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Original Paper

Study on the Reconfiguration Mechanism of the "Production-Living-Ecological Space" in Rural Areas of Xizang under the Gradient of Altitude and Cultural Geographical Environment

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Abstract

The unique altitude gradient of the Qinghai-Tibet Plateau and its profound cultural-geopolitical environment jointly shape the fundamental pattern of the rural regional system in Xizang. Focusing on the "Production-Living-Ecological" spaces, this study aims to reveal their reconstruction mechanisms under the dual influence of the high-altitude environment and ethnic culture. By constructing a "Production-Living-Ecological" spaces classification system incorporating altitude factors and employing GIS spatial analysis and the Geodetector model, this research quantitatively analyzes the spatial pattern evolution in the Xizang Autonomous Region from 2000 to 2020. The results indicate that during the study period, driven by the ecological priority strategy, Xizang's territorial space underwent a fundamental transformation from "production-dominated" to "ecology-dominated," with the proportion of ecological space increasing from 48.0% to 75.2%. The altitude gradient serves as the rigid framework for vertical spatial differentiation, with low, medium, and high-altitude zones corresponding to "living-production core areas," "agro-pastoral ecological transition zones," and "absolute ecological dominance zones," respectively. Geodetector results show that the interaction between road network density and GDP is the core economic engine driving the agglomeration of production and living spaces, while its superposition with natural endowments (e.g., precipitation) constitutes a primary pressure source on ecological space. The cultural-geopolitical environment, with social capital, folk traditions, and ecological ethics at its core, deeply regulates and maintains the internal order and resilience of rural spaces through mechanisms of "cohesion," "activation," and "regulation." Accordingly, this paper proposes an optimization pathway of "vertical division of labor, cultural empowerment, and zonal coordination," aiming to provide theoretical reference and practical guidance for harmonizing human-land relationships and achieving sustainable development in high-altitude ethnic regions.

Keywords

Xizang rural areas, Production-Living-Ecological Spaces, altitude gradient, cultural-geopolitical environment, reconstruction mechanism

1. Introduction

The Xizang Autonomous Region is a crucial bastion for national ecological security and a significant carrier of distinctive Chinese national culture. Its rural development holds multiple strategic significances, encompassing ecological security, borderland stability, and cultural heritage. The unique geographical environment of the Qinghai-Tibet Plateau, with an average altitude exceeding 4,000 meters, creates a pronounced altitude gradient effect. This leads to vertical zonal differentiation in resource endowments like light, heat, water, and soil, fundamentally predetermining the suitability and limitations of land use. Simultaneously, the cultural-geopolitical environment, primarily shaped by Tibetan culture and integrating multi-ethnic elements, is deeply embedded in the fabric of rural space through historically accumulated social networks, values, and production modes. Against the backdrop of synergistic advancement of ecological civilization construction and rural revitalization strategies, optimizing the layout of the "Production-Living-Ecological Spaces" has become a core issue for Xizang to achieve high-quality development. However, contradictions exist between the fragility of the plateau's ecological environment and development needs: traditional extensive pastoralism leads to grassland degradation; the expansion of production and living spaces in river valleys squeezes ecological space; infrastructure and public services remain inadequate in remote villages. Although national fiscal transfers and counterpart assistance provide substantial external support, constructing an endogenous development mechanism aligned with regional characteristics still requires an in-depth analysis of the internal logic of its spatial reconstruction. Existing research either focuses on macro ecological pattern assessment, emphasizes characteristic industry development, or examines the impacts of urbanization and infrastructure. There is a lack of comprehensive studies that systematically deconstruct the reconstruction mechanisms of the "Production-Living-Ecological Spaces" by combining the rigid natural constraints of the altitude gradient with the flexible social shaping of the cultural-geopolitical environment.

Therefore, this paper adopts "altitude gradient" and "cultural-geopolitical environment" as core analytical perspectives, aiming to systematically reveal the characteristics, multi-dimensional driving forces, and interaction mechanisms behind the evolution of the "Production-Living-Ecological Spaces" pattern in Xizang's rural areas, and to explore adaptive spatial optimization pathways. This research not only contributes to enriching theories of rural geography and territorial spatial planning in special-type regions but also provides a scientific basis for balancing protection and development within an ecological civilization framework for Xizang and other high-altitude ethnic regions.

2. Theoretical Foundation

2.1 "Production-Living-Ecological Spaces" Theory and Its Localized Interpretation

The "Production-Living-Ecological Spaces" theory is a core planning concept in China for balancing development and protection. Its connotation requires localized interpretation in the Xizang context:

(1) Production Space: This includes not only intensive agriculture (highland barley, vegetables) in river valleys and point-distributed industrial/mining and clean energy bases but also emphasizes pastoral production spaces in alpine meadows and grasslands, which are the pillar of Xizang's traditional economy and the livelihood foundation for farmers and herders. Following the "dominant function" principle, this study defines high and medium-coverage grasslands as pastoral production space and distinguishes low-coverage grassland as grassland ecological space for more precise functional identification.

(2) Living Space: Characterized by a typical pattern of "large dispersion, small agglomeration," settlement distribution is strongly influenced by water sources, farmland/pastureland, and cultural nodes. Its expansion and optimization are closely related to infrastructure improvement, equalization of public services, and the inheritance of traditional culture.

(3) Ecological Space: As the absolute main body of territorial space, it carries crucial ecosystem service functions such as water conservation, biodiversity protection, and carbon sequestration. It represents the ecological bottom line for regional development and a potential source of value transformation.

2.2 Altitude Gradient and Cultural-Geopolitical Environment

The altitude gradient is a decisive factor shaping the spatial differentiation of both the natural environment and human activities on the plateau. As altitude increases, natural elements like temperature, precipitation, and soil change regularly, forming a vertical natural zonation spectrum from river valley agricultural belts to alpine frigid desert belts. This pattern profoundly constrains the suitability of land resources, agricultural production potential, and ecological sensitivity across different altitude zones, thereby predetermining the basic framework for the vertical differentiation and functional division of the "Production-Living-Ecological Spaces". The altitude gradient is fundamental for understanding the vertical differentiation and functional division of "Production-Living-Ecological Spaces" in Xizang's rural areas.

The cultural-geopolitical environment refers to the socio-cultural system formed through long-term interaction and integration of history, ethnicity, religion, customs, etc., within a specific geographical space. In Xizang, centered around Tibetan Buddhist culture and traditional tribal social networks, it encompasses rich social capital, local knowledge, and ecological ethics. This environment not only shapes unique settlement landscapes and spiritual spaces but also continuously participates in the construction and reproduction of rural space by influencing collective action logic, resource use norms, and community governance models.

2.3 Literature Review and Position of This Study

Domestic and international research provides a foundation. International studies offer references in spatial structure theory and ecosystem service assessment. Domestic research has achieved fruitful results

in "Production-Living-Ecological Spaces" identification methods, pattern evolution, functional evaluation, and driving force analysis, with research methods increasingly trending towards multi-model integration and dynamic simulation. However, systematic research on "Production-Living-Ecological Spaces" in regions like the Qinghai-Tibet Plateau, characterized by extreme environments and unique cultural overlays, remains relatively weak. Most existing studies list natural and socio-economic factors in parallel, failing to deeply reveal how the altitude gradient modulates the spatial effects of socio-economic drivers and how cultural-geopolitical factors participate in spatial reconstruction as endogenous variables. This paper attempts to bridge this gap by integrating natural and humanistic perspectives to construct a more explanatory analytical framework.

3. Research Design

3.1 Study Area

The Xizang Autonomous Region features a unique natural geographical environment with significant climatic vertical differentiation. Population and economic activities are highly concentrated in relatively low-altitude river valley areas like the "One River and Two Tributaries" (Yarlung Zangbo River, Lhasa River, and Nyangchu River). Rural settlements are dispersed, significantly constrained by terrain, water sources, and usable grassland resources. The Tibetan ethnic group is the main population, and local distinctive ethnic culture has a profound influence, forming a unique cultural-geopolitical environment integrating cultural beliefs, traditional customs, and social organization.

3.2 Data Sources

Land use data are from the Resource and Environment Science and Data Center, Chinese Academy of Sciences (five periods of 30-meter resolution land use remote sensing data for 2000, 2005, 2010, 2015, and 2020). Socio-economic data are from the Xizang Statistical Yearbook and China City Statistical Yearbook for various years. Natural geographical data (e.g., DEM, temperature, and precipitation raster data) are from relevant datasets of the Chinese Academy of Sciences. Cultural-geographical data are primarily obtained from local chronicles, cultural heritage lists, and field research materials.

3.3 Research Methods

GIS Spatial Analysis and "Production-Living-Ecological Spaces" Classification: Based on the dominant function principle and the reality of Xizang, a classification system with 9 secondary categories was established (see Table 1). The key step is subdividing grassland into pastoral production space and grassland ecological space based on function. ArcGIS was then used for spatial visualization, area statistics, etc.

Table 1. "Production-Living-Ecological Spaces" Classification System for the Xizang Autonomous Region

Land use function classification		Corresponding to the classification in GB/T 21010-2017	Corresponding to the current classification of land use
Primary classification	Secondary classification		
Production Space (Y_prod)	K1 Agricultural Production Space	00101 Paddy fields, 0102 Irrigated land, 0103 Dry land, 0201 Orchards, 0202 Tea gardens, 0203 Rubber plantations, 0204 Other gardens	11 Paddy fields, 12 Dry land
	K2 Pastoral Production Space	0401 Natural pastures, 0403 Artificial pastures	31 High coverage grasslands, 32 Medium coverage grasslands
	K3 Industrial and Mining Production Space	1001 Railway Land, 1002 Rail Transit Land, 1003 Road Land, 1004 Urban and Village Road, 1005 Transportation Service Station Land, 1006 Rural Road, 1007 Airport Land, 1202 Facility Agricultural Land, 106 Port and Wharf Land, 1008 Port and Wharf Land, 1009 Pipeline Transportation Land, 1109 Hydraulic Construction Land, 0601 Industrial Land, 0602 Mining Land, 0603 Salt Field, 0604 Storage Land, 0906 Scenic Spot Facilities Land	53 Construction Land for Industry and Transportation
Living Space (Y_life)	K4 Urban Living Space	05 Commercial Service Land, 0701 Urban Residential Land, 08 Public Administration and Public Service Land	51 Urban Land
	K5 Rural Living Space	0702 Rural Homestead Land	52 Rural Residential Area
Ecological Space (Y_eco)	K6 Forest Ecological Space	0301 Tree Forest Land, 0302 Bamboo Forest Land, 0303 Mangrove Forest Land, 0305 Shrub Forest Land, 0307 Other Forest Land	21 Forest Land, 22 Shrub Forest Land, 23 Open Forest Land, 24 Other Forest Land
	K7 Grassland Ecological Space	0404 Other Grassland	33 Low Coverage Grassland
	K8 Water Ecological Space	1101 River Water Surface, 1102 Lake Water Surface, 1103 Reservoir Water Surface, 1104 Pond Water Surface, 1105 Coastal Mudflat,	41 River Channel, 42 Lake, 43 Reservoir Pond, 44 Permanent

		1106 Inland Mudflat, 1107 Ditch, 1108 Marshland, 1110 Glacier and Permanent Snow, 0304 Forest Marshland, 0306 Shrub Marshland, 0402 Marsh Grassland	Glacier Snow, 45 Mudflat, 46 Beachland, 64 Marshland
	K9 Other Ecological Space	1201 Vacant Land, 1203 Field Slope, 1204 Saline Soil, 1205 Sandy Land, 1206 Bare Land, 1207 Bare Rock and Gravel Land	61 Sandy Land, 62 Gobi, 63 Saline Soil, 65 Bare Land, 66 Bare Rock and Gravel, 67 Other Unutilized Land

Geodetector Model: Used to quantitatively detect the explanatory power and interaction of various factors on the differentiation of "Production-Living-Ecological Spaces". Five key factors were selected: altitude (X1), road network density (X2), GDP (X3), scenic spot density (X4), and population (X5). This model effectively handles categorical variables and detects non-linear relationships.

Theoretical and Empirical Combined Analysis: Based on quantitative analysis, qualitative interpretation of the mechanisms of the cultural-geopolitical environment is provided by combining historical literature and cases, achieving mutual verification between macro patterns and micro mechanisms.

4. Results Analysis

4.1 Overall Pattern of "Production-Living-Ecological Spaces" in Xizang

Based on the established classification system, ArcGIS was used for spatial visualization of Xizang's "Production-Living-Ecological Spaces" (Figure 1). The "Production-Living-Ecological Spaces" in Xizang exhibit typical characteristics of "ecology-dominated, production-constrained, and living-agglomerated." Ecological space is widespread across the region, forming the base of the rural territorial system. Production space is constrained by natural conditions, concentrating in river valleys and some medium-to-high altitude pastures. Living space appears as point-like scatterings relying on farmland, pastureland, and transportation routes, forming a rural settlement system of "large dispersion, small agglomeration."

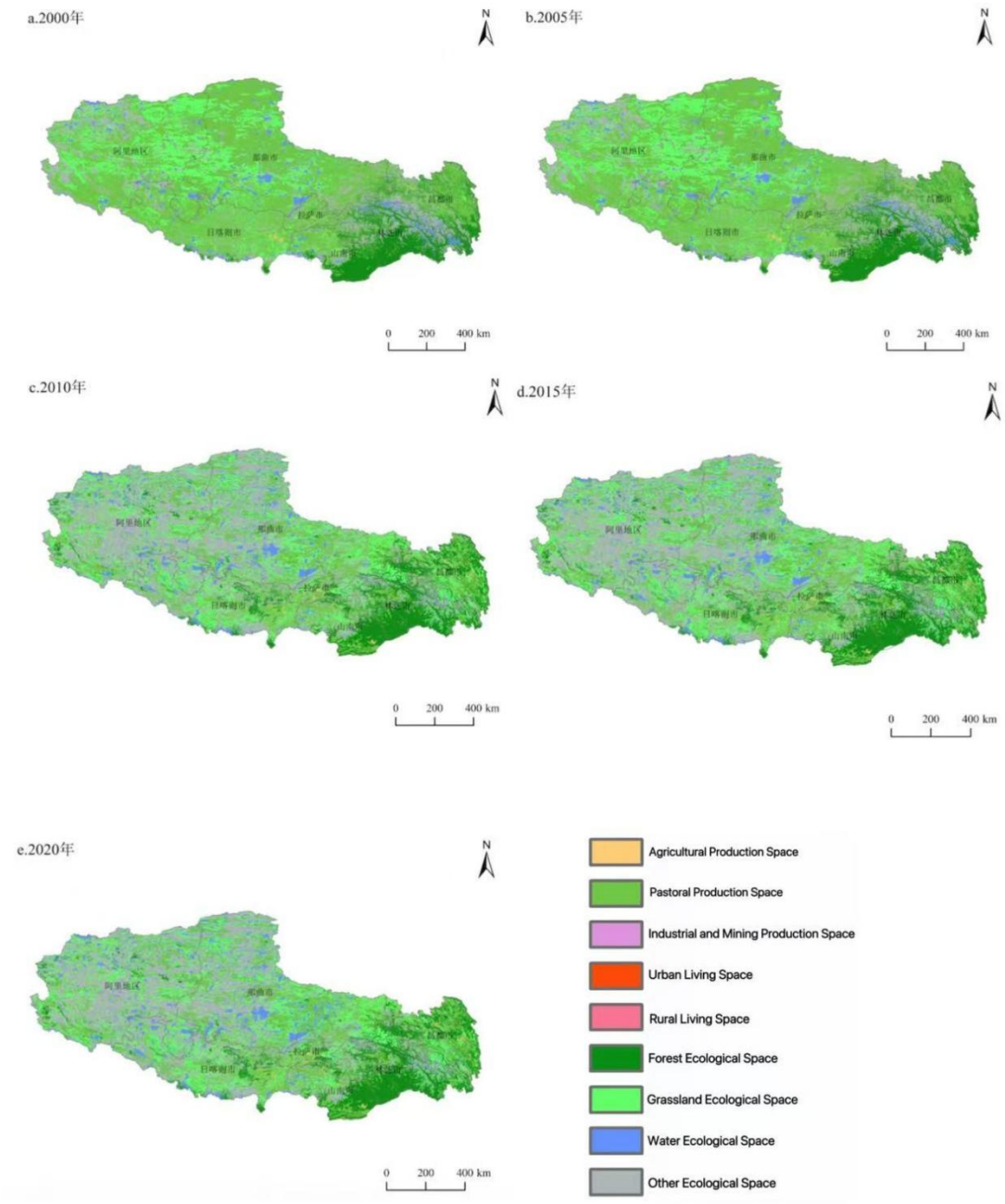

Figure 1. Distribution Map of "Production-Living-Ecological Spaces" in the Xizang Autonomous Region (2000-2020)

4.2 Spatiotemporal Evolution: Ecological Transformation and Spatial Reconstruction

Based on the extraction of the area of "Production-Living-Ecological Spaces" in the Xizang Autonomous Region from 2000 to 2010 using ArcGIS, an analysis of the data changes was conducted and summarized in Table 2.

Table 2. Changes in the Proportion of "Production-Living-Ecological Spaces" Area in the Xizang Autonomous Region (2000-2010)

Spatial Type	Production Space	Living Space	Ecological Space	Main Characteristics of Change
Proportion in 2000	52.0%	<0.01%	48.0%	Production space held relative dominance, primarily consisting of pastoral production.
Proportion in 2010	24.8%	0.02%	75.2%	Ecological space expanded rapidly, while production space contracted significantly.

The period from 2000 to 2010 marked a crucial decade of fundamental and strategic restructuring in the territorial spatial pattern of Xizang. During this time, the proportion of ecological space achieved a leap from 48.0% to 75.2%, an increase of 27.2 percentage points, firmly establishing its position as the absolute dominant component of the territorial space. In stark contrast, the proportion of production space plummeted from 52.0% to 24.8%, a decrease of nearly half. This dramatic shift primarily stemmed from the comprehensive implementation of major national ecological projects, such as the "Grazing Ban and Grassland Restoration" initiative, which drove the large-scale, systematic functional conversion of pastoral production spaces (medium- and high-coverage grasslands) into ecological spaces. Although the proportion of living space increased from nearly zero to 0.02%, its scale remained minimal. The spatial evolution during this period clearly demonstrates that, under the strong guidance of national policies and the impetus of ecological security strategies, Xizang's territorial spatial functions underwent a profound transformation from "production-dominated" to "ecology-dominated," laying a solid spatial foundation for fortifying the national ecological security barrier.

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Spatial Type	Production Space	Living Space	Ecological Space	Main Characteristics of Change
Proportion in 2010	24.8%	0.02%	75.2%	Ecological space already dominated, with production primarily based on pastoralism.
Proportion in 2020	24.7%	0.03%	75.2%	Ecological space remained stable, production space underwent minor adjustments, and living space experienced a slight increase.

From 2010 to 2020, the pattern of "Production-Living-Ecological Spaces" in Xizang entered a stage of structural stabilization and internal optimization. The proportion of ecological space stabilized at a high level of 75.2%, indicating that the large-scale ecological expansion of the previous phase was largely complete, and the main framework of the ecological barrier had become relatively consolidated. The proportion of production space showed a minor adjustment from 24.8% to 24.7%, a decrease of only 0.1 percentage points, signifying a significant narrowing of the rate of change. This reflects that after undergoing drastic contraction, the spatial carriers of production activities entered a phase of stock optimization and intensive utilization, with industries such as characteristic agriculture and animal husbandry, as well as clean energy, pursuing high-quality development under strict ecological constraints. The proportion of living space increased slightly from 0.02% to 0.03%. Although the increase was small, analysis based on transition matrices reveals that its sources became more diversified, reflecting the continuous optimization of rural settlement layouts driven by policies such as rural revitalization and housing security projects. Overall, the evolutionary characteristics of this stage shifted from "dramatic scale change" to "structural fine-tuning" and "quality enhancement," placing greater emphasis on the coordination of internal functions within the three spaces and the cultivation of sustainable development capacity, while firmly maintaining the ecological bottom line.

4.3 Vertical Differentiation of "Production-Living-Ecological Spaces" under the Altitude Gradient

Based on DEM, the study area was divided into low (<3500m), medium (3500-4500m), and high (>4500m) altitude zones. The composition of "Production-Living-Ecological Spaces" differs significantly across these zones.

Low-altitude zone (<3500m): This is the core densely populated area for production and living. Although the area is limited, it concentrates most of the farmland, towns, industrial and mining facilities, and transportation routes. The economic density is high, making it the engine of regional growth.

Medium-altitude zone (3500-4500m): It presents typical characteristics of agricultural and pastoral transition and ecological transition. The proportion of pastoral production space is significant, while the living space is scattered. Ecological sensitivity and human activities are intertwined, making it a key area for coordinating protection and development.

High-altitude zone (>4500m): Ecological space occupies an absolute dominant position. Human activities are limited to extremely low-intensity seasonal nomadism. The ecosystem is extremely fragile, making it the core area of the national ecological security barrier.

Table 4. Statistics and Changes in the Area of "Production-Living-Ecological Spaces" Across Different Altitude Gradients in the Xizang Autonomous Region (2010-2020) Unit: km²

Altitude Gradient (m)	Space Category	Sub-class Composition	Area in 2010	Area in 2020	Area Change (2020-2010)	Change Rate (%)
<3500	Production Space	K1+K2+K3	13482.75	13468.15	-14.60	-0.11
	Living Space	K4+K5	39.39	59.10	+19.71	+50.06
	Ecological Space	K6+K7+K8+K9	71256.61	71252.21	-4.40	-0.01
3500-4500	Production Space	K1+K2+K3	53871.78	53859.64	-12.14	-0.02
	Living Space	K4+K5	194.59	336.88	+142.29	+73.14
	Ecological Space	K6+K7+K8+K9	137785.27	137652.97	-132.30	-0.10
＞4500	Production Space	K1+K2+K3	289630.15	288781.20	-848.95	-0.29
	Living Space	K4+K5	23.22	51.42	+28.20	+121.48
	Ecological Space	K6+K7+K8+K9	883025.66	883846.47	+820.81	+0.09

Summary of Key Change Patterns:

(1) Production Space: Stable with Minor Adjustments

Production space experienced slight contraction across all altitude gradients, with change rates ranging from –0.11% to –0.29%, indicating overall stability.

The low-altitude zone (<3500 m) decreased by 14.60 km², primarily due to the reduction in agricultural production space.

The mid-altitude zone (3500–4500 m) decreased by 12.14 km², representing the smallest change.

The high-altitude zone (>4500 m) decreased by 848.95 km², the largest relative decline, mainly driven by adjustments in pastoral production space.

(2) Living Space: Marked Expansion

Living space increased significantly across all altitude gradients, reflecting progress in urban-rural development and livelihood improvement.

Low-altitude zone: Increased by 19.71 km² (+50.06%), representing the core area of urbanization and population agglomeration.

Mid-altitude zone: Increased by 142.29 km² (+73.14%), the largest absolute growth, indicating notable achievements in housing projects and rural revitalization.

High-altitude zone: Increased by 28.20 km² (+121.48%), the highest growth rate, suggesting improved settlement conditions in extreme environments.

(3) Ecological Space: Generally Stable

Ecological space showed minimal decline in low- and mid-altitude zones (–0.01% to –0.10%).

In the high-altitude zone, ecological space increased by 820.81 km² (+0.09%), primarily attributable to

the notable expansion of water ecological space (glacial and lake changes) and the transformation or restoration of other ecological land types.

Pronounced Altitude Gradient Effects

<3500 m: The most intensive expansion of living space alongside minor ecological adjustments, reflecting characteristics of a core development zone.

3500–4500 m: The largest-scale expansion of living space, with stable ecological and production spaces, representing a key zone for human-environment coordination.

>4500 m: Ecological space remains overwhelmingly dominant and slightly increased, while living space shows rapid growth from a small base, and production space undergoes modest optimization, embodying a development logic of ecological priority with limited development.

4.4 Driving Force Analysis Using Geodetector

To quantitatively identify driving factors, the Geodetector model was employed. Using 2020 spatial data, seven driving factors were selected (X1 built-up area, X2 road network density, X3 scenic spot density, X4 temperature, X5 precipitation, X6 population, X7 GDP) to analyze dominant driving forces and interaction effects for different space types.

Single-factor detection results (Table 5) show: Road network density (X2) has the strongest explanatory power for the differentiation of production space (q=0.702) and living space (q=0.627), indicating that transportation conditions are a core infrastructure variable reshaping the socio-economic space of Xizang's rural areas. GDP (X3) also has relatively strong explanatory power for production space (q=0.491). For ecological space, natural endowments (e.g., altitude X1) still have a foundational influence, but the high q values for road network density (q=0.691) and GDP (q=0.630) highlight the pervasiveness of human activity pressure.

Table 5. Single-Factor Detection Results for "Production-Living-Ecological Spaces" in the Xizang Autonomous Region in 2020

Driving factor	Production Space		Living Space		Ecological Space	
	q	p	q	p	q	p
X1	0.275	0.026	0.139	0.036	0.386	0.001
X2	0.702	0.000*	0.627	0.000*	0.691	0.000*
X3	0.303	0.021	0.134	0.048	0.314	0.005
X4	0.363	0.001	0.704	0.000*	0.362	0.001
X5	0.400	0.001	0.404	0.001	0.547	0.000*
X6	0.467	0.000*	0.175	0.044	0.581	0.000*
X7	0.491	0.000*	0.222	0.131	0.630	0.000*

Interaction detection (Figure 2) shows: Factors exhibit two-factor enhancement or nonlinear enhancement effects. "Road network density ∩ GDP" has the strongest explanatory power for production space (interaction q value >0.9), forming a "transportation-economy" growth coupling engine driving industry and population agglomeration to advantageous areas. Interactions like "Road network density ∩ Altitude" or "GDP ∩ Scenic spot density" have extremely high explanatory power for ecological space, revealing the superposition and amplification effects of development pressure in ecologically fragile or high-value areas, representing a major challenge for ecological protection.

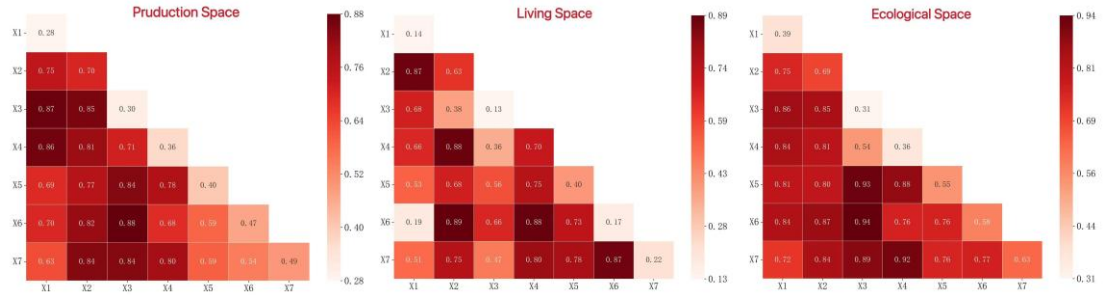

Figure 2. Heat Map of Interaction Factor Detection for "Production Space, Living Space, and Ecological Space" in the Xizang Autonomous Region in 2020

5. Discussion on the Mechanism of Cultural-Geopolitical Environment

Quantitative models cannot fully capture the complex influence of the cultural-geopolitical environment, but its mechanisms can be elucidated through qualitative analysis, corroborating with quantitative patterns.

The "Cohesion" and "Organization" Mechanism of Social Capital: Historically formed social networks based on monasteries and tribes serve as the social foundation for modern rural cooperatives, tourism consortia, and other new economic organizations. This social capital reduces transaction costs, promotes the sharing of information, labor, and even risks among dispersed villages, strengthening the internal connections and organizational resilience of rural socio-economic space, partially offsetting the barriers caused by spatial distance in high-altitude areas.

The "Spatiotemporal Activation" and "Value Transformation" Mechanism of Folk Festivals: Traditional festivals such as Tibetan New Year, Ongkor Festival, and Horse Racing Festival periodically and ritually create and reinforce specific public spatiotemporal nodes. These nodes are not only carriers of cultural inheritance but also temporary markets, information exchange centers, and social interaction platforms, activating rural economic and social space and facilitating the spatial transformation of cultural capital into tourism economic capital.

The "Implicit Regulation" and "Community Co-management" Mechanism of Ecological Ethics: Beliefs like the worship of "Sacred Mountains and Holy Lakes" and the concept of the equality of all beings are internalized into community norms, forming an informal "implicit regulation." This complements "explicit policies" like national ecological compensation, guiding residents to spontaneously participate

in actions such as pasture rotation, garbage cleaning, and poaching prevention. It enhances the community's subjective role and internal motivation in ecological space management and protection, serving as important cultural support for the implementation of ecological policies.

6. Optimization Pathways: Development Choices Based on Dual Constraints and Empowerment

Based on the constraining nature of the "altitude gradient" and the empowering nature of the "cultural-geopolitical environment," future optimization of "Production-Living-Ecological Spaces" in Xizang's rural areas should implement differentiated and coordinated pathways.

6.1 Industrial Dimension: Implement the "Vertical Division of Labor and Integrated Value-Added" Pathway

Low-altitude river valley area: Strengthen technological support, develop green high-value agriculture, agricultural product deep processing and cultural tourism services, and create an intensive growth pole.

Mid-altitude agricultural and pastoral transitional zone: Promote the "family ecological pasture + cooperative + brand e-commerce" model to promote grassland-cattle balance and promote the deep integration of pastoralism with ecological tourism and cultural experiences.

High-altitude ecological area: Strictly protect, explore the development of ecological management public welfare positions, special operations (such as high-end scientific research, photography tours) and carbon sink projects.

6.2 Living Dimension: Practice the "Cultural Inheritance and Livable Space" Pathway

Spatial form: Rural construction should respect traditional textures surrounding monasteries and adapting to mountains and waters, adopting methods of "micro-renovation, refined enhancement" to avoid homogenization.

Functional activation: Encourage the conversion of traditional dwellings and idle public buildings into intangible cultural heritage learning centers, community museums, and characteristic homestays, integrating cultural heritage spaces into modern life and consumption chains.

Governance innovation: Explore "cultural point systems" or community funds, linking residents' participation in cultural inheritance and environmental governance with collective welfare to stimulate endogenous governance vitality.

6.3 Ecological Dimension: Improve the "Zonal Management and Value Realization" Pathway

Strict protection zones: Utilize technologies like remote sensing and drones for intelligent management and protection.

Restoration and moderate utilization zones: Scientifically implement ecological engineering projects and explore the development of ecological products like water conservation and climate regulation.

Mechanism innovation: Actively research and pilot market-based trading mechanisms for regional water rights, carbon sinks, landscape rights, etc., promoting the value transformation of "lucid waters and lush mountains" into "valuable assets."

Production-Living-Ecological Spaces

7. Conclusion and Outlook

Integrating natural and humanistic perspectives, this study draws the following conclusions on the reconstruction mechanism of "Production-Living-Ecological Spaces" in Xizang's rural areas:

Pattern and Evolution: From 2000 to 2020, Xizang's territorial space underwent a profound ecological transformation. The dominant position of ecological space was unprecedentedly strengthened, reflecting the powerful spatial shaping force of the national ecological security strategy.

Vertical Differentiation Pattern: The altitude gradient constitutes the rigid framework for the vertical differentiation pattern of the "Production-Living-Ecological Spaces". Low, medium, and high-altitude zones form functionally distinct "core development areas," "coordination transition areas," and "absolute protection areas," respectively.

Core Driving Forces: The coupling of improved road network density and economic growth is the core economic engine driving the agglomeration of production and living spaces towards low-altitude advantageous areas. The superposition of this developmental momentum with the fragile ecological endowment constitutes the primary pressure source faced by ecological space.

The Internal Role of Culture: The cultural-geopolitical environment is not a passive backdrop. Through social capital networks, folk festival practices, and ecological ethical norms, it deeply participates in the construction, maintenance, and adaptation of rural space via mechanisms of "cohesion," "activation," and "regulation," serving as important soft power for endogenous rural development.

Future research could deepen in the following directions: First, employing technologies like Agent-Based Modeling (ABM) to simulate the dynamic responses of "Production-Living-Ecological Spaces" under different policy scenarios. Second, constructing quantitative systems for soft indicators like social capital and cultural identity, and analyzing their correlation with spatial performance. Third, conducting in-depth community case tracking to reveal the micro-processes and mechanisms of human-land interaction within specific cultural-geopolitical units in a refined manner.

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