Coordinated Development and Spatiotemporal Evolution of the Rural Population-Land-Economic System in Sichuan (Postprint)

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Abstract

This study employs quantitative analysis and GIS spatial analysis methods, using Sichuan Province as a case study, to examine the spatiotemporal variation characteristics and issues of coordinated development among rural population, land, and economy under the background of rapid urbanization, and to explore pathways for sustainable rural socio-economic development. The results indicate: In 2014, Sichuan' s rural population-land-economy system was dominated by barely coordinated transition and well-coordinated development types, yet with substantial regional disparities, manifesting as the coexistence of high-quality coordinated development and severe imbalance decline. From a temporal perspective, the sequential changes in the coordinated development of the rural population-land-economy system from 2000 to 2014 were significant; lightly imbalanced decline zones and barely coordinated transition zones decreased, while well-coordinated development zones gradually increased. In 2000, barely coordinated transition zones and well-coordinated development zones accounted for 61.90% and 14.29% of the total number of cities (prefectures), respectively, whereas by 2014 they accounted for 33.34% and 52.38%, respectively. Meanwhile, both high-quality coordinated development zones and severely imbalanced decline zones remained unchanged, showing an overall positive development trend. From a spatial perspective, regions with higher coordination development degrees were mainly distributed in plains and hilly areas, while areas with poorer natural geographical conditions such as mountains and plateaus exhibited lower coordination development degrees. Overall, due to influences from topography, resource endowments, and geographical location, significant differences exist among cities (prefectures) in Sichuan in terms of rural population, land, and economic development levels, as well as the coordination degree among the three. Therefore, agricultural development goals and priorities should be established according to regional development characteristics and deficiencies to promote sustainable rural socio-economic development.

Full Text

Preamble

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Coordinated Development and Its Spatio-Temporal Evolution of Rural Population, Land and Economy System in Sichuan Province

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Abstract: This paper employs quantitative analysis and GIS spatial analysis methods to examine the spatio-temporal characteristics and challenges of coordinated development among rural population, land, and economy in Sichuan Province amid rapid urbanization, aiming to explore pathways for sustainable rural socio-economic development. The findings reveal that in 2014, Sichuan' s rural population-land-economy system was dominated by barely coordinated transition and well-coordinated development types, though significant regional disparities existed, with high-quality coordinated development coexisting alongside severe imbalance and decline. Temporally, substantial changes occurred in the coordinated development of the rural population-land-economy system between 2000 and 2014: regions with mild imbalance and decline and barely coordinated transition decreased, while well-coordinated development regions gradually increased. In 2000, barely coordinated transition and well-coordinated development regions accounted for 61.90% and 14.29% of prefecture-level cities (autonomous prefectures) respectively, shifting to 33.34% and 52.38% by 2014. High-quality coordinated development and severely imbalanced decline regions remained unchanged, indicating an overall positive development trend. Spatially, regions with higher coordination degrees were primarily located in plains and hilly areas, while those with poor natural geographical conditions such as mountains and plateaus exhibited lower coordination degrees. Overall, influenced by topography, resource endowments, and geographical location, Sichuan' s prefecture-level cities (autonomous prefectures) demonstrate considerable variation in rural population, land, and economic development levels and their coordination degrees. Development goals and priorities should be established according to regional characteristics and deficiencies to promote sustainable rural socio-economic development.

Keywords: Coordinated development degree; Population-land-economy system; Spatio-temporal evolution; Sichuan Province

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Introduction

Over recent decades, rural areas in developing and emerging countries have undergone major structural transformations. Extreme poverty, hunger, and rising spatial and interpersonal disparities have become primary challenges facing rural regions internationally [1]. With China' s rural land system reforms and the emergence of various new types of business entities, agriculture has developed new patterns in operational scale, technology selection, branding, and marketing. However, widespread problems persist in China' s rural areas, including land abandonment, excessive capitalization and non-agricultural utilization of land, predatory cultivation practices, and difficulties in restoring land to its original condition after conversion [2-3]. These issues demonstrate that rural population, land, and economic development face both opportunities and challenges. In March 2016, Premier Li Keqiang proposed in the Government Work Report the establishment of a "population-land-finance" linkage mechanism [4], setting new requirements for advancing new urbanization. Therefore, against the backdrop of rapid urbanization, integrated urban-rural development, and efforts to resolve "three rural issues" (agriculture, rural areas, and farmers), effectively utilizing rural land, promoting efficient use of rural land resources, facilitating rational flow of production factors between urban and rural areas, achieving sustained rural economic growth, improving farmers' living standards, and properly managing relationships among rural population, land, and economy have become urgent issues for rural China.

The coupling coordination degree among rural population, land, and economy systems serves as a crucial indicator for measuring the interaction intensity among living standards, land use intensity, and regional economic development at various rural development stages. It aims to explore pathways for sustainable rural socio-economic development by analyzing existing problems and contradictions. Scholars have conducted extensive research on coordinated development degrees and evaluation methods for urban economy, ecology, and environment [5-7], as well as population, tourism, urban areas, transportation, and land [8-14], but relatively few studies have focused on rural coordination development [15-16]. Some researchers have examined regional population-land-economy coordination from an urbanization perspective [17-18], often focusing on pairwise relationships (population-land, economy-land, population-economy) rather than systematic analysis of all three elements [19]. However, rural population, land,

and economy interact and correlate with each other, and their coordinated development facilitates diversified and sustainable rural socio-economic development. Achieving diversified and sustainable rural development represents an effective approach to enhancing land and economic resilience, withstanding global development pressures, and increasing rural economic competitiveness [20].

Based on this understanding, this paper analyzes the coordinated development degree of Sichuan' s rural population-land-economy system, using this typical agricultural province as a case study to provide insights for coordinated development in Sichuan and western China.

1. Interaction Mechanism of Rural Population-Land-Economy System

Efficient allocation of population and land resources is crucial for improving socio-economic efficiency [21]. This paper constructs a theoretical framework illustrating the internal relationships and interaction mechanisms of the rural population-land-economy system (Figure 1) to provide theoretical support for research methods and indicator selection. This framework examines the comprehensive development levels of rural population, land use, and economy, as well as their coordination degree against the backdrop of new urbanization. Specifically: (1) Economic development determines population development, while population development either promotes or hinders economic growth [18]. On one hand, population urbanization facilitates the transfer of rural surplus labor to rural industries, further accelerating economic growth [22]. On the other hand, rising urban and developed-area economies may widen rural wealth gaps, which must be addressed through rural economic growth and adjustments to population and industrial structures [23]. (2) Improved land development and utilization increase crop yields and land use efficiency, thereby enhancing rural economic development levels. Conversely, higher rural economic development accelerates agricultural modernization and promotes comprehensive land use improvement. Large-scale land use also significantly impacts rural employment, as capital-intensive industries create competition for limited positions and generate crowding-out effects. However, investment in cash crops can create labor-intensive operations through agricultural cooperation and production, providing better employment prospects for farmers [24]. (3) Rural land provides conditions for production and living, as all rural production and residence occur on land. As farmers' living standards improve and urbanization accelerates, adjustments to employment structures among the three industries may create opportunities for land use scaling but may also lead to severe land abandonment and idle homesteads [25].

2.1 Data Sources

Socio-economic data used in this paper primarily derive from the *Sichuan Statistical Yearbook* (2001–2015). Some indicators were calculated secondarily. To

ensure comparability across years and reflect actual rural economic development while eliminating price fluctuation effects, economic indicators were converted to 1990 constant prices using price indices (constant price data = current price data / price index).

2.2.1 Evaluation Index System Construction

Following principles of scientific rigor, systematicity, operability, comparability, and hierarchy, and referencing existing evaluation indicators [15-16], this study selected evaluation indicators based on rural population-land-economy realities and data availability/quantification. The rural population-land-economy system evaluation index system comprises 15 indicators representing comprehensive development levels of population, land use, and economy. The population subsystem includes four indicators characterizing rural population structure, employment structure, and living standards. The land subsystem includes seven indicators representing basic land information, agricultural modernization, land input levels, and land output levels. The economy subsystem includes four indicators characterizing rural economic development level, structure, and efficiency (Table 1). First-level indicators represent overall system development, while second-level indicators represent comprehensive development levels of population, land, and economy. Positive indicators promote comprehensive development (higher values are better), while negative indicators inhibit development (lower values are better).

2.2.2 Data Analysis Methods

Referencing relevant data analysis methods [25-26], indicators underwent dimensionless processing, mean and standard deviation calculations, and weight determination using the mean square deviation method. Specific procedures were as follows:

(1) **Dimensionless Processing of Indicators**: To facilitate comparison and weighting of indicators with different units or magnitudes, data were first processed using the range standardization method:

$$Y_{ij} = \frac{X_j - X_{j\min}}{X_{j\max} - X_{j\min}}$$

where i represents the three subsystems (a population, b land, c economy), j represents specific indicators within each subsystem, X_j is the original indicator value, $X_{j\max}$ and $X_{j\min}$ are the maximum and minimum values of the same indicator within the subsystem, and Y_{ij} is the standardized result with $Y_{i1}, Y_{i2}, \ldots, Y_{in} \in [0, 1]$.

To unify indicator directions, the negative indicator $a2$ was transformed using:

$$Y_{ij} = 1 - \frac{X_j - X_{j\min}}{X_{j\max} - X_{j\min}}$$

After transformation, all data range between [0,1], with higher values indicating better performance. For each indicator, the maximum value across all years becomes 1 and the minimum becomes 0, eliminating dimensional effects and enabling comparison across indicators and years.

(2) **Determination of Indicator Weights** W_j:

(3) **Mean Square Deviation** A_j:

$$A_j = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(Y_{ij} - \bar{P}_j)^2}$$

(4) **Mean of Random Variables** $\bar{P}_j$:

$$\bar{P}_j = \frac{1}{n}\sum_{i=1}^{n} Y_{ij}$$

where $\bar{P}_j$ represents the mean of standardized values for the same indicator, A_j represents the standard deviation, W_j represents the weight of the indicator within its subsystem, n is the total number of regions for the same indicator, and m is the total number of indicators in each subsystem.

(5) **Calculation of Rural Population, Land, and Economy Development Indices** $f(a)$, $f(b)$, $f(c)$:

$$f(a) = \sum_{j=1}^{m} W_j Y_{ij}$$

$$f(b) = \sum_{j=1}^{m} W_j Y_{ij}$$

$$f(c) = \sum_{j=1}^{m} W_j Y_{ij}$$

where $f(a)$, $f(b)$, and $f(c)$ represent development indices for rural population, land, and economy systems respectively. Higher indices indicate better subsystem development.

2.3 Construction of Coupling Degree and Coordinated Development Models for Rural Population-Land-Economy System

2.3.2 Coupling Coordinated Development Model

Since coupling degree only reflects interaction strength within systems but cannot reveal coordination levels between systems, this paper adapts a coupling coordinated development model from literature [16] to evaluate coordination in rural population-land-economy system development. The basic formulas are:

Coupling Degree Model:

$$C = \left\{ \frac{f(a) \times f(b) \times f(c)}{[(f(a) + f(b) + f(c))/3]^3} \right\}^k$$

Coordinated Development Degree Model:

$$D = \sqrt{C \times T}$$

where C is coupling degree, D is coordinated development degree, and T is the comprehensive evaluation index of rural population-land-economy development. Higher T values indicate higher comprehensive development levels. X, Y, and Z are undetermined coefficients. In rural development, land plays a decisive role as agriculture depends on land, rural residents' production and living occur on land, and farmland bears responsibilities for food security and ecological landscape shaping. Therefore, this paper assumes land is more important for rural population-land-economy system development, with values $X = 0.3$, $Y = 0.4$, $Z = 0.3$ [18].

$$T = X \times f(a) + Y \times f(b) + Z \times f(c)$$

where k is an adjustment coefficient. This study examines three subsystems (population, land, economy), so $k = 3$ [27]. C represents coupling degree with $C \in [0, 1]$. Higher C values indicate stronger coupling and more orderly development, while lower values suggest disorderly development.

2.3.3 Evaluation Criteria for Rural Population-Land-Economy System Coordination

Healthy rural socio-economic development depends on coordinated rural population-land-economy system development, which reflects rural socio-economic development levels. Referencing relevant literature [16,27], this paper establishes evaluation standards, grades, and types for rural population-land-economy system coordination (Table 2).

3. Study Area Overview

Sichuan Province is located in southwestern China, with parallel ridge-valley terrain and central Sichuan hills in the east, Chengdu Plain in the center, and western Sichuan plateau in the west. The province covers 486,000 km^2 with 18 prefecture-level cities and 3 autonomous prefectures under its jurisdiction. The complex topography includes plateau, mountain, hill, and plain landforms. Land resources are characterized by large total area but small per capita availability, low development intensity, and low productivity. Significant regional disparities exist in land resources, with imbalanced quantity and quality structures, relatively few high-quality land categories, and scarce reserve resources for agricultural cultivation [29]. At the end of 2014, total registered population reached 91.591 million, including 64.651 million agricultural population (70.59%) and 26.94 million non-agricultural population (29.41%). Regional GDP reached 2,853.666 billion yuan, with per capita GDP of 35,128 yuan. The three-industry structure was 353.105 billion yuan (primary), 1,396.241 billion yuan (secondary), and 1,104.320 billion yuan (tertiary), with employment distribution of 39.50:26.40:34.10.

Based on the *Sichuan Province 12th Five-Year Plan Outline (2011-2015)* and geographical characteristics, Sichuan is divided into five regions: Central Sichuan Plain, Southern Sichuan Hills, Northeastern Sichuan Hills, Northwestern Sichuan Plateau, and Panxi Region. The Central Sichuan Plain includes Chengdu, Deyang, Mianyang, Meishan, and Ziyang. Southern Sichuan Hills includes Yibin, Zigong, Luzhou, Neijiang, and Leshan. Northeastern Sichuan Hills includes Nanchong, Suining, Dazhou, Guang' an, Bazhong, and Guangyuan. Northwestern Sichuan Plateau includes Ganzi and Aba autonomous prefectures. Panxi Region includes Panzhihua City, Liangshan Prefecture, and Ya' an City (Figure 2 [Figure 2: see original paper]).

4.1 Coordinated Development of Rural Population-Land-Economy System in Sichuan Regions

Rural population, land, and economy development indices show unbalanced characteristics with considerable variation across cities and prefectures (Table 3). Between 2000 and 2014, population development indices remained relatively stable with no significant fluctuations, while land and economy development indices showed greater volatility with an overall upward trend. In 2014, Chengdu and Panzhihua had relatively high rural population development indices (0.998 and 0.872 respectively). However, Panzhihua exhibited low land and economy development indices with a coordination degree of 0.492, placing it in the barely coordinated transition stage. This occurred because Panzhihua, rich in mineral, hydropower, and agricultural resources with high comprehensive competitiveness, is Sichuan' s only prefecture-level city where urban population exceeds rural population and labor is imported. With urbanization reaching 64.03% in 2014 (second only to Chengdu' s 70.37%) [30], the city achieved high urban

development levels and living standards, resulting in high rural population development indices. However, abundant mineral resources gave secondary industry a large share, leaving agriculture relatively underdeveloped with agricultural output accounting for only 3.33% in 2014, thus yielding low rural land and economy development indices.

Significant regional disparities exist in coordinated development degrees of rural population-land-economy systems, with high-quality coordination coexisting alongside severe imbalance and decline (Table 4). Chengdu achieved high-quality coordinated development, while Ganzi Prefecture experienced severe imbalance and decline. Ganzi, an ethnic minority concentration area with low urbanization, high agricultural employment proportion, low living standards, extensive land use patterns, and animal husbandry-dominated agriculture, showed small agricultural output shares in the three-industry structure. In 2014, Ganzi' s population, land, and economy development indices were 0.001, 0.084, and 0.272 respectively—far below provincial averages (0.412, 0.470, 0.420) and vastly different from Chengdu (0.952, 0.701, 0.711). This indicates Ganzi' s rural population and land development lagged behind economic development, hindering overall system coordination.

Correlation analysis using SPSS 22.0 revealed that coordinated development degrees significantly correlated with comprehensive evaluation indices and coupling degrees at 99% confidence levels (correlation coefficients of 0.864 and 0.831 respectively). Regions with higher comprehensive evaluation indices and coupling degrees also showed higher coordination degrees, with coordination degrees falling between coupling degrees and comprehensive evaluation indices, influenced by both.

Overall, Sichuan' s cities and prefectures show large differences in coupling degrees and comprehensive evaluation indices, indicating varying interaction intensities and development levels among subsystems. In 2014, most regions exhibited well-coordinated development ($0.6 \leq D < 0.8$), with some in barely coordinated transition ($0.4 \leq D < 0.6$). According to evaluation criteria, regions can be classified into five types: severely imbalanced decline (Ganzi), mildly imbalanced decline (Liangshan), barely coordinated transition (Panzhihua, Guangyuan, Guang' an, Dazhou, Ya' an, Bazhong, Aba), well-coordinated development (Zigong, Luzhou, Deyang, Mianyang, Suining, Neijiang, Leshan, Nanchong, Meishan, Yibin, Ziyang), and high-quality coordinated development (Chengdu).

4.2.1 Temporal Evolution Characteristics

Figure 3 [Figure 3: see original paper] shows that Sichuan' s rural population-land-economy system coordination experienced significant temporal changes, primarily manifested by decreases in mildly imbalanced decline and barely coordinated transition regions and increases in well-coordinated development regions, while high-quality coordinated development and severely imbalanced decline re-

gions remained unchanged. In 2000, three regions (Luzhou, Yibin, Liangshan) showed mild imbalance and decline, reducing to one region by 2014 as Luzhou and Yibin developed into well-coordinated regions. Compared with 2000, both cities saw increased land and economy indices and decreased population indices, but the three indices became more balanced with better mutual coupling, demonstrating positive coordination development trends. In 2000, barely coordinated transition and well-coordinated development regions accounted for 61.90% and 14.29% respectively, with barely coordinated transition dominating. By 2014, these shifted to 33.34% and 52.38% respectively, with well-coordinated development becoming dominant.

Recent rural land policy reforms have positively activated land stock and improved land use efficiency, while urban-rural integration has promoted rural economic development, increasing both land and economy development indices. Population development indices changed little or even declined because farmers' living standards did not genuinely improve, urbanization rates and employment structures remained stable, and rural per capita net income and living expenditures (converted to 1990 constant prices) increased minimally or even decreased. This indicates that improving farmers' quality of life remains a priority for rural work.

4.2.2 Spatial Differentiation

Sichuan's rural population-land-economy system coordination degrees rank from highest to lowest as: Central Sichuan Plain, Southern Sichuan Hills, Northeastern Sichuan Hills, Panxi Region, and Northwestern Sichuan Plateau. Spatially, higher coordination degrees occur in plains and hilly areas, while lower degrees appear in mountainous and plateau regions with poor natural conditions, showing high coordination in central, southern, and northeastern Sichuan but low coordination in northwestern plateau and Panxi regions, consistent with Sichuan' s actual conditions.

The Central Sichuan Plain benefits from favorable natural resources, geographical location, and developed transportation. Chengdu' s strong economic base creates agglomeration effects on surrounding cities, providing advantages for industry and economic development that promote population, land, and economy development, yielding the highest indices among all regions. Southern Sichuan Hills has experienced rapid rural land and economy development trends, achieving well-coordinated development. Northeastern Sichuan Hills shows relatively weak population and land development, with only Nanchong and Suining achieving well-coordinated development while others remain in barely coordinated transition. This is because these two cities serve as important nodes in the Chengdu-Chongqing two-hour economic circle within the northeastern Sichuan urban agglomeration, providing geographical advantages for rural land and economy development. Northwestern Sichuan Plateau and Panxi Region, constrained by natural and geographical conditions, have inherently low population, land, and economy development indices with large disparities in compre-

hensive evaluation indices, leading to weakened system interactions, decreased coupling degrees, and low coordination.

5. Discussion and Conclusions

This paper analyzes the coupling coordinated development of Sichuan' s rural population-land-economy system using four cross-sectional datasets since 2000 to provide insights for Sichuan' s socio-economic development. Results show that regional disparities in coordination degrees were significant from 2000 to 2014, with substantial temporal changes and an overall positive development trend. Studying regional population, land, and economy conditions helps relevant departments formulate agricultural development plans tailored to local conditions. Compared with previous research, this paper constructs a theoretical framework for rural population-land-economy system interactions, further defining and explaining the system' s extension and connotation. Based on internal relationships among population, land, and economy, it analyzes spatio-temporal evolution characteristics of Sichuan' s rural population-land-economy system, enriching theoretical research on rural areas and providing practical significance for rapid rural socio-economic development. However, the short data interval may result in less obvious coordination differences, and the study did not fully consider Sichuan' s complex topography, landforms, and location characteristics. Coordinated development of rural population-land-economy systems involves multiple influencing factors. Indicator selection should consider not only population-land-economy related indicators but also transportation location, natural resource endowments, population cultural quality, and relevant policy mechanisms. However, these abstract concepts are difficult to quantify, representing a direction for future research. Effectively coordinating rural population-land-economy development requires identifying weak links and implementing targeted policy support to ensure funding, talent, and technical support for relatively backward regions.

Based on the spatio-temporal evolution analysis of Sichuan' s rural population-land-economy system coordination, this paper draws the following conclusions:

1) In 2014, significant regional disparities existed in Sichuan' s rural population-land-economy system coordination, with high-quality coordination coexisting alongside severe imbalance and decline. Regions can be classified as: severely imbalanced decline (Ganzi), mildly imbalanced decline (Liangshan), barely coordinated transition (Panzhihua, Guangyuan, Guang' an, Dazhou, Ya' an, Bazhong, Aba), well-coordinated development (Luzhou, Deyang, Mianyang, Suining, Neijiang, Leshan, Nanchong, Meishan, Yibin, Ziyang, Zigong), and high-quality coordinated development (Chengdu).

2) Rural population-land-economy development indices show unbalanced characteristics. Coordination degrees significantly correlate with comprehensive evaluation indices and coupling degrees at 99% confidence.

Regions with higher comprehensive evaluation indices and coupling degrees also show higher coordination degrees. Temporally, coordination experienced substantial changes, with decreases in mildly imbalanced decline and barely coordinated transition regions and increases in well-coordinated development regions, while high-quality coordinated development and severely imbalanced decline regions remained stable. Spatially, higher coordination degrees occur in plains and hilly areas, while lower degrees appear in mountainous and plateau regions, showing high coordination in Central Sichuan Plain, Southern Sichuan Hills, and Northeastern Sichuan Hills, but low coordination in Northwestern Sichuan Plateau and Panxi Region.

3) Sichuan' s rural land development has achieved considerable success, positively promoting land scaling and population-industrial structure adjustments. However, farmers' living standards and economic development require further improvement. Accelerating population urbanization, surplus labor transfer, and rural economic development represent important future directions. Specific measures include: (1) Accelerating population urbanization by establishing unified residence systems, equalizing public service resources, and improving medical insurance systems to enable farmers to share urbanization benefits. (2) Introducing competitive leading enterprises or farmer cooperatives to create spillover effects, increase employment, promote surplus labor transfer, and accelerate economic growth. (3) Supporting industries in economically backward rural areas and using the internet to market characteristic agricultural products, broadening sales channels, increasing farmers' income, and satisfying consumers' demand for green and healthy products to achieve win-win outcomes.

4) Rural population, land, and economy are interrelated and interactive. For plains and hilly regions with higher coordination degrees, ecological civilization construction and farmland protection should be emphasized to avoid pressure on natural resource development. For plateau and mountainous regions with lower coordination degrees, regional characteristics should be leveraged by developing local tourism and industries to drive rural socio-economic development. Meanwhile, advantages in well-coordinated regions should be maintained, poorly coordinated regions should be promoted, and technology-driven, policy-guided, and agricultural modernization-based approaches should encourage coordinated rural population-land-economy development.

References

[1] Rodríguez-Pose A, Hardy D. Addressing poverty and inequality in the rural economy from a global perspective[J]. Applied Geography, 2015, 61: 11-23
[2] Zhu D L, Wang J, Lin R R. Outlook for China' s rural collective land system reform: Reviews from "roundtable forum for land policy and law 2014" [J]. China Land Sciences, 2014, 28(9): 89-94

[3] Zhai Y. Evaluation and evolution of the Chinese land policy[D]. Xi' an: Xi' an University of Architecture and Technology, 2010
[4] Li K Q. Government Work Report —in March 5, 2016 at the fourth Session of the Twelfth National People' s Congress[J]. China Collective Economy, 2016(8): 14-25
[5] Yin H W, Kong F H. Analysis of the coordination degree between economic development and environment in Shandong Province[J]. Human Geography, 2005, 20(2): 30-33
[6] Wu L. The system of economy and environment coordination degree study in Beijing, China[J]. Modern Economic Information, 2015(17): 489
[7] Zhang X D, Chi T H. Differentiating and analysis of the coordination degree between economic development and environment of provinces (regions) in China[J]. Geographical Research, 2001, 20(4): 506-515
[8] Chen X L, Li S J, Guo Z X. Analysis on the harmonious degree between land use and ecological environment in Yanbian Korean Autonomous Prefecture, Jilin Province[J]. China Land Science, 2009, 23(7): 66-70
[9] Hou P, Li C, Yang Q Y. Analysis of the coordination degree between urbanization and eco-environment of Chongqing City in recent 12 years[J]. Research of Soil and Water Conservation, 2015, 22(5): 240-244
[10] Wang Y M, Ma Y F. Analysis of coupling coordination between urban tourism economy and transport system —A case study of Xi' an City[J]. Journal of Shaanxi Normal University: Natural Science Edition, 2011, 39(1): 86-90
[11] Du A, Liu J M, Shi H C. Coordinative relationship between tourism and urban development in Beijing during 1995-2011[J]. Progress in Geography, 2014, 33(2): 194-201
[12] Wang X J, Hu Q G. Chinese mariculture and marine ecological environment coordination degree analysis[J]. Chinese Rural Economy, 2013(11): 86-96
[13] Wang Y. Regional economic development coordination degree evaluation method research[J]. Gansu Science and Technology, 2015, 31(16): 96-98
[14] Si G N. The population-economy system coordination degree analysis[J]. Statistics & Decision, 2008(4): 48-50
[15] Lü S C, Cheng H D. The coordinated development of population and economy in rural area[J]. Economic Problems, 2007(12): 87-88
[16] Liu H N, Wang D Q. Research on the comprehensive improvement of rural land under the coordinated development of regional economy[J]. Agricultural Economy, 2014(3): 49-51
[17] Cao W L, Zhang X L, Pan Y Y, et al. Coordinate development among population, land and economy urbanization in developed area: The case of Jiangsu Province[J]. China Population, Resources and Environment, 2012, 22(2): 141-146
[18] Liu F W, Xu H Z, Wang S. Analysis on spatial-temporal coupling coordinate degree among population, land and economy urbanization: Based on China provincial panel data[J]. Urban Development Studies, 2014, 21(8): 7-11
[19] Fan H J, Liu Z Y. Study on the development trend of urbanization in China —Based on the coordinated development of population, land and economy[J].

Inner Mongolia Social Sciences, 2014, 35(1): 95-100
[20] Horlings L G, Kanemasu Y. Sustainable development and policies in rural regions: Insights from the Shetland Islands[J]. Land Use Policy, 2015, 49: 310-321
[21] Liu H, Deng H B, Li X F. Research on the spatial and temporal difference of coordinated development between population urbanization and land urbanization in Yangtze River economic belt[J]. China Population, Resources and Environment, 2016, 26(5): 160-166
[22] Xiao L S, Yu Z W, Ye H, et al. The research of coupling rural development and economy cluster in Fujian Province[J]. Acta Geographica Sinica, 2015, 70(4): 615-624
[23] Chen J D, Wang Y, Wen J, et al. The influences of aging population and economic growth on Chinese rural poverty[J]. Journal of Rural Studies, 2015, doi: 10.1016/j.jrurstud.2015.
[24] Kleemann L, Thiele R. Rural welfare implications of large-scale land acquisitions in Africa: A theoretical framework[J]. Economic Modelling, 2015, 51: 269-279
[25] Liu Y S, Long H L, Chen Y F, et al. China' s Rural Development Research Report —Rural Hollowing Out and Its Control Strategy[M]. Beijing: Science Press, 2011
[26] Qu A X. A study on the synthetical measure of the new industrialization level in Jiangsu Province[J]. Economic Geography, 2006, 26(1): 55-59
[27] Zhao J, Liu X P, Liu X H, et al. Analysis on coupling coordination degree between agriculture and animal husbandry systems in Tarim River basin[J]. Arid Land Geography, 2015, 38(5): 1077-1084
[28] Tang H, Yang D G, Qiao X N, et al. Evaluation of coordination degree between regional development and eco-environment on the northern slope of the Tianshan Mountains[J]. Progress in Geography, 2009, 28(5): 805-813
[29] Deng L J, Zhang S R, Li D Y, et al. Analysis on the current situation and issues in Sichuan land resource —1. The current situation in Sichuan land resource[J]. Journal of Sichuan Agricultural University, 1999, 17(2): 179-186
[30] Panzhihua Statistics Bureau. The statistics communique on national economy and social development of Panzhihua 2014[EB/OL]. (2015-04-24). http://www.panzhihua.gov.cn/zfxxgk/tjsj/tjgb/551391.shtml

Note: Figure translations are in progress. See original paper for figures.