

## Article

# Space as Sociocultural Construct: Reinterpreting the Traditional Residences in Jinqu Basin, China from the Perspective of Space Syntax

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**Abstract:** The traditional residence with protogenetic spatial arrangement is regarded as a critical carrier of social logic of space, which makes it an ideal object for studying the relationship between the spatial form and social context. To this end, a comparative analysis is conducted using Depthmap Software. This study is based on space syntax theory between two groups of proxies of sharp differences in spatial organization in one geomorphic unit where the natural factors show little variations, while the human factors present a bifurcating distribution. Furthermore, the study clarifies the differences among genotypes of the domestic space system. Finally, combined with historical material, it proves the dual division of regional sociocultural factors as decisive forces shaping the traditional living space and its constructed manifestations.

**Keywords:** traditional residence; spatial form; space syntax; genotype; sociocultural factor



**Citation:** Chen, Y.; Xu, K.; Liu, P.; Jiang, R.; Qiu, J.; Ding, K.; Fukuda, H. Space as Sociocultural Construct: Reinterpreting the Traditional Residences in Jinqu Basin, China from the Perspective of Space Syntax. *Sustainability* **2021**, *13*, 9004. <https://doi.org/10.3390/su13169004>

Academic Editor: Guy M Robinson

Received: 28 May 2021

Accepted: 6 August 2021

Published: 12 August 2021

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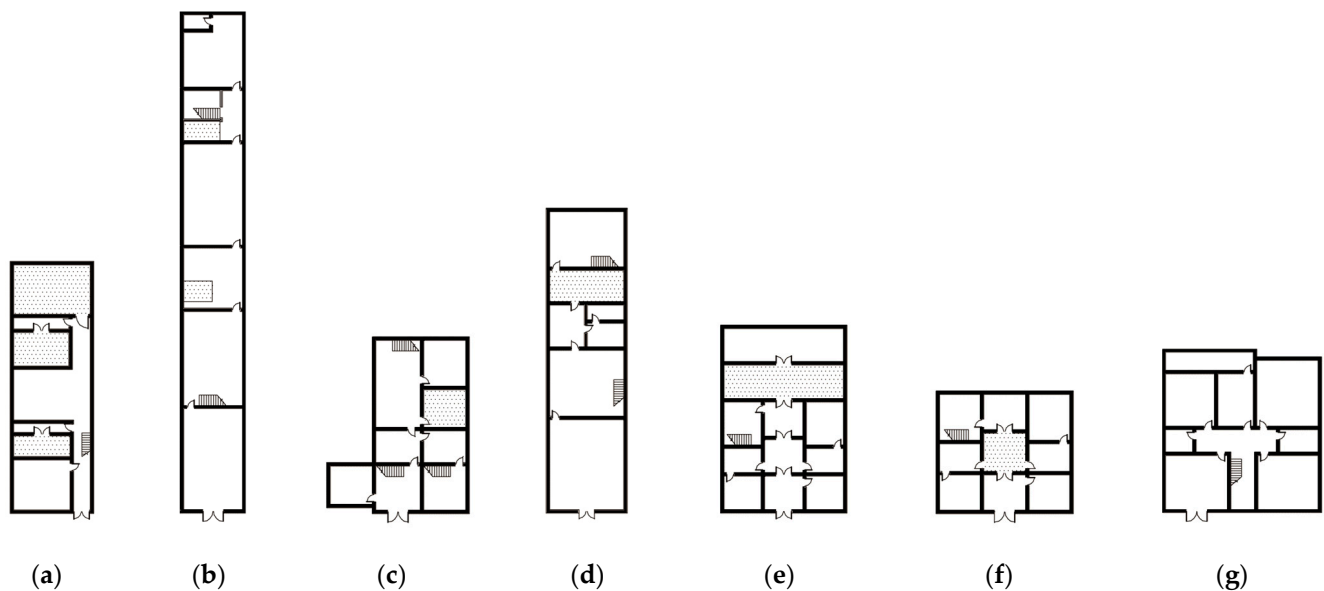
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## 1. Introduction

To embrace industrialization and modernization, China has been undergoing a thorough reform in rural construction for over a century. Since the regime stabilized in 1949, rural construction framework and methods have gradually narrowed down from governance mechanisms and economy transformations to the remolding of living environment. This process can be divided into four stages as presented in Table 1: Collectivization period (1949–1978); Household Contract System period (1978–2005); New Rural Construction period (2005–2013), and the period under the background of new urbanization (from 2013 to now) [1] (p. 123). Figure 1 shows 7 typical ground floor plans of residences across different periods surveyed in Luzhangwan village in the north of Zhejiang Province with the most developed rural areas in China. A comparison between this series of plans shows an apparent continuity in spatial pattern, which is centered by an ambiguous space or courtyards (the dotted parts) and sustained regardless of building materials, structure and appearance. However, an abrupt mutation occurred in the latest proxy built in 2013 in a relocated collective settlement—the inner courtyard disappeared, which changed the orientation and sequence of the other spaces. This is not an individual case. In the fourth period, local governments almost assumed control of the execution of rural construction behaviors, supported by external design forces selected through bidding. Thus far, the users have completely lost control of their living spaces, with homes degenerating to houses that scarcely echo habitants' patterns of movement, which arise from people ordinarily conducting their routine activities.

**Table 1.** The four stages of rural construction after 1949 and their characteristics [1] (p. 200).

Stage	Subject	Object	Changes in Living Environment
1949–1978	Commune cadres	Commune	the influence is little, basically lies in ideology
1978–2005	Peasant household; Village collective organization	Individual dwelling; Infrastructure	The village expanded, the rural spatial mechanism and overall style have been changed to certain extent
2005–2013	Peasant household; Local Government	Relocated collective settlement; Municipal public service facility; Renovation of dilapidated buildings	Original village disappeared, new settlement adopted and copied urban style, development unbalanced
2013–	Local Government	Relocated collective settlement; Municipal public service facility; Village landscape; Commercial project	Original village disappeared, rural aesthetics is reviving, rural value is being recognized and reevaluated



**Figure 1.** Typical ground floor plans of residences in different periods surveyed in Luzhangwan village. (a) is the ground floor plan of a house built before 1949; (b) is the ground floor plan of a house built in the 1970s; (c,d) are the ground floor plans of two houses built in the 1980s; (e,f) are the ground floor plans of two houses built in the 2000s; (g) is the ground floor plan of a house built in 2013.

Nevertheless, as early as 2003—the transition from the third to the fourth period—the CPC Central Committee formally presented and enforced sustainable development strategy in rural construction. However, to date, cultural and social welfare, which has been repeatedly acknowledged as one of the three fundamental dimensions of sustainable housing, was subjected to technicians' personal work ethics. Contrarily, requirements of ecological and economic sustainability have been standardized by an entire set of national and local standards issued in the ensuing decade.

If the administration and technicians are not to blame, the problem may lie in the issue itself. Indeed, the social logic of space is poorly understood, despite being pervasive in everyday experiences [2]. An empirical summary about surface properties and styles cannot be expected to succeed as a social discourse without a rational analysis because a summary does not concern the fundamental sociology of buildings. This theoretical gap has obsessed scholars in different fields for over 30 years, and several breakthroughs have been made. This study aims to supplement the academic culmination by researching the lawfulness of spaces created for human social purposes through examples in east China.

The motivation for this paper was generated from an optimistic view: we believe rural areas in China will retain the vernacular characteristics of local society, at least in the coming decades, as the rural registered residence population in this country is more than 800 million, accounting for 55% of the total population, according to the latest census. Different from urban residents, rural residents are entitled to establish their homes in the allotted homestead based on the household unit, implying that regardless of the way they earn their living, their identities, social welfare, offspring's education and so on, are tied up with their native land. Therefore, the sociocultural pattern, including values, beliefs, conventions and shared interests of lineage society, will preserve and exert its influence on spatial behaviors.

By uncovering the closeness, delicacy and complexity in the relationship between traditional residential space and social circumstances, this study aims to lay the groundwork for developing an externalization methodology for transforming tacit knowledge into explicit design knowledge that aids the designers and planners in the production of sociocultural supportive environments.

Placing the study within the sustainability discourse, the overarching approach to sustainability within the architectural discipline should be viewed within the parameters of a complex system and should be more inclusive of non-technological viewpoints. Sustainability is a cultural and social issue requiring approaches from both science and society [3]. In the 2030 Agenda's 17 Sustainable Development Goals (SDGs) proposed by United Nations and adopted by all member States in 2015, SDG11 was specifically established for inclusive, safe, resilient and sustainable cities and human settlements and its targets emphasizes the cultural heritage safeguard and positive social links between urban, peri-urban and rural areas [4]. Thus, the premise of the study is coherent with the core elements of Sustainable Development.

## 2. Literature Review

In the 1920s, Liang and Liu—who are the earliest overseas students with architectural backgrounds—initiated the research of Chinese traditional architecture based on Western theories. Through 10 years' arduous field survey and mapping, the publication of *A History of Chinese Architecture* in 1937 [5] marked the successful embedment of Chinese elements into the international academic framework. For attaining systematic soundness—as an indispensable part of the architecture—large-scale field investigations and mapping work have been conducted, comprehensively covering various residential buildings throughout the country.

However, in the 1980s, research on traditional residence was dominated by the processual paradigm with archaeological surveying, which was challenged by international "cultural turn" trend. Even though archaeology concerns itself with the excavation and interpretation of diverse domestic structures, the interpretation has been confined to descriptions with little explanations [6] (p. 2). The concerns were universal, and the most far-reaching publication can be traced back to *House Form and Culture* written by Rapoport in 1969, detailing the examination of social and cultural meanings of domestic use of space as revealed through local architecture. Afterwards, several books shared the fundamental principle that culture is an essential factor in understanding the local built environment, which addressed various themes concerning vernacular architecture worldwide (e.g., Bourdier and Alsayyad 1989; Duncan 1982; Glassie 1975; Oliver 1969, 1987; Seainon and Mugerauer 1985; Turan 1990). In the realm about China, Yu proposed that residential architecture is a prototype of the composition and image expression of various buildings, and he held the view that all kinds of local buildings shared an obvious isomorphism—a hall is the entity of the cultural core image, and a courtyard is the virtual body of space core [7]. Xie stated that despite the changes caused by advancements in economy, technology and materials, the internal layout and etiquette taboos continue to be potentially inherited, and the deep psychological mechanism shared by the villagers shows the strong conservatism and stability in China [8]. In 1991, Prof. Knapp published the *Chinese house: craft, symbol*

*and the folk tradition*, in which he elaborates the philosophy behind the location, structure, and surface decoration of Chinese dwellings and further discussed the belief and norms shaping the architectural space and the relationship between each part [9].

The importance of interpreting the architecture, especially the vernacular residences, in a sociocultural contextual framework was reinforced by the global demand for Sustainable Development proposed in the 1980s. The overlapping of the core values of sustainability and “culture turn” movement agreed on human habitation embedded in a system of interlocked spaces (physical, temporal, social and conceptual) [10]. In the last two decades, supported by the theoretical progress of sustainable development and computational analysis methodology, extensive research works exploring the potential interface between traditional vernacular and contemporary construction processes have been carried out in the area, faced with a rapid renewal of the built environment due to climatic, economic or political reasons. Kellett argued that contemporary construction can be regarded as a continuation of existing vernacular traditions by analytical frameworks, which address the broad spectrum of non-professionally produced environments and their relevance, demonstrated using data from a longitudinal ethnographic study of informal settlements in Latin America [11]. Elwerfalli revealed how the courtyard housing typology has been adapted and modified to address the current housing market and occupants’ lifestyles by analyzing the three new projects in Libya. The findings of the study demonstrated how vernacular logics of design are being appropriated to strengthen the cultural aspects of sustainable housing designs [12]. By exploring the traditional architecture and their cultural meanings in Najdi—the central region of Saudi Arabia—Alnaim argues that the core concepts and forms are not necessarily meant to describe or specify a form appearance, as the form can be a manifestation developed over time from different related components and constraints within the built form [13]. Miller investigated the dialectic relationship between Marshallese culture and the built-environment and uncovered the continuity of deep cultural patterns (DCP) in the production of the Marshallese built-environment. In addition, this study expanded DCPs by representing indigenous knowledge and should be applied to design frameworks for climate-forced displacement and resettlement to produce culturally supportive built-environments demonstrating resilience [3]. Zhao situated the scholarship between place, home and tradition and offered an understanding of the stability of tradition in the physical, psychological and social construction of home in rural China, in addition to providing guidance for the local practice of a new socialist countryside [14]. By thoroughly exploring the spatial design of villages in Jiangnan, Liu established a pedigree to support sustainable development, which integrated the dynamic (cultural changes over a certain period of time) and static (spatial features at a fixed time) of spaces with artistic features exhibited in traditional Chinese villages [15].

Notably, along with the empirical studies, another group of scholars continued to work on methodological approaches to explore spatial patterns to understand the underlying organizational principles. Steadman [16] and Hillier and Hanson [2] introduced the analyses of domestic space configuration through architectural morphology. This approach, later known as the space syntax, used spatial layout as an architectural variable to reveal social and behavioral patterns; it has since become a widely applied tool in various research disciplines and design applications. Aided by this method, Thungsakul accomplished a comprehensive analysis of spatial configuration to understand continuity and change in vernacular living spaces in the upper northeast Thailand [17]. However, with evolving theories and relevant software systems, most research continue to focus on the individual architecture examples.

To summarize, many scholars and researchers have argued that there is a close connection between the sociocultural context and physical form. Their approaches and interests may vary, but they are united in their beliefs in the vitality of vernacular traditions and its corresponding core forms and agree that its continuity acts as a dynamic mechanism in creating sustainable spatial and physical forms, in which people can express their identity. Nevertheless, further research is needed for establishing a universally compatible

framework to elaborate and interpret how sociocultural factors are related to the pattern of spaces or spatial configuration.

### 3. Cases and Methods

#### 3.1. Cases

This paper focuses on the traditional dwellings in the Jinqu Basin in Zhejiang, China, to explore the influence of the regional human factors on the architectural spatial form. In this study, 31 traditional residential buildings in 19 villages scattered across the area were selected and analyzed using Depthmap. Analysis objects were limited to the ground floor due to two reasons: first, most samples are of one and a half stories high, and the upper floor is only used for storage; second, in some cases, the coffins prepared for the elderly are placed on the space above the living room, which prohibited the survey.

Jinqu basin is a flat strip-like area of close latitude with similar climatic and topographical characteristics [18]. However, its humanistic elements showed a significant bifurcating distribution until the 19th century—in the Song Dynasty—a crucial period in the transition of social morphology of China [19]—two major schools of Confucianism, represented by Chen Liang and Zhu Xi, were quite active in the east and west of the Jinqu Basin [8,20]. The confrontation between the factions led to the corresponding socio-cultural differentiation [21] (pp. 156–161).

Interestingly, despite having a continuous and constant geographical structure (as shown in Figure 2), the region's traditional buildings, mainly housings, are divided into two completely different categories, according to the study on the typology of local vernacular architecture [22] (pp. 175–177, 197–199). The sociocultural and architectural structures, which was scarcely influenced by natural factors, makes the traditional architecture in this area an ideal research subject for exploring the mapping relationship between human elements and architectural space.

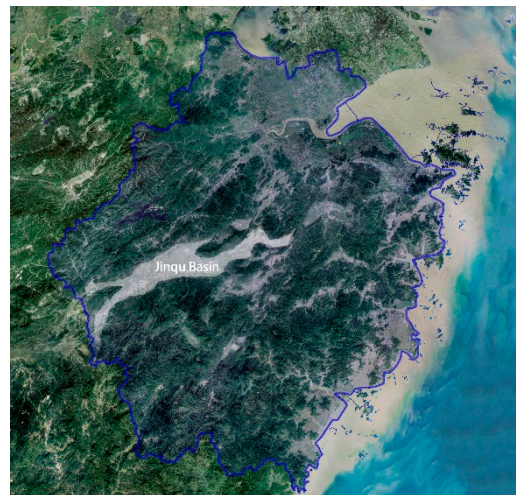
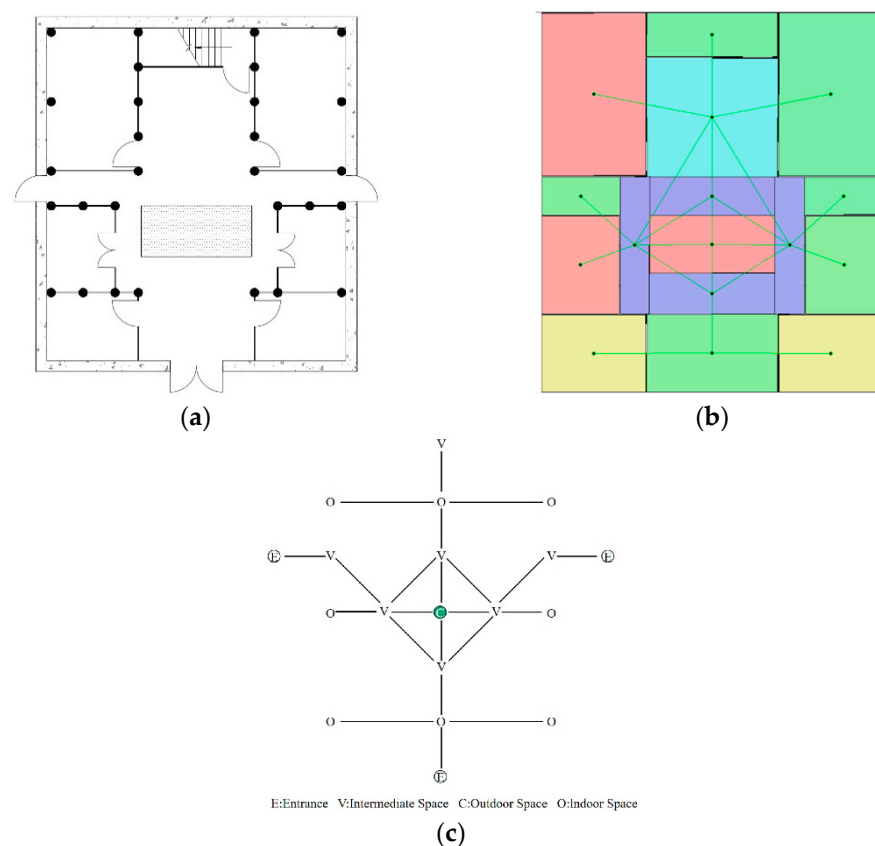


Figure 2. Jinqu Basin area.

Internationally, the particularity of the case study area lies in three aspects. First, as mentioned above, the feature has one uniform geo-morphic unit but is based on the junction of two cultural spheres. This is academically important and attracts a global interest for any study in the field, as cultural diversity aims to address the challenges of homogenization across the world. Moreover, the area covers the outer fringe around the downtown of Jinhua and Quzhou City, where fierce advancement of rural built environment is being conducted. Finally, Zhejiang Province in China, the location of the study, is the frontier of rural construction both on constitutional and substantial levels against the process of urbanization. The previous two points are especially meaningful to developing countries in the Asia-Pacific area, confronting the conflicts between city and countryside, urban residents and farmers and industry and agriculture.

### 3.2. Methods

This study adopts the space syntax method to further analyze the issue. Founded in the 1970s, this theory is the most widely recognized and used mathematical modeling tool of space [2] (pp. 48–49). The syntactic analysis implements a descriptive autonomy in that spatial patterns described and analyzed elucidates the built environment as a combination of multiple spatial cells formed by a specific topological structure (Figure 3). In addition, the topological structure is regarded as the internal genotype of architecture, and its corresponding concrete architectural entities are called phenotypes [2] (pp. 43–45). Different from the concept of biology, the genotype proposed by space syntax is inverted [9] (p. 44); phenotypes are not derived from genotypes but from spatial-temporal realities and activities to form a discrete system generating the mechanism. From a syntactic perspective, a series of topological relations of space is called the configuration [23] (pp. 185–186).



**Figure 3.** Architectural plan and topology structure. (a) is the original architecture plan; (b) is the transformed space syntax—convex map; (c) is the space relationship diagram according to the topological relationship.

Phenotype-based typology is established at the level of visual properties or appearances and could be interfered with researchers' subjective cognition, while genotype is obtained by mathematical analysis on space, which is more inherent and objective. Since the genotype reveals the deep-seated logical arrangement of architectural space, it is typically used to study the relationship and interaction between space and society [24].

A topological structure-based genotype shows a stability, as it eliminates the changes in color, decoration, embellishments or even materials, which are rather susceptible to the inhabitant's personal interests and activity habits. Thus, the study on genotype is concerned about a group's social morphology and structure, and the architectural genotype evolution usually accompanies regional society's vicissitudes [25]. Exploring the relationship between the external social causative agencies and architecture's genotypes is one of the major aims of establishing the space syntax theory.

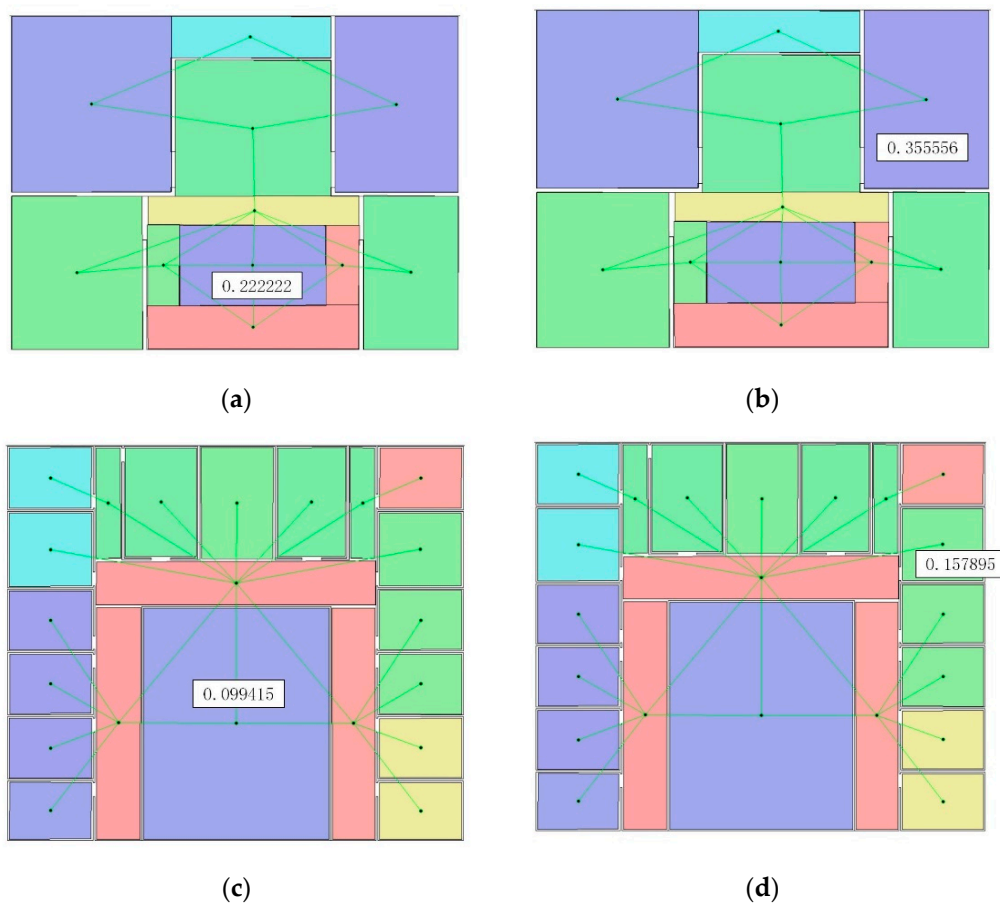
Based on the spatial gramma-analysis and interpretation on socio-cultural duality in this area, the study will conduct a quantitative analysis of the traditional residential buildings in Jinqu Basin to precisely and explicitly verify and explain the differences at the genotype level. The research is divided into two parts: verification and explanation. The verification process resorts to a mathematical model to ensure the objectivity of the results, while the explanation refers to detailed historical information to achieve a reasonable elaboration.

### 3.2.1. The RA Value Analysis

Relative asymmetry (RA) is adopted in the verification process. RA value is the only parameter used to describe social distance, and it is the first and most frequently used syntactic parameter used for the genotype study of objects of a similar scale. The calculation of RA adopts the following equation:

$$RA = \frac{\text{Mean depth} - 1}{\frac{N}{2} - 1} \quad (1)$$

The RA value was improved by P. Steadman for standardizing the mean depth (MD) concept by eliminating the interference of structural symmetry. Thus, RA can be regarded as the quotient of MD of the selected point and the symmetry of the system. Figure 4 shows the process of obtaining the RA values using the DepthMap 10 (Windows Version 10.08.00r) software.



**Figure 4.** Diagram of the RA value calculated by DepthMap Software. The figure shows the RA values of different types of spaces in traditional residences. (a) is the RA value of courtyard space of a proxy around Quzhou; (b) is the RA value of a bedroom space of a proxy around Quzhou; (c) is the RA value of courtyard space of a proxy around Jinhua; (d) is the RA value of a bedroom space of a proxy around Jinhua.

As a quantitative analysis tool, space syntax transforms the void in a physical building into a topological structure with interconnected spatial cells or points. The number of cells that crosses the shortest route from one cell to another, including the last cell, is called depth. MD is obtained from the total depth, which is the sum of the depths from point  $X_1$  to the remaining points, divided by the total number of the cells or points excluding  $X_1$  [2] (pp. 108–112). The concept of depth was originally derived from the research results of applying graph theory. It is the most important concept in space syntax and is of great social and cultural significance. Mean depth is computed from the following equation:

$$MD(X_1) = \frac{\text{Total Depth}(X_1)}{N - 1} \quad (2)$$

MD expresses the topological accessibility of a specific cell, or its degree of convenience in the entire spatial system. Accordingly, the RA value can represent the theoretical degree of the cell's integration with other points, or the extent to which the cell is integrated into the entire complex for a certain kind of space. The larger the RA value is, less integrated with the spaces and vice versa. Space syntax assumes that architecture is a designed configuration whose peculiarities are derived from structural differences [23] (pp. 216–218). The RA value is thus used to quantify the differentiations of the same type of space in different configurations and articulate the diversity of genotypes through numerical results.

### 3.2.2. Visibility Graphs Analysis

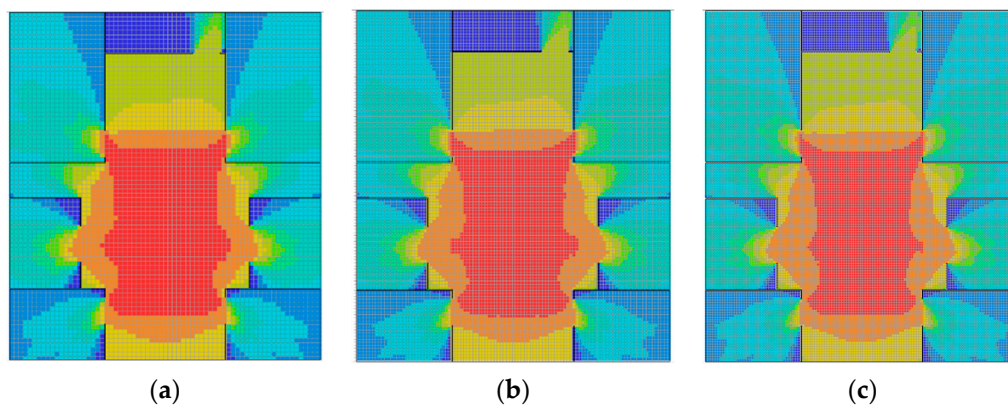
In space syntax theory, a convex space, a visibility graph and an axial map are three spatial segmentation methods available for human perceptual analysis. While the first two methods are mostly applied for studying indoor architectural space configuration, an axial map is more suitable for public spatial analysis on the urban or other settlement scale. Even though the convex space is a powerful approach to describe and represent spaces in a spatial layout, in practice, however, it is difficult to convert all spaces into convex spaces, especially for vernacular dwellings, which tend to adopt idiosyncratic forms to adapt to the special sites or uses [26]. Therefore, visibility graphs analysis (VGA) is a universally compactable tool that allows us to understand the configurational properties of a space. Contrary to the above numerical analysis, VGA results are obtained by a picturized representation in Depthmap.

The generation process of visibility graphs also avoids the interference of researchers' subjective perception and obtains the results through an algorithm. Based on the syntactic calculation software Depthmap, the building plan is imported and placed in a grid of a specific density, with each grid unit being the calculation object. The algorithm's core logic is to select certain grid units, usually of strategic significance and calculate the visual connectivity of the remaining units to these units. The overlapping relationship between the visual areas is converted into the diagram shown in different shades of color, which represents the values of syntactic variables at each point. Figure 5 shows the differences in VGA while the grid spacing properties settings are changed.

Another difference between analyses of VGA and RA values is that the former provides a better reflection of figurative characteristics of the two-dimensional spatial form. Even though the generation of diagram is based on calculations, the results reveal a conscious guidance and suggestion to the inhabitants and visitors by the space organization. Hence VGA is typically utilized for interpreting the relationship between social and mental process and external environment.

Through these visual stimulation results, two types of spatial configurations of dwellings are compared and the corresponding imprinted conceptual differences are discovered, in addition to explaining the relationship between a space and socio-cultural information. Furthermore, based on local historical materials, the analysis enables an in-depth elaboration of the role of human factors in the evolution of architectural spatial forms.





**Figure 5.** Visibility graphs analysis diagram. From left to right: the denser the grid, the smoother the image and the more accurate the results. (a) is the grid spacing of 400 units; (b) is the grid spacing of 250 units; (c) is the grid spacing of 100 units.

#### 4. Data Analysis

##### 4.1. The RA Value Analysis

First, to show the genotype distinctions under the phenotype differences, RA values of principal rooms on the ground floor, such as the courtyard, living room and bedroom (toilet and kitchen are usually located outside the main building), are calculated using Depthmap software.

The values for the 31 proxies are given in Table 2. The variation indicates the degree to which a particular space is integrated into or segregated from the spatial pattern of the entire complex; the higher the RA value, the lower the integration with the system [27]. Second, as shown in Figure 6, the straight-line distances from each sample to the two regional administrative and cultural centers (Jinhua and Quzhou) of the same time (from the 1720s to 1949, covering the middle Qing Dynasty to the foundation of Peoples' Republic of China) are measured to imply the degree of cultural influence imposed on buildings (Table 3). The calculation is based on the assumption that there is a positive correlation between cultural diffusion and the geographic distance.

**Table 2.** The RA value of different spaces in traditional dwellings.

Number	Courtyard RA	Bedroom RA	Living Room RA
Qu 1-1	0.194444	0.416667	0.194444
Qu 1-2	0.181818	0.454545	0.287879
Qu 2-1	0.222222	0.355556	0.200000
Qu 2-2	0.127273	0.381818	0.309091
Qu 2-3	0.177778	0.377778	0.266667
Qu 3-1	0.200000	0.600000	0.266667
Qu 3-2	0.168421	0.305263	0.305263
Qu 3-3	0.168831	0.372294	0.281385
Qu 4-1	0.222222	0.266667	0.066667
Qu 4-2	0.181818	0.424242	0.242424
Qu 5-1	0.205128	0.384615	0.230769
Qu 6-1	0.155556	0.355556	0.244444
Qu 7-1	0.152381	0.380952	0.247619
Qu 8-1	0.194444	0.416667	0.194444
Qu 8-2	0.155556	0.444444	0.311111
Jin 1-1	0.151515	0.378788	0.318182
Jin 2-1	0.104878	0.129268	0.073171
Jin 3-1	0.069182	0.077269	0.077448
Jin 4-1	0.091593	0.129528	0.129528

Table 2. Cont.

Number	Courtyard RA	Bedroom RA	Living Room RA
Jin 5-1	0.103896	0.216450	0.095238
Jin 5-2	0.111111	0.222222	0.181287
Jin 6-1	0.116959	0.198830	0.198830
Jin 7-1	0.119774	0.203390	0.151977
Jin 8-1	0.163636	0.418182	0.272727
Jin 8-2	0.133333	0.391667	0.283333
Jin 9-1	0.120879	0.263736	0.263736
Jin 10-1	0.099415	0.157895	0.157895
Jin 11-1	0.084656	0.150794	0.150794
Jin 11-2	0.111111	0.157895	0.157895
Jin 12-1	0.074074	0.148148	0.148148
Jin 12-2	0.111111	0.150327	0.150327

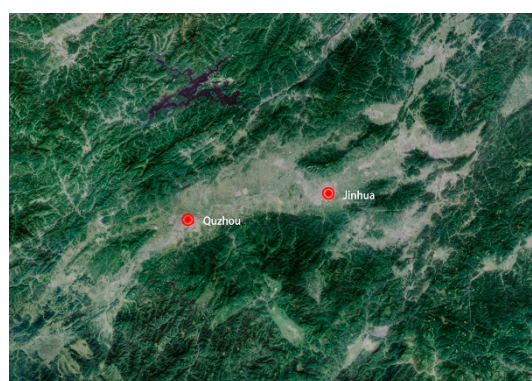


Figure 6. The location of Quzhou and Jinhua from the 1720s to 1949 in the Jinqiu Basin.

Table 3. The straight-line distance between each sample and the regional administrative and cultural centers in Jinqiu Basin.

Building Number	Administrative Division	Village Name	Distance from Jinhua (km)	Distance from Quzhou (km)
Qu 1-1	Changshan, Quzhou	Tungkungshan	121.45	43.85
Qu 1-2	Changshan Quzhou	Tungkungshan	121.72	44.21
Qu 2-1	Kaihua, Quzhou	Xiashan	123.13	59.34
Qu 2-2	Kaihua, Quzhou	Xiashan	123.37	59.68
Qu 2-3	Kaihua, Quzhou	Xiashan	123.14	59.30
Qu 3-1	Jiangshan, Quzhou	Winghingwu	121.43	50.40
Qu 3-2	Jiangshan, Quzhou	Winghingwu	121.42	50.41
Qu 3-3	Jiangshan, Quzhou	Winghingwu	121.47	50.36
Qu 4-1	Kecheng, Quzhou	Tuntau	89.02	11.40
Qu 4-2	Kecheng, Quzhou	Tuntau	89.13	11.03
Qu 5-1	Qujiang t, Quzhou	Poshi	87.66	29.13
Qu 6-1	Qujiang, Quzhou	Poshi	81.05	33.91
Qu 7-1	Qujiang, Quzhou	Wengyuan	76.02	30.22
Qu 8-1	Longyou, Quzhou	Yangkeng	54.67	35.81
Qu 8-2	Longyou, Quzhou	Sanmenyuan	54.70	35.82
Jin 1-1	Lanxi, Jinhua	Sanmenyuan	38.81	53.02
Jin 2-1	Wucheng, Jinhua	Xiapan	27.34	51.97
Jin 3-1	Wuyi Jinhua	Yuyuan	34.76	81.65
Jin 4-1	Wuyi, Jinhua	Shanxiabao	52.60	89.81
Jin 5-1	Jindong, Jinhua	Suoyuan	16.88	94.51
Jin 5-2	Jindong, Jinhua	Suoyuan	16.90	94.48
Jin 6-1	Wuyi, Jinhua	Kwotung	34.91	97.38

Table 3. Cont.

Building Number	Administrative Division	Village Name	Distance from Jinhua (km)	Distance from Quzhou (km)
Jin 7-1	Yiwu, Jinhua	Huangshanwu	39.20	110.24
Jin 8-1	Pujiang, Jinhua	Songxi	61.65	127.76
Jin 8-2	Pujiang, Jinhua	Songxi	61.70	128.12
Jin 9-1	Yongkang, Jinhua	Houwu	52.02	120.11
Jin 10-1	Panan, Jinhua	Damin	81.23	156.20
Jin 11-1	Dongyang, Jinhua	Caizhai	86.23	162.55
Jin 11-2	Dongyang, Jinhua	Caizhai	86.34	162.43
Jin 12-1	Panan, Jinhua	Juxi	88.28	163.13
Jin 12-2	Panan, Jinhua	Juxi	88.23	163.17

Generally, most of the samples share the same order of RA values—the space with the highest value is the bedroom, followed by the living room and the courtyard, indicating that the bedroom is the most segregated space among the system and the courtyard the most integrated.

Conversely, although the RA value sequence has been characterized as an important criterion for the induction in genotypes by Bill Hillier, in the study of British homes [2] (p. 155), we insist that there are subtle but fundamental differences in the genotypes of the space inside traditional houses in Jinqu Basin. This is because the organization of space around courtyards of different scales can be considered the most pronounced feature of the traditional Chinese architecture, which largely determined the RA value ranking, and if we simply make the judgement accordingly, then this study leads to no way.

To further visualize the calculation results, scatter plots with the distance from JH/QZ and the RA values are drawn, as shown in Figures 7–14. The two plots show a clear tendency that the RA values, collectively or separately, become more dispersed and larger with the increase of distance from Jinhua; conversely, the further away from Quzhou, the more concentrated and smaller the values. In Figure 15, the phenomenon is presented with greater clarity and details. Regarding family spaces in traditional houses, the lowest RA values of bedrooms, living rooms and courtyards occur most frequently in the western end of the basin, and the highest in the eastern end. The split in the domestic space configurations reflected by RA values corresponds the bifurcating distribution of human factors in the Jinqu Basin. Surprisingly, a transformed interior seems to impose its influences beyond the two sides of the basin, which spatially proves that the Jinqu Basin lies at the junction of two completely different social and cultural regions.

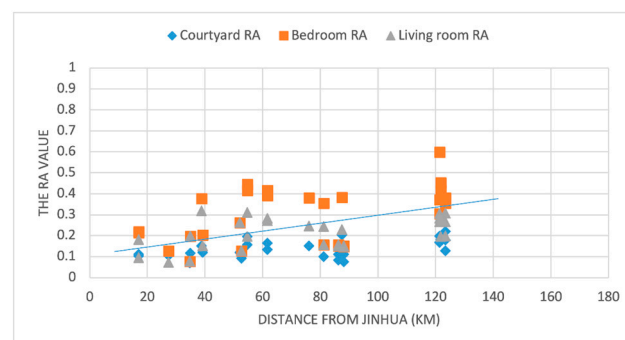


Figure 7. Distance from Jinhua (km)—the RA value scatter plot.

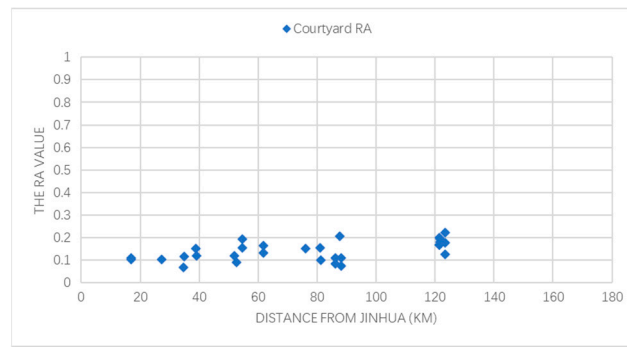


Figure 8. Distance from Jinhua (km)—the Courtyard RA value scatter plot.

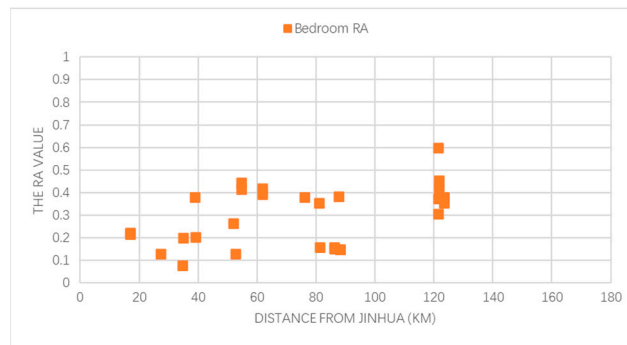


Figure 9. Distance from Jinhua (km)—the Bedroom RA value scatter plot.

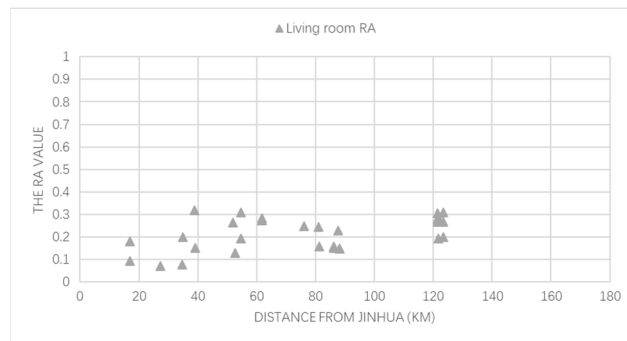


Figure 10. Distance from Jinhua (km)—the Living room RA value scatter plot.

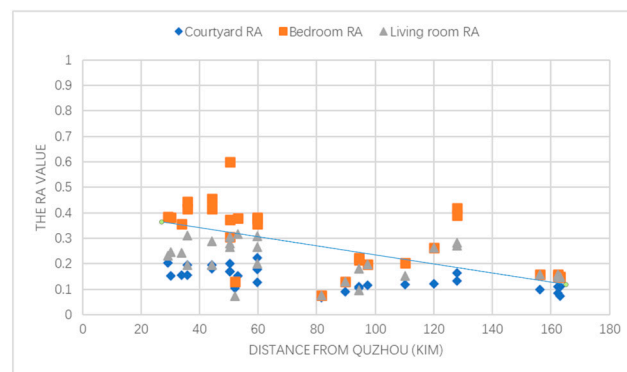


Figure 11. Distance from Quzhou (km)—the RA value scatter plot.

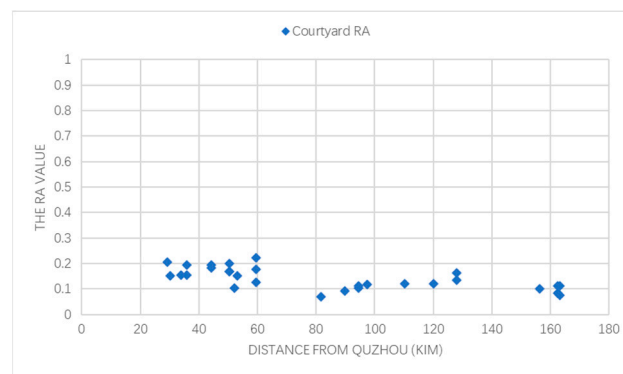


Figure 12. Distance from Quzhou (km)—the Courtyard RA value scatter plot.

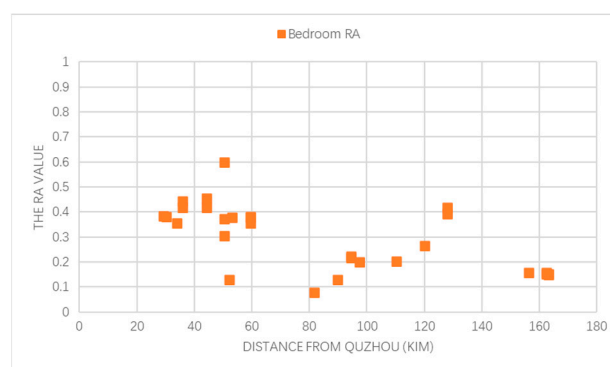


Figure 13. Distance from Quzhou (km)—the Bedroom RA value scatter plot.

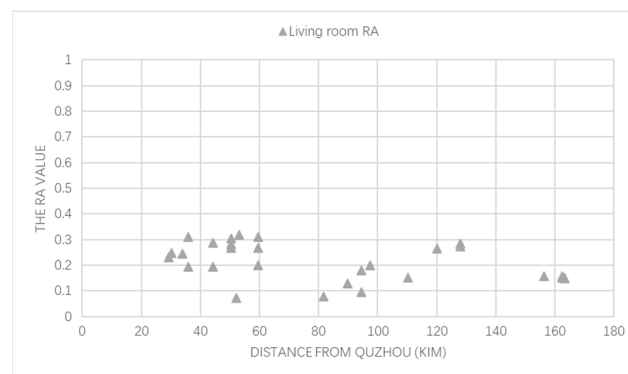
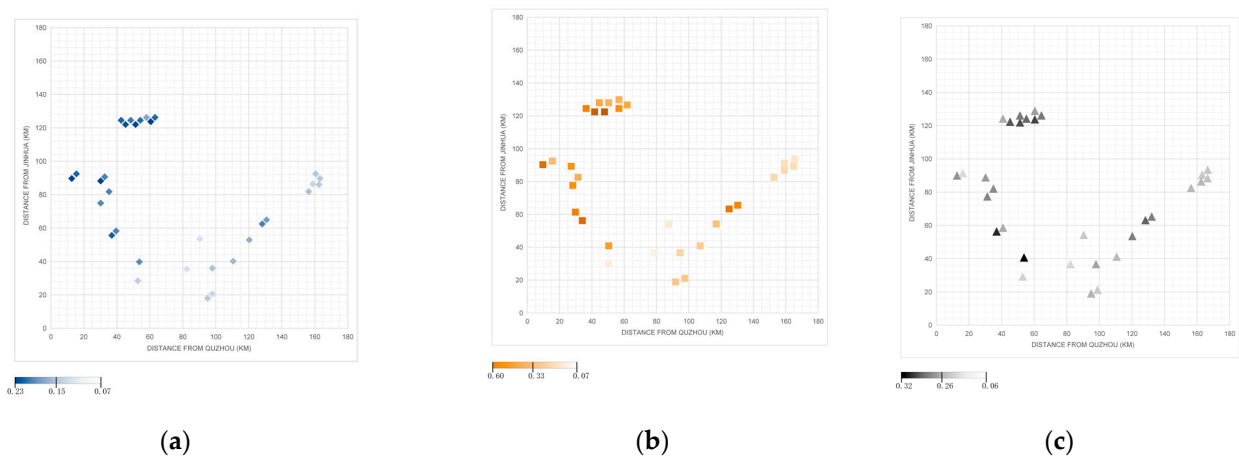


Figure 14. Distance from Quzhou (km)—the Living room RA value scatter plot.

The duality of interior structuring of space was reflected in the overall RA values distribution and the relationships between the main values. Samples located in the east wing of the basin, or around Jinhua, shares very close RA values of different kinds of spaces. Conversely, there is a striking variation in RA values for different points in a building around Quzhou. In addition to the degree of integration and segregation of major spaces on the ground floor, the RA values provides more behavioral and social information, implying that there are differences between the concept of transpatial and spatial solidarity. The first difference lies in the form of solidarity realized through the control of categories in isolation, and the other in the interpenetration of categories by spatial contiguity and random movement [4] (p. 159). Therefore, the traditional Quzhou interiors articulated two kinds of solidarity, which led to the strong differentiation of space in terms of RA; the Jinhua interior articulates only one form of solidarity—the spatial form.



**Figure 15.** The relation between the RA value and distance from Jinhua and Quzhou. (a) is relation between bedrooms' RA values and distances; (b) is living rooms' RA values and distances; (c) is courtyards' RA values and distances.

Cases around Jinhua share much weaker categories of use than those around Quzhou, and this weakening of categoric distinctions is reflected in the considerable reduction of RA values. As the merging of use and reduction of the degree of segregation are parallel phenomena [2] (p. 160), the interior space emphasizes building complex patterns of relationships between spaces that only represent the weak categories of use. From the social perspective, the indoor space encourages the movement across partitions and links the members of the habitants by contiguity and encounter. The courtyard space, as seen in all the samples in this area, plays the role of a theatre of everyday life and interaction, with the lowest relative asymmetry of any ground-floor space; that is, this space has the highest integration with the rest of the household. Syntactically, it acts as a central area in the household. Its theoretical nature is the key position of spatial solidarity, contrary to transpatial solidarity. All members of the household have equal access to, and equal rights in, this space. Furthermore, local interaction in this space is dependent on spatial proximity—relationship with neighbors and locally based kin. In its more developed forms, some neighbors will have the right to access this space [9] (p. 159). Figure 16 shows a typical architectural plan of a traditional residence owned by a big family around Jinhua.

The RA values of various spaces around Quzhou show a completely different story. Bedrooms with RA values of almost two to three times the values of yards simply maximize the relative asymmetry of all the spaces, achieving the maximum segregation effect. Traditional dwellings in the Quzhou area are residences with minimal internal functions. Bedrooms are usually located on both sides of the living room, with more private compound functional spaces than rooms for only resting. In the cases studied, the bedrooms are insulated from its immediate surroundings and everyday transactions. Contrary to spatial solidarity, based on analogy and difference, transpatial solidarity emphasizes the separateness of the interior. The bedroom is a transpatial space. Accordingly, its function is to articulate the relationships across greater distances, including spatial and social. To achieve this, it must be unlinked from the surrounding spatial system. The syntactic values of the space express this requirement. The courtyard space in this area is a typical instance of a ritualized space. The non-use of low asymmetric and most controlling spaces by persons perfectly illustrates the non-personal, but highly positional, nature of the system. The orientation of the domestic space and lifestyle toward the ritualization of everyday existence finds its perfect spatial expression in these subtly different spatial relations.

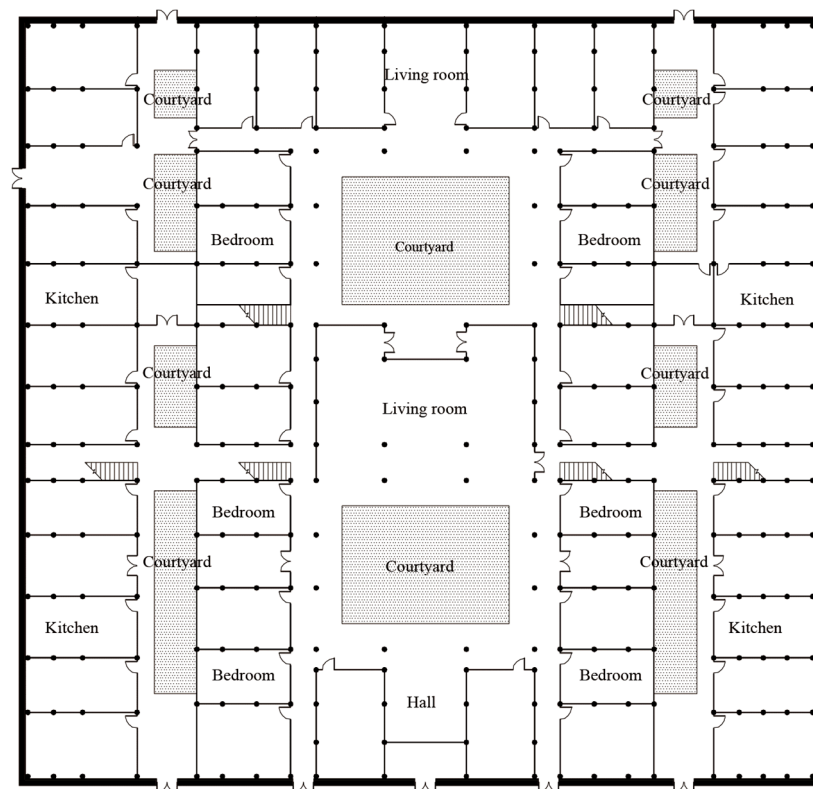


Figure 16. Plan of a traditional residential building (Jin 3-1) in Jinhua Yuyuan Village.

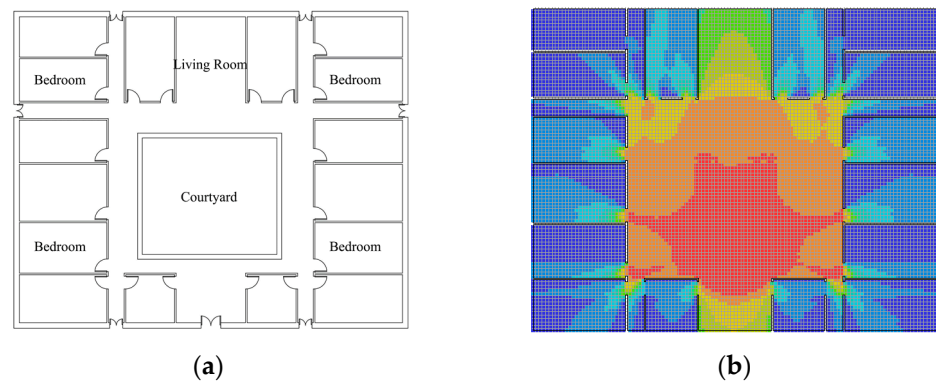
As the courtyard space is a Chinese traditional residence, we try to account for the social significance of the above analysis. Generally, courtyard spaces of houses in the west of the basin or around Quzhou, which are usually of extremely limited size but the best position, reflect a spiritual and ritual symbol in the entire spatial system. However, the courtyard space in Jinhua area is a functional public space involved with daily group activities, similar to the square space in micro-community. Moreover, there are explicit causality between the results and local cultural environment—doctrine of ChenLiang school in Jinhua emphasizes utilitarianism’s merit ethics [21] (pp. 114–120). Nevertheless, the ZhuXi school of Quzhou regards motive ethics of personal virtue as decisive [21] (pp. 121–128). The differences in ethical norms followed by the local elite class, who oversees the vernacular rural society and communities, are usually reflected in built environment [28]. In the traditional residential buildings of Jinqu Basin, the relationship is decoded as the corresponding dialogues between the spatial configuration, courtyard typology and collectivism or individualism biases in the sociocultural structure. The apparent contradiction between the two interior genotypes can be regarded as a precise representation of what Berstain has characterized as the difference between a personal and a positional system. A positional system deals with the control of categories, that is, of people considered as categories; a personal system considers the categories as persons. In line with the present model, positions are transpatial, while persons are spatial [2] (p. 161).

#### 4.2. Visibility Graphs Analysis

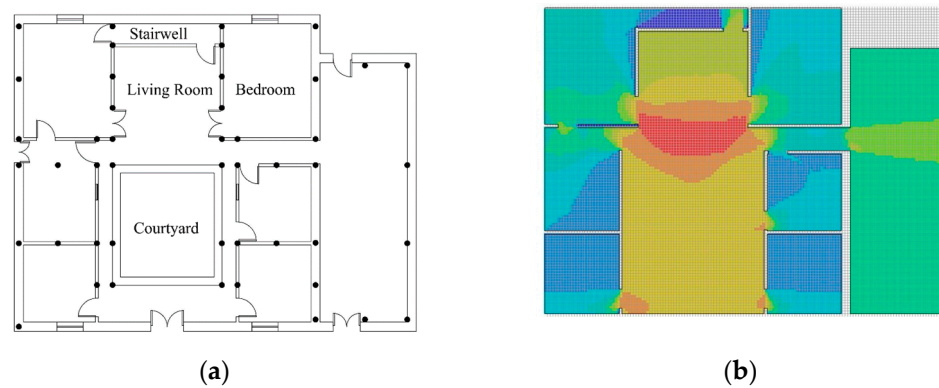
Considering further interpretations of the two genotypes against the background of different social mechanisms underlying domestic space patterning, VGA of DepthMap is used for mapping the global configurations of the building, apart from the above abstract parameterization comparison.

Taking a traditional residential building in Jinhua area as an example (Figure 17), its VGA diagram implies an apparent tree shape. The courtyard space constitutes the trunk of the system, and the surrounding space is the branch. However, this characteristic is not found in Quzhou region (Figure 18). By comparing more samples (Figures 19 and 20), it

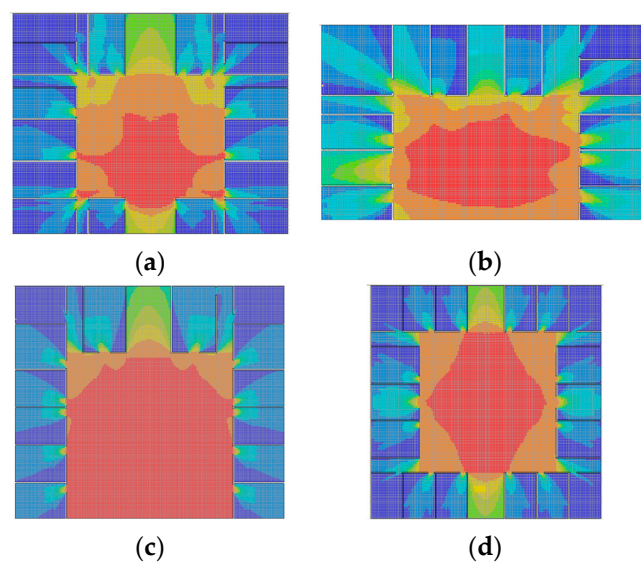
can be found that this tree-like form is much more common in building samples in the area around Jinhua.



**Figure 17.** Visibility graphs analysis of traditional dwellings in Caizhai village. (a) is the original architectural plan of the building; (b) is its VGA diagram.

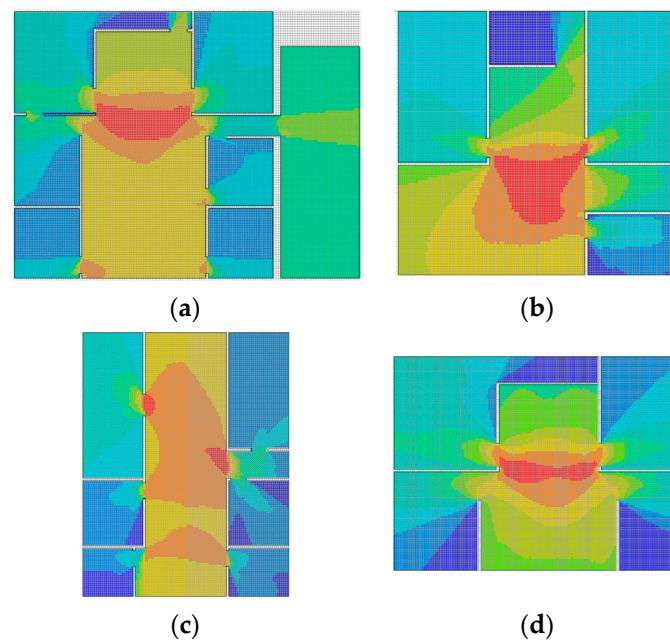


**Figure 18.** Visibility graphs analysis of traditional dwellings in Wengyuan village. (a) is the original architectural plan of the building; (b) is its VGA diagram.



**Figure 19.** Visibility graphs analysis of Jinhua traditional dwellings. (a) is the VGA diagram of Jin1-1; (b) is the VGA diagram of Jin2-1; (c) is the VGA diagram of Jin4-1; and (d) is the VGA diagram of Jin7-1.





**Figure 20.** Visibility graphs analysis of Quzhou traditional dwellings. (a) is the VGA diagram of Qu1-1; (b) is the VGA diagram of Qu2-1; (c) is the VGA diagram of Qu6-1; (d) is the VGA diagram of Qu8-1.

The symmetry structure in VGA reflects a centrality in organization. The warmer the color of the area, the higher the interactive degree of its space in VGA; its gradient represents the decrease of the value, implying the direction of the space guidance. Compared with the examples around Quzhou, the courtyard space of traditional dwellings near Jinhua is not only the geometric center of plan layout but also the center of each direction in the AVGs. As shown in the graphs, an obvious linear transition exists between the courtyard space and each surrounding space, implying that the courtyard has a strong guiding force over the surrounding spaces. Unexpectedly, this feature does not exist in the graphs of proxies around Quzhou, although the courtyard spaces are usually located at the geometric center of the plan. The result indicates the deep underlying differences in handling of doors or, more specifically, the thresholds in the two social groups.

As human behavior is interlinked with space, the architectural space shares the framework for everyday life, and similar to other vernacular architecture worldwide, the traditional houses embody social and symbolic information into a meaningful spatial form [29]. In the traditional Chinese residential buildings, due to the intimate relationship between lifestyle, behavior and secular etiquette and conventions in eastern Asian culture, domestic space has become an important manifestation of the sociocultural environment. Various representations and measures developed from the space syntax theory present more explicit and scientific descriptions of space from the sociocultural viewpoint [30]. Notably, references of historical materials are indispensable for interpreting the interaction between the space form and social variables [31]. This necessity indicates that images' morphological rules cannot be explained by a pure graph theory without including socio-cultural perspectives. The internal mechanism is usually derived from profound human activities than the spatial morphological evolution.

Referring to the relevant perspectives of the cultural landscape, graphic logic of artificial space is the accumulation of human consciousness over time [32]. On the sociological level, ethical relationships and community activities of human communities are time-dependent behavioral organizations. Accordingly, spatial structure characteristics can be comprehended as a mechanism for operating this long-term collective behavior. The phenomenon of Jinhua's courtyard space in visibility graphs is the expression of its special regional culture at the spatial level, which is lacking in the neighboring Quzhou area. This

also proves the sharp alternation in human factors between Jinhua and Quzhou. Considering the history of Jinhua and Quzhou, this fluctuation may be due to Jinhua's unique community culture, which promotes social utilitarianism. The courtyard space of traditional residential houses is considered as a specific place presenting this regional culture.

In conclusion, VGA shows more details in the logical characteristics of spatial orientation and linkage between spaces, and the analyses expound the nuances in human physical and mental perception in residential spaces of similar configuration but different genotypes. The evolution of traditional dwellings shows impressive finesse in its embodiment of the socio-cultural principles of the inhabitants. A traditional architectural space is not only the container of human lives but also the accumulation results of these activities over time; in other words, architecture is the static mapping of this mechanism.

## 5. Conclusions and Discussion

With two syntactic analyses, including quantitative and graphic, conducted by Depthmap, this study articulates the differences among the genotypes of the residential buildings in Jinqiu Basin. Moreover, the elimination of climatic and topographic interference by various natural factors in the research area allowed the hypothesis to be tested and proved, which presents the correspondent relation between the division in local human factors and the duality in spatial configuration and solidarity of form.

Based on the above, combined with historical material, the research indicates that the regional and sociocultural forces shapes and differs the space ordering in settlements and explains the potential projection mechanism. In Jinhua, socioculture focusses on the community, creating the high degree of integration of its domestic spatial structure, while in Quzhou, personal virtue is highly valued and the interior space is relatively close to a modern residence, emphasizing individuality and a spiritual space. Conversely, the architectural space reflected the two regimes of daily behavior, which are governed by and oriented from an earthly morality and inner restraint, respectively. Second, the study also revealed that a courtyard space is a significant space category that is worth being the focus of spatial topology and visibility analysis. This space is also crucial for addressing the subtle differences between genotypes.

Space-embodied social purposes are easier to be comprehended than analyzed, but with the help of the calculation and stimulation by the software based on space syntax theory, clarifying the tacit sociocultural meanings embedded in the spatial configuration was possible. A thorough understanding of this conclusion will enable much more efficient and enduring measures in the preservation and restoration of vernacular dwellings as part of the local cultural heritage.

Another less direct but more fundamental contribution of the study is that it offers a starting point for the development of academic framework and planning strategies coherent with local sociocultural aspects, which is of great significance for Social Sustainability—one of the three core values of Sustainable Development established by the UN in the 1980s. Specifically, the research and its follow-up study may bring changes on three levels, as given below:

1. A more comprehensive academic framework on the vernacular architecture: Instead of focusing on several representative works, the study attempted a panoramic analysis within a sociocultural context and emphasized the narration and interpretation of spatial traits of various kinds of dwellings, which provides the setting for human habitation. We want to sustain an authentic human experience-oriented heritage preservation methodology, and this contention will facilitate our team's efforts toward the study's next phase.
2. More place-based designing and planning strategies: Being different from the modern urban residences, the rural dwellings have been functioning as an integral of primary metaphor and a sign of local social advancements. We aimed to encouraged anyone with a voice in the decision-making process to respect and prioritize the demands of local history, cultural believes and events, social organization and everyday occur-

rences. This will allow the beauty in the indigenous style architecture to be inherited in future construction practice.

3. More dialogue-based policies: The approach foregrounds the ethical dimension of sustainability, is concerned with the question of authenticity, and promotes, if possible, a dialogue-based approach to decision-making, including deliberative democratic and policy-making practices in the rural, social reconstruction wave in China.

In the last four decades, the Chinese government has endeavored to meet the gap between rural and urban areas by reducing the disparity in physical living environment of local communities, which results in negative repercussions in a top-down administrative system. Thus, this study's attempt at understanding the rural traditional dwellings will improve the stability and resiliency of the settlements in the future, while respecting the local diversity in a sociocultural structure, which is the foundation of a cooperative, cohesive and reciprocal relationship in the urban-rural development context.

**Author Contributions:** Conceptualization, Y.C., K.X. and K.D.; methodology, Y.C.; software, K.X.; validation, P.L., R.J. and J.Q.; formal analysis, Y.C.; investigation, Y.C. and K.X.; resources, Y.C.; data curation, R.J.; writing—original draft preparation, Y.C.; writing—review and editing, Y.C. and K.D.; visualization, P.L., R.J. and J.Q.; supervision, H.F.; project administration, Y.C.; funding acquisition, Y.C. and K.D. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded General Scientific Research Project of Education Department of Zhejiang Province in 2019 (Grant No. Y201942087), Hangzhou Planning Program of Philosophy and Social Science (Grant No. M19JC052).

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author, K.D. The data are not publicly available due to the architectural information of residences could compromise the privacy of research participants.

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

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