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Living Sustainably: Transformation of the Built Environment in Xiaqiao Village, China

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Abstract

The built environment is always inhabited. A settlement is always built by people, occupied by people, and is designed for people. Its establishment, growth and further transformation are influenced greatly by people's behaviors and their lifestyles. There is a reciprocal relationship between people and the built environment. This paper is a case study of a small Chinese village named Xiaqiao (*下桥*, under bridge). This case study includes observations and analyses of the transformation of the village during the past 300 years, as well as its sustainability and adaptions as a result of villagers' changing needs. The approach taken in this case study is a cross reference between rural social history and the built environment. The clan system is the major social structure, and collective living is the predominant life style. The layout of the village is composed of three levels: the single build complex, the inner space, and the structure. The purpose of this paper is to identify the relationship between architecture and local inhabitants in pre-modern rural China. A small village can be sustainable over the course of hundreds of years if the local inhabitants are repositioned in accordance with the changes in architectural development.

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Keywords: Sustainable; village; Chinese traditional dwellings; wood structure

1. Introduction

During the late 20th Century, there was a rapid increase in the construction of housing in both urban and rural districts in China. Much of this housing is of a similar architectural style and was constructed using similar methods. Although a Chinese citizen who wants to move to another location in the country may be presented with thousands

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of possible options, he or she has no control over the architecture of these new-built houses, and is therefore a 'passive receiver'.

Looking backwards is always a good strategy when dealing with modern issues. In traditional Chinese society, village is the basic unit of a residential community. Villages are established spontaneously at places where people's needs are satisfied. In addition, villages always grow, are transformed and are adjusted to meet the inhabitants' changing requirements. In this way, a village becomes a sustainable built environment that can exist for hundreds of years.

In this paper, a small village located in the southern region of the Zhejiang province is the subject of an in-depth case study on the interaction between housing and people. The Xiaqiao village is located in a mountainous area, with has such a long history that it can be dated back to the Five Dynasties. During its one-thousand-year history, both its natural and artificial environments have changed greatly. Today, most people living there are descended from four clans: Chen, Tang, and two offshoots of Lin. Their ancestors arrived at the village during different historical periods. In this study, the autonomous self-housing system in the village dating from the end of the Ming Dynasty to the present day will be analyzed.

A multi-layered analysis framework is used to disintegrate the village's transformation during different periods. The methodology used in this paper is based on the Open Building Theory that helps to articulate different functions of various architectural elements and the corresponding design strategies by setting up different analysis levels. In 1960s, John Habraken [1] defines a whole building entity into two levels, structure and infill. The stratification method comes into the analysis of production of urban space in 1990s. According to this theory, the whole built environment is divided into several inter-influencing levels, according to the following hierarchy: conurbation, architecture, indoor space, and infill. There is a relationship between a higher level and a lower one, in that the former provides a setting for the latter. By separating different levels, a more flexible content can be provided. The multi-layered analysis framework has also be used in urban morphology theory. M.R.G. Conzen [2] develops a method to analyze the urban environment into three levels, street, block and building.

Due to the advantages on articulating different built elements specifically, an analysis is conducted with reference to these four levels in order to clarify how the settlement and dwellings were transformed to adapt to the villagers' changing needs. The advantages of the village's location, the growth of the settlement, the transformation of its buildings, and the varied roles of its residents in the community are detailed. The layout of the village was influenced by competition and cooperation among its clans, which in turn became the predominant force over the model and transformation of the settlement. Another parameter is the villagers' lifestyle, which has an influence on the village houses' forms and inner spaces. It may be said that architecture is a response to inhabitants' needs, and so the village and its dwellings therefore reflect the requirements of its residents.

2. Level 1 - Location of the Village

The selection of a settlement location is the result of much decision-making during different periods in history. Instead of a fixed decision, the process of decision making in terms of the location of a settlement is, to some extent, a flexible system that is open to possibilities, and which can be adjusted freely and easily according to changing economic and social requirements. A village is composed of several independent settler groups at a sub-level. Each group in the village can change in order to adapt to new situations, but as a whole, these sub-settlements are organized and cooperate together, and so the function and boundary of a village become fixed.

The Xiaqiao village contains several independent sub-level settlements, which emerged and developed during different periods in response to different situations. Settlers who appreciated the landscape, and who realized that they could make a living on the site first established the village. The landscape of the Xiaqiao village, with its four rivers and interweaved mountains, makes for an ideal 'Taohuayuan' setting, a safe and peaceful place that was undisturbed by warfare, and where residents could live sustainably. Thus, the earliest sub-settlements in the village are ones that form an independent geographical unit, within mountain coves, with beautiful views of mountains and rivers. They were constructed for the purpose of aesthetic satisfaction, which was valued more by the first immigrants.

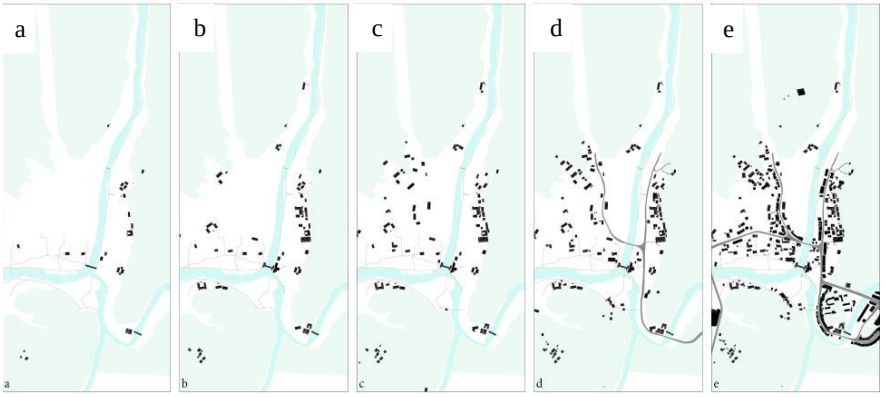

Fig. 1. The growth of settlement (a) Phase I; (b) Phase II; (c) Phase III; (d) Phase IV; (e) Phase V

Things changed dramatically during the second period of immigration, during the Ming and Qing dynasties. In order for the village to fulfill new requirements, the sub-settlements were reorganized. This era was marked by intense conflict over land. Due to frequent warfare, court policies and an increasing population, a large number of people escaped into the mountains in a search for available plots of land, some of who became the second wave of immigrants to Xiaqiao. These people were not intellectual elites who yearned for a utopic way of life, but were displaced migrants who were trying to survive. Thus, the sub-settlements that developed during this second period were constructed on the slopes outside or on the plains along the river, where these incomers could till the soil.

In recent decades, following the construction of a road, the sub-settlements in Xiaqiao village have been recombined again. The land on both sides of the road has become intensely inhabited as residents, driven by economic interests, have sought good transport links. Meanwhile, the old sub-settlements further away from the road have fallen into decline. The village is therefore an example of both self-renewal and self–vitalization, in that its layout has been changed in response to different social environments, so that it can remain sustainable.

Generally, the changes to the site location of Xiaqiao village occurred due to the changing needs of settlers during different periods of the village's history. Instead of fully occupying all of the surrounding lands, the villagers have selected different places according to specific needs.

3. Level 2 - Growth of Settlement

Xiaqiao village has grown and has been transformed as a result of the needs of its residents, rather than by thorough planning by designers or planners. The location has met the requirements of different groups of people during different periods in history, and the village itself has been transformed as a result.

3.1. The Five Phases of Xiaqiao's History

Of the four family surnames in Xiaqiao, two are derived from immigrants who arrived during the Song Dynasty: the Jinan (济南) Lin arrived during the early North Song Dynasty, and the Chen arrived at a later period. The former group became the dominant power that controlled the whole village. Most of the Lins lived in settlements, including Houchi (后池, after pool), Huayuan (花园, Garden) and Xi' an (西安, safely west). Their power even expanded to other adjacent areas as their offspring multiplied. The Chens were not strong enough to compete against the Lins, and they were forced to live in a peripheral area of the village named Nanshandi (南山底, Under Nanshan) until the late Qing Dynasty. The other two surnames – Xihe (西河) Lin, and Tang lineage – are derived from immigrants who arrived at the end of the Ming Dynasty and the early Qing Dynasty, respectively. A co-administrative system was formed among the four groups of descendants, and this strongly influenced the development of the village. The growth of Xiaqiao can be divided into the following five phases (Figure 1):

- Qing Dynasty Phase I: prior to the Jiaqing (嘉庆) period of the Qing Dynasty (before 1821);
- Qing Dynasty Phase II: Daoguang (道光) period to the Xuantong (宣统) period, to the end of the Qing Dynasty (1821-1912);
- Republic Phase: 1912-1948;
- PRC Phase I: 1949-1979; and,
- PRC Phase II: 1980 to present.

The settlement of Xiaqiao has grown over time. The transformation of settlement is detailed in Table 2, and its social changes are detailed in Table 1.

(1) Due to the increasing population, more land was chosen for house-building. Although the density of the village is still low, it slowly increases. The two periods of rapid construction correspond to the two periods of rapid increases in population.

(2) There have been various reasons behind the village's expansion. During the agricultural period, in response to the pressure brought by population growth, new dwellings were built on the slopes of the mountain, or on the open spaces between previous dwellings, in order to protect farming lands. During the post-agricultural period, new dwellings were hurriedly built alongside the new road, and so former farming land was converted into building sites.

(3) After an unstable period marked by wars and disturbances, Chinese society entered a more peaceful era. Agricultural productivity was enhanced, and new techniques were introduced. For example, during Phase II, a kind of new food crop, sweet potato, was introduced. This higher yield crop can feed more people, and so the population increased. During Phase V, the village's stable social environment has been characterized by greatly enhanced productivity, a rapid increase in population, and a great accumulation of personal wealth. In recent years more advanced building techniques have been introduced, and so there has been large-scale housing construction. During both these periods, there has been effective management of public spaces. In Phase II, a public temple was built beside Dongxi Bridge (*东溪*, East river), a trade center was raised beside Beijian Bridge (*北涧*, North river), and several ancestral halls served as residential centers.

(4) The settlement has transformed from a dotted-distribution model (based on independent families), to a cluster-distribution model (expanding families), and then to a linear-distribution model (the result of modern 'nuclear' families).

Table 1. The table of social changes

Phase No.	Phase Name	Political System	Social situation	Industry Type	Population/ Family Structure	Local Govern Power	Technical Innovation	Social Changes
Phase I	Qing Dynasty Phase I	Premodern Society (Qing Dyansty)	Instable, wars and disturbance	Extremely rely on Agriculture, Periodical Fair	Low level/Large Family	Force of Lineage	N/A	N/A
Phase II	Qing Dynasty Phase II	Premodern Society (Qing Dyansty)	Stable, few disturbance	Extremely rely on Agriculture, Periodical Fair and Few Fixed Shops	Great Increasing/ Large Family	Force of Lineage	Well-developed Wood structure	More flourish than before
Phase III	Republic Phase	Republicanism	Instable, wars and disturbance	Less Agriculture, More Fixed Shops	Slowly Increasing/ From Large Family to Main Family	Force of Lineage	New material Bricks	Become a hub of transportation during the war to fight Japan
Phase IV	PRC Phase I	Socialist State	Rather stable	Less Agriculture, More Fixed Shops	Slowly Increasing/ Main Family	Government	Bricks, concrete	Establishment of road
Phase V	PRC Phase II	Socialist State	Stable	Less Agriculture, More Commercial, and Tourism	Great Increasing/ Nucleus Family with few peoples	Government, and the renaissance of lineage force	Bricks, concrete, and much advanced techniques	More establishments of road

Table 2. The table of settlement tranformation

Phase No.	Phase Name	Number of New Settlements	Location	Major Developed Lineage	Number of New Dwellings	Type of New Dwellings	Public Buildings	
Phase I	Qing Dynasty Phase I	Foure	Mountain coves, the foot of mountain	Houchi Branch of Jinan Lin	Few	Single dwelling, small courtyard dwellings	Beijian Bridge	One Ancestral Hall
Phase II	Qing Dynasty Phase II	Seven	Mountain slope, Plain ahead mountains	Cooperation of all the four lineages	Many	Large courtyard dwellings, single dwellings	Rebuilt Beijian Bridge, Linshui Temple, Chendaweng Temple	Two Ancestral Halls
Phase III	Republic Phase	One	Areas surrounding the old dwellings	Cooperation of all the four lineages	Few	Single dwellings with three to five lius	N/A	N/A
Phase IV	PRC Phase I	Several	Along the road	Cooperation of all the four lineages	Some	Single dwellings with three lius	Great Hall of Xiaqiao, Primary school	N/A
Phase V	PRC Phase II	Several	Along the road	Cooperation of all the four lineages	Many	Rowed single dwellings with one liu	Middle school, public pavilions serving for travelling	One new Ancestral Hall

4. Level 3 - Transformation of Buildings

During these five phases, both the settlement and the architecture of Xiaqiao have changed substantially (Table 3). These changes are evident in both courtyard and building design (Figure 2):

Table 3. The table of Building Transformation

Phase No.	Phase Name	Type of New Dwellings	Type of New Dwellings	Structure	Height
Phase I	Qing Dynasty Phase I	Single dwelling/Small courtyard dwelling	Five to seven lius (five as major)	Wood structure	One floor/Lower two floors
Phase II	Qing Dynasty Phase II	Large courtyard dwelling/Single dwelling	Five to thirteen lius (seven as major)	Wood structure	Higher two floors
Phase III	Republic Phase	Single dwelling	Three to five lius (three as major)	Wood structure/Brick/Stone/Mud	Two to three floors
Phase IV	PRC Phase I	Single Dwelling	Three lius	Brick/Stone/Mud/Few Wood	Three to four floors
Phase V	PRC Phase II	Rowed Single dwelling	One liu	Brick/Concrete	Three to five floors

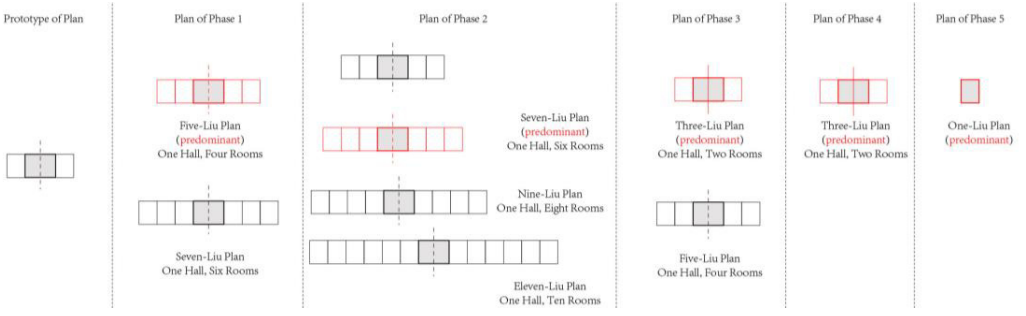

Fig. 2. Transformation of Plan through Five Phases

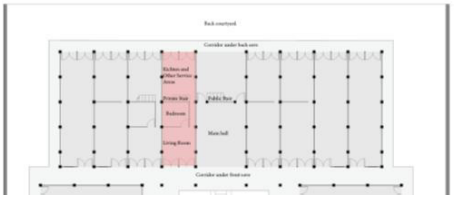

Fig. 3. The space of liu and function in a typical courtyard dwelling with nine-liu plan (Old Tang House)

4.1. Courtyard

A courtyard is not a compulsory part of a dwelling, and so courtyards tend only to be built by wealthy families. According to the family archives of the Houchi Lin branch, of the five houses they built before the Jiaqing period of the Qing Dynasty, three of them included courtyards, and only two of those three buildings have side buildings.

A courtyard is an open space enclosed by walls in front of the main building. However, unlike other regions in China, in this village the courtyards walls do not impose a strong sense of enclosure since they are only two meters high. Moreover, the wall contains small windows that allow for eye contact between the inside and the outside. The courtyard wall forms a boundary that clearly signifies the owner's territory. A courtyard is used by the residents for semi-public activities such as hanging clothes, and for drying crops and vegetables. The courtyard is also used for special events including marriages, funerals and other public receptions.

Older courtyards are generally smaller than more recent courtyards. Between 1821 and 1912, large independent families constructed courtyards, both because they were wealthy and also due to family size. Wealthy families prospered during this relatively peaceful era, and so they were able to buy up more land and replace fields with buildings. Each individual family also desired a common space where they could hold family activities and still retain a sense of privacy.

In addition, the size of a rectangular courtyard correlates with the size of a dwelling. The width and depth of courtyard always corresponds with the widths of the main building and the side building. According to local dialect, the spatial unit is 'liu' (*榴*, a file of space). This represents the space between two rows of columns from front to back (Figure 3). It depicts the length from the front door to the courtyard end, which reflects the recognition of inner space by local residents. The width of a courtyard is the same as the length of main building facing onto it; and the depth is the same as the length of the side building. In older houses with courtyards, the main building is five lius, and the courtyard extends by three lius. The courtyard extends as far as the side building (three or five lius). Thus, an older courtyard is narrow, with an area of 3 x 5 liu, or 3 x 5 liu. However, during the 19th Century, a house had more rooms and was several more lius larger, and its courtyard would be 5 x 7 liu) or even 7 x 9 liu.

During Phase III, the era of the Republic, few houses with courtyards were built due to several reasons, including limited land, the unstable social environment, limited wealth, and more importantly, the changing family structure. There was no obvious need to build a big courtyard beside a house when a family unit of as many as a hundred people was broken down into several small main families with only a dozen people each. During Phase V (from 1980 to the present), the nuclear family with three to five people has become mainstream, and so there is no practical need to construct a big courtyard.

4.2. Building Plan

The dwellings in Xiaqiao consist of collective housing for independent family groups. The the scale of family units has shrunk over time, from a big group with more than a hundred people during Phase I and Phase II, to a dozen people in Phase III and Phase IV, down to three to five in a nuclear family. As a result, the layout of dwellings has changed significantly (Figure 4).

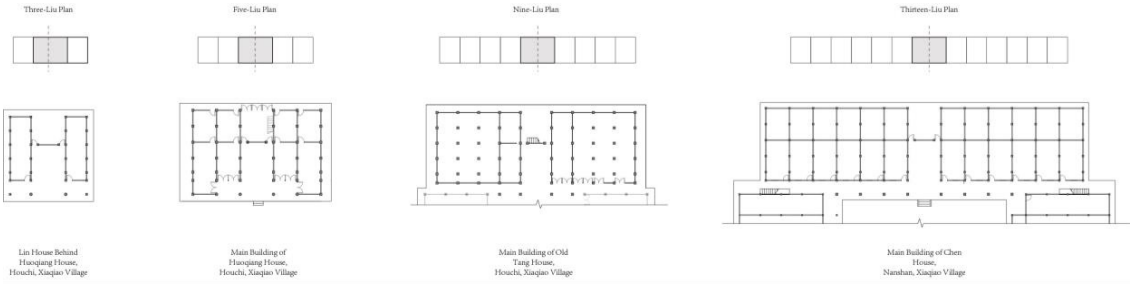

Fig. 4. Cases with Different Plans

The prototype of a building comprises one hall and two rooms, a bilateral symmetric plan centered by a main hall as a public gathering space. The room next to one side of the hall is an independent spatial unit. It is the living space for each independent sub-family in the big group. In fact, the sub-family is the basic living unit as it is composed of the closest relatives. Thus, in this plan, there is a modular strategy of space usage, in that the independent spatial unit corresponds to the independent living unit. This flexible plan system can be easily adapted to different situations. For example, as the population grows, more rooms are added to each end of the house. There length of extensions (in lius) depends on the number of sub-families. A few three-liu dwellings were built around the end of the Ming dynasty. More common plans include five-liu “one hall, four room” houses and seven lius “one hall, six room” houses built during Phase I; and the nine liu “one hall, eight room” houses and eleven-liu “one hall, ten room” houses for the richest families during Phase II.

During Phase III and Phase IV, dwellings were no longer being extended in this fashion. Sub-families started to move out from the original big family house, as people sought to live more independent lives based on smaller family units. Meanwhile, continuous wars and other disturbances greatly curtailed population growth, and so houses were no longer being organized around big families. Building plans consisted of houses of only three to five lius in length. The situation has transformed greatly in modern society during Phase V. Households now consist of only three to five people; such a unit once lived within a space of dimensions of only one liu, whereas nowadays, the nuclear family lives separately from collective life.

Over the years, houses have widened in terms of width, but not in terms of depth. The width of dwellings reflects the structure of the family group, and the depth is a reflection of the amount of space being used by each family unit. Due to changes in people’s living requirements, the independent living spaces of houses have also changed over the years, but only in terms of height. There were one-floor dwellings during Phase I, two to three floors in dwellings built during Phases II, III and IV, and six-floor dwellings have been built in recent years (Phase V).

A dwelling can be perceived as the projection of real life into space. The older, more collective housing style reflects a homogeneous and equalized life in a common Chinese village during pre-modern times. It represents equality both in terms of the level of space and the occupants. Ideally, each sub-family occupied a space, the dimensions of which were one-liu, no matter how rich or poor it was. However, times have changed, and the space provided for each sub-family has been adjusted to meet emerging requirements in a changing society.

4.3. Height

The dwellings became higher responding to the increasing requirements of life, basing on the born of new

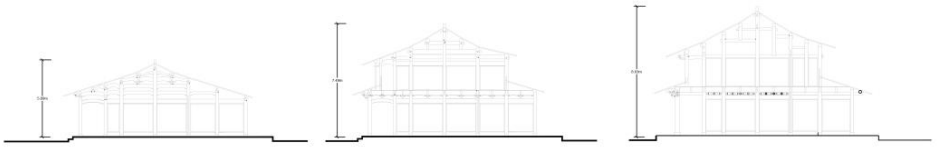

Fig. 5. Change of Building’s Height

technologies.(Figure 5) At the early period of Phase I, they are usually one floor high, due to a slower growth rate of population and the undeveloped multi-floor techniques in village. But later, an alternation from one-floor to two-floor began. It started with the adding of attic inside the original one-floor dwelling. So the first batch of two-floor dwellings were rather lower inheriting from the one-floor ones. In Phase II, the higher birthrate implied an enlarged sub-family that needs more living area in each liu space. More two-floor dwellings have been built that time, and they became much higher due to the matured building techniques mastered by common people. Even in the end of Phase II, a three-floor dwelling is built in Xiaqiao village to solve the conflict between people and space.

A great increasing of height happened after Phase III, both the number of building floor and the height of each floor are increased. It can be imagined that as the social progress, people pursue a better living environment. For example, people need higher space to improve the poor daylighting and ventilation in previous dwellings, and meanwhile they also like to possess a capacious house with more spaces. The availability brought by the improvement of techniques. The application of new materials like bricks and concrete decreases the difficulty comparing to traditional wood structure. Thus, the new dwellings built in recent decades always have four to six floors with three to four meters high for each floor.

5. Conclusion

The sustainability of the built environment is a broad topic that is the subject of extensive academic discourse. Technical approaches can be used to achieve greater sustainability. However, it is also necessary to consider the relationship between residents and their living environment.

Xiaqiao's building system has changed substantially during the past 400 years due to the changes in residents' living conditions and expectations. The village has evolved from a whole settlement, to a group of large buildings, to a large number of single family unit buildings. However, the fact that the villagers themselves have constructed and transformed the buildings to meet their own needs is of greater significance.

According to the Open Building Theory [3], traditional settlements and housing must be adaptable since villagers' needs change over time. Sustainability can also be achieved by proper design strategies and by careful community management [4].

In conclusion, sustainable building concerns building techniques using advanced sustainable techniques, as well as more innovative ways to create, design and construct buildings. The needs and functions performed by residents also need to be taken into account, and proponents of sustainable building should consider the relationships among people in traditional villages. There are lessons to be learned from the styles and changes to house-building over the centuries, which could help to address contemporary housing problems.

Acknowledgements

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