

Postprint: Analysis of Multi-system Synergy Level, Spatio-temporal Evolution, and Mechanism of Rural Tourism Public Services in China

Authors: Zhang Xincheng

Date: 2022-02-11T01:34:56+00:00

Abstract

By constructing a five-element system coupling model, this study measures the coordination degree of rural tourism public information services, safety and security services, transportation convenience services, people-benefit and convenience services, and public administrative services across 30 provinces (autonomous regions, municipalities) in China from 2007 to 2018, employs a dynamic evolution model to examine the operational result states of the five-element subsystems and their linear velocity evolution processes, and explores the functional mechanisms of the coupled and coordinated development of the five-element system through qualitative comparative analysis. The findings reveal: (1) The overall level of coupling coordination degree of the five-element system for rural tourism public services in China is relatively low, with problems of systematic coordination imbalance. Spatially, it exhibits a non-equilibrium pattern, primarily resulting from differential impacts generated within and through the overlapping of eastern, central, and western regions. (2) The spatial structure evolution of the five-element system coupling degree demonstrates a multi-polarization trend, and the linear evolution velocity trend of the coupling degree conforms to the law of diminishing marginal utility. Specifically, hotspot areas exhibit periodic characteristics of alternating fast and slow evolution, warm spot areas have entered a transition period from increasing to diminishing marginal effects, while cold spot areas have entered an upward cycle. (3) The five-element subsystems have shown significant overall improvement, yet substantial differences remain among the various systems, and the dominant factors of each subsystem also differ, which also constitute an important reason for the relatively low coupling degree of rural tourism public services. (4) The multi-coordinated development of China's rural tourism public service system is the result of the joint action of the five major systems: information service is a sensitive factor, security service is a non-sensitive factor, transportation service is a fundamental

factor, people-benefit service is an internal supporting force, and administrative service is an external supporting force.

Full Text

Spatiotemporal Evolution and Functional Mechanism of Multi-System Coordination in China's Rural Tourism Public Services

Abstract

This study constructs a five-element system coupling model to measure the coordination degree of rural tourism public information services, security assurance services, transportation convenience services, people-benefiting convenience services, and public administrative services across 30 provinces (autonomous regions and municipalities) in China from 2007 to 2018. Using a dynamic evolution model, we examine the operational state of the five-element subsystems and their linear velocity evolution processes, and explore the mechanisms of coordinated development through qualitative comparative analysis. The findings reveal that: (1) The overall coupling coordination level of China's rural tourism public service five-element system remains relatively low, with systemic coordination imbalances evident. Spatial patterns show pronounced non-equilibrium, primarily attributable to differential impacts within and across eastern, central, and western regions. (2) The spatial structure evolution of the five-element system coupling degree exhibits multipolarization trends, with linear evolution velocities following the law of diminishing marginal utility. Specifically, hotspot regions display alternating fast-slow periodic characteristics, warm spot regions are transitioning from increasing to decreasing marginal effects, while cold spot regions have entered an upward cycle. (3) While the five subsystems have improved overall, significant inter-system differences persist, with varying dominant factors across subsystems, representing an important cause of low coupling coordination. (4) The diversified and coordinated development of China's rural tourism public service system results from the joint action of five major systems: information services serve as sensitive factors, security services as non-sensitive factors, transportation services as foundational factors, people-benefiting services as internal support forces, and administrative services as external support forces.

Keywords: rural tourism; tourism public services; coupling; Bayesian hierarchical spatio-temporal model

1. Introduction

As market demand continues to grow, rural tourism has become a crucial pathway for achieving rural revitalization and high-quality development goals. How-

ever, sustainable development of rural tourism faces numerous constraints, particularly evident in shortcomings of tourism public services such as information gaps, inadequate medical security, and poor scenic area transportation. In 2018, the *Guiding Opinions on Promoting Sustainable Development of Rural Tourism* identified improving tourism service facilities and systems in rural areas as a primary objective. That same year, the *Action Plan for Upgrading the Quality of Rural Tourism Development (2018-2020)* proposed promoting standardized development of rural tourism services and establishing supporting facilities including signage, transportation stations, and tourist toilets in rural destinations. Against this backdrop, what is the current coordination level of this integrated rural tourism public service system? How do subsystems evolve differently, and what are their combined interaction pathways? Addressing these questions is essential for filling gaps in the rural tourism public service system, improving service quality, and promoting rural revitalization.

Existing literature on rural destination tourism public service system development remains relatively scarce. With the rise of rural tourism, foreign scholars have migrated urban tourism public service research frameworks to rural destinations, examining service quality, service management, transportation, policy, safety, and convenience services. Domestic research started later. Although China proposed the Beautiful Countryside Construction Strategy in 2013, theoretical research still lags behind practical development. Studies have discussed the importance of rural tourism public service construction in the context of rural revitalization, urban-rural integration, tourism poverty alleviation, and high-quality development. A few scholars have focused on rural tourism public service system development. For instance, Dong Dandan noted that rural tourism public service construction should meet both tourist needs and improve rural residents' living standards. Jiang Mengda identified transportation and people-benefiting services as common shortcomings. Luo Chenghua et al. proposed that a sound government administrative service system is essential for rural tourism public service supply, suggesting a "shared by hosts and guests" supply system. Li Shuang et al. argued that with diversified tourist demands, the third sector's role in rural tourism public service supply will become increasingly prominent. Zhang Xincheng et al. suggested that rural tourism development's early stage should emphasize hard infrastructure, while later stages should focus on soft environment construction. Gao Nan et al. identified issues such as inadequate administrative services, insufficient breadth of public information services, and lagging people-benefiting convenience services.

While existing research provides a foundation, theoretical discussions dominate, with limited empirical studies, particularly lacking measurement of collaborative development levels, dynamic evolution, and functional mechanisms among subsystems. This study constructs an evaluation index system for rural tourism public service systems, measures multi-system coordination levels through a system coupling coordination model, analyzes the evolution of five-element system coupling degrees and subsystems using Bayesian spatio-temporal hierarchical models and Kernel density estimation, and explores interaction mechanisms

through qualitative comparative methods. This research reveals the spatiotemporal evolution patterns and functional mechanisms of China's rural tourism public service system coordination, aiming to provide decision-making references for scientifically improving China's rural tourism public service system construction.

1.1 Indicator Construction and Data Sources

The *China Tourism Public Service "Twelfth Five-Year" Special Plan (2011)* first proposed "improving tourism information consulting service systems, tourism safety assurance service systems, tourism transportation convenience service systems, tourism people-benefiting convenience service systems, and tourism administrative service systems." Specifically, the tourism public information service system focuses on constructing tourism consulting centers and gradually improving online and offline tourism information service coverage. The tourism safety assurance service system aims to ensure destination safety production and emergency rescue, emphasizing risk disaster monitoring and emergency response. The tourism transportation convenience service system centers on promoting public transportation service functions, requiring both improved destination accessibility and efficient intra-regional transportation networks. The tourism people-benefiting convenience service system aims to maximize the sharing function of public services, continuously improving people-benefiting projects and convenience service construction. The tourism administrative service system targets building a service-oriented government, strengthening policy support while requiring high-quality human resource supply.

Based on this, we established an evaluation index system for rural tourism public service systems (Table 1). Research sample data were obtained from the *China Rural Statistical Yearbook*, *China Urban-Rural Construction Statistical Yearbook*, and *China Statistical Yearbook* for 2007-2018. Due to missing data for Tibet, Hong Kong, Macao, and Taiwan, these regions were excluded, yielding samples from 30 provinces (autonomous regions and municipalities). Indicator weights were assigned using the entropy method.

1.2 Methodology

1.2.1 Coupling Coordination Degree Model First, we calculated the development level of each subsystem. Second, through mathematical derivation, we computed the deviation coefficient (C) of the five-element system comprising rural tourism public information (Y_1), safety assurance (Y_2), transportation convenience (Y_3), people-benefiting convenience (Y_4), and public administration (Y_5):

$$C = \frac{5}{5-1} \left(1 - \frac{\sum_{i=1}^5 Y_i^2}{(\sum_{i=1}^5 Y_i)^2} \right)$$

where C represents the coordination degree, ranging between 0 and 1. Finally, we established the rural tourism public service system coupling coordination degree model:

$$D = \sqrt{C \times G}, \quad G = \sum_{i=1}^5 \alpha_i Y_i$$

Considering the equal importance of the five subsystems in coordinated development, the 待定 coefficients ($\alpha, \beta, \gamma, \lambda, \dots$) were uniformly set to 0.2. G represents the development degree, and D represents the coupling coordination degree. The coordination levels were classified as: 失调衰退 (coupling degree $[0, 0.4)$), 过渡类型 (coupling degree $[0.4, 0.6)$), and 协调上升类型 (coupling degree $[0.6, 1]$).

1.2.2 Dynamic Evolution Model To investigate the coordinated development of China's rural tourism public service five-element system and the dynamic evolution patterns of its subsystems, we employed Kernel density estimation to calculate the evolution trajectories of coupling coordination degrees and subsystems:

$$f(x) = \frac{1}{Nh} \sum_{i=1}^N K\left(\frac{x - X_i}{h}\right), \quad h = 1.06 \times S \times N^{-0.2}$$

where $f(x)$ is the Kernel density function, N is the sample size, h is the bandwidth, $K(x)$ is the kernel function, X is the sample value, x is the sample mean, and S is the sample standard deviation. Smaller bandwidth values yield higher estimation accuracy.

Bayesian Hierarchical Spatio-Temporal Model: The Bayesian hierarchical spatio-temporal model introduces spatio-temporal interaction terms for comprehensive observation of dynamic evolution processes. Suitable for multidimensional normal distribution forms, it includes three sub-models:

Sample likelihood function: $Y_{it} \sim MVN(\mu_{it}, \sigma_Y^2)$

Parameter prior distribution: $\mu_{it} \sim MVN(\lambda_{it}, \sigma_\mu^2)$

Spatio-temporal process function: $\lambda_{it} = S_i + (b_0 + b_i) \times (t - t_{mid}) + \delta_i \times (t - t_{mid})^2 + \varepsilon_{it}$

where i and t represent region and year; Y , λ , and $\sigma^2 Y$ are sample values, expectations, and variance; λ and σ^2 are expectations and variance of sample expectations; α is a fixed constant; S is the relatively stable spatial pattern formed during the observation period; b_0 represents the overall linear trend; b reflects region i 's change speed; δ represents region i 's local change trend; $b + 2\delta(t - t_{mid})$ indicates whether region i 's speed trend is expanding (or slowing); $(t - t_{mid})$ is the relative time difference between observation and mid-period; ε is the disturbance term.

Based on Richardson's standard, samples were clustered into hotspot, warm spot, and cold spot regions, representing high, medium, and low coupling coordination levels. The posterior probability estimate (p) of the spatial pattern term was used: $p > 0.8$ for hotspot regions, $0.2 \leq p \leq 0.8$ for warm spot regions, and $p < 0.2$ for cold spot regions.

1.2.3 System Combination Path Analysis Qualitative Comparative Analysis (QCA) effectively handles complex causal relationships among multiple variables. Through combination path analysis, it comprehensively 解析 the comprehensive 作用机制 of five-element system coordinated development:

$$\text{Consistency} = \frac{\sum \min(x_i, y_i)}{\sum x_i}, \quad \text{Coverage} = \frac{\sum \min(x_i, y_i)}{\sum y_i}$$

where X is the multivariate set, Y is the outcome variable set, and x, y are membership degrees in sets X and Y . Consistency represents the probability of a specific outcome when a variable appears, indicating sufficient conditions (threshold ≥ 0.8). Coverage represents the probability of explaining a specific outcome when all variables appear simultaneously, indicating necessary conditions (threshold ≥ 0.6). Variables were calibrated using four-value fuzzy set methods, with values of 1, 0.67, 0.33, and 0 representing full membership, partial membership, partial non-membership, and full non-membership.

2. Spatiotemporal Evolution Characteristics

2.1 Temporal Characteristics

Analysis of the five-element system coupling coordination degree from 2007-2018 reveals that the national average fluctuated between 0.403 and 0.595, overall 处于过渡类型 (Fig. 1). The coordination degree showed a 平缓上升趋势, belonging to the 濒临失调-勉强协调等级. From 2007-2011, the coupling coordination degree ranged from 0.403 to 0.491, 处于濒临失调类型. The 2012 "National Rural Tourism 'Hundreds of Millions' Project" and the "1+2+5" holiday model spurred rapid development of short- and medium-distance rural tourism markets, but insufficient accommodation and parking facilities hindered systematic coordinated development. Subsequently, the *Tourism Service Quality Improvement Outline (2013-2017)* promoted rural tourism public services into a quality improvement adjustment period with 平缓发展.

From 2015-2018, the coupling coordination degree ranged from 0.501 to 0.595, 属于勉强协调类型. China's first tourism public service plan in October 2011, the *China Tourism Public Service "Twelfth Five-Year" Special Plan*, promoted increasingly 完善 rural tourism public service systems.

Regarding subsystems, the people-benefiting convenience and transportation convenience systems showed relatively high development levels. The people-benefiting system had the highest development level with an average annual growth rate of 11.92%, contributing most to rural tourism public service construction. The transportation system showed fluctuating upward trends with an average annual growth rate of 9.41%, climbing significantly after 2015. The 2011 *Guiding Opinions on “Twelfth Five-Year” Rural Road Construction* promoted balanced development of rural roads and supporting facilities across eastern, central, and western regions, improving rural tourism road construction levels.

The public information, safety assurance, and public administration systems had similar development levels, with average annual growth rates of 2.46%, 8.94%, and 5.93%, respectively. The public information system had the lowest growth rate, indicating substantial future improvement potential. The safety assurance system showed relatively high growth, reflecting significantly enhanced safety awareness. The public administration system rose noticeably after 2015, with the 2015 *Comprehensive Implementation Plan for Deepening Rural Reform* clarifying service-oriented government construction goals and strengthening government investment in rural public affairs, promoting rural public administration service development.

2.2 Spatial Characteristics

China's rural tourism public service five-element system coupling coordination degree shows polarized characteristics (Fig. 2). In 2018, the highest was Shandong and the lowest was Qinghai, with a 3.2-fold difference. The three major regions show a 阶梯递减格局 from east to west, aligning with China's economic spatial pattern. Jiangsu, Shandong, Guangdong, Sichuan, and Zhejiang consistently remained in the 协调上升类型, mostly concentrated in the east. Hebei, Liaoning, Fujian, Anhui, Jiangxi, Henan, Hubei, and Hunan consistently remained in the 过渡类型. Tianjin, Hainan, Jilin, Heilongjiang, Inner Mongolia, Guangxi, Guizhou, Gansu, Qinghai, Ningxia, and Xinjiang consistently remained in the 失调衰退类型, with western regions dominating. Beijing and Shanghai shifted from 协调上升类型 to 过渡类型 during 2015-2018, while Shanxi, Chongqing, Yunnan, and Shaanxi upgraded to 过渡类型, with western provinces showing particularly prominent continuous upward development.

We used the Dagum Gini coefficient to detect sources of non-equilibrium gaps (Table 2). During the observation period, the overall gap only decreased by 0.7%, with the largest spatial non-equilibrium differences between eastern and western regions. Inter-regional gap contributions peaked in 2011, but intra-regional and super-variable density differences contributed 71.21% in 2018, indicating that most gaps could be explained by intra-regional and cross-regional overlapping differences. Although central and western regions lag behind the east overall, some areas within them exceed eastern development levels, creating overlapping phenomena. This confirms that relatively stable multipolar development centers have formed within the three major regions, becoming important sources

affecting national rural tourism public service system coordinated development differences.

2.3 Dynamic Evolution Patterns

Bayesian hierarchical clustering shows that Jiangsu, Zhejiang, Shandong, Guangdong, Shanghai, Hunan, and Sichuan are hotspot types; Hainan, Heilongjiang, Jilin, Guizhou, Gansu, Qingqing, Ningxia, and Xinjiang are cold spot types; remaining provinces are warm spot types.

3. Dynamic Evolution Patterns of Subsystems

3.1 Tourism Public Information Service System

The public information service system showed multipolar development patterns. In 2007, most provinces clustered in the cold spot zone. In 2011, multiple peaks broadened and shifted rightward, showing fusion phenomena and indicating emerging multipolar differentiation 消融. However, the main peak remained at the cold-warm spot boundary, with overall levels needing improvement, while the satellite peak at the hotspot boundary showed particularly prominent height increases. In 2015, overall rightward shift was evident, with a three-peak pattern emerging, indicating substantial improvements in most provinces' rural tourism public information service systems. In 2018, the linear change speed showed a slowing trend.

The evolution speed trend (Fig. 4) shows that most regions' growth wave amplitudes converged, causing multi-peak convergence and fusion, likely due to comprehensive information technology 普及 creating spatial spillover effects that promote 融合趋同 in neighboring regions. Hotspot regions showed high-speed expansion throughout the observation period, explaining why satellite peaks at warm-hotspot boundaries continuously increased. Most western provinces showed significant growth rate declines, with large quantity scales and small fluctuations causing the main peak to stagnate at the cold-warm spot boundary, indicating that rural tourism information service system development exhibits Matthew effect characteristics where the strong become stronger.

3.2 Tourism Safety Assurance Service System

The safety assurance system showed overall rightward shifts but relatively low development levels. In 2007, the main peak was at the cold-warm spot boundary, with a right satellite peak of low height and small scale in the warm spot zone. In 2011, rightward displacement was minimal. In 2015, the main peak shifted rightward significantly, showing multipolar differentiation. The evolution speed trend (Fig. 4) differs from hotspot regions' sustained rapid growth: warm spot provinces showed alternating positive-negative fluctuations in the first two periods due to the construction cycle requirements for rural medical institutions,

personnel training, and funding, causing periodic fast-slow evolution. Cold spot regions developed relatively slowly, especially Qinghai, Gansu, and Xinjiang as agricultural/pastoral areas with scarce rural medical resources. Most provinces showed significantly accelerated growth in the third period. In 2015, China's first *National Medical and Health Service System Planning Outline (2015-2020)* and the *Implementation Opinions on Strengthening Rural Doctor Team Construction* promoted comprehensive rural medical service coverage, improving rural medical security service facilities.

3.3 Tourism Transportation Convenience Service System

In 2007, the main peak appeared at the cold-warm spot boundary, with right shoulder and satellite peaks in warm and hotspot zones, respectively, indicating low overall development levels. In 2011, the main peak broadened and shifted rightward, with shoulder and satellite peaks also broadening, showing improved development compared to the previous period. In 2015, the main peak and right shoulder peak showed fusion phenomena, while the hotspot satellite peak narrowed on the right side.

The evolution speed trend (Fig. 4) shows that hotspot regions' linear speeds slowed, while warm spot provinces (Shanxi, Anhui, Jiangxi, Henan, Hubei, Guangxi, Yunnan, Shaanxi) showed rapid growth in the third period. This indicates that as rural roads develop toward 均衡化, coverage and accessibility rates have significantly increased, causing the main peak to continuously broaden rightward. Except for Heilongjiang and Jilin with slow development speeds, most cold spot provinces showed significantly accelerated growth in the third period.

3.4 Tourism People-Benefiting Convenience Service System

The people-benefiting convenience system shows overall right-skewed patterns with relatively low development levels (Fig. 3). In 2007, the main peak was at the cold-warm spot boundary, with a right shoulder peak and one satellite peak in the warm spot zone, and the far-right satellite peak in the hotspot zone. In 2011, the main peak shifted rightward, splitting into a left shoulder peak while the right shoulder peak disappeared, but remained at low development levels. The warm spot satellite peak shifted rightward with enhanced scale, while the hotspot satellite peak showed weak displacement and declining scale. In 2015, the main peak narrowed, showing localized 均衡化 trends, while the warm spot shoulder peak rose, indicating increased quantity scale, and the hotspot satellite peak shifted rightward significantly, highlighting growth trends. In 2018, the warm spot shoulder peak continued to rise and broaden, with clear dual-main-peak patterns and 明朗两极分化, while the hotspot satellite peak had not yet shown significant improvement.

The evolution speed trend (Fig. 4) shows that the warm spot shoulder peak rose twice, respectively due to speed expansion in some warm spot regions dur-

ing the second and third observation periods. Cold spot region growth slowed, while hotspot region speeds showed periodic fast-slow alternating fluctuations. This is because people-benefiting convenience services must address both basic needs of rural residents and tourists and 超额需求 for food, accommodation, transportation, sightseeing, shopping, and entertainment, requiring certain production and living service facilities as foundations. Hotspot and warm spot regions have first-mover advantages in people-benefiting convenience services, with relatively faster development speeds.

3.5 Tourism Public Administration Service System

In 2007, the curve showed a single-peak right-skewed trend, with right shoulder and satellite peaks in warm and hotspot zones, respectively. In 2011, the curve did not shift, with the main peak narrowing, indicating localized 均衡化 diffusion. The warm spot shoulder peak rose, showing enhanced quantity scale, while the hotspot satellite peak shifted rightward significantly, highlighting growth trends. In 2015, the warm spot shoulder peak continued to rise and broaden, with dual-main-peak patterns emerging and 明朗两极分化, while the hotspot satellite peak had not yet shown significant improvement.

The evolution speed trend (Fig. 4) shows that warm spot regions exhibited 平缓增长, while cold spot regions showed gradually accelerating trends. Since human resource supply and policy support are concentrated in government public economic behaviors closely related to regional economic development, they can significantly promote local public administration service construction, causing western cold spot regions' growth to lag.

4. Mechanism of Five-Element System Coupling and Coordinated Development

The above analysis shows that hotspot, warm spot, and cold spot type differences determine distinct evolution patterns in five-element system coordination levels. However, why do these three development types form? What functional positions do subsystems assume? Using the five-element system coupling coordination degree spatial pattern term as the dependent variable (Y) and subsystems as independent variables (X_1 - X_5), we conducted qualitative comparative analysis. Results (Fig. 5) show all path consistency requirements met, indicating all paths are sufficient condition combinations, though individual path coverage rates did not reach minimum thresholds, showing each path is situation-specific and highly targeted.

Merging paths in Fig. 5 yields formulas (1)-(3), corresponding to hotspot, warm spot, and cold spot region subsystem path combinations (where “·” represents logical AND, “+” represents OR, and “~” represents NOT):

Formula (1) shows that lacking tourism public information service system

(X_1) inevitably causes coupling degree decline, demonstrating highly sensitive characteristics. As quasi-infrastructure leading new rural construction, efficient and convenient tourism information services can attract and radiate to local and neighboring 客源市场, becoming sufficient conditions affecting rural tourism public service system coordination.

Formula (2) represents cold spot region configuration combinations, serving as verification for hotspot and warm spot configurations. Simultaneously lacking tourism public information (X_1), safety assurance (X_2), people-benefiting convenience (X_4), and administrative services (X_5) inevitably causes five-element coordination to 徘徊 at low levels, 侧面验证 hotspot and warm spot conclusions.

Formula (3) shows warm spot region configuration combinations. Comparing the three region-type configurations reveals tourism transportation convenience service system (X_3) as a common core system across all, representing rural destination accessibility crucial for self-driving and independent travel. Fast and convenient tourism transportation networks can attract tourists and improve destination distribution efficiency, making it a foundational factor. Regional differences appear in warm spot configurations: compared to central and eastern regions, western regions show significant gaps in tourism people-benefiting convenience service system (X_4), which is closely related to rural living environment construction and must satisfy both basic shared needs and thematic 超额需求, serving as internal support forces. Eastern and central-western differences exist in tourism public administration service system (X_5), representing government public economic decision-making behaviors and reflecting regional economic strength's external indicators, determining government fiscal capacity for rural tourism public services. Eastern regions' relatively higher fiscal capacity continuously adjusts and optimizes administrative service resources including human resources and investment, serving as external support forces. Additionally, when tourism people-benefiting convenience service system (X_4) is lacking, tourism public administration service system (X_5) also becomes lacking, indicating that internal support force shortages trigger external administrative service deficiencies. An imperfect people-benefiting convenience service system struggles to attract tourists, further shrinking market radiation radius, causing internal environment deterioration and growth potential depletion, triggering human resource loss and weakening government support policy effects, creating a vicious cycle. Therefore, improving the people-benefiting convenience service system becomes the primary task for western region tourism public service construction.

5. Conclusions and Outlook

This study systematically examined China's rural tourism public service system coordination evolution based on theoretical analysis of tourism public service concepts and system development. Using a five-element coupling coordination

model, we analyzed spatiotemporal patterns, parsed regional five-element subsystem linear evolution processes, and explored interaction mechanisms through qualitative comparative analysis. Key conclusions:

1. **Overall low coordination with systemic imbalances:** China's rural tourism public service five-element system coupling coordination remains predominantly in the transition type, showing a 阶梯递减 pattern from east to west. The spatial structure evolution exhibits multipolarization trends, with linear evolution velocities following diminishing marginal utility laws. Most hotspot regions show alternating fast-slow periodic characteristics, warm spot regions are transitioning from increasing to decreasing marginal effects, and cold spot regions have entered an upward cycle.
2. **Subsystem improvements with persistent disparities:** The five subsystems have improved overall, but significant inter-system differences persist with varying dominant factors, causing low coupling coordination. Under information technology spatial spillover effects, the public information system improved most notably. Policy 倾斜 and 红利 effects drove safety assurance system improvements. Rural road coverage and accessibility rates influenced potential tourism demand scale. Rural production and living service facility levels affected the people-benefiting convenience system. Administrative service system construction concentrated in local government public economic behaviors.
3. **Joint action of five subsystems:** The diversified and coordinated spatiotemporal pattern results from joint action of five subsystems. Public information services are sensitive factors, safety assurance services are non-sensitive factors, transportation convenience services are foundational factors, people-benefiting convenience services are internal support forces, and public administration services are external support forces.

Previous research focused on comprehensive supply capacity evaluation or satisfaction perception of tourism public services, lacking understanding of internal subsystem coordination. Methodologically, quantitative models were rarely introduced, and comprehensive evaluation systems based on five-element systems remain scarce. Research objects rarely focused on macro-regions, concentrating on urban destinations while neglecting rural destinations. Compared to urban tourism services, rural tourism services face issues like incomplete facilities, weak functions, and low quality, making urban development models unsuitable.

Based on existing research, this study constructed a five-element system coupling coordination model, expanded existing system coupling methods, measured five-element subsystem development trends, regional differences, speed changes, and functional mechanisms through dynamic evolution models. The hotspot, warm spot, and cold spot type classification helps scientifically grasp rural tourism public service system coordination evolution patterns.

Policy Implications: China's overall rural tourism public service five-element system coordination remains imbalanced with regional multipolarization and

non-equilibrium development. Hotspot regions have entered a slowdown cycle requiring resource 要素更新 and upgrading. Warm spot regions are in transition periods. Cold spot regions must prioritize filling development gaps to prevent exacerbating systemic imbalances. Regarding functional mechanisms, except for the significant role of transportation convenience services, other subsystems' roles remain limited with substantial development potential.

Limitations: This study explores China's rural tourism public service system coordination from a macro perspective but cannot reflect internal evolution patterns within individual rural destinations, representing an important future research direction.

References

- [1] Gao Nan, Zhang Xincheng, Wang Linyan. The spatial temporal patterns and formation mechanism of China's rural tourism public service level[J]. *Scientia Geographica Sinica*, 2021, 41(2): 252-260.
- [2] Zhang Xincheng, Gao Nan, He Xuming, et al. Study on the quality evaluation and promotion model of rural tourism public services[J]. *Journal of Arid Land Resources and Environment*, 2020, 34(10): 179-186.
- [3] Melo A J, Hernández R M, Muñoz P A. Service quality perceptions, online visibility, and business performance in rural lodging establishments[J]. *Journal of Travel Research*, 2017, 56(2): 250-262.
- [4] Jesus C, Franco M. Cooperation networks in tourism: A study of hotels and rural tourism establishments in an inland region of Portugal[J]. *Journal of Hospitality and Tourism Management*, 2016, 29: 165-174.
- [5] Luo Zhang, Wang Shuo. Rural tourism endogenous poverty alleviation mechanism under the vision of targeted poverty alleviation: A case study of Chongqing Mugen Model[J]. *Rural Economy*, 2018(1): 51-55.
- [6] Zhou Li, Cai Zhangyao, Huang Deping. The realistic demand, enriched connotation and realization path of the high quality development of rural tourism in western minority regions[J]. *Rural Economy*, 2021(6): 137-144.
- [7] Dong Dandan. Research on the construction of rural tourism infrastructure[J]. *Agricultural Economy*, 2020(4): 43-45.
- [8] Jiang Mengda. Study on the satisfaction of rural tourism public service based on factor analysis[D]. Kaifeng: Henan University, 2017: 17-21.
- [9] Luo Chenghua, Liu Anquan. The dilemma of rural tourism public service supply in Wuling Mountain area and its solution[J]. *Guizhou Social Sciences*, 2019(10): 85-91.

- [10] Li Shuang, Wang Peng, Liu Xiaoning. On the supply of rural tourism public service from the perspective of the third sector[J]. *Tourism Research*, 2018, 10(4): 7-9.
- [11] Li Shuang, Huang Fucai. Systematic thinking on the construction of urban tourism public service system[J]. *Tourism Tribune*, 2012, 27(1): 7-9.
- [12] Corina S G, Evelina S A. Evolutions of rural tourism in Romania and Europe[J]. *Ovidius University Annals, Economic Sciences Series*, 2018, 18(2): 182-185.
- [13] Hu Weixia, Xie Yingying. Spatial evolution mechanism of peripheral environment of local village residential style scenic spot in Shanxi Province[J]. *Arid Land Geography*, 2020, 43(6): 1603-1611.
- [14] Yu Fawen, Huang Xin, Yue Hui. The high quality development of rural tourism: Connotative features, key issues and countermeasures[J]. *Chinese Rural Economy*, 2020(8): 27-39.
- [15] Sun Jingwen, Ma Yuanjun, Wang Zhenbo, et al. Rural tourism industry revitalization path based on the analysis of lock-in effects[J]. *Progress in Geography*, 2020, 39(6): 1037-1046.
- [16] Sun Jiuxia, Wang Xueji. Urban-rural cycle restoration: The framework and issues for rural tourism to construct a new urban-rural relationship[J]. *Journal of Southwest Minzu University (Humanities and Social Science)*, 2021, 42(1): 25-32.
- [17] Zou Yafeng, Li Yajing, Yuan Zhihong. Comprehensive research on new urbanization level of provincial capital cities in western China[J]. *Arid Land Geography*, 2020, 43(6): 1612-1621.
- [18] Yu Yang, Zhang Limei, Chen Cai. Pattern evolution of the coordinated development of economy-energy-environment-science-technology quaternionic system in eastern China[J]. *Economic Geography*, 2019, 39(7): 14-21.
- [19] Wang Yongsheng, Li Yuhang, Jie Xiaomeng, et al. Coupling between marine technology, economy and environment systems in China[J]. *China Population, Resources and Environment*, 2020, 30(8): 168-176.
- [20] Li Hengji, Qu Jiansheng, Pang Jiaying, et al. Spatial-temporal synthetic measurement of coupling coordination and sustainable development of population-economy-society-resource-environment system in Gansu Province[J]. *Arid Land Geography*, 2020, 43(6): 1622-1634.
- [21] Sun Caizhi, Zhu Yunlu. Discussion on the spatial disequilibrium pattern and causes of regional marine innovation in China based on Dagum Gini coefficient[J]. *Economic Geography*, 2020, 40(1): 103-113.
- [22] Wang Longjie, Zeng Guojun, Bi Doudou. Spatial spillover effects of ICT on tourism industry growth[J]. *Acta Geographica Sinica*, 2019, 74(2): 366-378.

- [23] Richardson S, Thomson A, Best N, et al. Interpreting posterior relative risk estimates in disease-mapping studies[J]. Environmental Health Perspectives, 2004, 112(9): 1016-1025.
- [24] Zhang Xincheng, Liang Xuecheng, Song Xiao, et al. Spatial pattern of the mismatch degrees of the high quality development of tourism industry in the Yellow River Basin[J]. Journal of Arid Land Resources and Environment, 2020, 34(12): 201-208.
- [25] Zhang Xincheng, Gao Nan, Wang Linyan. An analysis of the spatial network structure and formation mechanism of the attention degree of Long March themed red tourism resources[J]. Tourism Science, 2021, 35(3): 1-23.

Figures

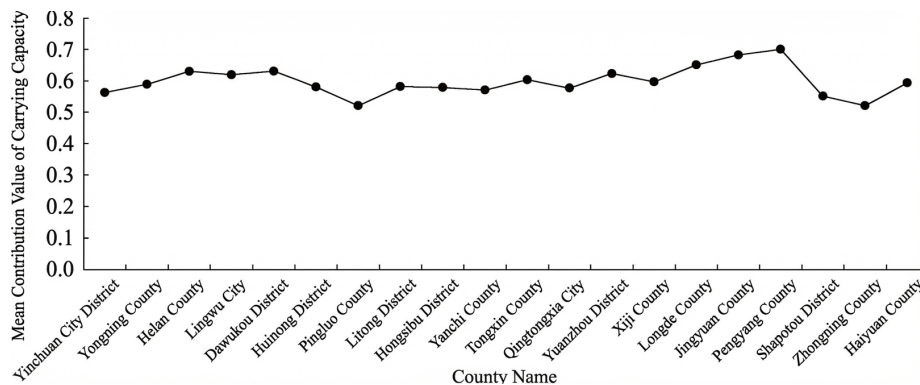


Figure 1: Figure 1

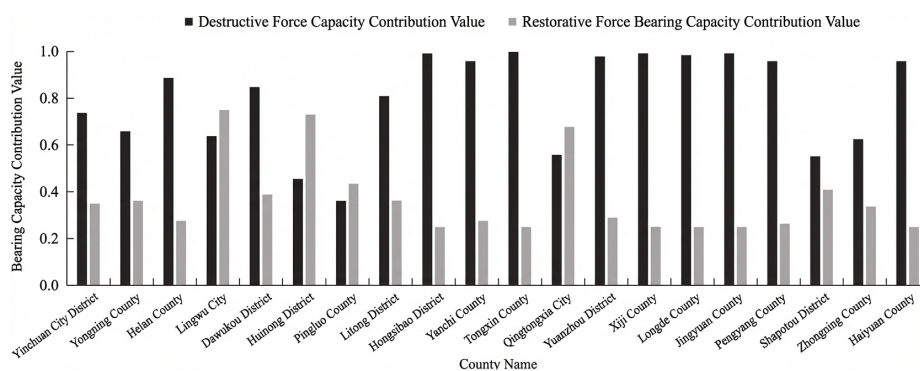


Figure 2: Figure 2

Source: ChinaXiv – Machine translation. Verify with original.

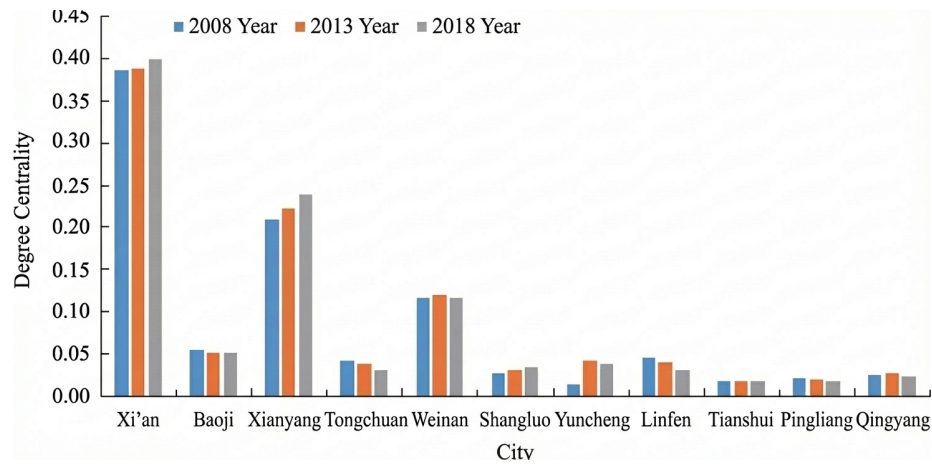


Figure 3: Figure 3

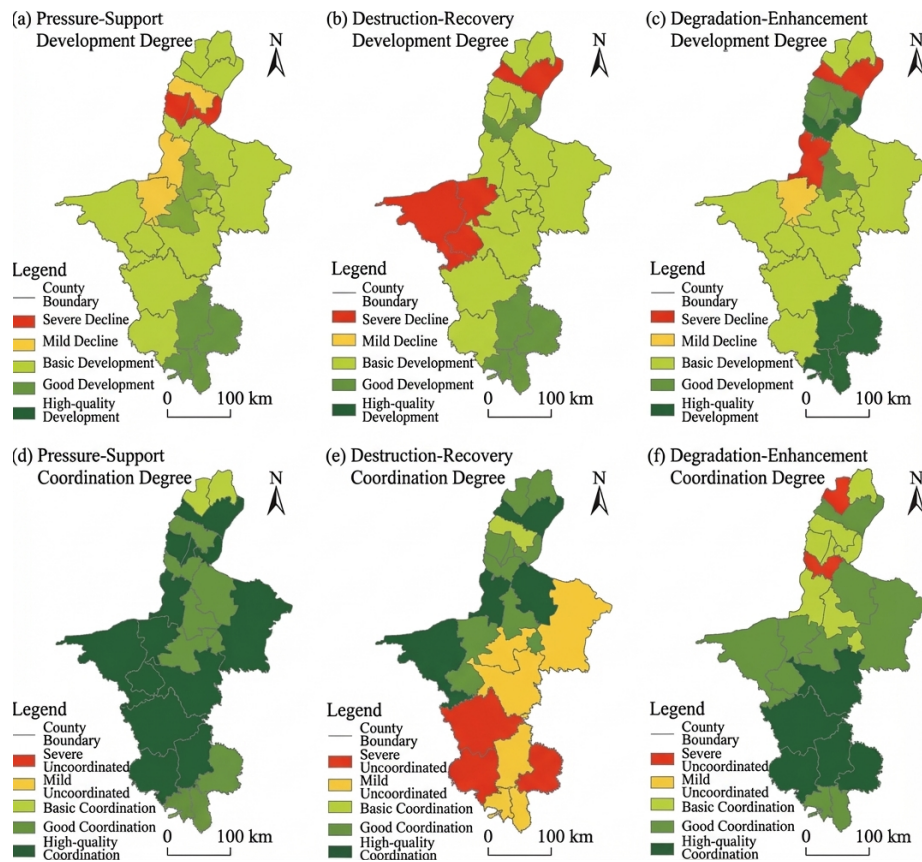


Figure 4: Figure 4

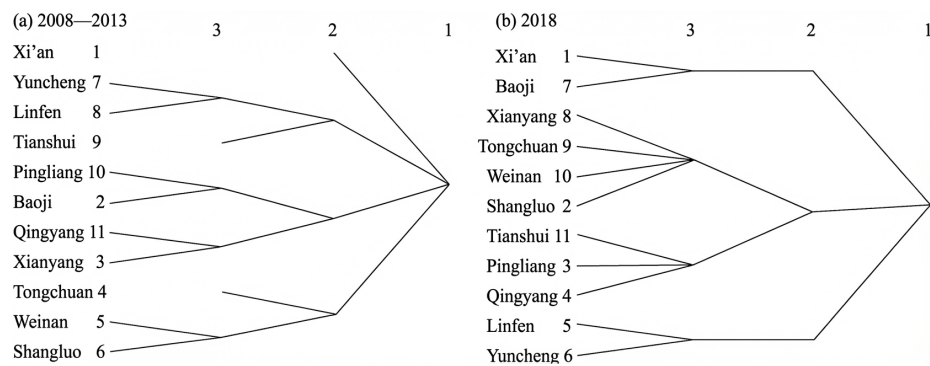


Figure 5: Figure 5