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Architectural design of Residential Buildings in Qinba Mountains based on knowledge mapping



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ABSTRACT

This article has selected knowledge mapping as the research method and China HowNet as the references source, 222 related research papers are selected to analyze and summarize the keyword co-occurrence network, aiming at the problems of residential architecture research in Qinba Mountains. For the clustered hotspots, taking the traditional residential buildings in Qinba Mountains as an example, this paper carries out a survey and summarizes the ways of residential design in Qinba Mountains, with a view to providing a better reference for the design of residential buildings in this area.

1. Introduction

Qinba area is located at the junction of Sichuan, Chongqing, Shaanxi, Hubei and Henan provinces and cities. It includes Hanzhong, Ankang, and Shangluo from Shaanxi, Xiangfan, Shiyan, Jingmen, Suizhou, and Shennongjia Forest District from Hubei, Dazhou and Bazhong from Sichuan, Wanzhou from Chongqing and Nanyang from Henan. There are East-West Mountains like Qinling and Daba, the longest tributary of the Yangtze River, the Hanjiang River, all run through this area, with geographical integrity and the consistency of natural-ecological conditions. Many connected small basins and valleys among here are fertile and well climate, with geographical integrity and the consistency of self-ecological conditions [1].

Knowledge mapping is a modern technology theory that integrates many disciplines. It is based on mathematics, informatics, metrology and other knowledge. It shows the relationship between knowledge development process and knowledge structure of a discipline in the form of visual mapping, so that users can grasp the development history, frontier areas and the overall knowledge structure of the discipline quickly and accurately [2].

In recent years, it has become an important research direction for many disciplines to use knowledge mapping to visualize the development of disciplines. However, there are only few applications in the field of architecture, especially in the study of residential buildings in Qinba Mountains. In this paper, we used knowledge mapping as research method to analyze the research hotspots of residential buildings in Qinba Mountains, and based on this, targeted research is carried out. Questionnaire survey and field survey are used to investigate and experience dozens of villages in Qinba Mountains. Data collected from 1600 data collections and building thermal environment tests are taken as research objects, the current situation of building formation is investigated and studied, and the reference is provided for the design of local residential buildings.

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2. Introduction of research methods

2.1. Data sources

In this study, CNKI database was selected as the references source. In this paper, "Qinba", "Southern Shaanxi" and "folk houses" are used as the subjects and keywords to search, and the unrelated documents are removed from the search results. Finally, 222 relevant documents from 2008 to 2018 are obtained for analysis.

2.2. Research methods

Cite Space V [3], developed by Professor Chen Chaomei of Drexcel University, USA, is used as the tool for knowledge mapping. Cite Space has good adaptability to different data sources, can directly identify or support format conversion of document records in at least nine common databases at home and abroad. In addition, Cite Space V provides 11 different types of knowledge maps, including author collaboration maps, keyword co-occurrence maps, co-citation maps, etc. This paper chooses the keyword co-occurrence of knowledge mapping for analysis. Keyword co-occurrence network is generally used to analyze the research hotspots in a certain field over a period of time. Its main indicators are keyword frequency and centrality. The frequency of keywords is the number of keywords appearing in the current period, and the centrality is the important degree to reflect a certain keyword.

3. Relevant theoretical analysis and research

3.1. Construction of mapping

This paper draws a knowledge map about the design of residential buildings in Qinba Mountains by Cite Space V, as shown in Fig. 1. It should be noted that the nodes in the graph represent the keywords in the literature, and the size of the nodes indicates the frequency of the keywords appearing in the literature. The higher the frequency of occurrence, the larger the nodes. The lines in the graph connect the keywords that are found in the literature, when keywords such as "architectural design" and "green cycle" which appear in a document at the same time, and then there will be a line connects the two nodes. The thickness of the line indicates the intensity of the co-occurrence of two keywords, that is, the frequency of the co-occurrence of two keywords in the literature data. In order to highlight the hot keywords, the author sets the threshold parameters of node display. Only the parameters whose frequency is higher than the threshold can display the label in the knowledge map. From Fig. 1, we can see that the keywords with high frequency are residential buildings, traditional villages, and ecological civilization and so on. In order to make the research theme clearer, the author has done further clustering treatment. The research topics in this field focus on architectural design, traditional villages, ecological civilization, human settlements and other directions. Next, this paper will make an in-depth analysis of the information obtained in the knowledge map.



Fig. 1. Clustering Atlas of keywords in residential architecture research papers in Qinba Mountains.

Visible	Count	Centr	Year	Keywords
V	56	0.76	2015	Dwellings
V	33	0.52	2016	Qinba Mountain Area
V	9	0.32	2015	Residential buildings
2	7	0.06	2016	Indoor thermal environment
~	6	0.03	2016	Traditional villages
V	6	0.17	2016	Qinling Mountains
V	5	0.06	2015	Southern Shaanxi
V	5	0.05	2016	Southern Shaanxi
~	4	0.01	2016	Qinba Mountains in Sichuan Province
V	4	0.25	2016	protect
~	4	0.02	2016	Architect
V	4	0.00	2014	Ancient town
~	3	0.07	2016	countryside
V	3	0.13	2016	Architectural design
~	3	0.03	2016	traditional residence
V	3	0.05	2016	ecology
V	3	0.17	2016	The People's Republic of China
V	3	0.36	2018	Ecological Civilization
V	3	0.00	2016	Vernacular Architecture
V	3	0.01	2016	Tourist attraction
V	2	0.00	2018	Architecture in Qinba Mountain Area
V	2	0.05	2016	space
V	2	0.01	2016	land use
V	2	0.02	2016	Artist
V	2	0.00	2018	energy conservation
V	2	0.00	2016	Targeted poverty alleviation
V	2	0.00	2016	Green Cycle Development
V	2	0.00	2017	Architectural style
r	2	0.00	2017	Style of Art
V	2	0.00	2016	Tourist attraction
V	2	0.05	2016	Tourist attraction
~	2	0.00	2016	Tourist attraction

Fig. 2. Hotspots of residential architecture research in Qinba mountains.

3.2. Key issues analysis

The keyword co-occurrence map of the current residential research in Qinba Mountains obtained by Cite Space V can clearly identify the research hotspots in this field. From Fig. 1, we can see that, around the research direction of residential buildings in Qinba Mountains, Chinese scholars mainly focus on the following aspects: First, the study of residential buildings, including architectural design, village protection, and traditional villages and so on. Secondly, another object level of the study of residential buildings in Qinba Mountains includes Qinba Mountains, ecological civilization, human settlement environment, etc. In addition, part of the research also involves specific architectural decoration technology, such as indoor thermal cycle, courtyard, and artistic style and so on. Next, this section will combine the above knowledge map to conduct a more in-depth analysis of the residents of Qinba Mountains. Different experts and scholars have different understandings about the research in this field. Xu Juan [1] and others mainly studied the architectural characteristics, ecological adaptability and settlement layout of Qinba Mountains. Gaoyuan [4] and others carried out research on residential building structure, heat storage capacity, ecological and environmental protection in Qinba Mountains. Zhang Guoqing and others [5] carried out research on seismic capacity, functional layout and physical environment. Zhang Tong [6] and others have done some research on the post-disaster residential buildings in Qinba Mountains, but through the analysis of the knowledge map, we can find the hot issues in the research of the residential buildings in Qinba Mountains, but through the analysis of the knowledge map, we can find the hot issues in the research of the residential buildings in Qinba Mountains, but through the analysis of the knowledge map, we can find the hot issues in the research of the residential buildings in Qinba Mountains, but through the analysis of the knowledge map, we can find the hot issues in

At present, the research on residential buildings in Qinba Mountains ranks first, with 56 related papers, of which the degree of centrality is 0.76; followed by Qinba Mountains, with 33 related papers, of which the degree of centrality is 0.52; ecological civilization, with 9 related papers, of which the degree of centrality is 0.36; followed by protection, with the degree of centrality being 0.25; Qinba Mountains (6 papers, Centrality is 0.17, indoor thermal environment (7, 0.06), traditional villages (6, 0.03), and finally green cycle (5 related papers, of which the centrality is 0.06). Based on this data, we can see that there are many directions for the study of residential buildings in Qinba Mountains. However, at this stage, geographic location, ecological civilization, protection of traditional villages and other aspects of the research heat is relatively high, green cycle involved less; this paper focuses on this research.

Based on the analysis of the literatures in the past ten years from 2008 to 2018, this paper puts forward the problems existing in the geographic and climatic suitability of traditional dwellings in Qinba Mountains, and constructs the principles and strategies for

Table 1

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Keyword	Frequency	Centrality
Dwellings	56	0.76
Qinba Mountain Are	33	0.52
Ecological Civilization	6	0.36
Residential buildings	9	0.32
Protection	4	0.25
Qinba Mountain	6	0.17
Indoor thermal environment	7	0.06
Traditional villages	6	0.03
Green Cycle	5	0.06

the suitability design of dwellings. On the base of covering the hot issues, the contents of the study focus on green cycle through the analysis of the location and form of dwellings, architectural layout and form, architectural structure and technology, etc. Cycle related topics are studied in depth in order to provide practical guidance for local residential construction.

4. Green architectural design strategy of Residential Buildings in Qinba Mountains

4.1. Site selection and form of buildings

Using the ecological concept of architectural technology design, combining with the original architectural culture of residents, and aiming at the current situation of residential buildings, this paper puts forward a reasonable combination design scheme, which can improve the existing residential buildings to the greatest extent by the most economical method, and make them become the original and energy-saving green mountain buildings with diversified architectural forms and morphological adaptability to the geomorphological environment.

Adapting mountain geomorphic environment. When dealing with the elevation difference of terrain, buildings and courtyards need a certain extension space, which can solve the problem of elevation difference caused by terrain. On the one hand, courtyards can be used to adapt to relatively flat land use and change the form of buildings to adapt to the variation of terrain elevation (Fig. 3); on the other hand, buildings can adapt to relatively flat land use and courtyards can be used to connect land with different elevation differences (Fig. 4).

4.2. Architectural layout and form

In Chinese culture, ethics is used to replace religion, which is embodied in the symmetry of the central axis as a clear symbol. The building unit uses rectangular plane, a family with three rooms, and a hall in the middle. It runs through the whole deep, left and right separated bedrooms and kitchens to form a figure layout (Fig. 5); or the kitchen, dining room, bathroom and other ancillary rooms are located on the main side to form L-shaped cloth (Fig. 6) ... According to the population size and economic conditions of each family, bedrooms can also be added on the other side of the main building for children, relatives and friends to live in, forming a U-shaped layout (Fig. 7). The layout of the residential pattern in Qinba Mountains fully reflects the traditional Chinese living concept of orderly growth and childhood, different from the inside and outside. At the same time, this layout form is similar to the traditional quadrangle of one-in-one courtyard with flexible layout and open architecture to the environment, just like the personality of Bashu people, warm and hospitable.

4.3. Architectural form design

There are more mountainous areas and less flat land in Qinba Mountains. The layout of traditional dwellings generally conforms to the trend of the mountain situation, or along the contour line of slope land. The combination form of the dwelling houses is



Fig. 3. The interior of the building is adapted to the terrain elevation difference.



Fig. 4. The courtyard space adapts to terrain elevation difference.



Fig. 5. 1 Graphic Layout (Unit mm).



Fig. 6. L-shaped layout (unit mm).

relatively free, and the layout of the buildings varies in elevation and height along the terrain to minimize the impact of the dwelling courtyards on the natural environment.

Because of the limitation of the site in mountainous countryside, the layout of the front courtyard of the "one" type of traditional dwelling occupies a large number. This form of dwelling is simple and basic in plane, compact in space and occupies less land. Especially in mountainous countryside, it is flexible in organization and easy to construct.

Limited by the topography and landform of Qinba Mountains, the shape and space of native buildings are regular, and the regular plane form is conducive to adapting to the local climate environment. "L-shaped" building is the most common flat form; the east side of the house is longer than the West side. The temperature difference between morning and evening in mountainous areas is large, and the longer east-facing gable in the morning delays the sunshine incident time to prevent discomfort caused by over fast warming



Fig. 7. U-shaped layout (unit mm).

of the courtyard. In the evening, it avoids the Western gable being too long to shield the sunshine and shortens the length of the Western gable to prolong the irradiation time. At the same time, the Eastern building can also reflect sunlight in the courtyard to prevent the courtyard temperature from falling too fast. In summer, the courtyard passes through the courtyard doors and courtyards, building doors and windows form a cross-hall wind, which is cooler; in winter, the north side of the building does not open windows or small high windows to avoid the cold wind entering the room (Fig. 8).

4.4. Architectural structure and technology

Suitable for villagers to farming production-oriented building structure. In order to reflect the regional characteristics of Qinba Mountains in a better way, on the premise of ensuring structural safety, in line with the principle of energy saving and material saving, the wood structure system (Fig. 9) is adopted, and the wooden bamboo bars are applied to the earth wall. Flexible transformation of structural form is similar to bucket-piercing timber frame, which is different from traditional bucket-piercing timber frame. When large space needs to be built, the beam-lifting type is used, while the bucket-piercing type is used when small space needs to be divided. The bucket-piercing structure is lighter in weight, which is beneficial to earthquake resistance and agricultural production.

In the design of residential buildings, the north wall is thermal insulation wall (Fig. 10), which can reduce the heat loss in winter, and can also use the sunshine room to raise the room temperature and maintain the continuous heat. Setting up solar hot water system and solar collector on the roof platform of staircase can effectively improve the indoor thermal environment of residential buildings in winter and reduce the felling of natural forest as heating energy. Simple mountain spring water storage system is designed, and mountain spring water is used as domestic water through simple purification and filtration system, so as to protect the overall water environment resources.

5. Summary

Based on the knowledge map as the research method and the Journals Collected by China HowNet as the literature source, 222 research papers were selected to analyze the keyword co-occurrence network and summarize the hot issues of residential buildings in Qinba Mountains. Found a number of research hotspots, such as residential buildings, Qinba Mountains, ecological civilization, residential buildings, protection, indoor thermal environment, traditional villages and so on. After cluster analysis, 10 of them were selected as the research objects, and focused on the research of green buildings. On the basis of field visits to villages in Qinba Mountains, this paper summarizes the approaches of residential design in Qinba Mountains from four aspects: site selection and form, layout and form, form design, structure and technology, with a view to providing a good reference for residential design in Qinba Mountains.



1—wind; 2—Afternoon sunshine; 3—The afternoon sun; 4—Summer sunshine; 5—Winter sunshine; 6—Summer wind direction; 7—Winter wind direction





Fig. 9. Wood structure system.



Fig. 10. Insulation wall.

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