HOW GEOMETRIC CHARACTERISTICS OF BLOCKS MAKE SENSE: A GENERAL SURVEY IN BEIJING, CHINA

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ABSTRACT

This paper demonstrates a general block survey in the light of Conzenian tradition and a recent study in similar methods, aiming to identify urban form characteristics of mega city like Beijing, especially the geometric indicators. The study makes a thorough investigation of blocks within urban area in Beijing, and examines the distribution of blocks according to geometric characteristics (shape, size, Shape Index and angle), thus building up a systematic cognition of urban fabric in Beijing. Further, the paper preliminarily explores the relevance between these characteristics and road system and urban planning.

The central argument of the study is to construct a block database for further research and ultimately find out the existing problems and challenges of urban form of Chinese mega city at the scale of block, thus revising classic theories of urban morphology in China. This paper verifies that blocks are important agents of urban form to some extent, and leads to a simple summary of designing rules for blocks which are valuable for urban design reference.

BACKGROUND

The Conzenian school founded by M.R.G. Conzen has developed town plan analysis comprising three distinct 'plan elements': streets, plots and block plans of buildings. How do streets have relationship with plot? The answer is definitely 'block', which is a significant element defining urban fabric. The settlements following modern urban planning basically result in street system at first, then plots as further division of urban area are arranged within blocks. It is block that makes sense in identifying different modern cities.

Chinese cities have seen dramatic changes of urban form with the process of urbanization in past three decades, tight intertwining of traditional urban fabric and modern urban planning is widely concerned. Morphologic studies of Chinese cities have been conducted for a few years, however basic properties of shapes, angle and distribution of Chinese city blocks are not well investigated and documented due to lack of open planning data. The situation is improved in recent years and related studies are increasing gradually. A fundamental morphological analysis of Chinese city block is essential to describe the great regeneration of urban form, thus clarifying the problems and challenges during modern urban planning.

LITERATURE REVIEW

The plan analysis following Cozenian tradition has been identified as a fruitful approach. Evolution of blocks has influence on city development (Baird, 1978) and it is proved to some extent through a case study of city centre (Moudon, 1986). A quantified investigation of 12 city centres' block sizes and forms leads to an excellent comparative study in both historical and contemporary urban fabric and reveals that certain block forms and size perform better than others and have different effect on the process of subsequent development (Siksna, 1990, 1997). Furthermore, kinds of indicators of city blocks are raised to quantify urban fabric, such as compactness, shape index, fractal dimension (Mc Garigal & Marks, 1995, Bogaert, Rousseau, Hecke, & Impens, 2000) etc.

Above all, relative research at block level in China has been conducted more and more. How Chinese urbanization is influence by block size and boundary has been demonstrated initially (Cao, Jiang, 2007). Long et al. make great efforts to build up an open city data source-Beijing City Lab, and carries on studies of urban form at different levels, such as plot direction study (Long et al, 2010), investigation to find out whether all cities are of similar forms or not(Long et al, 2018) etc. However, there is still lack of a systematic exploration of blocks' geometric characteristics of Chinese modern cities. This paper accordingly makes an attempt to focus on city blocks, describing their morphological characteristics, thus exploring the problems and challenges of Chinese urban form.

MORPHOLOGICAL STUDY OF BLOCKS

Figure 1. Blocks defined by city street networks in old town centre(shaded) and main urban area.

Street networks and city blocks are interdependent for their topological relation of spatial structure. Especially in modern cities, blocks' characteristics are basically recognized by street networks, hence 'block' is defined as land surrounded by either city main roads, secondary roads or their branches. Provided by Beijing City Lab (Long, 2019), 4594 city blocks, including 477 blocks of old town centre and 4117 ones of main urban area in Beijing (Figure 1.), make up a sound basis of the study. Based on mass data of these blocks, GIS and statistics are effective tools to build up appropriate classification and contribute to focus on further analysis.

Shape, shape index, area and angle are main geometrical characteristics of blocks, which are worthy of discussing their features, distribution and evolution.

Block Shape

All the shapes of blocks are sorted into 6 categories after carefully examining and reasonably simplifying: triangle, square, rectangle, L-shape, trapezoid and polygon (Figure 2.). Then it's found that square and rectangular blocks as regular shapes together are the most common types, counting for 42 percent, while triangular blocks are quite rare. The proportion is quite similar in a former morphologic study of plots in Nanjing, revealing that for urban planning, regular shape is relatively adaptive and favored in the long term. Surprisingly, there are 1702 trapezoid blocks (37%) distributing uniformly all over the city, which indicates that oblique roads are quite common (Figure 3.). The distribution of different shapes in old town centre and main urban area implies how old town grows in subsequent development and how new urban area is planned consciously.

Triangle Square Rectangle Trapezoid L-shape Polygon

Figure 2. Categories of block shapes.

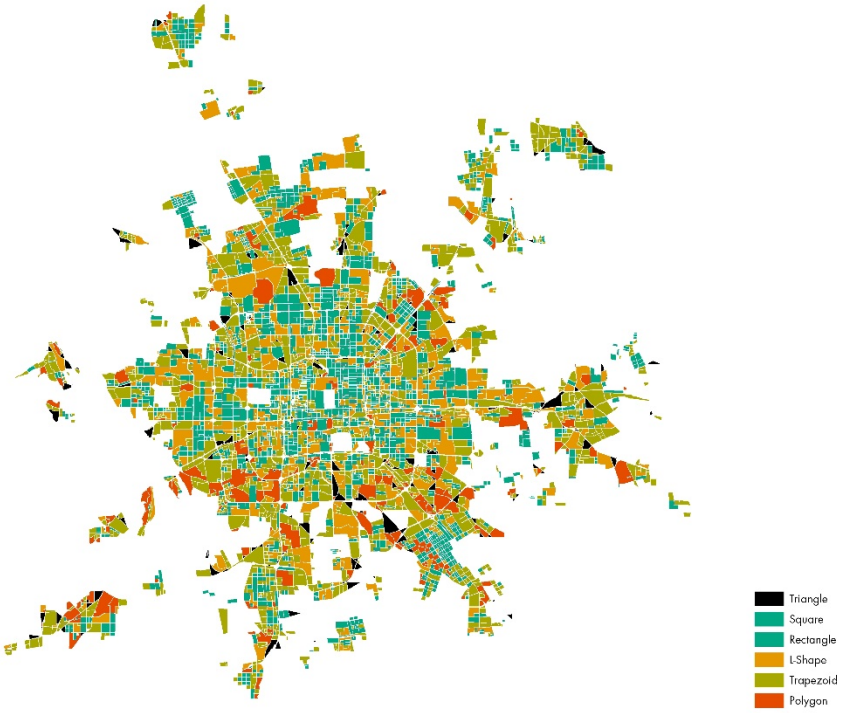

Figure 3. Distribution of block shapes.

Block size and shape-index (SI)

Block size has a significant effect on the nature of urban development (Siksna, 1999). Area is a basic attribute of block, while block form can be described by Shape Index (SI), which is a ratio of original shape perimeter and the one of square with same area. The higher the ratio is, the greater the degree of block fragmentation is. It is a useful indicator to reflect the process of urbanization, for the way of land use has been changed since 20th century.

The statistics of block area shows that size of most blocks are under 19000m^2, making up nearly 66% of all blocks, and it is obviously seen that size of block is increasing radially from old town centre to suburbs, blocks in new urban area are quite larger than those in old town centre by contrast(Fig.3). Urban renewal of old town's blocks are always based on street networks defined before modern urbanization, whose scale is quite small relatively. Meanwhile, new urban area is planned in new century following popular urban theory, economic benefit and policies, thus forming many blocks at large scale to accommodate increasing population.

In terms of Shape Index (SI), values of SI are mainly around 1.0, which shows that most blocks' boundary is not that fragmentized or it has not been changed too much by subsequent urban development.

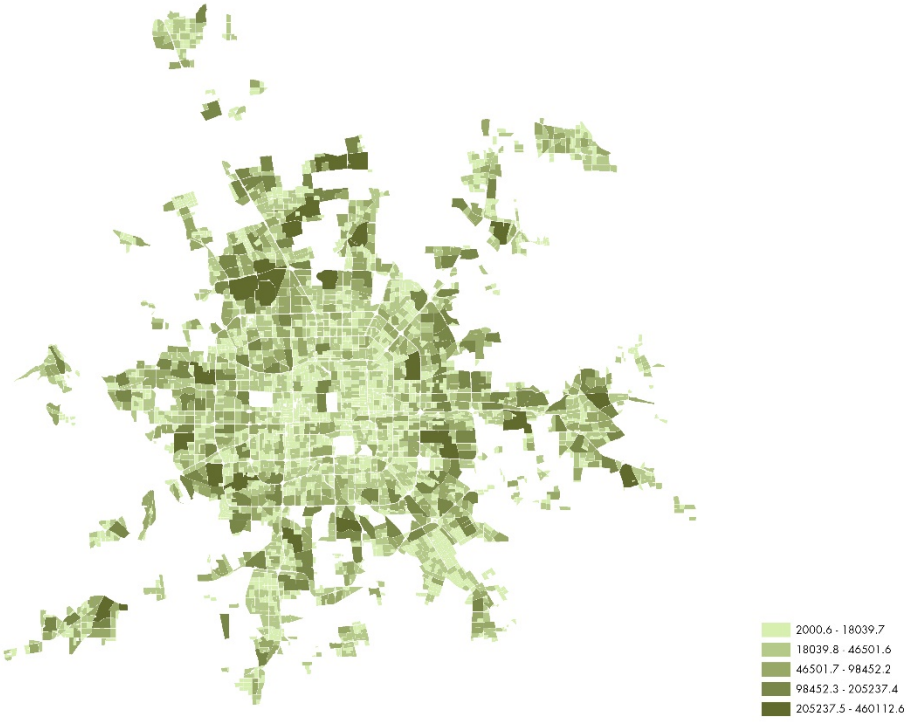

Figure 4. Distribution of block areas.

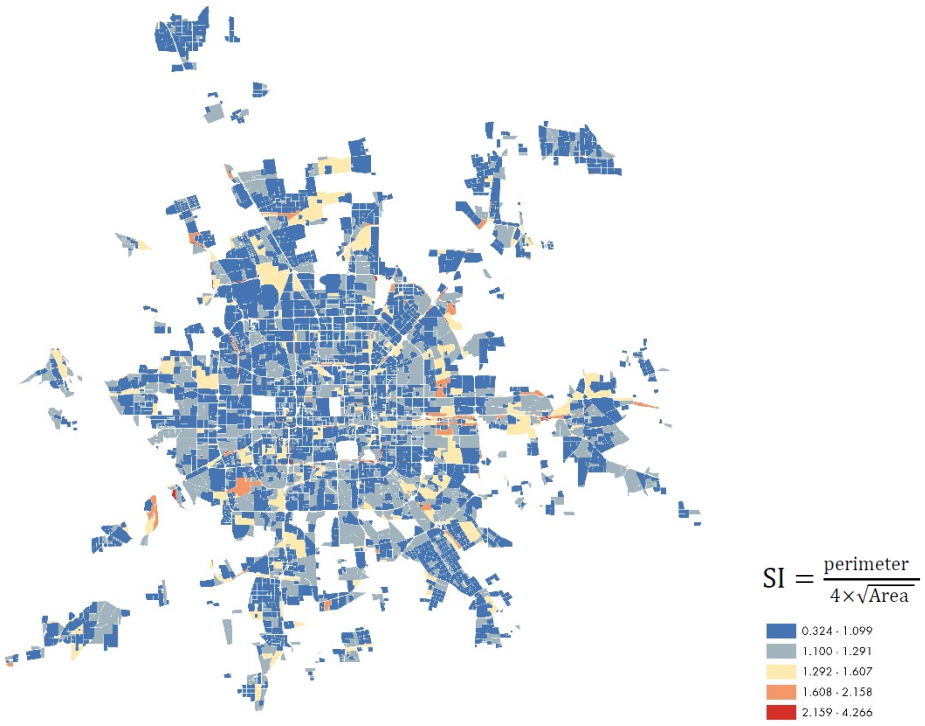

Figure 5. Definition of shape index (SI) and distribution of block SI.

Block Angle

Long et al. put forward the term of 'parcel direction' to analyze spatial characteristics of urban form quantitatively at plot level and take the city of Beijing as an example (2010). Blocks are divided by roads of different levels, and made up of several plots within, thus block angle can be identified by 'parcel direction' indirectly. From their findings, it is demonstrated in the case of

Beijing that the urban form in terms of the parcel direction can be divided into four types, including normal, slanting, mixed and ecological types; the direction is not correlated with the perimeter, area, or compactness indictor of parcels; the parcel direction is explicitly spatial heterogeneous, and the probability density function of the parcel direction can be adopted to examine the urban form. And finally the parcel direction can be used to evaluate to what extent the planned form inherits the historical form via comparing the parcel direction index of the two forms. Long's investigation offers an effective method to clarify the similar properties of city blocks in the future.

GENERAL RULES OF BLOCK MORPHOLOGICAL CHARACTERISTICS

Block shape/angle and urban planning

It's well-known that there is an obvious hierarchical structure in ancient Beijing city at different levels and the road network is a regular grid. The study above reveals that in old town centre, the original planning structure is mostly kept, which results in more regular block shapes and north-south block directions. In other main urban areas planned following modern planning theories to accommodate increasing population, the road orientation varies instead of a vertical and horizontal network, thus forming more trapezoid block shape and various block angles. Since block shape is related with road planning and division, it's recommended that city block is divided into regular shape like square and rectangle. In another Chinese case, the city of Dalian started new town planning after occupation of Tsarist Russia at the beginning of 20th century, when radial pattern of road was popular, thus forming some irregular block shapes like trapezoid, pentagon etc. During the following processing of urban development, these irregular block shapes were still kept while the inner plots were divided into regular shapes as much as possible for equal distribution of land and commercial deal. Block shapes basically remain unchanged for they are mainly defined by city main roads, while plots vary more in subsequent urban development.

Block angle is mainly influenced by urban planning, in other words, the road system makes sense. But why the ancient town centres in Beijing, Dalian etc. keep a traditional and regular block system while in other main urban area the distribution of block shape looks like more disorderly? Diverse road systems lead to various block shapes and angles, which is not easy to restrict the plots pattern within, thus creating an obvious contrast of urban fabric between blocks and inner plots.

Block area/shape-index and urban renovation

Statistics of block area shows that super-blocks are quite common in new urban area of Beijing. It's demonstrated in Siksna's study that large blocks' accessibility is compromised and they have all developed finer circulation meshes during the late development. The density of road network is quite intensive in old town and keeps a relatively stable state, the scale of blocks is consequently smaller and easier to remain unchanged than those in new urban area. From main road system to these branches within large blocks, once they are not planned after fine designing, it easily brings out a disorder urban fabric. Block shape indicates topological block form as a whole, while shape index is defined to assess the detail of how block shape varies subsequently during urbanization. Same as above reasons, oversize blocks eventually are divided into smaller ones with spontaneous and irregular road system for better land use.

For the influence of block area/shape-index above, it's essential to control block scale or area reasonably in urban planning. Considering block angle together, oversize blocks have an effect on road system in the city, which will make a difference in plot pattern in turn. Siksna suggests that 80-

110 meters road interval will benefit the development of downtown area for it is easy to keep the initial form with urbanization. Therefore, control of shape and shape index is of great necessity to inherit the initial urban spatial characteristics and more effective use, leading to a more sustainable urbanization system.

CONCLUSIONS

The paper pays attention to block level in the light of Conzenian morphological study. By investigating 4594 blocks in Beijing main urban area as mass database, geometrical characteristics of blocks and their influence have been examined. GIS and statistics provide effective ways for processing data to articulate the classification in typological analysis.

Studies above investigate urban form of Beijing city preliminarily to reveal the overall distribution of block shapes, angles and areas, which can be seemed as an opposite process of urban design. All these achievements verify that blocks make great sense in urbanization following Conzenian tradition in Chinese modern mega cities and lead to a simple summary of designing rules of urban planning at block level, which are valuable for urban design reference.

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