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Analysis of the Influencing Factors of the High-Quality Utilization of Territorial Space Based on the Perspective of Spatial Equilibrium: A Case Study of Hunan Province, China

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Abstract: In order to promote the efficient and coordinated utilization of counties' territorial space in Hunan Province, this paper identifies the state of high-quality utilization of territorial space based on the perspective of spatial equilibrium from 2010 to 2020, and uses the spatial econometric model to analyze its influencing factors and propose effective optimization strategies. The results show that: (1) From 2010 to 2020, the quality of agricultural space utilization continued to decline in some areas, and elsewhere to decreased first and then increased. The core area of Chang-Zhu-Tan and the central urban areas of some prefectures have always been high-value areas for the quality of urban space utilization; the agricultural space utilization quality in the Dongting Lake Plain area and the Chang-Zhu-Tan area were high. By 2020, the range of Chang-Zhu-Tan agricultural space categorized as of high-value utilization quality areas has been significantly reduced; the high-value ecological space utilization quality areas were located in areas with large ecological scales, such as counties in the Wuling Mountains, etc. (2) From 2010 to 2020, the near-imbalance and barely balanced development have always been the main types of balanced development, and the balanced development in the core area of Chang-Zhu-Tan and Dongting Lake plain is high. (3) From 2010 to 2020, the types of high-quality utilization of territorial space in Hunan Province were mainly urban-agricultural-ecological spaces with low-quality equilibrium, and high-quality utilization of county areas were rare. The number of high-quality utilization counties was gradually decreasing, and by 2020, there was only one in Wuling District, Changde City. Therefore, the other 121 counties' territorial space utilization status needs to be improved. (4) The high-quality utilization of territorial space in Hunan province was influenced by both regional background factors and external factors, and the external factors were more significant. Among them, population density, consumption level and other factors played an important role. Relevant departments can take effective measures to promote the efficient and coordinated use of county territorial space by taking such measures as relaxing the conditions for the introduction of talents, increasing financial investment, and so on.

Keywords: spatial equilibrium; “urban-agricultural-ecological” space; territorial space; high-quality utilization; influencing factors



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1. Introduction

High-quality utilization of territorial space refers to the spatial performance of the interaction between humans and various resource elements of territorial space at a certain stage and is an important guarantee for the implementation of the three major strategies of urbanization, agriculture, and ecological security [1]. Since the reform and opening up, China has significantly increased the level of industrialization, accelerated the process of urbanization, and rapidly expanded urban areas, resulting in significant changes in the spatial pattern of the territory, which has led to new opportunities and challenges for the efficient and coordinated use of territorial space [2]. On 9 May 2019, the Central Committee of the Communist Party of China (CPC) and the State Council issued “Several Opinions on

Establishing a Territorial Spatial Planning System and Supervising its Implementation”, proposing to do a good job with the top-level design of territorial spatial planning through the requirements of high-quality development, playing a fundamental role for territorial spatial planning in the national planning system, and providing a spatial guarantee for the implementation of national development plans on the ground. The 14th Five-Year Plan of Hunan Province also clearly points out the need for “building a spatial layout and support system for high-quality development”. Therefore, identifying the state of high-quality utilization of territorial space and analyzing its influencing factors can promote the efficient and coordinated utilization of territorial space.

At present, scholars have seen few research results on the high-quality utilization of territorial space, and there are more evaluative research results on the quality of territorial space utilization. Although the research on the quality of territorial space utilization in China started late, it is developing rapidly. In the early days, some scholars studied intensive land use and land use optimization from the perspective of ecological civilization, and some scholars conducted zoning research on the multi-functionality of land space [3–5]. In recent years, there have been many research results on the comprehensive evaluation of the quality of territorial space utilization based on the “production-ecology-ecology” space and function [6–9]. Scholars tended to explore the driving mechanism of the territorial spatial pattern, but rarely directly studied the influencing factors of the high-quality utilization of territorial space [10,11]. Zhao Xiaoqing proposed the optimization of territorial space structure from the perspective of “urban-agricultural-ecology” space using spatial classification, which could provide support for the balanced development of territorial space [12]. On this basis, other scholars evaluated the quality of Guangnan County’s territorial space function and analyzed its coupling coordination [13]. Kong Yu initially proposed the evaluation idea of high-quality utilization of territorial space with “urban-agriculture-ecology” as the starting point, but did not carry out empirical research [1]. Scholars from other countries have focused on the assessment and coordination of territorial spatial functions, evaluation of territorial space suitability, the optimal layout of territorial space in their research on the quality of territorial space utilization [14–16]. Bagheri subjectively combines Delphi and AHP to assess territorial use suitability for coastal urban management, while Aymen uses remote sensing and GIS technology to assess agricultural land suitability [17,18]. The suitability of green space in Kathmandu, Nepal, is evaluated using AHP and GIS analysis methods, and the results of this research can provide a reference for the planning of urban space [19]. Azuara-Garcia developed models for spatial planning to efficiently optimize the spatial layout of the country [20]. Farhan et al. analyzed the current situation of the city and reasons for its formation, namely Islamic culture and climate, in view of the theme of the transformation of the urban model of Al-Najaf city in Iraq, and they put forward some suggestions from the legislative and other levels to protect and realize the sustainable development of the city, which will serve as a basis for other locations [21]. In short, the existing research results have laid a theoretical and methodological foundation for further promoting the research on high-quality utilization of territorial space, and have the following characteristics. (1) From the research point of view, the research was more inclined to study the quality of territorial space utilization from the space of “production-life-ecology”, and there were few relevant research results from the space of “town-agriculture-ecology”. (2) From the perspective of research content, existing research tended to evaluate the quality of territorial space utilization, and there were few research results on influencing factors. (3) From the perspective of research ideas, existing research results have independently studied the quality of territorial space utilization and coordination, but rarely combined the two. In view of this, from the perspective of spatial equilibrium, this paper takes Hunan Province as the research object, takes the “urban-agricultural-ecological” space as the breakthrough point, and believes that the three types of single territorial space utilization quality should all be of high level and above, and that the balanced development of the three spaces can be achieved. The aim is the high-quality utilization of territorial space in the sense of spatial balance, so as to ensure the high-quality utilization of territorial space

in Hunan Province, analyze its influencing factors, and propose some strategies according to the local conditions to promote the efficient and coordinated utilization of territorial space according to local conditions. The specific research ideas of this paper are as follows (Figure 1).

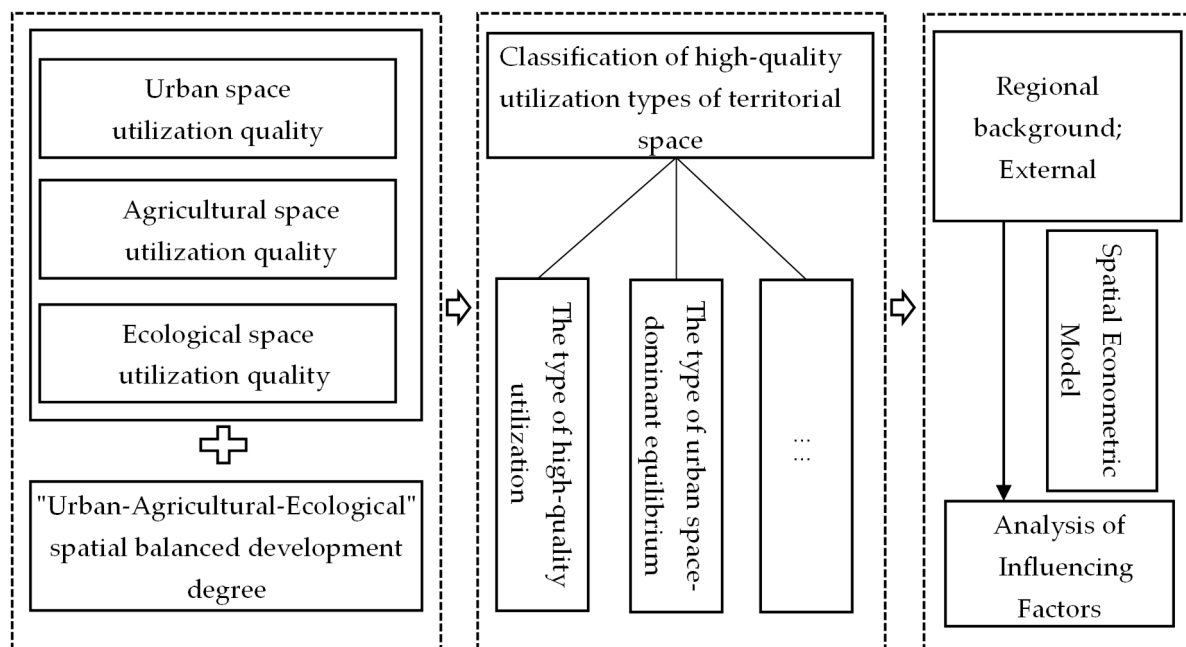


Figure 1. Research ideas.

2. Materials and Methods

2.1. Study Area

This study is based on Hunan Province, China, with a territorial area of 211,800 square kilometers, dominated by mountainous and hilly terrain, with 14 prefectures and 122 counties (Figure 2). From 2010 to 2020, with the implementation of China's "Rise of Central China" strategy and the "Hunan Province Overall Functional Area" program, this Province made significant progress in economy and society. In 10 years, the rate of urbanization increased from 43.3% to 58.76%, and the structure of three industries was adjusted from 13.3:45.2:41.5 to 10.1:38.2:51.7. The second territorial survey showed that the cultivated fields covered 3,926,500 hectares, and the third territorial survey showed that the arable land decreased to 3,628,900 hectares in Hunan Province. Therefore, it was obvious that the agricultural space was shrinking. Although ecological restoration work has been carried out, such as returning fields to lakes and closing mountains for forestry, the problem of ecological and environmental pollution is still prominent in the traditionally agricultural province. Meanwhile, Hunan Province is located in the hinterland of southeast China and is an important area of the Central Rising Strategy and the Yangtze River Economic Belt. Therefore, it is crucial to investigate the factors affecting the high-quality utilization of territorial space and propose corresponding strategies to promote the efficient and coordinated utilization of territorial space in Hunan Province.

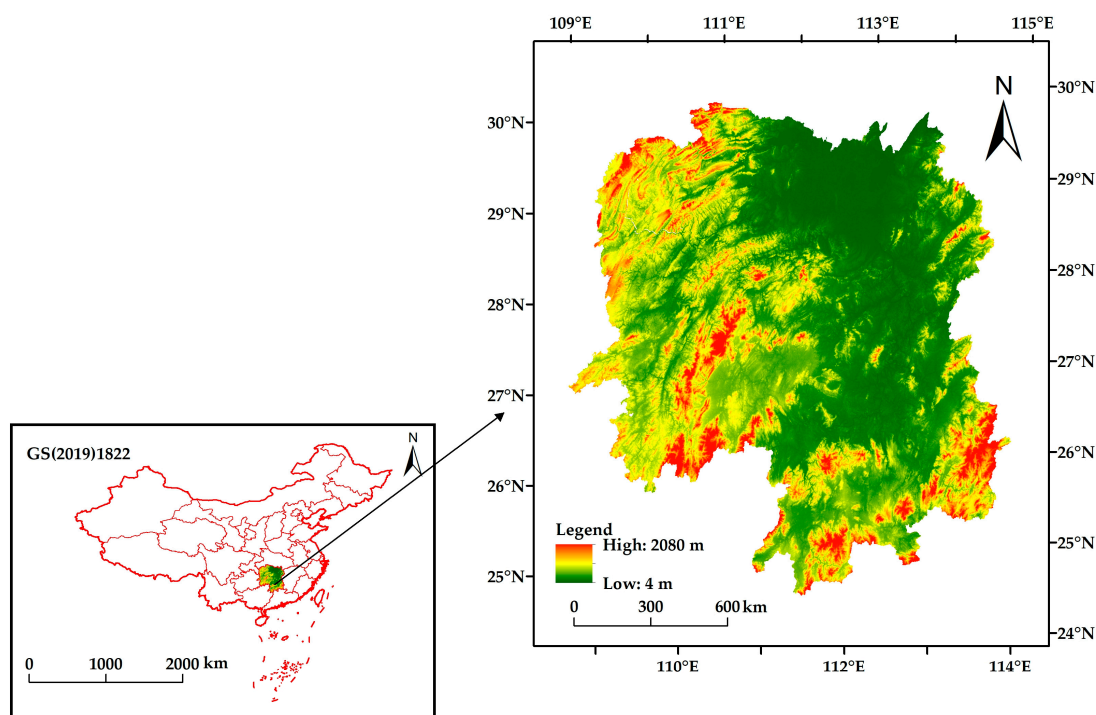


Figure 2. Location map of Hunan Province, Schematic of elevation.

2.2. Data Sources

The data required for the study are mainly statistical data and remote sensing data. The statistical data are mainly obtained through Hunan Statistical Yearbook 2011, 2016, 2021, Hunan Rural Statistical Yearbook 2011, 2016, 2021, and Hunan Survey Yearbook 2011, 2016, 2021. The current land use data, temperature and precipitation data for 2010, 2015 and 2020 are obtained through the Resource and Environment Science and Data Center of the Chinese Academy of Sciences (<http://www.resdc.cn>, accessed on 23 May 2021). The DEM data are obtained through the geospatial data cloud platform (<http://www.gscloud.cn/sources/index?pid=302>, accessed on 5 March 2022).

2.3. Indicator System

2.3.1. Quality Evaluation Index System of Territorial Space Utilization

Based on the perspective of spatial equilibrium, the evaluation index system of spatial utilization quality of territory is constructed by taking the space of “town-agriculture-ecology” as the starting point, according to the requirements of the spatial development and protection pattern of territory in the 14th Five-Year Plan of Hunan Province. Based on the basic principles of scientificity, completeness, independence, and accessibility, and concerning the existing researches and regional characteristics [7,9], nine indicators such as per capita investment intensity of fixed assets, per capita GDP, and urban population density were selected to measure the quality of urban spatial utilization; nine indicators such as land reclamation rate, the ratio of agricultural workers and Engel coefficient of rural residents were used to measure the quality of agricultural spatial utilization; the quality of ecological spatial utilization was measured by the intensity of pesticide use, forest land cover, landscape fragmentation, etc. (Table 1). In order to improve the scientificity and rationality of the weights, the objective weighting of the entropy method and the subjective weighting method of the analytic hierarchy process are combined to set the index weight [22].

Table 1. Evaluation index system of territorial space utilization quality.

Target Layer	Criterion Layer	Indicator Layer and Unit	Calculation	Weight
Urban space	Efficient utilization	Investment intensity of fixed assets per land (yuan/km ²)	Fixed asset investment/Construction land area	0.06
		Land development intensity (%)	Built-up area/Total administrative area	0.192
		Employment in secondary and tertiary industries per land (people/km ²)	Employment in the secondary and tertiary industries/Built-up area	0.045
	Economic agglomeration	GDP per capita (yuan)	GDP of secondary and tertiary industries/Total urban population	0.126
		The added value of the secondary and tertiary industries per land (yuan/km ²)	The added value of the secondary and tertiary industries/Built-up area	0.06
		Per capita disposable income of urban residents (yuan)	The Hunan Statistical Yearbook	0.078
	Population agglomeration	Urban population density (people/km ²)	Total urban population/Built-up area	0.092
		Urbanization rate (%)	Total urban population/Total population	0.257
		Medical education allocation index	Number of schools × Number of teachers × Number of health facilities × Number of beds to the power of 4	0.090
Agricultural space	Agricultural productivity	Land reclamation rate (%)	Cultivated area/Total administrative area	0.112
		The ratio of agricultural employees (%)	Agricultural working population/Total working population	0.101
		Per capita arable land area (km ² /person)	Cultivated area/Total population	0.078
	Agricultural product security rate	Grain yield per unit area (kg/km ²)	Grain yield/Cultivated area	0.063
		Effective irrigation area ratio (%)	Effective irrigation area/Agricultural land area	0.045
		Per capita grain possession (kg)	Grain yield/Total population	0.156
	Rural quality of life	Per capita disposable income of rural residents (yuan)	Hunan Rural Statistical Yearbook	0.196
		Disposable income of rural residents (km ²)	Food expenditure/Total household consumption expenditure	0.144
		Engel coefficient (%)	Total electricity consumption/Total rural population	0.107
Ecological space	Ecosystem	Pesticide use intensity (kg/km ²)	Pesticide usage/Agricultural land area	0.078
		Agricultural plastic film use intensity (kg/km ²)	Agricultural plastic film usage/Agricultural land area	0.134
		Per capita afforestation area (%)	Afforestation area/Total population	0.078
	Ecological scale	Forest coverage (%)	Extract via ArcGIS	0.079
		Grassland coverage (%)		0.21
		Water coverage (%)		0.225
	Landscape quality	Fragmentation index	Extract via Fragstats	0.087
		Diversity Index		0.107

2.3.2. Index System of Influencing Factors of High-Quality Utilization of Territorial Space

The high-quality utilization of territorial space is affected by multiple factors. According to the previous studies and the actual conditions of the study area, an index system of factors affecting the high-quality utilization of territorial space is constructed from the regional background and the external background [23,24]. Among them, X1 to X8 are obtained through existing research, and the other two factors are original. The average altitude, terrain relief, annual average temperature, and annual average precipitation represent regional background factors, and external factors are represented by population density, industrial output value above designated size, local financial expenditure, resi-

dents' consumption level, length of local fiscal expenditure, and soil erosion control area (Table 2).

Table 2. Index system of influencing factors of high-quality utilization of territorial space.

Criterion Layer	Independent Variable	Unit	Calculation
Regional background factors	Average altitude (X1)	m	Extract via ArcGIS
	Topographic relief (X2)	m	
	Annual average temperature (X3)	°C	
	Annual average precipitation (X4)	mm	
External factors	Population density (X5)	people/km ²	Total Population/Total area of Administrative Region
	Resident consumption level (X6)	yuan/people	Total retail sales of social consumer goods/Total population
	Average industrial output value above designated scale (X7)	yuan/km ²	Industrial output value above designated size/Construction land area
	Local fiscal expenditure (X8)	yuan	Hunan Statistical Yearbook
	Dike length from local fiscal expenditure (X9)	km	
	Water and soil loss control area (X10)	km ²	Hunan Rural Statistical Yearbook

2.4. Research Methods

2.4.1. Evaluation Model of Territorial Space Utilization Quality

First, the range method is used to standardize the original data. Due to the needs of calculation, the standardized data is subjected to overall translation processing, so the quality of each space has a value greater than 1 [25]. Secondly, the entropy weight method and the analytic hierarchy process are used. Finally, the following model is used to calculate the quality of each single territorial space utilization [26,27].

$$U_i = \sum X_{ij}w_{ij} \quad (1)$$

In Equation (1), U_i is the evaluation value of spatial utilization quality of every single territory, X_{ij} is the standardized value of j indicators in the county, and W_{ij} is the weight of j indicators.

2.4.2. The Model of Equilibrium Degree and Equilibrium Development

When identifying the type of high-quality utilization of territorial space, the balanced development status of urban, agricultural, and ecological space utilization quality is one of its necessary conditions. Therefore, an equilibrium development model is proposed to analyze the level of equilibrium development of the three spaces.

Spatial equilibrium refers to the degree of interaction and influence of various systems under the influence of certain conditions. In this paper, the degree of interaction between the "urban-agricultural-ecological" space can be obtained by calculating the spatial equilibrium degree. This equation is as follows [28].

$$C = 3 \times \left\{ \frac{U_1 \times U_2 \times U_3}{(U_1 + U_2 + U_3)^3} \right\}^{1/3} \quad (2)$$

In Equation (2), C is the degree of spatial equilibrium, $C \in [0, 1]$; the larger the value of C , the higher the degree of spatial equilibrium, and vice versa. U_1 represents the quality of urban space utilization, U_2 represents the quality of agricultural space utilization, and U_3 represents the quality of ecological space utilization.

The degree of spatial equilibrium only represents the degree of interaction of each system, but cannot identify the degree of its effect. Sometimes the spatial equilibrium is high when the developed level of the three spaces is low. Therefore, the equilibrium development model can be introduced to measure spatial equilibrium in the sense of development. This equation is as follows [28].

$$D = \sqrt{C \times T}, T = \alpha \cdot U_1 + \beta \cdot U_2 + \gamma \cdot U_3 \quad (3)$$

In Equation (3), T is the comprehensive evaluation index; α , β , and γ are the undetermined coefficients, and D is the spatial equilibrium development degree. Consider that each space is equally important to the high-quality utilization of territorial space and has a complementary relationship, and the undetermined coefficient is set to 1/3. Refer to relevant research results to classify the level of balanced development [29,30]: extreme disequilibrium ($0 \leq D \leq 1$), severe disequilibrium ($1 < D \leq 2$), moderate disequilibrium ($2 < D \leq 3$), slight disequilibrium ($3 < D \leq 4$), on the verge of disequilibrium ($4 < D \leq 5$), barely equilibrium ($5 < D \leq 6$), primary equilibrium ($6 < D \leq 7$), intermediate equilibrium ($7 < D \leq 8$), well equilibrium ($8 < D \leq 9$), premium equilibrium ($9 < D \leq 10$).

2.4.3. Spatial Econometric Model

According to the different cognition angles of spatial effects, there are two types of spatial econometric models, including the spatial lag model (SLM) and the spatial error model (SEM). These equations are as follows [31].

$$Y_i = \rho W_y + X\beta + \varepsilon \quad (4)$$

$$\begin{cases} Y_i = X\beta + \varepsilon \\ \varepsilon = \lambda W_\varepsilon + \mu \end{cases} \quad (5)$$

Equation (4) is the spatial lag model, and Equation (5) is the spatial error model, where β is the independent variable parameter; ρ and λ are the spatial variable regression coefficients [32]. β represents the rate of change of the dependent variable Y when the independent variable X increases or decreases by one unit while other independent variables remain unchanged; ε represents the random error after removing the influence of m independent variables on the dependent variable. In this paper, Y_i respectively represents the quality of urban space utilization, agricultural space utilization, ecological space utilization, and the balanced development degree among the three spaces. In the regression results, a positive coefficient means that the independent variable X is positively correlated with the dependent variable Y , and a negative coefficient means that the independent variable X is negatively correlated with the dependent variable Y .

3. Results and Analysis

3.1. Spatial and Temporal Characteristics of Territorial Space Utilization Quality and Spatial Equilibrium Development Degree

3.1.1. Spatial and Temporal Characteristics of Urban, Agricultural, and Ecological Space Utilization Quality

The average quality of urban space utilization in Hunan Province in 2010, 2015, and 2020 was 0.287, 0.293, and 0.283, respectively. The quality of urban space utilization increased first and then decreased during the study period, and the overall quality was mainly low and medium in Hunan Province (Figure 3a–c). During the research period, the maximum difference between the quality of urban space utilization in Hunan Province was 1.31, which showed that there was a significant difference in the quality of space in the province. In 2010, counties with low and medium-quality of urban space utilization were

distributed in various prefectures and cities in Hunan Province, and the urban functions were not prominent. High and higher-quality counties were located in the core area of Chang-Zhu-Tan and some prefectures with high urban space development intensity. In the central urban area, low-quality counties are distributed pointwise in the mountainous counties in western and southern Hunan. By 2015, the quality of urban space utilization had improved, mainly because the counties in the non-core area of Chang-Zhu-Tan and its surrounding counties were in the core area of Chang-Zhu-Tan. The degree of economic and population agglomeration has increased under the influence of radiation in Hunan Province. However, although the urban space in some counties in western Hunan and southern Hunan has expanded, the number of people employed in the secondary and tertiary industries per unit of land area has decreased, and the degree of efficient utilization of urban space has decreased. By 2020, the overall quality of urban space utilization in Hunan Province had slightly decreased, but the quality of urban space utilization has been significantly improved by the process of undertaking industrial transfer and upgrading in western Hunan and southern Hunan. Although the higher quality areas in Chang-Zhu-Tan was expanding to the surrounding areas, the average number of people in secondary and tertiary industries and per capita GDP in the core counties were still high. These changes in urban space restricted the improvement of the quality of urban space utilization.

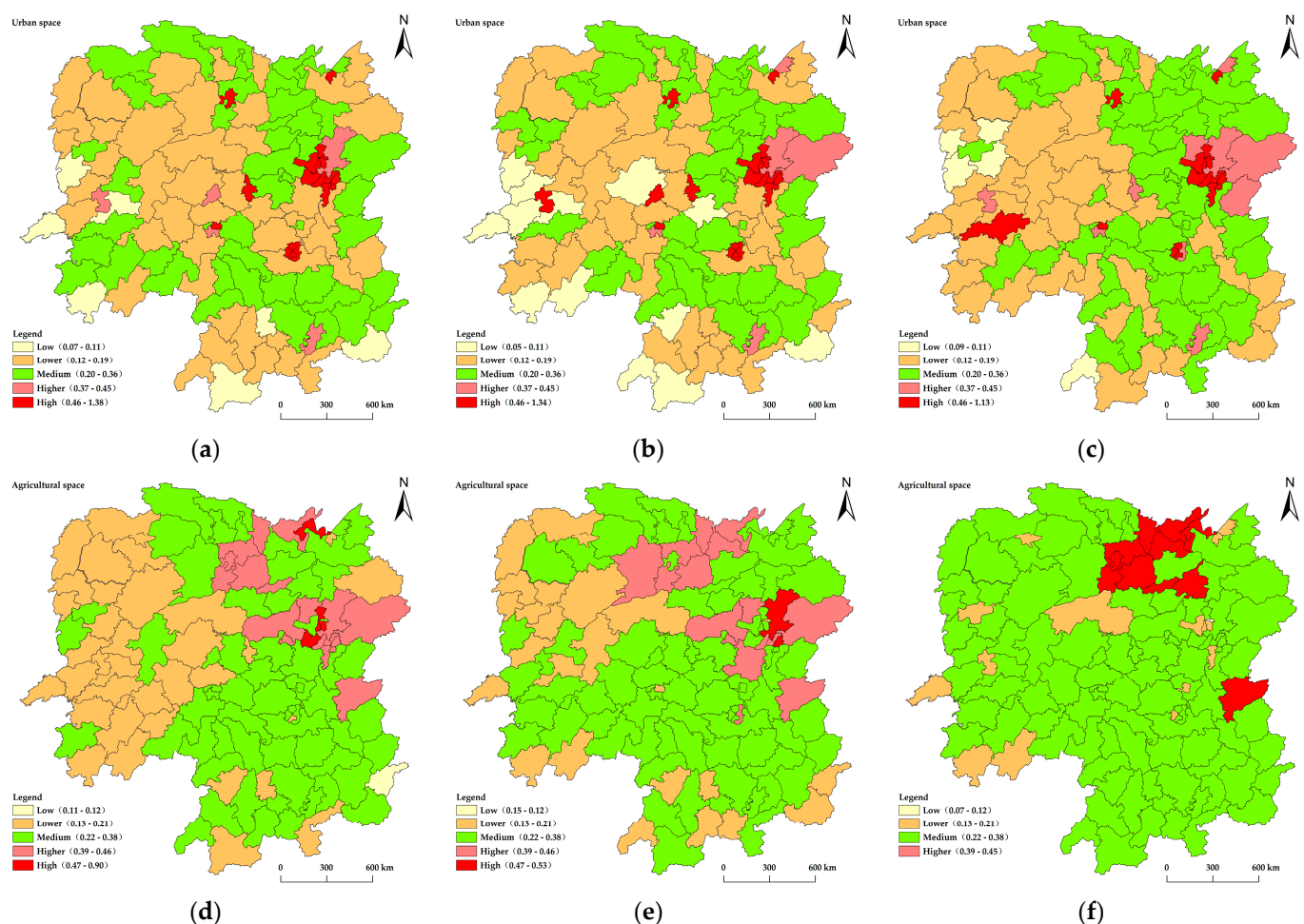


Figure 3. Cont.

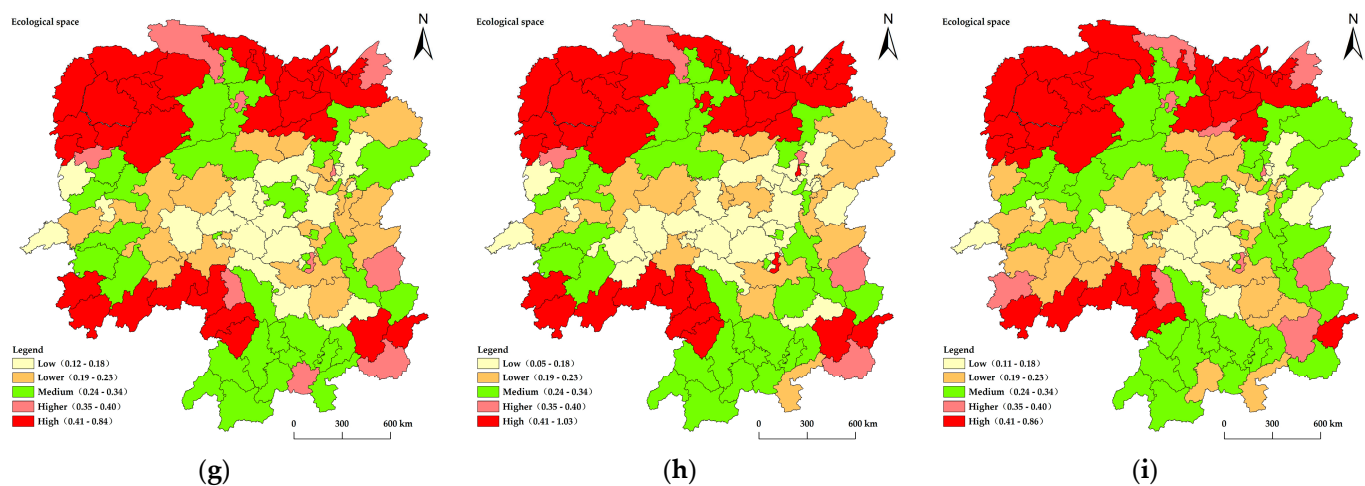


Figure 3. The spatial pattern of territorial space utilization quality in Hunan Province. (a) 2010; (b) 2015; (c) 2020; (d) 2010; (e) 2015; (f) 2020; (g) 2010; (h) 2015; (i) 2020.

The average quality of agricultural space utilization in Hunan Province in 2010, 2015, and 2020 was 0.289, 0.282, and 0.275, respectively. During the study period, the quality of agricultural space utilization showed a continuous downward trend, and the overall quality was mainly medium in Hunan Province (Figure 3d–f). During the research period, the maximum difference between the quality of agricultural space utilization in Hunan Province is 0.79, which showed that there was a significant difference in the quality of space in the province. In 2010, the counties in the central part of the Dongting Lake Plain and most of the counties in the area of Chang-Zhu-Tan were high-quality and high-value areas of agricultural space utilization. The central part of the Dongting Lake Plain had sufficient water and heat, and the natural background of agricultural production was good. The benefits were significant and the quality of life of farmers is high. The quality of agricultural space utilization in counties such as Zhuzhou City and Guidong County, where resources of the cultivated field are relatively fragmented in western Hunan and southern Hunan, is low or below, and the quality of agricultural space utilization in other areas was medium [33]. By 2015, the overall quality of agricultural space utilization has declined slightly, and the agricultural infrastructure in western Hunan has been increasingly improved with the support of the policy of benefiting farmers. However, the agricultural space in the core area of Chang-Zhu-Tan and Junshan District in Yueyang City has shrunk in the process of urban development, and the quality of agricultural space utilization has declined. By 2020, the high-value areas of quality of agricultural space utilization were disappearing, and the high-value areas greatly reduced in Hunan Province. In the area of Chang-Zhu-Tan, the area of cultivated fields decreased, and the ratio of agricultural employees declined. The quality of agricultural space utilization declined significantly.

In 2010, 2015, and 2020, the average quality of ecological space utilization in Hunan Province was 0.318, 0.325, and 0.319, respectively. During the study period, the quality of ecological space utilization increased first and then decreased, and the overall quality was mainly moderate and high in Hunan Province (Figure 3g–i). During the research period, the maximum difference between the quality of ecological space utilization in Hunan Province was 0.98, which showed that there was a significant difference in the quality of space in the province. In 2010, the high-value and higher-value areas were located in areas with large ecological scale, such as the Wuling Mountain area, the southern section of Xuefeng Mountain, some counties of Nanling, Luoxiao Mountain, and the Dongting Lake Plain, among which the forest coverage rate in mountainous counties such as Wuling Mountain was high, while Dongting Lake has vast waters and is an ecological highland in Hunan Province. The median area is distributed around the higher value area and the high-value area, and the distribution is more concentrated in southern Hunan. The lower-value area and the low-value area are mostly distributed in the middle of Hunan

Province. The ecological scale was small and the landscape quality was not high, and the ecological advantages were not significant; by 2015, the spatial pattern of ecological space utilization quality had changed little. It is worth noting that the ecological scale of the Dongting Lake Plain area has expanded under the in-depth implementation of the policy of returning farmland to the lake. The quality of ecological space utilization has been improved, and the overall landscape fragmentation of several counties in Zhuhui District of Hengyang City, Kaifu District, and Tianxin District of Changsha City has been greatly reduced. In the process of developing traditional agriculture in some counties in western Hunan, southern Hunan and Dongting Lake Plain, agricultural non-point source pollution has led to a decline in the quality of the county's ecological environment and the quality of ecological space utilization.

3.1.2. Spatial and Temporal Characteristics of the Spatial Equilibrium Development Degree of "Urban-Agricultural-Ecological"

Overall, the level of spatially balanced development of "urban-agriculture-ecology" was generally not high in Hunan Province. The average levels of balanced development in 2010, 2015, and 2020 were 0.518, 0.519, and 0.517, which increased first and then decreased over the past 10 years. Barely equilibrium was the main type of balanced development. The counties of primary equilibrium and intermediate equilibrium were mainly located in the core area of Chang-Zhu-Tan, Dongting Lake Plain, and the center of Hengyang City. The counties of bare equilibrium and verge of disequilibrium are evenly distributed throughout Hunan, and mildly unbalanced counties in Western Hunan, Southern Hunan, and Central Hunan are distributed in a "point-like" pattern (Figure 4). From 2010 to 2015, the degree of balanced development of "urban-agriculture-ecology" increased slightly in Hunan Province. There were 5 types of balanced development, and the spatial pattern changed little. The proportion of counties that were close to disequilibrium and bare equilibrium ranged from 81.15% to 84.43%, which is related to the reduction of slightly imbalanced counties and primary equilibrium counties. Among them, some counties in the core area of Chang-Zhu-Tan, and the Yueyanglou District of Yueyang City were mainly urban development, the degree of economic agglomeration has increased, and the gap between urban space, agricultural space, and ecological space has increased, and the conflict between the three types of space was obvious. With the support of relevant policies, the quality of urban space and agricultural space utilization has been improved, and the gap between the three types of space has narrowed. From 2015 to 2020, the "urban-agricultural-ecological" spatial equilibrium development degree decreased slightly in Hunan Province, among which the urban spatial development in the core area of Chang-Zhu-Tan became more and more prominent, and the gap with the other two types of spaces increased. Significant progress has been made in the construction of various types of infrastructure in western, central, and southern Hunan, and the development among the three types of spaces has become increasingly balanced. The types of balanced development have been reduced from five to three. For 2020, the two types of slight disequilibrium and intermediate equilibrium should disappear.

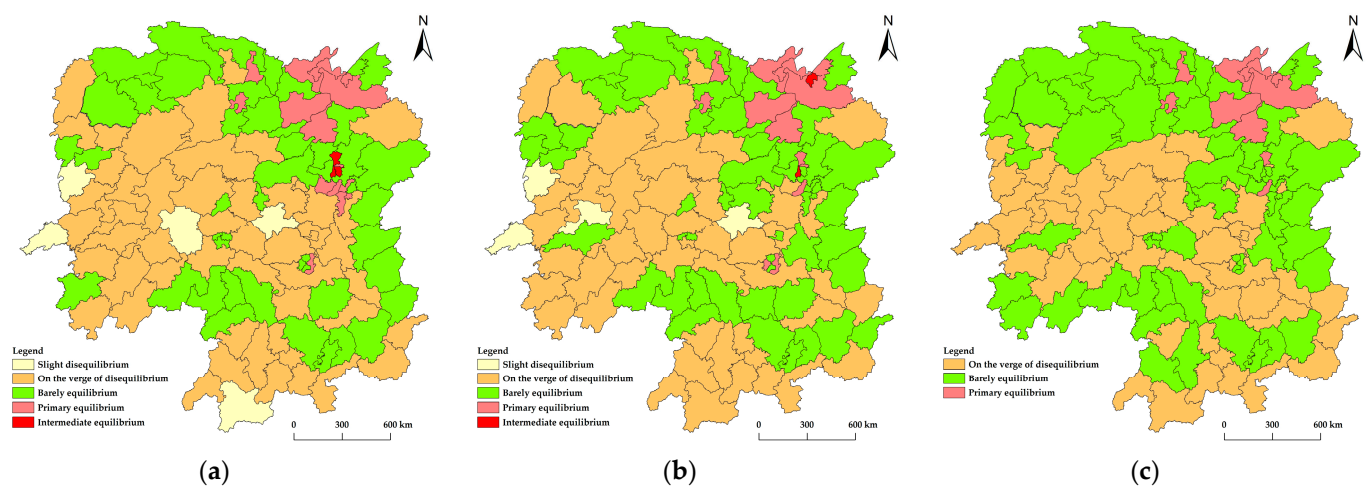


Figure 4. Spatial pattern of “urban-agricultural-ecological” spatially balanced development levels in Hunan Province. (a) 2010; (b) 2015; (c) 2020.

3.2. Classification of High-Quality Utilization Types of Territorial Space

According to the results of the quality of urban, agricultural, ecological space utilization and the balanced development degree among the three, the “three types of single space utilization quality + balanced development degree” was used as the criterion to identify the types of high-quality utilization of territorial space in Hunan Province (Table 3).

Table 3. Classification criteria for high-quality utilization of territorial space types in Hunan Province.

High-Quality Utilization Partition Type		Feature			
		U ₁	U ₂	U ₃	D
I	The type of high-quality utilization	≥higher	≥higher	≥higher	Balanced development
II	The type of urban-agricultural-ecological space is a low-quality equilibrium	≤medium	≤medium	≤medium	Balanced development
III	The type of urban-agricultural space-driven equilibrium	≥higher	≥higher	≤medium	Balanced development
IV	The type of agricultural-ecological space-driven equilibrium	≤medium	≥higher	≥higher	Balanced development
V	The type of town-ecological space-driven equilibrium	≥higher	≤medium	≥higher	Balanced development
VI	The type of urban space-dominant equilibrium	≥higher	≤medium	≤medium	Balanced development
VII	The type of agricultural space-dominant equilibrium	≤medium	≥higher	≤medium	Balanced development
VIII	The type of ecological space dominant equilibrium	≤medium	≤medium	≥higher	Balanced development
IX	The type of urban-agricultural-ecological space has low-quality disequilibrium	≤medium	≤medium	≤medium	Unbalanced development
X	The type of urban-agricultural space lag disequilibrium	≤medium	≤medium	≥higher	Unbalanced development
XI	The type of urban-ecological space lag disequilibrium	≤medium	≥higher	≤medium	Unbalanced development
XII	The type of agricultural-ecological space lag disequilibrium type	≥higher	≤medium	≤medium	Unbalanced development

Note: U₁ is the quality of urban space utilization. U₂ is the quality of agricultural space utilization. U₃ is the quality of ecological space utilization. D is the balanced development degree of “urban-agricultural-ecological” territorial space utilization of the quality.

The high-quality utilization status of territorial space in 122 counties in Hunan Province in 2010, 2015, and 2020 was classified into 12 combination types. In 2010 and 2015, there were 12 types, and by 2020, it was reduced to 10 types (Figure 5). In 2010, the high-quality utilization type of land space in Hunan Province was dominated by the low-quality imbalance type of urban agricultural ecological space, accounting for 36.89% of the total regional unit. It was widely distributed in the central and southern parts of Western Hunan, southern Hunan, and central Hunan, especially in most counties of Western Hunan autonomous Prefecture, Huaihua City and Shaoyang City. Secondly, the ecological space dominated balanced counties, which are some counties with large ecological scales compared with the urban agricultural space lagged and unbalanced counties. There are two counties of high-quality utilization, namely Tianxin District of Changsha City and Wuling District of Changde City. The low-quality balanced counties in the urban

agricultural ecological space are distributed in the south of Hunan and the Chang-Zhu-Tan area and its surrounding areas. The core area of Chang-Zhu-Tan is mainly driven by urban and agricultural space. The quality of urban and agricultural space utilization was high, but the development of ecological space lagged. Huarong County of Yueyang City and other counties with agricultural ecological space balance were less in number, and they were located in the plain area of Dongting Lake. There were two counties with urban ecological space balance, which were Yueyanglou District of Yueyang City and Zhuhui District of Hengyang City. The dominant and balanced type of urban space is seen in the Furong District of Changsha City and other counties with urban development as the mainstay. The balanced counties dominated by agricultural space showed the trend of “large agglomeration and small dispersion”. Xiangtan City, Shaoshan City, which is a county with lagged and unbalanced urban ecological space, and Hecheng District, Huaihua City, which was a county with lagged and unbalanced agricultural ecological space, are “dotted”. By 2015, Wuling District of Changde City and Tianxin District of Changsha City were no longer high-quality land space utilization counties due to the reduction of agricultural space quality. The improvement of agricultural water conservancy facilities in Zhuhui District of Hengyang City made it the only high-quality territorial space utilization County in Hunan Province in 2015; The low-quality balanced counties in the urban agricultural ecological space of Chang-Zhu-Tan area are decentralized, the southern Hunan area is centralized, and Huaihua City and Hongjiang City are newly added in Western Hunan. The types of high-quality territorial space utilization in the core area of Chang-Zhu-Tan are diversified, from the urban agricultural space driven balanced type to the urban ecological dominated balanced type and the agricultural ecological space lag unbalanced type. The spatial change of land use types in other areas is small. By 2020, the types of high-quality utilization of land space in Hunan Province will have been reduced to 10 types, and the urban agricultural space driven balanced type and the urban ecological space lagged unbalanced type will no longer exist, and will be transformed into urban space dominated balanced type and other types. In the process of urban development, the guaranteed rate of agricultural products in Zhuhui District of Hengyang City has decreased, and it is no longer a county with high-quality utilization of territorial space. Wuling District of Changde City had once again become a county with high-quality utilization of territorial space through the construction of an agricultural characteristic industrial park. Under the leading role of urban space, the advantages of urban development in the northern part of Chang-Zhu-Tan area were prominent, and many counties have been transformed into balanced counties dominated by urban space.

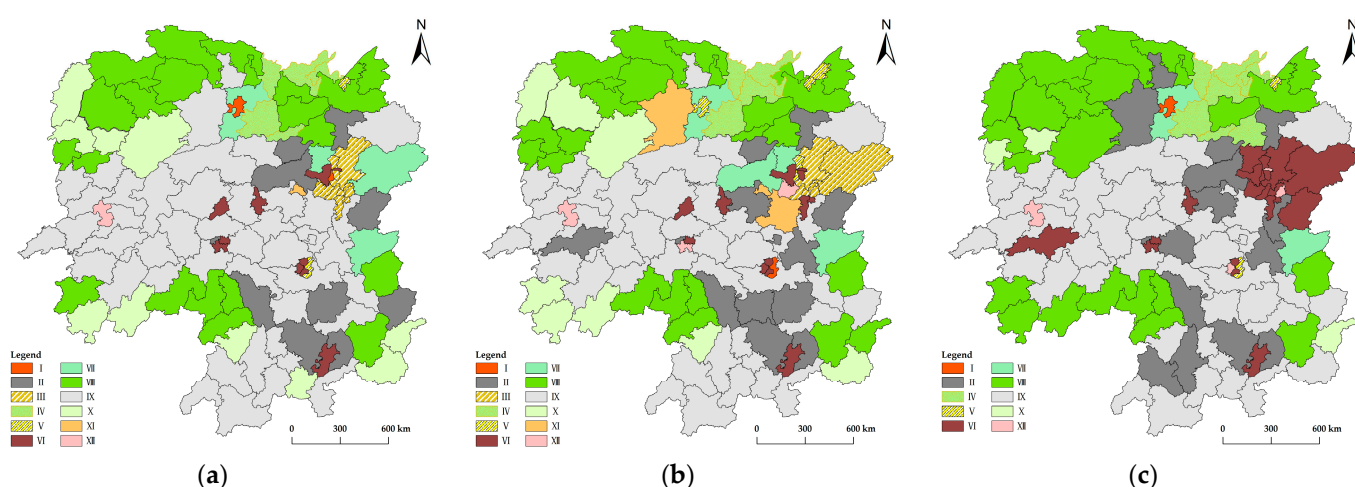


Figure 5. Distribution of territorial space utilization quality types in Hunan Province. (a) 2010; (b) 2015; (c) 2020.

3.3. Analysis of Influencing Factors on High-Quality Utilization of Territorial Space

Firstly, the OLS model is used to perform regression analysis on the quality and equilibrium development of every single space in 2010, 2015, and 2020, and the optimal regression model is selected. Finally, the SEM model is selected to analyze the influencing factors of the quality of agricultural space utilization and the balanced development degree of “urban-agricultural-ecological” space in 2015 and 2020, and the SLM model is selected to analyze the influencing factors of the other 8 dependent variables. The regression analysis results of the influencing factors on the high-quality utilization of territorial space are obtained for Hunan Province as shown in Tables 4–7.

Table 4. Regression analysis results of influencing factors of urban space utilization quality in Hunan Province.

Factors	U ₁			Factors	U ₁		
	The Year 2010	The Year 2015	The Year 2020		The Year 2010	The Year 2015	The Year 2020
X1	−0.042	−0.763 ***	−0.549 ***	X6	0.414 ***	0.346 ***	0.327 ***
X2	−0.085	−0.112	−0.007	X7	0.127 ***	0.104 ***	0.106 ***
X3	0.09	−0.303	−0.136	X8	−0.049	−0.034	0.064
X4	0.026	0.223	−0.053	X9	−0.065 **	−0.069 ***	−0.055 *
X5	−0.35 ***	−0.514 ***	−0.627 ***	X10	−0.007	−0.028	−0.043

Note: *, **, and *** indicate that the independent variable is significantly related to the dependent variable at the 0.1, 0.05, and 0.01 significance levels, respectively.

Table 5. Regression analysis results of influencing factors of agricultural space utilization quality in Hunan Province.

Factors	U ₂			Factors	U ₂		
	The Year 2010	The Year 2015	The Year 2020		The Year 2010	The Year 2015	The Year 2020
X1	0.007	−0.037	−0.019	X6	0.433 ***	−0.05	−0.047
X2	−0.082 **	−0.042	0.019	X7	0.023	0.094 *	0.017
X3	−0.017	−0.005	−0.022	X8	0.163 ***	0.446 ***	0.139
X4	0.004	−0.033	−0.062	X9	0.074	0.007	0.062
X5	0.463 ***	0.572 ***	0.704 ***	X10	−0.003	−0.089	0.039

Note: *, **, and *** indicate that the independent variable is significantly related to the dependent variable at the 0.1, 0.05, and 0.01 significance levels, respectively.

Table 6. Regression analysis results of influencing factors of ecological space utilization quality in Hunan Province.

Factors	U ₃			Factors	U ₃		
	The Year 2010	The Year 2015	The Year 2020		The Year 2010	The Year 2015	The Year 2020
X1	0.153	−0.516 **	−0.154	X6	0.113	−0.057	−0.111
X2	−0.004	−0.112	−0.068	X7	−0.021	−0.048	−0.112
X3	−0.111	−0.706 ***	−0.176	X8	−0.261 **	−0.27 **	−0.17
X4	0.062	0.423 ***	0.258 ***	X9	0.275 ***	0.178 **	0.055
X5	−0.142	0.035	−0.127	X10	−0.049	0.037	−0.083

Note: *, **, and *** indicate that the independent variable is significantly related to the dependent variable at the 0.1, 0.05, and 0.01 significance levels, respectively.

Table 7. Regression Analysis Results of Influencing Factors of “Urban-Agricultural-Ecological” Spatial Equilibrium Development Degree in Hunan Province.

Factors	D			Factors	D		
	The Year 2010	The Year 2015	The Year 2020		The Year 2010	The Year 2015	The Year 2020
X1	−0.052	−0.686 **	−0.331 *	X6	0.691 ***	0.421 ***	0.334 ***
X2	−0.057	−0.136	−0.009	X7	0.157 ***	0.171 ***	0.093
X3	−0.037	−0.511 **	−0.187	X8	−0.156 **	−0.012	−0.066
X4	0.017	0.228	0.092	X9	0.127 **	−0.041	0.032
X5	−0.302 **	−0.013	−0.214	X10	−0.027	−0.024	−0.074

Note: *, **, and *** indicate that the independent variable is significantly related to the dependent variable at the 0.1, 0.05, and 0.01 significance levels, respectively.

3.3.1. Factors Affecting the Quality of Urban Space Utilization

From the perspective of regional background factors, only terrain relief was significantly negatively correlated with the quality of urban space utilization in 2010, which indicates that in mountainous and hilly areas with rugged terrains, such as the mountainous counties in central and southern Hunan, development and urban space utilization was more difficult. Since 2015, the topographic relief has been no longer the main factor affecting the quality of urban space utilization. From the perspective of external influencing factors, population density, resident consumption level, and industrial output value above the designated size are all significantly positively correlated with the quality of urban space utilization at a significance level of 0.01 from 2010 to 2020. Among them, population density had the greatest influence and the intensity of influence increases year by year. This showed that the greater the population density, the higher the degree of population aggregation and the more efficient the use of urban space; the improvement of residents' consumption level could promote the optimization and upgrading of the industrial structure, stimulate economic growth, and promote the improvement of the quality of urban space utilization.

The above industrial output value represents the level of industrialization of a city. The improvement of the level of industrialization can drive urban development and improve the quality of urban space utilization. The Chang-Zhu-Tan region and municipal districts of various cities are typical representatives. From 2010 to 2015, the length of the embankment was significantly negatively correlated with the quality of urban space utilization, but the significance and influence increased first and then weakened. This indicates that the construction of water conservancy projects such as county embankments limited the development of urbanization and industrialization along the river, and water conservancy facilities. The more perfect it was, the lower was the numerical value for the quality of urban space utilization.

3.3.2. Factors Affecting the Quality of Agricultural Space Utilization

From the perspective of regional background factors, only the average altitude was negatively correlated with the quality of agricultural space utilization from 2015 to 2020, and its influence gradually weakened, indicating that the resources of cultivated land resources in the areas with high average altitudes were relatively fragmented, and the natural background of agricultural production was poor. The quality of agricultural space utilization was low. From the perspective of external influencing factors, the population density was significantly negatively correlated with the quality of agricultural space utilization from 2010 to 2020, and its influence gradually increased, which indicates that the contradiction between humans and land was more prominent in the process of population urbanization, the use of agricultural land has changed, and the quality of agricultural space utilization has become higher. The area of the cultivated fields in the third national land survey decreased by nearly 300,000 hectares compared with the second; the consumption level of residents was positively correlated with the quality of agricultural space utilization in 2010, and it is no longer the main influencing factor since 2015. The improvement of agricultural production increased the demand for agricultural products and increase

the income of farmers; the industrial output value above the land average scale had a significant impact on the quality of agricultural space utilization only in 2015, and the industry back-feeding agriculture had a certain effect during this period. Local financial expenditure was the main factor affecting the quality of agricultural space utilization in 2010–2015. Hunan Province as a whole had focused its financial expenditure on supporting “the areas of agriculture—rural—farmer”, agricultural production conditions have been significantly improved, the rural social service system has been gradually improved, and the quality of agricultural space utilization has been improved. By 2020, it should no longer be its main influencing factor.

3.3.3. Factors Affecting the Quality of Ecological Space Utilization

From the perspective of regional background factors, the average altitude and annual average temperature had a significant negative impact on the quality of ecological space use only in 2015. The higher the average altitude and annual average temperature, the lower the quality of ecological space utilization; from 2015 onwards by 2020, the annual average precipitation had a significant positive effect on the quality of ecological space utilization, but the influence was weakened. The increase in precipitation helped the growth of vegetation and biodiversity. The richer the precipitation, the better the utilization of ecological space. From the perspective of external influencing factors, local fiscal expenditures were significantly negatively correlated with the quality of ecological space utilization from 2010 to 2015, which means that the more the local fiscal expenditures, the lower the quality of ecological space utilization. Expenditure accounts for a large proportion. Although the expenditure on ecological and environmental protection increased in 2010, the ecological space was squeezed in the process of urban expansion, and the problem of agricultural non-point source pollution in traditional agricultural areas was still prominent. By 2020, it should no longer be a significant impact on the quality of ecological space utilization factor. The length of the embankment was significantly positively correlated with the quality of ecological space utilization from 2010 to 2015, which indicated that the construction of the water conservancy embankment project played an important role in the water ecosystem, especially in the wetland protection of East Dongting Lake in Hunan Province, By 2020 it is no longer its main influence.

3.3.4. Analysis of Influencing Factors of “Urban-Agricultural-Ecological” Spatial Balanced Development Degree

From the perspective of regional background factors, the average altitude is significantly negatively correlated with the balanced development between the three spaces from 2015 to 2020, indicating that the higher the altitude, the lower the balanced development level of the “urban-agricultural-ecological” space, and vice versa. However, in mountainous counties with rugged terrains, such as Wuling Mountain and Xuefeng Mountain in western Hunan and Nanling and Luoxiao Mountain in southern Hunan, the quality of agricultural space utilization was not high, which seriously restricted the balanced development of the three spaces. The degree of balanced development of agro-ecology space was significantly negatively correlated with altitude. In Hunan Province, the high temperature was not conducive to the growth of vegetation, the quality of ecological space utilization was reduced, and the gap between the three types of space was increased. From the perspective of external influencing factors, the population density was only significantly negatively correlated with the equilibrium development degree among the three spaces in 2010. The greater the population density, the higher the quality of urban space utilization, and the lower the quality of agricultural space. The stronger the conflict, the more it ceased to have a significant impact from 2015 onwards. From 2010 to 2020, the level of residents’ consumption has been significantly positively correlated with the balanced development of the “urban-agricultural-ecology” space, but its influence has gradually weakened, which shows that the increase in the level of residents’ consumption has greatly expanded domestic demand. The level of balanced development in the three spaces could

also be improved. From 2010 to 2015, the land-average industrial output value above the designated size was positively correlated with the balanced development degree among the three spaces, which indicates that the development of industrialization means the efficient use of urban space boosts the level of balanced development among the three spaces under the leading role of urban space. Local fiscal expenditure was only significantly negatively correlated with the equilibrium development degree among the three spaces in 2010, and the equilibrium development among the three spaces was reduced under the restriction of the quality of ecological space utilization, which may be related to the government's response to the financial crisis of 2008. The length of the embankment was only increased in 2010 and was significantly positively correlated with the balanced development of the three spaces, which indicates that although the construction of the embankment project is not conducive to the development of urbanization along the river, it was of great benefit to the protection of the ecosystem. It could be significantly improved under the leading effect of balanced use of space.

4. Conclusions and Discussion

4.1. Conclusions

This paper uses the model of territorial space utilization quality, equilibrium development, and the model of spatial measurement to study the high-quality utilization status and its influencing factors of Hunan Province from 2010–2020. These conclusions are as follows.

- (1) During the research period, the quality differences in the quality of urban, agricultural, and ecological spaces were significant. From 2010 to 2020, the quality of urban space utilization and ecological space utilization both increased first and then decreased, but the quality of agricultural space utilization continued to decline in Hunan Province. This spatial pattern of the three was relatively stable. The core area of Chang-Zhu-Tan with high economic and population agglomeration and some central urban areas in some prefectures were high-value areas of urban space utilization quality, but the urban space utilization quality in western and southern Hunan with backward infrastructure was not high. In 2010 and 2015, the high quality of agricultural space utilization in the Dongting Lake Plain and Chang-Zhu-Tan regions was related to their unique natural conditions. With the development of urbanization, most areas of Chang-Zhu-Tan were no longer the high-quality agricultural space utilization in 2020. In the value area, the quality of agricultural utilization in western Hunan and southern Hunan where cultivated land resources are fragmented has not been high. The high-value areas of ecological space utilization quality have always been in areas with large ecological scales, such as the county of Wuling Mountains.
- (2) The spatial equilibrium development degree of “urban-agricultural-ecology” increased first and then decreased in Hunan Province. The near-imbalance and barely balanced development have always been the main types of balanced development. Some counties in the core area of Chang-Zhu-Tan, and Dongting Lake Plain and the central urban area of Hengyang had a relatively high degree of balanced development driven by one or two types of space utilization quality. From 2010 to 2015, there were five types of balanced development. By 2020, because the quality of urban space utilization in the core area of Chang-Zhu-Tan was more prominent, the gap between the three spaces increased. However, with the increased infrastructure construction in western and southern Hunan, the gap between the three spaces narrowed, and the intermediate equilibrium and slight disequilibrium types of “urban-agricultural-ecology” space were no longer present in Hunan Province.
- (3) From 2010 to 2020, the types of high-quality utilization of territorial space decreased in Hunan Province. There were 12 types of combination types in 2010 and 2015, and they were reduced to 10 types by 2020. During the study period, the type of urban-agricultural-ecological space of low-quality disequilibrium was the main type. From 2010 to 2020, the high-quality utilization of territorial space in Hunan Province

from the perspective of spatial equilibrium has decreased from 2 in Tianxin District of Changsha City and Wuling District of Changde City in 2010 to 1 in Zhuhui District of Hengyang City in 2015. By 2020, with the quality of agricultural space utilization improvement, the Wuling District of Changde City once again ranked among the counties with high-quality utilization of territorial space in Hunan Province, but the other 121 counties' territorial space utilization status needs to be improved. Therefore, from the perspective of spatial equilibrium, Hunan Province still has much room for improvement to promote the high-quality utilization of territorial space.

- (4) The high-quality utilization of territorial space in Hunan Province is affected by the combined effect of regional background factors and external influencing factors. Among them, the regional background factors had a strong limiting effect, such as average altitude, topographic relief, and annual average temperature. However, external factors had a strong driving effect, such as population density, resident consumption level, and so on. Only the area of soil erosion control had no significant impact on the high-quality utilization of territorial space. Nine influencing factors, such as average altitude and population density, had different degrees of influence on the high-quality use of territorial space, and each factor had a significant effect on the high-quality use of territorial space. Due to complexity, the same influencing factor may have had different effects in different periods. On the whole, the factors of population density, resident consumption level, and average industrial output value above the designated scale have an important impact on the high-quality utilization of territorial space. Therefore, it is a good choice to promote the high-quality utilization of territorial space from these aspects.

4.2. Discussion

The high-quality utilization of territorial space in Hunan Province should start from external factors, and taking measures related to factors such as population density is conducive to promoting the efficient and coordinated utilization of territorial space [1]. To this end, optimization strategies can be taken from the following aspects. (1) Relax the conditions for the introduction of talents. Counties with low quality of urban space utilization are generally located in areas with rugged terrain, urban development is relatively late, and the degree of population and economic agglomeration is low. Therefore, these counties can appropriately lower the threshold for talent introduction, and include excellent and professional undergraduates into the talent introduction system. Formulate corresponding supporting measures for the settlement of talents, solve the problems of housing, medical care, children's schooling, etc., and truly realize the entry of talents, which can not only promote population agglomeration, but also inject new momentum into economic development, and further improve the quality of urban space utilization. (2) Increase financial investment. The quality of agricultural space utilization in counties with fragmented arable land resources and backward agricultural infrastructure construction is low, so it is necessary to increase financial investment and focus on the agricultural sector. On the one hand, the government has invested in the construction of a wide range of machine roads to mechanize more farmland and improve agricultural productivity, and on the other hand, the government has invested in improving the irrigation system of water channels to expand the beneficiary area of irrigated farmland to improve the security rate of agricultural products. (3) Improve the legislative guarantee system. The counties with low quality of ecological space utilization are either small in their own ecological scale or have serious levels of agricultural non-point source pollution. Therefore, the ecological space should be more strictly protected in legislation. On the one hand, the punishment for crossing the ecological protection red line should be increased to ensure the sustainable and stable development of the ecological space. On the other hand, a responsibility system for agricultural non-point source pollution should be established to improve the quality of the ecological environment.

The high-quality utilization of territorial space should be the high-quality utilization of the entire space, rather than the high-quality utilization of a certain type of space. Therefore, this paper identifies the state of high-quality utilization of territorial space from the perspective of spatial equilibrium, which enriches the connotation of high-quality utilization of territorial space, and can also provide references for researches related to high-quality utilization in other fields. This paper uses the spatial econometric model to analyze the influencing factors of the high-quality utilization of territorial space in Hunan Province, explores its main restrictive factors and driving factors, and proposes strategies to promote the efficient and coordinated utilization of territorial space in combination with the characteristics of the county, which is not only beneficial to the high-quality utilization of territorial space in Hunan Province, but also provides a reference for the development of territorial space in analogous regions. Although the influence of regional background factors on the high-quality utilization of territorial space is smaller than that of external factors, the impact of regional background factors on the high-quality utilization of territorial space cannot be ignored. However, there are some limitations in this paper that could be improved in future research. The first is to reduce the scale of the study and study the high-quality utilization of territorial space in a certain area more microscopically from the village and town scale; the second is to incorporate more factors into the index system of influencing factors of high-quality utilization of territorial space, and explore its limiting factors and driving factors in depth; the third is to promote the strategy of high-quality utilization of territorial space, which can be considered from other aspects.

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