Research on the technical method of constructing the evaluation system of geological cultural village

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Abstract. The current rural construction presents a new situation in which multiple perspectives are involved. As one of the important cut-in points for intervention, the academic community has begun to explore and practice the rural construction model based on “geological culture”. Starting from the ontology of rural geological environment resources, the four-dimensional attributes including geological relics, agricultural geological resources, human landscapes and natural landscapes are concerned, and the evaluation method of geological culture village based on analytic hierarchy process (AHP) is discussed. Through the comprehensive evaluation index system of geological culture villages with two basic connotations of environmental resources, development conditions and development benefits, seven types of geological relics, agricultural geological resources, human landscape, natural landscape, human settlement environment, public service and development benefit are proposed. The second-level index consists of a total of 16 third-level indicators of the comprehensive evaluation system of geological culture villages. The article aims to lay a foundation for the planning and design of geological and cultural villages through the construction of the evaluation system and promote the healthy and sustainable development of the geological culture villages.

1. Introduction

The geological park is a unique natural area composed of geological relics and the integration of other natural and human landscapes [1]. However, it is worth noting that higher-level geological relics do not have a dominant position in quantity, and most of the geological relics do not meet the requirements of national and provincial geological parks. However, such relics also have development value, especially combining them with rural human settlements safety, environmental protection, tourism development and precision poverty alleviation. It has become a new topic in the context of the new era, in which geological culture villages are geological relics. It becomes a powerful grip for rural construction [2-3]. Therefore, the establishment of a comprehensive evaluation system is a powerful guarantee for the comprehensive excavation of geological cultural village geological resources, laying the foundation for the planning and design of geological and cultural villages, and establishing a basis for the evaluation of post-construction geological and cultural villages.
2. The evolution of rural revitalization based on “geological culture”

2.1 Exploration of the cultural essence based on “geological relics”
As a special and valuable resource, geological heritage resources have gradually gained human attention. Human exploration and protection of geological relics has gone through a long process from spontaneous, conscious to systematic research. Before the middle of the 20th century, countries around the world established geological heritage reserves or national parks. Since then, UNESCO has played an important role. In 1948, United Nations Educational Scientific and Cultural Organization (UNESCO) founded the World Conservation Union (IUCN) in Paris and established the “National Parks and Nature Conservation Committee” (CNPPAI/UCN), which officially incorporated the protection of geological landscapes and the promotion of scientific development. National Park Standards; the term “Geological Parks” was created by UNESCO in 1999 and proposes the creation of a global network of geological sites with unique geological features, “protecting important geological environments as an integral part of sustainable development strategies in each region.”[4-6] Geographical park plan. "In China, the Ministry of Land and Resources has promulgated a series of technologies such as “Technical Requirements and Work Guidelines for Construction of China National Geoparks (2002)”, “China Geological Relics Survey Standards (2014), and “Technical Requirements for Planning of National Geoparks (2016)”[7-9] Norms and standards, the protection of geological heritage is at the forefront of the world.

2.2 The development direction of Chinese villages with "geological culture" as the core
Since the beginning of the last century, rural construction has always been an important issue in China's development process. The new round of rural construction under the background of "rural revitalization" has presented a diversified new situation on the basis of past practical experience. The strong support of national policies has given the country a great space for development; unlike the extensive mode of overall construction in the new rural construction period, rural development has gradually entered the transition period of rational exploration. Since 2017, Xi Jinping pointed out in the report of the 19th National Congress that the implementation of the rural revitalization strategy and the priority development of agriculture and rural areas. The development of rural construction has entered a new stage. However, with the rising living standards of people, the rural tourism that should have flourished has been exhausted due to the limitations of its own factors. Many rural tourist areas have been struggling after the glimpse of the scenery[10].

As an active responder to the UNESCO Global Geoparks Program, China is one of the pilot countries of the World Geoparks Program. Under the promotion of the UNESCO World Geoparks Program, the Ministry of Land and Resources approved 271 national geological parks in eight batches from 2001 to 2018. However, in addition, there are still a large number of geological relics in rural areas that do not meet the requirements of national and provincial geological parks. For such ruins, it is impossible to ignore and establish a geological park or a protected area for development and utilization. As a result, relevant research on rural revitalization and development based on “geological culture” has begun to receive academic attention. However, the results only stayed in the field investigation and basic data collection stage.

3. The composition of environmental resources in geological culture village
“Geological Culture Village” is a new type of village integrating geological heritage resources, characteristic agricultural resources, cultural resources and tourism resources. It is rich in geological relics and supported by characteristic agricultural products and folk customs. Tourism and leisure and science education activities.

3.1 Geological relics
Geological relics refer to the precious, non-renewable geological natural heritage formed, developed and left behind by the geological role of internal and external dynamics during the long geological history of the evolution of the earth. It includes natural relics such as scenic spots and natural scenery,
as well as relics of interactions between humans and geological bodies during the formation of humans in the late geological history.

3.2 Agricultural geological resources

Agricultural geological resources refer to agricultural products that produce a certain agricultural product in a specific area with a comparative advantage in terms of output, especially in terms of quality compared with other regions. The production of special agricultural products has certain conditions. First, the production of characteristic agricultural products should be suitable for local natural conditions; secondly, it has obvious comparative advantages in location.

3.3 Human landscape

The human landscape, also known as the cultural landscape, is a landscape composed of people's daily life, in order to meet certain material and spiritual needs, superimposed on certain cultural characteristics on the basis of natural landscape. The human landscape has occupied an important position in the process of China's historical development. It not only bears the inheritance and spread of Chinese traditional culture, but also maintains the development of rural clan and social culture.

3.4 Natural landscape

Natural landscapes have a natural occurrence from the perspective of genetics, mainly referring to natural complexes that are less affected by human activities. It is a combination of multiple natural elements in a certain geographical environment, and does not transfer with the will of human beings. All natural landscapes are the product of long-term development and change of nature.

4. The evaluation methods of Geological cultural village

Geological cultural villages cover a wide range of content. Therefore, when evaluating geological and cultural villages, on the one hand, select appropriate methods to avoid deviations caused by subjective factors, and on the other hand, establish appropriate evaluation indicators. The Analytic Hierarchy Process was proposed by American operations researcher Thomas Sati to break down a complex problem into several levels. The single ranking (weight) and total ranking are calculated by the fuzzy quantization method of qualitative index, which can be used as a systematic method for optimal decision making of multi-target and multi-scheme.

In order to ensure the accuracy of the evaluation results, this study invited more than 20 peer experts to assign value weights for the construction and development of geological culture villages by filling out questionnaires. Let the matrix be a, theoretically analyzed: if a is a completely consistent pairwise comparison matrix, then there should be a matrix with the largest eigenvalue \( \lambda_{\text{max}} = n \). However, it is impossible to fully satisfy the above formula in actual operation. Therefore, the regression requires a certain consistency of the pairwise comparison matrix, and the general indicator of a pairwise comparison matrix A (\( n > 1 \)st order square matrix) is Consistency Index (CI). Calculate weights and maximum eigenvalues by excel software \( \lambda_{\text{max}} \), and further calculate CI.

\[
\lambda_{\text{max}} = \sum_{i=1}^{n} \frac{(AW)_{ii}}{nW_j}
\]  

(1)

A and \( W_i \) are pairwise comparison matrix and criteria weight vector respectively.

\[
\text{CI} = \frac{\lambda_{\text{max}}(A) - n}{n-1}
\]  

(2)

Among them, the larger the value of the general indicator CI, the greater the degree to which the judgment matrix deviates from the complete consistency, that is, the worse the consistency of the matrix; conversely, the smaller the value of CI indicates that the judgment matrix is closer to complete consistency. In order for the pairwise comparison matrix to have satisfactory consistency, CI and Random Index (RI) need to be compared. RI is an average random consistency indicator that is only
related to the matrix order \( n \) (Table 1). The ratio of \( CI \) to \( RI \) is called the test coefficient Consistency Ratio (CR).

\[
CR = \frac{CI}{RI}
\]

When CR is less than 0.10, A has acceptable consistency; When CR is greater than or equal to 0.10, A needs to be re-adjusted and corrected.

| N | 1  | 2  | 3   | 4   | 5   | 6   | 7   | 8   | 9   |
|---|----|----|-----|-----|-----|-----|-----|-----|-----|
| RI| 0  | 0  | 0.52| 0.89| 1.12| 1.36| 1.41| 1.46| 1.49|

5. The construction of geological culture village evaluation system

The comprehensive evaluation is based on the single factor evaluation, and the evaluation index of each factor is obtained by the weighted evaluation method, and the equation of the comprehensive evaluation is obtained. This study will be based on the "National Geopark Construction Standards", "Special Rural Construction Regulations" (db33t-912-2014), "Traditional Village Evaluation and Identification Index System (Trial)" and literature research on relevant geological and cultural village evaluations. The construction evaluation index system is divided into two main first-level indicators: “environmental resources” and “development conditions and development benefits”. Under these two first-level indicators, they are decomposed down into 16 individual evaluation indicators (Table 2).

| Primary indicator | Secondary indicator | Tertiary indicator |
|-------------------|---------------------|-------------------|
| Environmental resources(A1) | Geological relics(B1) | Scientific value(C1) |
| | | Historical and cultural value(C2) |
| | Agricultural geological resources(B3) | Aesthetic Value(C3) |
| | Human landscapes(B2) | Agricultural products(C4) |
| | | Historical or cultural richness(C5) |
| | | Story and historical connotation(C6) |
| | | Human activities(C7) |
| | | Village features(C8) |
| Natural landscapes(B4) | Diversity of ancient and famous trees(C9) | |
| Development conditions and development benefits(A2) | Human settlement environment(B5) | Sanitation conditions(C11) |
| | Residential facilities(C12) | |
| | Public services(B6) | Transportation and public facilities services(C13) |
| | | Information service(C14) |
| | Development benefits(B7) | Economic benefits(C15) |
| | | Environmental benefits(C16) |

For the environmental resources, the four indicators of geological relics, agricultural geological resources, human landscapes and natural landscapes were selected. These indicators can reflect the basic situation of geological heritage in Geological Village, and can comprehensively judge the value of resources. For the development conditions and development benefits, the three aspects of human settlement environments, public services and development benefits are selected for comprehensive evaluation. The first two indicators are closely related to people's daily life. The development benefits mainly concern whether the geological cultural villages are protected by geological heritage resources while they are located in the economic development.
In the comprehensive evaluation of the construction potential of geological and cultural villages, determining the weight of each evaluation index is a key step of the whole evaluation, and should be determined according to the relative importance of the indicators, that is, the contribution of the indicators to the comprehensive evaluation. According to the principle of analytic hierarchy process, firstly, the importance of the two factors between the criterion layer and the object layer in Table 3 are compared step by step, and the relative importance value is used to form the judgment matrix, and the maximum judgment matrix is solved. The eigenvalue and its corresponding eigenvector yield the relative importance of this set of metrics.

6. Conclusion
Combining the full text with the structure of the components of the geological and cultural village, the model weights are constructed by the AHP analytic hierarchy process, and the sample is evaluated by the weighted summation method. The comprehensive evaluation model of the geological culture village is established, and the geological cultural villages are calculated. The weight of the factor, through the relevant data to calculate the degree of influence of each factor on the construction of the geological and cultural village, can comprehensively evaluate the potential of the traditional village construction geological culture village. The core of the geological culture village is geological culture. The carrier is a geological and cultural product. It introduces “geology + culture + tourism” and transforms rural geology, agriculture and human landscape into geological and cultural tourism products. In order to provide a practical and feasible quantitative basis for the subsequent planning and design of more characteristic geological and cultural villages, it will provide useful reference for China's geological and cultural villages.

References
[1] Li-Sheng, H., & Xue-Gong, X. U. (2004). Connotation and value characteristics of national geopark. Geological Technoeconomic Management., 26(1):48-50.
[2] Hua, D., Ming-Ming, C., Hong, D. (2007). Features of geological heritages and construction of geoparks in shaanxi. Journal of Arid Land Resources and Environment, 21(9):761-764.
[3] Gazzola, L. La casa della Fenice: la città e la casa nella cultura architettonica cinese[M]. Roma: Diagonale, 1999.
[4] Morgan, L. H. Houses and House-life of the American Aborigines[M]. Washington: Government Printing Office, 1881.
[5] Olgyay, V., Olgyay, A. Design with Climate: Bioclimatic Approach to Architectural Regionalism[M]. Princeton University Press, 1963.
[6] Oliver, P. The Encyclopedia of Vernacular Architecture of the World[M]. Cambridge and New York: Cambridge University Press, 1997.
[7] Ting, Z. (2002). The construction and significance of european geoparks. Acta Geoscientia Sinica., 23(5):463-470.
[8] Hua, D., Xing, C., & Yun-Yang, Z. (2012). Research on space distribution, tourism benefit and future development of global geoparks in china. Economic Geography., 32(12):187-190.
[9] Chen, A. Z. (2016). The establishment and development of tourism earth-science and geopark, and geoheritage resources in china: celebrating the 60th anniversary of chinese academy of geological sciences. Acta Geoscientica Sinica, 37(5):535-561.
[10] Otto, F. Occupying and Connecting: Thoughts on Territories and Spheres of Influence with Particular Reference[M]. Edition Axel Menges, 2009.