Analysis method of renovation potential of hollow village in hilly area

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Abstract. The long-term existence of Hollow Village wasted national land resources and was not conducive to the construction of new rural areas. Under the background of the lack of the evaluation and analysis of the remediation potential of Hollow Village in my country, the evaluation method of the remediation potential of the Hollow Village in the hilly area and the determination method and process of the potential correction coefficient are proposed, and the land remediation potential of Hollow Village in Chengcheng County is analyzed through an example. The research results can provide a basis for evaluating the remediation potential of Hollow Village, which is beneficial to the cost accounting of land remediation departments and the decision-making of competent authorities.

1. Introduction

"Hollow Village" was a special phenomenon that appeared in the process of China's rural economic system reform and the changes of farmers' production and lifestyles, and it was also a common phenomenon in the process of the "three modernizations" of industrialization, urbanization, and agricultural modernization in the world [1-2]. "Hollow villages" were also a common phenomenon in China, and they have spread in recent years [3-4]. The emergence of "hollow villages" has many disadvantages, such as serious waste of land resources, endangering the rural living environment, affecting social stability and development, and hindering rural economic development, etc. [5]. Therefore, carrying out the renovation of hollow villages in mountainous and hilly areas will help solve the problem of rural land structure, the problem of soil cultivability, the improvement of the human settlement environment in mountainous and hilly areas, and the ecological environment of mountainous and hilly areas. The problems are of great significance and will produce significant economic and social benefits [6-7].

However, what kind of hollow village is suitable for remediation and can achieve the optimal economic investment ratio, which requires an analysis of the remediation potential of the hollow village to be renovated. At present, there are not many potential evaluation methods. This research is based on
this and proposes the evaluation method of village remediation potential and the determination method of potential correction coefficient in mountainous hills hollow villages. The research results can provide a basis for evaluating the remediation potential of Hollow Village, which is conducive to the cost accounting of the land remediation department and the decision-making of the competent authority.

2. Potential evaluation method

2.1. Per capita construction land standard method
Combining the land use of residential areas in the loess hilly area and the national standard for per capita construction land in villages and towns, the consolidation potential is calculated based on the difference in land area. The calculation formula is:

$$\Delta S = S_t - B_t \times Q_t$$

Where, $\Delta S$ is the consolidation potential of rural residential areas; $S_t$ is current situation is the area of the current residential area; $B_t$ is the land use standard per capita; $Q_t$ is the rural population.

According to the national standard "Village and Town Planning Standards" (GB50188-93), considering the natural and socio-economic conditions of typical hollow villages and towns in mountainous and hilly areas, it is determined in combination with the overall rural planning.

Table 1. Per capita construction land index

| Current level of construction land per capita (m²/person) | Per capita construction land index level | Allow adjustment range (m²/person) |
|---------------------------------------------------------|----------------------------------------|-----------------------------------|
| 100.1-120                                               | III, IV                                | -0~15                             |
| 120.1-150                                               | IV, V                                  | -0~20                             |
| 150                                                     | V                                      | <150                              |

2.2. Per household construction land standard method
The principle of the average household land use standard is roughly the same as that of the per capita construction land standard. With reference to the relevant national and provincial standards, the planned and designed rural construction land household average land use standard is used to calculate the remediation potential. Calculation formula:

$$\Delta S = S_t - M_t \times P_t$$ (1)

Where, $\Delta S$ is the consolidation potential of rural residential areas; $S_t$ is current situation is the area of the current residential area; $M_t$ is per household construction land standard; $P_t$ is the number of rural households.

According to the "Guidelines for the Construction of Rural Villages in Shaanxi Province (Trial)" and "Technical Guidelines for the Construction of New-type Rural Communities in Shaanxi Province", since Chengcheng County is mostly mountainous and hilly landforms, taking into account natural environmental factors, the land use index per household is determined (Table 2).

Table 2. Index of land use per household

| Area category           | Land use standard per household indicator(m²) | villages                                              |
|------------------------|-----------------------------------------------|-------------------------------------------------------|
| Plateau area           | 200                                           | Chengguan town, Wangzhuang town, Siquan town, Weizhuang Town |
| Mountain and hilly area| 267                                           | Leijiawa township, Shanhuai Township, Anli Township, Luojiawa township, Zhuangtou Township |
2.3. Idle rate

The land unused rate method is mainly based on the survey of the unused land area in the typical rural residential areas in the project area to obtain the land unused rate and calculate the potential of rural residential area consolidation. Calculation formula:

\[ \Delta S = S_t \times a \]  

Where, \( \Delta S \) is the consolidation potential of rural residential areas; \( S_t \) is current situation is the area of the current residential area; \( a \) is the idle rate of land.

3. Determination of the correction coefficient for the consolidation potential

3.1. Construction of a comprehensive index system

The index factors used in the production, construct a comprehensive evaluation index system (Table 3), comprehensively analyze and evaluate the development potential of rural residential areas in Chengcheng County.

Two representative indexes, topographic position index and slope, were selected for natural factors. Topographic bit index is described by the topographic attribute of elevation and slope at a certain point in space. Its calculation formula is as follows:

\[ T = \log \left[ \left( \frac{D}{\bar{D}} + 1 \right) \times \left( \frac{S}{\bar{S}} + 1 \right) \right] \]  

Where: \( T \) is topographic bit index; \( D \) and \( \bar{D} \) represent the space of a little elevation value and the average area at a height value; \( S \) and \( \bar{S} \) represent the space of a little slope and point average gradient value of the area. From the formula, it can be seen that the topographic position index with low elevation and small slope is small, and conversely, the topographic position index is large. Slope direction is an important factor affecting agricultural production and residents’ life in hilly areas. The influence of slope direction on sunshine duration and solar radiation intensity is huge. The south slope has the most radiation income, while the north slope has the less radiation income. Therefore, slope direction has an important influence on the distribution of rural settlements. It is quantified by assignment, and is represented as 5, 4, 3, 2, and 1 in sequence: south, south, east, west, north, and north.

| Factors layer | index layer | Assignment instructions |
|---------------|-------------|-------------------------|
| Natural factor layer | Topographic bit index | Negative effect: DEM data extraction |
| economic factor layer | Per capita net income of farmers | Positive effect: from chengcheng County statistical yearbook |
| | Agricultural output value | Positive effect: from chengcheng County statistical yearbook |
| | Total grain output | Negative effect: from chengcheng County statistical yearbook |
| social factor layer | Proportion of non-agricultural population | Positive effect: from chengcheng County household census |
| | Proportion of young adults | Positive effects: Percentage of the agricultural population aged 15-64 |
| | Changes in cultivated land | Negative effect: the absolute value of the change in cultivated land |

Four indicators were selected for social factors, namely, the proportion of non-agricultural population, the proportion of young and middle-aged population, the increase and decrease of cultivated land and the per capita cultivated land area. The action basis of each index is no longer repeated, and the change index of cultivated land only considers the change size, not the change direction.
3.2. Data standardization
Since the indicators selected in the study have different units and dimensions, the variation of their values may be very large. In order to facilitate the processing and analysis of data, it is necessary to standardize the data. The standard processing adopts a very poor method. The formula is as follows:

\[ x'_{i} = \frac{x_{i} - x_{i\text{min}}}{x_{i\text{max}} - x_{i\text{min}}} \]  

(4)

The maximum and minimum value of each element in the new data obtained after standardization according to the above formula are 1, 0, and the remaining values are between 0 and 1, thus eliminating the influence of dimension and order of magnitude. In addition, reverse indicators such as topographic position index, slope direction, total grain output and per capita cultivated land area need to be converted into positive indicators, and the formula is as follows:

\[ x'_{i} = \frac{x_{i\text{max}} - x_{i}}{x_{i\text{max}} - x_{i\text{min}}} \]  

(5)

Among them, \( x_{i\text{max}} \) is the maximum value of the variable, and \( x_{i\text{min}} \) is the minimum value of the variable.

3.3. Determination of index weight
This study uses AHP decision analysis and entropy weight method to determine the weights of various factors affecting nature, economy and society. Decision analysis method is a process by which decision makers transform the decision-making process of a complex system into a modeled and quantified process. This study uses yaahp software to calculate the weight of each indicator; the entropy weight method is an objective weighting method, which uses the amount of information provided by the entropy value of each indicator to determine the weight of the indicator. It can exclude human interference factors and make the evaluation results more in line with reality; and through the calculation of the entropy value of each indicator, the amount of indicator information can be measured to ensure that the indicator reflects most of the information. The specific algorithm is as follows:

(1) Calculate the proportion of the Jth index value of sample I:

\[ p_{ij} = \frac{X_{ij}}{\sum_{i=1}^{m} X'_{ij}} \]

(2) Calculate the entropy value of the jth index:

\[ e_{j} = -\frac{1}{\ln(m)} \sum_{i=1}^{m} (Y_{ij} \times \ln Y_{ij}) \]

(3) Calculate the coefficient of difference of the Jth index:

\[ d_{j} = 1 - e_{j} \]

The bigger \( d_{j} \) is, the more information this index provides, and the greater index weight should be given.

Calculate index weight:

\[ w_{j} = \frac{d_{j}}{\sum_{j=1}^{n} d_{j}} \]

In the formula, \( X_{ij} \) represents the value of the jth evaluation index of the ith sample, where \( m \) is the number of evaluation years and \( n \) is the number of indexes.
Table 4. Index weights

| Index                                | AHP method | Entropy method | Weighted value |
|--------------------------------------|------------|----------------|----------------|
| Number of terrain places             | 0.3269     | 0.0760         | 0.2014         |
| slope                                | 0.1645     | 0.0933         | 0.1289         |
| Total value of agricultural output   | 0.1034     | 0.0984         | 0.1009         |
| Rural per capita net income          | 0.1641     | 0.3191         | 0.2416         |
| Grain total output                   | 0.0434     | 0.1460         | 0.0947         |
| Agricultural population              | 0.0816     | 0.0425         | 0.0620         |
| Proportion of young adults           | 0.0408     | 0.1401         | 0.0904         |
| Changes in cultivated land           | 0.0213     | 0.0380         | 0.0297         |
| Arable land per capita               | 0.0521     | 0.0465         | 0.0493         |

3.4. Determination of correction factor

The formula for calculating the correction coefficients of natural, economic, and social factors using the multi-factor comprehensive evaluation method is as follows:

\[ Q_i = \sum_{j=1}^{n} w_{ij} \times f_{ij} \]

Where, \( Q_i \) is the theoretical correction coefficient of rural residential area in the factor layer \( i \); \( w_{ij} \) is the weight of the corresponding factor in the factor layer; \( f_{ij} \) is standardized values of each impact factor.

According to the determination method of correction absorption, the correction coefficients of each town in Chengcheng County were calculated (Table 5).

Table 5. Correction coefficient of each town in Chengcheng County

| Name of the town      | Correction coefficient | Name of the town      | Correction coefficient | Name of the town      | Correction coefficient |
|-----------------------|------------------------|-----------------------|------------------------|------------------------|------------------------|
| Shiqian town          | 0.5147                 | zhuangtou town        | 0.5270                 | Luojiawa township      | 0.3206                 |
| Weizhuang town        | 0.7868                 | Anli town             | 0.3355                 | Luojiawa township      | 0.3815                 |
| Jiaodao town          | 0.5243                 | Wangzhuang town       | 0.3912                 | Shanhua Township       | 0.3411                 |
| Yaotou town           | 0.4023                 | Zhaozhuang town       | 0.3177                 | Luojiawa township      | 0.5028                 |
| Chegnguan town        | 0.5318                 | Fengyuan town         | 0.2347                 |                        |                        |

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