expanded trade opportunities, boosting the regional economy [20].

- **Infrastructure and Service Enhancement:** Improved infrastructure has facilitated economic activities by reducing transportation costs and improving access to education, healthcare, and markets. This has had a multiplier effect on economic development and social well-being [27].

- **Promotion of Sustainable Practices:** Financial incentives and policy support have encouraged the adoption of environmentally sustainable practices. This not only preserves the grassland ecosystem but also ensures the long-term sustainability of the pastoral economy [22].

Negative Impacts:

- **Economic Disparities:** Unequal access to resources, technology, and markets has led to widening income gaps between wealthier and poorer herders. Those with more capital can invest in better technologies and larger herds, while others may struggle, leading to social tensions [21].

- **Cultural and Social Challenges:** Rapid economic changes and modernization have sometimes resulted in the erosion of traditional nomadic cultures and lifestyles. The shift away from traditional practices can affect social cohesion and lead to a loss of cultural heritage [24].

- **Short-Term Economic Hardships:** Policies such as grazing bans and livestock reduction programs have caused immediate income losses for herders who rely heavily on livestock grazing. Without adequate alternative income sources or sufficient compensation, some herders face economic difficulties [27].

- **Overexploitation of Resources:** In the pursuit of economic growth, there have been instances of resource overuse. Increased economic activities, if not properly managed, can lead to environmental degradation, undermining the very ecological foundation necessary for sustainable economic development [26].

The economic development of Inner Mongolia's pastoral areas reflects a complex balance between modernization, ecological sustainability, and the well-being of herding communities. While significant progress has been made in improving productivity and integrating the pastoral economy into broader markets, challenges remain in ensuring that development is equitable and culturally sensitive. Addressing issues such as economic disparities and cultural preservation is essential. Future strategies should continue to promote sustainable practices and technologies while providing support to herders during transitions, ensuring that economic advancement benefits all members of pastoral communities without compromising ecological integrity [21].

2.2.2 Mongolia

In Mongolia, while similar challenges exist, the approach to economic development in pastoral areas differs. The government has initiated community-based natural resource management projects to empower local herder groups and improve pasture management. Traditional nomadic mobility remains central to grazing systems, helping manage climatic variability and avoid overgrazing. However, the privatization of livestock in the 1990s led to wealth disparities and increased pressure on pastureland due to rising livestock numbers. Addressing these issues requires careful balancing of traditional practices with sustainable management and economic development strategies [22].

2.3 Environmental Protection

2.3.1 Inner Mongolia

2.3.1.1 Core Content of Environmental Protection Policies

The core of environmental protection policies is to safeguard and restore grassland ecosystems, prevent desertification, and ensure the sustainable development of the pastoral economy. The main contents include:

- **Anti-Desertification Efforts:** Implementing large-scale projects like the "Three-North Shelter Forest Program," establishing ecological barriers through afforestation and grassland restoration to prevent soil erosion and desert expansion [13].

- **Regulations on Industrial Activities:** Enacting strict regulations to control industrial activities such as mining that negatively impact pastoral areas, reducing industrial pollution and ecological

destruction [16].

- Ecological Restoration and Protection: Promoting policies like "Grain for Green" and "Returning Grazing Land to Grassland," converting over-cultivated farmland and overgrazed pastures back to forests and grasslands to restore ecological balance [5].

2.3.1.2 Evolution of Environmental Protection Policies

The evolution of environmental protection policies has progressed from localized management to comprehensive ecological civilization construction:

- Afforestation and Anti-Desertification Programs (1978 onwards):

Three-North Shelterbelt Program: Initiated in 1978, this massive afforestation project aims to establish shelterbelts to combat wind erosion and improve the climate [15].

"Grain for Green" and "Returning Grazing Land to Grassland" Programs: Converted erosion-prone farmland and overgrazed areas back to forests and grasslands to reduce land degradation [10].

- Ecological Civilization Framework (2012 onwards):

Integration of Ecology in Development: Post-2012, the nation emphasized ecological civilization, integrating environmental protection into the core of economic and social development, and advocating for green, circular, and low-carbon growth [3].

- Enhanced Environmental Regulations:

Stricter Enforcement: Amendments to environmental laws increased penalties for violations [18].

Monitoring and Assessment: Established improved mechanisms for environmental impact assessments and monitoring to ensure effective policy implementation [28].

2.3.1.3 Impacts of Environmental Protection Policies (Positive Impacts, Negative Impacts)

These policies have had profound effects on Inner Mongolia's pastoral areas:

Positive Impacts:

- Improved Ecosystems: Vegetation restoration increased grassland coverage and biodiversity, significantly enhancing the ecological environment [1].

- Reduced Soil Erosion: Afforestation and grassland restoration effectively prevented soil erosion, promoting sustainable agriculture and herding [29].

- Increased Environmental Awareness: The promotion of policies heightened the importance of environmental protection among herders and local governments, fostering community involvement in environmental management [7].

Negative Impacts:

- Inappropriate Afforestation: Forced tree planting in unsuitable areas led to water depletion and low tree survival rates, wasting resources [30].

- Loss of Pastureland: Some grazing areas were repurposed for afforestation or other ecological projects, reducing available pasture and pressuring herders' livelihoods [5].

- Conflicts over Land Use: The clash between environmental protection goals and herders' traditional land use needs led to land disputes and social tensions [13].

By analyzing the above, we can see that environmental protection policies have achieved positive results in promoting ecological restoration and enhancing environmental awareness. However, they have also had adverse effects on herders' livelihoods and traditional culture during implementation. This indicates that when formulating and executing environmental policies, it is essential to consider ecological, economic, and social factors comprehensively to achieve sustainable development goals [9].

2.3.2 Mongolia

Mongolia prioritizes balancing traditional pastoral practices with ecological sustainability. The country has encouraged sustainable land-use strategies through local-level initiatives that integrate environmental conservation with herder livelihoods. Mongolia's traditional mobile pastoralism has proven more adaptable to climate variability, helping mitigate grassland degradation [31].

2.4 Technical Solution

2.4.1 Inner Mongolia

2.4.1.1 Core Content of Major Technical Solutions

From the 20th century to the present, China's Inner Mongolia pastoral areas have implemented several important technical solutions to improve the grassland ecological environment and promote sustainable pastoral development. These technologies include:

- **Nature-Based Solutions:** Utilizing the inherent functions of ecosystems, such as ecological restoration, grassland management, and biodiversity conservation, to address environmental and social issues [11].
- **Grass Banks:** Establishing grass bank mechanisms that allow herders to store and borrow grassland use rights in degraded areas, achieving rational allocation and sustainable utilization of grassland resources [2].
- **Fresh Grass Projects:** Promoting the artificial planting of high-quality forage grass to improve fodder supply, reduce grazing pressure on natural grasslands, and enhance livestock nutrition [13].
- **Breeding Centers (Livestock Custody Centers):** Establishing facilities for centralized feeding and management, providing livestock hosting and professional management services to herders to improve pastoral production efficiency and livestock quality [10].
- **Ecological Migration:** Relocating herders from ecologically fragile areas to regions with better conditions to reduce pressure on vulnerable ecosystems and provide new livelihood opportunities for herders [8].
- **Grassland Fire Prevention and Pest Control Technologies:** Applying modern technologies such as remote sensing monitoring and satellite positioning to prevent and control grassland fires and pests, protecting grassland ecological security [3].
- **Information and Digital Management:** Utilizing remote sensing, GPS, and IoT technologies to achieve digitization and intelligence in grassland ecological monitoring, livestock management, and early warning systems [15].

Water Resource Management Technologies: Developing water conservancy facilities such as drilling wells, building reservoirs, and rainwater harvesting systems to solve water scarcity issues in pastoral areas, ensuring livestock drinking water and grassland irrigation [17].

2.4.1.2 Evolution of Technical Solutions

- **Mid-20th Century:** Began to pay attention to grassland degradation and desertification issues, adopting initial grassland protection and restoration measures such as enclosure and grazing bans [14].
- **Late 20th Century:** Introduced advanced agricultural and pastoral technologies, including artificial grass planting and improved livestock breeding techniques, to enhance pastoral productivity and grassland carrying capacity [16].
- **Early 21st Century:** With the intensification of ecological environmental problems, implemented large-scale ecological projects like "Returning Grazing Land to Grassland" and "Fresh Grass Projects," promoting nature-based solutions and strengthening ecological protection efforts [4].
- **2010s:** Applied information technology and digital means to strengthen grassland ecological monitoring and management, developing smart pastoralism. Established grassland fire monitoring systems and pest early warning mechanisms to improve grassland disaster prevention and control capabilities [9].

Recent Years: Placed greater emphasis on sustainable development and ecological civilization construction, comprehensively using various technical means such as renewable energy utilization and water resource management to promote coordinated development of the pastoral area's ecology, economy, and society [5].

2.4.1.3 Impacts of Technical Solutions (Positive Impacts, Negative Impacts)

Positive Impacts:

- **Improvement of Ecological Environment:** Through ecological restoration and prevention technologies, the trend of grassland degradation has been curbed, vegetation coverage has increased, biodiversity has risen, and ecological functions have been enhanced [1].
- **Enhanced Pastoral Productivity:** The introduction of advanced pastoral technologies and facilities improved fodder supply, optimized livestock breeds and breeding methods, and increased pastoral efficiency and income [7].
- **Improved Living Standards for Herders:** The application of diverse technologies provided herders with new income sources and employment opportunities, improving living conditions and promoting economic development in pastoral areas [12].

Negative Impacts:

- **Technological Adaptation Issues:** Some technical solutions did not fully consider local natural conditions and herders' needs, leading to unsatisfactory results or even negative impacts, such as excessive consumption of water resources [18].
- **Cultural and Social Impacts:** Measures like ecological migration and centralized feeding may lead to changes in herders' traditional lifestyles, affecting cultural inheritance and causing changes in social structures that are difficult to adapt to [28].
- **Uneven Resource Allocation:** The investment of technology and funds may favor regions or groups with better economic conditions, causing regional development imbalances and social inequities, leading to conflicts among herders [32].

By analyzing the above technical solutions, it can be seen that while the various technical means implemented in Inner Mongolia's pastoral areas have promoted ecological environmental improvement and pastoral development, they also face challenges in cultural preservation and social equity. In the future, it is necessary to pay more attention to local conditions in technology application, fully consider herders' needs and the local ecological environment, and balance ecological, economic, and social benefits to ensure sustainable development of pastoral areas [13].

2.4.2 Mongolia

Mongolia has implemented several technical solutions to address pastoral challenges. Community-based approaches like CBNRM focus on improving pasture management by empowering local herder groups. Mongolia also emphasizes the sustainability of nomadic grazing, leveraging traditional mobility to manage climatic variability and avoid overgrazing [30].

Water scarcity, one of the main environmental challenges, is being addressed through local-level initiatives to improve water management and pasture quality [31].

2.5 Ethical Culture

2.5.1 Inner Mongolia

2.5.1.1 Core Content of Ethnic Cultural Policies

The core of ethnic cultural policies focuses on protecting and promoting the Mongolian language, culture, and traditions, aiming to foster ethnic unity and social harmony. The main contents include:

- **Cultural Preservation Initiatives:** Supporting Mongolian language education and media development to ensure the use of Mongolian in schools and media. Organizing festivals and cultural events to showcase and transmit Mongolian traditions, customs, and art forms, thereby enhancing ethnic identity [33].
- **Economic Support Programs:** Providing targeted funding and subsidies for ethnic minorities and promoting development projects in minority regions. Through economic assistance, these policies aim to improve living standards and economic opportunities in ethnic minority areas [34].

2.5.1.2 Evolution Process of Ethnic Cultural Policies

The evolution of ethnic cultural policies has progressed from legal safeguards to policy

adjustments:

- Law on Regional Ethnic Autonomy (1984): Established the legal framework for ethnic autonomy, granting ethnic minorities the right to self-governance in areas such as cultural and educational affairs, and safeguarding the legitimate rights of ethnic minorities [35].
 - Bilingual Education Policies: The government supported schools in providing instruction in both Mandarin and Mongolian to preserve minority languages. However, policy adjustments in 2020 increased the emphasis on Mandarin education in some subjects, raising concerns over cultural assimilation and language loss, leading to protests and dissatisfaction in certain regions [25].
 - Cultural Preservation Initiatives: Government funding was allocated to support festivals, arts, and cultural institutions. Laws were enacted to protect historical sites and intangible cultural heritage, strengthening the preservation of Mongolian culture [36].
- Economic Support Measures: Subsidies and incentives were implemented to improve living standards in minority regions. The government also made efforts to increase the representation of ethnic minorities in political processes and leadership positions [37].

2.5.1.3 Impacts of Ethnic Cultural Policies (Positive Impacts, Negative Impacts)

These policies have had multiple impacts on Inner Mongolia's pastoral areas:

Positive Impacts:

- Cultural Revitalization: Support for cultural activities strengthened Mongolian identity and the transmission of traditional culture, enhancing ethnic pride [24].
- Improved Living Standards: Economic support policies helped reduce poverty and increased access to services such as education and healthcare, improving the living conditions of herders [38].
- Increased Educational Opportunities: Bilingual education promoted literacy and educational attainment among Mongolian youth, providing them with more opportunities for personal and professional development [39].

Negative Impacts:

- Cultural Assimilation Pressures: Policy shifts toward emphasizing Mandarin education raised fears of losing linguistic and cultural heritage, leading to a cultural identity crisis and social tensions.
- Heightened Ethnic Tensions: Inequities and misunderstandings in policy implementation may trigger social discontent and protests, affecting ethnic unity and social stability [40].
- Implementation Inequities: Variations in how policies were applied across different regions could favor certain groups, leading to unfair resource distribution and causing resentment.

From the above analysis, it is evident that ethnic cultural policies have achieved positive outcomes in protecting and promoting Mongolian culture, improving living standards, and providing educational opportunities. However, adjustments and inconsistencies in policy implementation have also brought challenges such as cultural assimilation pressures, heightened ethnic tensions, and implementation inequities. This indicates that when formulating and executing ethnic cultural policies, it is crucial to carefully balance cultural preservation, social equity, and national unity to ensure that policies genuinely benefit ethnic minority groups and promote social harmony [41].

2.5.2 Mongolia

Mongolia's nomadic culture remains deeply intertwined with its pastoral management systems. Traditional pastoral practices continue to play a central role in preserving ethnic and cultural identity, despite pressures from modernization and climate change. The government supports pastoralists' efforts to maintain their cultural heritage alongside sustainable ecological practices [42].

3. Challenges and Opportunities

The collaborative economic and cultural development of the Mongolian steppe between China and Mongolia offers substantial opportunities, particularly in the fields of economic cooperation, cultural preservation, environmental protection, and infrastructure development. However, this partnership also faces various challenges, including policy discrepancies, environmental concerns,

cultural differences, and geopolitical pressures. Below is an analysis of potential areas for collaboration and the obstacles that may arise.

3.1 Challenges

3.1.1 Policy and Legal Coordination

Policy and legal inconsistencies between China and Mongolia could create barriers to effective collaboration. Mongolia's legal framework can be complex, and its policies are sometimes unstable, posing challenges for foreign investment, environmental protection, and cultural preservation. Furthermore, cross-border projects may encounter legal hurdles concerning investment protection, intellectual property rights, and environmental regulations [43].

3.1.2 Infrastructure and Funding Constraints

Mongolia's infrastructure remains underdeveloped, particularly in transportation, communications, and electricity, which limits economic growth, especially in remote steppe regions. While China has provided investment through the BRI, large-scale projects require substantial financial and technological support, and Mongolia's small economy and limited investment capacity may hinder progress [44].

3.1.3 Environmental and Resource Management Challenges

The Mongolian steppe's fragile ecosystem faces severe degradation, and without coordinated management, both countries risk exacerbating these environmental challenges. Overuse of natural resources—whether through livestock overgrazing or mining—without adequate conservation measures may further degrade the land. Without sustainable policies, large-scale livestock or resource exploitation projects could intensify land degradation and reduce water availability, damaging the ecosystem's sustainability [3].

3.1.4 Cultural Differences and National Identity

Although Mongolia and China share cultural commonalities, particularly in steppe and nomadic traditions, significant differences in governance, cultural policies, and national identity exist. For instance, while Inner Mongolia has integrated more into Chinese culture and language, Mongolia has preserved a distinct Mongolian identity. These cultural differences could create friction in collaborative efforts, particularly in cultural projects, and affect deeper cooperation [34].

3.1.5 Geopolitical Tensions

Mongolia is situated between two powerful neighbors—China and Russia—both of whom exert influence on its political and economic decisions. Mongolia's cooperation with China can sometimes be constrained by its historical ties with Russia and a desire to maintain political balance. Additionally, geopolitical pressures from external actors may interfere with China-Mongolia collaboration, particularly in areas such as trade, energy, or strategic development, leading to delays or resistance in joint initiatives [45].

3.2 Opportunities

3.2.1 Collaborative Economic Development of the Steppe

- **Livestock Industry Cooperation:** The Mongolian steppe is central to the livestock industry. China and Mongolia can collaborate on technologies related to animal husbandry, grassland management, and livestock breeding. By introducing modern breeding techniques and sustainable pasture management, both countries can improve pasture productivity while preventing overgrazing and land degradation [3].

Livestock Trade: There is significant potential for livestock and agricultural product trade between the two nations, particularly as China's demand for high-quality organic meat grows. Mongolia's premium beef and lamb products can be exported to China, boosting Mongolia's economy [34].

- **Eco-tourism Collaboration:** The vast natural landscapes and unique nomadic culture of the Mongolian steppe attract many international tourists. China and Mongolia could jointly develop eco-tourism projects that promote green economic growth. For example, cross-border tourism routes could connect Inner Mongolia and Mongolia's natural and cultural sites, attracting a larger international audience [42].

Infrastructure Development: Mongolia's infrastructure is underdeveloped, particularly in transportation, electricity, and telecommunications. China could provide investment and technical support under the Belt and Road Initiative (BRI) framework to enhance Mongolia's transportation networks and power supply, facilitating economic growth in the steppe region [44].

3.2.2 Environmental Protection Cooperation

- **Grassland Conservation:** The Mongolian steppe faces severe environmental challenges such as land degradation and desertification. China and Mongolia can deepen collaboration on ecological conservation by implementing joint projects to combat desertification, restore vegetation, and manage water resources. China's successful experience in combating desertification in Inner Mongolia can serve as a valuable model for Mongolia [5].

Cross-border Wildlife Protection: The Mongolian steppe is home to many migratory species such as the Mongolian gazelle and wild horses. As the two nations share an interconnected ecosystem, they can work together to establish transboundary wildlife protection corridors, allowing animals to migrate freely and minimizing the negative impacts of infrastructure barriers on biodiversity [10].

3.2.3 Cultural Cooperation

- **Preservation of Nomadic Culture:** The nomadic culture of the Mongolian steppe is a shared cultural heritage for both Mongolia and China's Inner Mongolia. The two countries can collaborate on projects aimed at preserving and promoting nomadic traditions, such as joint cultural research, publishing, exhibitions, and the international promotion of Mongolian steppe culture to a global audience [33].

- **Cultural and Educational Exchanges:** China and Mongolia can further promote cultural and educational exchanges to enhance mutual understanding. This includes language programs, Mongolian studies cooperation, artist exchanges, and joint cultural festivals to strengthen ties between the two nations.

3.2.4 Renewable Energy Cooperation

Development of Renewable Energy: The Mongolian steppe has abundant solar and wind energy resources. China and Mongolia could cooperate in developing renewable energy projects, such as solar power plants and wind farms. With China's technological and financial support, Mongolia can expand its renewable energy sector to meet domestic needs and potentially export energy to China [42].

China and Mongolia have substantial opportunities for collaboration in economic, environmental, cultural, and energy sectors across the Mongolian steppe, including livestock trade, tourism, infrastructure development, renewable energy, and cultural preservation. However, the success of these initiatives will depend on overcoming significant challenges, such as infrastructure limitations, environmental degradation, policy inconsistencies, and geopolitical factors. By fostering closer dialogue, policy alignment, environmental sustainability, and respect for cultural differences, both countries can achieve more significant economic and cultural cooperation for mutual benefit [38].

3.3 Referential Practices

3.3.1 The North American Prairies – Canada and the USA

The North American prairies, spanning Canada and the United States, are vital grassland ecosystems supporting pastoral economies and herders' livelihoods. Both countries have developed collaborative practices in pasture management policies, economic development, environmental

protection, technological solutions, and ethnic policies. These coordination mechanisms have significantly promoted high-quality pastoral development and improved the lives of herders.

3.3.1.1 Collaborative Pasture Management Policies

- **Joint Grazing Management:** Canada and the U.S. align pasture management policies to ensure consistent grazing practices across borders. This includes setting similar stocking rates and grazing seasons to prevent overgrazing and land degradation [46].
- **The Great Plains Initiative:** Both countries participate in this initiative to promote sustainable land management practices, fostering information exchange on pasture rotation and regenerative grazing techniques [47].

Impact: Healthier grasslands enhance forage availability and livestock productivity, leading to economic stability for herders by preventing pasture degradation [48].

3.3.1.2 Economic Development Collaboration

- **Trade Agreements:** Agreements like NAFTA and USMCA reduce trade barriers, allowing free flow of livestock and agricultural products, benefiting herders and pastoral communities [49].
- **Joint Agricultural Programs:** Governments support initiatives providing financial assistance, subsidies, and insurance to pastoralists, helping manage market fluctuations and environmental risks [50].

Impact: Increased market opportunities enable herders to diversify products and improve profitability. Enhanced trade fosters infrastructure improvements in rural areas, facilitating business operations [51].

3.3.1.3 Environmental Protection Initiatives

- **Collaborative Conservation Efforts:** Agencies collaborate on cross-border projects focusing on preserving native prairie ecosystems, species at risk, and biodiversity [52].
- **Prairie Conservation Action Plan (PCAP):** Both countries coordinate habitat preservation efforts, enhancing ecosystem services vital for pasture health [53].

Impact: Conservation efforts maintain ecosystem balance, supporting water regulation and soil fertility, ensuring long-term viability of pastoral activities and herders' livelihoods [54].

3.3.1.4 Technical Solutions

- **Shared Research and Innovation:** Universities and research centers collaborate on sustainable agriculture research [46].
- **Technology Transfer Programs:** Joint initiatives facilitate sharing of technologies like precision agriculture and remote sensing for pasture monitoring [55].

Impact: Access to advanced technologies helps herders optimize grazing patterns, improve herd health, and increase efficiency. Technological tools enable better management of environmental risks [52].

3.3.1.5 Ethnic Policies and Cultural Preservation

- **Support for Indigenous Communities:** Recognition of Indigenous rights and cultural exchange programs promote cultural preservation and knowledge sharing [56].

Impact: Supports the continuation of traditional pastoral practices, enhancing cultural sustainability and community empowerment through involvement in decision-making [57].

3.3.2 The Serengeti-Maasai Grasslands – Tanzania and Kenya

The Serengeti-Maasai grasslands, spanning Tanzania and Kenya, are iconic ecosystems vital for biodiversity and the livelihoods of the Maasai people. Both countries have developed collaborative practices in pasture management policies, economic development, environmental protection, technological solutions, and ethnic policies. These coordination mechanisms have significantly promoted high-quality pastoral development and improved herders' livelihoods.

3.3.2.1 Collaborative Pasture Management Policies

- **Transboundary Grazing Agreements:** Tanzania and Kenya allow Maasai herders to move livestock across borders, respecting traditional migratory routes and seasonal patterns. Community-Based Natural Resource Management (CBNRM) empowers local communities to sustainably manage grazing lands through Grazing Committees that regulate intensity and timing [58].

Impact: Sustainable pasture use maintains grassland health and productivity, securing herders' livelihoods and preserving traditional practices [59].

3.3.2.2 Economic Development Collaboration

- **Tourism Revenue Sharing:** Joint eco-tourism development in the Serengeti National Park and Maasai Mara National Reserve attracts millions of tourists. Revenue-sharing models allocate a portion of tourism income to Maasai communities, funding education, healthcare, and infrastructure projects [60].

- **Cross-Border Trade Facilitation:** Improved regulations facilitate livestock trade, expanding market access for herders [61].

Impact: Economic diversification reduces reliance on pastoralism alone, while enhanced infrastructure improves quality of life [62].

3.3.2.3 Environmental Protection Initiatives

- **Joint Wildlife Conservation:** Managing contiguous protected areas and coordinating anti-poaching efforts preserve wildlife habitats and migration corridors [63].

- **Sustainable Land Management:** Collaborative land-use planning balances agricultural expansion with conservation, minimizing habitat fragmentation [64].

Impact: Biodiversity preservation supports ecosystem services vital for pastoralism and reduces human-wildlife conflict, protecting both livelihoods and wildlife [65].

3.3.2.4 Technological Solutions

- **Innovative Pastoralism Support:** Mobile technology provides herders with real-time information on weather, pasture conditions, and market prices. Satellite monitoring aids in planning grazing patterns and detecting environmental changes [66].

- **Capacity Building:** Joint programs offer training in sustainable grazing practices, animal health, and business skills [67].

- *Impact: Improved decision-making enhances productivity and resilience; technology aids in disease control and risk management [68].*

3.3.2.5 Ethnic Policies and Cultural Preservation

- **Recognition of Maasai Rights:** Legal frameworks safeguard Maasai land rights and access to grazing lands. Cultural preservation initiatives support Maasai traditions through festivals, educational programs, and integration into tourism [62].

- **Community Participation:** Inclusive governance ensures Maasai representation in decision-making processes at local and national levels [69].

Impact: Empowerment sustains the Maasai's livelihoods and cultural identity, fostering social cohesion and stability [64].

4. Proposal and Recommendations

4.1 Past Efforts and Results of Inner Mongolia

4.1.1 Past Efforts

- **Promotion of Eco-Tourism:** Developing tourism infrastructure in pastoral regions and creating tourism projects that feature Mongolian culture, history, and lifestyle. This includes attracting tourists to experience the unique grassland culture through cultural exhibitions and events [70].

- **Sustainable Agriculture and Renewable Energy:** Introducing sustainable farming practices and

encouraging organic agriculture to meet the growing market demand for green and healthy products. Investing in wind and solar energy projects leverages the rich natural resources of pastoral areas, promoting energy transformation and improving the ecological environment [19].

4.1.2 Good Results

- **Economic Diversification:** The development of new industries provided herders with diversified income sources, reducing dependence on traditional animal husbandry and increasing household income and living standards [22].
- **Infrastructure Improvement:** The construction of tourism and energy projects led to upgrades in infrastructure such as roads, electricity, and communication, improving living conditions and the development environment in pastoral areas [23].
- **Cultural Preservation and Promotion:** Eco-tourism emphasizes Mongolian traditional culture, promoting its inheritance and dissemination, and enhancing ethnic pride [71].

4.1.3 Negative Impacts

- **Cultural Commodification:** The commercialization of tourism may lead to the oversimplification or commercial packaging of traditional culture, weakening its authenticity and spiritual significance [72].
 - **Land Use Conflicts:** Renewable energy projects occupied portions of pastureland, reducing the area available for grazing and disrupting herders' traditional migratory routes and lifestyles [27].
- Environmental Issues:** Large-scale infrastructure development may cause ecological fragmentation, destruction of wildlife habitats, and environmental pollution, placing pressure on local ecosystems [26].

4.2 Future Collaboration Recommendation

China and Mongolia can leverage their shared interests and complementary strengths to promote the high-quality ecological development of the Mongolian steppe. This comprehensive approach addresses policy alignment, economic growth, environmental sustainability, renewable energy development, technological advancement, and cultural preservation, ultimately benefiting both nations and the pastoral communities that depend on the steppe ecosystem.

4.2.1 Management Policy Collaboration

Policy Alignment and Harmonization: China and Mongolia can collaborate to align their grassland management policies to ensure the sustainable use of the steppe ecosystem. By sharing best practices and harmonizing regulations on grazing management, pastureland use, and environmental protection, both countries can mitigate overgrazing and land degradation. Joint committees can be established to coordinate policy development and implementation.

Joint Policy Frameworks: Establishing bilateral agreements or joint policy frameworks can facilitate coordinated management of cross-border grasslands. This includes agreements on grazing periods, livestock numbers, and rotational grazing practices that respect traditional nomadic lifestyles while promoting ecological sustainability.

Legal and Regulatory Cooperation: Both countries can work together to strengthen legal protections for grasslands and herders' rights. Sharing experiences in implementing laws like China's Grassland Law can help Mongolia enhance its legal frameworks, ensuring effective enforcement and compliance.

Capacity Building and Training: Collaborative training programs for policymakers, local officials, and herders can enhance understanding of sustainable grassland management practices. Workshops, seminars, and exchange programs can facilitate knowledge transfer and improve policy implementation on both sides of the border.

4.2.2 Collaborative Economic Development of the Steppe

Livestock Industry Cooperation: The Mongolian steppe is central to the livestock industry. China and Mongolia can collaborate on technologies related to animal husbandry, grassland management,

and livestock breeding. By introducing modern breeding techniques and sustainable pasture management, both countries can improve pasture productivity while preventing overgrazing and land degradation.

Livestock Trade: There is significant potential for livestock and agricultural product trade between the two nations, particularly as China's demand for high-quality organic meat grows. Mongolia's premium beef and lamb products can be exported to China, boosting Mongolia's economy.

Eco-tourism Collaboration: The vast natural landscapes and unique nomadic culture of the Mongolian steppe attract many international tourists. China and Mongolia could jointly develop eco-tourism projects that promote green economic growth. For example, cross-border tourism routes could connect Inner Mongolia and Mongolia's natural and cultural sites, attracting a larger international audience.

Infrastructure Development: Mongolia's infrastructure is underdeveloped, particularly in transportation, electricity, and telecommunications. China could provide investment and technical support under the Belt and Road Initiative (BRI) framework to enhance Mongolia's transportation networks and power supply, facilitating economic growth in the steppe region.

4.2.3 Environmental Protection Cooperation

Grassland Conservation: The Mongolian steppe faces severe environmental challenges such as land degradation and desertification. China and Mongolia can deepen collaboration on ecological conservation by implementing joint projects to combat desertification, restore vegetation, and manage water resources. China's successful experience in combating desertification in Inner Mongolia can serve as a valuable model for Mongolia.

Cross-border Wildlife Protection: The Mongolian steppe is home to many migratory species such as the Mongolian gazelle and wild horses. As the two nations share an interconnected ecosystem, they can work together to establish transboundary wildlife protection corridors, allowing animals to migrate freely and minimizing the negative impacts of infrastructure barriers on biodiversity.

Development of Renewable Energy: The Mongolian steppe has abundant solar and wind energy resources. China and Mongolia could cooperate in developing renewable energy projects, such as solar power plants and wind farms. With China's technological and financial support, Mongolia can expand its renewable energy sector to meet domestic needs and potentially export energy to China.

4.2.4 Technical Solutions Cooperation

Sharing of Technological Innovations: China and Mongolia can cooperate in developing and sharing technological solutions for grassland management and pastoralism. This includes nature-based solutions, such as ecological restoration techniques, and advanced methods for monitoring grassland health using remote sensing and satellite imagery.

Implementation of Grass Banks and Fresh Grass Projects: Both countries can work together to establish grass banks that allow for sustainable grazing practices. By creating reserves of forage that can be used during droughts or harsh winters, herders can maintain livestock without overgrazing natural pastures. Fresh grass projects involve cultivating high-quality forage crops, reducing pressure on natural grasslands and improving livestock nutrition.

Establishment of Livestock Custody Centers: Collaborating on the development of livestock custody centers can help improve livestock quality and production efficiency. These centers provide herders with access to centralized feeding, veterinary services, and professional management, leading to healthier animals and higher-quality products.

Information Technology and Digital Management: Joint efforts in utilizing technologies such as remote sensing, GPS, and the Internet of Things (IoT) can enhance grassland ecological monitoring, livestock management, and early warning systems for disasters like grassland fires and pest outbreaks. Developing shared databases and information platforms can improve decision-making and resource management.

Water Resource Management Technologies: Cooperative development of water resource

management technologies, such as drilling wells, building reservoirs, and implementing rainwater harvesting systems, can address water scarcity issues in pastoral areas. Sharing expertise in efficient irrigation methods and water conservation can benefit both countries.

Disaster Risk Reduction and Management: Collaborating on technologies and strategies for disaster risk reduction, including monitoring weather patterns and developing rapid response mechanisms, can help mitigate the impacts of extreme weather events on herders and grasslands.

4.2.5 Cultural Cooperation

Preservation of Nomadic Culture: The nomadic culture of the Mongolian steppe is a shared cultural heritage for both Mongolia and China's Inner Mongolia. The two countries can collaborate on projects aimed at preserving and promoting nomadic traditions, such as joint cultural research, publications, exhibitions, and the international promotion of Mongolian steppe culture to a global audience.

Cultural and Educational Exchanges: China and Mongolia can further promote cultural and educational exchanges to enhance mutual understanding. This includes language programs, Mongolian studies cooperation, artist exchanges, and joint cultural festivals to strengthen ties between the two nations.

5. Conclusion

The Mongolian steppe, shared by China and Mongolia, represent a unique ecosystem and cultural landscape that demands careful, coordinated management. Both countries face significant challenges in promoting sustainable development across the steppe. The economic pressures of increasing livestock production, the degradation of grasslands, and the loss of biodiversity all require innovative, collaborative approaches that balance short-term needs with long-term sustainability.

Cultural preservation is also a key component in this complex issue. The traditional nomadic lifestyle, which has historically been intertwined with the health of the steppe, is at risk of being overshadowed by modernization, leading to the potential loss of centuries-old practices that are crucial for sustainable land management. In both Inner Mongolia and Mongolia, language shifts and educational policies further complicate the efforts to preserve cultural identity.

However, there are also numerous opportunities for collaboration. By learning from global best practices—such as those from the Serengeti-Maasai grasslands and the North American prairies—China and Mongolia can develop joint strategies that include shared wildlife conservation efforts, cross-border trade in livestock, renewable energy development, and the promotion of eco-tourism. These initiatives can help protect the biodiversity of the steppe while supporting economic growth.

Ultimately, the future of the Mongolian steppe depends on the ability of China and Mongolia to harmonize their policies, respect cultural differences, and work towards common environmental goals. International cooperation, technology sharing, and a focus on both ecological and cultural sustainability are essential for ensuring the long-term prosperity of the Mongolian steppe and the communities that rely on it.

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