land

Article

The Resource Potential and Optimization of Rural Housing Land under Utility Structure Evaluation in Metropolitan Suburbs Villages of China

Qinglei Zhao [1], Guanghui Jiang [2,*], Wenqiu Ma [3], Yuting Yang [4] and Tao Zhou [2]

1 College of Geography and Tourism, Qufu Normal University, Rizhao 276826, China; zqlsdxt05@163.com
2 State Key Laboratory of Earth Surface Process and Resource Ecology, School of Natural Resources, Faculty of Geographical Science, Beijing Normal University, Beijing 100875, China
3 College of Engineering, China Agricultural University, Beijing 100083, China
4 Department of Geography, Ghent University, 9000 Ghent, Belgium
* Correspondence: macrophage@bnu.edu.cn

Abstract: Reasonable resource potential calculation is the basic premise for the country to formulate planning and carry out rural housing land consolidation, which can deepen the research on the economical and intensive use of rural construction land. This paper evaluates farmers' area demands of rural housing land by using the consumption utility function, analyzes the spatial pattern characteristics of demand and potential, and puts forward suggestions for the resource optimization of rural housing land based on the survey data of 613 farmers and land use data in the Pinggu District of Beijing in 2005 and 2018. Research shows that the utilities of life, production, and the ecological are carried and measured by the corresponding internal land-use structure of rural housing land. The proportion of life land area was the largest, and the life and production land area decreased from plain to mountain, from 119.76 m^2 to 89.07 m^2 and from 44.87 m^2 to 32.85 m^2, respectively. The average area potential is 395.64 m^2 and the change range is -30.35–1413.75 m^2, which is basically in accordance with the normal distribution. The area potential can be divided into five grades, which are expressed by I, II, III, IV, and V in order of potential from small to large by using the natural fracture method. The utility needed should be enhanced and expanded, and the redundant utility should be removed and socialized in the village. The resource optimization and allocation of rural housing land should be promoted according to the idea of regionalization and classification. It provides scientific support for the reform of rural housing land.

Keywords: rural housing land; utility structure; farmers demand; land resource optimization; metropolitan suburbs

check for updates

Citation: Zhao, Q.; Jiang, G.; Ma, W.; Yang, Y.; Zhou, T. The Resource Potential and Optimization of Rural Housing Land under Utility Structure Evaluation in Metropolitan Suburbs Villages of China. *Land* **2023**, *12*, 646. https://doi.org/10.3390/land12030646

Academic Editor: Maria Rosa Trovato

Received: 31 January 2023
Revised: 28 February 2023
Accepted: 6 March 2023
Published: 9 March 2023

1. Introduction

Rural housing land is a central expression of rural human–land relations [1,2], referring specifically to land that is primarily used for farmers' residences or associated with nonagricultural activities [3–5]. As rural development has become a global issue in recent years, the spiraling downward trend of rural development elements (e.g., farmers' livelihoods, educational resources, and labor resources) has become a growing concern [6–11]. The areas where rural residents live and produce [12,13] are facing various global challenges, such as depopulation, economic decline, unemployment, poverty, housing vacancy, and land abandonment.

In developing countries represented by China, the movement of the population between urban and rural areas and the reorganization of regional socioeconomic development factor allocation have been accelerating [14–16]. At present, there is a reverse evolution pattern of "people decrease and land increase" in the area of residential land in some areas, and there are problems of exceeding the standard of residential land per household with multiple houses in one household and idleness being prominent [17,18]. It is imperative to improve the efficiency of residential land use. Rural housing land is the main part of rural collective construction land [19]. Therefore, to improve the utilization efficiency of rural collective construction land, it is necessary to take the lead in exploiting the economical and intensive utilization potential of rural housing land. With the continuous advancement of China's urbanization and the deepening of the system reform of rural housing land, it has become an inevitable requirement for the realization of urban–rural integration development and rural revitalization in the new era to break the inefficient use and excavate the multi-functional use of rural housing land [18,19]. Reasonable potential calculation of rural housing land consolidation is the basic premise for the country to formulate planning and carry out rural housing land consolidation [20]. The traditional methods of calculating the potential of rural housing land consolidation mainly include the index method of land use per person (household) [21–25], the land idle rate [26,27], the potential coefficient revision based on GIS and multi-factor comprehensive evaluation technology [28–31], the potential calculation based on high-resolution remote sensing and GIS technology [19,32], the farmer's willingness survey [19,33–36], and the estimation of multi-method fusion [15].

However, due to many factors, the actual potential value is often much lower than the theoretical. For this reason, scholars often revise the theoretical potential when calculating the realistic potential, and explore methods such as the multi-factor comprehensive evaluation method, the step-by-step correction method, the model difference calculation method, and the regional difference calculation method [33,37,38]. Other scholars mainly focus on the priority of remediation, the public financial support for remediation, the economic value assessment after land remediation, and the comprehensive benefits of remediation. Scholars consider more natural, economic, social, and other factors in the process of calculating the potential of rural housing land consolidation, but rarely take into account the willingness of farmers [39]. In terms of research scale, scholars have made a lot of explorations on the medium and macro scales of the country, province, city, and county (district) [21,26,37,38], but on the micro scale, there are few studies on the potential of rural housing land consolidation in various types of villages [20,34]. Due to the fineness of land survey data and other issues, most of the existing research mainly focuses on the potential estimation of rural construction land consolidation, while the research on the potential calculation of rural housing land consolidation is relatively insufficient [36].

In recent years, the central government has paid more attention to the management of rural housing land, and has taken the renovation of inefficient abandoned rural housing land as an important part of the whole area's renovation plan and the improvement of rural living environments. The formulation of rural housing land-use standards is generally on the basis of the 'Land Management Law of the People's Republic of China', 'Regulations on the Implementation of the Land Management Law of the People's Republic of China', and other relevant laws and policies, combined with existing standards and local economic and social indexes. According to the national village and town planning standards, the existing standards of provinces and cities, and the comprehensive analysis of local indexes, or according to the collective economy and the resource endowment of peasant households, the standard area of rural housing land is defined from the per capita cultivated land and the type and grade of suburban and rural land [18]. In the future, county-level local governments will take the responsibility of planning, construction, and renovation of rural housing land for a long time [36,40–42]. How to identify the spatial scope with high consolidation potential in various villages will be an important part of it [43–45].

The above research and practice enriches the research system, but these potential calculation methods of rural housing land only come from the theory of architectural engineering: the rural housing land is equivalent to the urban residential land, and the land-use standard is calculated in the same step without considering the differences between rural and urban economic development, income level, and construction environment. There is no differential analysis of the utility of rural housing land and urban residential land in meeting the consumption preferences of different groups. The purpose of land use is to meet the needs of human beings [45–47]. In the process of land use, the idea of it as people-oriented should be fully reflected. The intensive use of rural housing land should be carried out on the premise of fully respecting the wishes of farmers [48–50]. The area standard of rural housing land should not only reflect the people-oriented idea, ensure the needs of farmers' production, life and ecological land, and realize the value of residential security, but also realize the goal of intensive and economical use of rural land resources and ensure that collective public interests are not occupied by private interests [51–54].

Therefore, this paper regards farmers as a consumer subject with certain economic payment ability, and always chooses the consumption bundle that maximizes its utility from its feasible consumption set. The rural housing land is regarded as a consumer goods with various life, productive, and ecological effects, and its maximum demand for consumer goods is considered under the constraint of a budget expenditure level. Based on the principle that farmers can bear and collectively accept, the consumption utility function calculation model is introduced. Farmers are regarded as 'rational economic people' with certain economic ability, which provides a guarantee for releasing the potential of rural stock construction land, safeguards farmers' land rights and interests, realizes rural revitalization, and also provides a basis for optimizing a rural housing land management strategy. The rest of this paper is organized as follows. Section 2 summarizes the sources of data and the selection of a typical study area, and introduces the methodology used in our study. Section 3 measures the demand and potential of rural housing land in a metropolitan suburb in 2018. Section 4 discusses the contribution to research, limitations, and future work, as well as puts forward policy enlightenments for the optimization and allocation of rural housing land. Section 5 draws the conclusion.

2. Methodology

2.1. Study Area

Beijing is both the capital of China and the second-largest city in the country. The Pinggu District is in the range of 40°01′ N–40°22′ N and 116°55′ E–117°24′ E, and belongs to the outer suburbs of Beijing (Figure 1). The span of the region along the latitude is about 38.5 km, the span along the longitude is about 40.25 km, and the land area is 948.35 km^2. The Pinggu District, a typical county selected by the project, has significant differences in the types of landforms in the territory. The areas of plain, hilly, and mountainous landforms are equivalent and, on the whole, it is similar to the natural pattern of the central urban area-uburb-outer suburbs of Beijing. As a result, the heterogeneity of farmers' livelihood and living style is high. As a metropolitan suburb, the Pinggu District has experienced great social and economic transformation in the past ten years. The urban and rural development is rapid, and the population flow and land-use patterns have changed strongly. It is the area where researchers have done relevant research when participating in previous scientific research tasks. In the research, time series statistical data, a remote sensing image map, a land-use status map, a DEM, and other data have been accumulated. In particular, some first-hand data of rural housing land survey have been obtained, which provide solid basic data support for the smooth development of research.

2.2. Data

The difference of landform and location is the basis of the differentiation of village economic development level [4]. In order to ensure the rationality of the sample, in 2005, according to the differences of landform and location in the county, the research group adopted the participatory rural appraisal (PRA) method and combined it with the high-resolution remote sensing image and field survey to carry out a household-based rural housing land sampling survey (Table 1). Using a stratified sampling method in the county, the townships were divided into upper, middle, and lower three layers according to the social and economic development status and other statistical indexes of the survey area, and representative townships on the rural housing land were selected.

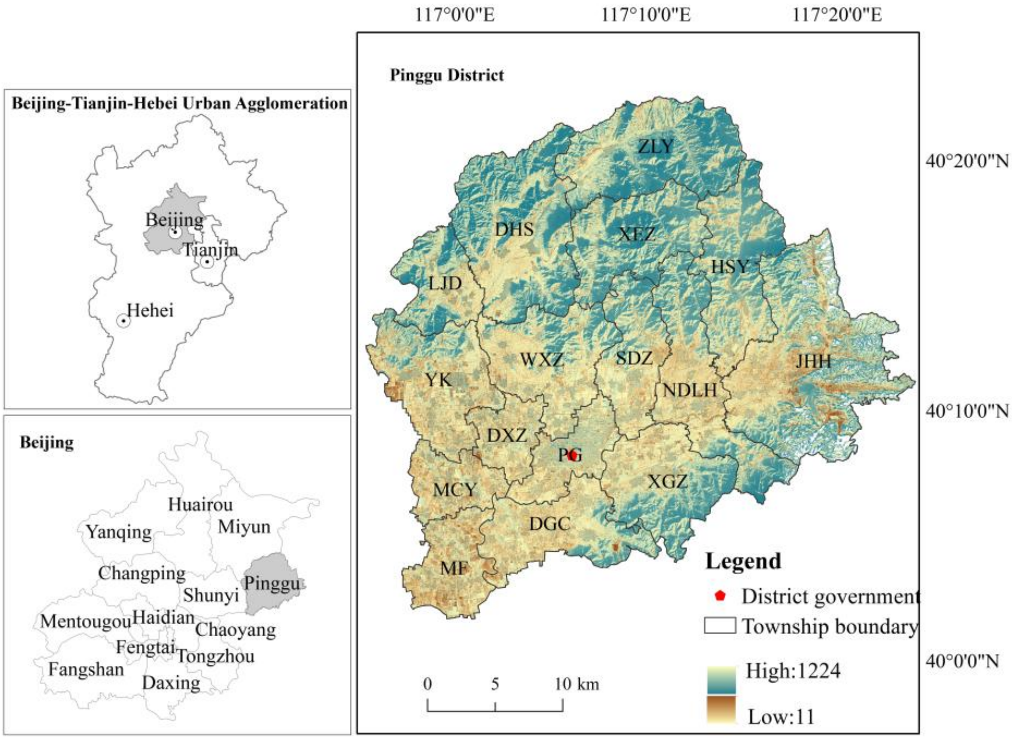

Figure 1. Study area (the abbreviations of the townships are as follows: PG (Pinggu), DXZ (Daxingzhuang), DGC (Donggaocun), MCY (Machangying), WXZ (Wangxinzhuang), XGZ (Xiagezhuang), MF (Mafang), YK (Yukou), SDZ (Shandongzhuang), JHH (Jinhaihu), LJD (Liujiadian), NDLH (Nandulehe), DHS (Dahuashan), XEZ (Xiongerzhai), ZLY (Zhenluoying), and HSY (Huangsongyu)).

Table 1. The calculation index of the estimation parameters of the optimal area of rural housing land.

Variable		**Source and Explanation**
The overall property of rural housing land	Occupied areas Total construction price	Field research
Internal land-use structure of life, production and ecological	Construction area Construction price Usable area	
What kind of land use or housing utility does farmer pay more attention to?		1 = Life land, 2 = Production land, 3 = Ecological land

On this basis, the villages were queued in the same way, the sampling frame was compiled, and the villages were selected by equal spacing method [45]. Based on the research of the research group in 2005, the authors selected 43 villages from 16 townships in the plain, semi-mountainous, and mountainous areas of the study area as the research sample villages according to the typical sampling method in September, 2018. Then, according to the principle of random sampling, a one-to-one participatory farmer survey method was adopted to investigate about 10 households in each village. The research contents of the households include the area of rural housing land, the total construction expenditure, the construction area of various types of land space, the use area, and the land type that farmers pay attention to. The sample data were statistically analyzed according to the terrain area. Among them, the number of households in each village comes from the data of the economic management station, and some village information is corrected by the data of Beijing Yinong Information Network.

2.3. Methods

2.3.1. Utility Structure of Rural Housing Land

Human beings use land in order to meet their own needs, so the idea of being people-oriented runs through the process of land use and the use of rural housing land. Rural housing land has existed for more than 5000 years around the world [55]. It always accounts for a large proportion of urban and rural construction land in developing countries with a large agricultural population [56], addressing peasant housing, ensuring rural development, and maintaining urban–rural stability [57]. Rural housing land includes the dual use of courtyard and building [58], which is also one of main features differentiating rural housing land from urban housing [59]. The initial setting of China's rural housing land system is the consideration of welfare and social security functions to ensure farmers can enjoy low-cost and stable living conditions. A rural courtyard is the basic place for farmers' production and life formed with the development of Chinese traditional farming civilization and small-scale peasant economy. The frequent rural–urban migration and the improvement in life standards provoked farmers' demands for housing quality and refined living functions of rural housing land. Higher demands on their living environment [60] causes change in the utility supply of rural housing land [61–63]. The utility of rural housing land goes from the single living to a multifunction combination of living, producing and processing, commerce, holiday tourism, and sightseeing experiences.

Moreover, rural house is becoming more similar to those houses in the city, separating spaces for the functions of residence, meeting, and cooking, as well as separate spaces for functions of storage and bathrooms [64]. The purpose of farmers dwelling at rural housing land is to take advantage of relevant utility. There is an intrinsic relationship between the utility and land-use structure of rural housing land, and the evolution of internal land-use structure is continuously adapting to the demand of utility changes. The change of internal land-use structure can be used to illustrate utility change of rural housing land.

It is necessary to make a balance between ensuring and respecting the rights and interests of farmers and realizing the intensive and efficient use of land [18]. In this section, farmers are regarded as rational-economic men, and their consumption process consciously or unconsciously follows the principle of maximizing their own utility—that is, they generally choose the consumption bundle that can bring the greatest utility in the possible consumption set. At the same time, this paper argues that rural housing land, as a type of land use, itself has multiple functions and can be seen as a collection of different utility of consumer goods. Farmers reasonably allocate the development and construction expenditure of various land types within the rural housing land according to their own economic level and current demand, so as to maximize their own utility and form the maximum area demand of rural housing land utility (Figure 2).

The utility is a measure of people's psychological satisfaction, which is often used to characterize the ability of a certain type of utility items, especially goods, to meet the needs of consumers desire [65]. As far as this paper is concerned, in real life, every desire of farmers cannot be fully satisfied at the same time, which is limited by their own family economy, population, and other conditions, as well as the total amount and distribution characteristics of resources. Therefore, farmers pursue the maximization of consumption utility under certain constraints, allocate the limited expenditure budget to each utility demand reasonably, and form a variety of household consumption bundles—that is, the utility structure of farmers' consumption. Similarly, the consumption behavior of rural housing land is also in line with such a decision-making process. Based on the cognition of the functional types of rural housing land, this paper summarizes the utility of rural housing land into three categories—life, production, and ecological—according to the different use combinations of internal land-use structures formed by farmers when they consume or use rural housing land [18,66,67]. Among them, life utility U1 refers to the utility of rural housing land to meet the functional needs of farmers and their families, such as living, social interaction, living storage, catering, cooking, and using the bathroom. Production utility U2 refers to the utility of planting and breeding, productive storage, part-time industry, and commerce, leasing and drying for rural housing land. Ecological utility U3 refers to the utility of landscape ecology provided by rural housing land. Each utility is carried and measured by the corresponding internal land-use structure of rural housing land, and finally forms the total utility (Table 1, Figure 2).

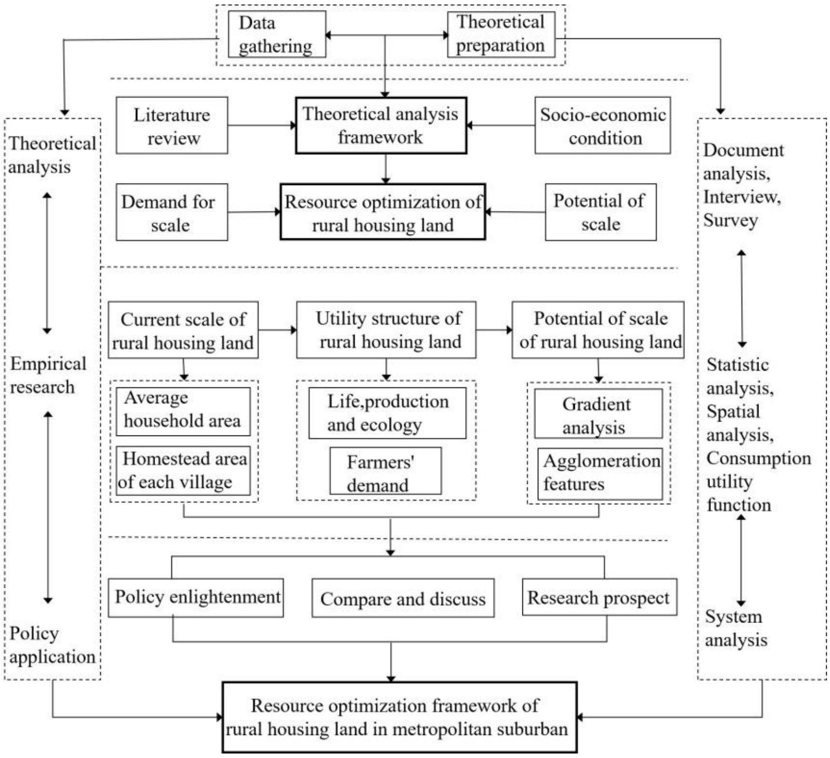

Figure 2. Frame diagram of the resource optimization of rural housing land under utility structure.

2.3.2. Consumption Utility Function

The maximum utility value obtained when farmers consume rural housing land is a necessary variable to measure the area demand of farmers' rural housing land. However, the general mathematical model method cannot properly measure and express the utility with strong subjective intention. This paper introduces the consumption utility function defined by scholar Wang [68] to quantitatively express the mathematical relationship between the consumption utility of farmers' rural housing land and its related variables such as consumption preference, housing construction price, and consumption structure. The function formula is shown in (1):

$$\mathrm{U} = \sum_{n=1}^{m} w_n \left(1 - e^{-\frac{cs_n}{d_n p_n}}\right) \quad (1)$$

where U represents the degree of farmers' preference for a certain type of land or housing (life, production, ecological) within the rural housing land, and ultimately affects the choice and structure of the spatial type of farmers' rural housing land. $\mathrm{w_n}$ is the preference weight coefficient of type n consumption: $w_n \geq 0$, $\sum_{n=1}^{m} w_n = 1$. d_n is the demand intensity of farmers for the nth type of consumption and has the following attributes, that is, $\forall \mathrm{d_i} \in \{1, 2, \cdots, \mathrm{n}\}$, and it represents the utility measurement of a certain type of land or building in the rural housing land obtained by farmers on the basis of their own economic conditions and psychological acceptance assessment. C is the total expenditure of rural housing land construction, which is the construction cost of the nth type of land or housing inside the rural housing land. s_n is the proportion of the construction price of the nth type of land or housing type in the total expenditure of rural housing land construction: $s_n \geq 0$, $\sum_{n=1}^{\mathrm{m}} s_n = 1$, where n is 3 in this paper.

When solving the land structure function of rural housing land under maximizing utility, this part establishes the Lagrangian function:

$$\mathrm{L} = \sum_{n=1}^{m} w_n \left(1 - e^{-\frac{cs_n}{d_n p_n}}\right) + \lambda \left(1 - \sum_{n=1}^{m} s_n\right) \tag{2}$$

Set to the extreme conditions, there are:

$$\begin{cases} \frac{\partial L}{\partial s_n} = \frac{w_n c}{d_n p_n} e^{-\frac{cs_n}{d_n p_n}} - \lambda = 0 \\ \frac{\partial L}{\partial \lambda} = 1 - \sum\limits_{n=1}^{m} s_n = 0 \end{cases}$$

Let Formula (3) be 0, then:

$$\lambda = \frac{w_n c}{d_n p_n} e^{-\frac{cs_n}{d_n p_n}} \tag{5}$$

From Formula (3):

$$s_n = \frac{\ln(w_n c) - \ln(d_n p_n) - \ln \lambda}{c/(d_n p_n)} \tag{6}$$

Take Formula (4) with Formula (6), and finally sort out:

$$s_n = \frac{(d_n p_n)^2 \ln\left(\frac{w_n c}{d_n p_n}\right)}{c(w_n c - d_n p_n)} \tag{7}$$

Equation (7) is the land structure function of rural housing land when the utility of farmers is maximized. It refers to the fact that farmers, as rational-economic men, generally allocate limited construction funds to the nth type of land structure that can maximize the utility of themselves and their families according to their subjective cognition of their own status. Further analysis shows that the multiplication of the land structure of rural housing land S_n and the total household budget C is the total construction cost of the nth type of land. Comparing this value with the unit price p_n of the nth type of land construction, the size Y_n of the nth type of land can be obtained when the farmer's utility is maximized, as shown in Formula (8):

$$Y_n = \frac{CS_n}{p_n} = \frac{(d_n p_n)^2 \ln\left(\frac{w_n c}{d_n p_n}\right)}{p_n(w_n c - d_n p_n)} = \frac{(d_n)^2 p_n \ln\left(\frac{w_n c}{d_n p_n}\right)}{(w_n c - d_n p_n)} \tag{8}$$

The preference coefficient w_n of farmers' consumption of rural housing land depends on the current subjective land preference of farmers. The calculation formula is shown in (9):

$$W_n = \frac{r_i}{\sum_{i=1}^{n} r_i} \tag{9}$$

where r_i is the frequency of a preference land space type. n is the total land-use type. Here, $n = 3$.

3. Results and Analysis

3.1. Parameter Solution of the Model

According to Equation (8), in the consumption utility function of rural housing land, to get the value of Y_n it needs to determine the values of C, p_n, w_n, and d_n. Among them, the total amount of housing C and the construction price p_n of the nth land space can be obtained by investigation and statistics. In a certain period of time, the fluctuation in farmers' rural housing land structure preference and demand intensity in specific areas is generally small, which can be regarded as constant. Based on this, w_n and d_n can be obtained by analyzing the survey data.

In fact, each sample farmer has a utility value, but the individual utility evaluation is not only difficult to operate, but also not easy to analyze and use. Therefore, this paper analyzes the characteristics of three groups of farmers in plain, semi-mountainous, and mountainous areas according to the topographic areas and evaluates their utility values U respectively. Among them, the preference coefficient of farmers' consumption of rural housing land w_n depends on the current subjective land preference of farmers. Based on the relevant research, this paper is based on the proportion of the sample number of farmers in the region who choose a land structure or house type within the rural housing land to the total sample number.

Demand intensity d_n indicates the importance of a land type in the rural housing land to meet the relevant needs of farmers. This paper argues that the calculation of the demand intensity of rural housing land is not only to investigate the psychological satisfaction of farmers in the process of using it, but also to analyze whether the scale of farmers' consumption or use of a certain land within the rural housing land is real. According to the theory of marginal utility value, farmers as rational agents can follow the principle of utility maximization and maintain the optimal land scale. However, the survey found that under the current reality of uneven levels of farmers' cognition and conceptual awareness, and imperfect rural housing land-related systems and policies, the situation of exceeding the upper bound of utility maximization is everywhere. The result is that not all the land within the rural housing land has use value, and the idle area is widespread. The actual scale of rural housing land owned by farmers is usually larger than the actual demand scale or intensity when their utility is maximized. This study estimated the value of d_n by subtracting the idle land area of the corresponding land type from the current area of a certain land type inside the farmer's rural housing land, which can explain the demand intensity of farmers' rural housing land to a certain extent.

In this part, according to the formula established for solving the preference coefficient and demand intensity of land use inside the rural housing land, the relevant variables obtained in the survey are brought in. The consumption preference coefficient w_n and demand intensity coefficient d_n of rural households in the plain areas, semi-mountainous areas, and mountainous areas in the study area were estimated, respectively. The results are shown in Table 2.

Table 2. Estimated value of consumption preference coefficient and demand strength coefficient.

		Life Land	**Production Land**	**Ecological Land**
Plain area	Consumption preference frequency	87	42	3
	Consumption preference coefficient	0.655	0.322	0.023
	Demand intensity coefficient	116.853	61.697	11.129
Semi-mountainous	Consumption preference frequency	242	113	7
	Consumption preference coefficient	0.668	0.312	0.020
	Demand intensity coefficient	96.202	47.029	10.732
Mountain area	Consumption preference frequency	75	38	6
	Consumption preference coefficient	0.635	0.315	0.050
	Demand intensity coefficient	88.422	45.756	12.091

The Equation (8), that is, the total expenditure C of rural housing land construction and the unit construction price p_n of the internal land of the n-type rural housing land in the scale calculation function of the internal land of rural housing land, was obtained through investigation. In this study, the total expenditure of rural housing land construction and the construction unit price of residential land, production, or ecological land and houses in rural housing land are based on the survey data of 2018, which can better reflect the actual cost of rural housing land construction of farmers at present and in the future. At the same time, with reference to relevant research, in the calculation equation of the internal land-use scale of rural housing land in each topographic area, this paper brings in the average value of the total expenditure of rural housing land construction in the Pinggu District and the unit price of a certain type of land construction in the whole area, but does not take the value of each village or topographic area separately (Table 3).

Table 3. Construction spending per household of the overall building and all kinds of houses internally.

	Total Expenditure per Household Building C (yuan)	Living Space Construction Unit Price P1 (yuan/m^2)	Production Space Construction Unit Price P2 (yuan/m^2)	Ecological Space Construction Unit Price P3 (yuan/m^2)
Whole area	97,672.99	667.02	325.10	7.91

3.2. The Demand and Potential of Rural Housing Land

3.2.1. The Area Demand

Substituting the parameters in Table 2 into Equation (8), the function group of the average rural housing land area (divided into mountainous area, semi-mountainous area, and plain) when the farmer's utility is maximized is Equations (10)–(12):

$$\begin{cases} Y_{p1} = \dfrac{13654.65\times\ln\left(0.0056\times\frac{c}{pn}\right)}{\left(0.655\times\frac{c}{pn}-116.85\right)} \\ Y_{mm1} = \dfrac{3806.53\times\ln\left(0.0052\times\frac{c}{pn}\right)}{\left(0.322\times\frac{c}{pn}-61.70\right)} \\ Y_{m1} = \dfrac{123.85\times\ln\left(0.0021\times\frac{c}{pn}\right)}{\left(0.023\times\frac{c}{pn}-11.13\right)} \end{cases} \tag{10}$$

$$\begin{cases} Y_{p2} = \dfrac{9254.75\times\ln\left(0.0069\times\frac{c}{pn}\right)}{\left(0.664\times\frac{c}{pn}-96.20\right)} \\ Y_{mm2} = \dfrac{2211.73\times\ln\left(0.0066\times\frac{c}{pn}\right)}{\left(0.664\times\frac{c}{pn}-47.03\right)} \\ Y_{m2} = \dfrac{115.18\times\ln\left(0.0019\times\frac{c}{pn}\right)}{\left(0.664\times\frac{c}{pn}-10.73\right)} \end{cases} \tag{11}$$

$$\begin{cases} Y_{p3} = \dfrac{7818.36\times\ln\left(0.0072\times\frac{c}{pn}\right)}{\left(0.664\times\frac{c}{pn}-88.42\right)} \\ Y_{mm3} = \dfrac{2093.60\times\ln\left(0.0068\times\frac{c}{pn}\right)}{\left(0.327\times\frac{c}{pn}-45.76\right)} \\ Y_{m3} = \dfrac{146.21\times\ln\left(0.0041\times\frac{c}{pn}\right)}{\left(0.009\times\frac{c}{pn}-12.09\right)} \end{cases} \tag{12}$$

Among them Y_{p1}, Y_{mm1}, Y_{m1} represent the scale of living land and buildings per household required to maximize the life utility U1 of farmers in plain, semi-mountain, and mountain areas, respectively. Y_{p2}, Y_{mm2}, Y_{m2} are the scale of production land and buildings that need to be built when the production utility U2 of farmers in plain areas, semi-mountainous areas, and mountainous areas is maximized. Y_{p3}, Y_{mm3}, Y_{m3} are the scale of ecological land and buildings that need to be built when the ecological utility U3 of farmers in plain areas, semi-mountainous areas, and mountainous areas is maximized. Finally, the data of the total expenditure of rural housing land construction and the unit price of various types of land construction (Table 3) obtained from the survey are substituted into the function group, and the total scale of rural housing land and the scales of life, production, and ecological land per household are obtained when the utility of farmers in plain, semi-mountainous, and mountainous areas is maximized (Table 4).

Table 4. The construction area of all kinds of houses in the rural housing land (m^2/household).

	Living Land Construction Area Y1	Construction Area of Productive Land Y2	Ecological Land Construction Area Y3	The Total Area of Rural Housing Land Buildings per Household Y
Mountain area	89.07	32.85	1.46	123.33
Semi-mountainous	110.19	37.82	1.36	150.49
Plain area	119.76	44.87	0.92	165.84

According to the analysis, the average construction area of rural housing land in the plain area is the largest, which is 165.84 m^2, and the mountain area is the smallest at only 123.33 m^2. The proportion of life land is the largest, and the area of life and productive land decreases from plain to mountainous areas, from 119.76 m^2 to 89.07 m^2 and from 44.87 m^2 to 32.85 m, respectively (Figure 3). The ecological land area is the largest in the mountainous area and the smallest in the plain area. The spatial distribution of the optimal area of rural housing land reflects the pattern characteristics of farmers' land demand. According to the above marginal utility value theory analysis, with the improvement of farmers' ideas, the transformation of livelihood methods and the reform and improvement of rural housing land related policies and systems. Farmers with the characteristics of the rational-economic man will gradually develop in the direction of pursuing maximum consumption utility in the process of using their rural housing land, and the degree of economical and intensive use of rural housing land will continue to increase. Therefore, the scale and utility structure of farmers' rural housing land based on the survey statistics represent the optimal results after years of historical adjustment and evolution.

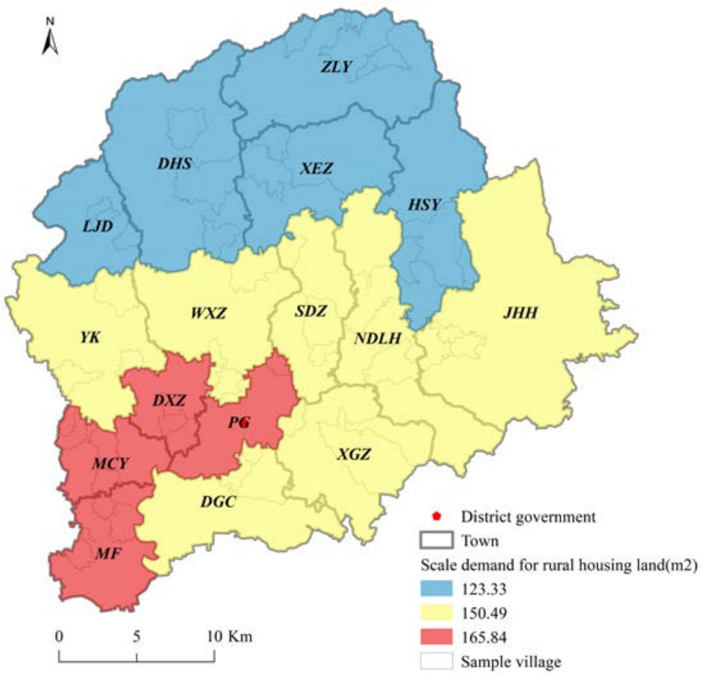

Figure 3. The optimal land area of rural housing land in different topographic areas under utility structure of farmer.

3.2.2. The Area Potential

(1) The total area of rural housing land in Pinggu District is 4030.75 hm^2, the average household area is about 543.76 m^2, and the variation range is 135.49–1537.08 m^2. The proportions of plain area, semi-mountainous area, and mountainous area are 0.217, 0.610, and 0.173, respectively. Among them, the total area of the semi-mountainous area is the largest, reaching nearly 2500 hm^2. Jinhai Lake and Donggao Village are the top two towns

in terms of rural housing land, with an area of nearly 500 hm^2, while Pinggu Town has the smallest area of rural housing land, which is less than 100 hm^2. The per household area of rural housing land in the Pinggu District was 75–580 m^2 in 2005, with an average of 225.72 m^2 and a coefficient of variation of 0.38. In 2018, it was 100–533.4 m^2, with an average of 240.47 m^2 and a coefficient of variation of 0.32. From 2005 to 2018, the per household area of rural housing land increased and the spatial heterogeneity decreased. This may be due to the fact that at the beginning of the 21st century, as a fringe area of the Beijing metropolis, Pinggu experienced considerable changes in population and land use in the process of urbanization and industrialization. The population in many rural areas decreased by 18.86%, from 228,000 in 2005 to 185,000 in 2015, while the area of rural residential land decreased by only 10.55%, from 4413.35 hectares to 3947.45 hectares (Table 5, Figure 4).

Table 5. Spatial distribution of rural housing land scale.

Topographic Area	Town	Area (hm^2)		Proportion	
Plain area	Pinggu	75.28	873.45	0.086	0.217
	Machangying	254.56		0.292	
	Mafang	305.07		0.349	
	Daxingzhuang	238.54		0.273	
Semi-mountainous	Yukou	324.15	2458.45	0.132	0.610
	Wangxinzhuang	384.75		0.156	
	Shandongzhuang	214.07		0.087	
	Nandulehe	317.51		0.129	
	Jinhaihu	496.05		0.202	
	Donggaocun	482.53		0.196	
	Xiagezhuang	239.38		0.097	
Mountain area	Liujiadian	112.87	698.85	0.162	0.173
	Dhuashan	241.41		0.345	
	Zhenluoying	121.85		0.174	
	Xiongerzhai	107.01		0.153	
	Huangsongyu	115.72		0.166	
Whole area			4030.75		1

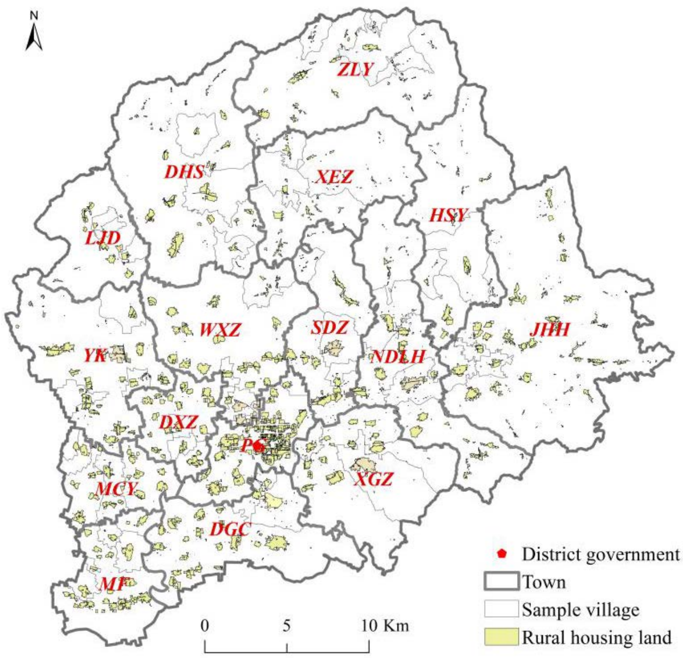

Figure 4. Spatial distribution of rural housing land.

This decline in the rural population is far more than the rate of reduction in residential land, resulting in low-density land use and residential land structure changes. With the development of a regional economy and society, the economic level of farmers and the demand for housing have increased, and houses and courtyards have generally expanded. The region promulgated the 'Pinggu District Villagers' Residential Planning and Construction Management Measures', etc., which made relatively uniform requirements for farmers' housing construction, resulting in reduced regional heterogeneity. The main layout of rural housing land in the Pinggu District is the courtyard layout, with a size of 173.33 m^2 (70%). The main room is the living room and the bedroom, which are about 30 m^2 and 18 m^2, respectively. The two sides of the room are generally two wing-rooms, each of which is about 10 m^2, which are used as a kitchen, dining room, sundries room, bedroom, toilet, bathroom, and so on. The south wing room connected to the gate is generally used as a bedroom or sundry room, with a size of about 12 m^2. If farmers own supermarkets, restaurants, or rentals, they will generally use the wing-room, with an average area of 20 m^2.

In 2012 and 2017, the Pinggu District successively promulgated the 'Pinggu District Rural Villagers' Residential Construction Management Measures' and the 'Pinggu District Rural Villagers' Residential Planning and Construction Management Measures', which clearly and in detail standardized the specific requirements for the approval and construction of farmers' rural housing land in this area. At the same time, since 2012, Beijing has implemented an afforestation project in the plains. A large amount of cultivated land in the rural areas of the Pinggu Plain has been converted into forest land. Relevant farmers are no longer engaged in traditional agricultural production, and the livelihoods of farmers in the area have changed to varying degrees. The average prices of commercial housing in Beijing and the Pinggu District in 2018 were 62,300 yuan/m^2 and 24,800 yuan/m^2, respectively. This price is generally higher for farmers. The change of regional social and economic background will cause the change of livelihood mode of village farmers and the adjustment of rural housing land structure, which will inevitably affect the utility of rural housing land.

(2) The average area of rural housing land of each village in the Pinggu District is compared with the land area demand of the terrain area. The average land potential is 395.64 m^2, and the change range is -30.35–1413.75 m^2, which is basically in accordance with the normal distribution. Overall, the regional rural housing land has great area potential. Using the natural fracture method, the potential can be divided into five grades, which are expressed by I, II, III, IV, and V in order of potential from small to large (Figure 5).

In a grade I potential region, the area potential value is -30.35–250.24 m^2, the average value is 180.26 m^2, mainly distributed in Xigao Village, Tasi Village, Nanniantou Village, other central and western plains, and eastern semi-mountainous areas, including 40 villages, accounting for 14.7%. In a grade II potential region, the area potential value is 250.25–372.38 m^2, the average value is 318.36 m^2, mainly distributed in Qiaotou Village, Dongshanxia Village, Nantaiwu Village, and other northwestern mountainous areas and semi-mountainous areas, as well as southeastern semi-mountainous areas—a total of 91 villages—accounting for 33.3%. In a grade III potential region, the area potential value is 372.39–515.46 m^2, the average value is 431.72 m^2, mainly distributed in Shangying Village, Taihou Village, Emei Mountain Village, and other northern mountainous areas, the central mid-mountain area, the southwest plain area—a total of 98 villages—accounting for 35.9%. The IV-level potential region has an area potential value of 515.47–807.52 m^2, with an average value of 608.60 m^2. It is mainly distributed in the northern mid-mountain area of Yuzishan Village, Waguantou Village, Yingcheng Village, and the southern plain area, including 39 villages, accounting for 14.3%. The V-level potential area is 807.53–1413.75 m^2, with an average of 1097.25 m^2. It is mainly distributed in the northern mountainous areas such as Donggou Village, Huayu Village, and Diaowo Village, including 5 villages, accounting for 1.8%. It can be seen that grade II and grade III are the main land-use potential levels, accounting for nearly 70% of the total number of villages, which are widely distributed in various terrain areas. The maximum and minimum values account for less than 20% and are concentrated in the northeastern mountainous and semi-mountainous areas.

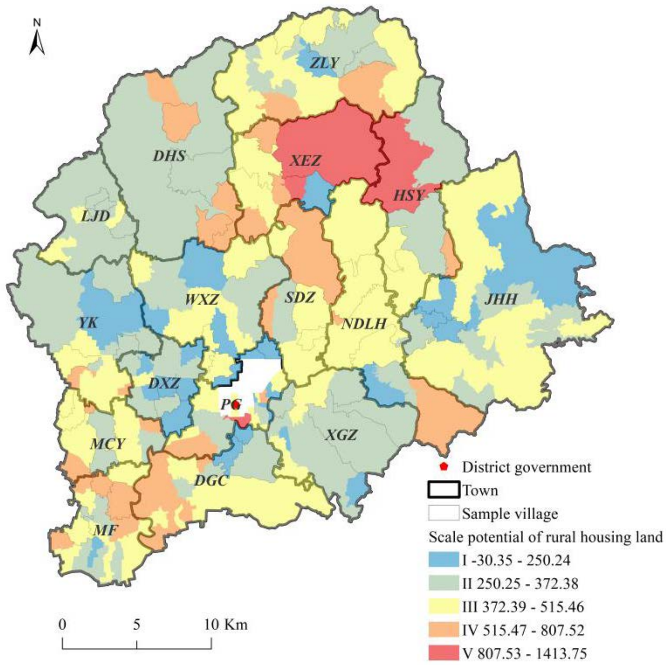

Figure 5. Land use potentiality of rural housing land in Pinggu District.

(3) According to the distribution of land-use potential value, grade I and II can be divided into low land-use potential level, grade III can be regarded as medium land-use potential level, and grade IV and V can be classified as high land-use potential level. From Figure 5, it can be seen that the rural housing land in the northern mountainous area, the mid-eastern semi-mountainous area, and the southern plain area of the Pinggu District is mainly at the level of medium or above land-use potential, while the rural housing land in the western mountainous area and semi-mountainous area is mainly at the level of low land-use potential. In the northern mountainous area of the Pinggu Valley, the population loss is serious, and the hollow village is intensified, causing the decrease of people and the increase of land, and the average household area of rural housing land is large. The southern plain area is the main area of urbanization. This process has also promoted the development and progress of the regional economy and society and the expansion of the land. At the same time, the flat terrain and the vast area provide the inherent advantages for the expansion of the rural housing land, resulting in low-economic and intensive land-use consciousness in rural housing land. The mid-eastern semi-mountainous area, as the link between the plain area and the hilly and mountainous area, is the most volatile and diversified area of economic and social development and farmers' livelihood in the Pinggu District.

This area is a concentrated distribution of leisure tourism resources and ecological resources in the Pinggu District. The courtyard space expansion of rural housing land is used to develop rural tourism reception, which leads to the increase of land-use potential. However, the level of rural economic development in the western mountainous and semi-mountainous areas of the Pinggu District is not high, and the urbanization process is slow. The rural economy, society, and cultural landscape still maintain the original village appearance and layout. Farmers have entered the city to work and gradually settled in the city. The countryside is only a concentrated area for the employment and living of workers with agriculture as their main industrial activity. The utility of rural housing land is relatively simple and the land-use potential is not high.

4. Discussion

4.1. Optimization of Land-Use Structure in Rural Housing Land

Using the consumption utility function to estimate the standard of rural housing land can not only maximize the utility of rural housing land, but also make the area of the rural housing land meet the requirements of aggregate utilization, which has the advantages of simple calculation and convenient use [68]. As a special commodity, rural housing land contains market value and non-market value. The calculation model of consumption utility function combines economics and psychology and connects the number of rural housing land occupied by farmers with family economic level, land-use preference, demand intensity, and other factors. It is feasible in theory and operation to calculate the area demand for rural housing land, which can be used as a pilot area for rural housing land system reform [18,19]. It provides a scientific measurement method and the realization of policy benefit maximization. The utility needed should be enhanced and expanded, and the redundant utility should be removed and socialized in the village. The study found that some land-use structures within the rural housing land still exist but no longer exist in terms of its land-use function, which is an important source of land remediation potential within the rural housing land. With the change of farmers' livelihood mode and the rise of living standards, when some utility or land-use structure is no longer the main land-use orientation of rural housing [18,45,54], the area of rural housing land can be moderately reduced, so as to promote the intensive saving of rural housing land.

Generally, there are two ways: (1) The transformation of different land-use structures within the rural housing land, that is, the weakened land-use types in the rural housing land—such as productive storage, breeding, drying, etc.—can be adjusted to reduce or eliminate this part of the land and to enhance or add land-use types—such as living, living storage, bathroom, etc.—in order to improve the supply capacity of rural housing land. (2) The adjustment between rural housing land, land-use type, and village land use mainly includes two directions. One is that idle rural housing land can be reclaimed into cultivated land. Secondly, in view of the current general demand of farmers' living storage land, such as car parking, small supermarkets, and other types of industrial and commercial land, this part of the land structure can be separated from the rural housing land and through village land planning, unified as the construction of parking lot and commercial housing, so that it can be socialized in the village. In this way, it not only regulates the land use of villages, but also meets the utility needs of farmers for rural housing land, and also saves land for rural housing land (Figure 6).

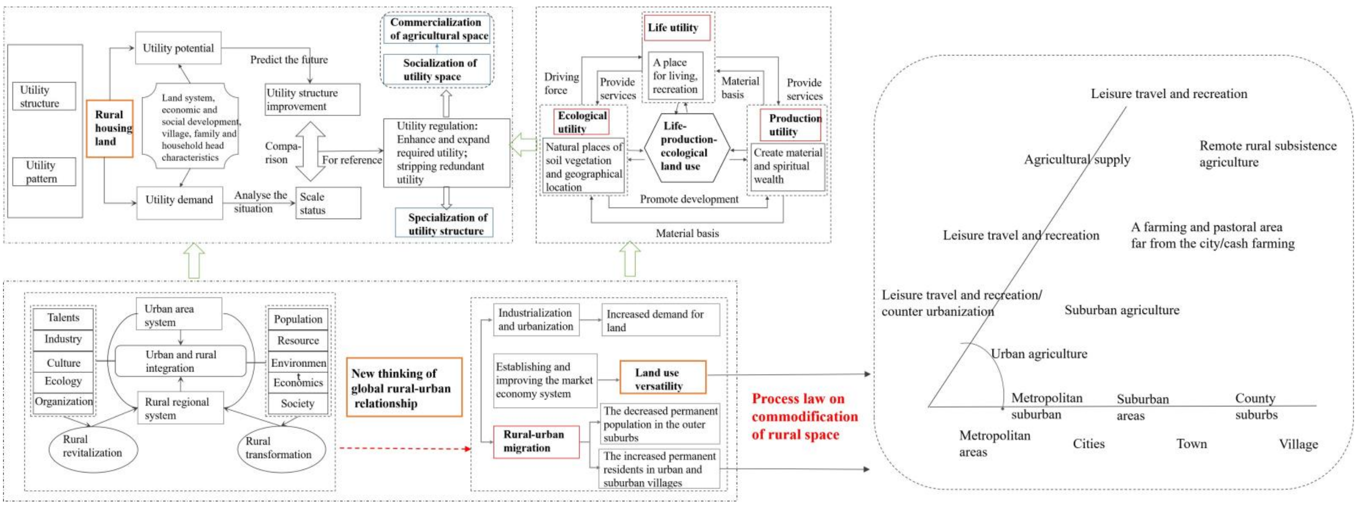

Figure 6. The process mechanism of rural housing land utility structure optimization for urban–rural integration.

4.2. Utility Configuration with Regionalization and Classification of Rural Housing Land

From the historical change and the trend of farmers' independent choice, the living function is the dominant function of rural housing land, whose non-residential function can be separated from rural housing land and socialized within the village through rural land planning. The function space separation and socialization of rural housing land is an important basis for the commercialization of rural spaces, and provides the source of land use. The commodification of rural space is a process of re-resourcing in rural areas, emphasizing that the role of modern rural space as material production is declining while the role of consumption space as non-material products is gradually increasing. Western rural geography believes that the commercialization of rural space is one of the most important factors to promote rural change and a panacea to save rural economic decline [69]. It emphasizes the role of capital and power in rural change, which is the theoretical advantage as an international frontier perspective of rural geography (Figure 6). The commercialization of rural space pays more attention to the nonmaterial goods attached to concrete resources. Immaterial good created by material entities can be consumed repeatedly, and consumers pay for and gain access to immaterial goods, rather than ownership. According to studies on the commodification of rural space, one of the paths to realize the commercialization of rural space is the consumption of rural space by urban residents brought by reverse urbanization, and rural tourism especially can attract people's vision [70]. The utility evolution of rural housing land shows the characteristics of diversification and regional differentiation.

(1) Suburbs, economic development zones, and other surrounding areas of the plain include Duxinzhuang Village in Pinggu Town; Daxingzhuang Village and Guanjiazhuang Village in Daxingzhuang Town; Machangying Village, Dongshuangying Village, and Wanggezhuang Village in Machangying Town; Yingcheng Village, Wali Village, and Hebei Village in Mafang Town; and Donggao Village, Xigao Village, and Nanniantou Village in Donggao Town. The production utility of rural housing land is obviously enhanced, and it also has strong life utility. The land-use potential is medium level. Farmers mainly use the surplus rural housing land to rent, open restaurants or print shops, etc., and the functional content is more abundant. For example, Duxin Village in Pinggu Town is only 2 km away from the urban area, and there are a large number of enterprises on the south side of the village. Therefore, the proportion of farmers' rural housing lands used for renting or opening restaurants is more than 60%, which enhances the income function. At the same time, most farmers have a better economic level and are able to buy new housing in cities and towns. However, due to the convenient sharing of urban resources, most farmers feel that it is not necessary to purchase houses in the urban area, but rather to renovate rural housing land houses and enhance their social security functions.

Under the guidance of industrial development in industrial parks and urban areas, we will improve the perfection of public service facilities in villages, focus on maintaining and repairing rural ecological environment, implement the renovation of human settlements environment, and strengthen the degree of livability. At the same time, we should control the disorderly expansion of rural housing land, strengthen the social security function of rural housing land, and create better basic conditions for the development of production utility. Among them, for some villages close to the urban area and where farmers have a strong willingness to urbanization, farmers can be resettled through the construction of centralized residential communities with relatively complete basic conditions. The original rural housing land or house courtyard can be reclaimed for farming and planting vegetables or trees. It can also be used to develop secondary and tertiary industries, while some rural housing lands with protection value or utilization value can be retained. At the same time, because the production utility of this area is relatively strengthened, the rural housing land that was originally close to the road or concurrently used for industry and commerce can be directly designated as industrial development land and will not be demolished, and the planned land will be concentrated along the street. In this way, it can not only ensure the functional requirements, improve the living quality of farmers, but also realize the intensive use of rural housing land.

(2) The marginal area of the new town and the semi-mountainous area around the central town have strong idle rate of rural housing land, the land-use potential is medium and above, and includes Xiaoxinzhai Village and Taipingzhuang Village in Wangxinzhuang Town, Dongtumen Village in Jinhaihu Town, Guanshang Village in Zhenluoying Town, Emeishan Village and Nandulehe Village in Nandulehe Town, Lixinzhuang Village in Shandongzhuang Town, Nantaiwu Village and Magezhuang Village in Xiagezhuang Town, and Beiyangjiaqiao Village and Hujiaying Village in Yukou Town, for a total of seven towns and 11 villages. In the semi-mountainous area between the plain area and the mountainous area, it is impossible to enjoy the urban resources conveniently. Therefore, most of the farmers with certain economic ability choose to buy a house in the workplace, so the social security ability of the rural housing land is relatively poor.

Driven by the construction of new urbanization, such areas can put villages and towns together for planning and construction, use the population and industrial advantages of cities and towns to improve the utilization rate of rural housing lands, and reduce the proportion of idle land. This can also alleviate the contradiction between employment and residence of some farmers. At the same time, the state should speed up the construction of rural housing land system, especially the exit mechanism, strengthen the social security system of rural villagers, and promote the smooth exit of farmers' rural housing land. Strengthening the governance of village human settlements should be built on the same level as towns. The idle rural housing land can be reclaimed as cultivated land according to its location in the village or built into public facilities, such as parks and green spaces, elderly housing, parking lots, and so on.

(3) In the remote mountainous areas far away from the new town and the central town, the life utility of the rural housing land is strong, the land-use potential is mainly at the high potential level, and includes Taoyuan Village and Qingshui Lake Village in Luoying Town, Yindong Village and Dongshanxia Village in Liujiadian Town, Suziyu Village and Waguantou Village in Dahuashan Town, Huayu Village and Xiongerzhai Village in Xiongerzhai Township, and Huangsongyu Village and Dadonggou Village in the Huangsongyu Township, for a total of five towns and 10 villages. Farmers generally have a poor family economic level and are unable to purchase housing in urban areas. The farmers who work outside are mostly renting houses, so the rural housing land has a strong social security function. We should respect the wishes of farmers and the actual situation of life and livelihoods and continue to retain the village rural housing land. The area does not have the objective conditions for building new communities, demolishing rural housing lands, and living upstairs. In the future, the focus of village and rural housing land planning should be to optimize the living conditions of farmers through the policy of dilapidated housing renovation and improve the residential security function of rural housing land. We should strengthen the construction of auxiliary land for agricultural production in villages, guide the withdrawal of some functional structures in farmers' rural housing lands, promote the separation of agricultural production and living space, adjust and optimize the land-use pattern of villages and rural housing lands, and improve the specialization of functions and the rationalization of utility structure.

(4) In the typical non-agricultural development of suburban villages, production utility is more concentrated, land-use potential is given priority to with low level, with examples including Wang Xinzhuang town of Empress Dowager Village, the Huang Songyu Township of Heidouyu Village, Nandu Lehe Town of Beizhai Village, the Xiongerzhai Township of Laoquankou Village, Shandong Zhuang town of Yuzishan Village, Shandong Zhuang Village, Liu Jiadian town of Xinggong Village, Jinhaihu Town of Huzhuang Village, and Dahuashan town of Dahuashan village, for a total of eight towns and nine villages. This type of village in Pinggu District mainly relies on high-quality tourism resources, uses rural housing land to set up farmhouses, and develops characteristic rural tourism. In some remote tourist areas or industrial parks, farmers themselves or the idle labor force in the village to open hotels and farmhouses. This not only improves the utilization rate of rural housing land, but also solves the work of idle labor force (mainly middle-aged women) in

the village. The Taihou Village in Wangxinzhuang Town, although 15 km away from the city, has convenient transportation and rich tourism resources. Therefore, the proportion of rural housing lands used to set up farmhouses reaches 15%. Although located in a remote mountainous area, Bolitai Village in Luoying Town is rich in tourism resources. Driven by policies, it has become a folk tourism village. The proportion of rural housing land used for farmhouse management in the village is more than 80%.

For this type of rural housing land, we should speed up the planning and construction of villages, establish a unified brand of villages and a distinctive farmhouse business model in the region. Furthermore, it fully reflects the regional landscape and cultural differences, so that the income function of rural housing land can be sustainable. Since most of these villages are located in mountainous and semi-mountainous areas, traffic conditions and local infrastructure conditions play an important role in attracting tourists and playing the role of rural housing land income. Therefore, a sound system of public service facilities should be established, covering transportation, supermarkets, express delivery points, medical institutions, and other facilities. At the same time, we should improve the rural social security system, such as pension and assistance, promote and refine the " two rights mortgage " policy, and guide the transformation of rural housing land to production utility.

4.3. System Construction of Rural Housing Land for Fairness and Efficiency

Perfecting the rural housing land system is not only to strengthen the residential security of the rural housing land, but also to improve the utilization efficiency of the rural housing land [27]. Rural housing land is owned by the village collective, so that farmers cannot buy and sell it at will, which limits the free circulation of the rural housing land. However, it also guarantees the interests of farmers, so that farmers who work in cities do not have to worry about having no room to live in after they fail to enter the city, thus providing a retreat for them and encouraging their determination to enter the city. At the same time, it also makes them only pursue wage income in the city and not care about the protection of social welfare. Even wage arrears will not cause large social refugees or unrest, effectively maintaining social stability (Figure 6).

Therefore, in the future construction of the rural housing land system, it is necessary to take into account fairness and efficiency: both to protect the housing needs of farmers, but also maximize the conservation and intensive rural construction land. To ensure the fairness of rural housing land allocation, we can try to innovate the rural housing land acquisition system. Rural areas with relatively abundant rural housing land resources and relatively backward farmers' economic conditions can continue to adopt the form of physical distribution of rural housing land. For the urban area or internal villages where the rural housing land resources are relatively tight and the farmers' economic conditions are relatively superior, the farmers who have the demand for rural housing land and meet the conditions are only allocated to their rural housing land indicators and no longer give the rural housing land material. However, it can exchange this index for the corresponding urban housing according to certain regulations, so as to protect the housing security rights of farmers in the urban–rural transition period to a certain extent.

4.4. Contributions, Limitations, and Prospects

Due to the urban–rural dual economic structure, the change of rural land function in China is different from that in western countries [33]. In practice, the government departments in the new rural construction or rural housing land consolidation are often in accordance with the 'remediation potential' to promote the whole village. However, in fact, even in the same region or even the same village, the function of farmers' rural housing land is different, and the demand of farmers is also diversified [2,3]. The level of rural housing land asset attributes is closely related to its location. Only 5% of the country's urban villages, suburban villages, and villages with special resource endowments have higher asset values [27]. The rural areas in the suburbs of the metropolis carry out commercial development on the rural housing land, such as the development of homestays, rural tourism, farmhouses, etc.

The research on the direction of rural residential land consolidation under the guidance of different types of farmers in the Pinggu District shows that the agricultural-led type is suitable for the central village integration model, the agricultural-industrial type is suitable for the intensive model in the village, and the non-agricultural-led type is more suitable for the urban transfer model and the industrial drive model. The reform of the rural housing land system should be implemented in different regions and types, not simply from the developed areas to the underdeveloped areas [37]. We should follow the principle of being people-oriented, land saving, adapting to local conditions and extensive participation, developing a dual-objective optimization path of rural housing land function for function improvement and land-use potential release, and classifying and optimizing the use of rural housing land so as to maximize the benefits of land and meet the needs of rural development land [46–48].

5. Conclusions

Based on the survey data and land-use data of 613 farmers in the Pinggu District of Beijing, this paper identifies the utility structure of rural housing land, uses the consumption utility function to estimate the land demand of farmers' rural housing land in the Pinggu District, and compares it with the current scale of village rural housing land to analyze its potential spatial pattern characteristics, and puts forward suggestions for optimizing rural housing land resources. The conclusions are as follows:

(1) In terms of the demand for land area per household, the plain area is the largest, 165.84 m^2, and the mountain area is the smallest, only 123.33 m^2. The average area of each village rural housing land is compared with the intensive and economical area of the topographic area in which it is located. The average potential of rural housing land in the Pinggu District is 395.64 m^2, with a range of -30.35–1413.75 m^2. According to the potential size, the potential of rural housing land in each village can be divided into five grades, which are expressed by I, II, III, IV, and V, from small to large.

Among them, Class II and III are the main potential levels. The area potential value is 250.25–515.46 m^2, accounting for nearly 70% of the total number of villages. It is widely distributed in the mountainous and semi-mountainous areas in the northwest, the central semi-mountainous area, and the southeastern semi-mountainous area. The proportion of villages with maximum and minimum land-use potential is less than 20%, and it is concentrated in the northeastern mountainous area and some plain areas.

(2) Based on the study of the spatial pattern characteristics, change rules, and driving mechanism of rural housing land function, a matrix is established according to the combination characteristics of rural housing land function changes, different types are divided, and the rural housing lands of the surveyed farmers are classified and analyzed. Based on the relationship between structure and function, this paper summarizes the problems, adaptability, and obstacles in the functional utilization of rural housing land. Combined with the analysis of the driving force of land-use structure and the demand of land use in rural housing land, the optimization path of rural housing land function in different regions and types is formulated.

According to the combination characteristics of 'terrain gradient differentiation, function classification and land use potential level', this paper puts forward the optimization path of rural housing land function, such as implementing the separation of three rights of rural housing land, enhancing and expanding the functions needed, and guiding the stripping of redundant functions. Combined with the research in this paper, the authors believe that the optimization of residential base function should implement differentiated optimization strategies in different regions. In the future construction of a rural housing land system, it is necessary to take into account fairness and efficiency, gradually implement the separation of three rights of rural housing land, classify and design the adjustment scheme of land-use structure within rural housing land, and put forward the guarantee system of rural housing land function optimization from the aspects of policy guidance, urban and rural development, industrial support, and village planning.

Author Contributions: Conceptualization, Q.Z. and G.J.; methodology, Q.Z. and W.M.; software, Q.Z.; validation, Q.Z. and T.Z.; formal analysis, Q.Z.; investigation, Q.Z.; resources, Q.Z.; data curation, Q.Z.; writing—original draft preparation, Q.Z.; writing—review and editing, W.M. and Y.Y.; visualization, Q.Z.; supervision, G.J.; project administration, G.J.; funding acquisition, G.J. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Natural Science Foundation of China (Grant No. 42071249, 42001199), the Natural Science Foundation of Rizhao City (RZ2021ZR38), Shandong Higher Education Youth Innovation and Technology Support Program (2022RW040), the National Social Science Foundation of China (Grant No.20&ZD090).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Jiang, G.H.; Zhang, F.R.; Chen, X.W.; Wang, W.; Wu, J.Z. On Countryside Urbanization and Preservation of Countryside Characteristics. *Res. Agric. Mod.* **2004**, *25*, 198–201.
2. Long, H.L.; Li, M.; Zhang, Y.N.; Qu, L.L. Multifunctional rural development in China: Pattern, process and mechanism. *Habitat. Int.* **2022**, *121*, 102530. [CrossRef]
3. Liu, Y.S. Research on the geography of rural revitalization in the new era. *Geogr. Res.* **2019**, *38*, 461–466. [CrossRef]
4. Qu, Y.B. Transition of rural settlements: Concept, feature, mechanism and path. *Sci. Geogr. Sin.* **2020**, *40*, 572–580. [CrossRef]
5. Ottomano, P.G.; Govindan, K.; Loisi, R.V.; Dal, S.P.; Roma, R. Greenways for Rural Sustainable Development: An Integration between Geographic. *Inf. Syst. Group Anal. Hierarchy Process. Land Use Policy* **2016**, *50*, 429–440. [CrossRef]
6. Ma, W.Q.; Zhu, D.L.; Jiang, G.H. Research on land use structure transition of rural settlements facing the rural vitalization. *Geogr. Res.* **2022**, *41*, 2615–2630.
7. Qu, Y.B.; Wu, M.J.; Zhan, L.Y.; Shang, R. Multifunctional Evolution and Allocation Optimization of Rural Residential Land in China. *Land* **2023**, *12*, 339. [CrossRef]
8. Li, Y.R.; Liu, Y.S.; Long, H.L.; Cui, W.G. Community-Based Rural Residential Land Consolidation and Allocation Can Help to Revitalize Hollowed Villages in Traditional Agricultural Areas of China: Evidence from Dancheng County, Henan Province. *Land Use Policy* **2014**, *39*, 188–198. [CrossRef]
9. Turner, M.D.; McPeak, J.G.; Ayantunde, A. The Role of Livestock Mobility in the Livelihood Strategies of Rural Peoples in Semi-Arid West Africa. *Hum. Ecol.* **2014**, *42*, 231–247. [CrossRef]
10. Liao, L.W.; Long, H.L.; Gao, X.L.; Ma, E.P. Effects of Land Use Transitions and Rural Aging on Agricultural Production in China's Farming Area: A Perspective from Changing Labor Employing Quantity in the Planting Industry. *Land Use Policy* **2019**, *88*, 104152. [CrossRef]
11. Zhou, T.; Jiang, G.H.; Ma, W.Q.; Li, G.Y.; Qu, Y.B.; Tian, Y.Y.; Zhao, Q.L.; Tian, Y.Y. Dying Villages to Prosperous Villages: A Perspective From Revitalization of Idle Rural Residential Land (IRRL). *J. Rural Stud.* **2021**, *84*, 45–54. [CrossRef]
12. Yang, R.; Liu, Y.S.; Long, H.L.; Zhang, Y.J. Research Progress and Prospect of Rural Transformation and Reconstruction in China: Paradigms and Main Content. *Prog. Geogr.* **2015**, *34*, 1019–1030. (In Chinese) [CrossRef]
13. Ma, W.Q.; Jiang, G.H.; Li, W.Q.; Zhou, T. How Do Population Decline, Urban Sprawl and Industrial Transformation Impact Land Use Change in Rural Residential Areas? A Comparative Regional Analysis at the Peri-Urban Interface. *J. Clean. Prod.* **2018**, *205*, 76–85. [CrossRef]
14. Elshof, H.; Haartsen, T.; van Wissen, L.J.G.; Mulder, C.H. The Influence of Village Attractiveness on Flows of Movers in a Declining Rural Region. *J. Rural Stud.* **2017**, *56*, 39–52. [CrossRef]
15. Long, H.L.; Ge, D.Z.; Zhang, Y.N.; Tu, S.S.; Qu, Y.; Ma, L. Changing Man-Land Interrelations in China's Farming Area under Urbanization and its Implications for Food Security. *J. Environ. Manag.* **2018**, *209*, 440–451. [CrossRef]
16. Tu, S.S.; Long, H.L.; Zhang, Y.N.; Ge, D.Z.; Qu, Y. Rural Restructuring at Village Level Under Rapid Urbanization in Metropolitan Suburbs of China and its Implications for Innovations in Land Use Policy. *Habitat Int.* **2018**, *77*, 143–152. [CrossRef]
17. Liu, Y.S.; Wang, L.J.; Long, H.L. Spatio-temporal analysis of land-use conversion in the eastern coastal China during 1996–2005. *J. Geogr. Sci.* **2008**, *18*, 274–282. [CrossRef]
18. Hu, Y.G.; Yu, Y.Y.; Dong, W.J.; Xu, X.F.; Zeng, W. Estimation of Effective Threshold for Paid Land Use Area: An Empirical Study Based on Homestead System Reform in Pilot Area. *J. Agro-For. Econ. Manag.* **2019**, *18*, 667–674.

19. Hu, Y.G.; Wu, X.; Liao, C.Q.; Wang, C. Measurement methods of homestead release potential in two lakes plain. *Areal Res. Dev.* **2018**, *37*, 116–120, 132. (In Chinese with English Abstract)
20. Song, W. Land Consolidation Potential of Rural Housing Land in China. *Chin. Agric. Sci. Bull.* **2014**, *30*, 301–307.
21. Jiang, G.H.; Zhang, F.R.; Kong, X.B. Determining conversion direction of the rural residential land consolidation in Beijing mountainous areas. *Trans. CSAE* **2009**, *25*, 214–221. (In Chinese with English Abstract)
22. Zou, L.L.; Wang, J.Y. Review of Research on Layout Optimization of Rural Settlements in China. *China Popul. Resour. Environ.* **2015**, *25*, 59–68.
23. Song, W.; Zhang, F.R.; Kong, X.B.; Jiang, G.H.; Chen, X.W. Estimation of the consolidation potential of rural residential areas in Tianjin under the restriction of natural economy. *J. Nat. Resour.* **2006**, *21*, 888–899.
24. Chen, R.Q.; Zhang, F.R.; Zhang, J.L.; Xue, Y.S.; Dou, J.L. Potential for Rural Housing Land Consolidation in Wendeng County, Shandong. *Resour. Sci.* **2008**, *30*, 1206–1211.
25. Shen, Y.; Zhang, T.; Liao, H.P. Evaluation and Gradation of Rural Residential Land Reclamation Potential in the Southwest Knoll District—A Case St udy of Changshou Chongqing. *J. Southwest Univ. (Nat. Sci. Ed.)* **2008**, *30*, 141–147.
26. Dang, H.; Zheng, X.Q.; Bai, S.J.; Yuan, Z.Y. Study on the methods of potential calculation for rural residential area. *Areal Res. Dev.* **2016**, *35*, 124–127. (In Chinese with English Abstract)
27. Tu, S.S.; Long, H.L.; Liu, Y.Q.; Li, T.T. Research progress and prospects in the methodology of assessing the potential of rural residential land consolidation. *J. Nat. Resour.* **2015**, *30*, 1956–1968. (In Chinese with English Abstract)
28. Shi, S.Y.; Zhang, X.L. Current situation analysis and land reconsolidation potential calculation of rural residential areas in Jiangsu province. *China Land Sci.* **2009**, *23*, 52–58. (In Chinese with English Abstract)
29. Zhou, K.H.; Tan, R.H.; Liu, Y.F.; Kong, X. Assessing of land-saving potential in Hubei province based on per capita constructive land standards. *Trans. Chin. Soc. Agric. Eng. (Trans. CSAE)* **2012**, *28*, 222–231. (In Chinese with English Abstract)
30. Song, W.; Chen, B.M.; Jiang, G.H. Research on land consolidation potential of rural habitat in China: Review and preview. *Econ. Geogr.* **2010**, *30*, 1871–1877. (In Chinese with English Abstract)
31. Wang, N.; Hao, J.M.; Li, M.; Chen, A.Q. Zoning and potential of rural housing land consolidation in Hebei province under background of livelihoods transformation. *Trans. Chin. Soc. Agric. Eng. (Trans. CSAE)* **2019**, *35*, 255–264. (In Chinese with English Abstract)
32. Liu, M.; Li, M.C.; Huang, Q.H.; Wang, Y.H.; Hong, W.Y. The evaluation the remediation potential of urban construction land based on GIS and FAHP: Taking Wujin District Changzhou City as an example. *Acta Agric. Univ. Jiangxiensis* **2013**, *35*, 1318–1324.
33. Liu, S.K.; Wei, S.Q.; Chen, S.L.; Gao, Y.H. Voronoi diagram-based research on spatial distribution characteristics of rural settlements and consolidation potential evaluation. *Resour. Sci.* **2014**, *36*, 2282–2290. (In Chinese with English Abstract)
34. Zhu, X.H.; Chen, Y.F.; Liu, Y.S.; Zhang, J.; Li, Y.Y.; Ding, J.J. Technique and method of rural land consolidation potential investigation and assessment: A case study of Yucheng City, Shandong province. *Acta Geogr. Sin.* **2010**, *65*, 736–744. (In Chinese with English Abstract)
35. Guo, J.; Xiao, S.C.; Ou, M.H.; Ou, W.X. Realistic potential calculation of rural settlements consolidation based on willingness of participants. *China Land Sci.* **2017**, *31*, 86–94. (In Chinese with English Abstract)
36. Yang, H.; Lu, X.H.; Chen, D.J. Potential zoning and development paths of homestead renovation for rural revitalization in southern Hunan Province of China. *Trans. Chin. Soc. Agric. Eng. (Trans. CSAE)* **2021**, *37*, 263–272. (In Chinese with English Abstract)
37. Huang, S.; Wang, Y.; Liu, R.; Jiang, Y.; Qie, L.; Pu, L. Identification of Land Use Function Bundles and Their Spatiotemporal Trade-Offs/Synergies: A Case Study in Jiangsu Coast, China. *Land* **2022**, *11*, 286. [CrossRef]
38. Qin, Y.; Luo, G.; Li, Y.; Tan, Q.; Zheng, C.; Yu, M.; Liao, J.; Li, M. Assessment of Sustainable Development of Rural Settlements in Mountainous Areas: A Case Study of the Miaoling Mountains in Southwestern China. *Land* **2022**, *11*, 1666. [CrossRef]
39. Huang, L.; Zheng, M.; Wang, R. Rural Housing Rental Rates in China: Regional Differences, Influencing Factors, and Policy Implications. *Land* **2022**, *11*, 1053. [CrossRef]
40. Barbosa, V.; Santé-Riveira, I.; Crecente-Maseda, R.; Redondo, C.D.; Trinidad, J.P.; López, J.P.; Biempica, R.D.; Ferreira Neto, J.A. A New Spatial Criteria Method to Delimit Rural Settlements towards Boundaries Equity: Land Use Optimization for Decision Making in Galicia, NW Spain. *Land* **2022**, *11*, 800. [CrossRef]
41. Long, H.L.; Liu, Y.S.; Zou, J. Assessment of Rural Development Types and Their Rurality in Eastern Coastal China. *Acta Geogr. Sin.* **2009**, *64*, 426–434.
42. Jiang, G.H. *Evolution and Regulation of the Morphology of Rural Settlement during the Socio-Economic Transition Period*; China Agricultural University: Beijing, China, 2007.
43. Jiang, G.H.; He, X.; Qu, Y.B.; Zhang, R.J.; Meng, Y. Functional evolution of rural housing land: A comparative analysis across four typical areas representing different stages of industrialization in China. *Land Use Policy* **2016**, *57*, 645–654. [CrossRef]
44. Zhao, Q.L.; Jiang, G.H.; Yang, Y.T.; Tian, Y.Y.; Fan, L.H.; Zhou, T.; Tian, Y.Y. Multifunction change of rural housing land in metropolitan suburbs from the perspective of farmer households'land-use behavior. *Land Use Policy* **2022**, *119*, 106206. [CrossRef]
45. Tian, Y.Y.; Jiang, G.H.; Zhou, D.Y.; Zhou, T.; Ma, W.Q. A Refined Rural Settlements Simulation Considering the Competition Relationship among the Internal Land Use Types: A Case Study of Pinggu District. *Land* **2022**, *11*, 661. [CrossRef]
46. Nizam, D.; Tatari, M.F. Rural revitalization through territorial distinctiveness: The use of geographical indications in Turkey. *J. Rural. Stud.* **2022**, *93*, 144–154. [CrossRef]

47. Wang, B.Y.; Tian, J.F.; Wang, S.J. Process and mechanism of transition in regional land use function guided by policy: A case study from Northeast China. *Ecol. Indic.* **2022**, *144*, 109527. [CrossRef]
48. Zhang, Y.N.; Long, H.L.; Tu, S.S.; Ge, D.Z.; Ma, L.; Wang, L.Z. Spatial identification of land use functions and their trade-offs/synergies in China: Implications for sustainable land management. *Ecol. Indic.* **2019**, *107*, 105550. [CrossRef]
49. Pérez-Soba, M.; Petit, S.; Jones, L.; Bertrand, N.; Briquel, V.; Omodei-Zorini, L.G.; Helming, K.C.C.; Farrington, J.H.; Mossello, M.T.; Wascher, D. Land use functions—A multifunctionality approach to assess the impact of land use changes on land use sustainability. In *Sustainability Impact Assessment of Land Use Changes*; Springer: Berlin/Heidelberg, Germany, 2008; pp. 375–404. [CrossRef]
50. Li, H.B.; Yuan, Y.; Zhang, X.L.; Li, Z.; Wang, Y.H.; Hu, X.L. Evolution and transformation mechanism of the spatial structure of rural settlements from the perspective of long-term economic and social change: A case study of the Sunan region, China. *J. Rural Stud.* **2022**, *93*, 234–243. [CrossRef]
51. Xu, X.Q.; Zhou, K.C.; Li, X.Q.; Dai, J.; Liu, W.T.; Wang, R.J. Calculation of Homestead Consolidation Potential Based on Survey of Farmers' Willingness: Taking 11 Villages in Xiangxiang City as an Example. *J. Nat. Sci. Hunan Norm. Univ.* **2020**, *43*, 27–34.
52. Kong, X.S.; Liu, Y.F.; Zou, Y.F.; Chen, Y.Y. Calculation of land consolidation potential and optimization of rural residential areas based on households'willingness. *Trans. Chin. Soc. Agric. Eng. (Trans. CSAE)* **2010**, *26*, 296–301. (In Chinese with English Abstract)
53. Pašakarnis, G.; Maliene, V.; Dixon-Gough, R.; Malys, N. Decision support framework to rank and prioritise the potential land areas for comprehensive land consolidation. *Land Use Policy* **2021**, *100*, 104908. [CrossRef]
54. Wojewodzic, T.; Janus, J.; Dacko, M.; Pijanowski, J.; Taszakowski, J. Measuring the effectiveness of land consolidation: An economic approach based on selected case studies from Poland. *Land Use Policy* **2021**, *100*, 104888. [CrossRef]
55. Qu, Y.B.; Jiang, G.H.; Yang, Y.T.; Zheng, Q.Y.; Li, Y.L.; Ma, W.Q. Multi-scale analysis on spatial morphology differentiation and formation mechanism of rural residential land: A case study in Shandong Province, China. *Habitat Int.* **2018**, *71*, 135–146.
56. Liu, Y.S.; Li, Y.H. Revitalize the world's countryside. *Nature* **2017**, *548*, 275–277. [CrossRef]
57. Chaney, P.; Sherwood, K. The resale of right to buy dwellings: A case study of migration and social change in rural England. *J. Rural Stud.* **2000**, *16*, 79–94. [CrossRef]
58. Doberstein, C.; Hickey, R.; Li, E. Nudging NIMBY: Do positive messages regarding the benefits of increased housing density influence resident stated housing development preferences? *Land Use Policy* **2016**, *54*, 276–289. [CrossRef]
59. Cloke, P.; Edwards, G. Rurality in England and Wales 1981: A replication of the 1971 index. *Reg. Stud.* **1986**, *20*, 289–306. [CrossRef]
60. Qu, Y.B.; Jiang, G.H.; Zhang, F.R.; Shang, R. Models of rural residential land consolidation based on rural households willingness. *Trans. Chin. Soc. Agric. Eng.* **2012**, *28*, 232–242.
61. Banski, J.; Wesolowska, M. Transformations in housing construction in rural areas of Poland's Lublin region—Influence on the spatial settlement structure and landscape aesthetics. *Landsc. Urban Plan.* **2010**, *94*, 116–126. [CrossRef]
62. Liu, S.Y.; Xiong, X.F. Changes in economic structure, village transformation and changes in homestead system: A case study of homestead system reform in Luxian County, Sichuan Province. *Chin. Rural Econ.* **2018**, *6*, 2–20.
63. Cheng, M.Y.; Liu, Y.S.; Zhou, Y. Measuring the symbiotic development of rural housing and industry: A case study of Fuping County in the Taihang Mountains in China. *Land Use Policy* **2019**, *82*, 307–316. [CrossRef]
64. Kathleen, O. The influence of land use changes on open defecation in rural India. *Appl. Geogr.* **2018**, *99*, 133–139.
65. Tezcan, A.; Büyüktaş, K.; Aslan, ŞT.A. A multi-criteria model for land valuation in the land consolidation. *Land Use Policy* **2020**, *95*, 104572. [CrossRef]
66. Marschak, J. Rational Behavior, Uncertain Prospects, and Measurable Utility. *Econometrica* **1950**, *18*, 111–141. [CrossRef]
67. Zhang, Y.R.; Qiu, D.C.; Li, Y.; Luo, D.Q.; Shi, Y.M. Standards of Rural Housing Construction Land Based on the Utility Function: An Example of 11 Districts and Counties over Northeastern Chongqing Municipality. *Resour. Sci.* **2011**, *33*, 120–126.
68. Wang, Y.Z.; Feng, C.L. Fuzzy consumption utility function and its preliminary application. *J. Quant. Tech. Econ.* **1986**, *6*, 39–47.
69. Wang, P.F. A study on commodification in rural space and the relationship between urban and rural areas in Beijing city. *Acta Geogr. Sin.* **2013**, *68*, 1657–1667.
70. Perkins, H.C. Commodification: Re-resourcing rural areas. In *Handbook of Rural Studies*; Cloke, P., Marsden, T., Mooney, P.H., Eds.; SAGE Publications: London, UK, 2006; pp. 243–257.