Measuring the Level of Hollowing out in Rural Hainan Province and the Influencing Factors

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Abstract

Rural hollowing has become an important obstacle to consolidate the effective linkage between poverty eradication and rural revitalization in China. Taking 18 cities and counties in Hainan Province as the research area, we use the land data and socio-economic data of Hainan Province in 2019 to construct an index system for measuring the level of rural hollowing in Hainan Province in terms of population, economy and land, and measure it by entropy value method and multiple regression analysis to reveal the geographical distribution pattern and formation mechanism of rural hollowing in Hainan Province. The results show that: 1. the high areas of land hollowing and comprehensive hollowing in Hainan Province are found in the north and south of Qiong; the high areas of population hollowing are found in the central Wuzhishan City; the economic hollowing is mainly concentrated in the northwest of Qiong. 2. the spatial differentiation pattern of comprehensive hollowing in Hainan Province is significantly coupled with regional economic development, but also influenced by natural conditions. 3. rural hollowing is the result of a combination of factors The improvement of rural living and production conditions, the increase of farmers' income level and the development of regional economy are the main factors influencing rural hollowing.

Keywords

Hainan Province; Rural Revitalization; Rural Hollowing Out; Level Measurement.

1. Introduction

"Hollowing out" is a complex concept in rural social problems. It includes population decline, idle residential land, backward industries, cultural decline, ineffective governance and unsuitable living environment. China is in a period of economic transition and social transformation[1,2], and the large-scale absorption of rural resources by cities [3] has caused huge changes in the social and demographic structures of rural areas, bringing challenges to rural development [4]. According to the report published in the China Urban and Rural Construction Statistical Yearbook 2019, the number of villages nationwide decreased from 3.137 million in 2005 to 2.252 million in 2019, a decrease of 615,000 in 14 years. The hollowing out of China's rural areas has gone through three stages, namely, leaving the land and not leaving the village - leaving the land and leaving the village - leaving the land and leaving the village and leaving the roots [5]. Developed countries and regions have also suffered from rural hollowing out during the process of industrialization and urbanization, such as the decline of rural population in Japan since the 1960s, which led to the hollowing out of land in the 1980s and eventually the problem of village decay [6], and the "New Village Movement" in South Korea, which started in the 1970s to remedy rural hollowing out [7]. The problem of rural hollowing has received widespread attention [8], and the current research on rural hollowing by domestic scholars is mainly divided into two categories: the first category is the relationship between institutional factors and rural hollowing. The main focus is on the process of institutional factors such as household registration system, land system, social security system and urban-rural dual system on the formation and development evolution of rural hollowing [9,10,11],

and the crack to manage the rural hollowing problem through relevant institutional reforms [12]. The second category, non-institutional factors and rural hollowing relationship. It mainly explores the inner logic of the influence of non-institutional factors on rural hollowing, including the influence of changes in culture, natural resources, and environmental degradation on the formation of rural hollowing [13], and advocates the reconstruction of rural culture, improvement of rural living environment, and protection of agricultural production resources [14]. Most scholars have reached the following consensus on the study of rural hollowing: the root cause of rural hollowing lies in institutional mechanisms; geospatial hollowing is the initial manifestation of rural hollowing; and population reduction is the final result of hollowing in pursuit of better economic benefits. However, China is a vast country with huge differences among different regions, and the main influencing factors for the formation of rural hollowing are different, i.e., the natural factor-led type of rural hollowing formed by environmental deterioration, and the institutional factor-led type formed by the influence of institutional factors. In conclusion, the study of rural hollowing should be reflected to a specific region at the micro level in order to accurately grasp the root cause of the rural hollowing problem in that region. Taking 18 cities and counties in Hainan Province as the research geographical units, we enrich the study of rural hollowing in specific regions under the perspective of rural revitalization, and construct the regional differentiation pattern of rural hollowing in Hainan Province and its influencing factors in terms of population, economy and land, so as to provide a reference for deciphering the problem of rural hollowing in Hainan Province in the rural context and narrowing the differences among different places in the region.

2. Research Area

Hainan Province is located at the southernmost tip of China, established in 1988, is the oldest province and the largest special economic zone in China, the second largest island in China after Taiwan Island. The northern part of the province is delimited by the Qiongzhou Strait and Guangdong Province, the western part is bordered by the Gulf of Tonkin opposite Guangxi and Vietnam, and the eastern part is bordered by the South China Sea, with several Southeast Asian countries across the sea. Hainan Province is located in a tropical area, between 18°10′-20°10′ N latitude and 108°37'-111°05' E longitude, with a land area of 35,400 square kilometers and a sea area of 2 million square kilometers, the topography presents a medium-high circumferential low. Hainan Province has four prefecture-level cities, five county-level cities, four counties and six autonomous counties. In the statistics published in 2020, the province's GDP was 553.239 billion yuan, the total population was about 10 million, the rural population was 4 million, the urbanization rate was 60%, the proportion of the three major industries was 20.5:19.1:60.4, and the per capita net income of urban and rural residents was 37,097 yuan and 16,279 yuan, respectively. The disparity of regional economic development level within Hainan province is large, the economic condition, infrastructure and social services in coastal cities and counties are better developed than in central areas, which makes the population mainly concentrated in coastal cities and counties, the transfer of population in central areas, the decrease of rural population and the increase of idle land make the degree of hollowing out aggravated and provide a better case for this study.

3. Rural Hollowing Evaluation Index System

Rural hollowing is the result of the action of population, economy, and land. By constructing three subsystems of population, economy, and land [15], we concentrate to reflect the pattern of geographical differentiation of rural hollowing in each region of Hainan.

3.1.   Population Subsystem

Population decline is the ultimate result of rural hollowing out. This subsystem consists of four indicators (Table 1), namely, village population centrality, urbanization rate, number of agricultural employees, and rural population settlement rate. The urbanization rate and the number of agricultural employees reflect the migration of the rural population to urban areas and non-farm employment, and the increase in the urbanization rate and the decrease in the number of agricultural employees inevitably bring about an increase in rural hollowing out. The lower the population center of a village, the higher the degree of hollowing out. The lower the settlement rate, the higher the degree of hollowing out.

3.2.   Economic Subsystem

The economy is the driving force of rural hollowing out. The economic subsystem is mainly composed of farmers' income level, regional economic structure and economic development level (Table 1); farmers tend to go to cities to buy houses or build houses in villages when their income level increases, which leads to the decrease of rural population or the original house bases being left idle, and the hollowing out increases; the regional economic structure reflects the employment situation of primary, secondary and tertiary industries. When the proportion of primary industry decreases to a certain degree, the employment opportunities in secondary and tertiary industries increase, and the non-agricultural employment of farmers rises, which aggravates rural hollowing out; the level of economic development is the key factor for rural labor transfer, and the higher the level of economic development, the greater the driving force to promote rural labor transfer, which also changes the rural population structure and land use pattern. The higher the level of economic development, the greater the driving force to promote rural labor migration, which also leads to changes in rural population structure and land use patterns, and intensifies rural hollowing.

3.3.   Land Subsystem

Land is the external manifestation of rural hollowing out. The land subsystem is mainly composed of five indicators: per capita arable area, land settlement rate, grain yield, marginalization rate of arable land and total power of agricultural machinery per land (Table 1). The higher the per capita arable land area, the land settlement rate and the average total power of farm machinery reflect the land use status and utilization degree of the region from the quantity of labor input and power input. The degree of hollowing. When the marginal rate of grain yield and arable land reflects the space for farmers to rise in agricultural income, the greater the grain yield and marginal rate of arable land, the higher the income of farmers, the smaller the income gap between secondary and tertiary industries, and the low desire of farmers to go out to work, the smaller the degree of rural hollowing out.

4.   Data Source and Processing

4.1.   Data Source

The data involved in this study include 18 cities and counties in Hainan Province, and on the basis of the construction of the system of land indicators, economic indicators and population indicators, the Hainan Statistical Yearbook-2020 and the statistical bulletin on the national economic and social development of Hainan Province in 2020 are chosen as the data sources.

4.2.   Data Processing

Due to the existence of quantiles in the selected data, in order to make the data comparable, the data were normalized in the following way.

(1) If b is extremely large (positive indicator).

$$b'_{ij} = \left[\frac{b_{ij} - \min(b_{1j}, b_{2j}, \cdots, b_{nj})}{\max(b_{1j}, b_{2j}, \cdots, b_{nj}) - \min(b_{1j}, b_{2j}, \cdots, b_{nj})} \right] \qquad (1)$$

(2) If b is a very small size (negative indicator).

$$b'_{ij} = \left[\frac{\max(b_{1j}, b_{2j}, \cdots, b_{nj}) - b_{ij}}{\max(b_{1j}, b_{2j}, \cdots, b_{nj}) - \min(b_{1j}, b_{2j}, \cdots, b_{nj})} \right] \qquad (2)$$

In the expressions of (1)(2), b'_{ij} is the standardized value of the i-indicator of the jth geographical unit, j=1,2...n is the total number of geographical units, b_ij is the original value of the i-indicator of j geographical units, $\max(b_{1j}, b_{2j}, \cdots, b_{nj})$ is the maximum value of the i-indicator, $\min(b_{1j}, b_{2j}, \cdots, b_{nj})$ is the minimum value of the i-indicator.

4.3. Determination of Indicator Weights

After the normalization process, the indicator weights are determined by calculating the information entropy of the indicator data through the entropy value method, which is an objective weighting method as follows.

$$W_i = \frac{D_i}{\sum_{i=1}^{n} D_i}, \quad 0 \le i \le m \qquad (3)$$

In equation (3), W_i is the weight of the ith indicator, D is the utility value of the ith indicator, and D is the difference between 1 and the entropy value of the ith indicator.

5. A Model for Measuring the Level of Rural Hollowing

Based on the normalization of the data and the assignment of weights, the values of the three sub-indicators of population, land, and economy are calculated separately, from which the hollowing out of each study area is measured in the following way.

$$H_i = \sum_{j=1}^{m} w_j \times p_{ij}, \quad i = 1,2,3,\dots,n \qquad (4)$$

In equation (4), H_i_i is the value of the rural cavitation level of the ith study unit, j is the number of principal component factors, p_{ij} is the factor score, and w_j is the weight assignment of the corresponding principal component factors.

Table 1. Comprehensive level measurement system of rural hollowing in Hainan Province in 2019

Target layer	Guideline layer	Indicator layer	Nature of Indicator	Indicator weights	Calculation method
Rural Hollowing	Population Subsystem	Urbanization rate	+	0.054	Urban population/total population
		Numberof Agriculture	−	0.039	primary sector/total population
		Village population centrality	−	0.079	Village population/number of administrative villages
		Settlement rate of rural population	−	0.089	Rural resident population/total rural population

		Arable land per capita	–	0.101	Arable land area/total population
		Land reclamation rate	–	0.096	Arable land area/total area of the region
	Land Subsystem	Grain yield	–	0.095	Total food production / arable land area
		Marginalization rate of arable land	–	0.099	Agriculture, forestry, animal husbandry and fishery output value / arable land area
		Total power of agricultural machinery	+	0.066	Total year-end power of agricultural machinery / arable land area
		Farmers' income level	+	0.088	Per capita net income of farmers
	Economic Subsystem	Regional Economic Structure	–	0.090	Value added of primary industry/GDP
		Economic Development Level	+	0.103	GDP / total regional population

5.1. Level Measurement Evaluation

Equations (3) and (4) were used to calculate the index weights of land data and socio-economic data of 18 cities and counties in Hainan Province, and the levels of population hollowing, land hollowing, economic hollowing and comprehensive hollowing of each city and county were obtained respectively (Table 2), and the levels of population hollowing, land hollowing, economic hollowing and comprehensive hollowing were classified into three levels of low, medium and high zones respectively by GIS natural breakpoint method, and then their spatial territorial differentiation patterns were analyzed (Figure 2).

Table 2. Results of measuring the level of rural hollowing in cities and counties in Hainan Province in 2019

Study area	Population hollowing out	Land Hollowing	Economic hollowing out	Integrated Hollowing
Haikou	0.094	0.104	0.062	0.261
Sanya	0.097	0.119	0.045	0.262
Wuzhishan	0.129	0.086	0.032	0.248
Wenchang	0.086	0.098	0.055	0.239
Qionghai	0.075	0.089	0.065	0.223
Wanning	0.087	0.094	0.047	0.228
Ding'an	0.077	0.104	0.047	0.227
Tunchang	0.069	0.119	0.041	0.231
Chengmai	0.054	0.098	0.062	0.213
Lingao	0.077	0.108	0.034	0.219
Danzhou	0.064	0.092	0.049	0.204
Dongfang	0.069	0.053	0.057	0.179
Qiongzhong	0.090	0.085	0.019	0.195
Baoting	0.094	0.046	0.029	0.169
Lingshui	0.059	0.068	0.048	0.175
Baisha	0.088	0.064	0.021	0.174
Changjiang	0.057	0.086	0.038	0.181

5.2.   Population Hollowing out

It can be learned from Table 2 that the low, medium and high population hollowing areas in Hainan account for 50%, 44.4% and 5.6% of the total regional area, respectively. From the spatial regional distribution (Figure 1), the low population hollowing out area is mainly distributed in Lingao County, Dongfang City, Qionghai City, Danzhou City, Changjiang County, Chengmai County, Tunchang County, Ding'an County and Lingshui County, these 9 cities and counties are mainly distributed in the western and northwestern areas of Hainan, which are important agricultural production bases in Hainan, with a high proportion of rural resident population, a low proportion of farmers working outside the home, and a low degree of population hollowing out. The development of western and northwestern Hainan started late, the degree of development is not high, the level of urbanization in this region is lower than the overall regional level. High degree area population hollowing out appears in the central Wuzhishan city, and is the only high degree area, unlike other places, Wuzhishan is the highest altitude area in Hainan, mainly mountainous, with very little arable land area and high average total land power of agricultural machinery, plus in the central part, bordering with many surrounding cities and counties, going out to work becomes the main source of income for farmers, Wuzhishan is also a backward area of Hainan's economic development level. The moderate area is scattered branches in Haikou City, Wenchang City, Baoting County, Baisha County, Wanning City, Qiongzhong County, Ledong County and Sanya City, running through the north, middle and south of Hainan. Therefore, the relationship between high degree of population hollowing and regional economic development level, i.e., low population hollowing and low development level have coupling, low population hollowing and low economic development level; high population hollowing and high development level do not necessarily have coupling, i.e., high population hollowing and not necessarily high economic development level, which may be influenced by natural factors in addition to economic factors.

5.3.   Land Hollowing

From the degree of land hollowing (Table 2), 27.8%, 44.4%, and 27.8% of the total area of the study area was occupied by low, medium, and high land hollowing areas in Hainan Province, respectively. In terms of geographical distribution (Fig. 1), the low land hollowing areas are mainly found in Dongfang City, Baisha County, Baoting County, Ledong County, and Lingshui County in Qiongnan and Qiongnan Southwest, where the level of urbanization is low; at the same time, the utilization rate of agricultural mechanization is not high, which makes it difficult to free more laborers from the land. The land hollowing in the medium degree area runs from Qiongxi to Qiongdong, with a wider division, and is mosaic with the high degree area. The high zone land hollowing is distributed in Haikou city, Lingao county, Dingan county, Tunchang county and Sanya city, among which Haikou and Sanya are the two poles of Hainan's economic development, attracting farmers from the surrounding cities and counties to work in the city, so that farmers are liberated from the land and the per capita arable land area is gained large; but due to various institutional barriers, farmers after moving to the city can not deal with agricultural land and residential bases, land is in a long-term idle state. Lingao is Hainan's largest fishing county, farmers rely more on the sea than on the land, coupled with the high total power of agricultural machinery per capita, making a high degree of land hollowing. It can be seen that there is a certain coupling between land hollowing and regional urbanization development level, which shows that the higher the level of urbanization, the higher the level of land hollowing, and vice versa, the lower.

5.4.   Economic Hollowing Out

By (Table 2) the degree of economic hollowing, the low, medium and high economic hollowing areas accounted for 33.3%, 38.9% and 27.8% of the total area of the region, respectively. In terms of distribution areas (Figure 1), the low degree areas are mainly in Qiongzhong County,

Baisha County, Wuzhishan City, Ledong County, Baoting County in the central region and Lingao County in the north. These areas are mainly distributed in the central mountainous areas, where the natural conditions are relatively poor, coupled with imperfect infrastructure and underdeveloped transportation, and the weaker economic strength also hinders the trend of outward migration of farmers, so the level of rural hollowing out is not high. High areas are mainly concentrated in Chengmai County in the northeast, Haikou City, Wenchang City, Qionghai City and Dongfang City in the west. The northeast is the most developed area of secondary and tertiary industries in Hainan, with a high degree of agricultural non-agriculturalism and a high level of urbanization in the province; Dongfang City in the west, with a relatively well-developed industrial base and a relatively high level of farmers' income in the west, and a stronger drive for farmers to expand outside, the level of rural hollowing out in this region is higher. The medium degree area is scattered around and set between the low degree area and the high degree area. Therefore, it can be seen that the high level of economic hollowing out shows a high degree of coupling with the level of urbanization, i.e., the higher the level of urbanization development, the higher the degree of economic hollowing out.
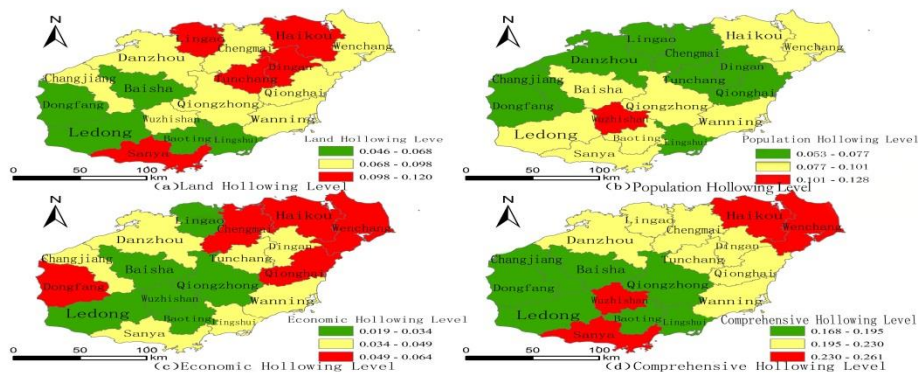

Figure 1. Regional distribution of population, land, economy and integrated hollowing by cities and counties in Hainan Province

5.5. Integrated Hollowing

In terms of comprehensive hollowing out (Table 2), the low, medium and high zones account for 38.9%, 38.9% and 22.2% of the total area, respectively. In terms of geographical distribution, it shows a certain regularity, i.e., the high zone is mainly distributed in the north and south, the medium zone is distributed in the middle, and the low zone is distributed in the south-central region, and the economic development level reflects a high-middle-low-high situation. Among them, the high area appears in 4 areas of Haikou City, Sanya City, Wenchang City, and Wuzhishan City; the medium area appears in 7 areas of Danzhou City, Chengmai County, Lingao County, Tunchang County, Qionghai City, Dingan County and Wanning City; the low area appears in 7 areas of Changjiang County, Dongfang City, Ledong County, Baisha County, Qiongzhong County, Lingshui County and Baoting County. Except for Wuzhishan City, which is more special due to the influence of natural conditions, the comprehensive hollowing out in the remaining areas is the result of the combined effects of population hollowing out, land hollowing out and economic hollowing out. Thus, it can be seen that the level of comprehensive hollowing and the level of urbanization also have a certain degree of spatial coupling.

6. Identification of Factors Influencing Rural Hollowing in Hainan Province and the Mechanism of Influence

6.1. Rural Hollowing Index and Correlation Analysis

In order to further analyze the factors affecting rural hollowing and the magnitude of the influence of each factor, the data of Hainan Statistical Yearbook 2009-2019 from 18 cities and

counties in Hainan Province were used as the research object. There are many factors affecting rural hollowing out, influenced by population, land, economy, infrastructure, management and natural conditions, etc. It is difficult to explain all the influencing factors on rural areas. The most prominent manifestation of rural hollowing is population decline, i.e., the hollowing of population has evolved into the hollowing of land, industry, public services and infrastructure as a whole. Therefore, the hollowing out index is constructed by taking the rural population decline as an indicator of the severity of rural hollowing out, with the formula.

$$G = \left(1 - \frac{R}{T}\right) \times 100\% \tag{5}$$

Where,G represents the hollowing out index, T is the total rural population, and R is the rural resident population. The ratio of the rural resident population R to the total rural population T represents the proportion of rural population lost, and the difference between 1 and this proportion is the degree of hollowing. Finally, combining with the actual situation of rural hollowing performance in the previous paper, the rural hollowing index is selected as the dependent variable (Y), and the rural electricity consumption (X_1), the total output value of agriculture, forestry, animal husbandry and fishery (X_2), the number of agricultural employees (X_3), the per capita arable land area (X_4), the fixed asset investment amount (X_5), the per capita fiscal revenue (X_6), the per capita net income of rural residents (X_7), the effective irrigated area (X_8), the crop sowing area (X_9), and total agricultural machinery power (X_{10}), with 10 indicators as independent variables [16]. SPSS 25.0 was used to correlate the index data, and the following Table 3 was obtained.

Table 3. Correlation analysis of factors influencing rural hollowing in Hainan Province

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	Y
X1	1										
X2	.798**	1									
X3	.851**	.707*	1								
X4	-0.322	-0.445	-0.377	1							
X5	.911**	.767**	.948**	-0.283	1						
X6	.968**	.740**	.839**	-0.258	.938**	1					
X7	.996**	.805**	.864**	-0.333	.932**	.980**	1				
X8	0.477	0.528	0.576	0.092	.688*	0.550	0.505	1			
X9	-.954**	-.788**	-.799**	0.403	-.834**	-.869**	-.940**	-0.337	1		
X10	.941**	.777**	.862**	-0.323	.954**	.961**	.955**	.687*	-.858**	1	
Y	.762**	.859**	0.550	-0.424	.618*	.661*	.737**	0.445	-.798**	.733*	1

Note: **. At the 0.01 level (two-tailed), the correlation is significant, *. At the 0.05 level (two-tailed), the correlation is significant.

As can be seen from Table 3, the hollowing out index and rural electricity consumption, gross output value of agriculture, forestry, animal husbandry and fishery, fixed asset investment amount, average local fiscal revenue, per capita net income of rural residents, crop sowing area and total agricultural machinery power correlate well.

6.2. Model Construction of Hollowing Influence Factors based on Multiple Linear Regression

Through the correlation analysis of the factors influencing the hollowing out index in Hainan Province, it was found that the factors influencing the hollowing out index consisted of seven

influencing factors, including rural electricity consumption (X_1), total output value of agriculture, forestry, animal husbandry and fishery (X_2), fixed asset investment amount (X_5), average land revenue (X_6), per capita net income of rural residents (X_7), crop sown area (X9) and total agricultural machinery power (X_{10}). After multiple linear regression analysis, the parameters of each regression variable were obtained (Table 4). Among them, the goodness of fit of the simulated equation $R2=0.971$, the F-statistic value is 48.463, the probability is 0.004, which is less than 0.05, the sample regression effect has a good fit, the linear relationship between each influencing factor and the hollowing index of Hainan Province is significant, and the regression equation derived from the simulation is feasible.

Table 4. Regression analysis of factors influencing hollowing index in Hainan Province

Models	Regression coefficient	t	Sig
Constants	0.533	2.701	0.074
Rural electricity consumption X_1	2.819	4.476	0.021
Total output value of agriculture, forestry, animal husbandry and fishery X_2	3.793	7.828	0.004
Fixed asset investment amount X_5	-1.685	-2.845	0.065
Average local fiscal revenue X_6	0.001	1.792	0.171
Net income per capita of rural residents X_7	-5.428	-5.058	0.015
Crop sown area X_9	-5.513	-2.337	0.098
Total power of agricultural machinery X_{10}	0.001	5.265	0.013

The regression coefficients of each indicator were obtained from Table 4, and the regression equations (6) of rural hollowing index (Y) and rural electricity consumption (X_1), total output value of agriculture, forestry, animal husbandry and fishery (X_2), fixed asset investment amount (X_5), average land revenue (X_6), per capita net income of rural residents (X_7), crop sown area (X9) and total agricultural machinery power (X_{10}) are as follows:

$$Y = 0.533 + 2.819_{X1} + 3.793_{X2} - 1.685_{X5} + 0.001_{X6} - 5.428_{X7} - 5.513_{X9} + 0.001_{X10} \quad (6)$$

7. Analysis of Results

Table 4 shows that rural hollowing index is affected by rural electricity consumption (X_1), gross output value of agriculture, forestry, animal husbandry and fishery (X_2), fixed asset investment (X_5), average local fiscal revenue (X_6), per capita net income of rural residents (X_7), crop sowing area (X_9), and total power of agricultural machinery (X_{10}). Among them, rural electricity consumption (X_1), total output value of agriculture, forestry, animal husbandry and fishery (X_2), average local fiscal revenue (X_6), total power of agricultural machinery (X_{10}) and rural hollowing index are positively correlated; investment in fixed assets (X_5), net income per rural resident (X_7), crop sown area (X_9) and rural hollowing index are negatively correlated.

7.1. Improvement of Rural Living and Production Conditions

Rural electricity consumption and total agricultural machinery power are one of the indicators reflecting rural life and production. Table 4 shows that rural electricity consumption, total agricultural machinery power and hollowing index are positively correlated (regression coefficients are: 0.001 and 2.819, respectively). As one of the essential energy sources in rural areas, rural electricity consumption plays a vital role in rural development, promoting rural economic development and the convenience of life, but it is also important to pay attention to the pollution problem brought by the massive use of electric energy, rural electricity

consumption in Hainan Province rose from 56,404 (million kWh) in 2009 to 186,840 (million kWh) in 2019, an increase of 3.3 times, but rural resident population only increased 0.8 times from 2009 to 2019, and the increase of rural electricity consumption can significantly contribute to the degree of hollowing out of rural areas in Hainan Province, therefore, in future development, attention should be paid to energy conservation and emission reduction, and the use of new energy sources instead of traditional fossil energy sources should be promoted. The total power of agricultural machinery is one of the indicators reflecting the conditions of agricultural production and agricultural modernization. The increase of total power of agricultural machinery can save more manpower, which can free more manpower from the land and create conditions for working in the city, which in turn promotes the scale of land management. From 3,690,700,000 kilowatts in 2009 to 5,582,100,000 kilowatts in 2019, an increase of 0.66 times, which has a catalytic effect on the deepening of rural hollowing.

7.2. Increase in Income Level of Farmers

The total output value of agriculture, forestry, animal husbandry and fishery, net income per rural resident and crop sown area reflect the increase of rural residents' income. Among them, the gross output value of agriculture, forestry, animal husbandry and fishery and the hollowing index are positively correlated (regression coefficient: 3.793), while the net income per rural resident and crop sown area are negatively correlated (regression coefficients: -5.513 and -5.428, respectively). The increase in the gross output value of agriculture, forestry, animal husbandry and fishery constitutes the economic volume of the primary industry, and the increase in the gross output value of agriculture, forestry, animal husbandry and fishery increases the income of rural residents engaged in the primary industry and has a significant effect on hollowing out. The net income per capita of rural residents intuitively reflects the income of rural residents, and the net income per capita of rural residents in Hainan Province increased from 4744 yuan in 2009 to 15113 yuan in 2019, which increased 3.2 times and has a strong influence on rural hollowing out. The crop sown area is the strongest influence on hollowing out within all indicator systems, and the indicators show that with the increasing number of rural exodus, hollowing out is aggravated, more land will be left idle and abandoned, coupled with the increase of people's income, farmers have a strong desire to build houses, and the crop sown area further decreases. crop sown area in Hainan Province decreased from 792,389 ha in 2009 to 694,941 in 2019.

7.3. Development of Regional Economy

The average local fiscal revenue and fixed asset investment, on the other hand, are a reflection of regional economic development. The average local fiscal revenue is positively correlated with the hollowing out index (regression coefficient: 0.001), which is an important reflection of regional economic strength. As the largest special economic zone and national free trade port in China, the average local fiscal revenue in Hainan Province increased from 427,240,000 yuan/hm2 to 1,845,340,000 yuan/hm2 from 2009 to 2019, with an average annual growth of 128,900 yuan/hm2, The increase in local strength drives employment opportunities to be larger, which makes farmers more driven to work outside the city, and more children will follow their parents to go to school in the city, which intensifies the degree of rural hollowing out. Fixed asset investment is negatively correlated with hollowing index (regression coefficient: -1.685), and in 2009 and 2019, the primary industry accounted for 1.56% and 0.93% of the fixed asset investment in Hainan Province in the three industries respectively, showing a decreasing trend, which widens the gap between rural life and production and urban areas, prompting more people to leave the countryside to find better living conditions in the cities, intensifying the rural The process of hollowing out.

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