APPLICATION OF SPACE SYNTAX IN URBAN MASTER PLANNING:

A case study of Fuyang in China

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Jin Duan
Southeast University
e-mail: seduanjin@263.net

Han Lu
Southeast University
e-mail: hanlu.seu@gmail.com

Abstract

Space Syntax is considered to be very helpful, which can combine the physical space with its socio-economic properties directly in an objective and evaluative way. Currently, it has been effectively applied in many Chinese urban planning projects at different scales, but rarely be used in urban master planning. In order to fill this gap, this paper will take urban master planning of Fuyang as an example, which aims to relive the problem that Chinese urban planners always depend on experiential judgments, and to explore a set of urban planning methods based on quantitive and objective studies.

Keywords: *Space Syntax, Spatial Analysis, Urban Master Planning*

Theme: *Architectural Design and Practice*

1. INTRODUCTION

It has been nearly three decades since the theory of space syntax was advanced by Professor Bill Hillier and Professor Julia Hanson in 1984. At present, there are more than seventy related research institutions in the world. But the development of space syntax is late and laggard in China, which is generally known and accepted by Chinese researchers from the beginning of 21 centuries.

After several years' development, a large number of research results are springing up in China, which cover areas of urban planning, architecture, Chinese garden, landscape, geography and sociology, etc. But during these studies, most are related to the theoretic development of space syntax and its application in some special research, only a few of them involve the application in the projects of urban planning, especially in urban master planning.

Furthermore, in current China, planners always depend on subjective judgments of experience, lack of the respect for the space itself. With the unscientific method, more and more projects become consistent and ineffective. In this case, it is necessary for us to use a quantitative and scientific method.

2. CASE STUDY

Fuyang, located in the north of Huai River, east-central China, is the most populous city in Anhui province. So far, the population has surpassed 10.3 million. The city covers an area of 9775 square kilometers, including 585,000 hectares of cultivated land. The level of urbanization is relative backward. Average personal income is lower than the level in Anhui province.

The transportation here is very convenient. Highway, railway, civil aviation and water carriage can extend in all directions. In particular, the Beijing-Kowloon Railway together with Luofu, Qingfu and other two national important railways run through the city, which makes Fuyang become one of the six important railway hubs in China (Figure 1).

In addition, compared to other cities with the problem of water shortage in Northern Anhui, Fuyang is a typical waterside city, which has abundant water resources. The group of lakes and rivers form a wonderful natural reserve in this city. Especially, after eighteen rivers were knocked through to each other, it forms an organic water network in central area. This is one of the important spatial characteristic of the city (Figure 2).
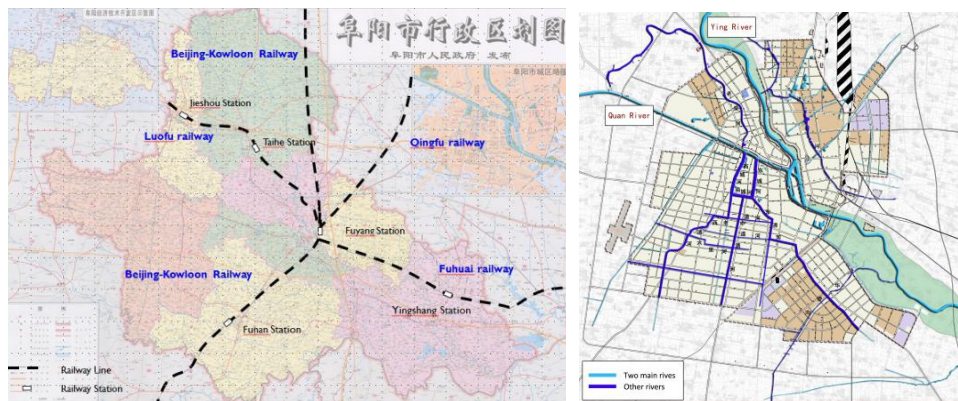

Figure 1 (left) The present railway condition in the territory of Fuyang
Figure 2 (right) The present water resource in the central area.

3. METHODOLOGY

The methodology included two strategic steps to conduct this research.

The first stage is syntax analysis on the present urban spatial structure. It involves a segment analysis of the spatial network at global and local scale.

The second stage is regulation and syntax analysis of the planning city network. Based on above syntactic analysis, we get to know the original spatial structure. In order to improve the rationality of spatial network, some adjustments are made in the new master planning.

4. SYNTACTIC ANALYSES

4.1. Actuality Research Using Space Syntax

a)   Analysis of Integration Measures
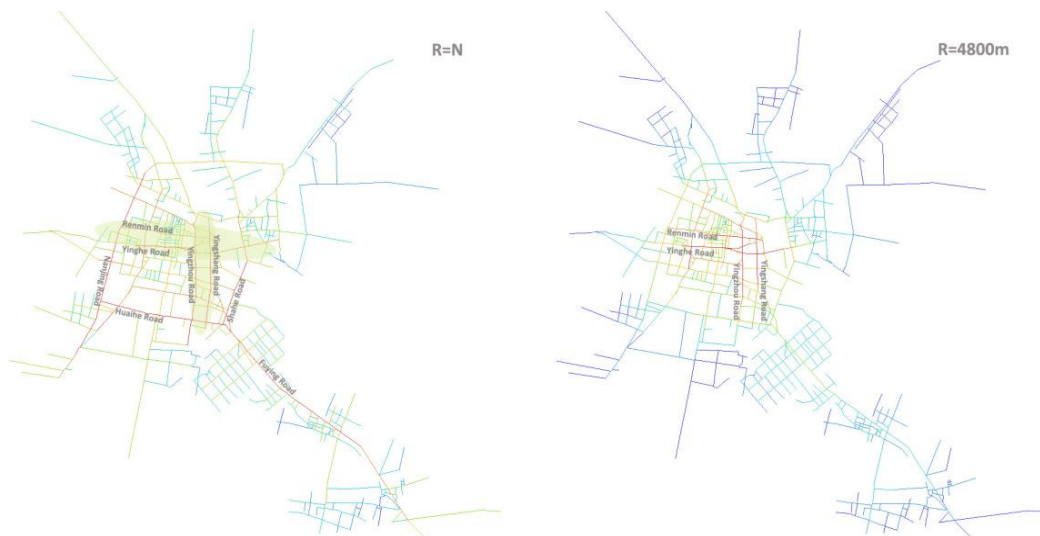
• Angular Integration R

Figure 3 The angular INT map at the radius of N and 4800m

According to the map of segment analysis in Angular INT N, the existing integration structure is strongly located at the urban expressway and urban arterial roads, including Nanjing Road, Shahe Road, Huaihe Road, Yingzhou Road, Fuying Road, Yingshang Road and Yinghe Road. Among them, the four urban expressways have the higher values of the global integration than other two urban arterial roads. But we all know that, unless using traffic vehicles, it is not convenient for us to reach there. Professor Hillier has explained this phenomenon, for some space, if the value of integration (choice) is only high at global scale, it means that it may be the urban expressway for car only (Hillier,1996; Hillier and Lida,2005). In this case, from the point of human behavior, the integration core takes a structure like the Chinese character "井". It has a strong tendency to spread to the surrounding areas along the Yingzhou Road, Yingshang Road and Yinghe Road.

• Angular Integration R

Figure 4 (up) The angular INT map at the radius of 800m, 1200m, 1600m.
Figure 5 (down) The angular INT map at the radius of 2000m, 2400m, 3200m

As the expansion of the radius, the core of the integration changes gradually. In the range of the radius from 800m to 1200m, there is only one sub-center, which is located at the old town.

In the range of 1600m to 2000m, the original integration core gradually moves to the outside of the old town, at the same time, the other three regions had a unobvious sub-center. With the increase of the radius, the four more obvious sub-centers continue to expand and begin to appear a convergent phenomenon.

At the radius of 3200m, they have basically connected to each other. In contrast, there are some urban arterial roads with high values of local integration, including Yinghe road, Yingzhou road and Renming road. At the radius of 4800m, the integration core has move to the intersection of Renmin Road, Yinghe road, Yingshang road and Yingzhou road, which is similar to the integration core of the whole city.

However, no matter what radius is, the historical core of the city has a much stronger integration structure than the other three areas.

• Synergy

Results show that the synergy value is at 0.5. Especially, the old city center has a little lower value than the average value of the whole city (Figure 6).
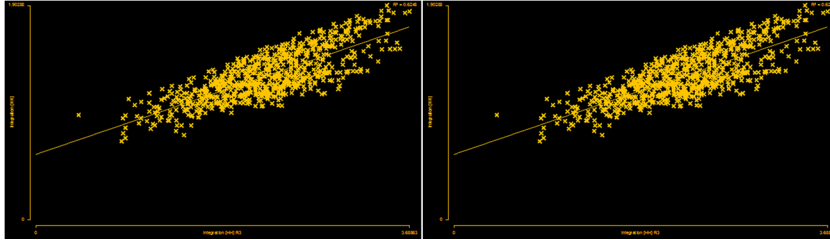

Figure 6 The synergy of the whole city
The synergy of the old city.

b) Analysis of Choice Measures

• Choice N

Figure 7 The choice map at the radius of N and 4800m.

Similarly to the Angular INT N analysis, the result emphasis the urban expressway and urban arterial road as the most easily element to pass through in the network, including Fuying Road, Huaihe Road, Nanjing Road, Guquan Road and Shahe Road, which just constitute the second circle line of the city, furthermore, Yingzhou Road and Yinghe Road have higher values than other roads as well (Figure 7).

• Choice R

Similar to the result of the Angular INT analysis, the 800m to 1600m choice measure illustrate the high value areas focus on the inside of the old city. The higher choice lines focus on Renmin Road and Jiefang Road. On the other hand, the choice measures of other lines in the old city are extremely low.

With the increase of the radius, the high choice area expands to the outside of the old city along Renmin Road and Yinghe Road. Until the radius of 3200m, the core area has achieved to the

Yingzhou Road, Linquan Road and Binhe Road. Generally speaking, roads in the east-west direction are easy for people to cross in Hexi area. In contrast, roads in south-north direction are much more difficult to pass by.

At the radius of 4800m, the high valuable area has begun to move to the Quanbei area and Yingdong area. The development trend to the north-east direction is very obvious. But the lines with highest choice values still focus on the Hexi area, including Yingzhou Road, Yingshang Road, Yinghe Road and Renmin Road.
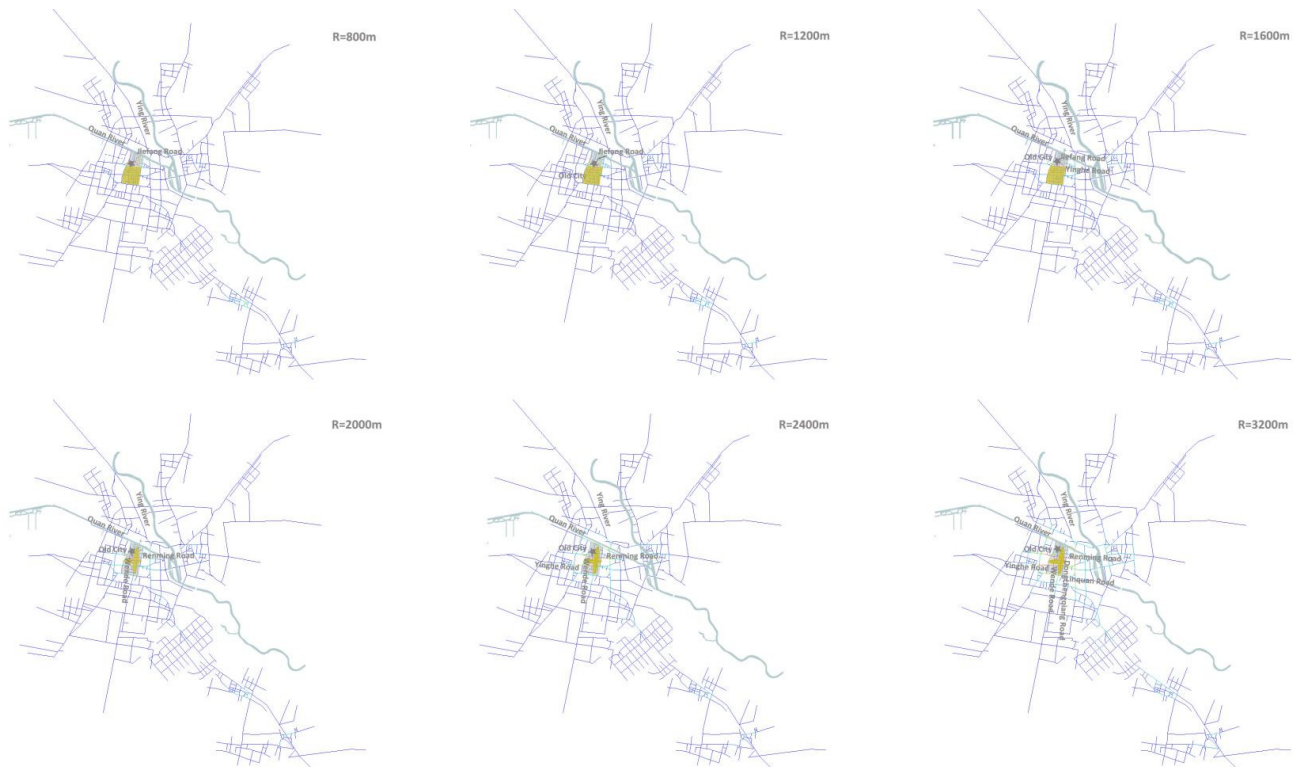

Figure 8 (up) The choice map at the radius of 800m, 1200m, 1600m.
Figure 9 (down) The choice map at the radius of 2000m, 2400m, 3200m.

c) Land use analysis

At the radius of N, expect the urban expressway, Yingzhou Road, Yingshang Road and Yinghe Road have higher value both in INT and Choice analysis.

Compared to the land use condition, the land use types are mainly commercial and administrative, and it is the actual location of the business center of the whole city (Figure 10).

According to the feedback of 3000 questionnaires, most of the Fuyang citizens depend on bicycle for transportation, and the radius of activity range in their daily life is 5000m in average. In this case, the INT and Choice analysis at radius of 4800m can basically represent the regular movement pattern of Fuyang citizens in the large-scale.

The results of INT and Choice measures at different radius reply that there is only one obvious 'sub-center' in the whole city. It is located at the central-south of the old city, nearby Jiefang Road and Yinghe Road. Compared to the land use image, the land use types are mainly residential and

commercial. In the course of investigation, we found that this area is really easy to attract people. But due to neglecting planning and control, most of the roads in the old city are discontinuous, so it is difficult to pass through, which districts the development of this area. We can see that the INT and Choice value are very low in the old city. In addition, compared to the analysis results at different radius, we found that the results at the radius of 1600m are particular close to the present condition. So, we think that the movement patterns at this radius are well accorded with the culture background and human behavior in Fuyang.

In this case, we will choose the radius at 1600m (equal to 20 minutes walking) and 4800m represent the local and global scale in the following analysis of the urban master planning.
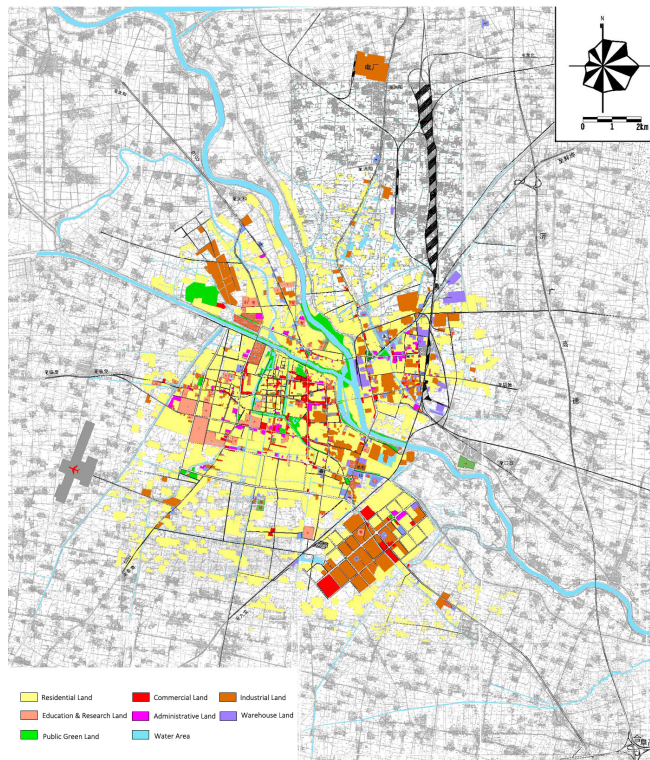

Figure 10 The present land use condition.

d) Findings

There are some spatial differences between the traditional area and new development area. For example, the development area, located in the east part of the city where land use types are mainly residential and industrial, the road lines are configured in the form of large-scale blocks with long axial lines, and they always take an orthogonal configuration. In contrast, the old city, located in the south of Quan River, the syntactic structure is much more intensive with several short axial organization and small islands, and the axial configuration looks much more natural and organic, which is the result of urban self-organized.

• Questions

- Lack an obvious center area in the whole city;
- The feature of sub-center is not obvious, which could not meet the demands of citizens at different scale;
- The problems of end-breakage road and the dislocation of T – junction are serious in the old

city;
- The scale of road network in the new district is too big to get to each other easily;
- The wholeness and relatedness of the urban space are limited to an extent due to the particular geographic environment, such as the airport restricts the city expand to the west, Quan River and Ying River restrict the city develop to the north, the Beijing-Kowloon railway and Ji-Guang highway restrict the city move to the east;

• Suggestions

- Plan an efficient and reasonable transportation system, strengthen the function of the core street in the old city;
- Combine with the spatial structure of Fuyang, establish the multi-level and multi-center urban structure system;
- Optimize the function of different districts, strengthen the connection between the central urban area and other sub-areas, in order to realize a common development;
- Improve the level road network structure, appropriately increase the number of axial lines, which get through the old city, and then improve the density of road in the development area.

4.2. Urban Master Planning Using Space Syntax

A. Plan One

a) Analysis of Integration Measures
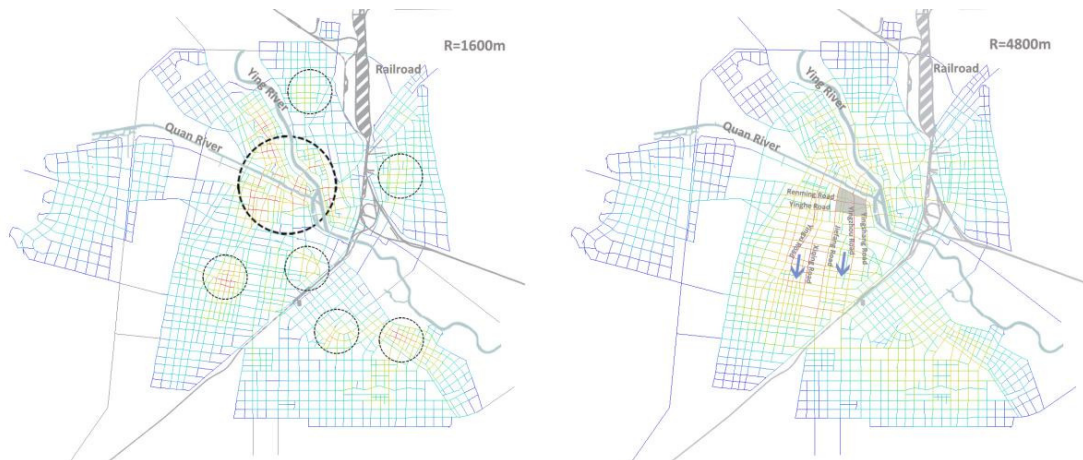
• Angular Integration R (1600/4800m)

Figure 11 The angular INT map at the radius of 1600m and 4800m.

According to the angular INT map, at the radius of 1600m, there will be seven sub-centers in the whole city. The biggest sub-center is the expanded original living center in Hexi area.

At the radius of 4800m, there will be two highest value areas in the whole city. The core lines will focus on Renmin Road, Yingshang Road, Xiqinghe Road and Jiefang Road. Similar to the result of local INT analysis, the global INT value nearby Xiqinghe Road is higher. Interestingly, the local government just wants to move their office location to this area, in order to led the development of this area and set up the second core of the whole city (Figure 11).
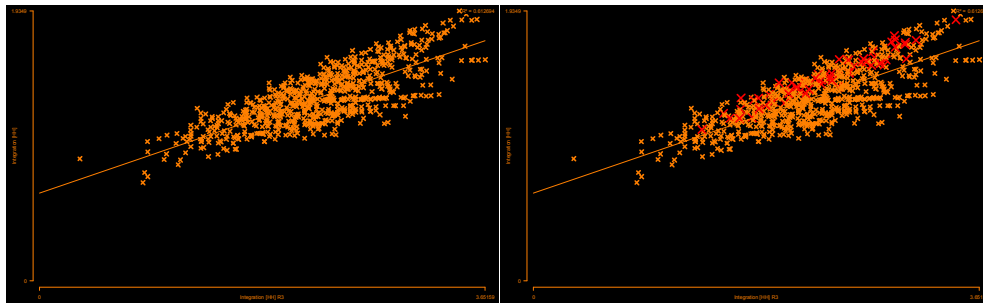
• Synergy

Figure 12 The synergy of the whole city of urban master planning.
The synergy of the old city of urban master planning.

The value of synergy is up to 0.61. Furthermore, the synergy of the old city is higher than the average level of the whole city. It seems that the old city will embed into the urban context without much difficult.

b) Analysis of Choice Measures

• Choice R (1600/4800m)

The result from the 1600m analysis shows that there will be eight highest value areas in Fuyang. The choice measures in the old city will improve a lot.

At the radius of 4800m, the result replies that the development trend to the north-east and south areas become much strong, in addition, the pace of the development in the new district will accelerate in the further. In spite of this, the highest value area is still located at the Hexi area(Figure 13).

Figure 13 The choice map at the radius of 1600m and 4800m.

• Land use analysis

The syntactic analysis result is very close to the planning land use condition. The land use types of the sub-centers are mainly commercial and residential, expect one area which is located at the

new development area (Figure 15). The planning land use type is industrial, which is difficult to form a sub-center.

In this case, we decide to change the land use type to commercial and residential ones to coordinate with the objective development of spatial structure.

The Government of Fuyang would like to set up another urban center nearby the Xiqinghe Road at the same level to the original one. But according to the INT and Choice analysis results, it is difficult to realize the idea, in the respect of the present or the potential development abilities.
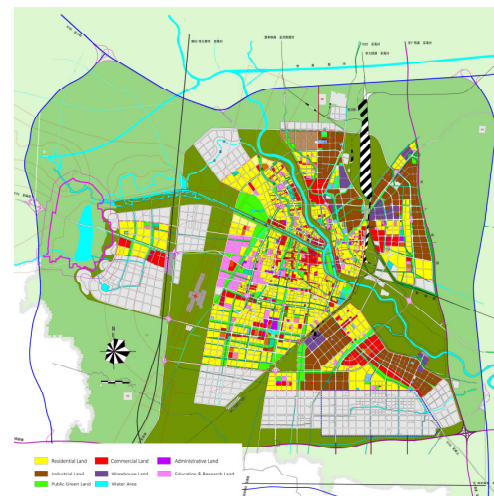

Figure 14 The land use condition of urban master planning

c) Measures to improve

- Improve the number of road cross through the old city, increase the density of Quanbei area and the south area in Hexi area;

- Strengthen the correction of the new development area and Hexi area;

- Change the land use type of industrial to commercial and residential in the new development area.

B. Plan Two

a) Analysis of Integration and Choice Measures

After strengthening the correction of the new development area and Hexi area and increasing the density of the road network, we found that, from the point of physical spatial area, the tentative idea about the Two-core structure could be realized in the further.

At the radius of 4800m, the result shows that the focus of the city development will move to the south of the Hexi area, which is just the location of the new government. In contrast, the development trend to the north-east will be weakened.

At the radius of 1600m, there are still seven sub-centers in the city, and the core range of the sub-core nearby the Xiqinghe Road expands obvious. On the other hand, the range of highest core expands slowly. What is more, it has weakened to some extent, compared with the value of INT in plan one(Figure 15).

Furthermore，the results of analysis choice measures are similar to the analysis of angular integration above(Figure 16).
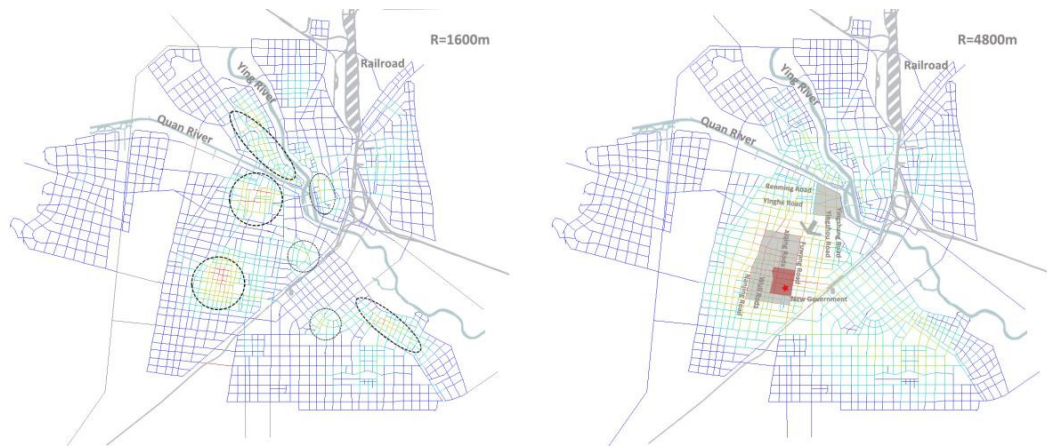
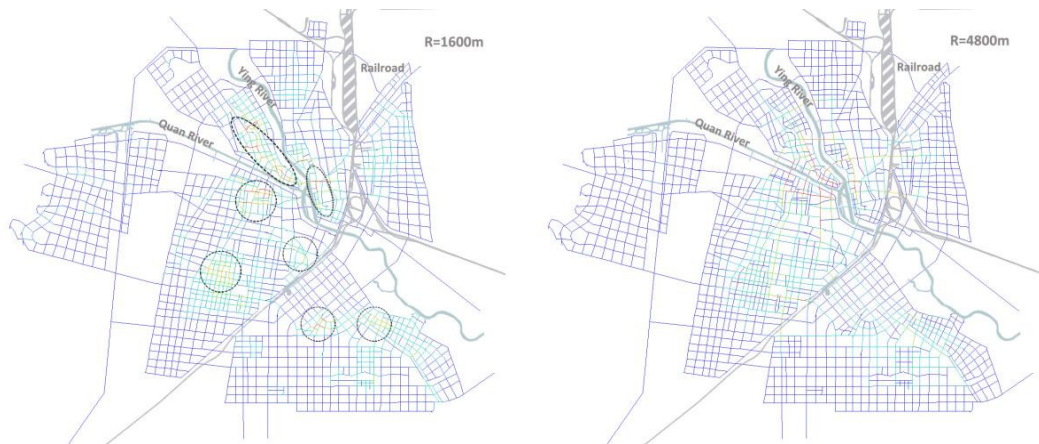**Figure 16** The angular INT map at the radius of 1600m and 4800mm.

Figure 17 The choice map at the radius of 1600m and 4800m.

5. CONCLUSION

In the course of urban morphology evolution, the old town is always the result of self-organization, with several small islands and short axial organization. The city texture is organic and natural. In contrast, the new development area is always the result of hetero-organization in the form of large-scale blocks, with long axial lines and fewer islands. In this case, different areas of the city could not convergent to each other. Furthermore, as the city grows, the integration core generally will move out of the old city. The overall integration structure of the city is however dominated by a series of modern thoroughfares as super-grids, which is a result of compartmentalized development process characteristic of recent fast urban expansion. The lack of connections with its urban context leaves the old town as an independent system that is rather segregated from the city (Haofeng WANG 2012), which will restrict the long-term development of the city. We all know that space syntax is a kind of technology, which reflects the objective development pattern of the city. In this case, with this method, the urban planners can get more scientific guidance and avoid subjective judgments. Then, the urban planning (hetero-organization) can be in harmony with the natural development of the city (self-organization), leading to the fast and efficient urban development in the long-term.

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