

Enlightenment from the “Ecological Nature” of Huizhou Ancient Residential Courtyard Landscape

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Abstract:

The courtyard of Huizhou ancient dwellings is a part of the traditional architectural space in Huizhou. Due to the influence of environmental space, the courtyard size is small and narrow, but it has complete functions and reasonable layout. It pays attention to the ecological balance between living space and nature, and shows the cultural concept of “Harmony between nature and man”. Based on the survey and actual measurement of landscape features of the courtyards of Huizhou ancient dwellings, this paper describes the design concept of its simple “ecological nature” from aspects of landscape shape characteristics, spatial layout, airport circulation, water feature design, etc. to provide a reference for modern urban landscape design.

Keywords:

Ecological Nature, Huizhou Ancient Dwelling, Courtyard, Spatial Layout, Water Feature Design

1. Introduction

Huizhou ancient dwellings mainly refer to the residential building groups in Huizhou region in the Ming and Qing Dynasties, and together with the ancestral halls and the archways in Huizhou, they are called the three unique buildings of Huizhou ancient buildings. The site selection for settlement and landscape layout of Huizhou ancient dwellings respects nature and adapt to local conditions. It emphasizes the ecological planning concept of harmonious coexistence between man and nature. “Genealogy of Ren-faction of Hu Family in Mingjing, Xidi Village” during the period of the Emperor Daodao of Qing Dynasty and “Genealogy of Wu Family in Xixinan, Shexian County” during Ming Dynasty recorded the reason for selecting Huizhou region and settling there [1]. In recent years, with the continuous advancement of urbanization, more and more people have begun to consider the harmonious development of living spaces and nature, society and economy, and also pay attention to the ecological sustainability of living space. The sustainable ecological strategy presented by the time-honored Huizhou ancient dwellings provides a reference for the ecological design of modern living spaces.

2. Landscape Characteristics of Courtyard of Ancient Dwelling in Huizhou Region

Huizhou region is abundant of mountainous areas and hills with less land and narrow landform, which are not conducive to construction. The Huizhou ancestors guide site selection for settlement to create residential houses with Fengshui theory according to the local conditions and using the geographical environment of “height and orientation difference makes different weather in valleys” [2]. Huizhou ancient dwellings present a square enclosed space individually. The front part of the space form is the “skylight” and the rear part is the main house [3]. “Skylight” is a characteristic of Huizhou ancient dwellings, and the form is a narrow small open space enclosed by the main house and walls with concurrent functions of lighting, ventilation and water drainage. As an important part of Huizhou ancient dwellings, the courtyard is affected by the settlement location and architectural system, and its volume is relatively small. It consists of a vestibule, a backyard, a side yard and a skylight hall (as shown in Figure 1). The courtyard form is self-contained and interrelated. The spatial form is mainly axisymmetrical structure and form of free combination.

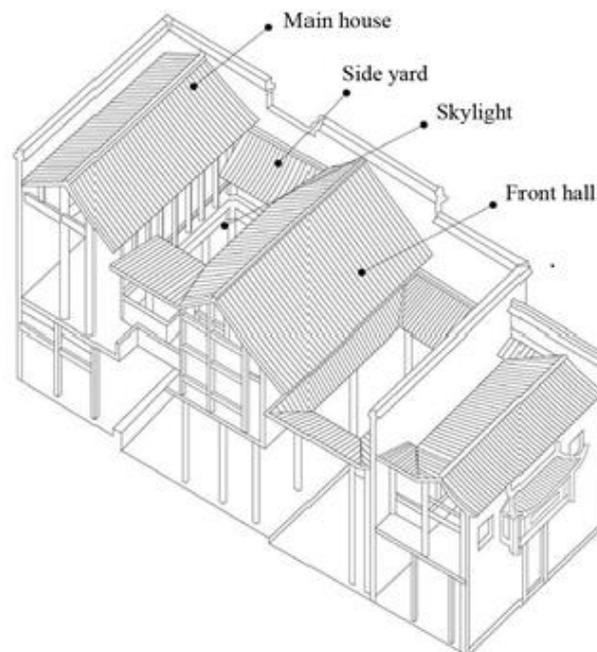


Figure 1. Schematic diagram of the axisymmetric structure of Huizhou ancient dwellings.

Illustration source: drawn by the author himself.

The courtyard of axisymmetrical structure is symmetrically arranged to the central axis of the dwelling, and is mainly represented by the skylight type courtyard. It is rectangular in floor plan and its length is twice its width. The climate in ancient Huizhou region is warm and humid, and the use of mountainous land is difficult, resulting in the courtyard being elongated in the direction of vertical height and the space surrounded by the four eaves forming a direction clear, spatially smooth and orderly skylight. Along the central axis in the courtyard, the shallow pool or platform is arranged around the ditch for water supply and drainage. The central area is paved with slates, and the appropriate area is decorated with stone flowers, trees and bonsai

and fish ponds. Creating a compact, simple, rigorous and regular landscape in the limited space, presenting a clear, delicate and elegant courtyard effect.

The courtyards in the form of free combination often appear in spaces limited by terrain. The shape of the courtyard is triangular, rectangular, a polygonal, etc. Due to the constraints of the foundation conditions, they mostly deviate from the axis of the building and are located at the corners of the outer corridor or both sides of the door. The compositional technique is free, flexible, light and full of spatial changes, reflecting the “simple way” of courtyard architecture. Courtyard elements such as rocks, water body and green plants can be freely combined into different forms of space. And displays moderate, appropriate and elegant aesthetic charm in the selection and matching of topographical locations and plants. It embodies the natural concept of “harmony between nature and man” [4].

Compared with the courtyards in north regions, the courtyard of Huizhou ancient dwelling is small in size but has complete functions. The unique courtyard of residential dwelling with high-wall deep rectangular or triangular courtyard as the unit models itself on nature with its periphery closed and its interior open. It is not only connected to the external environment but also independent. It undertakes the ecological function of integration of artificial environment and natural environment.

3. “Ecological Nature” Embodiment of Courtyard Landscapes of Huizhou Ancient Dwellings

The “ecological nature” of the courtyards of Huizhou ancient dwellings is mainly reflected in their spatial layout and water feature design and treatment. Under the constraints of the narrow space environment, the ancient people choose a land to settle, live in proximity to water, ingeniously transform the natural environment while adapting themselves to the environment, rationally divert the river, water ditch and pond to pursue a livable living space in a courtyard with limited space. The arrangement of the spatial form and benefits from water reflect the Fengshui cultural viewpoint of Huizhou people. This viewpoint of ecological culture covers the settlement spaces of ancient Huizhou dwellings.

3.1. Spatial Layout

The courtyards of ancient dwelling in Huizhou region are small in size and focus on practicality. They are combined in different forms in a limited space to meet the aesthetic, labor and communication needs of residents.

Functionality: courtyard space of Huizhou ancient dwelling is arranged with various functional areas to meet the functional needs of rest, traffic, communication, drying in the air, etc. The space is divided by different paving forms with clear orientations. More intimate spaces are separated by walls or corridors for private contact or rest; and open spaces are by green plants or water bodies for the needs of easy communication, traffic and drying in the air. For example, the Xiyuan Garden in Xidi, Yixian County, Huangshan City, which is of a rectangular structure, is divided into front, middle and back courtyards. The space of the front yard is divided by the rockeries and ponds to form a guiding passage; the central yard is equipped with a pool and stone benches along the wall, where the space is wide and is the main area for residents to communicate and dry in the air. The back yard has a kitchen and an ancient well, and is decorated with bonsais that are carefully taken care of and collected by the owner of the household. It is the main activity place for the family.

The entire courtyard is located between “bounded and unbounded, separated and unseparated”, with layers connected mutually, making the entire narrow long courtyard look deep and quiet [5]. (As shown in Figure 2)

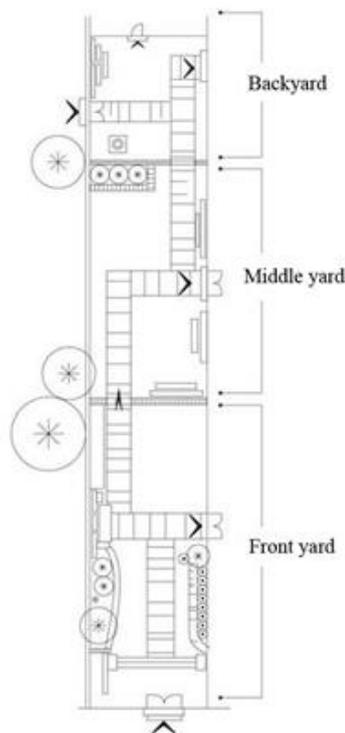


Figure 2. Schematic diagram of the space in Xiyuan Garden, Xidi ancient village, Yixian County.

Illustration source: drawn by the author himself.

Fitness: from a bird’s eye view of the Huizhou courtyards, the plane shape is mainly the axisymmetric type and free corner type. The axisymmetrical structure is rigorously shaped and arranged symmetrically along the axis. For example, for a courtyard with a “skylight”, rectangular shallow pools or platforms are arranged along the central axis, and are appropriately dotted with rockeries, pools, green plants, etc., to create simple, precise, delicate and layered landscape effect in a relatively limited space. The free corner type landscape form is often located in the gap section between the houses in front of the courtyard. The landscape forms are mostly irregular shapes, the materials are obtained locally and matched with green plants and dotted with bonsais. In terms of waterscape, due to the fluidity of water body, water body not only cultivates the ornamental fish, but also is used for vegetable washing and irrigation, so it integrates aesthetics and practicality. In addition, the courtyard landscape artfully uses the latticed windows to present the changing landscape effect of “taking the scenery outside the garden” and “conveying felling through the scenery”, for example, the design of fish pond hall of Chengzhi Hall in Yixian County. Although the owners of courtyards of Huizhou ancient dwellings are rich, they do not over-fell the forest, but follow the principle of moderate construction, make full use of the surrounding environment to form a suitable scale, and the landscape form of creating big space in small space is worth learning.

3.2. Air Inlet Circulation

In Huizhou region, the sunshine in summer is strong, and the courtyards of the dwellings are surrounded by high walls. Most of them are east-west long spaces, their transverse dimension is relatively large, which blocks the direct sunlight to a large extent, thus reducing the temperature of the courtyard with a skylight covered by the eaves. The low temperature of the space at the bottom of the skylight forms a temperature difference with the high temperature of the space at the top of the skylight. This temperature difference causes the air in the two spaces to alternate with each other to form vortexes, the so-called “chimney effect.” The densely populated dwellings with a courtyard are connected by multiple courtyards, that is, from courtyard to the building and then to the courtyard, the buildings and courtyards are connected in series or in parallel along the axis. When the doors and windows that connect the courtyard, the courtyard and the interior of the building form a coherent whole. The air introduced by the “chimney effect” of multiple courtyards forms a continuous airflow effect with good ventilation and cooling effect. At the same time, the green plants and fish ponds built in the courtyard are not only for aesthetic needs or a natural life, but also play a role of improving air quality. The planted green plants, soil and water constitute a circular ecosystem to provide fresh air to increase the oxygen content, and meet the requirements of different space temperature regulation in combination with the air channel transport mode formed by the high windows, forming a good environment which is warm in winter and cool in summer.

If we liken the courtyard space to the respiratory system of the building, then the invisible air flow is like a blood vessel, closely connecting the courtyard with the corners of the building, etc. The ancient dwellings in Huizhou are still full of vitality and vigor, the air in the indoor space is constantly refreshed, flowing like blood. Without relying on the intervention of technology, the cold and warm air change relies on its own circulation system. Flowing water and green plants increase purification function of the air. This provides a reference for the internal respiratory system of modern buildings to achieve the function of circulation through information technology and equipment technology.

3.3. Water Feature Design

The Confucian scholar Zhu Xi of The Southern Song Dynasty lived in the villages of Huizhou region for a long time. He once sang a poem: “Half mu of the pond is opened like a mirror, and the light of sky and the clouds are wandering together; asked why the pond water is so clear, because there is running water from the source.” This poem can be used as a true portrayal of water feature treatment project and environmental treatment of Huizhou dwellings. Take the Moon Pond in Hongcun village of Huizhou region as an example, Hongcun was built in the Southern Song Dynasty, due to the torrential flow of water, the Moon Pond was excavated in Ming Dynasty for water storage, and then the South Lake was excavated later, forming an encircling shape, they are connected through the ditches between fields to dredge the source and regulate the running flow of water to benefit the descendants. The shape of the Moon Pond is like a half moon, and the dwellings gathered by the pond to form a settlement landscape centered about the pond. It is also a public space for washing water of the residents.

The courtyards and ponds of Huizhou ancient dwellings are different from the paradigm of “one pool and three mounts” of gardens on the southern bank of the Yangtze River. For example, the Deyi Hall and Shuren Hall in Hongcun are in the form of folk pond of “half-mu square pond” in different sizes. The gardens on the

southern bank of the Yangtze River focus on interest and charm, aesthetic appreciation and sight enjoyment, whereas the Huizhou folk ponds focus on both sight enjoyment and practicality. The courtyards of Huizhou ancient dwellings retain the dual attributes of the literati and hermits and the folk courtyards in mountainous area, creating a beautiful environment connecting the inside and outside of the building through water feature treatment. It can also avoid the occurrence of waterlogging during the rainy season. In the water feature treatment of courtyards of ancient dwellings in Huizhou region, it is mainly divided into “water introduction” and “water storage”.

The fish pond hall of Chengzhi Hall located in Hongcun Village, Yixian County, Huizhou region introduces water in the upper reaches of the Hongcun water system into the courtyard through the ditches between fields, making the water body flow faster through the height difference between the water inlet and outlet, it ensures the flowing and refreshing of water body in residential courtyard by artfully utilizing the terrain. In addition, the water body in the pond of the Fish Pond Hall also reflects the “ecological” features, it is respectively provided with water inlet and water outlet, there is separation in the middle of the water body, and the heights of the two parts of the separated pond are different. The pond connected to the water inlet is slightly higher, and the pond connected to the water outlet is slightly lower to form a natural water flow effect. The pond with higher water level is connected to the upstream of ditch between fields and is used for daily use and cleaning of fruits and vegetables; the pond connected to the water outlet is about two-thirds of the area, used for cultivating aquatic plants and koi carps, the water flow is slow and can play a role of sedimentation and purification and reduce pollution of the circulating water body system.

In the courtyard of Huizhou ancient dwelling, the “skylight” is the hall lighting center, it is a deep courtyard with high walls, the rainwater is collected into the skylight through the roof slopes, Huizhou people commonly call it “water in four direction returns to the hall.” The bottom of the skylight is usually paved with blue flagstone slabs. The space under the skylight is called “Mingtang”. “Mingtang” is usually slightly lower than the hall. The Mingtang is surrounded by open masonry channels. The rainwater flows into the Mingtang and then flows into the open channels, and then into the gutter through dredging by the open channels. The water body in the courtyard is connected with the ditches between fields, the pond and the fields outside the dwelling, metaphorically meaning “fertilizer does not flow to outsider’s field”. (As shown in Figure 3)

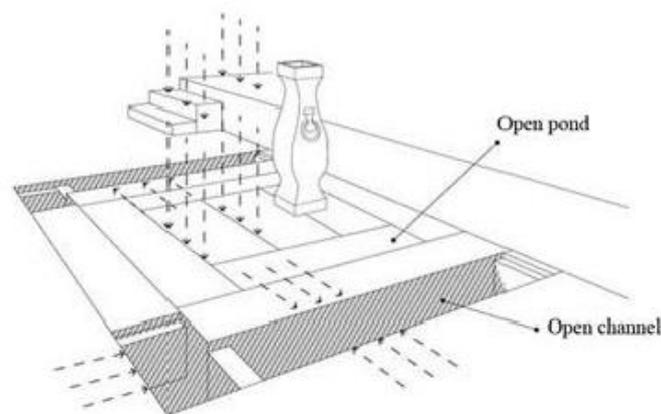


Figure 3. Schematic diagram of “Mingtang” water diversion.

Illustration source: drawn by the author himself.

The pavement of courtyard floor emphasizes water permeability. The commonly used paving materials are blue bricks, pebbles, blue flagstone slabs, broken tiles, etc. These materials have large pores when they are assembled, which is conducive to the natural penetration of water and avoids water accumulation on road area. Meanwhile, it can infiltrate the rainwater into the ground, reducing the single discharge burden of the ditches. In addition, there are drains provided at intervals to avoid excessive water accumulation during the rainstorm season. The drainage system of the courtyard of Huizhou ancient dwelling emphasizes fast-slow combination, which coincides with the “sponge city” drainage planning advocated by today’s cities.

4. The Enlightenment of “Ecological Nature” of Garden Landscape of Huizhou Ancient Dwelling to Modern Design

The gardening method in ancient Huizhou region follows the concept of adapting to local conditions, rational planning and configuration, and harmony with nature. Its ecosystem can not only effectively regulate climate change, but also has a stable circulation system. It provides references and examples for the design of living space environment in modern cities.

Many designers have insufficient understanding of the “ecological nature” in landscape design, and simply understand it as adding green plants to increase the greening rate. The design of modern landscape space should integrate traditional garden landscape design theory with modern design concept, and take protection of ecological balance and conservation of biodiversity as the benchmark to make modern garden landscape design more modern and scientific.

4.1. Suiting to Local Conditions

The courtyard of Huizhou ancient dwellings is small and narrow. On the basis of practicality, they design the limited space to meet different functional needs and introduce water into the courtyard according to local conditions. The space orientation is clear, and the planning of functional areas is reasonably. Modern garden landscape design should fully understand the distribution of resources, assess the environment, and plan various landscape ecological points to scientifically simulate the ecosystem. The designers should make full use of natural conditions in landscape design, reduce dependence on resources, use natural environmental resources, follow the principle of sustainability, and recycle resources. In addition, designers should coordinate landscape design with the surrounding environment to maintain the naturalness of the landscape, avoid excessive artifacts in order to achieve unity and harmony with nature.

4.2. Building Sponge Cities

Sponge city is a new concept to improve urban stormwater management. It has realistic and positive significance for alleviating the problems of waterlogging, water body pollution and waste of water resources in the construction process of modern cities. The water feature treatment of Huizhou ancient dwellings coincides with the concept of sponge city advocated today.

In the construction of modern urban landscapes, the ground water permeability is poor in the ground treatment in the land development process, the surface runoff area increases when rainstorm comes, when the drainage holes are congested, severe waterlogging will be formed. Moreover, rainwater can only be discharged into the

water body through the sewage pipelines, resulting in the loss of rainwater resources and a certain degree of pollution to the urban water body resources. In dealing with the ecological problems of urban water feature treatment, we can learn from the water feature treatment methods of Huizhou ancient dwellings.

In the “ecological” design and planning of urban landscapes, the problem of rainwater infiltration can be diverted through permeable pavement, sunken green spaces, ecological tree grates, etc. These measures can absorb and filter some pollutants through artificial ground infiltration design, they are the important methods for purification at initial period of rainwater. At the same time, biological padding is used instead of soil to fill the ground surface to build an artificial soil environment and improve soil permeability and air permeability. However, this artificial soil infiltration method is applicable to buildings, residential quarters and urban green spaces with a certain amount of space. In the subsequent maintenance and management, attention should be paid to the planting of trees and lawns. When the soil infiltration capacity is insufficient, the drainage layer should be replaced in time. When the drainage pipelines are blocked, they should be dredged or replaced in time. Second, we should store rainwater by resource-based way and design various rainwater storage modes, such as rainwater gardens, wetlands, and reservoirs that are widely used in residential areas and public buildings. We should determine the water storage scale and water storage capacity according to different annual runoff control rates. The rainwater stored in this way can be used for living, fire prevention, landscape, irrigation, etc. after pollutants are removed by the preliminary purification facilities, which not only greatly reduces the use of urban tap water, but also saves effective water resources.

In the process of establishing rainwater centralized storage and utilization mechanism, we should respect the natural ecosystem itself, develop and conserve the original wetlands, design rainwater gardens, recycle sewage resources, store and evaporate excess water, regulate air humidity and temperature in order to create a more comfortable living environment. Maintain good ecosystem continuity. Through learning the “ecological nature” of the courtyard design of Huizhou ancient dwellings, we should advocate the environment construction with ecological functions, the harmony and co-existence between city and nature, and the intensive and efficient, beautiful and livable ecological space planning.

5. Conclusion

As the basic component of Huizhou ancient dwellings and architectural community layout, the survival and development of the courtyards is rooted in the ecological view of traditional philosophy. The lands for ancient Huizhou dwellings are small and narrow, but the ancestors use the narrow gaps according to the natural terrain to carefully lay out them by making full use of the surrounding environment to create the landscape form of appropriate size, which integrates functions with aesthetics and get the big picture from small details. It reflects the ecological concept of “harmony between nature and man” of Huizhou ancestors. Although the courtyard of Huizhou ancient dwelling has a small area, it unifies integration of functions and aesthetics.

“Ecological nature” has become an indispensable part of modern design. The “people-oriented” pursued in modern design creates a comfortable living environment, and achieves the same goal with the ancestors’ concept of harmony between nature

and man. Whereas modern landscape design tends to separate people from nature, purely create landscaping, but ignore the unity of man and nature.

Through learning the concept of garden construction of Huizhou ancestors, we should avoid cumbersome and blind landscape planning and construction, learn to respect nature, respect the constraints of the geographical environment, tap the essence of the ecological design of courtyards of Huizhou ancient dwellings to create living spaces where people lives harmoniously with nature.

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Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this article.

References

- [1] Shen Jiayu; Shao Xiaofeng. The beauty of mutual promotion between truth and fiction in the Huizhou ancient dwellings. *Popular Culture & Arts*, 2018, 22, 59-60.
- [2] Gao Li; Wang Yuxia. Analysis of landscape design methods under the concept of conservation. *Shanxi Architecture*, 2018, 15, 203-205.
- [3] Temporal and spatial distribution of Huizhou traditional villages and its influencing factors. *Geographic science*, 2018, 10, 1690-1698.
- [4] Zhao Yonghua; Liu Lunbo. Discussion on ecological nature of landscape design. *Residence*, 2018, 9, 144.
- [5] Zhang Dan. Discussion on the integration of ecology and art in landscape design. *Art Education Research*, 2018, 5, 84.
- [6] Rong Xia. Spatial comparison between courtyards of Suzhou dwellings and skylights of Huizhou dwellings. *Idea and Design*, 2017, 5, 59-63.
- [7] Li Lingyu. Huizhou dwellings in the historical and cultural perspective. *Journal of Panzhihua University*, 2017, 1, 68-73.
- [8] Li Meng. Analysis of ecology in landscape garden design. *Scientific Chinese*, 2017, 03, 142.
- [9] Zhou Zhenping. Discussion on the application of garden design art in landscape planning. *Technology and Market*, 2017, 06, 340-342.
- [10] Yan Xinyi; Li Qi. The blending and application of Chinese traditional design and modern design in courtyard design. *Art and Design (Theory)*, 2017, 12, 53-54.

- [11] Sun Huasheng. Analysis of Huizhou courtyard — Taking the ancient dwellings of Yixian County as an example. *Anhui Architecture*, 2017, 4(2), 41-42.
- [12] Xie Xinxing. Urban ecological landscape and ecological landscape design. *Building Materials & Construction & Decoration*, 2016, 15, 68.
- [13] Qi Wanyuan; Lu Feng. The spatial form and ecological significance of Huizhou ancient residential courtyard. *Design Art*, 2016, 6(3), 15-18.
- [14] Kang Jingyao, Zhang Jinhe, Hu Huan, Zhou Wei, Xiong Jie. Analysis of spatial distribution characteristics of traditional Chinese villages. *Advance in Geographical Science*, 2016, 07, 839-850.
- [15] Hu Zui, Liu Peilin. The characteristics of the genome map of Chinese traditional settlement landscape. *Acta Geographica Sinica*, 2015, 10, 1592-1605.
- [16] Wang Hanqiu. Analysis of the courtyards and flower halls of Huizhou traditional dwelling. *Journal of Anhui Jianzhu University*, 2015, 2, 101-104.
- [17] Chen Yuema, Xiao Ya. Research on the thought and protection of “harmony between nature and man” in Huizhou ancient dwellings. *Art Science and Technology*, 2014, 7, 1-2.
- [18] Xiong Mei. Spatial distribution of Chinese traditional villages and its influencing factors. *Journal of Beijing Institute of Technology (Social Science Edition)*, 2014, 05, 153-158.
- [19] Liu Dajun; Hu Jing; Chen Junzi; Xu Xianyu. Research on spatial distribution pattern of traditional Chinese villages. *China Population Resources and Environment*, 2014(04).
- [20] Wang Xiaobin; Shi Qingchan. Cultural Analysis of the Residential Spaces of Regional Traditional Settlements — Taking the Residential Buildings in Huizhou Region in Southern Anhui as an Example. *Huazhong Architecture*, 2013, 12, 165-171.
- [21] Li Donghe; Meng Ying. Study on the protection and tourism utilization mode of ancient dwellings — Taking the Huizhou ancient dwellings in Huangshan City as an example. *Human Geography*, 2012, 02, 151-155.
- [22] Jiang Daoxia. Analysis of Cultural Psychology Formed by the Huizhou Dwellings in the Ming and Qing Dynasties. *Economic and Social Development*, 2010, 11, 114-116.
- [23] Wu Yongfa, Xu Zhen. Discussion on the humanistic spirit of Huizhou dwellings. *Chinese Famous Cities*, 2010, 07, 28-34.
- [24] Wu Zhennan; Feng Siqing. A preliminary study on the protection and continuation of the atypical traditional villages in Huizhou region. *Engineering and Construction*, 2010, 1, 28-33.
- [25] Huang Chenglin. Preliminary study on Huizhou cultural landscape. *Geographic Research*, 2000, 9(3), 257-258.
- [26] Xiang Xin. Ecological analysis of Suzhou classical garden construction techniques. Xi'an University of Architecture and Technology. 2018.

- [27]Zhang Lanyuan. Research on the synergy between decoration and space of Huizhou traditional residential buildings. *Journal of Anhui Jianzhu University*, 2017.
- [28]Pei Heming. Research on the remains and characteristics of Huizhou modern buildings. *Journal of Anhui Jianzhu University*, 2017.
- [29]Che Xiaomin. Study on the updating of internal spatial forms of Huizhou traditional residential buildings. Xi'an University of Architecture and Technology, 2015.
- [30]Zhao Zhi. Study on the characteristics of gardens in the courtyards in Southern Anhui Province — Taking Hu Zongxian's Historical Home in Longchuan Village as an example. Anhui Agricultural University, 2014.
- [31]Illustration of the characteristics of Huizhou traditional buildings. China Architecture and Building Press. Zhou Yanwei, 2015.
- [32]The evolution of the spatial structure of traditional villages in Huizhou Region, China. China Architecture and Building Press. NI Qi. 2014.



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