A Preliminary Investigation on the Relationship Between Building Forms and the Regional Environment in the Rural Areas of West China

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Abstract. To understand the relationship between the forms of buildings and their surrounding environment in the rural areas of west China, a series of literature reviews and field investigations were conducted targeting the self-designed and self-constructed rural houses in the Ningqiang county of south Shaanxi province. As a result, some typical forms of building clusters and individual buildings, which directly correspond with their specific environmental conditions, are identified in the researched region.

Introduction

It is observed that vernacular buildings in the rural areas all around the world largely maintain a close and friendly relationship with their surrounding natural environment, which is valuable for energy-saving, resource-saving and environmental protection. However, the forms of many of the contemporary buildings, including those in the rural areas, no longer respond to their natural environment so have caused increasing energy consumption and environmental load.

In the recent 20-30 years, a large amount of new houses have been constructed in the vast rural areas in west China. They are mostly self-designed and self-constructed, so directly reflect local residents’ understanding, perception and expectations of the forms of their houses. What kinds of forms have been applied in such buildings? Do they still keep a close relationship with their regional natural environment? What are the background reasons for the application of such forms? Whether they need to be improved or not? How can they be improved if needed? Supported by a number of funded projects, a series of researches have been conducted in the Ningqiang county of Shaanxi province to explore answers to the above questions. Some results of the preliminary investigations are introduced in this paper.

Main Features of Regional Natural Environment

The main features of regional natural environmental in the researched region are the following:

Climate. The location of Ningqiang county belongs to the Hot Summer & Cold Winter climate zone, which is one of the five major climate zones for building thermal design in China[1]. In the recent years: there are about 50% cloudy & overcast days, 37% rainy days, 10% sunny days and 2% snowing days each year; the daily highest temperatures are between 20℃-36℃ in the summertime and lowest temperatures between -5℃ ~ 4℃ in the wintertime. [2]

Natural resources. Seated at a large mountainous area with quite a dense river network, Ningqiang county has abundant wood, stone (e.g. shale), clay and water resources; at the same time, possesses limited plain and cultivated land.

Transportation. In the historical time, water transportation was more convenient than road transportation; while in the present age, the situation is conversed, road and rail traffic have become much more advanced so water transportation have largely been replaced by land transportation.
Forms of Rural Houses and their Regional Environment

To understand the relationship between the forms of buildings and their surrounding environment, a series of literature reviews and field investigations have been conducted targeting both traditional and contemporary buildings, especially the self-designed and self-constructed rural houses, in the researched region. The results are the following:

**Distribution of Building Clusters.** In the historical time, in order to have easy access to water resource in daily life and take advantage of water transportation, traditional rural houses in the researched region tended to concentrate at the narrow banding areas of rivers. (Fig.1 left)

When water supply was no longer a problem for daily life and water transportation was largely replaced by road transportation, contemporary rural houses began to allocate alone roads rather than rivers. In the recent years, many of the newly constructed rural house have been concentrated along the main traffic lines that lead to the nearby towns or cities. (Fig.1 right)

In both of the above cases, building clusters in the researched region mostly present in linear forms, which are largely defined by the trend of a river or a hill in the region.

**General Layout.** Due to the limitation of land resource, the general layout of the traditional and contemporary rural houses all take a compact form. They mostly consist of three parts: 1. *The main rooms* (living room, dining room and bedrooms) are usually arranged in a three-bay & two-depth rectangle space, with the living room and main bedrooms be placed at the front part of the house. 2. *The subsidiary rooms* (kitchen, toilet, stair, etc.) are usually arranged behind the main rooms and keep direct access to the backyards. 3. The backyards usually take irregular forms, which are partially defined by the feet-lines of hills at the back of the houses. (Fig.2.)
Roof. Traditional rural houses in the researched region are mostly built with wood-tile structure double slope roofs and deep eaves. Such roofs can provide sun-shading for the underneath space in the hot summertime and good protection against storms in the raining season.

It is interesting to find out that, many of the contemporary rural houses in the same region were originally built with flat concrete roofs, but added double slope wooden structural roofs on top of the flat concrete ones later on. Results of the field investigations revealed that, in the last 30 years, concrete structure flat roofs have been widely applied in the researched region. However, since many of them perform badly in the rainy seasons, the traditional slope roofs have largely been revived in the recent years. In many cases, a double slope wood-tile structural roof is added on top of an existing flat roof. (Fig.3.)

![Figure 3. Left: traditional rural house with a double slope roof. Right: contemporary rural house with a double slope roof on top of a flat roof (photo taken and edited by Yu LIU).](image)

Semi-outdoor Space. Traditional rural houses in the researched region mostly have a large semi-outdoor space underneath the deep eaves of roofs. This helps not only in providing good connections between indoor and outdoor spaces, but also in accommodating a variety of family activities. In the hot summer season, the cool semi-outdoor spaces are used even more often than the indoor spaces during daytime.

In the contemporary rural houses, there are still semi-outdoor spaces, which are not under eaves, but under balconies. The depths of such spaces are much smaller and they are much less used comparing to the traditional ones. (Fig.4.)

![Figure 4. Left: traditional rural house with a large semi-outdoor space underneath a deep eave. Right: contemporary rural house with a relatively smaller semi-outdoor space underneath a balcony (photo taken and edited by Yu LIU).](image)
Summary and Further Researches

The preliminary investigations of this research revealed the following: 1) linear form is a typical form of building clusters, which is largely defined by the rivers or hills of the region; 2) compact layout, double slope roof and semi-outdoor spaces are the typical forms of individual buildings that directly correspond with the hot and raining mountainous environment of the researched region.

Further researches are recommended to investigate deeper into the background reasons regarding the evolution of the forms of rural houses in the researched region and to explore whether & how such forms can effectively respond to a fast changing environment in the future.

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