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THE STUDY ON THE DISTRIBUTION OF VOLUME IN TRADITIONAL VILLAGE BUILDINGS BY THE MIDDLE REACHES OF NANXIJIANG RIVER IN SOUTHEAST CHINA RURAL AREA

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ABSTRACT: This article is a summary for our studies on the village's volume in Nanxijiang River drainage area that is in the rural area of Wenzhou in Southeast China Zhejiang province. In this area, many old villages are in their saturation. During our studies, we have found that the volumes including density and plot ratio are distributed in a special way. After statistics, we find out a volume model to describe the villages' volume distributions and we will use the model to support the further constructions in the area.

Keywords: Nanxijiang River drainage area, volume distribution model

INTRODUCTION

Introduction of the Area and its Villages

Nanxijiang River is the last branch of Oujiang River, which glides the northern rural area of Wenzhou in Southeast China Zhejiang province as is explained in Figure 1. In this area, abundance rainfalls and dense rivers are its characteristics. In summer, typhoons always bring a mass of sudden rainfalls. There are dozens of ancient traditional villages located in the Nanxijiang River Drainage Area (Fig 1).

Fig. 1 Location of Nanxijiang River drainage area and the villages

From Jin dynasty (AD265-AD420), the area had been developed step by step. Because of the surrounding mountains, this area has become an unaided countryside even in nowadays. Figure 2 illustrates that the more faraway from the Wenzhou city the more uncultured the villages. The villages had become a Shangri-la from the outside. Gradually, they had their own economy, culture, lifestyle and language. The dwellers had kept their cultural, customs and villages. They use the water system like what their ancestors used.

Recently, there has been great deal of constructions that are out-of-order in the villages. In the villages with free lands inside the old part, in order to get more rooms, new bricky buildings have been built to replace the old timber ones. However, in the villages without free lands, outside the old part, new parts had been created. In this case, the density of the villages had become inconstant and reached a high level not only in the center of the villages but also at the boundary area, and not only in the old parts but also in the new parts. The high level density brings a lot of challenges and problems. When the density and plot ratio rise, the buildings will get less sun shines; the danger of getting fire will become much greater; the efficiency of roads will decline. In other words, the living standard is getting worse while the density is going up.

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Note: Discussion on this paper is open until June 2008

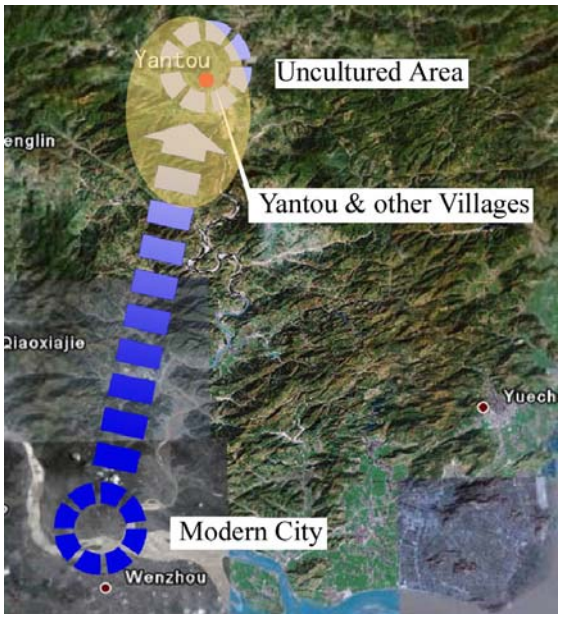

Fig.2 Difference between Yantou and Wenzhou. In this area, depending on the distance, the villages near Wenzhou is much more modern than the villages far away from Wenzhou.

Constructing of New Rural Area Program in China

As the population dwelling in the rural area occupies the main part of the whole country's population, the central government has carried out *The Construct of New Rural Area program.* Two of the primary goals of the program are to improve the living standard and to realize the Sustainable Development in the rural area. Therefore our research's purpose is to provide advice to the program and support the further constructions in the rural area.

THEORIES AND METHODS

The Basic Principles and Theories

In Lewis Munford's "The city in history", each town has its own volume. When the limit has been exceeded, it is going to stick to the container's rib. Like the container, when a village contains too many human beings and buildings, the balance of environment will disappear. So the last scene before the balance's breakup is the limit of the village's volume. In a village, expanding after a long-term balance is a typical image of the limit's breakup.

When talking about a village, we use *density* and *plot ratio* to describe its volume. Density is a planar value. It is a ratio between the residential land and the total area of the village. It describes the horizontal land use intensity. Plot ratio is a ratio between the total area of buildings and the total area of the village. It specifies the vertical land use intensity. With these two main values, we can create a three-dimensional image of village's volume. Beside these two values, the distribution of the density and plot ratio is also very important to describe the character of village's volume.

The traditional water system is as important as road system in the construction of the village. At the very beginning of a village, the water system has been put out. The system has been made from the river outside the village, drains, wells, pools, etc. This system was piped water in ancient times. A whole water system is made from water head, water supply, water use and drainage. Serving people who live in the villages is the chief function. Therefore, the water system and the living standard have a very close relationship. The distribution of the village's volume is also affected by the water system

The runoff value is the average of runoff coefficient in a certain catchments area (The runoff coefficient is the ratio between the rainfall and the outpour). Considering a courtyard, different surface has different runoff coefficient (ϕ) that equals to 0.90 for roof; 0.60 for paving; 0.45 for gravel road; 0.30 for ordinary road; 0.15 for grassplot (Fig. 3). The runoff value expresses the structure of surfaces (roofs) in different materials in a certain catchment area. Runoff value can be calculated by the following formula,

$$Rv = \Sigma Si \phi i / \Sigma Si \quad (1)$$

where, Rv is runoff value; Si is area in different materials (M^2); ϕ i is runoff coefficient.

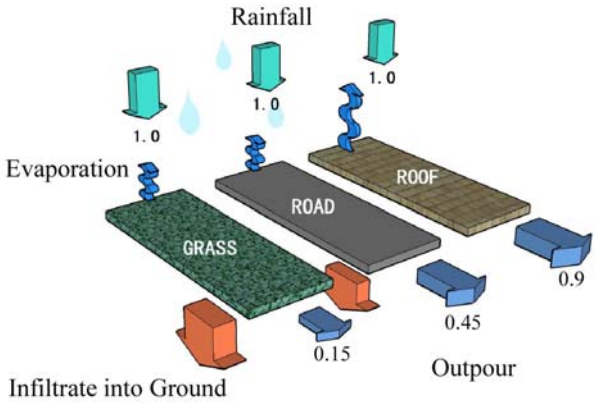

Fig. 3 Different surface has different runoff coefficients

The Study Methods

The study could be divided into 3 steps: data analysis, model creation and model modification. Figure 4 shows the process of our study. During data analysis course, we choose example villages, divide villages into blocks, get basic data and analyze with SPSS. During the study, we

divided the model-villages into 50m × 50m blocks. In this size, we can pick-up the multiple data that we need expediently. If the block's scale is too small, it would not be able to contain enough data. But a large scale will enhance the data processing and calculating.

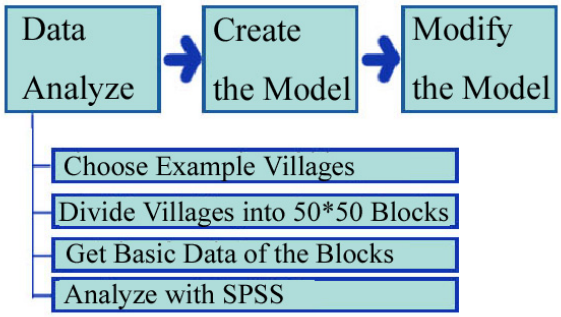

Fig. 4 Study process

How to Choose Examples

Choosing sample villages is the first step during the research. First of all, we must find a village with typical character in saturation. There are two standards of saturation: one is stabilization which means the village's volume remains in an unchangeable situation and there is no new building been built. The other standard is saturatio. That means if one more building was built, the village should have to expand the boundary. Under these two standards, a village is at its volume's limit. So we choose Cangpo Village, Yantou Village and Furong Village as examples. Figure 5 shows the locations of the villages.

Fig. 5 The location of the example villages (Cangpo village, Yantou Village & Furong Village)

After we have chosen the villages and divided the sample villages into 50m × 50m blocks (Figs. 6 and 7) we need the data form each block such as the elevation, the total building area, the total roof area, the pitching area, the distance between drain and residence etc. With these data, we can calculate the density, the plot ratio, the runoff value and so on.

Fig. 6 Yantou Village in 50m × 50m blocks

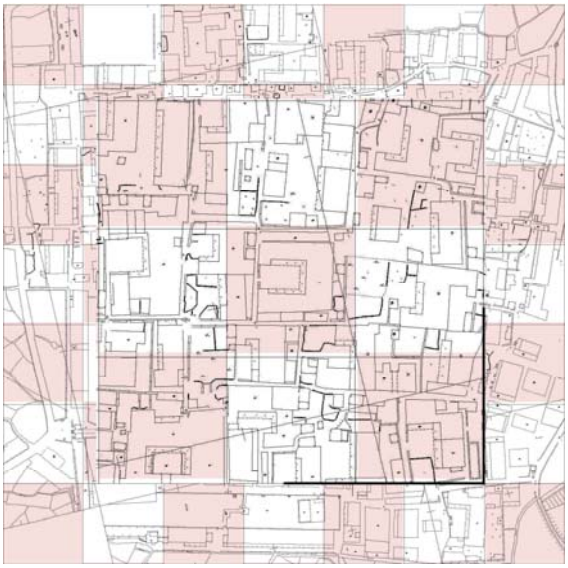

Fig. 7 Cangpo Village in 50m ×50m blocks

DATA AND ANALYSIS

Volume Distribution Model

The relationship between densities and the distance from boundary

In the villages, we have found that the distribution of volumes, including the density and plot ratio, has an

inverse ratio with the distance from the village's boundary. Let's take Cangpo village as an example. Table 1 and Fig. 8 show the relationship between densities and the distance from boundary in Cangpo village. From this data, it is clear that the densities in central blocks are higher than that in the boundary blocks. And from the statistical data in Table 1, we can find that there is a linear relationship between these two factors. We can also find this phenomenon in Furong village as is showed in Table 2 and Fig. 9.

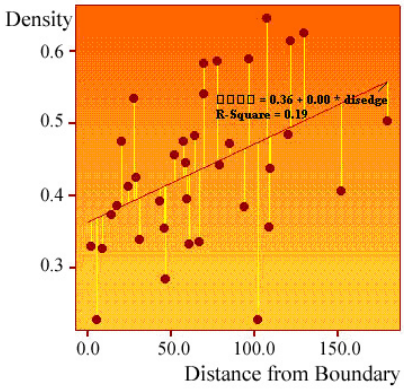

Fig. 8 Relationship between densities and the distance from boundary in Cangpo village

Table 1 Relationship between densities and distance from boundary in Cangpo village

			Density	Distance
Kendall's	Density	C.C	1.000	.358**
		Sig.	.	0.002
		N	36	36
	Distance	C.C	.358**	1.000
		Sig.	0.002	.
		N	36	42
Spearman's	Density	C.C	1.000	.485**
		Sig.	.	0.003
		N	36	36
	Distance	C.C	.485**	1.000
		Sig.	0.003	.
		N	36	42

** Correlation is significant at the 0.01 level 2-tailed

From these figures, we can learn the more centric part it is, the higher density (volume) it has. From a further analysis which examined the relationship between these two factors, the SPSS's result shows a close linear relationship. And we also get a three-dimensional model to explain the volume of the village. In the model, the X-axis and Y-axis are the plan of the village and the Z-axis means the volume.

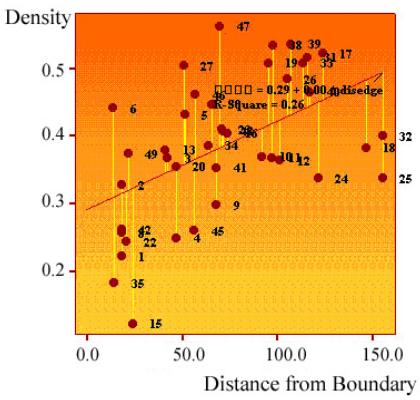

Fig. 9 Relationship between densities and the distance from boundary in Furong village

Table 2 Relationship between densities and the distance from boundary in Furong Village

			Density	Distance
Kendall's	Density	C.C	1.000	.352**
		Sig.	.	.001
		N	40	40
	Distance	C.C	.352**	1.000
		Sig.	.001	.
		N	40	43
Spearman's	Density	C.C	1.000	.520**
		Sig.	.	.001
		N	40	40
	Distance	C.C	.520**	1.000
		Sig.	.001	.
		N	40	43

** Correlation is significant at the 0.01 level 2-tailed

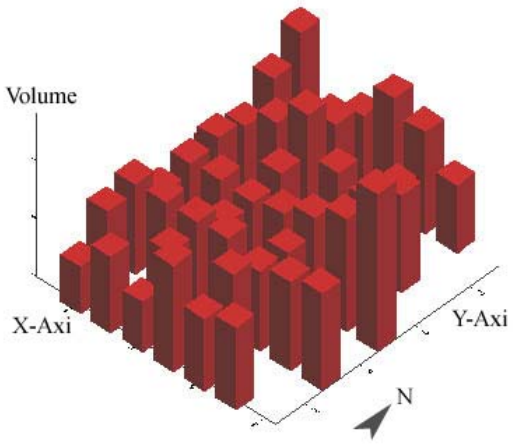

Fig.10 The Model of Yantou's volume distribution

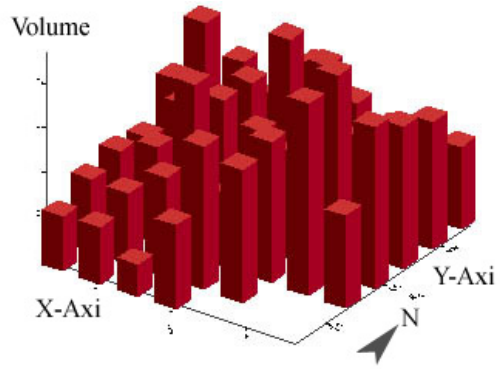

Fig. 11 Model of Cangpo's volume distribution

Figures 10 and 11 are two models of the volume's distribution for the sample villages. It is clear that, in a village, the centric part always has a higher volume and a lot of dwellers for its effective defensive and convenient habitation. However, by the boundary, the volume is usually at a low level.

Relationship between densities and water-fetching distance

Now we are going to check the size of villages. We know that water is important to people's living. The water-fetching distance is a key factor in making certain the scale's limits of a village. From the statistics data plotted in Fig. 12, we find that, in Cangpo village, almost 90% buildings are located in the blocks that have a water-fetching distance within 100m (This phenomenon has also been found in Fig. 13 and Table 3, in all sample villages). The average of the water-fetching distance in the examples is 50.31m. After this study, we conclude that a convenient living condition to fetch water is not faraway from the support drain. If the water-fetching distance is too long, afterward, there are two alternant: one is fissiparism which means creating a new village; the other is to build new drains across the village and divided the village into some parts.

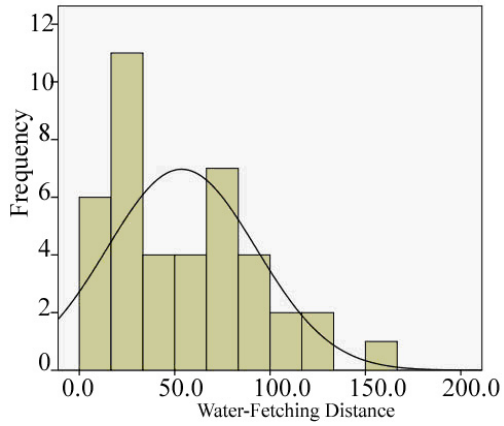

Fig. 12 The frequency of water-fetching distances of Cangpo village

Table 3 Statistic data of water-fetching distance and density in all sample villages

		Density	W.F distance
N	Valid	160	171
	Missing	58	47
Mean		.417956	50.3129
Std. Deviation		.1100794	36.47028
Skewness		-.472	.788
Std. Error of Skewness		.192	.186
Kurtosis		-.121	.165
Std. Error of Kurtosis		.381	.369
Minimum		.1164	.00
Maximum		.6456	156.60

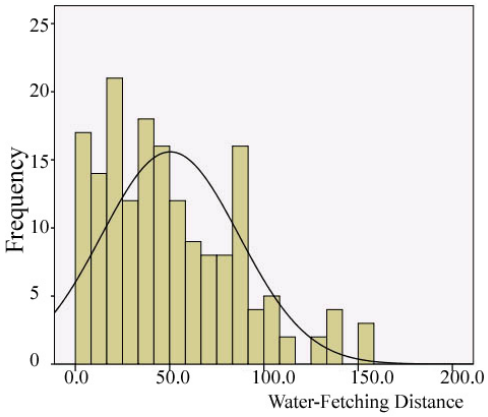

Fig. 13 Frequency of water-fetching distances in all sample villages, almost 90% buildings located in the blocks has a water-fetching distance within 100m

Relationship between density and elevation

In the villages, the statistic data also expresses a relationship between the volume and elevation. From Figs. 14 and 15, it is obvious that in the block having a maximal or minimal elevation, the volume is always kept in a low level, but in the medial the volume, that will be higher. The water flows from the highest to the lowest by its gravity. The max-elevation areas are the water head, and the min-elevation areas sometimes are infrastructures such as reservoirs, which keep water in drought. Low volume will protect the water from contaminated.

Special volume's distribution principle

For a protecting reason, there is a special volume's distribution principle. Inside a village, it does not always show that the more centric part to be the higher volume is. When a drain passes the centric part, the blocks beside the drain will reduce their volumes. For high volume bringing more people and more pollution, the descending will keep the water from contaminated.

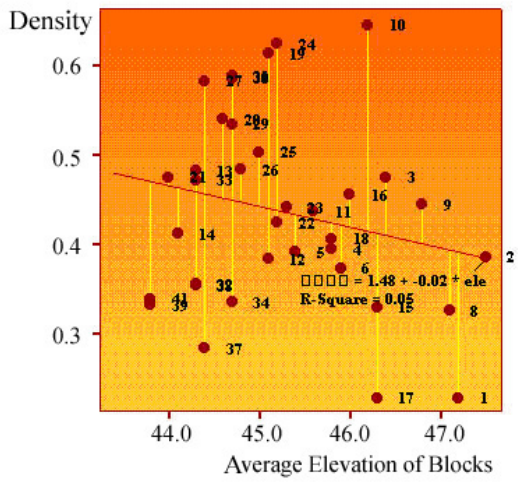

Fig. 14 Relationship between densities and average elevation of the blocks in Cangpo village

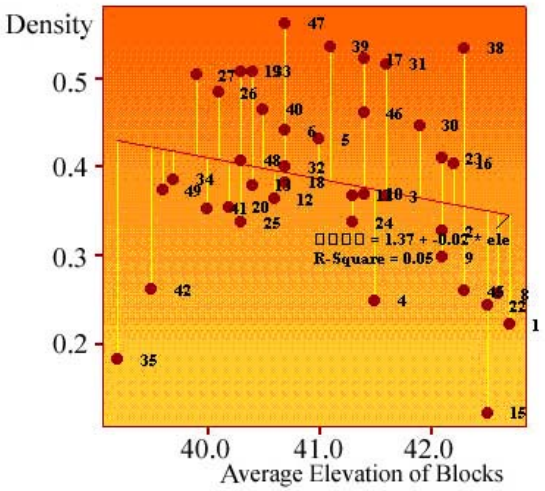

Fig. 15 Relationship between densities and average elevation of the blocks in Furong village

Analysis for Important Parameter

Density, plot ratio and their peak value

In a village, the volume including the density and the plot ratio cannot increase unboundedly. Moreover, the dwellers cannot cover all the land with buildings, because they need roads, gardens, drains and so on. They cannot build tall buildings in order to reach a high plot ratio. The dwellers need more resource such as water, sunshine and space. Both density and plot ratio have their peak values. From statistical data, the highest density in the villages is between 0.6 - 0.7, and the average value is 0.418. The highest plot ratio is near 1.25; and the average is 0.65. (Fig.16, Fig.17 and Table 4)

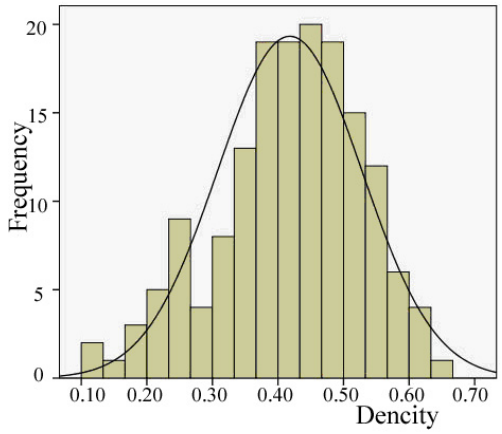

Fig. 16 Frequency of density in all sample villages

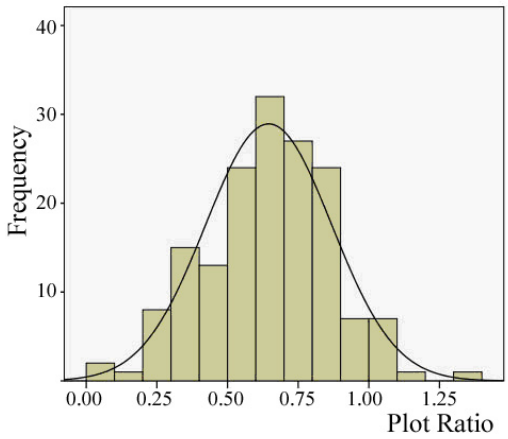

Fig.17 Frequency of plot ratio in all sample villages

Table 4 Statistical data of volumes and their distribution in all sample villages

		Density	Plot Ratio
N	Valid	160	162
	Missing	58	56
Mean		.417956	.6454
S.Deviation		.110079	.22338
Skewness		-.472	-.150
S.Err of S		.192	.191
Kurtosis		-.121	.359
S.Err of K		.381	.379
Minimum		.1164	.00
Maximum		.6456	1.35

Relationship between density and plot ratio

Density and plot ratio are two main aspects of volume. However, the two factors have their own relationship. Based on the statistical data, we get a linear relationship between them as plotted in Figs. 18 and 19. When densities are higher, the plot ratios go together in a linear relationship. The basic reason causing this trend is that

the block where has a high density is always a place with good condition for living. It can offer enough resource for more dwellers. So much more buildings are built in these blocks.

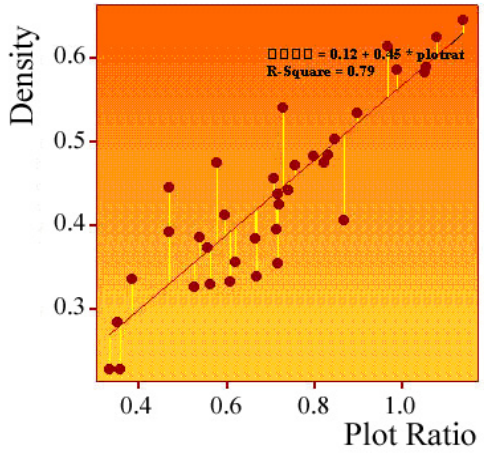

Fig. 18 Relationship between densities and plot ratio in Cangpo village

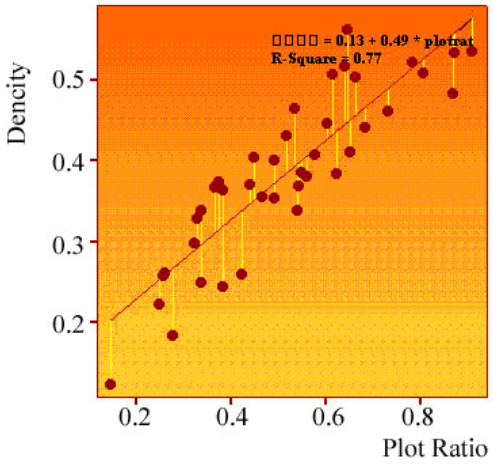

Fig. 19 Relationship between densities and plot ratio in Furong village

Relationship between density and runoff value

There is another interesting relationship we have found. The more centric area it is, the higher runoff value appears (as plotted in Figs. 20 and 21). The runoff value expresses the structure of surfaces (roofs) in different materials in a certain catchments area. A high runoff value means roofs cover the area mostly and this area will let out more rainwater during a rain. And a place with low runoff value will absorb most rainfall. In this case, the drainage will get a balance in rain: the centric part will absorb a little and let out more water but the surrounding parts will absorb more and let out less.

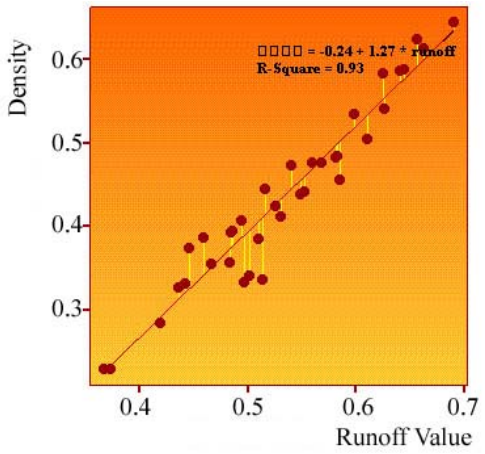

Fig. 20 Relationship between densities and runoff value in Cangpo village

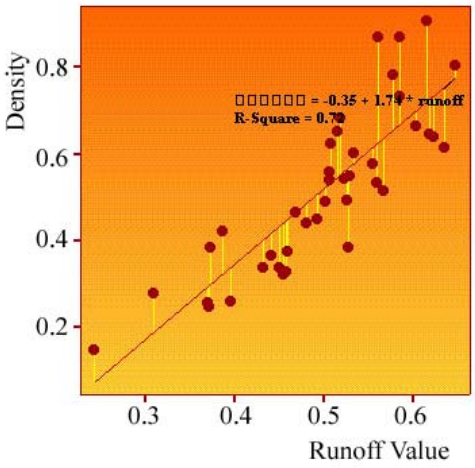

Fig. 21 Relationship between densities and runoff value in Furong Village

CONCLUSION

Three Principles of Distribution

In this area, the villages with sufficient water, the watery factor plays an important role in village's volume distribution. Considering the watery factors, there are three basic principles during the planning cause: protecting water from contamination, fetching water conveniently and draining water fleetly. Under these rules, the volume of villages in this area has been distributed naturally.

Summary of the Volume's Distribution

Around the villages located in this area, there are main support drains protecting the villages like walls. At the lowest part of the villages, infrastructures were built to collect water against the drought. In order to keep the

clean water from polluted, by the drainages and infrastructures, the village's volume is always kept in a low level. However, in the centric part of a village, the volume including the density of building and the plot ratio will be the highest. There is a close relationship between the water-fetching distance and the volume. When the distance is too far away, it will be discommodious to fetch water. In that case, in some big villages, there will be drains across the center of the village, dividing it into parts to cut down the water-fetching distance. Beside these drains and infrastructures, for protecting the clean water, the volume will drop down.

Land Use Intensity Model of Villages

From the study, we get the data and create the volume's model, which describes the village's characters. These basic data show us the peak value of the village's volume in this area. When some values overstep the limits, the balance of the village's volume is destroyed. When the density and plot ratio go over the limits, the buildings will get less sunshine, the danger of getting fire will be much greater, the efficiency of roads will decline and the standard of living will become worse. After that, a village needs outspread or fissiparism.

Further Construction

With the increase of population in villages, the regeneration will be a continual process. The Village's Volume Model will play a positive effect in these processes. The model shows the limits of village's volume including the value of density and plot ratio. Under the guidance of the Village's Volume Model, we can layout an appropriate scope of the village considering the water-fetching distance, and we can plan different volumes in different part of village in order to bring in a comfortable living condition with sufficient sunshine, land and space.

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