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RESEARCH ON URBAN SPATIAL FORM OF URBAN VILLAGE IN NEW DATA ENVIRONMENT — THE EXAMPLE OF XIASHA VILLAGE OF SHENZHEN CITY

LA MORFOLOGÍA DE LAS URBAN VILLAGE EN LA ERA DE LA DATIFICACIÓN. — EL EJEMPLO DE XIASHA VILLAGE THE SHENZHEN

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Dedication:

To my parents and my brother.

Abstract:

Currently, urbanization has become a global phenomenon. It pushes the human society to go forward, but meanwhile has produced numerous social problems. In China, the urban village revitalization coming with urbanization needs to be solved urgently. In the internet era, the generous data provides all-sided, objective, instant and dynamic basic data. They can help us to study this problem. This paper firstly explains the definition of Chinese urban villages, and studies the history of Shenzhen's urban villages. And then, from the macroscopic, mesoscopic and microscopic levels, using different tools and other new data to make a research on urban spatial form (morphology) of Shenzhen's urban villages. Finally, according to the results of the study, the revitalization strategy of urban villages is provided.

Key word: morpholoy, big data, Revitalization strategy

Resumen:

Actualmente, los procesos acelerados de urbanización y ocupación del suelo se han convertido en un fenómeno mundial. El crecimiento de las ciudades ha promovido el progreso de la sociedad, pero también ha producido numerosos problemas. En China, la revitalización de las aldeas urbanas (urban village) consecuencia de los procesos de urbanización necesitan encontrar soluciones urgentemente. En la era de Internet, la revolución de los datos nos proporciona información básica, objetiva, instantánea y dinámica. Toda ella puede ser de gran ayuda para estudiar este problema. En este trabajo primero se aborda una introducción y contextualización a la definición de los urban village chinos, y se estudia la historia de las urban village de Shenzhen. Después, se aborda un análisis a escala macroscópico, mesoscópico y microscópico, tratando de sacar partido a los datos disponibles que caracterizan el funcionamiento de dichas villages para hacer una investigación sobre la forma urbana espacial de las aldeas urbanas de Shenzhen. Finalmente, según los resultados del estudio, se proporciona la estrategia de revitalización de los urban village.

Clave palabra: morfología , datificación, estrategia de revitalización

Resum:

Actualment, els processos accelerats d'urbanització i ocupació del sòl s'han convertit en un fenomen mundial. El creixement de les ciutats ha promogut el progrés de la societat, però també ha produït nombrosos problemes. A la Xina, la revitalització dels llogarets urbanes (urban village) a conseqüència dels processos d'urbanització necessiten trobar solucions urgentment. En l'era d'Internet, la revolució de les dades ens proporciona informació bàsica, objectiva, instantània i dinàmica. Tota ella pot ser de gran ajuda per estudiar aquest problema. En aquest treball primer s'aborda una introducció i contextualització a la definició dels urban village xinesos, i s'estudia la història de les urban village de Shenzhen. Després, s'aborda una anàlisi a escala macroscòpic, mesoscòpic i microscòpic, tractant de treure partit a les dades disponibles que caracteritzen el funcionament d'aquestes villages per fer una investigació sobre la forma urbana espacial de les aldees urbanes de Shenzhen. Finalment, segons els resultats de l'estudi, es proporciona l'estratègia de revitalització dels urban village.

Clau paraula: morfologia, datificación, estratègia de revitalització

CONTENTS

1. INTRODUCTION

1.1 Background

"Surround the countryside with the cities."

Urban villages are villages that appear on both the outskirts and the downtown segments of major Chinese cities. They are surrounded by skyscrapers, transportation infrastructures, and other modern urban constructions. Urban villages are a unique phenomenon that formed part of China's urbanization efforts. Along with acceleration of China's urbanization, more lands were required for urban sprawls. The villages once located on outskirts of cities were compulsorily purchased and turned into urban land by the government. However, many policies and systems (The dualistic structure system of urban and rural areas) (Table 1.) existed in China for a long time. It was unlikely for them to make a quick adjustment to the dramatic changes brought by rapid urbanization. As a result, urban villages have been evolved into a form of space not compatible with the city's overall structure. Though these urban villages have been planned as urban land, the rural systems, particularly the collective land system, still remain. All these differences between urban villages and urban areas in terms of land use, planning, management, construction, social security, and social culture have upset the orderly development of cities.

An urban village is within the overall urban planning, with the land ownership mainly being collectively-owned. The land for previous rural human settlement is maintained or partially maintained. Though being a part of urban planning, an urban village has its human settlement environment and management separated from the modern city management. The land and the land attachments still constitute the major economic sources of an urban village. To sum up, an urban village is a community formed on the basis of the primary relationship (geographical and blood relationship) rather than the secondary relationship (industrial and contractual relationship).

The phenomenon exists widely in Chinese metropolises, and becomes an increasingly prominent problem especially in Beijing, Tianjin, Chongqing, Shanghai, Wuhan, Guangzhou, Shenzhen, etc. (Figure 1. and 2.)

Figure 1. View of Xian village, Guangzhou, China.
Source: web.

Figure 2. View of Gangsha village, Shenzhen, China.
Source: web.

The dualistic structure system of urban and rural areas	
The beginning	In China, the dualistic structure system of urban and rural areas was formed in the mid-1950s. It is a household-registry barrier between urban and rural areas. On January 1958, the 91st meeting of the Standing Committee of the National People's Congress (NPC) discussed the adoption of the Regulations of the People's Republic of China on the Registration of Household-registry, which marked the formation of China's household-registry system with strict restrictions on population movement as the core.
Content	The dualistic structure system of urban and rural areas is based on the dualistic structure system of household-registry, which includes the dualistic structure system of grain supply, non-staple food and fuel supply, education, employment, medical treatment, the old-age insurance, the labor security, the military ser-vice, Marriage, fertility and other 15 aspects of the society. The dualistic structure system of urban and rural areas is artificially divided into urban and rural areas, workers and peasants. They are treated differently in the aspect of politics, economics, culture and other aspects of the unified Chinese society the free flow of personnel and goods is prohibited and thus forms a serious barriers between urban and rural areas. In this dualistic structure system of urban and rural areas, one is composed of the urban community, while the other is composed of farmers in rural society. The strict household-registry system and a variety of policies will limit the farmers' mobility on the land, so that the land becomes a live-lihood of farmers, but at the same time inevi-tably force the farmers to be attached to the land. Accompanied by the loss of the rights and opportunities of the peasantry and the equality of society as a whole, such as equal employment, migration, social security, etc., it is difficult for farmers to live on the land or leave it.

Table 1. The dualistic structure system of urban and rural areas.
Source: author.

The dualistic structure system of urban and rural areas	
Land policy	According to the Constitution of PRC, urban lands are state-owned; while rural lands and lands in city outskirts are collectively-owned (excluding those prescribed to be state-owned). Rural household-registry of a household can have a residential land, the homestead area, shall not exceed the provinces, autonomous regions or municipalities prescribed standards. However, the law stipulates that the collectively-owned lands in rural areas are confined to the agricultural use or self-use. It is banned to transfer the lands to non-farmers for non-agricultural construction. The rural residential lands are often distributed to villagers in a specific city. Urban residents cannot purchase residential lands, rural residences or limited property houses in villages. [1]
The policy in Shenzhen City	On June 18, 1992 the Shenzhen Municipal People's Government promulgated "provisional rules on rural urbanization of Shenzhen special economic zone". In 1992 the Shenzhen Municipal People's Government launched the first time unified land expropriations for urbanization to realize the all rural land in the Shenzhen special economic zone into nationalization. In 2004 the Shenzhen Municipal People's Government launched the second time unified land expropriations for urbanization to realize the all rural land in the Shenzhen city into nationalization."
Termination	In July 30, 2014 the State Council announced the establishment of a unified urban and rural household-registry system. [2]

Continued to Table 1. The dualistic structure system of urban and rural areas.
Source: author.

[1] GENERAL OFFICE OF THE STATE COUNCIL OF CHINA (2007). *Notice on Enforcing Laws and Policies Related to Rural Collectively-Owned Lands.* <http://f.mlr.gov.cn/201702/t20170206_1436113.html> [Accessed: 5 Sep. 2017].
[2] STATE COUNCIL OF CHINA (2014). *Opinions on Further Promoting the Reform of Household-registry System*. <http://www.gov.cn/zhengce/content/2014-07/30/content_8944.htm> [Accessed: 5 Sep. 2017]

Shenzhen is a major city located in Guangdong, China. It is celebrated as the financial center of South China, and one of the four major first-tier cities in China along with Beijing, Shanghai and Guangzhou. Shenzhen was a fishery town. That changed in 1979 when Shenzhen was promoted to city-status following China's adoption of the reform and opening-up policy in 1978. [3] In 1980, Shenzhen was designated China's first Special Economic Zone (SEZ) [4]. As a symbol of China's reform efforts, Shenzhen's development is a history of rapid industrialization and urbanization. From 1979 to 2011, Shenzhen's built-up area skyrocketed from 300 ha to 93,400 ha, a growth of more than 300 times. The growth of its urban population was even more impressive, rising sharply from 30,000 to more than 15 million, a growth of more than 500 times. Shenzhen's GDP increased from 196 million yuan to 1.1 trillion yuan, a growth of more than 5,000 times. [5] All these remarkable achievements of Shenzhen have turned the city into one second to none in the world's history of city development. (Figure 3. and 4.)

However, this does not mean Shenzhen is developing without any problems. There are many urban villages in Shenzhen surrounded by the prosperous urban areas, forming a unique urban landscape. (Figure 5.) It has also brought serious social problems to Shenzhen, at present, Shenzhen is crying for land for its urban sprawl. There have been few idle lands for Shenzhen's further urbanization.

Figure 3. View of Shenzhen in 1985.
Source: web.

Figure 4. View of Shenzhen in 2015.
Source: web.

[3] Economic reforms introducing market principles began in 1978 and were carried out in two stages. The first stage, in the late 1970s and early 1980s, involved the decollectivization of agriculture, the opening up of the country to foreign investment, and permission for entrepreneurs to start businesses. The second stage of reform, in the late 1980s and 1990s, involved the privatization and contracting out of much state-owned industry and the lifting of price controls, protectionist policies, and regulations.

[4] Shenzhen Special Economic Zone, established in May 1980. The initial scope includes only Luohu District, Futian District, Nanshan District, Yantian District; to May 31, 2010, the Chinese State Council approved the Bao'an District of Shenzhen City, Longgang District since July 1 into the Shenzhen Special Economic Zone.

[5] SHENZHEN STATISTICS BUREAU (2016). *Shenzhen Ststistical Yearbook.* Shenzhen.

To seek the state-owned land increment, the Shenzhen Municipal People's Government launched two unified land expropriations for urbanization in 1992 and 2004, respectively, to realize the "regional land nationalization". At that time, it was widely believed that nationalization of land for unified use could eliminate the urban-rural binary structure in Shenzhen all at once. However, many regional villagers and grassroots organizations realized the huge gap between the government compensations and the future land value increase. Thus, a widespread resistant against the "unified nationalization" was launched. Houses were built to retain their lands. During the period, many illegal buildings appeared. Gradually, Shenzhen got evolved into a new binary pattern, "state-owned lands vs. houses of local people". [6]

Hence, Shenzhen's nationalization did not put an end to the urban-binary system. Urban villages become important carriers of the informal housing market. Currently, there are 241 urban villages in Shenzhen (Figure 6.), covering an area of 96,00 ha. By June 2009, there had been 357,000 "illegal buildings" (According to "Decisions of Shenzhen on Handling Illegal Buildings—Left-Over Problems of Rural Urbanization" issued in 2009, illegal buildings can be divided into two kinds based on the land legitimacy. The first kind refers to buildings not on legal lands. These lands nominally belong to the state in name, but a series of problems, including improper land expropriation, unreasonable ecological control lines, and ineffectiveness of land return indexes, have impeded the lands which should have been nationalized from being nationalized. The other kind refers to buildings which have obtained the legitimate land use right. However, due to expansion, extra building and modification, the government refuses to issue the five necessary certificates to the house owner. For example, the private building built by the local resident meets the principle of "one household, one building", but exceeds the upper limit of 480 square meters.

Figure 5. View of urban village.
Source: web.

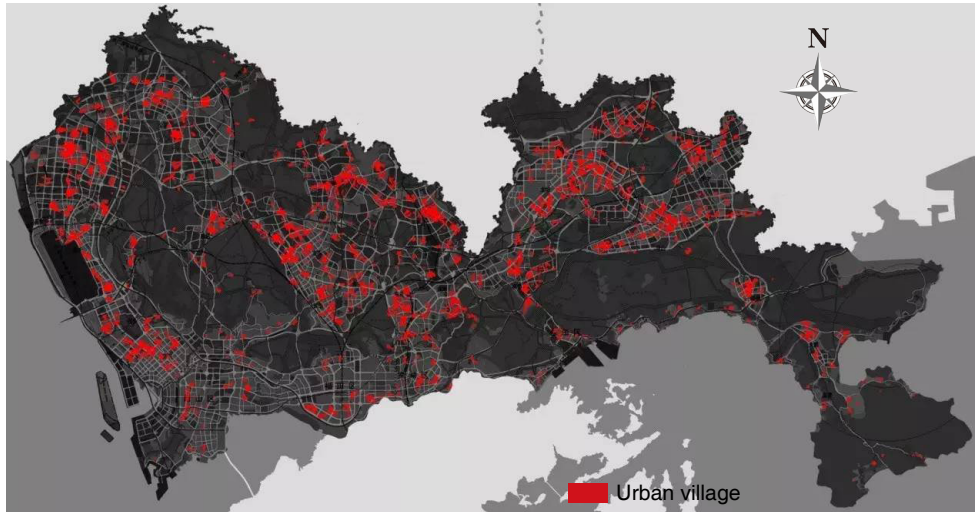


Figure 6. The distribution of urban villages in Shenzhen.
Source: Shenzhen Urban Planning and Land Resources Committee.

[6] NATIONAL SCHOOL OF DEVELOPMENT OF PEKING UNIVERSITY (2013). *Research Report on land system reform in Shenzhen.* <http://www.nsd.pku.edu.cn/publications/reports/2016/0428/26227.html> [Accessed: 20 Jul. 2017]

Illegal buildings in the urban villages belong to the second case) [7] in Shenzhen's urban villages, and the total building area has reached 390 million square meters, accounting for 57.5% and 47.6% of the total, respectively.

More severely, the floating population living in these illegal buildings has been as large as 7 million, nearly half of the total population in Shenzhen. The large floating population plays an indispensable role in Shenzhen's construction. Together with the local villagers, they have built an "informal Shenzhen". Similar to the "formal Shenzhen", the "collective economic organizations of the local residents" also have party organizations, administrative institutions and legal economic organizations (community holdings corporations). These informal organizations have been responsible for public services and social governance of more than half of people in Shenzhen.

Nearby every CBD in Shenzhen, there is a village in the city. Five years ago, I lived in Shenzhen. After a day's work, I left the office located in Chegongmiao CBD. Walking across Xisha Village, I arrived at my home in the residential area adjacent to the urban village. To go through the urban village made me feel as if Alice's adventures in wonderlands. I enjoyed walking among it, and quite soon a turn brought me in view of rows of high-end hotels. However, when I looked up, the low and chaotic residential buildings existed as a sharp contrast. Not far away, the high-rises made up of armored concrete were exhibiting their icy radiance. Despite of people coming and going in great number, it was still a safe place to live. Though the aged buildings stayed close to each other, "dirty", "disorderly" and "bad" were not suitable words to describe the environment there. To me, that place was the most representative of Shenzhen. Living there also inspired me to reflect more on the causes of problems with the urban village.

[7] THE SHENZHEN MUNICIPAL PEOPLE'S GOVERNMENT (2014). *Decisions of Shenzhen on Handling Illegal Buildings—Left-Over Problems of Rural Urbanization*. <http://www.sz.gov.cn/zfwj/zfwj/szfl/201510/t20151016_3283571.htm> [Accessed: 10 Jul. 2017]

Quantitative urban research in the new data environment

In 2016, the Internet penetration rate of Shenzhen was 84.8%, and the mobile Internet created a new form of social life, which subtly changed people's daily life. 79.2% of Shenzhen's Internet users have been online shopping, 58.0% of them have booked taxis online, and 21.3% of them have been exposed to the online education program. [8] The Internet has brought big data, statistics show that the daily data increase is 2.5 exabytes.

The explosive growth of data has made up shortages of many traditional research methods. On the one hand, in urban research through data research and analysis, we can enhance our understanding of the city, and increase the scientific nature of urban planning. We used to use only the statistics from the Bureau of Surveying and mapping, and now from the Internet data mining, intelligent equipment from the extracted data, the data of enterprise itself can serve as the basis for the study of urban; previously, the sample source of urban studies was only sampled, and now we have full sample data; and the data is updated faster and more timeliness; the accuracy of the data is higher and more objective. On the other hand, at present, the commonly-used new data include Point of Interest (POI), navigation data, mobile signaling data, public transportation card data, social media data, etc. A common characteristic of all these new data types is that they come directly from individuals and form a large scale.

Therefore, these data can reveal some issues both microscopically and macroscopically. When individual data are gathered, researchers will not make too many hypotheses about attributes of the individuals, because individual preferences or group preferences remain unknown until after a thorough analysis. In terms of city research based on the big data, the research objects are in essence numerous individual behaviors, and the research results are a reflection of objective phenomena in the real world.

The process of applying data-based city research findings to planning decision-making is actually an indirect process of public participation - a behavioral participation without subjective awareness. On the one hand, urban planning decision-making should take expectations and subjective experiences of stakeholders into consideration. On the other hand, the objective rules reflected by behavioral subjects rather than individual will of decision-makers should form the basis of decision-making. The above decision-making process is an organic combination of the top-down mechanism and the bottom-up mechanism.

In conclusion, using new data, planners can make more scientific and sustainable urban planning, providing the basis for decision making for urban managers, and providing convenience for people to live.

[8] SHENZHEN ASSOCIATION OF ONLINE MEDIA (2017). *2016 Shenzhen Statistical Report on Internet Development.* <http://last.sznews.com/wlwpdf/upfile/20170331171029.pdf> [Accessed: 2 Oct. 2017]

1.2 Research objectives and significance

Research objectives

From the perspective of architecture and urban planning, new data are adopted for a quantitative research of the spatial structure of urban villages. Based on results of the quantitative research, strategies to update urban villages are proposed.

Research significance

At present, Shenzhen is crying for land for its urban sprawl. There have been few idle lands for Shenzhen's further urbanization. According to a preliminary statistics of Shenzhen's land use in 2011, the territory area of the city is 1,993 square kilometers (5 times the area of Valencia), of which 906 square kilometers are for agricultural use; 153 square kilometers are not yet developed; and 934 square kilometers are for construction, accounting for 47% of the total municipal territory. By 2020, the newly-increased construction area, restricted by the land use, will have reached only 42 square kilometers. [9] (Figure 7.)

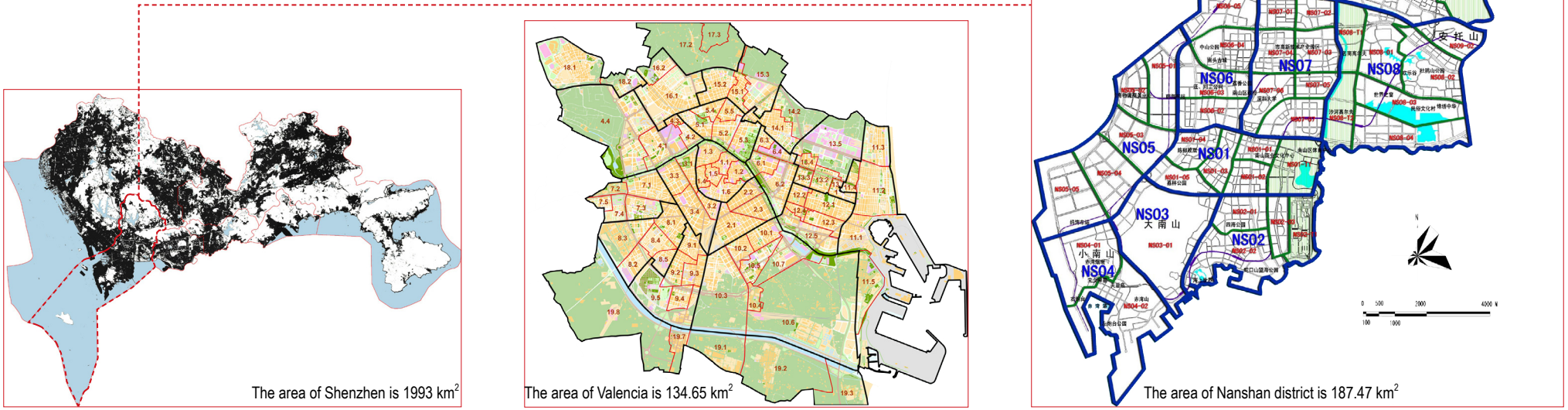


Figure 7. The area of Shenzhen City, Valencia and Nanshan district.
Source: web.

[9] NATIONAL SCHOOL OF DEVELOPMENT OF PEKING UNIVERSITY (2013). *Research Report on land system reform in Shenzhen.* <http://www.nsd.pku.edu.cn/publications/reports/2016/0428/26227.html> [Accessed: 20 Jul. 2017]

On the one hand, Shenzhen neither has the space for further expansion, nor can it dramatically increase the construction land under the current city development framework. In order to get rid of land restrictions, the future development focus of Shenzhen will be shifted to redevelopment of the stock land and improvement of the land utilization rate. On the other hand, the government's construction input in the public rental housing is inadequate. (Figure 8.) Consequently, most public rental houses are located in the marginal areas of Shenzhen, which is far away from the downtown area and thus lacks convenient transportation conditions and other service facilities. This has led to vacancy of many public rental houses.

Update of urban villages is a critical issue facing Chinese cities. These urban villages are often located in the central position of a city, thus enjoying convenient transportation. As compared with other apartments for renting, they offer a much lower rent for the floating population. Meanwhile, many traditional foods and entertainments are maintained in urban villages, and nearby residential areas enjoy visiting these places. Interests of land owners in these urban villages are often complex. All this enables urban villages to play a greater role in the current city development, but it has also increased difficulty of urban update.

More importantly, urban villages, especially those in Shenzhen (such as Baishizhou Village, Xiasha Village and Shuiwei Village), are irreproducible and nonrenewable. They are contemporary urban spaces with the value of world cultural heritage. As a combination between villages and the city, they are also a combination of the city's past and present. (Figure 9.) Here, many phenomena in the contemporary urban spaces are disappearing, including vigor, youth, mixture, complexity and integration. These daily living scenarios actually represent the profound value of urban villages.

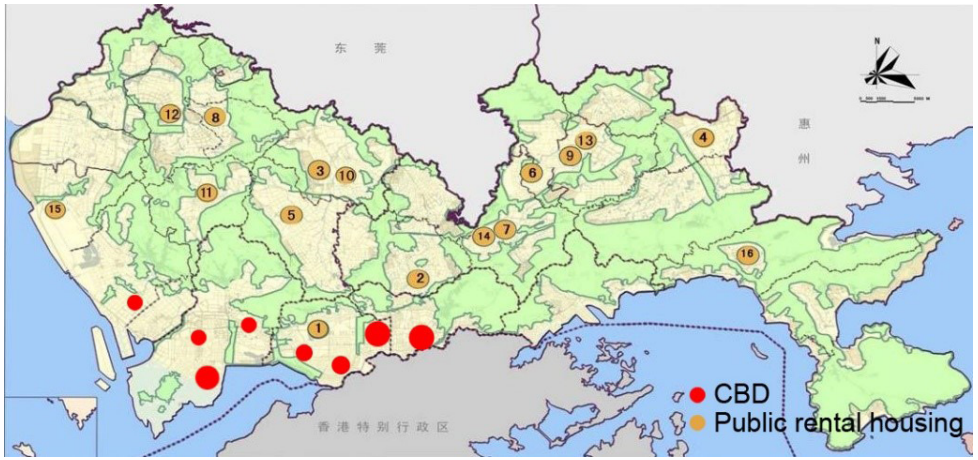


Figure 8. The distribution of public rental housing and urban villages in Shenzhen.
Source: Shenzhen Urban Planning and Land Resources Committee.

Figure 9. Don't dismantle Baidanzhou village activities.
Source: web.

1.3 Scope of research and concept definition

Scope of research

This paper studies urban villages in Shenzhen, especially urban villages within the original Shenzhen Special Economic Zone (Futian district, Luohu district, Nanshan district and Yantian district). (Figure 10.)

Urban village

In this paper, an urban village is within the overall urban planning, with the land ownership mainly being collectively-owned. The land for previous rural human settlement is maintained or partially maintained. Though being a part of urban planning, an urban village has its human settlement environment and management separated from the modern city management. The land and the land attachments still constitute the major economic sources of an urban village. To sum up, an urban village is a community formed on the basis of the primary relationship rather than the secondary relationship.

China's urban villages share many similarities with slums abroad. Both come into being during acceleration of urbanization, and both are low-cost residential areas mainly inhabited by the floating population. The United Nations Human Settlements Programme (UN-HABITAT) defines a slum as a densely-populated settlement area with sub-standard living conditions and poverty as basic characteristics. Based on the definition, the defining characteristics of a slum include a densely-populated human settlement; a sub-standard living environment; and poverty. According to the definition, China's urban villages can also be regarded as slums for the following reasons. First and foremost, urban villages are densely-populated settlement areas with sub-standard living conditions. Take the urban villages in the Pearl River Delta for example. The residential building density reaches as high as 90%. The plot ratio was 6, and the interval was less than 2 m. The ventilation, lighting and fire-fighting are all below standards. Despite of this, a large number of people live in these residential buildings.

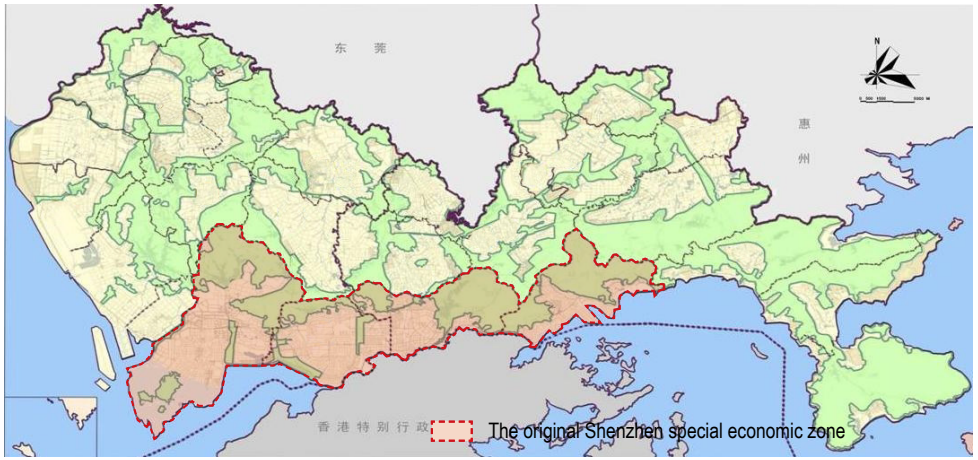


Figure 10. Scope of research.
Source: author.

It is said, in one urban village of Shenzhen, the 183 residential buildings provide 2935 rooms for 6,725 persons. On average, there are two to three persons sharing the same room. The inhabitants are mostly low-income floating population, notably migrant workers. Dachong Village in Shenzhen has a population of 60,000, but only around 1,000 residents are locals, meaning that most are migrant workers at the bottom of the society. Urban villages are like dead corners of urban management. All kinds of people gather there, leading to increasingly prominent environmental problems. “Dirty” and “disorderly” have become synonyms of these urban areas. [10] However, apart from lack of planning, property disputes and a dense population, China’s urban villages are equipped with furnished with complete urban public facilities, including water supply, power supply, gas supply and Internet access. Meanwhile, there are professional property management companies and urban security administration personnel guaranteeing a good order of these urban villages. Moreover, the tenants in China’s urban villages are more diversified than those in slums abroad. Either low-income workers or white-collars having received higher education choose to live in urban villages considering the convenient transportation and low rents. (Figure 11.)

Therefore, though China’s urban villages are similar to slums abroad in many aspects, there have not yet been slums in the strict sense in China.

Figure 11. The street in the urban village.
Source: web.

[10] ZHOU, Yigang (2007). "The Comparison between Two "Urban Disease"——Urban Villages in China and the Western Slum Problem around 19th Centuries". *New Architecture*, 2007, (2), pp.27-31. dio: 10.3969/j.issn.1000-3959.2007.02.007

New data = open data + big data

The new data employed by this research include open data and big data. Open data are a kind of data which are selected and licensed. Open to the public, these data are not restricted by the copyright, patent right or other kinds of management mechanisms. Anyone can use the open data for free publication or other purposes. In generation, open data are obtained from commercial websites, government websites, and social networks. As to big data, they are collected, processed and gathered by using certain software for crawling within a period of time. Mobile phone signaling data, public transportation card consumption records and credit consumption records are representatives of big data. Big data are comparatively hard to acquire. In this paper, the “new data environment” is a generic term for the current big data and open data. [11] (Figure 12.)

Comprehensive evaluation of urban spatial form

The urban system has three core concepts. First, the “urban form” refers to the spatial distribution pattern of various urban elements (including material facilities, social groups, economic activities and public institutions); the “urban interaction” refers to the “interaction” among different urban elements, which leads to integration of these elements into a functional entity or a sub-system. The traffic flows between different functional nodes represent the interaction between urban elements. The “urban spatial structure” refers to the internal mechanism governing the spatial distribution and interaction of urban elements, and it enables various sub-systems to get integrated into urban system pairs. To study the urban spatial patterns relies on analysis of the city’s external form, internal structure and their correlation. [12] In other words, analysis of the spatial form of an urban village is to analyze how natural, social and economic elements exert an impact on the special living environment spatially, and how the special spatial form contributes to harmony, progress and sustainable development of a city.

Figure 12. Open data and big data.
Source: web.

[11] LONG, Ying and LIU, Lun (2017). "Four Transformations of Chinese Quantitative Urban Research in the New Data Environment". *Urban Planning International*, 2017, 32(1), pp.64-73. dio: 10.22217/upi.2015.299
[12] BOURNE, Larry (1971). *Internal Structure of the City.* New York: Oxford University Press.

1.4 The review of research

Review of update of research about urban village

Since the binary structure of census register and land management is exclusive to China, urban villages are a special phenomenon in China. In other countries, slums and old city degradation areas are similar to China's urban villages, but are not urban villages in the real sense. Therefore, China can make reference to regional update findings of other countries, but should not copy them all without considering its national conditions.

(1) Urban Revitalization

After World War II (WWII), population and industries started getting shifted to outskirts of Western cities. This, on the one hand, turned outskirts into new economic growth spots. On the other hand, the original downtown area was on the decline. In order to cope with the problem, Western countries launched an urban update movement. These urban update movements mainly focused on three aspects, namely renovation and update of the old residential area, redevelopment and update of the downtown area, protection and update of the historical and cultural area.

The old city update process in Western countries experienced three periods, namely elimination of "slums", neighborhood reconstruction, and community update. The basic concept of the old city update also transferred from the large-scale "modern movement" with a simple objective and narrow content to "sustainable development of the residential area" with diverse range of objectives and connotations. In the very beginning, the large-scale renovation featured shape planning. This was to solve the problem of housing shortage after WWII. However, modernist urban planning with shape planning at its core and the urban reconstruction guided by architectural theories failed to achieve expected effects. On the contrary, historical elements and diversity of many old cities were lost. Worse still, slums kept sprawling, aggravating decline of the downtown area. Emergence of ideas, including sustainable development and human living environment, boosted development of the old city update theories and practices. "Community development" planning, advocacy planning, progressive planning and participatory planning were subsequently put forward, with more emphasis laid on the balance between humans and the environment. Meanwhile, importance of public participation was gradually realized. A multi-party participation among the government, communities, individuals and developers was promoted to effectively improve the environment, create more job opportunities and increase neighborhood harmony.

Based on the above urban update theories, large-scale renovation which separates the current city development pattern from its history and culture is not a preferable update model for China's urban villages. Efforts should be made to keep the original spatial pattern of villages with regional characteristics, and urban update should be targeted at creating diversified urban communities.

(2) Transformation of slums

The UN-Habit (United Nations Human Settlements Programme) divides transformation of slums into a series of specific activities, including situation analysis, city development strategies and feasibility research. Only after all this pre-stage work is done can a financial and institutional mechanism be built. The follow-up measures include transformation of critical infrastructures, including roads, drainage, hygiene and water supply; provision of basic health and educational services; resettlement of residents; provision of loans for housing restoration; creation of job opportunities, etc. All these measures adopted can guarantee sustainability of the project.

In coping with problems in slums, the British government, besides building new, cheap residences, has also paid great attention to old housing transformation in the old city. In the very beginning, a large-scale removal of slums was launched. Later, the focus had been shifted to maintenance of the existing community system and transformation of non-standard residences. To provide adequate funds for the transformation efforts, corresponding institutions, such as residential joint development companies, were set up. The government offered not only economic subsidies, but also preferential policies for them. These institutions were responsible for improving the residential environment of old residential areas and furnishing them with necessary community service facilities. Once finishing these tasks, the company transferred the residential areas to the residential association, the latter of which would then sell or rent the houses. Though the formation mechanism between slums and urban villages is entirely different, the two share similarities in terms of landscape characteristics, population characteristics and community characteristics. Therefore, experiences of landscape environmental transformation and fund-raising of slums abroad can also provide references for transformation of China’s urban villages.

(3) Progress of China's urban village update

Currently, update of China's urban villages is mainly realized through the following models:

(1) full demolition for full new construction; (2) update of public space; (3) partial demolition and new construction for comprehensive development; and (4) preservation and restoration. (Figure 13. and 14.) The current update design pays special attention to forms, functions, and other aspects of architecture, but fails to take the ownership into consideration. As a result, update measures can hardly be effectively implemented. All in all, update of China's current urban villages follows a top-down approach. Though urban villages have been thus made cleaner and neater, the original vigor of urban villages has disappeared. Sometimes, some urban villages are fully dismantled to make room for new constructions. However, after new constructions, the rent is often raised, and the original dwellers are forced to move to other places, especially suburbs, causing new problems in their resettled areas.

The revitalization theory of urban villages in China:

(1) Kowloon Walled City: A house is like a city

The architecture Suenn Ho studied the Kowloon Walls City and found that the buildings of Kowloon Walled City grew like an organism. When a building was built more and more high, it slowly takes up the roof of a building next to it. Suenn Ho thinks that Kowloon Walled City is not a failed urban form, but an ideal form. It has a high society fusion degree, and using space extremely efficiently. It can concentrate all functions (living, working, leisure and public services) in a dense, walkable area. It consumes the least amount of resource and materials. It is self-governing and self-repairing in a democratic manner and is subject to minimal supervision, regulation and taxation. It embodies the concept of a house like a city.

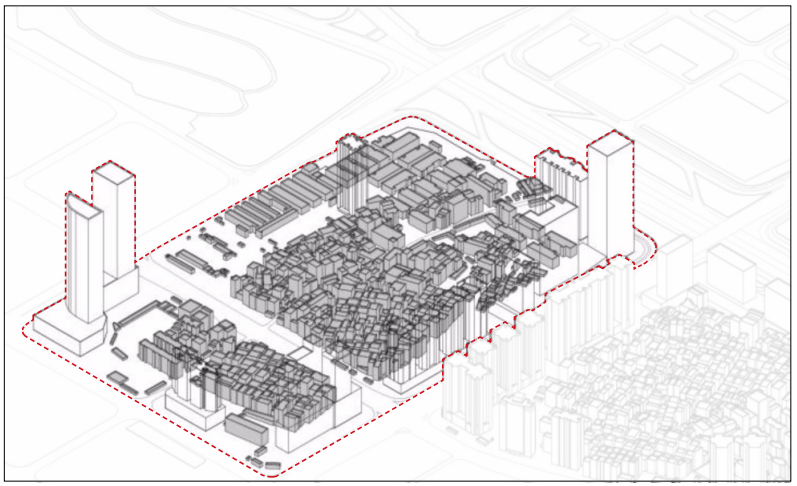


Figure 13. View of Gangsha village before regeneration.
Source: web.

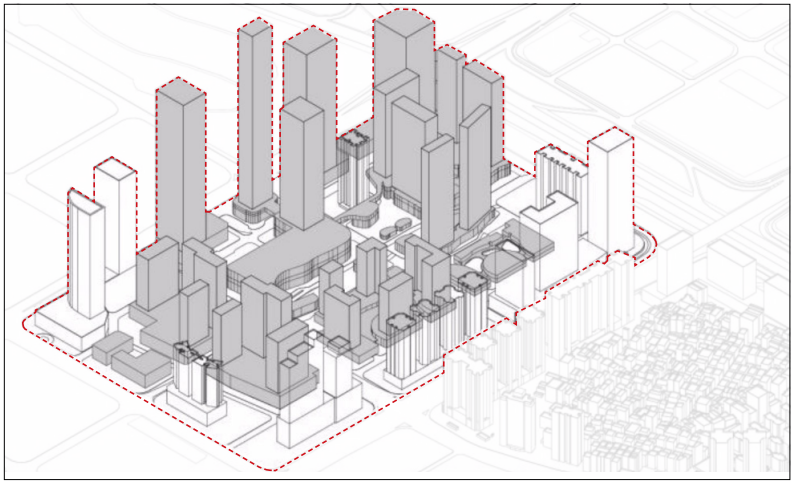


Figure 14. View of Gangsha village after regeneration.
Source: web.

Lam Po Chun is the “rooftop postman” of Kowloon Walled City. Once described his experience of delivering letters in the Kowloon Walled City: “In the Kowloon Walled City, you can walk up and down the rooftop. These rooftops connect every building, also can see the dweller’s life from the window. And I walk around the rooftop every day and say hello to then every day. I used climb from the rooftop of one of the building to the 12th floor broken window of another building, and then go through this broken window corridor to go to another building.” This is the amazing three-dimensional transportation system of Kowloon Walled City. [13] (Figure 15.)

(2) Dynamic rehabilitation

URBANUS suggested that by adjust the relative level of the roofs ang combine them into a larger space: add gardens and recreational facilities. And the rooftop can be transformed into a community activity apace. After all rehabilitation activities described above are completed, we can estimate that the remaining buildings will have a 300%. Some of the properties can be returned to the ex-villagers for their own homer. The rest would be controlled under the corporation’s management for the benefit of all. The ex-villagers finally finish the process of transferring themselves into shareholders. (Figure 16.)

(3) Space of individuals units & urban village model

The urban planner Zhang Yuxing suggested that urban village is a diverse social structure dominated by individuals’ units and mix of clan unit and family. The characteristic of some typical urban villages of Shenzhen is that the social structure of traditional clan unit remains and plays a controlling role in the daily social management of the urban village. The space model of individuals units is very close to a standard urban village. Living space of individuals units is the smallest living unit (3 x 3 meters room), surrounding traffic space can form a set of the most compact unit, set a number of unit is maintained between the minimum ventilation and daylighting, eventually form an efficient three-dimensional cluster. (Figure 17.)

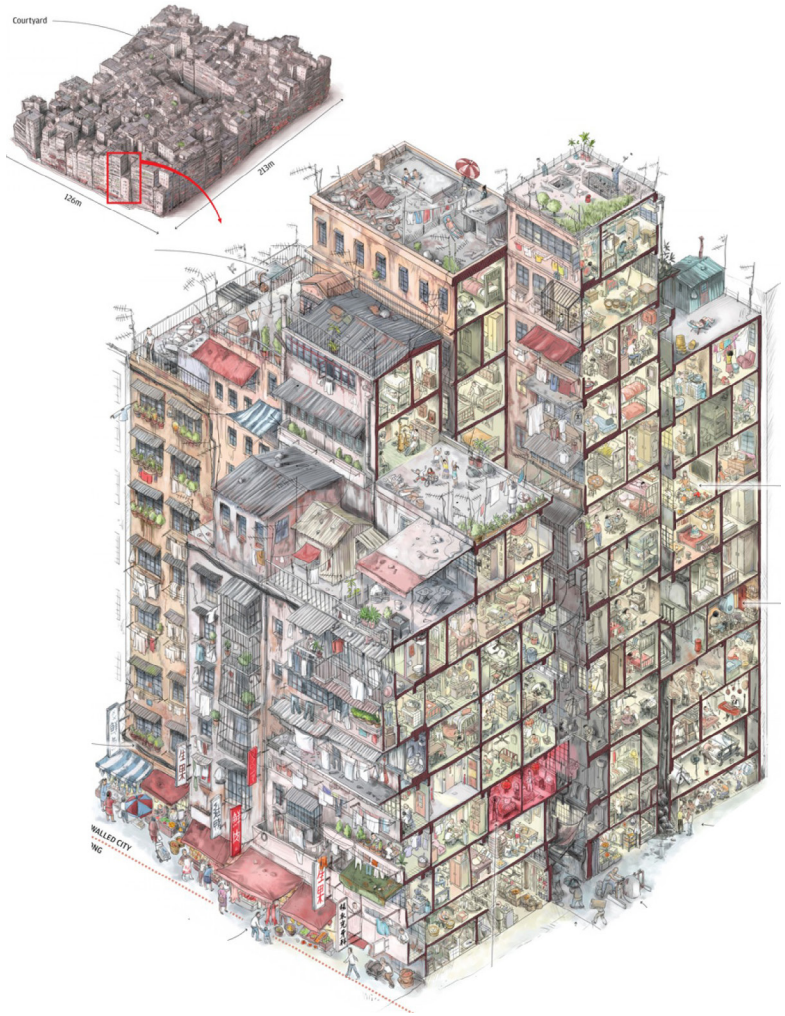


Figure 15. View of Kowloon Walled City.
Source: Adolfo Arranza.

[13] GIRARD, Greg and LAN, Lambot (2015). *City of Darkness : Life in Kowloon Walled City.* Hongkong: Zhonghua Book Company, p.256.

Review of qualitative city research using new data

Use of new data for analysis of urban space and group activities has become a general research trend in the current academic circles. City research of the kind can be preliminarily boiled down into seven types, including real-time description of social network data (real-time sensing), multi-transportation network data analysis, new urban data systems, new models of movement and location, city risk analysis of development path, new models and systems for mobility behavior discovery, and new tools for governance of mobility demand.

Currently, representative quantitative city research performed in the new data environment includes: using the public transportation card consumption records to study commuting behaviors, urban poverty, excessive commuting, public commuting spatial structure, etc.; using the mobile signaling data to study the urban population distribution, spatial structure, commercial circle influence and residents' trip distance; using the taxi GPS data to predict congestion points; using residents' GPS data to examine spatial characteristics of daily activities of residents in suburbs; using social network positioning information and sign-in information to study the urban land use functions and mixture degree, urban development boundary, distribution of urban activity regions, and structure of the urban network information space; using Baidu index to study network characteristics of regional cities; using Baidu Map [14] and Amap [15] migration data to study the town system, residents' travel behaviors on national holidays, etc.; using data from dianping.com to study the catering industry development pattern and restaurant site selection; and using the national PM2.5 monitoring online data to study the PM2.5 pollution distribution; and using the microscale demographic statistics to analyze China's urban development pattern.

[14] Baidu Maps is a desktop and mobile web mapping service application and technology provided by Baidu, offering satellite imagery, street maps, street view and indoor view[1] perspectives, as well as functions such as a route planner for traveling by foot, car, or with public transportation. Android and iOS applications are available. In 2016, it is reported that Baidu Maps has over 348 million monthly active users.

[15] Amap is a product of AutoNavi Software Co., Ltd. that is a Chinese web mapping, navigation and location-based services provider, founded in 2001. AutoNavi's own map application was the top mobile map app in China in 2012, with over 100 million users.

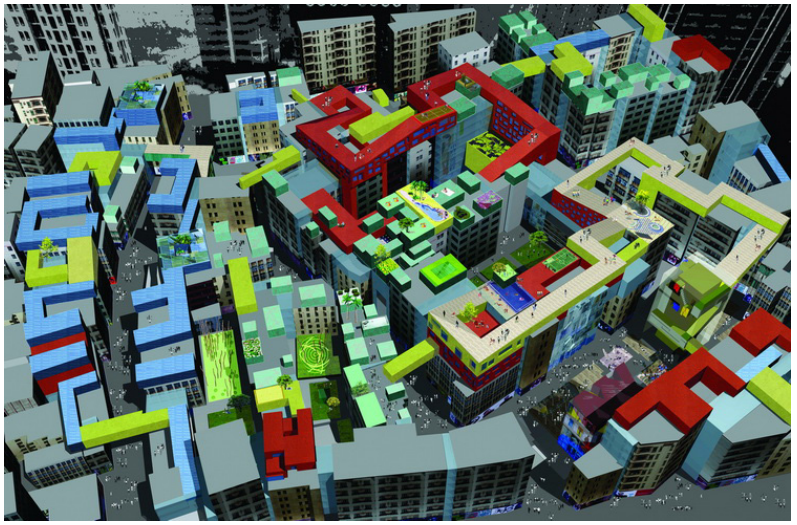


Figure 16. Dynamic rehabilitation.
Source: URBANUS.

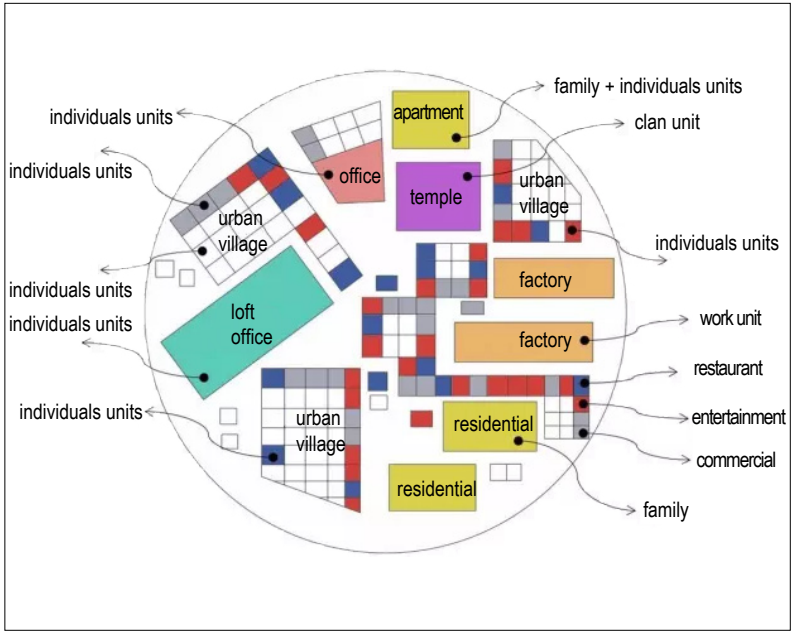


Figure 17. Space of individuals units & urban village model.
Source: Zhang Yuxing.

1.5 Research methodology

Research methodology

Major research methods for the pre-stage paper writing include literature review, analytic induction and case analysis. In this stage, the author mainly refers to a large number of books, master and graduate papers, journals, reports and websites related to the research topic, and gets a basic understanding of the latest research findings and implementation projects.

Major research methods for the mid-stage paper writing include crawling open data from websites, analyzing data via the ArcGIS platform, compiling the software programming to achieve visualization of data, and conducting interdisciplinary research of computer science.

Major research methods for the post-stage paper writing include analytic induction, deductive innovation, qualitative analysis and quantitative analysis. This stage mainly focuses on analytic induction of the crawled data to obtain better strategies for update of urban villages.

Research Status

The traditional data adopted for this research are from the Shenzhen Municipal Statistical Yearbook and the Shenzhen Municipal Planning Area. The new data adopted for this research mainly consist of the following four types:

(1) Landsat remote sensing data: The satellite remote sensing technology is a technology which perceives and analyzes some characteristics of a target through the satellite's surface observation, propagation and reception of electromagnetic waves (including optical waves). Landsat has been the earth observational plan lasting for the longest time ever. On July 23, 1971, an earth resources satellite was launched. Later, it got its current name, Landsat. The latest Landsat launched is Landsat 8 launched on February 11, 2013. This paper makes use of the Landsat remote sensing image data to recognize the urban built-up areas in Shenzhen over the past few years and to use the recognition outcomes to study urban sprawl. (Figure 18.)

(2) Heatmap for Baidu Map is a visual big data product launched by Baidu in 2014. The product is based on the geographical location data of LBS (location-based service) platform mobile users. The data are then processed in spatial expressions, and demonstrated to users' different degrees of population agglomeration degrees. In other words, different color lumps on the online map are overlaid to describe the distribution of urban population on a real-time basis. The Map was an instant success once it was launched for efficiently showing the degree of crowdedness on holidays. This provides great convenience for users' travel plans. Meanwhile, as a big data application storing geographical locations of more than 100 million mobile users, Heatmap for Baidu Map has been further tapped for its value in different professional fields. This paper uses the Baidu heatmap to analyze occupation of urban spaces and distribution of urban population. (Figure 19.)

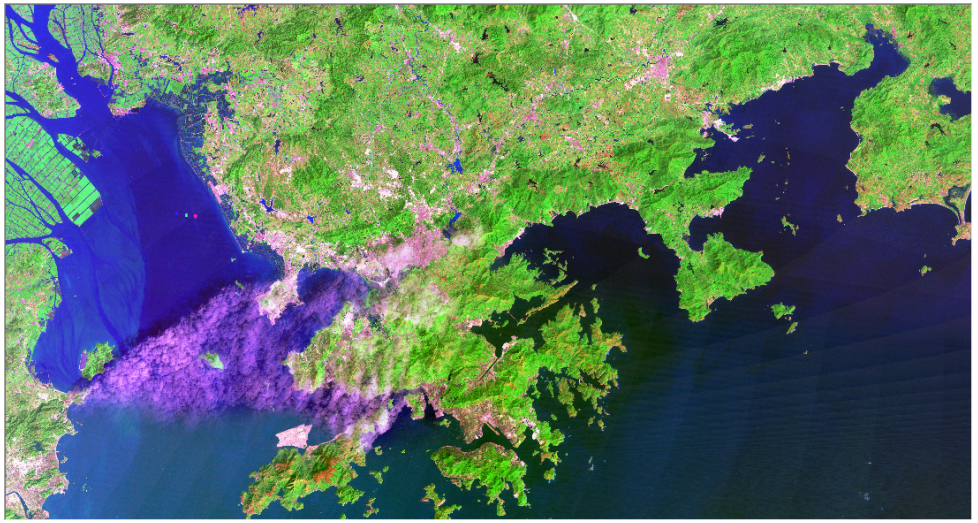


Figure 18. Landsat remote sensing image of Shenzhen, 1987.
Source: https://earthexplorer.usgs.gov/

(3) Point of Interest (POI) data refer to the geographical entities which can be abstracted into points, especially referring to facilities closely connected with people's daily life. They appear on the electronic map as landmarks. The POI data include data from various government departments, business institutions in different sectors, scenic spots, traffic facilities and educational facilities. The traditional geographical information collection requires the map surveying personnel to collect the latitude and longitude of a POI using precise surveying instruments, and then mark the POI. Therefore, to a geographical information system, the number of POI can, to some extent, represent the value of the whole system. The POI data are the dotted spatial data with rich attributes, including name, category, latitude, longitude, address, post code and telephone number. They are updated on an annual basis. There are many channels to obtain POI data, including buying from the map operators or crawling from the online map using the crawler technology. In the daily life, POI has a wide range of applications, mainly in the field of online information checking and trip navigation. In addition, along with emergence of more and more apps based on spatial information, POI data can provide more and more information, including the comments of restaurants and scenic spots, travel logs and photos. This paper makes use of the POI data in Shenzhen to obtain 196,997 pieces of data about the public facilities. These data also include the status and location of the public facilities. (Figure 20.)

(4) OpenStreetMap (OSM) is a representative of the open-source navigation information, which is generated based on the intelligent traffic system (ITS) and the LBS demands. The data include the starting point, ending point, traffic mode, distance, time, longitude, latitude, direction, etc. This paper introduces the OSM data mainly for the purpose of recognizing the urban roads, greenbelts, water systems and buildings, and their area. (Figure 21.)

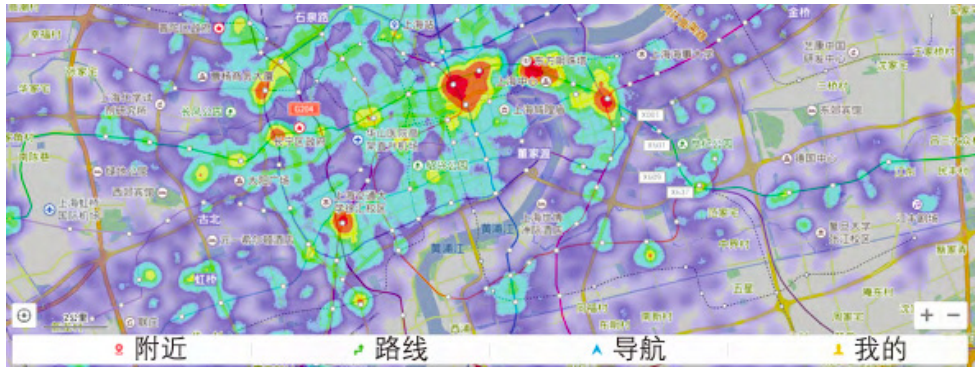


Figure 19. Interface of Heatmap for Baidu Map.
Source: Baidu Map.

Figure 20. The POI of all the museums in Shenzhen, including name, category, latitude, longitude, address, post code and telephone number.
Source: Baidu Map.

Figure 21. Open street map data and the data after processing.
Source: web.

2. VILLAGE SPACE FORM OF THE EVOLUTION IN URBANIZATION PROCESS OF SHENZHEN CITY

2.1 The urban extension of Shenzhen City

The main data adopted in this paper include the sustainable Landsat remote sensing data (Landsat 5 TM and Landsat 7 ETM). They are downed from the US Geographical Survey (USGS) (https://earthexplorer.usgs.gov/). In order to ensure image quality and index computing to authentically reflect the surface features, this paper chooses images whose cloud amount is smaller than 15%. The remote sensing inversion parameters are obtained through waveband operation of the ArcMap 10.2.

By analyzing the urban built-up areas of Shenzhen in 1987, 1997, 2007 and 2017, respectively, striking characteristics of urban sprawl can be observed. (Figure 22. - 25.) In 1987, the southern part of Shenzhen or the former Shenzhen Special Economic Zone (including Luohu District, Futian District and Nanshan District) were first developed. Later, Shenzhen kept on expanding northwards, eastwards and westwards. On the other hand, it was busy filling in the sea to grow grains. The decade from 1997 to 2007 was the fastest-developing one decade of Shenzhen's urbanization. Later, the urbanization slowed down. By 2017, Shenzhen's municipal area has almost got no area for further development. (Figure 26.)

Urban sprawl of Shenzhen could not be separated from its extensive land use model since 1996. The extensive development is without doubt unsustainable. Now, Shenzhen almost gets no further area for development. In response to the bottleneck of development, the Shenzhen Municipal Planning Bureau has shifted its development policy to "integration of increment and stock, and focus on optimization of stock".

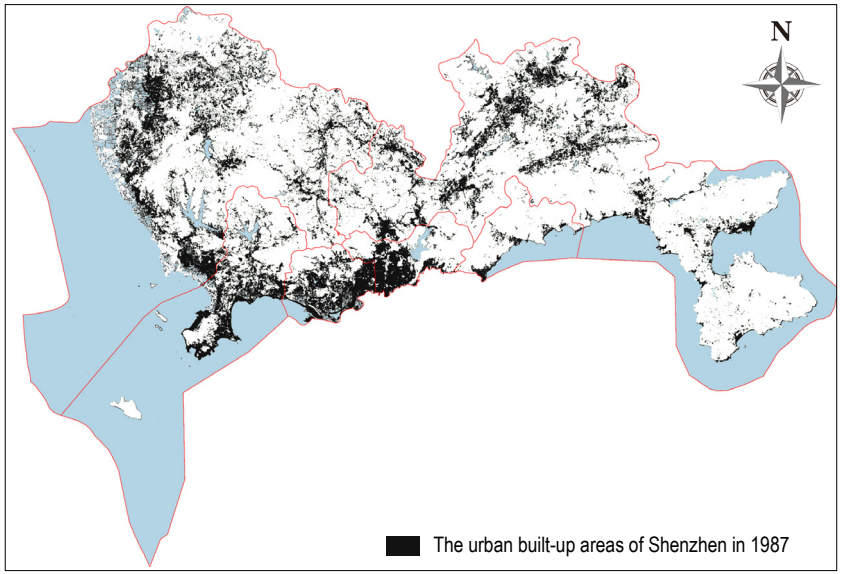


Figure 22. The urban built-up areas of Shenzhen in 1987.
Source: author.

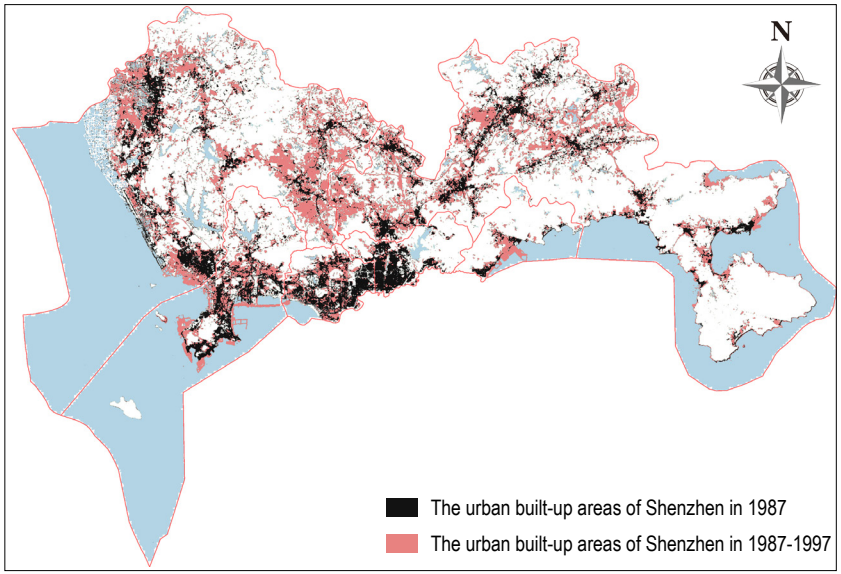


Figure 23. The urban built-up areas of Shenzhen in 1997.
Source: author.

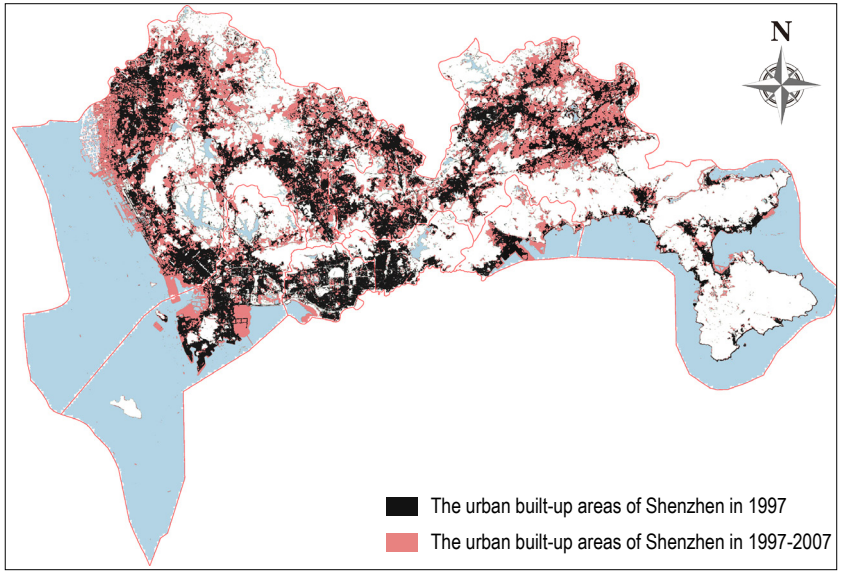


Figure 24. The urban built-up areas of Shenzhen in 2007.
Source: author.

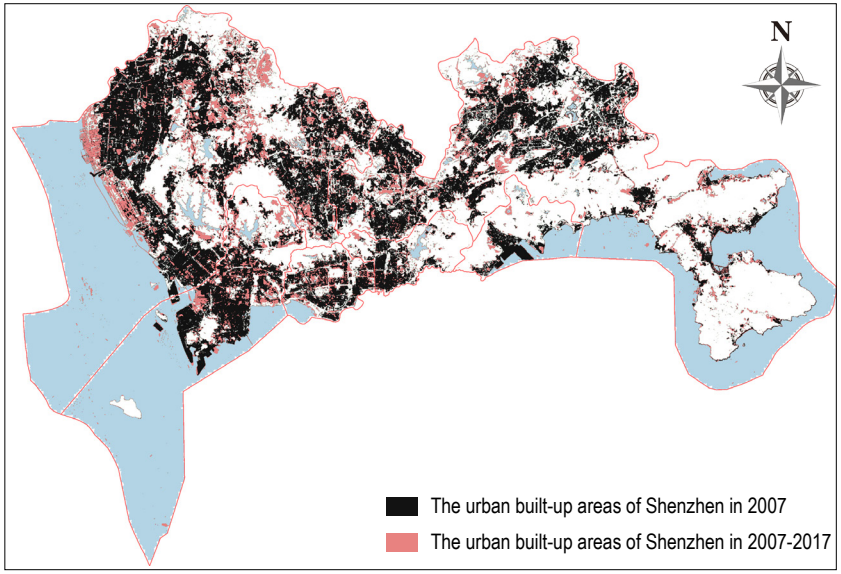


Figure 25. The urban built-up areas of Shenzhen in 2017.
Source: author.

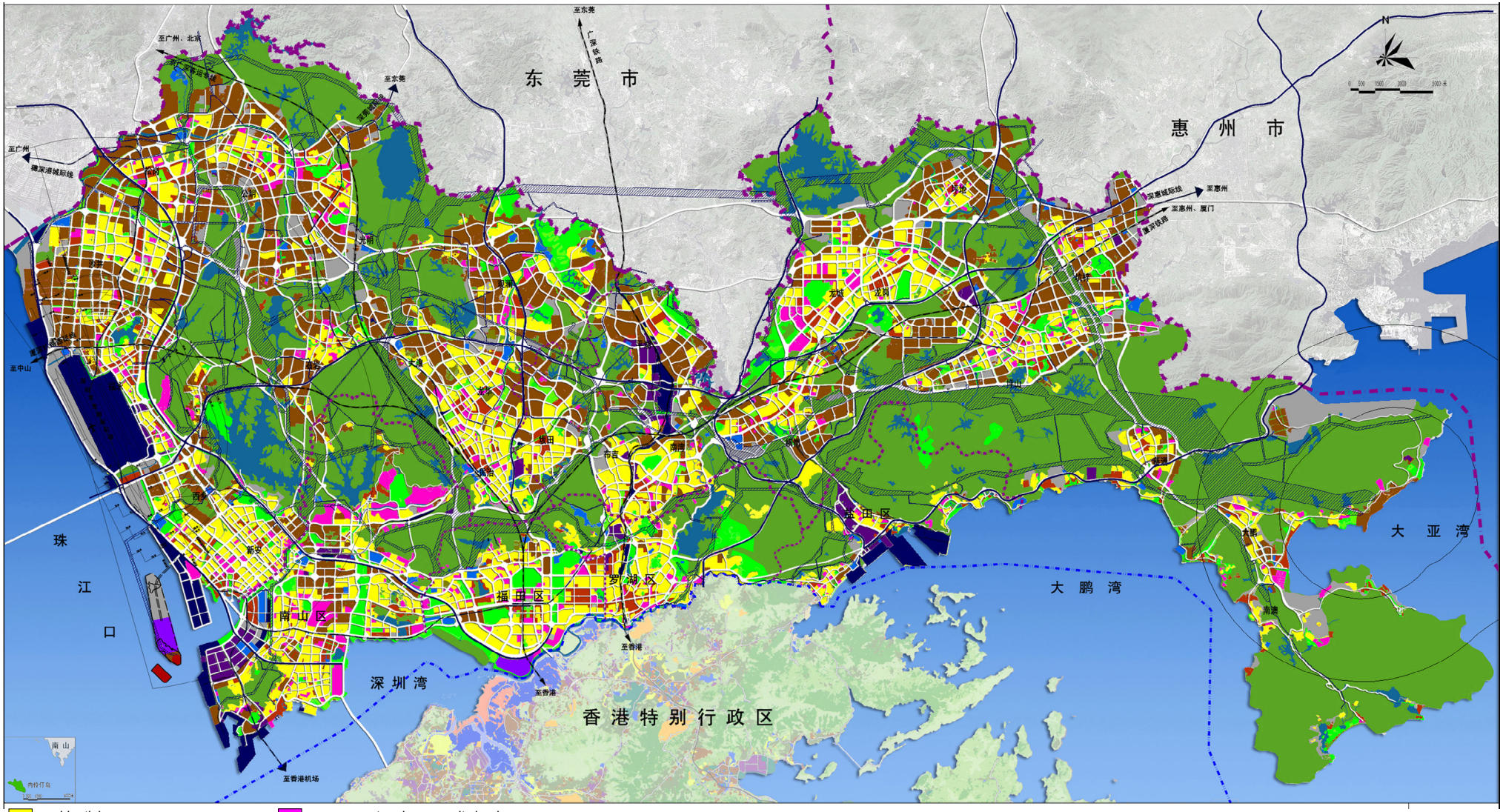


Figure 26. The land use planning map of Shenzhen.
Source: Shenzhen Urban Planning and Land Resources Committee.

2.2 From the natural village to the urban village

During the urbanization process of Shenzhen, the traditional villages still exist in the peripheral, margin and even downtown area in different forms. According to the history development clues and the space distribution clues, the Shenzhen's village space evolution process in general falls into three types: (1) "natural villages" in the traditional and historical form; (2) "marginal villages" during the evolution process of urbanization; (3) "urban villages" left over by urbanization. [16]

Before China's adoption of reform and opening-up policy (1978), most lands in Shenzhen served as agricultural lands. This defined dominance of the ecological villages in Shenzhen. These villages were social spaces formed by the traditional patriarchal, blood, and geographical relationship model. They coexisted with the geographical environments harmoniously, and the residential space of every village represented a traditional residential space with geographical characteristics. This reflected not only the natural ecological structure with regional characteristics, but also the specific architectural connotation conveyed by the traditional culture. After onset of China's reform and opening to the outside world, expansion of the urban space and increase of industrial facilities unavoidably included rural lands and traditional villages into the scope of urban sprawl. Then, the original structural form of villages was changed, and the villages have been left over to this date as a special urban space.

Seen from the development history of urban villages, urban infrastructures have changed the rural land nature and spatial form. The original village system has been transformed from the "natural village" to the "neighborhood committee" and "subdistrict office". Accordingly, the urban villages emerge as a form of residential space contradictory to the urban space system. The transformation process is, on the one hand, reflected as partial maintenance of the stereotyped form of traditional villages. On the other hand, transition happens to turn traditional villages into neither cities nor villages. All these types of village forms have accompanied the development of the whole city, restricting the city's harmonious development.

[16] GUO, Liyuan (2005). *Form "Natural village" to "Urban village" The evolution of village structure in the urbanization process of Shenzhen* (Master's thesis). Shenzhen university.

Taken as a whole, the transformation is a gradual degradation of the original social space dominated by clans, blood relationship, and geographic relationship. The traditional, harmonious rural cultural landscape endowed by the history has been reconstructed through the transition. Then, an uncertain urban social spatial structure with individuals as basic units appears to replace it. (Table 2.)

(1) Period 1 (the Ming and Qing dynasties-1978 (Economic reforms introducing market))

During the period, Shenzhen's villages existed as "natural villages". Residents made a living by fishing and farming. There were two major forms of traditional villages—overland settlements and seaside fishery settlements. The natural villages and their architectural forms fully reflected the ideal structure of China's ancient patriarchal society. Geomancy was at the core of Hakka's location of their settlements. Harmonious coexistence with the natural environment was emphasized. The architectural layout was in strict conformity with the hierarchical system, in which superiors and inferiors were strictly distinguished from each other. The traditional village buildings were one-store. The external façade was plastered with black bricks, and the roof was paved with black tiles. Meanwhile, the overcoating with local characteristics was adopted for decoration. The sociological significance within the building was inherited to exert a strong influence on development of the future village buildings. (Figure 27.)

(2) Period 2 (1978-1992 (the first-time unified land expropriations for urbanization))

During this period, villages were developed into "marginal villages". In the very beginning, the spatial form of marginal villages was a mirror of the natural ecological structure with the traditional village space characteristics. Driven by "village autonomy" and "introduction of industry to villages", the traditional spatial pattern sustained by the blood and geographical relationship was, to some extent, upset by the new spatial order. Due to spontaneous growth of economy, plants directly expanded in the marginal areas of villages.

Figure 27. View of natural village in Shenzhen.
Source: web.

Figure 28. View of marginal village in Shenzhen.
Source: web.

Large areas of agricultural lands were transformed into industrial lands to set up buildings and plants. As a result, the residential lands and the industrial lands were interwoven, leading to chaotic functional zoning of villages. The boundary of villages was thus blurred. Residents' living environment was influenced by plant wastes, such as noises, waste water, etc. The natural, organic architectural layout of traditional buildings was gradually dissolved along with industrial planning. However, some community spatial forms, such as the village road systems and the ancestral temples, were well-preserved. (Figure 28.)

(3) Period 3 (1992-2004 (the second-time unified land expropriations for urbanization))

During this period, along with acceleration of urbanization, almost all arable lands in villages were expropriated to cater to the urban sprawl. Consequently, villages were surrounded by a prosperous metropolis. Meanwhile, villagers, driven by economic interests, kept on building multi-store buildings. This led to a sharp increase of building density in villages. Many buildings were so close to each other, leaving little space between them. Unlike "natural villages", these compact buildings were not left over by the history, but a part of modernization. Despite of the rapid urbanization process, the residential lands, houses and many other production and living elements as well as the personnel and social relationship remained. Villages had no opportunities to participate in the new urban economic labor distribution and industrial layout. Thus, they had to rely on their lands and land accessories as a source of living (such as rents). The communities were formed based on the primary relationship (geographical and blood relationship) rather than the secondary relationship (industrial and contractual relationship). (Figure 29.)

Figure 29. View of urban village in Shenzhen.
Source: web.

Village space form of the evolution in urbanization process of Shenzhen City

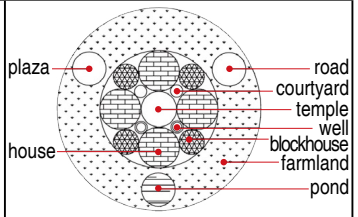
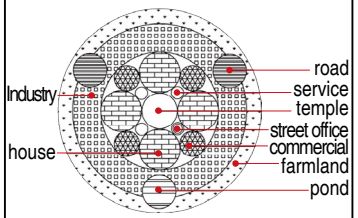
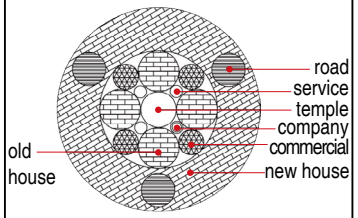
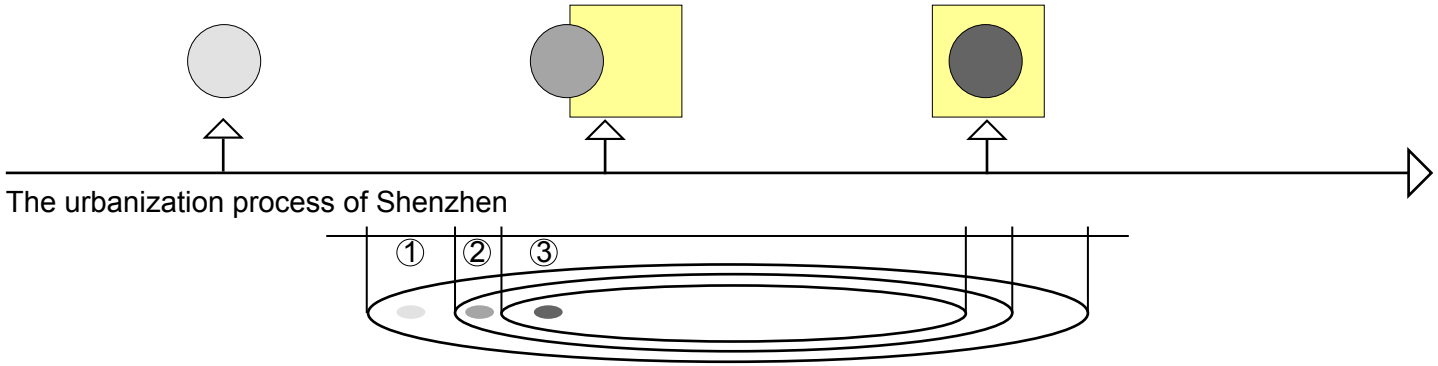
	construction time	Land status	Village form	The connection between the village and the city	Population Structure	Social Structure	Cultural feature	Field of economy	Typical cases	Schematic diagram
Natural villages	the Ming and Qing dynasties - 1978	Agricultural land Land ownership being collectively-owned	Natural state and decrepit buildings	Far from the city, the traffic is inconvenient	Local people	Clans, blood relationship, and geographic relationship	Traditional culture	Agricultural	Hehuxinju Dawanshiju	
Marginal villages	1978 - 1992	Mainly for industrial land Land ownership mainly being collectively-owned	Old and new mixed buildings and planning disorder villages	At the edge of the city, connect with the city	Local residents and temporary residents	Clans relationship and social properties during urbanization	Remix culture	Agricultural and industry	Longsheng village Wanfeng village	
Urban villages	1992 - 2004	In addition to residential land (house base), all other lands in villages were expropriated.	New construction but planning disorder villages	Surrounded by city	Mainly temporary residents	An uncertain urban social spatial structure with individuals as basic units	Immigrant culture and city culture	Houses tenancy and Services	Hubei village Xiasha village	
Shenzhen's village space evolution process										

Table 2. Village space form of the evolution in urbanization process of Shenzhen City.
Source: Table by author and image by Guo Liyuan.

3. RESEARCH ON URBAN SPATIAL FORM OF URBAN VILLAGE

3.1 Research on urban space at the macro level

Location distribution of urban villages.

From the map of distribution of urban villages, it can be observed the following characteristics of the distribution of urban villages in Shenzhen:

(1) So far, there have been 241 urban villages in Shenzhen. They are distributed throughout Shenzhen. Among them, 91 are distributed in the former Shenzhen Special Economic Zone, accounting for 37.8% of the total, consisting of 36 in Luohu District; 29 in Nanshan District; and 11 in Yantian District. There are 150 outside the former Shenzhen Special Economic Zone, accounting for 62% of the total. [17] (Figure 30.) As stated above, three kinds of villages, including natural villages, marginal villages and urban villages distributed in different districts of Shenzhen. Their spatial layouts and forms show striking differences. The housing construction strength of urban villages in the former Shenzhen Special Economic Zone is the highest, and their building quality is of high standards. Basically, there are no courtyard spaces. Outside the former Shenzhen Special Economic Zone, there are almost no courtyards. The buildings are highly concentrated. The construction strength and quality are no match of their counterpart in the former Shenzhen Special Economic Zone. On the marginal areas of Shenzhen, there are also many urban villages. Their construction strength is poor. Many plants are erected nearby. The living conditions are poor. Few courtyards or local primitive village constructions can be found. [18]

(2) The total area of Luohu District, Futian District, Nanshan District and Yantian District is 87.05 million square meters. The area of urban villages in these districts and the percentage of their area in the four districts can be calculated, respectively. Results show that urban villages in Yantian District are the largest, taking up 30% of the total.

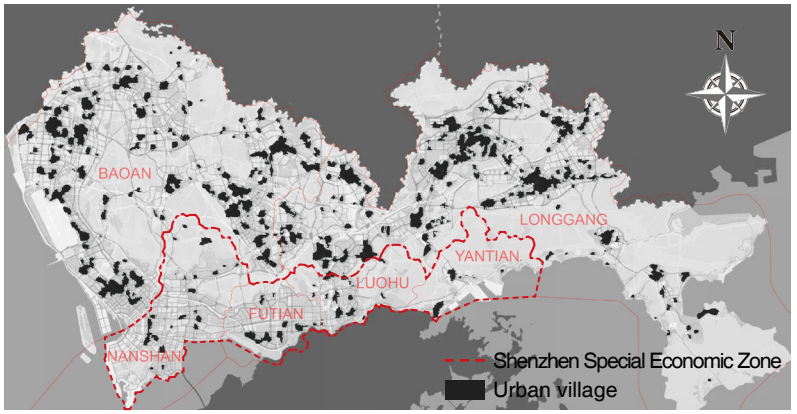


Figure 30. The distribution of urban villages in Shenzhen.
Source: author.

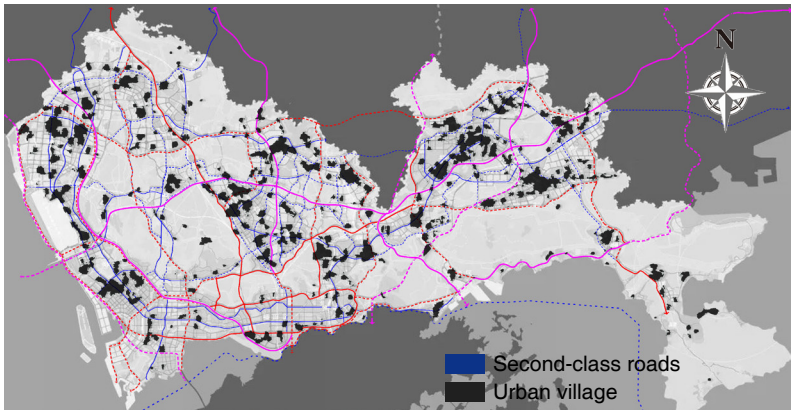


Figure 31. The distribution of roads and urban villages in Shenzhen.
Source: author.

[17] SHENZHEN URBAN PLANNING AND LAND RESOURCES COMMITTEE (2005). *General outline of urban village renovation in Shenzhen (2005-2010).* Shenzhen.
[18] MA, Hang (2013). "Research on the Characteristics and Evolution of Spatial Morphology of Urban Villages in Shenzhen under the Informal Housing Market". *South Architecture*, 2013, (2), pp.67-71. dio: 10.3969/j.issn.1000-0232.2013.02.067

The area of urban villages in Luohu District and Nanshan District is the same, accounting for 22% of the total area and ranking No. 2. Urban villages in Futian District is the smallest, accounting for 15% of the total. Among the urban villages in the four districts, the largest one is Baishizhou Village in Nanshan District, covering an area of 4,198 ha; in contrast, Yinglong Village in Louhu District is the smallest one, covering an area of just 0.28 ha. The gap between the largest and the smallest is close to 150 times.

(3) After overlapping Shenzhen's urban village distribution chart and traffic network chart, it can be found that most urban villages are concentrated on two sides of the urban traffic axis, especially the secondary trunks. For example, Futian District, Nanshan District and Luohu District revolves around the Shennan Road; in the west, Guangzhou-Shenzhen Highway constitutes the axis; in the east, Shenzhen-Huizhou Highway forms the axis. (Figure 31.)

(4) Most urban villages in these four districts are not far away from the urban built-up area, so they mostly have a convenient transportation. (Figure 32.)

Analysis of urban spatial structure based on heatmap for Baidu map

The urban spatial structures have both physical attributes and social attributes. However, previous scholars mostly focused on the physical attributes. Since the 1960s, potential influence of informationalization on the human community living behaviors and ecological environment has gained increasing attention. Along with expansion and increasing complexity of the urban scale, the explicit physical attributes can hardly reflect the practical operation status of the urban space. [19] On the contrary, the implicit social attributes, a measurement of urban population and economic distribution, thought impossible to be directly perceived, can more vividly reflect the essence of the urban spatial structure.

The heatmap for Baidu map exhibits the gathering information of population in different areas of a city and at different periods of time. The heatmap can reflect the occupation of urban space to a large extent. From the heatmap, one can directly observe which districts are the most densely populated, whether the population has gathered in line with the planner's planning intention, the duration of the dense population gathering, the difference of population distribution between days and nights, etc. Some scholars have adopted the heatmap for Baidu map as an analytic tool to make some preliminary explorations of the urban spatial structure. This paper refers to the dynamic big data obtained by Wu Zhiqiang et al. based on the heatmap for Baidu map, and attempts to make use of the real-time advantages of these data to come up with a brand-new method to study the urban space based on the space use intensity. [20]

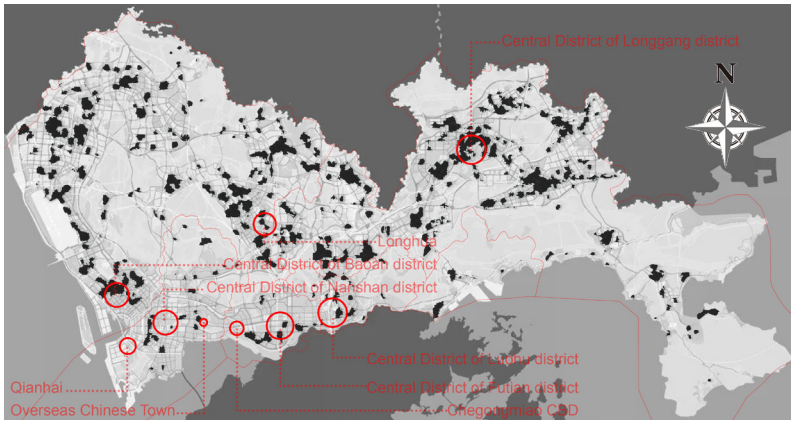


Figure 32. The distribution of CBD and urban villages in Shenzhen.
Source: author.

[19] WU, Qiyan and ZHU, Xigang (2001). "Review and Prospect of the Research on Urban Spatial Structure". *Geography and Territorial Research*, 2001, (2), pp.46-50.
[20] WU, Zhiqiang and YE, Zhongnan (2016). "Research on Urban Spatial Structure based on Baidu Heat Map: a case study on the central city of Shanghai". *City Planning Review*, 2014, (4), pp.33-40. dio: 10.11819/cpr20160407a

Data selection and assignment

Population activities in a city can largely reflect the weekly changes. Meanwhile, urban population distribution is different on weekends (Saturday and Sunday) and workdays (Monday through Friday). Current research findings of the urban population distribution have also demonstrated the rule. Therefore, this paper conducts several surveys based on the thermodynamic characteristics reflected by the heatmap for Baidu map on weekends and workdays. The author chooses data from the heatmap for Baidu map on random workdays and random weekends. The data are collected at an interval of 1h. In total, 146 heatmap images are collected, and adopted as the basic data for analysis. (Figure 33.)

To facilitate data analysis, the thermodynamic degree is used as a measure the density reflected by the thermodynamic chart. Different color areas are assigned with different thermodynamic values, ranging from 1 to 5. The higher the thermodynamic value is, the higher the population density is. The lower the thermodynamic value, the lower the population density is. To better describe the change rule, the following part defines the area whose thermodynamic value is 5 as the urban extreme heat district, and the area whose thermodynamic value is 4 as the urban sub-heat district. The extreme-heat district and the sub-heat district represent the area with a highly densely-populated area and a relatively densely-populated area, respectively. The larger the area is, the higher the degree of population concentration is. The smaller the area is, the higher the degree of population dispersion is.

Analysis of the workday data

This paper adopts data from the heatmap for Baidu map from 8:00 a.m. to 23:00 on Tuesday (July 25, 2017) as research samples. After assignment and analysis of the above the heatmap (Figure 34. - 37.), it can be found that the regional quantity, area and position of areas of different thermodynamic degrees change dramatically with the passage of time. There are two factors attributable to the changes. First, spatial distribution changes of mobile users in the urban areas. Second, changes of the proportion of mobile users with the passage of time.

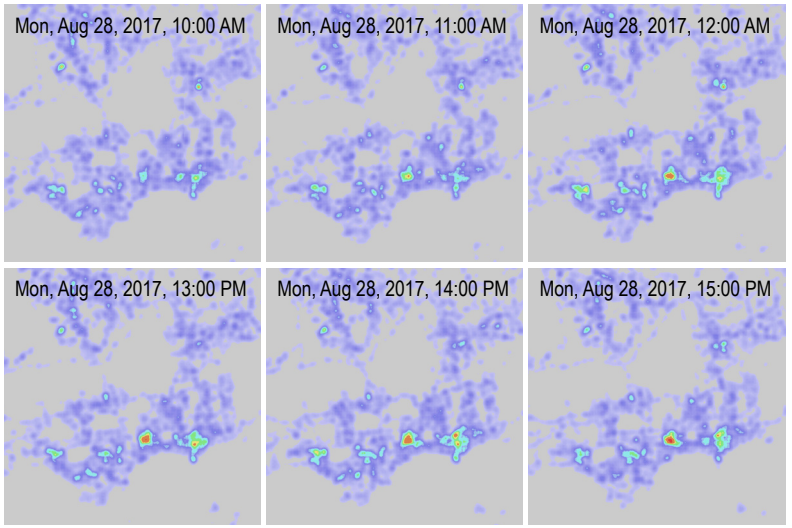


Figure 33. Part of heat map for Baidu Map captured on August 28.
Source: author.

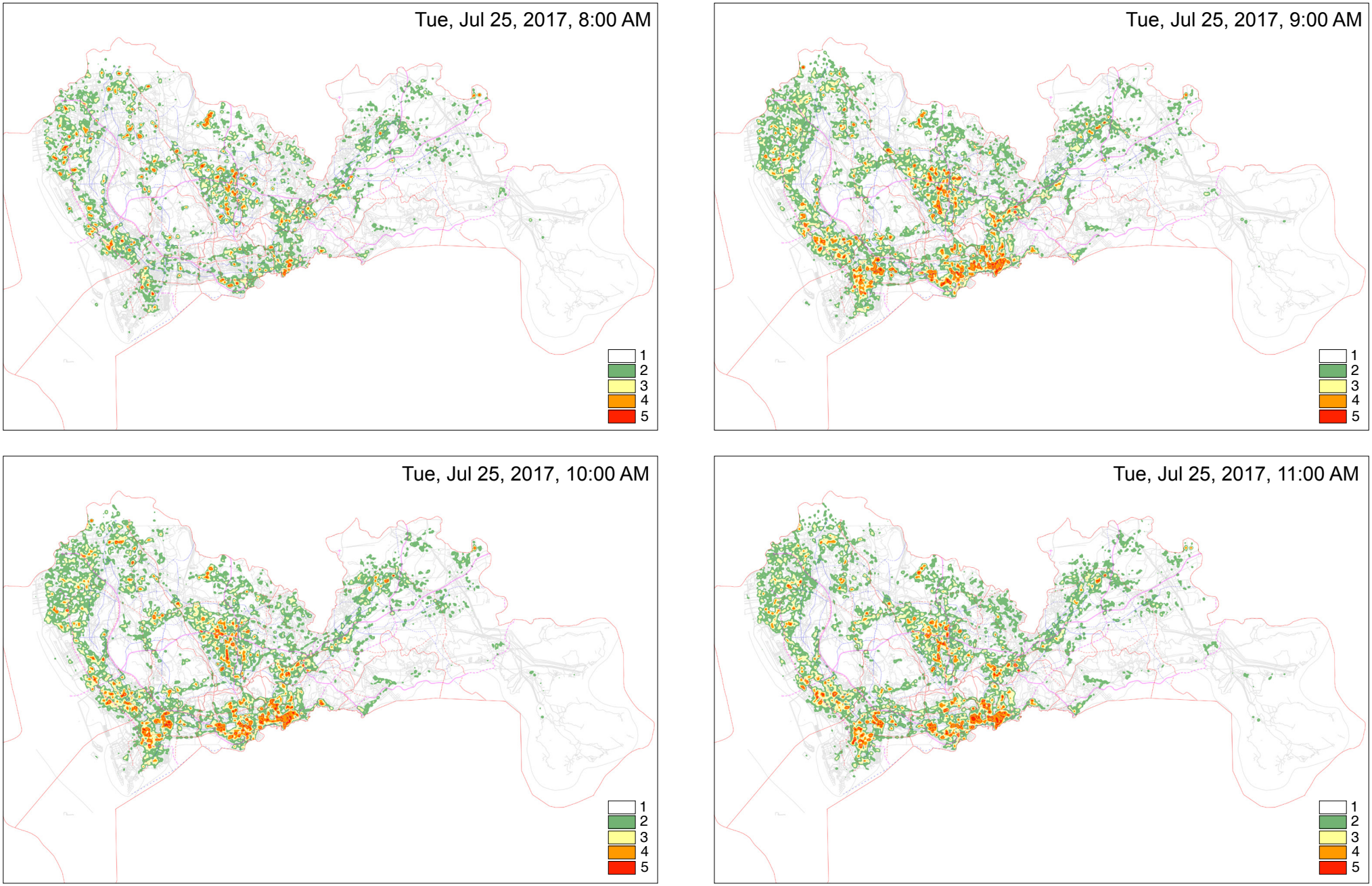


Figure 34. Value assigned heat map for Baidu map data (Tue, July 25, 2017).
Source: author.

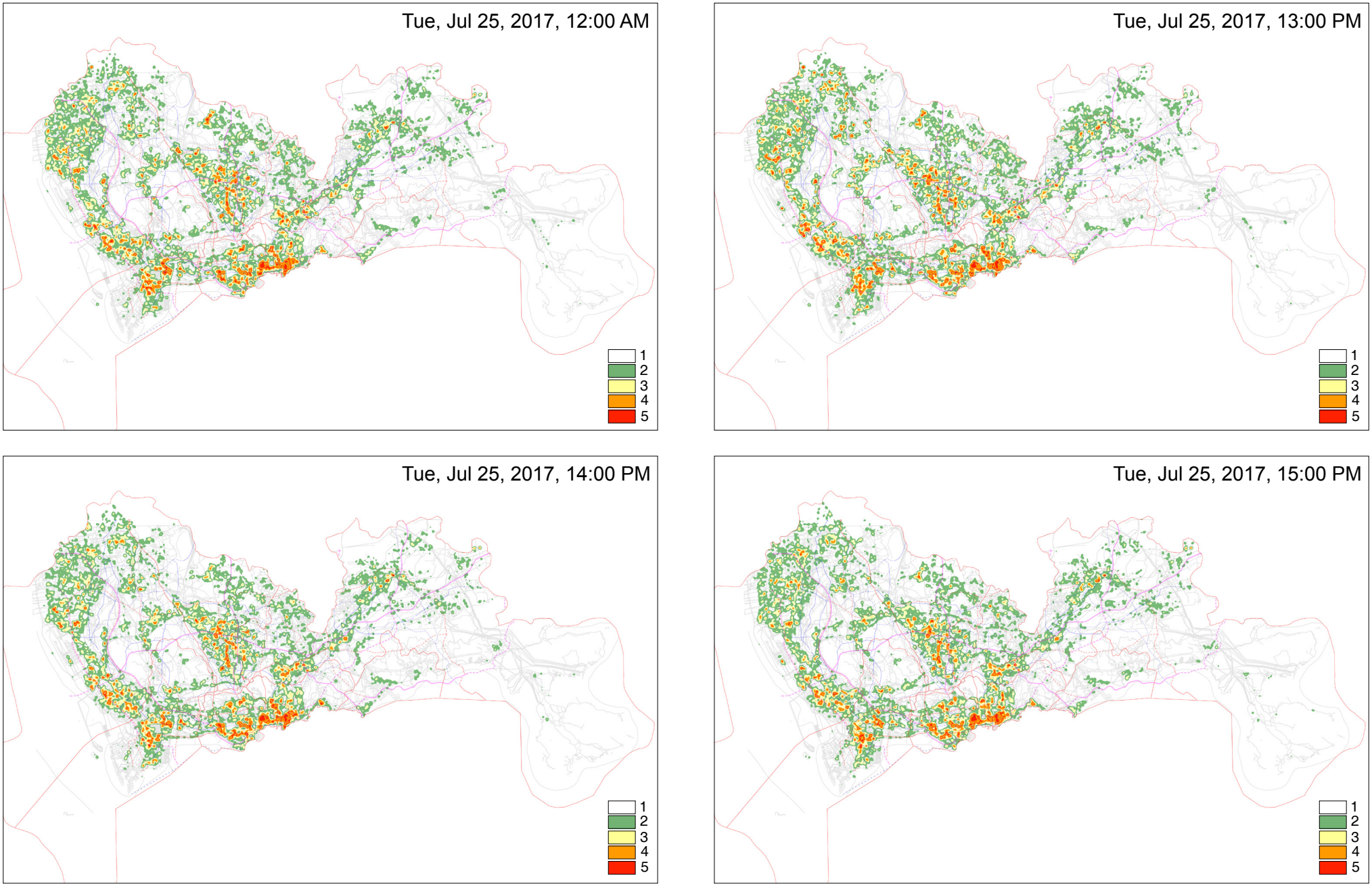


Figure 35. Value assigned heat map for Baidu map data (Tue, July 25, 2017).
Source: author.

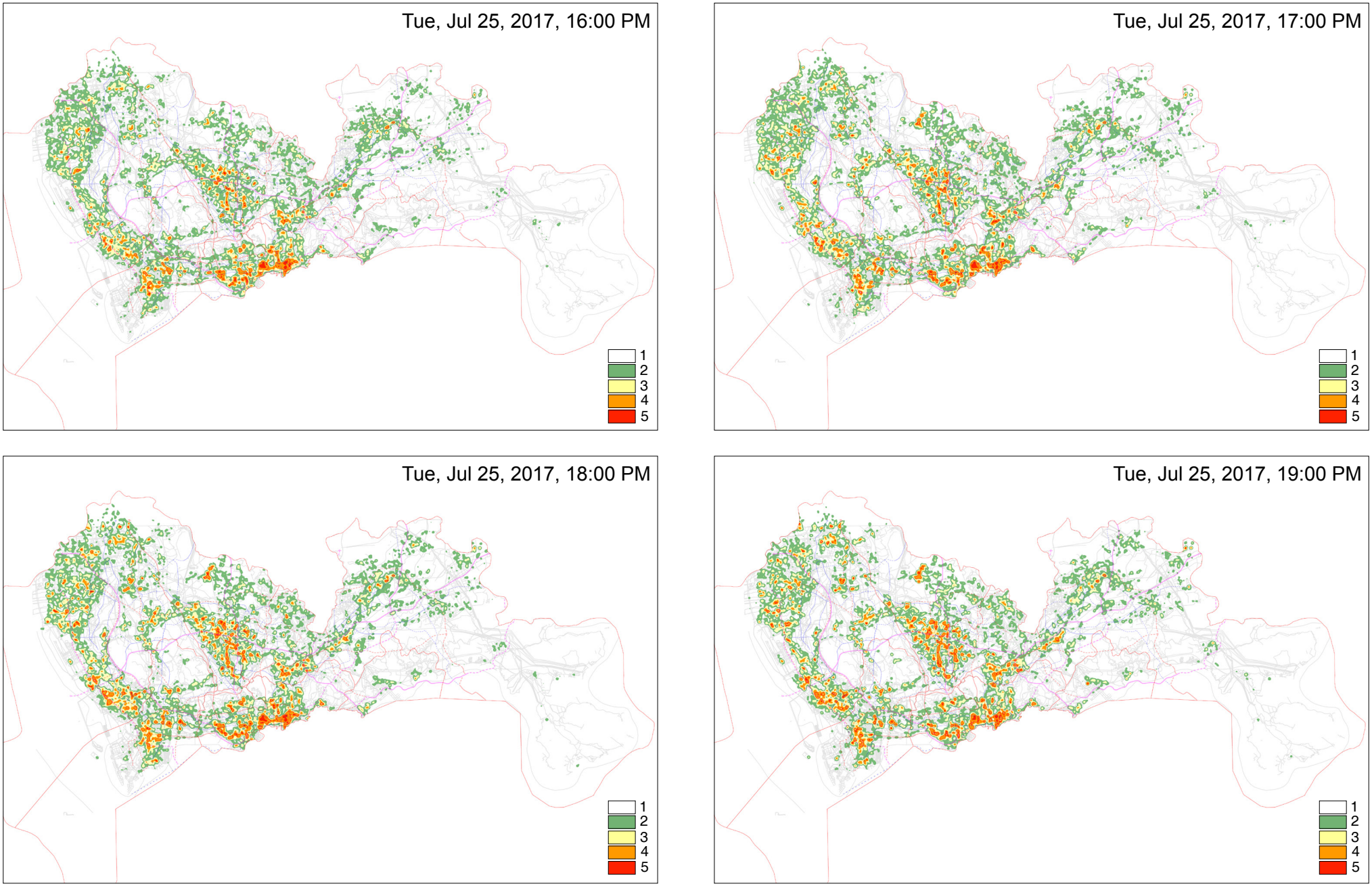


Figure 36. Value assigned heat map for Baidu map data (Tue, July 25, 2017).
Source: author.

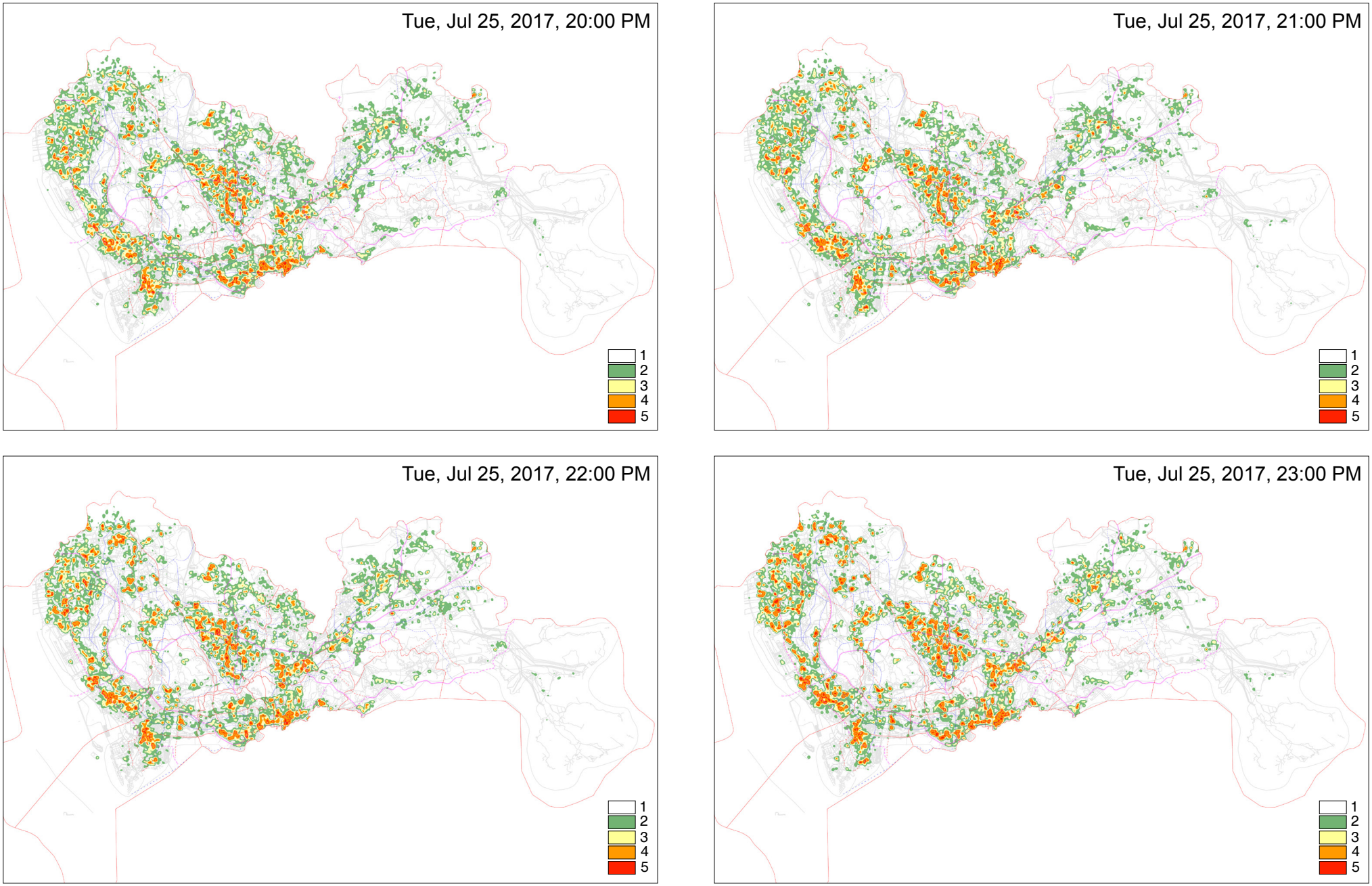


Figure 37. Value assigned heat map for Baidu map data (Tue, July 25, 2017).
Source: author.

(1) Trend of area change along with time of urban extreme-heat and sub-heat district on workdays

From the following Chart 1 and Chart 2, it can be observed that the urban extreme-heat area and the urban sub-heat area fluctuate dramatically along with the passage of time from 8:00 a.m. to 23:00 on Tuesday (July 25, 2017). Generally, the area is small in the morning and evening, and then the area expands from the morning to the afternoon. Meanwhile, the area in the evening is generally larger than that in the morning. The growth of the extreme-heat district and the sub-heat district from 8:00 a.m. to 9:00 a.m. of workdays. Through observation of the data curve, the extreme-heat district and the sub-heat district reach a sub-peak after 9:00 a.m. After 21:00, the area shrinks dramatically. The extreme-heat district and the sub-heat district reach a wave peak at 13:00 and 20:00, subsequently. The peak value of the urban extreme-heat area appears at 19:00, and the peak value of the sub-heat area appears at 21:00.

On workdays, the population activity intensity in the evening is far stronger than that in the daytime. The urban population concentration reached a sub-peak since the morning traffic peak at 9:00. It lasts to the evening traffic peak beginning at 18:00. The population concentration keeps on increasing, and reaches a peak from 19:00 to 21:00. Thus, it can be predicted that the daily population distribution first moves from the residential area to the workplace. This is the first significant population concentration. After office hours, people go to the commercial areas, restaurants, entertainment areas. This is the second significant population concentration. In the overlapped period of time of the two significant population concentrations, one can find the daily peak value of population concentration.

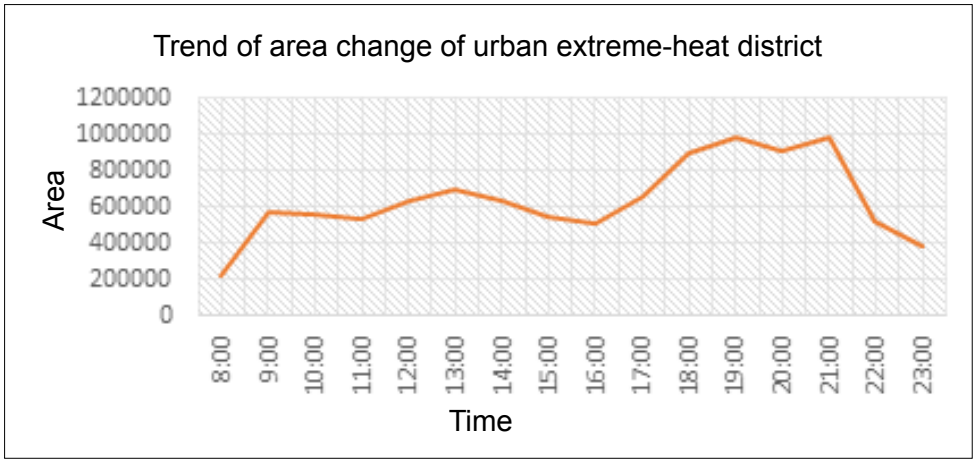


Chart 1. Trend of area change of urban extreme-heat district on Tuesday, July 25, 2017.
Source: author.

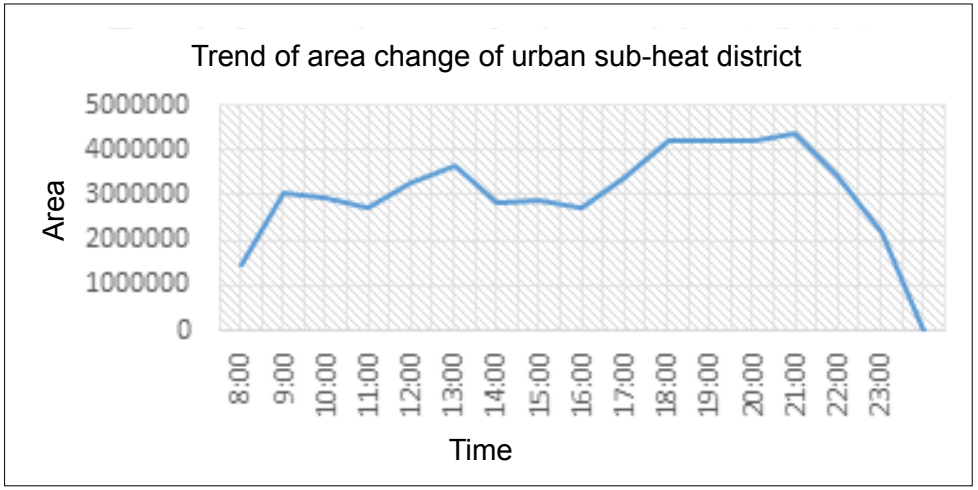


Chart 2. Trend of area change of urban sub-heat district on Tuesday, July 25, 2017.
Source: author.

(2) Spatial distribution of the extreme-heat district and the sub-heat district on workdays

In order to discover the spatial features of population distribution in urban areas, it is necessary to examine the geographical distribution of the extreme-heat district and the sub-heat district. Since the heatmap for Baidu map reflects the real-time dynamic data, the GIS is used to divided the city into “500m×500m” grids. The grid calculator (Equation 1.) is used to work out the average of daily data for further analysis. (Figure 38.)

$$\bar{H}_i = \sum H_{ix}/24 \qquad \text{(Equation 1.)}$$

H¯_i: the average heat value of cell “i”; H_i x: the heat value of cell “i” at point “x”; “x” = 1, 2, 3, ……, 24; “i” = 1, 2, 3, ……, n.

Analysis shows that there are eight continuous extreme-heat districts in the city. The eight extreme-heat districts are named by their geographical location, and ranked according to their size. They are Huaqiang North Commercial Area, International Trade Center, Dongmen Shopping Mall, Chegongmiao CBD, Sungang CBD, Bagualing, Shenzhen Exhibition Center and Luohu Train Station. After investigating the major urban functions of these areas into three commercial districts, four shopping malls and one traffic hub. On workdays, the population concentration is high in commercial districts and shopping malls.

Then, the areas with a high population concentration are statistically analyzed by different periods of time. In Futian District ant at 8:00 a.m., the extreme-heat areas appear in urban villages, including Xiasha, Shazui, Shishaa, Gangsha, etc. From 9:00 a.m., the population concentration centers transfer from urban villages to Chegongmiao CBD, Citizens’ Center CBD and Huaqiang North Commercial Area. In the daytime, the population concentration in the above CBDs last long until 20:00. After 20:00, the population concentration in the above areas starts falling. Meanwhile, the population density in urban villages nearby the CBDs starts rising. In Luohu District, the extreme-heat areas appear in urban villages, including Nigang and Hubei, in the morning and evening.

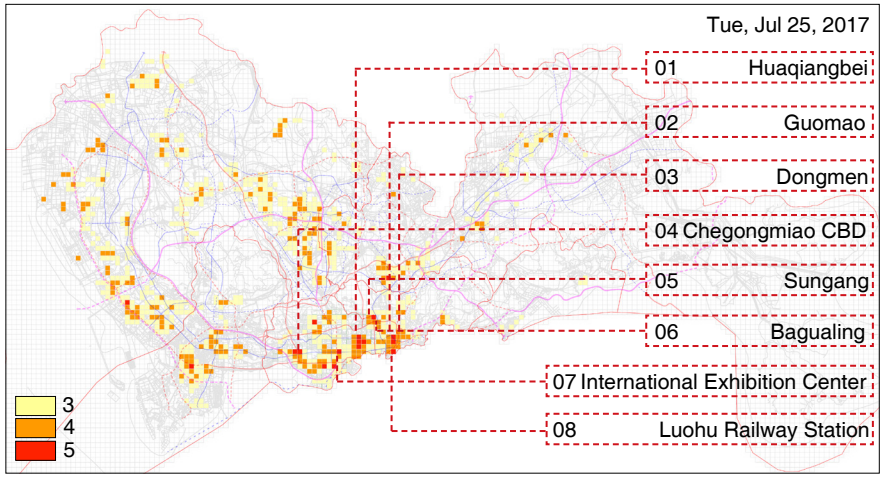


Figure 38. Average heat value of Tuesday, July 25, 2017.
Source: author.

The population concentration maintains at a high level in Luohu CBD, including International Trade Center and Dongmen Shopping Mall. Besides, the population activity in these areas is also higher than that of other commercial areas in the evening. In Nanshan District, the extreme-heat areas are distributed in two commercial areas, namely Technological Industrial Park and Nanyou, in the daytime, and in Nanshan Village and Wansha Community in the morning and evening. Hexi Community, Labor Community, Longsheng Village and Gong Village in Bao'an District are also teeming with population in the morning and evening. (Figure 39. - 41.)

Of special note is that the CBDs and the surrounding urban villages take turns to be the population concentration centers. Take Chegongmiao CBD [21] and the surrounding urban villages for example. From 8:00 a.m. to 13:00 on workdays, the population concentration centers move from the surrounding urban villages to the CBD. From 18:00 to 23:00 in the evening, the population concentration centers move the other way around. (Figure 42. and 43.)

Analysis of the weekends data

This paper adopts data from the heatmap for Baidu map from 8:00 a.m. to 23:00 on Sunday (August 27, 2017) as research samples to analyze changes of the urban thermodynamic value. (Figure 44. - 47.)

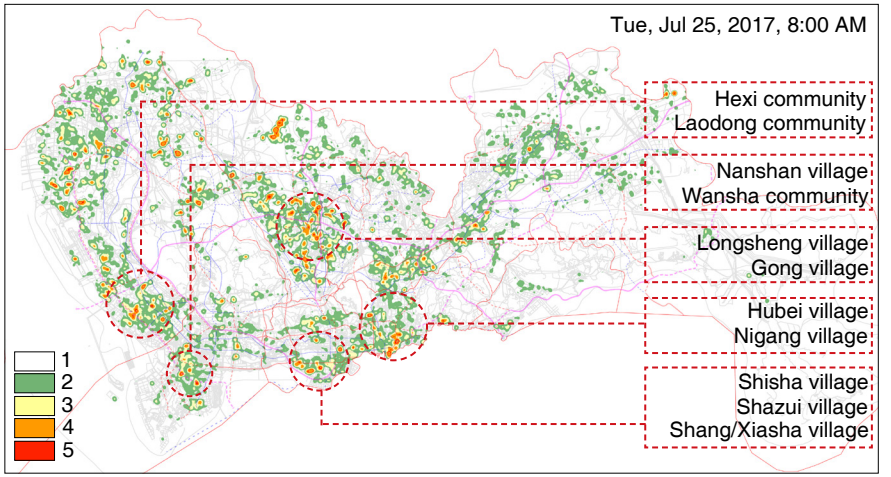


Figure 39. The areas with a high population concentration are statistically analyzed by different periods of time (Tuesday, July 25, 2017).
Source: author.

[21] Chegongmiao CBD is a large urban industrial park with more than 100, 000 workers.

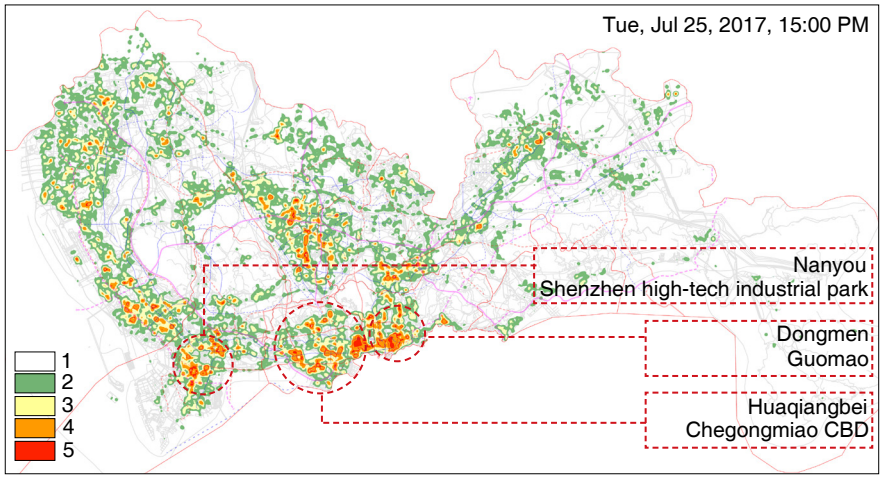


Figure 40. The areas with a high population concentration are statistically analyzed by different periods of time (Tuesday, July 25, 2017).
Source: author.

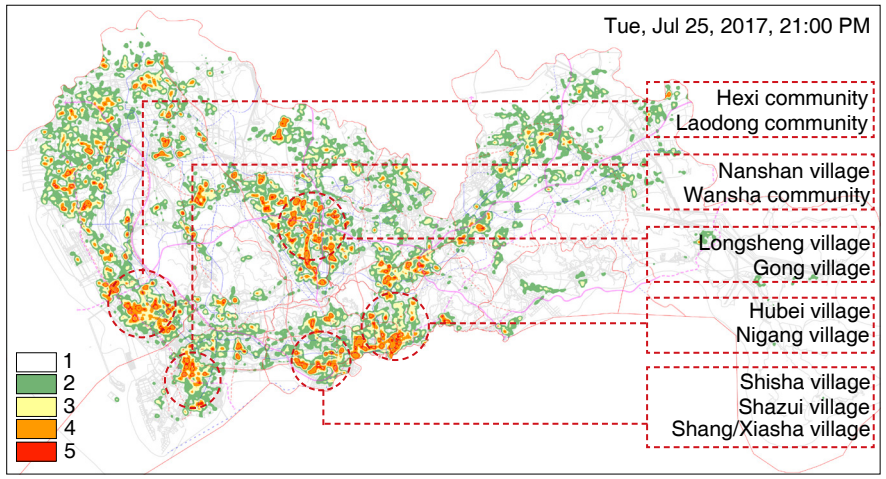


Figure 41. The areas with a high population concentration are statistically analyzed by different periods of time (Tuesday, July 25, 2017).
Source: author.

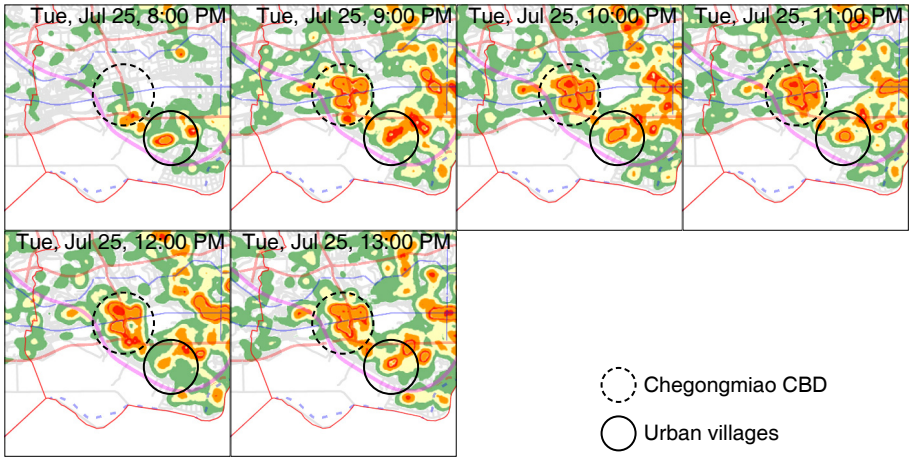


Figure 42. The change of population concentration of Chegongmiao CBD and its surrounding urban villages.
Source: author.

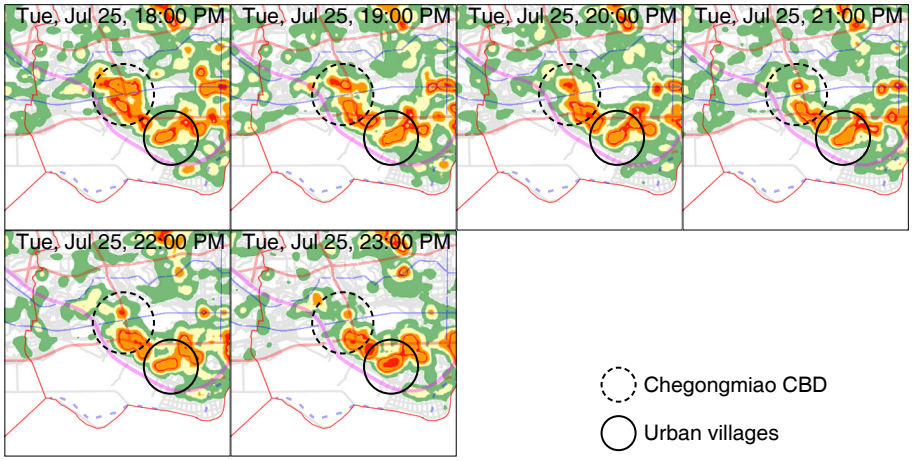


Figure 43. The change of population concentration of Chegongmiao CBD and its surrounding urban villages.
Source: author.

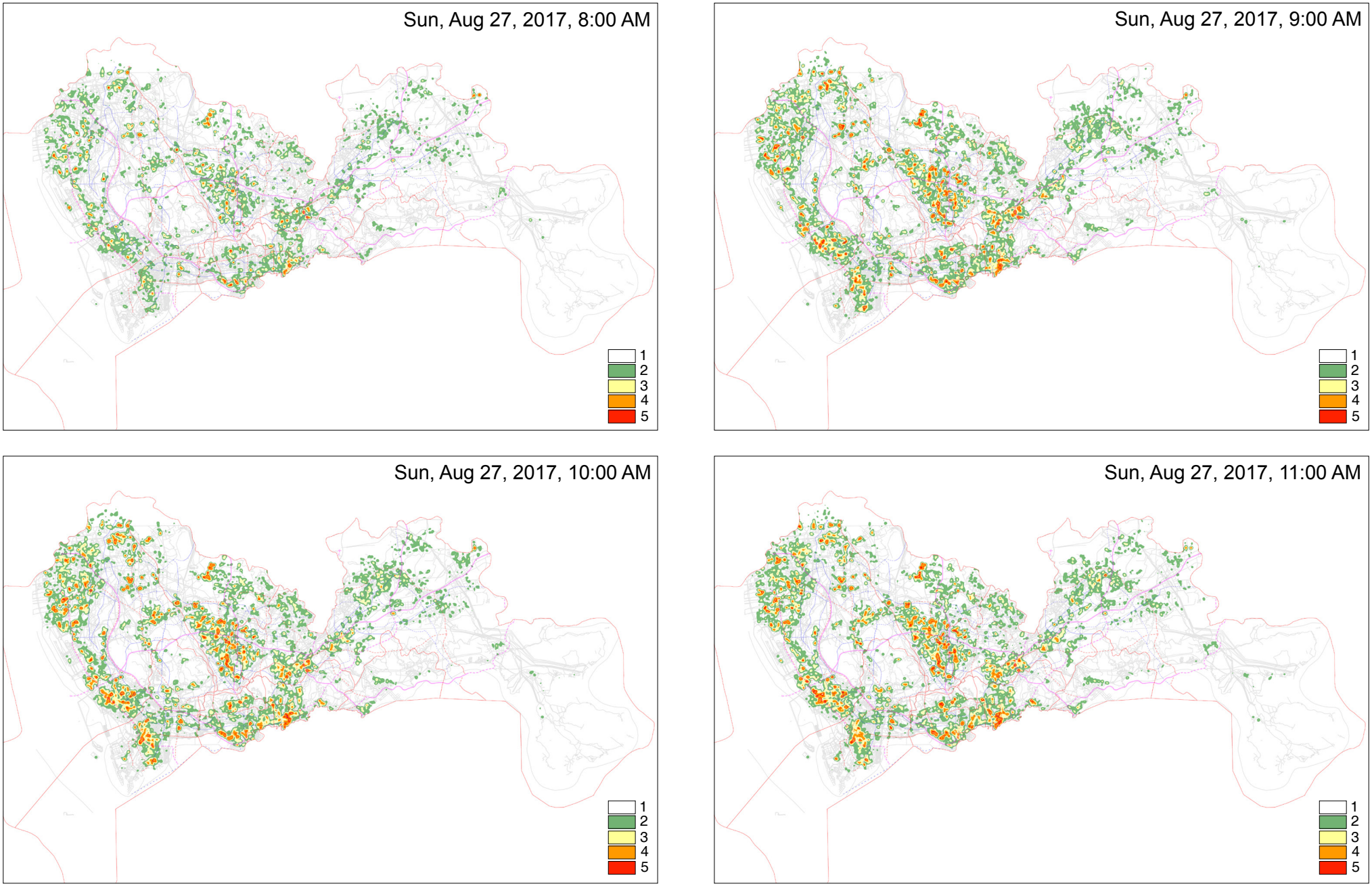


Figure 44. Value assigned heat map for Baidu map data (Sun, August 27, 2017).
Source: author.

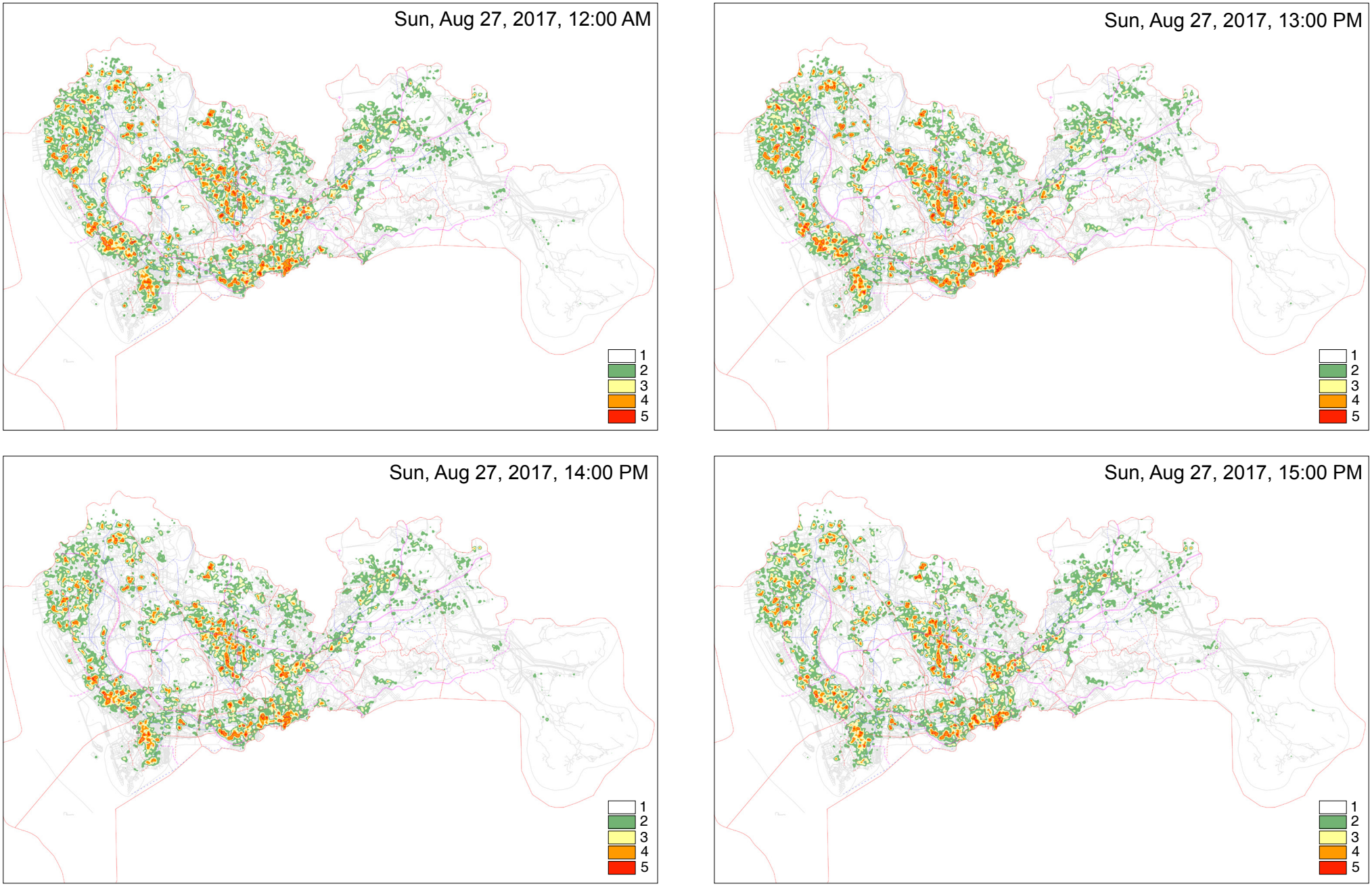


Figure 45. Value assigned heat map for Baidu map data (Sun, August 27, 2017).
Source: author.

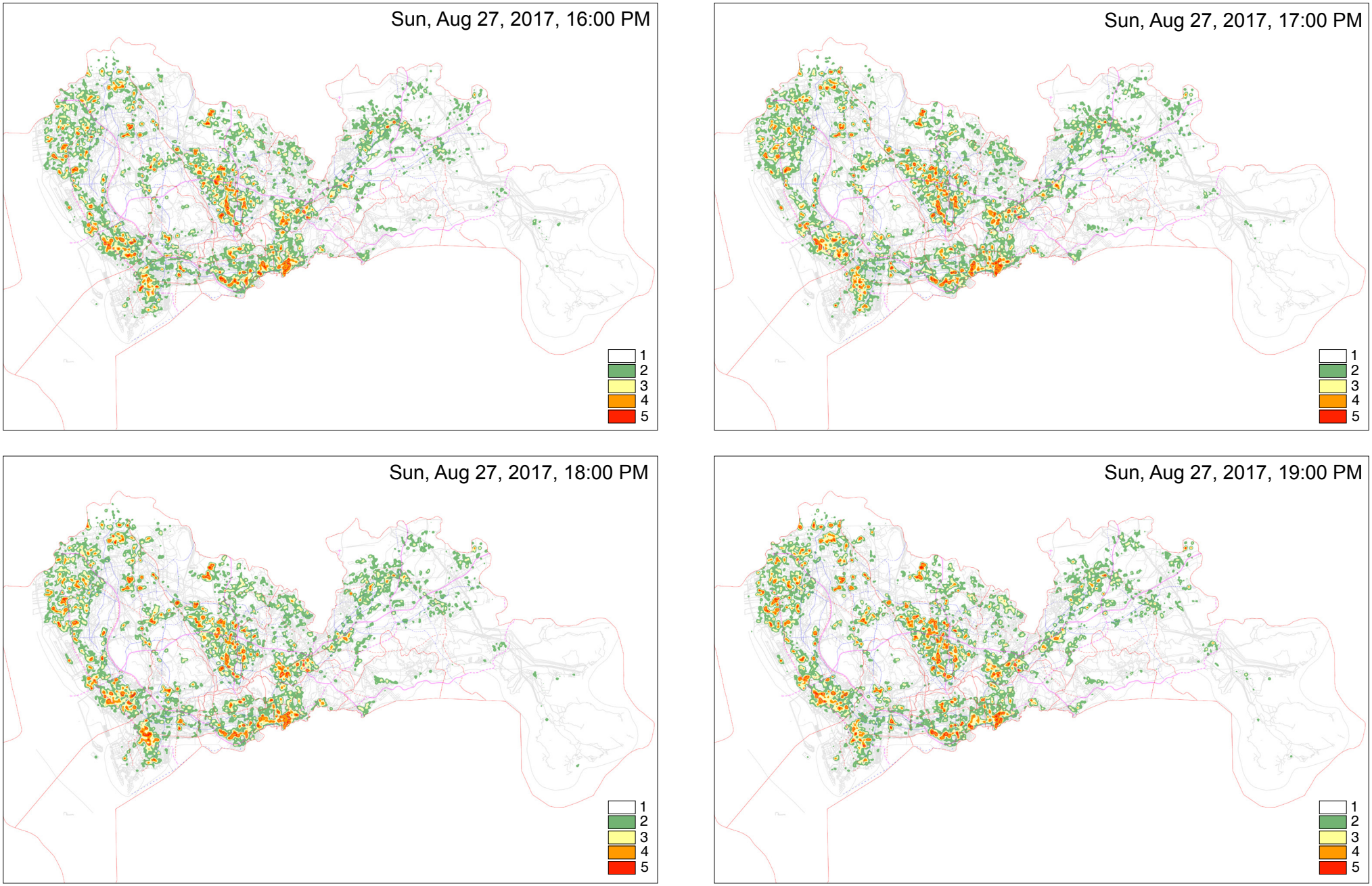


Figure 46. Value assigned heat map for Baidu map data (Sun, August 27, 2017).
Source: author.

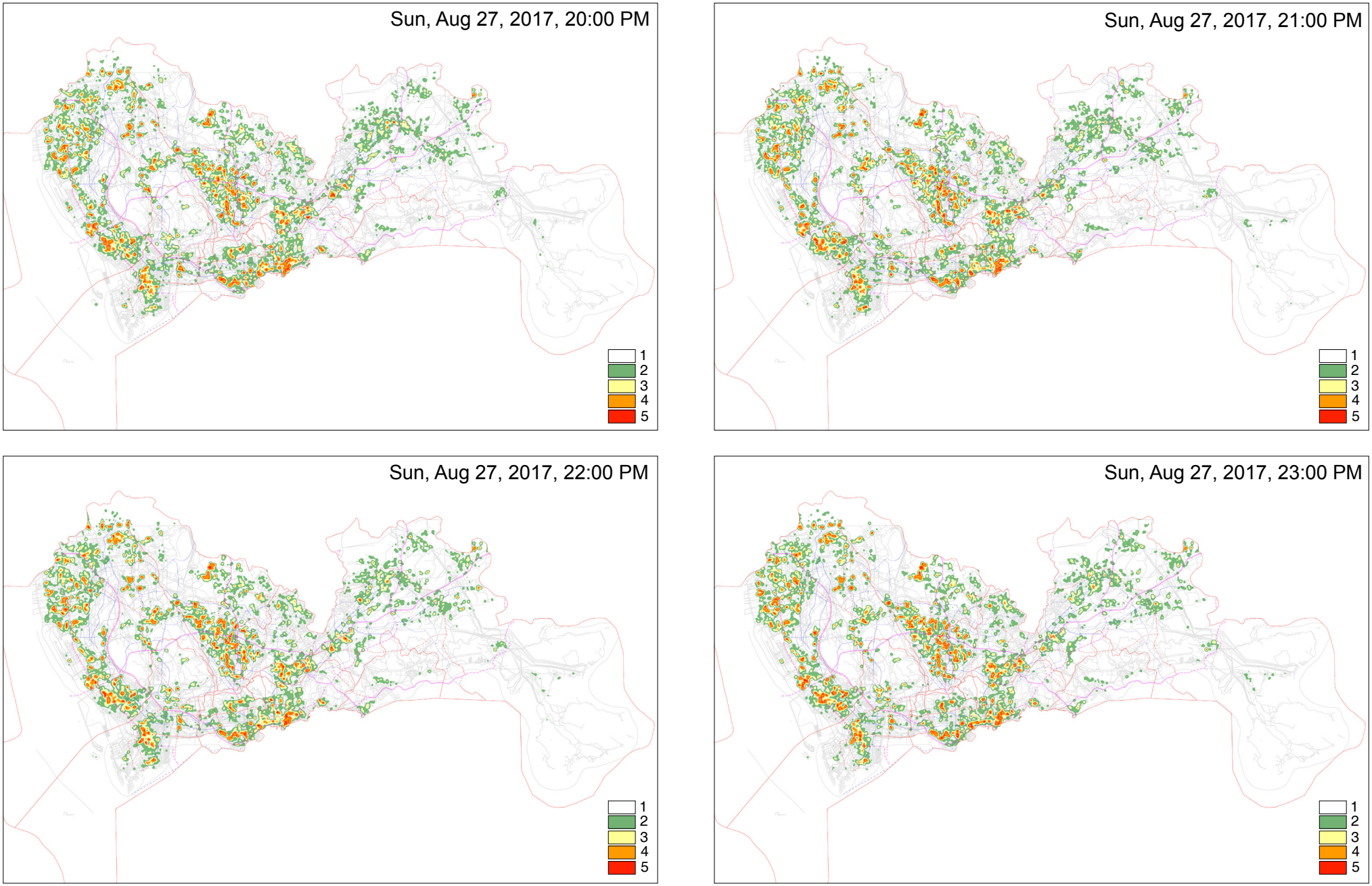


Figure 47. Value assigned heat map for Baidu map data (Sun, August 27, 2017).
Source: author.

(1) Trend of area change along with time of urban extreme-heat and sub-heat district on weekends

On weekends, the population activity intensity is low in the daytime, compared with that on workdays, but high in the evening. From the chart 3 and chart 4 it can be seen that, the growth of the extreme-heat districts and sub-heat districts from 8:00 a.m. to 13:00 is impressive. Especially from 11:00 a.m. to 13:00, the extreme-heat districts keep on expanding, reaching a peak at 13:00. Later, the extreme-heat districts and sub-heat districts slightly shrink, but still maintain at a high level. (Chart 3.) (Chart 4.)

(2) Spatial distribution of the extreme-heat district and the sub-heat district on weekends

From the Figure 48, it can be seen that the population concentration on weekends is scattering. More and more concentration centers appear, but each concentration area is smaller. Throughout the day, the five areas with the highest average concentration including Huaqiang North Commercial Area, International Trade Center, Dongmen CBD, Exhibition Center, and Xiasha Village. However, the influence of areas with commercial functions, such as Huaqiang North Commercial Area, on the population concentration is obvious. The population density in Xiasha Village is high. This means that the urban villages with a favorable geographical location usually have a higher population concentration on weekends.

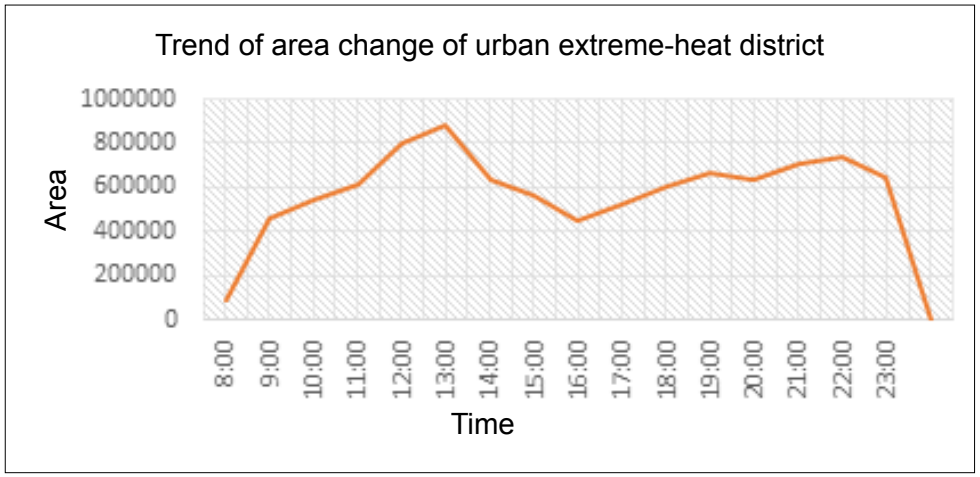


Chart 3. Trend of area change of urban extreme-heat district on Sunday, August 27, 2017.
Source: author.

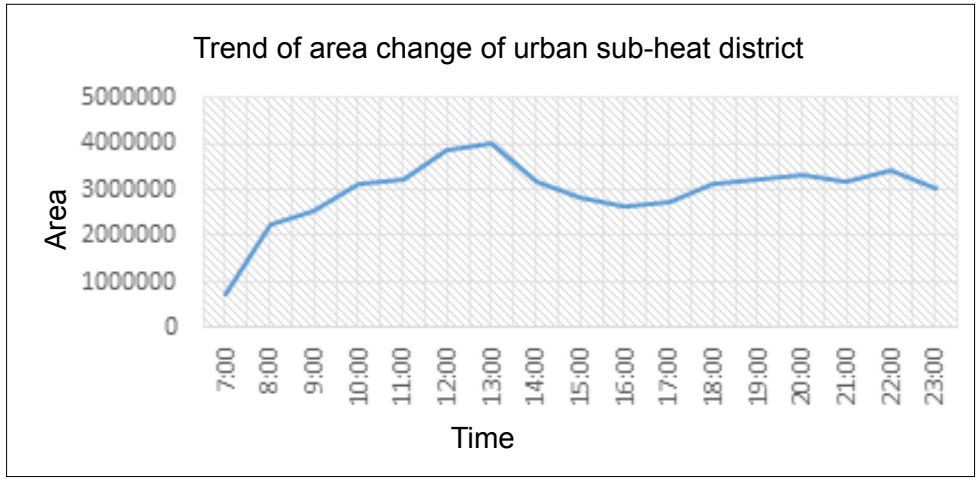


Chart 4. Trend of area change of urban sub-heat district on Sunday, August 27, 2017.
Source: author.

Comparison of population density data on workdays and weekends

Comparison of the population density data above shows the following characteristics of the population distribution and space use in Shenzhen on workdays and weekends.

(1) Either on workdays or on weekends, the urban population distribution shows a low concentration in the morning, but a high concentration in the afternoon and evening.

(2) On workdays, the population concentration maintains a high level much longer than that on weekends. Besides, the population concentration intensity on workdays is also higher than that on weekends.

(3) The peak value of urban population concentration on workdays appears in the morning and evening traffic peak hours. On weekends, however, the peak value of urban population concentration appears at noon.

(4) On workdays, the population tends to gather in several centers; while, on weekends, the population tends to gather at multiple centers and the concentration intensity is much lower.

(5) On workdays, the population concentration in urban villages is relatively high in the morning and evening. In the daytime, the population concentration is high in CBDs and shopping malls. The use intensity of shopping malls on weekends or other holidays is much higher than that of other areas. On weekends or holidays, the use intensity of urban villages is also higher.

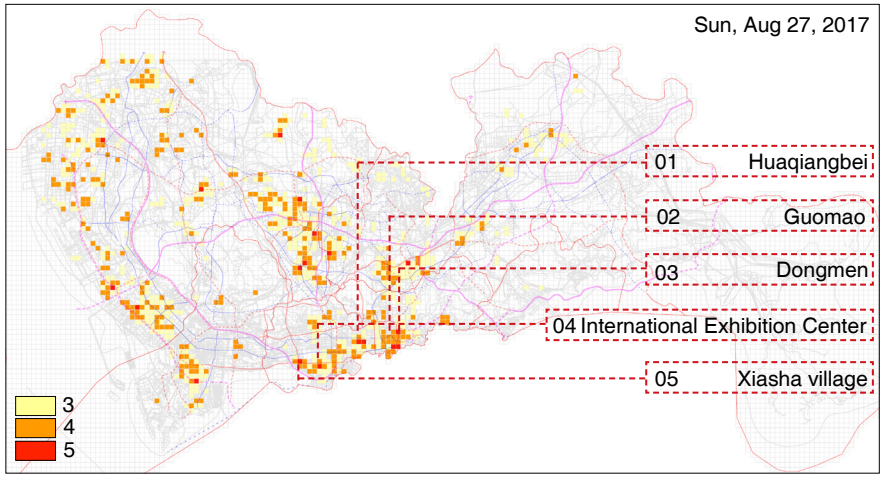


Figure 48. Average heat value of Sunday, August 27, 2017.
Source: author.

Research on spatial distribution of urban public facilities based on Point of Interest (POI) data

Distribution of the urban public facilities shows different regional allocations of community public resources in urban communities. Previously, the social and economic data from urban statistics and the subjective data obtained through social questionnaire surveys were used to build indexes and databases for objective evaluation. Limited by dimensional macroscopic characteristics of statistical data and the narrow scope of responders, the research results could not authentically reflect the living environment of the city. This paper uses the POI data and the GIS method for a more objective research.

The living circle refers to the area where residents have their daily activities. It is influenced by differences of residents' daily living demands. Accessibility of public resources under certain traffic conditions reflects the degree to which the public services meet residents' daily demands. Some Chinese scholars [22] have divided the life circle into three sub-circles based on different grades of public facilities. The three sub-circles include the basic life circle, the general life circle and the urban life circle. Among them, the basic life circle refers to the area which can meet residents' community-oriented service demands; the general life circle refers to the area which satiates residents' daily living demands; while the urban life circle refers to the area which is periodical and accidental, and meets residents' higher grade of demands, such as entertainment and recreation. The basic life circle is defined as the area with 0.5 km away from the residence (5min by foot); the general life cycle is defined as the area within 1 km away from the residence (15 min by foot). Based on the life circle division theory and the requirement of meeting residents' daily demands of public services, the "1 km × 1 km" grid is used to calculate the "average" public facility distribution index.

[22] XIAO, Zuopeng; CHAI, Yanwei and ZHANG, Yan (2014). "Overseas Life Circle Planning And Practice". *Planners*, 2014, (10), pp.89-95.

Confirmation of the evaluation index system and weight

This paper refers to the existing research about the life convenience index system of livable city. [23] And this paper sets the public facility distribution index using the analytic hierarchy process (AHP). According to the index, the public service facilities for community life are divided into eight types, including daily shopping facilities, educational facilities, restaurants, traffic facilities, medical facilities, handy services for the public, financial services and recreational services. Under every type, there are 26 evaluation indexes. Through qualitative index fuzzy quantification, the hierarchical ranking and the overall ranking of the indexes are worked out, and the conditional weight as well as the factor weight is identified. (Table 3.)

POI data preparation and processing

POI data include 308 types information labels. This enables POI data to cover almost all public service facilities. (Table 4.) According to the above index system, the POI data are summarized, and 111 types in accordance with requirements of this paper are extracted. Then, the GIS spatial analysis and the normalization formula are combined for weighting (Equation 2.). Finally, the symbol system, a tool of GIS, is used to visually express the data.

The sequences x_1,x_2,x_3,……,x_n are transformed:

$$y_i = \frac{x_i - \min\limits_{1\le j\le n}\{x_j\}}{\max\limits_{1\le j\le n}\{x_j\} - \min\limits_{1\le j\le n}\{x_j\}} \qquad \text{(Equation 2.)}$$

The new sequences y_1,y_2,y_3,……,y_n ∈ [0,1] and are dimensionless.

[23] CUI, Zhenzhen; HUANG, Xiaochun; HE, Lianna and ZHOU, Zhiqiang (2016). "Study on Urban Life Convenience Index Based on POI Data". *Geomatics World*, 2016, 23(3), pp.27-33.

Target	Evaluation factor	Factor weight W^1	Evaluation condition	conditional weight W^2	Normalized weight W
The public facility distribution index	Daily shopping facilities	0.25	Supermarket	0.5	0.125
			Farmersmarket	0.3	0.075
			Shoppingmall	0.2	0.05
	Educational facilities	0.1	Kindergarden	0.4	0.04
			Primaryschool	0.3	0.03
			Middleschool	0.3	0.03
	Restaurants	0.2	Fastfood	0.4	0.08
			Chinese restaurant	0.4	0.08
			Foreign restaurant	0.1	0.02
			Other restaurants	0.1	0.02
	Traffic facilities	0.15	Metro	0.6	0.09
			Bus stop	0.4	0.06
	Medical facilities	0.1	Community hospital	0.3	0.03
			General hospital	0.4	0.04
			Pharmacy	0.3	0.03
	Handy services for the public	0.1	Barbershop	0.4	0.04
			Laundry	0.3	0.03
			Express	0.3	0.03
	Financial services	0.05	ATM	0.5	0.025
			Four state-owned banks	0.4	0.02
			Other banks	0.1	0.005
	Recreational services	0.05	Sport facility	0.2	0.01
			Cinema and theatre	0.2	0.01
			Museum	0.1	0.005
			KTV	0.2	0.01
			Park	0.3	0.015

Table 3. The public facility distribution index.
Source: author.

The classification of POI data	
The first stage classification	**The second stage classification**
Food & Delights	Chinese Restaurant, foreign restaurant, fast food, snack bar, dessert shop, café, teahouse, bar, etc.
Hotel	Star hotels, express hotel, apartment hotel
Shopping	Shopping mall, supermarket, seven-eleven, home furnishing store, electrical apliance shop, market
Life Services	Telecom business office, post office, express company, ticket office, laundry, printing shop, real estate agent, maintenance point, newspaper kiosk, public toilet, etc.
Fashion	Hairdressing, cosmetology, nail care, etc.
Tourist attractions	Park, zoo, botanical garden, amusement park, museum, aquarium garden, bathing beach, cultural relics, church, scenic zone, etc.
Recreational	Resort, cinema, KTV, theatre, net bar, bath massage, etc.
Education	University, kindergarten, primary school, middle school, adult education, special education school, research institutions, training institutions, library, science museum, etc.
Sport & fitness	Stadium, gymnasium, etc.
Cultural media	Journalism, radio & television, gallery, etc.
Medical	General hospital, community hospital, specialized hospital, clinic, pharmacy, nursing home, etc.
Auto service	Auto sales, auto repair, car rental, etc.
Traffic facilities	Airport, railway station, metro, bus station, port, parking, gas station, etc.
Financial service	Bank, ATM, hockshop, etc.
Real estate	Office building, residential area, etc.
Company	Company, factory, industrial park, etc.
Government agencies	Procuratorial organs and people's courts, administrative unit, partisan, etc.

Table 4. The classification of POI data.
Source: author.

Comparative analysis of the results

From the Figure 49, it be seen that the distribution density of public facilities is high in the south of Shenzhen, but low in the north. In terms of administrative areas, the Luohu District and Futian District get the highest rating, followed by Nanshan District. The rating of Bao'an District and Longgang District is the lowest.

By comparatively analyzing each item, (Figure 50. - 57.) it can be seen that the traffic facilities and the recreational facilities have the widest and most proportional distribution throughout Shenzhen. The financial service facilities and commercial service facilities mostly concentrate in Nanshan District and Luohu District. The educational facilities, medical facilities and life service facilities are proportionally distributed throughout Shenzhen, but lack extensiveness. To sum up, within the former Shenzhen Special Economic Zone, the public facilities are complete, thus making life much convenient there. In Bao'an District (except Xixiang ang Longhua), commercial facilities and financial service facilities are lacking. In Longgang District, catering facilities and financial service facilities are inadequate.

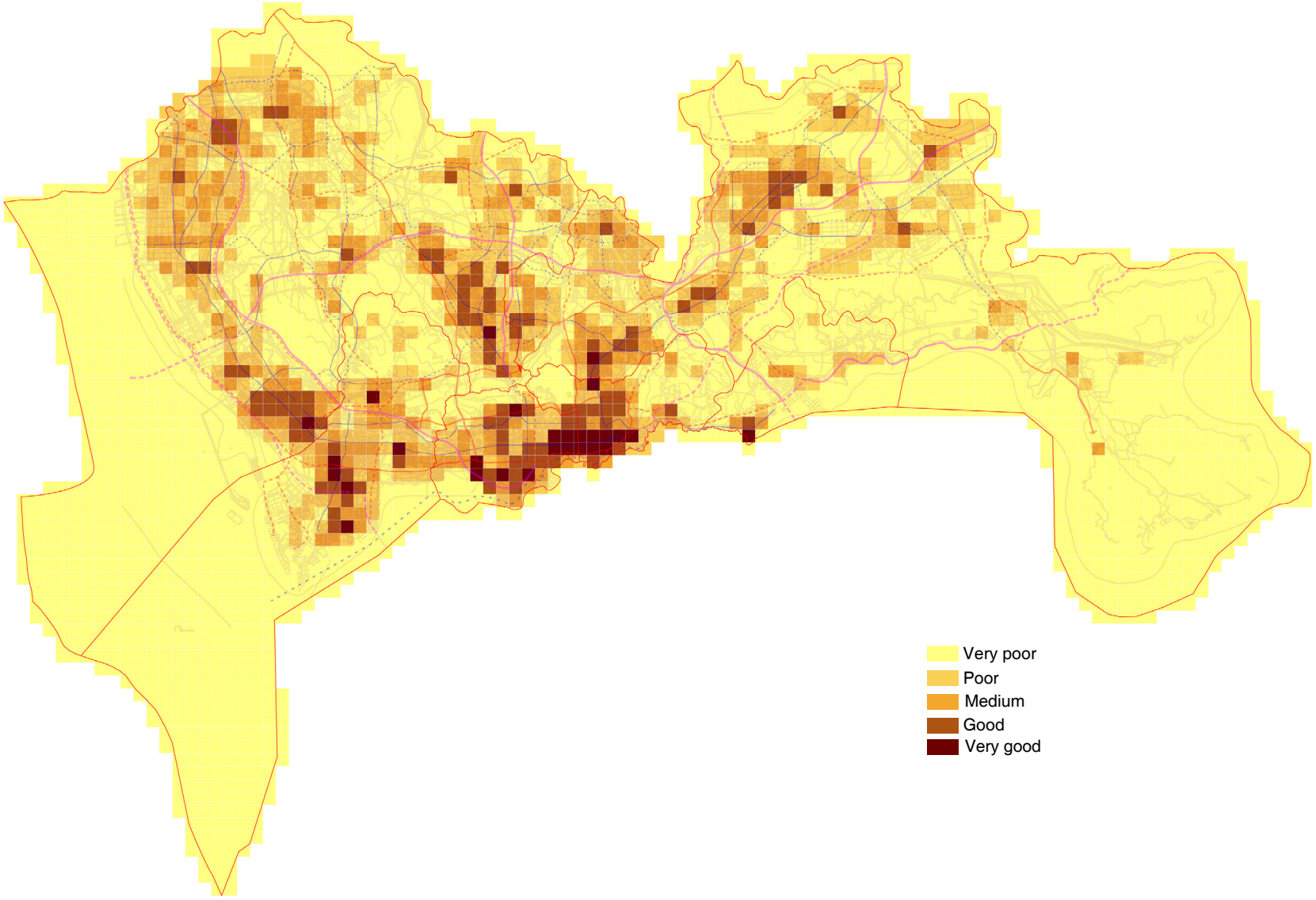


Figure 49. The public facilities density analysis distribution map of Shenzhen city.
Source: author.

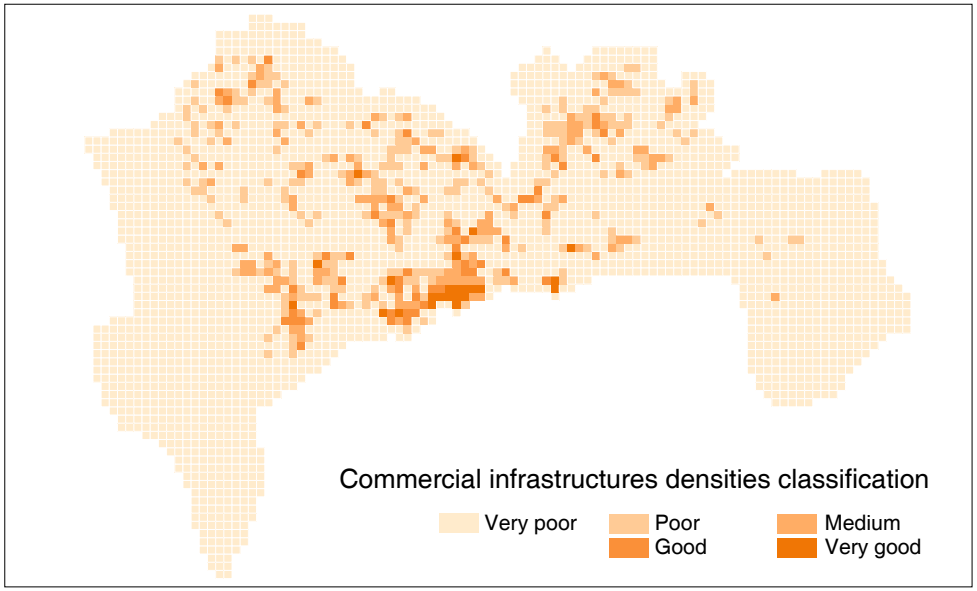


Figure 50. The commercial infrastructures density distribution map of Shenzhen city.
Source: author.

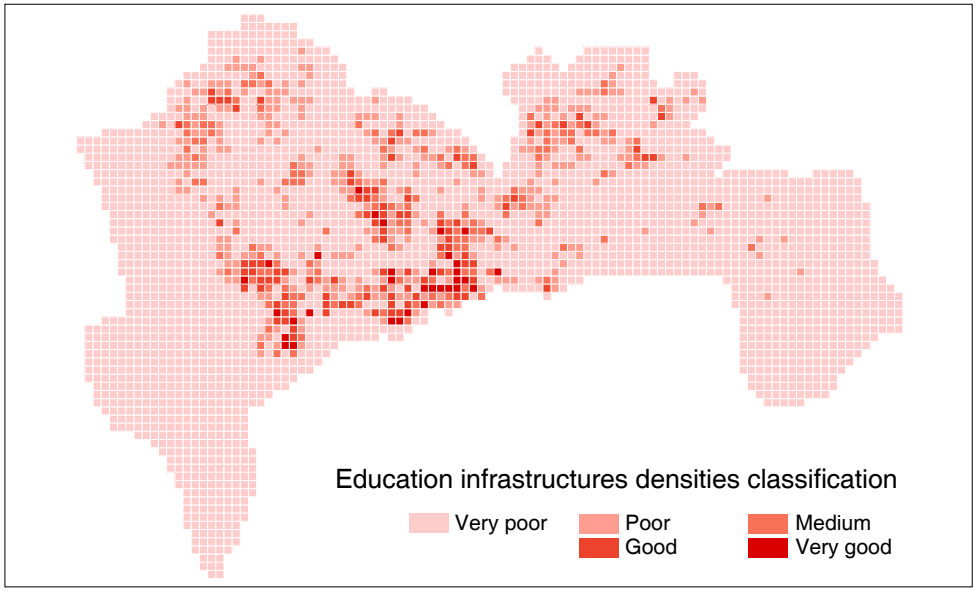


Figure 51. The education infrastructures density distribution map of Shenzhen city.
Source: author.

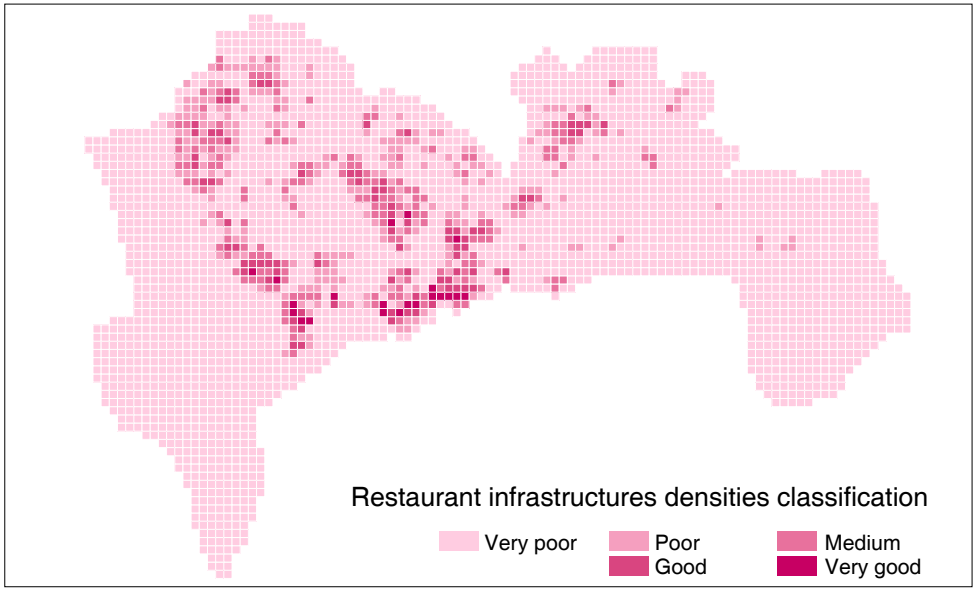


Figure 52. The restaurant infrastructures density distribution map of Shenzhen city.
Source: author.

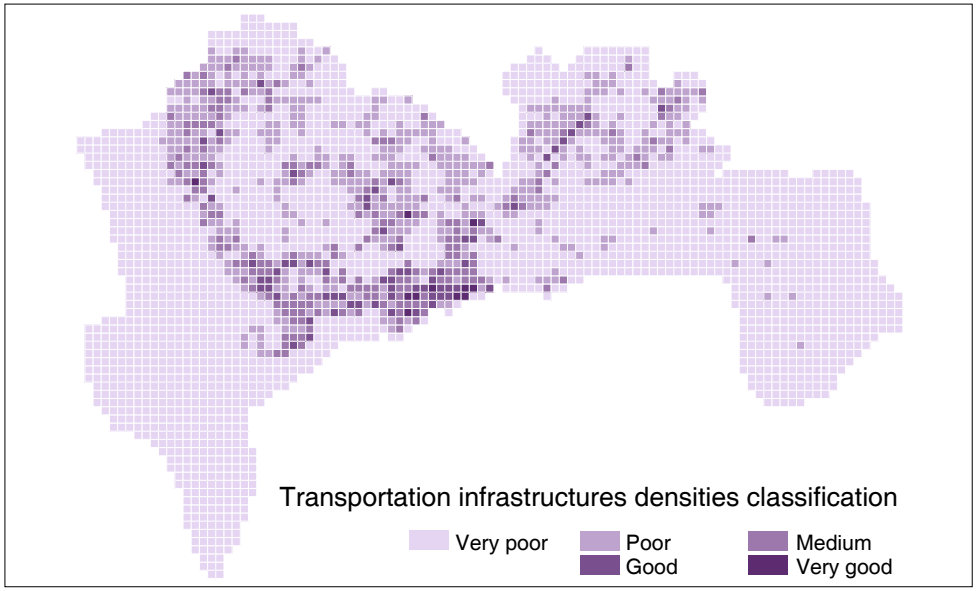


Figure 53. The transportation infrastructures density distribution map of Shenzhen city.
Source: author.

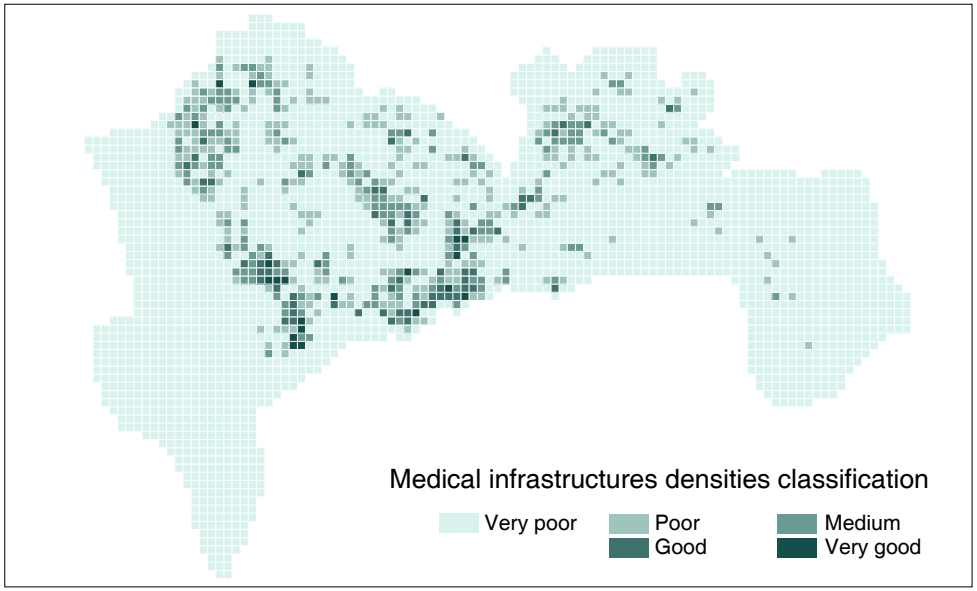


Figure 54. The medical infrastructures density distribution map of Shenzhen city.
Source: author.

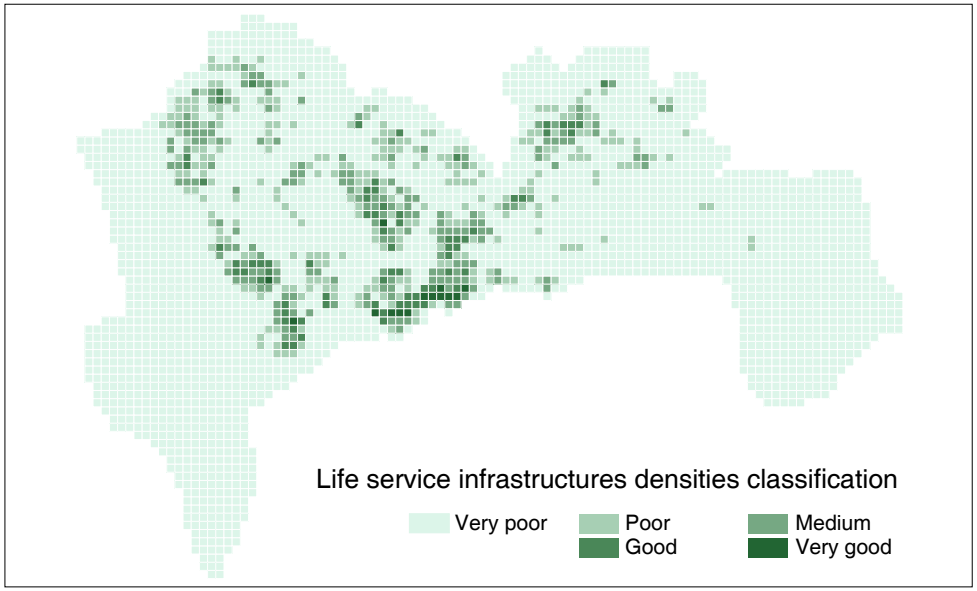


Figure 55. The live service infrastructures density distribution map of Shenzhen city.
Source: author.

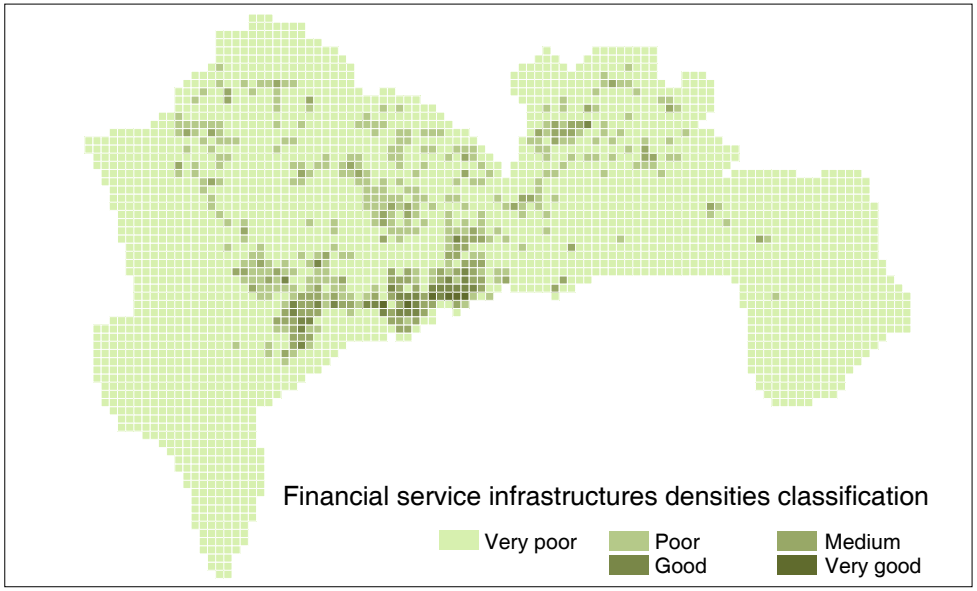


Figure 56. The financial service infrastructures density distribution map of Shenzhen city.
Source: author.

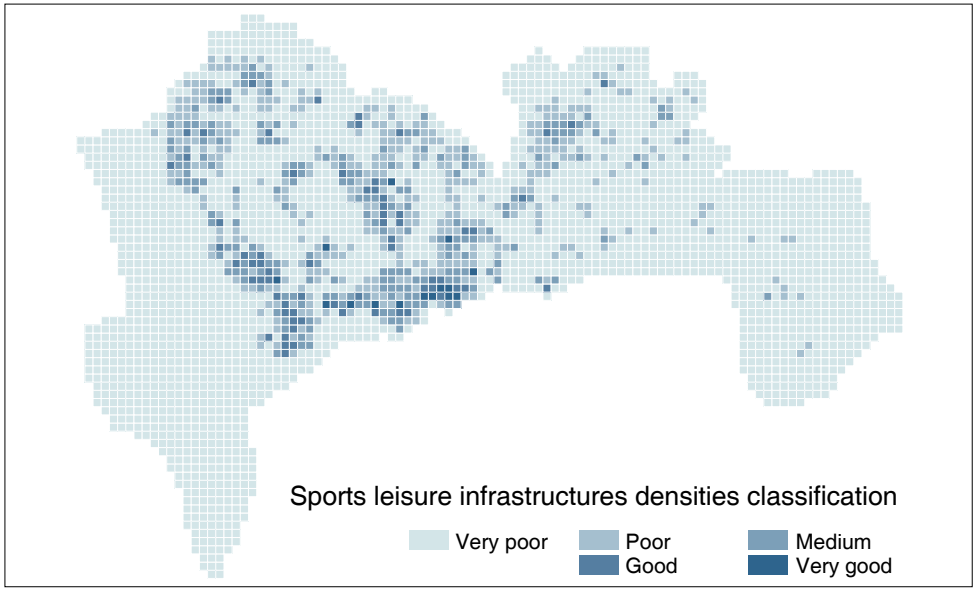


Figure 57. The sports leisure infrastructures density distribution map of Shenzhen city.
Source: author.

The stacking chart of the general public facilities distribution and the urban village distribution (Figure 58.) shows that most urban villages are located in areas with a high density of public facilities. In fact, urban villages themselves have contributed to abundance of the public facilities, especially restaurants, shopping malls and handy services for the public. Take Chegongmiao CBD and its surrounding urban villages for example. Statistical analysis shows that Chegongmiao CBD covers a total area of 90.68 ha, and 1,478 POIs, including 20 shopping facilities, 5 educational facilities, 1,070 restaurants, 22 traffic facilities, 12 medical facilities, 205 handy services for the public, 91 financial service facilities and 73 recreational facilities. The total area of Xiasha Village and Shangsha Village nearby Chegongmiao CBD is 70.28 ha, and they have 1,712 POIs, including 61 shopping facilities, 14 educational facilities, 1,210 restaurants, eight traffic facilities, 48 medical facilities, 286 handy services for the public, 30 financial service facilities and 55 recreational facilities. It is self-evident that, under the prerequisite of not considering the grade of public facilities, the public facilities density of Shangsha Village and Xiasha Village is higher than that of Chegongmiao CBD. (Figure 59.) (Table 5.) This could be because the city's population is so large that it has spawned a number of commercial facilities.

Type	Chegongmiao CBD	Urban villages
Site plan		
Area	90.68 ha	70.28 ha
Number of shopping facilities	20	61
Number of educational facilities	5	14
Number of restaurants	1070	1210
Number of traffic facilities	22	8
Number of medical facilities	12	48
Number of handy services for the public	205	286
Number of inancial service facilities	91	30
Number of recreational facilities	73	55
Total	1478	1712

Table 5. Statistics of public facilities of Chegongmiao CBD and urban villages.
Source: author.

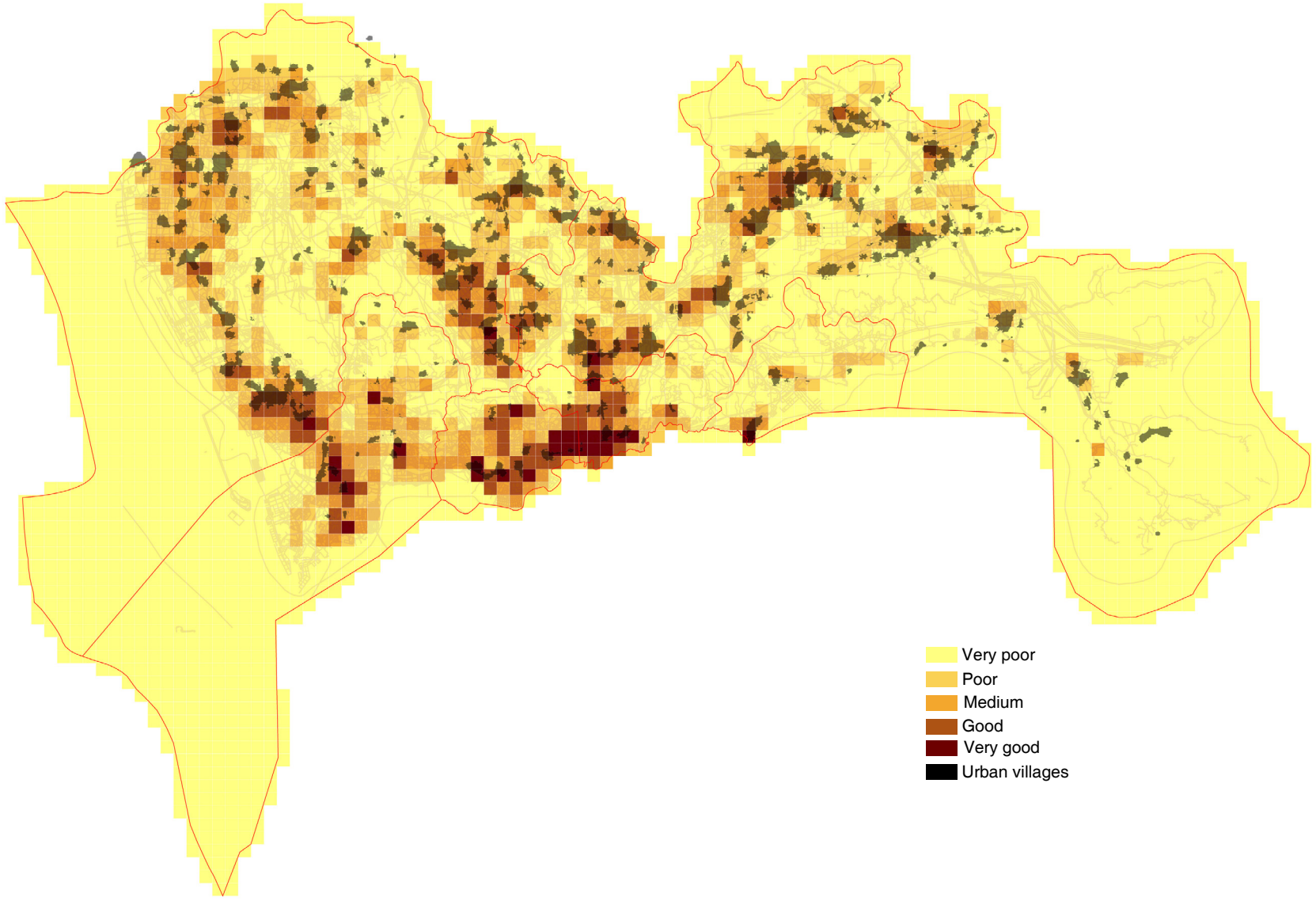


Figure 58. The stacking chart of the general public facilities distribution and the urban village distribution.
Source: author.

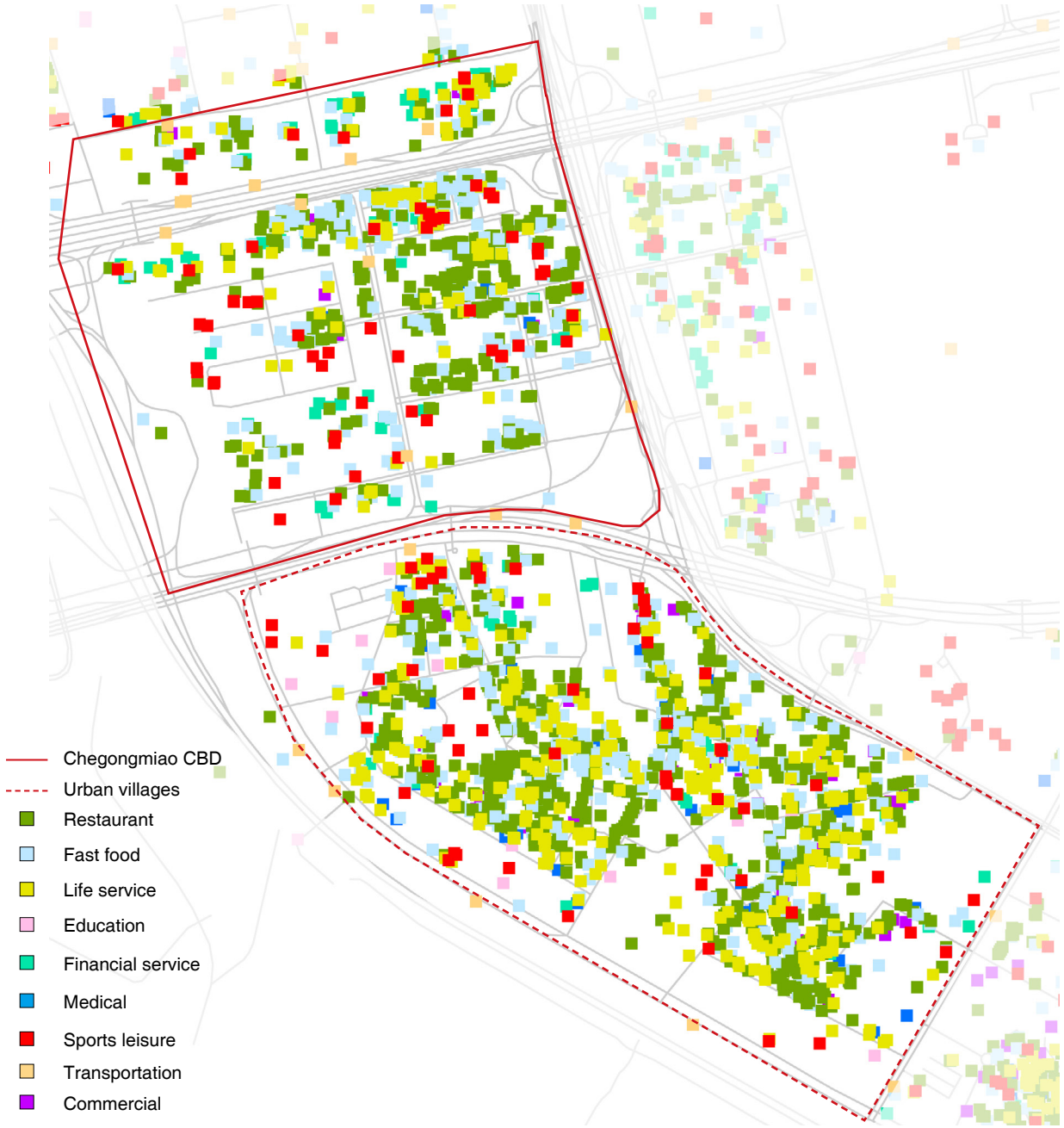


Figure 59. The public facilities distribution map of Chegongmiao CBD and urban villages.
Source: author.

3.2 Research on urban village space at the medium measure

Definition of urban fabric

The urban fabric is an abstraction of a real city. It extracts the 2D indexes from a real city to form data which can reflect characteristics of a city. The urban fabric is an outcome of long-term mutual integration between the natural systems which reflect the urban ecological environment and the artificial systems which reflect the city's history, traditions, economy, culture, technology and science. It is a whole entity constituted by the city, natural environment and people jointly. It directly reflects the structural forms and characteristics of a city; historical patterns of the people living in it; cultural characteristics of the regional environment; and various elements constituing the city's road network and spatial structures. The urban fabric is a crystalization of a city's history. With the passage of time, it is increasingly enriched. Therefore, the urban fabric is a form of human settlement organized in a city in certain scale and in line with certain organizational rules. The urban fabric takes on different forms in different periods, and even in the same period of time. Differences of geographical environments, cultural environments, and human activities lead to differences of the city texture. (Figure 60. - 63.) Rossi thought that the city texture should contain the collective memories of people living in the same area. Such memories are made up of memories of people about the space and the entity. The memories can in turn influence shaping of the future city image. [24] Therefore, when people shape a space, they shape it according to their desires and knowledge, but they cannot ignore limitations of material conditions. In other words, in studying and transforming urban villages, one should protect and get accustomed to the unique textual characteristics of urban villages. (Figure 64.)

In the existing research, the elements of the texture of the urban village are summarized as "framework" , "group" and "landmark". [25]

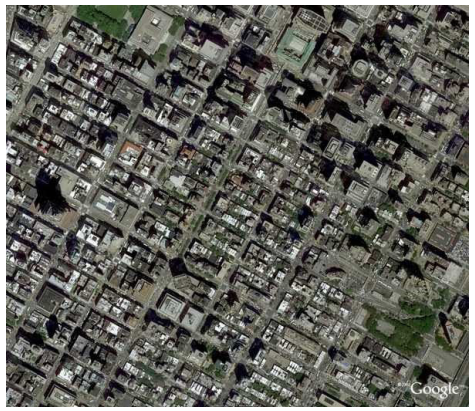


Figure 60. Urban fabric of New York.
Source: Google map.

Figure 61. Urban fabric of Barcelona.
Source: Google map.

Figure 62. Urban fabric of Paris.
Source: Google map.

Figure 63. Urban fabric of Pingyao, China.
Source: Google map.

[24] MA, Yan (2008). *Preliminary research on the urban texture from the perspective of urban planning* (Master's thesis). Xi'an university of architecture and technology.
[25] CHEN, Jiaxuan (2012). *Texture conservation and renovation reserach of Village in Guangzhou - with the renovation and reconstruction of Chajiao Village, Liwan District in Guangzhou as an example* (Master's thesis). South China university of technology.

The "framework" (Figure 65.) refers to the street network in urban villages. It can be divided into roads and nodes according to the use functions. Roads are habitual, accidental or potential mobile channels. They are dominating elements in an image. When people moving on the roads, village and other environmental elements are also laid out along the roads. Therefore, the two are closely linked with each other. The nodes are nodes of strategic importance, which can be observed, and are nodes where people travel frequently by. They can be connecting nodes, such as the rest stations in the traffic lines or the converging points, which transfer from one structure to the other structure, or the simple gathering points. As condensation of some functional or material features, they are highly important. For example, they can be a gathering ground nearby a street corner or an enclosed square.

The "group" (Figure 66.) refers to boundaries and regions. A boundary is a linear element apart from roads, and usually refers to the boundary between two regions. In this sense, a boundary serves as a reference object and a landscape. The rural group elements include elements, such as the architectural style and layout, which separate the rural areas from elsewhere, and the linear elements, such as the boundary, which can separate the rural areas.

The "landmark" (Figure 67.) refers to the tangible objects with simple definitions, such as buildings, stores or mountains. In other words, a landmark is an outstanding element selected from multiple potential elements. Some landmarks are far away from each other. They can be seen from a distance by going above the top of the low buildings from different angles. These landmarks form regional references. Landmarks in rural areas are often elements which are distinguished from other ordinary buildings.

Figure 65. The "framework".
Source: Qi Kang.

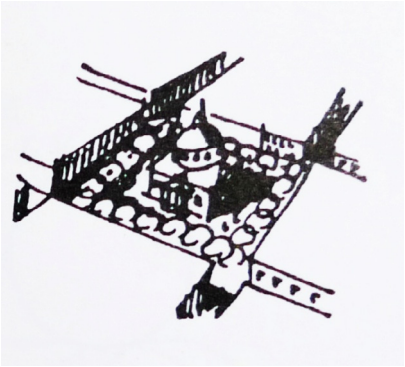


Figure 66. The "group".
Source: Qi Kang.

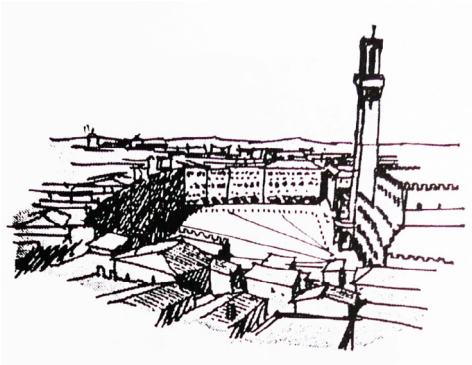
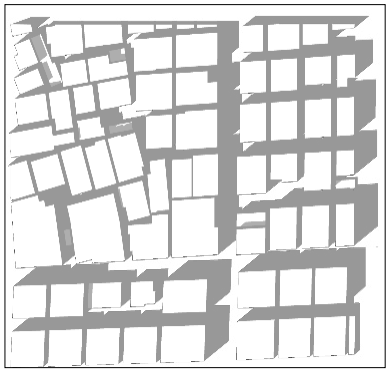
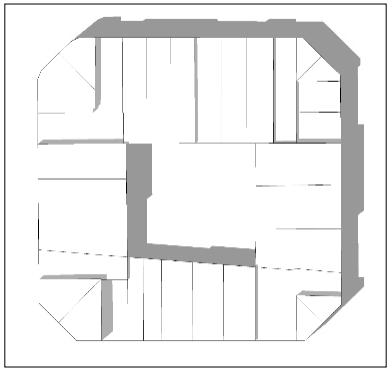


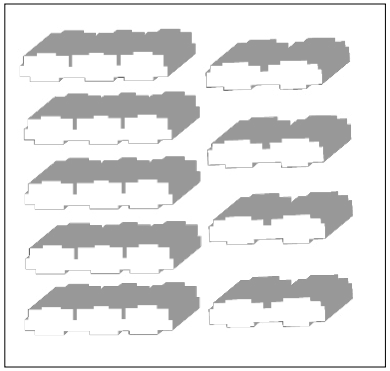
Figure 67. The "landmark".
Source: Qi Kang.



Building density of Xiasha village: 95%



Building density of block of Barcelona: 70%



Building density of residential district: 30%
Figure 64. Urban fabric and building density.
Source: author.

Urban villages are dominated by residential, production and consumption spaces. Of course, there are some other types of space. All these spaces are mixed to form a special landscape collage. In a 2D spatial layout, different spaces are intersected. (Figure 68.) In a 3D spatial layout, the spaces are highly compressed and compact. [26] (Figure 69.) Though the disorderliness of urban villages does not follow obvious rules, study of their texture can still help us explore the internal logic among different spatial elements. This chapter takes Xiasha Village for example to further study the urban fabric of urban villages.

Figure 68. Urban fabric of urban villages in Shenzhen.
Source: Studio G.

Figure 69. Urban fabric of urban villages in Shenzhen.
Source: web.

[26] ZHANG, Yuxing (2016). "Urban village is a world heritage from the future". <https://read01.com/EP7yk0.html#.WhrjCFWnHIU> [Accessed: 15 Aug. 2017]

Open Street Map (OSM) data preparation and processing

This chapter adopts the ELK plug-in in Grasshopper for processing of the Open Street Map geographical information. (The data include the starting point, ending point, traffic mode, distance, time, longitude, latitude, direction, etc.) (Figure 70.) This paper introduces the OSM data mainly for the purpose of recognizing the urban roads, greenbelts, water systems and buildings, and their area. Then, the data visualization method is used to make a data analysis vector diagram.

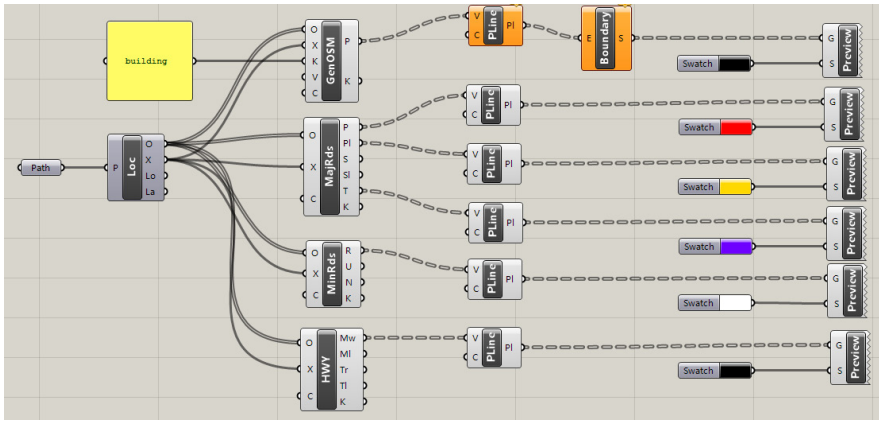


Figure 70. The flow chart of grasshopper.
Source: author.

Research on urban fabric features of urban village – the example of Xiasha village.

Introduction to Xiasha village

Xiasha Village was founded during the Southern Song Dynasty. So, it has been existing for more than 800 years. The village has many well-preserved historical relics, including Huang Siming Ancestral Temple, Chen Yanghou Ancestral Temple and Buddha Statue (located in Xiasha Cultural Square). Meanwhile, the local cultural customs either of the Southern Guangdong style or of the South of the Five Ridges. In 2002, the Pan Dish Banquet refreshed the Guinness World Record. Located in southwest of Futian District, Xiasha Village is adjacent to Shenzhen Bay, and faces Yuen Long, Hong Kong across the Bay. The favorable geographical location has created convenient transportation for Xiasha Village. The southern part of the Village is close to the city's secondary main road, namely Furong Road. It is also close to the Beijing-Hong Kong-Macao High-speed Railway. The northern part of the Village is the city's main road, Riverside Avenue. The eastern part of the Village is the city's secondary main road, Fuqiang Road. The northern part is also adjacent to Xiasha Station, a station of Subway Line 9. (Figure 71. and 72.) Xiasha Village covers a total area of 35 ha, and is divided into eight districts. (Figure 73.) Statistics released by the Shenzhen municipal authorities in 2007 suggested that there were 673 residential buildings in Xiasha Village, registering a total floor area of 592,637 square meters. The average floor area of each building is 880.6 square meters.

Figure 71. The location of Xiasha village.
Source: author.

The residential plot ratio is 3.94, and the building density is 66.9%. [27] Most of these residences are built after two to three dismantling and reconstruction by the villagers. Most buildings feature a brick-concrete structure and the framework structure. Most residential buildings range from seven floors to nine floors, accounting for 85% of the total. The percentage of residential buildings lower than three floors is just 3%. Residential buildings ranging from three floors to five floors, and higher than 10 floors account for 9% and 4% of the total, respectively. In Xiasha Village, there is a population of 45,667, of which 92% are temporary residents. After years of land transfers, some lands of Xiasha Village have been fully dismantled to build high-end communities and commercial buildings. So far, Xiasha Village is surrounded by prosperous urban areas. (Figure 74.)

Figure 74. The view of Xiasha village.
Source: web.

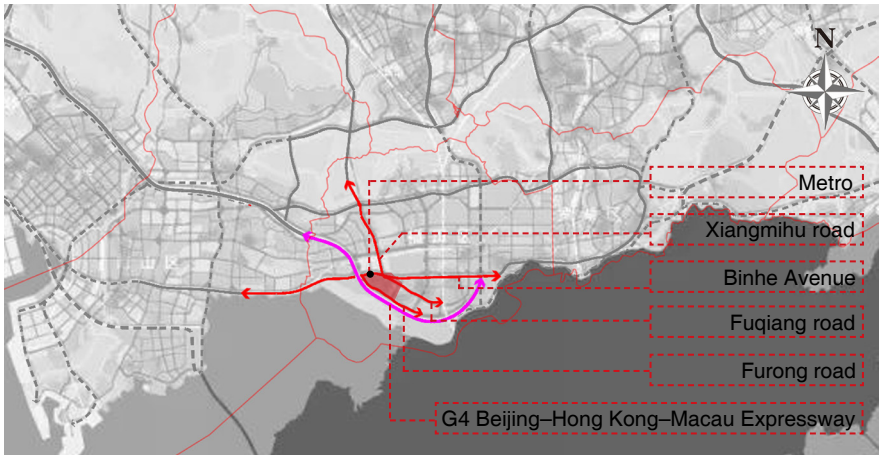


Figure 72. The flow chart of grasshopper.
Source: author.

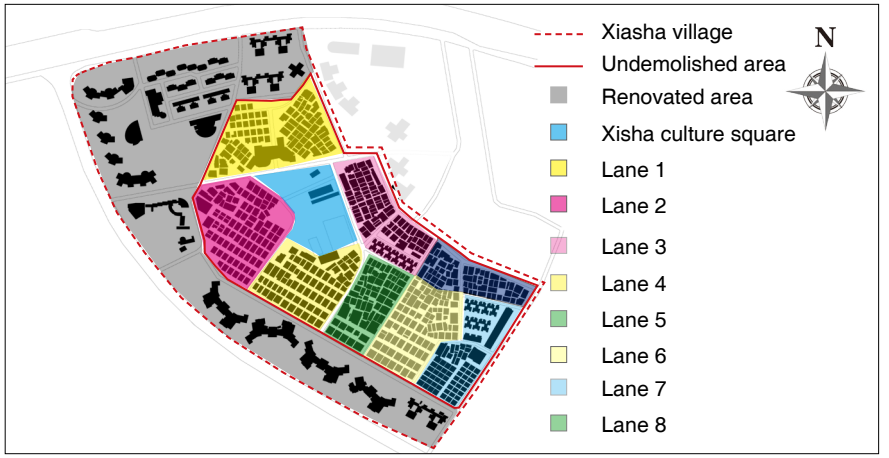


Figure 73. The location of Xiasha village.
Source: author.

[27] SHENZHEN FUTIAN DISTRICT PEOPLE'S GOVERNMENT (2007). *The 11th five-year plan of urban village renewal of Futian District*. <http://www.shenzhen.com.cn/ftq/ghjh/zxgh/200809/t20080903_1563.htm> [Accessed: 22 Sep. 2017]

Detailed Findings

The urban fabric of Xiasha Village can be divided into framework elements (current road systems and Xiasha Cultural Square); group elements (street stores and village buildings); landmarks (Xiasha Memorial Archway, Huang Siming Ancestral Hall, Chen Yang Ancestral Hall, Buddha Statue and Xiasha Museum).

(1) The elements of the texture of “framework”

The road systems

The road systems in Xiasha Village are composed of roads for vehicles and pedestrians. Without systematic planning, the roads in Xiasha Village are developing freely according to the geographical environment. The strong adaptability has enabled these roads to form their own characteristics. A main road going through Xiasha Village from the south to the north separates the updated parts from the parts not yet dismantled. Besides, there are five secondary main roads going through the village from the east to the west, separating the village into eight residential blocks. The main road is 6m wide, and the five secondary main roads are 3~5m wide each. Though these roads are connected with each other into rings, basic traffic demands of traffic, population and fire-fighting flows are not yet satiated. (Figure 75.)

The accessibility of the roads is further studied. Assume that the minimum road width for passing of vehicles is 4m. These roads are then extracted from the database. It is found out that the roads for passing of vehicles in most parts of Xiasha Village are not systematic, or even structurally disorderly. Some roads are interrupted without any signs, blocking vehicles to go further. The problem is especially serious in No. 3, No. 5 and no. 8 Residential Block, where there are almost no roads for passing of vehicles. (Figure 76.)

Figure 75. The road systems in Xiasha village.
Source: author.

Figure 76. Vehicle road analysis diagram.
Source: author.

The sidewalks form the main part of the Xiasha Village's road system, and mainly include the alleys between buildings. The pedestrians within Xiasha Village consist of two forms. One features a loose grid texture, while the other is just 1 to 2m on average with the narrowest being below 1m. (Figure 77. and 78.) The road width is highly inconsistent, and sudden changes are often found in some parts. Besides, due to the small space between buildings, there are serious safety and hygiene problems with these zigzagging and narrow roads. Once a fire disaster happens, the fire-fighting truck will be blocked. Due to lack of necessary fire-fighting facilities, there are many hidden dangers. Meanwhile, the drainage facilities are lacking. On rainy days, people and vehicles cannot go through here smoothly. (Figure 79.)

To further study accessibility of sidewalks, it is assumed that the width of sidewalks unsuitable for passing of pedestrians is below 1m. These parts are extracted from the road system. After these roads are blocked, the author finds out that the single building forms a large lump because of aggregation. Apart from No. 4 Residential Block, all other areas are unsuitable for passing of pedestrians. (Figure 80.)

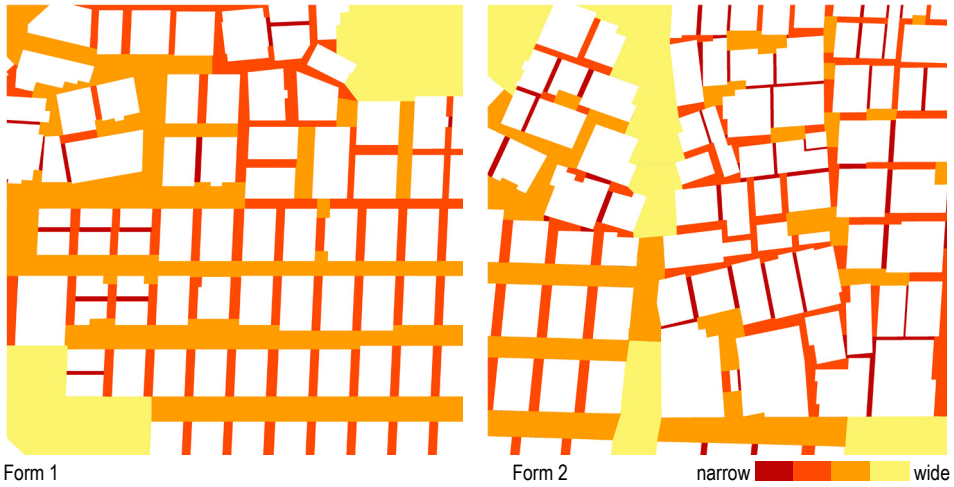


Figure 77. Two forms of pedestrians within Xiasha village.
Source: author.

Figure 78. A one-meter-wide street in the urban village.
Source: web.

Figure 79. The sidewalks of the Xiasha village.
Source: author.

Figure 80. Sidewalk analysis diagram.
Source: author.

The nodes

The public activity grounds and the public greenbelts are seriously lacking in Xisha Village. Xiasha Cultural Square is the only ground for entertainment. The Square is located to the northwest of the village. Built in 2007, it covers an area of 20,000 square meters. Under the ground is the parking lot and above the ground is the basketball field, tennis field, football court, track, park, etc. Xiasha Memorial Archway, Huang Siming Ancestral Hall, and Duke Temple are all located here. The Square is not only a recreational ground for local residents, but also an important groupd for Xiasha Village to hold traditional cultural activities. Annually, the traditional cultural activities, including the annual ancestral worship on the Double Ninth Festival and pan dish banquet, are held here. (Figure 81. and 82.)

Figure 81. Pan dish banquet traditional cultural activities.
Source: web.

Figure 82. Pan dish banquet traditional cultural activities.
Source: web.

(2) The elements of the texture of “group”

The buildings in the renovated area of Xiasha village are high-rise residential and commercial office buildings, most of which are above 30 stories’, with high-grade marble decoration, and reasonable planning and good landscape design. The buildings in the undemolished area mostly range from seven floors to nine floors. In terms of functions, residential functions are mixed with commercial functions. The buildings are laid out on two sides of the roads with the first floor being stores and the rest as residences. The buildings are brick-concrete-structured. The exterior wall is decorated with mosaic or tapestry bricks. The roof is made up of the reinforced concrete plates. The building layout features a chess-like pattern. Some areas feature the squeeze-in development pattern. However, due to a narrow space between buildings, the lighting is poor and dangers of fire disasters are looming. In the urban fabric, because the house base is divided mostly to the square of the same area, so Xisha village on the plane is the crazy copy of the square box. (Figure 83.)

The author makes a statistical analysis of the layout and construction form of Xiasha village, and the results are as follows: (Table 6.)

Figure 83. Aerial view of Xiasha village.
Source: http://china.earthol.com/bd/sz/

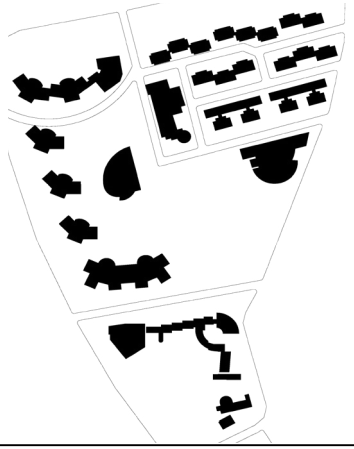
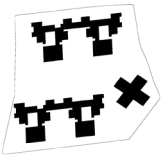
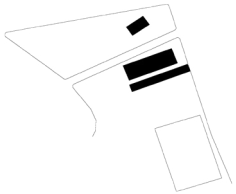
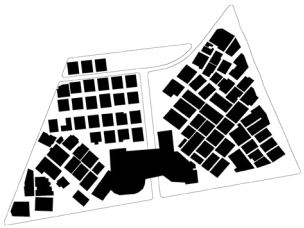
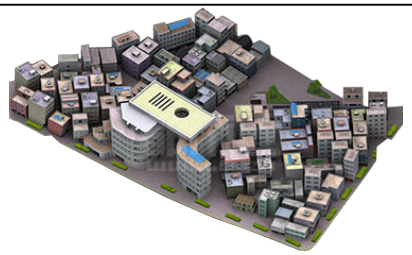
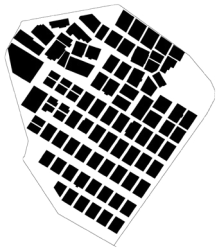
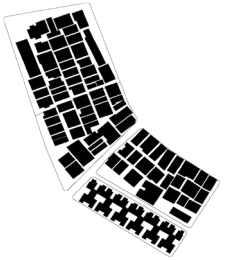
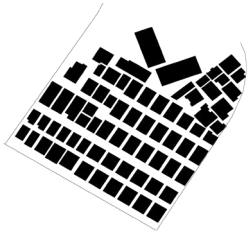
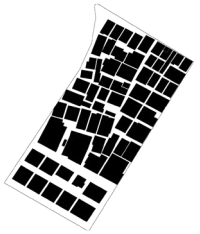
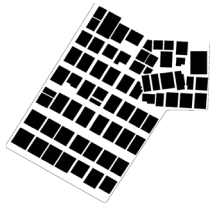
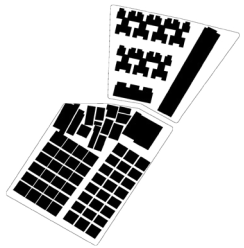
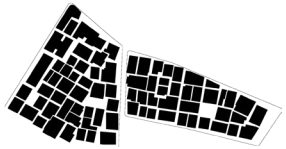
Area	Building index	Land use function and architectural layout	Urban fabric	Space form
Renovated area 1	Count Non-Structures Unit: 35 Total land-using area: 114397 m^2 Base area of construction: 28931 m^2 Building density: 25.29%	Land use function: residence and culture Architectural layout: The high-rise buildings are arranged along Furong Road. With parking lots and good landscape design, and the spacing of building to conform to the architectural design standards.		
Renovated area 2	Count Non-Structures Unit: 5 Total land-using area: 11958 m^2 Base area of construction: 2585 m^2 Building density: 21.62%	Land use function: business 0ffice Architectural layout: The high-rise buildings are arranged in a row. With parking lots and the spacing of building to conform to the architectural design standards.		
Xiasha Cultural Square	Count Non-Structures Unit: 3 Total land-using area: 20000 m^2 Base area of construction: 924 m^2 Building density: 4.62%	Land use function: fete, Park, sports facilities and parking Architectural layout: Three Chinese classical buildings are centrally located on the north side of the square.		

Table 6. Statistical analysis of the layout and construction form of Xiasha village.
Source: author.

Area	Building index	Land use function and architectural layout	Urban fabric	Space form
Lane 1	Count Non-Structures Unit: 89 Total land-using area: 22555 m^2 Base area of construction: 10751 m^2 Building density: 47.67%	Land use function: residence, commerc and culture Architectural layout: buildings are arranged in a row. The spacing between buildings is very close.		
Lane 2	Count Non-Structures Unit: 92 Total land-using area: 20094 m^2 Base area of construction: 9730 m^2 Building density: 48.42%	Land use function: residence and commerc Architectural layout: buildings are arranged in a row. The spacing between buildings is close.		
Lane 3	Count Non-Structures Unit: 86 Total land-using area: 15314 m^2 Base area of construction: 8442 m^2 Building density: 55.13%	Land use function: residence and commerc Architectural layout: buildings are arranged along the roads. The spacing between buildings is very close.		
Lane 4	Count Non-Structures Unit: 72 Total land-using area: 18379 m^2 Base area of construction: 9073 m^2 Building density: 49.37%	Land use function: residence and commerc Architectural layout: buildings are arranged in a row. The spacing between buildings is close.		

Continued to Table 6. Statistical analysis of the layout and construction form of Xiasha village.
Source: author.

Area	Building index	Land use function and architectural layout	Urban fabric	Space form
Lane 5	Count Non-Structures Unit: 67 Total land-using area: 12308 m^2 Base area of construction: 7452 m^2 Building density: 60.54%	Land use function: residence, commerc and culture Architectural layout: buildings are arranged in a row. The spacing between buildings is very close.		
Lane 6	Count Non-Structures Unit: 77 Total land-using area: 12308 m^2 Base area of construction: 8161 m^2 Building density: 66.31%	Land use function: residence and commerc Architectural layout: the buildings are arranged along the north and south directions, and buildings are arranged in a row. The spacing between buildings is very close.		
Lane 7	Count Non-Structures Unit: 71 Total land-using area: 15367 m^2 Base area of construction: 7773 m^2 Building density: 50.58%	Land use function: residence and commerc Architectural layout: the buildings are arranged along the north and south directions, and buildings are arranged in a row. The spacing between buildings is close.		
Lane 8	Count Non-Structures Unit: 70 Total land-using area: 10921 m^2 Base area of construction: 6535 m^2 Building density: 59.83%	Land use function: residence and commerc Architectural layout: buildings are arranged along the roads. The spacing between buildings is very close.		

Continued to Table 6. Statistical analysis of the layout and construction form of Xiasha village.
Source: author.

(3) The elements of the texture of “landmark”

Xiasha memorial archway

The memorial archway is a kind of ancient Chinese architecture. In the feudal society, memorial archways were set up to commemorate meritorious services, success in imperial examinations, morals, governance, loyalty, filial piety, etc., and carry forward the feudal ethics. Meanwhile, they serve for ancestral worship. (Figure 84.)

Huang Siming Ancestral Hall

Huang Siming Ancestral Hall was built in the Song dynasty by descendants of Family Huang in commemoration of the ninth ancestor, Huang Siming. In 1993, the ancestral hall was restored. Now, it has been one of the largest and most well-preserved ancestral halls in Shenzhen, and listed under the protection of the Shenzhen Municipal Cultural Relics Bureau. (Figure 85.)

Figure 84. Xiasha memorial archway.
Source: web.

Figure 85. Huang Siming Ancestral Hal.
Source: web.

Duke Temple

Duke Temple was built in late Ming dynasty. In 2012, the temple was restored. The new Duke Temple gets carved columns and beams, black tiles and bricks. In the temple, the screens, couplets, dragon-phoenix columns and statutes of gods are all decorated with gold foil. Above the roof, the figures in legendary stories, including “The Journey to the West”, “Three Gods of Fortune” and “Abode of Immortals”, look vivid. Lions, God of Sun and Moon, and Fortune Mouse are all made by the lime-sculpturing technique, a national intangible cultural heritage. The Duke Temple mainly celebrates Duke Yang and Duke Chen, so it is also called “Duke Yang and Chen Temple”. Meanwhile, it exists to worship the Mother Goddess and Lord Fude. (Figure 86.)

Xiasha Museum

Xiasha Museum was built in 2005, aiming at showing traditional cultural items with the style of Southern Guangdong and South of the Five Ridges. These exhibits include ancient relics, sculptures, paintings, photos, etc. The hall of the Museum is set up with the library, the center for retired cadres, CPC members and elders, the security monitoring center, the center of children’s education, and many other functional rooms. All of them are free and open to residents. (Figure 87.)

Apart from Xiasha Museum, all the above landmarks are ancient buildings with Cantonese characteristics in the South of the Five Ridges. They are worth better protection and utilization.

Figure 86. Duke Temple.
Source: web.

Figure 87. Xiasha Museum.
Source: web.

3.3 Research on urban village space at the micro level

The building of Xiasha village is mainly residential and commercial. In terms of functions, residential functions are mixed with commercial functions. The buildings with the first floor being stores and the rest as residences. (Figure 88.) In order to further analyze the spatial organization logic of Xiasha village, this chapter will make a more detailed typology study on the commercial space and residential space of Xiasha village.

Research on space of commercial

Through the analysis of relevant POI data of Xiasha village, it is found that the business type of Xiasha village is very rich, and basically contains the commodity requirements of a complete urban community. However, there are still many problems in the existing commercial forms, such as the small size of the shops, poor sanitation, low service level, limited service scope, and most of them are concentrated in daily consumer goods. Although compared to commercial and ordinary village Xiasha community commercial space, some confusion, low-end, crowded and disorderly, per capita commercial service area was significantly lower than the requirements of the relevant regulations of the index, but in practice under the village commercial street is very lively, commercial space has also been very active, the ratio of vacant shops has been at a low level. The relevant investigation of villages in Shenzhen shows that the residents in urban villages are satisfied with the overall environment of urban commercial space. The vast majority of the Shenzhen City Village commercial service facilities is to rely on the market from the configuration, facing the village residents of different consumer demand, through market regulation to update or replace shops, adjust business activities, not only to allow residents to enjoy the convenience of consumption, but also the prices of goods and services is kept at a relatively low level create a relatively low cost, the consumption environment. [28]

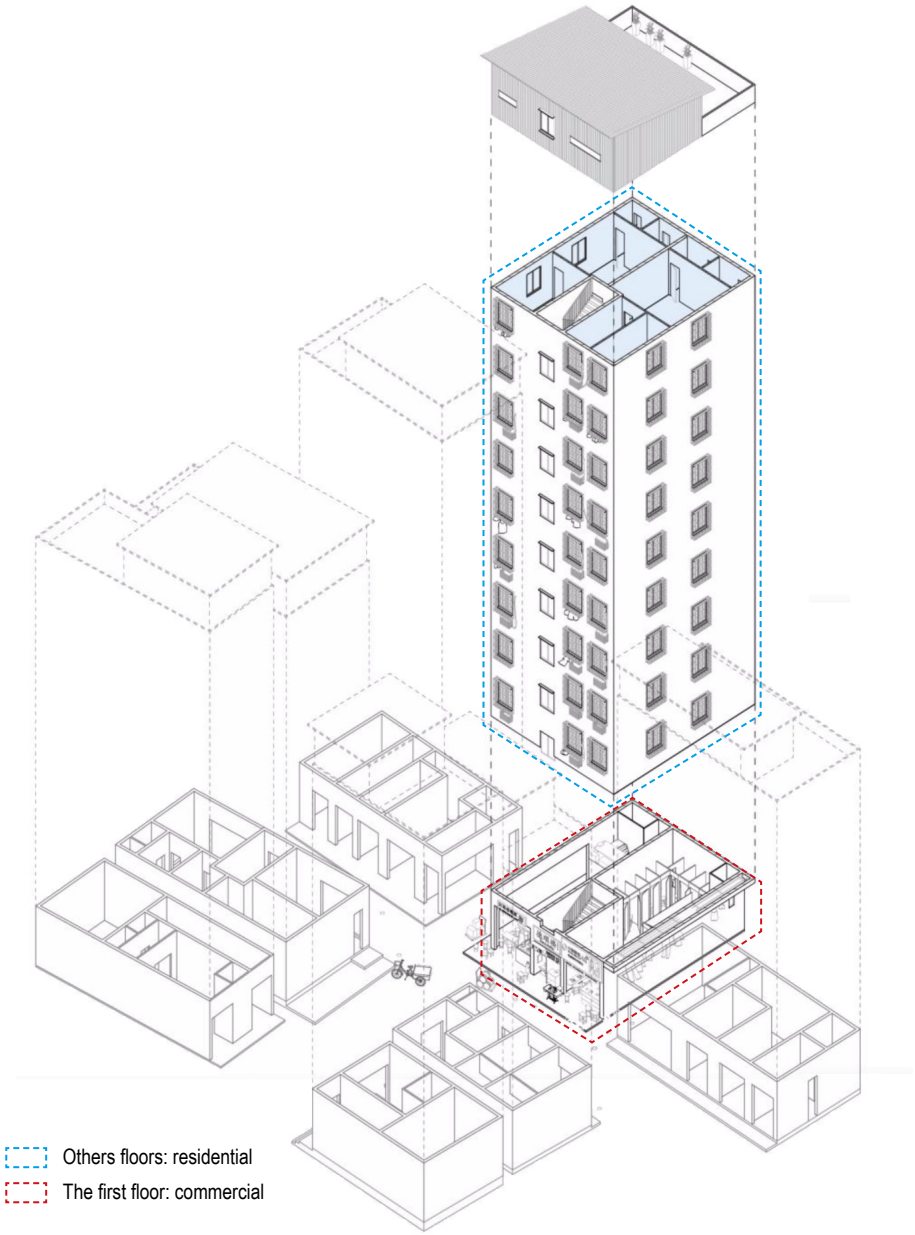


Figure 88. Typical building function of the urban village.
Source: Wen Fan.

[28] ZHANG, Li (2009). "China's informal ubanisation: conceptualisation, dimensions and implications". *Post-Commimist Economies*, 2009, 21(2), pp.203-225.

In Xiasha village there are commercial pedestrian streets, shopping center, hotels, the cultural square, etc. At the same time, Xiasha village has more than 800 stores and 26 manufacturing enterprises, most of the shops are engaged in catering, leisure and entertainment, beauty salons and other formats (47.44% retail, 45.29% catering, 1.75% entertainment industry) and more than 70% shops in 24 hours, to accommodate 10 thousand people to the employment of foreign workers. Xiasha village because of commercial facilities, convenient transportation, 24 hours of business, commercial traffic is very large, from 9 to 11 at night peak consumption stream of people can reach 20 thousand people. [29]

the following characteristics of the commercial space layout of Xiasha village:

(1) Close integration with the road

The commercial facilities of the Chinese residential communities generally concentrated and arranged independently, but the commercial facilities of Xiasha Village show the characteristics of the average distribution along the streets. At the same time, close the pedestrian bridge, bus stations and other important people flow and exit.

(2) High-quality facilities are concentrated, and basic service facilities are scattered

According to the different types of business services, Xiasha village of various types of shops can be roughly divided into two categories, the demand for flexibility relatively large "quality" and the demand for flexibility is relatively small, daily necessities necessary "basic". Among them, the "basic" occupy a higher proportion, about 53%. From the layout of the space, "basic" commercial facilities to the public as the representative of the supermarket evenly distributed, and along the street, has been deep into the interior of the area; and "quality" shops to clothing stores as a representative of a significant gathering Trends are usually distributed on the main road.

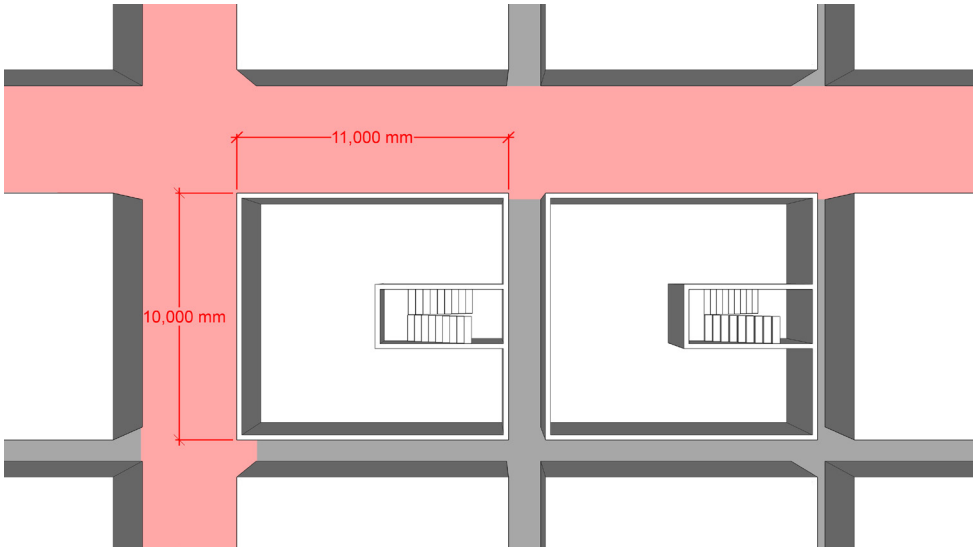


Figure 89. Schematic diagram of first floor plane.
Source: author.

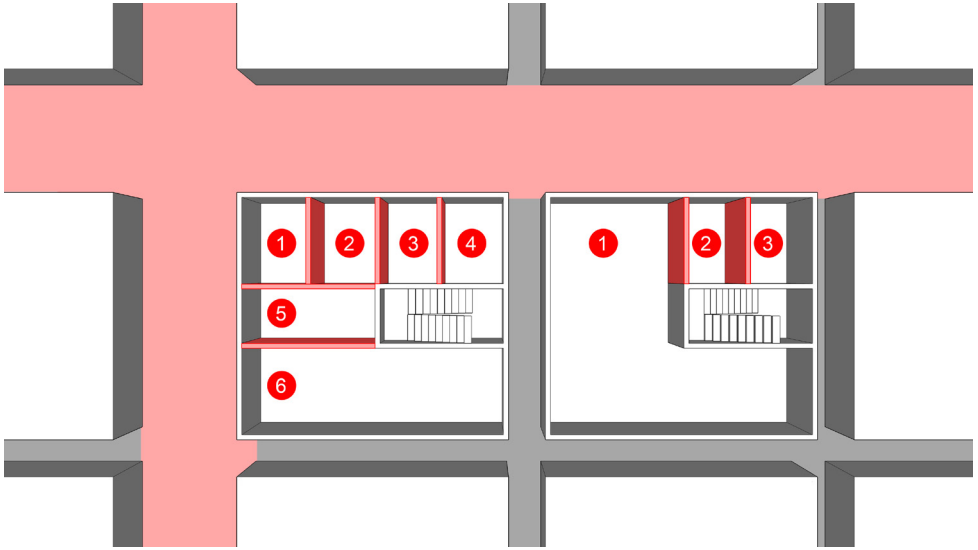


Figure 90. Schematic diagram of shop division.
Source: author.

[29] LI, Ping (2016). *Research on the status quo and renewal strategy of the typical villages-in-city in Shenzhen* (Master's thesis). Northeast forestry university.

(3) Flexible use of outdoor space

Xiasha village in addition to the fixed operation of the shops, at the same time in the popularity of the pedestrian street to form an orderly, large-scale, fixed-point outdoor booth business area, a total of more than 50 outdoor booths, this booth can be based on time changes Keep changing its function.

Study on the spatial demand of shops in Xiasha Village

According to the previous study of Xiasha village building density is very large, the dis-tance between the floor and the floor is very small, and the building area is mostly in the 80 to 120 m^2, many stores are being cut or mixed together, the depth and the width of store are small. (Figure 89. and 90.) Therefore, most of the shops in Xiasha village are characterized by miniaturization. According to the relevant research statistics, the shops are generally relatively small area, shops operating area of 2-3 m^2 stores accounted for 19.7%, less than 20 m^2 accounted for 78%, 83.1% of the monomer shops area of less than 30 m^2. (Chart 5.)

According to the consumption characteristics and space limitations of Xiasha village residents, and referring to the study, [30] we can divide the commercial space demand of Xiasha village into special-sized, microminiature, small-sized, middle-sized, large-sized and oversize. (Table 7.)

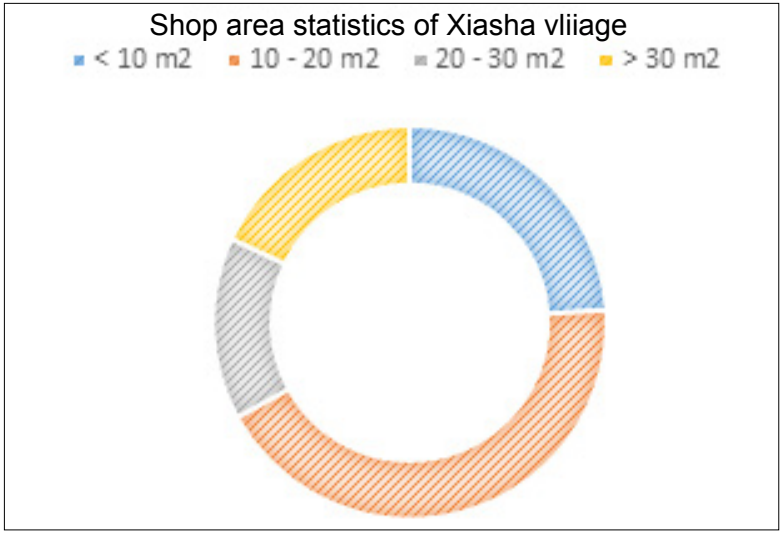


Chart 5. Shop area statistics of Xiasha village.
Source: author.

[30] STUDIO G (2015). "Research on the street system and interface morphology of Gangsha village".

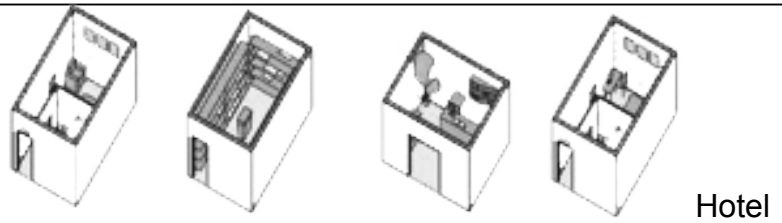
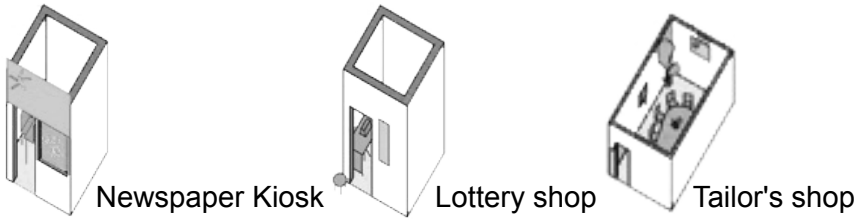
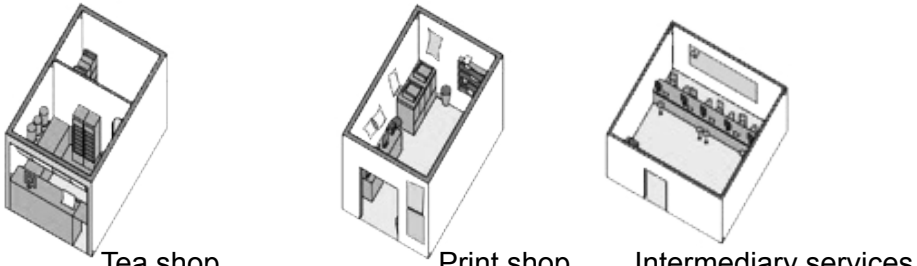
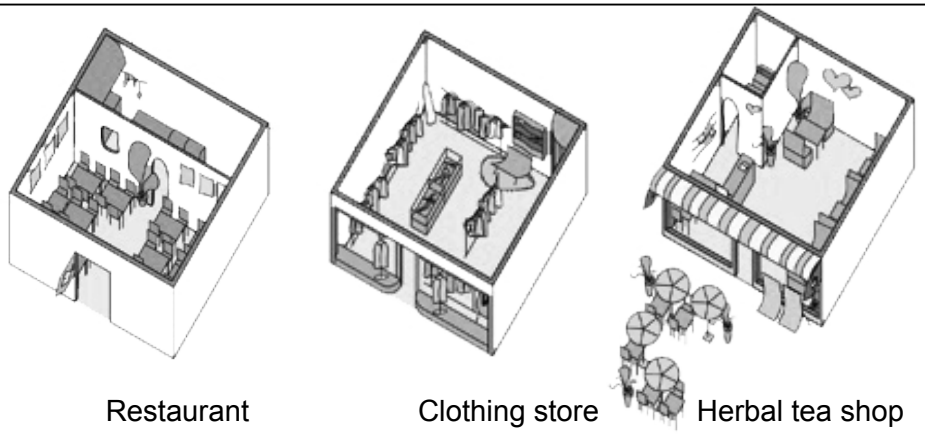
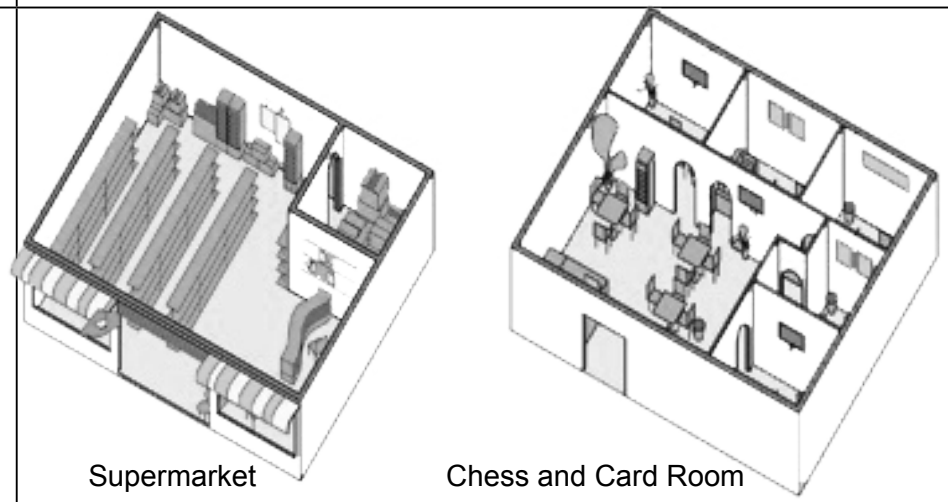
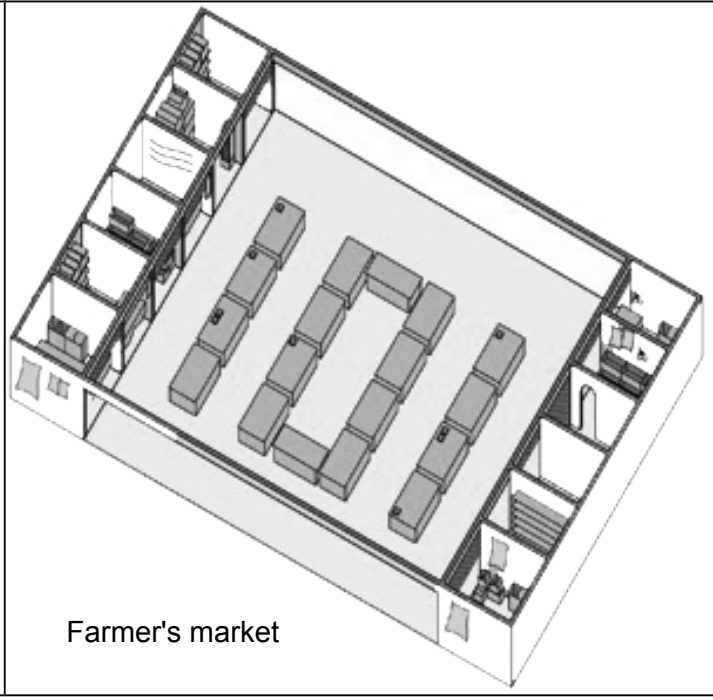
Type	Store	Count Number	Schematic diagram
Special-sized	Hotel Outdoor stall	1.5%	 Hotel
Microminiature 0-10 m^2	Newspaper Kiosk Lottery shop Tailor's shop	24%	 Newspaper Kiosk Lottery shop Tailor's shop
Small-sized 10-20 m^2	Convenient store Tea shop Print shop Public Phones IP Supermarket Intermediary services	43%	 Tea shop Print shop Intermediary services
Middle-sized 20-30 m^2	Restaurant Grocery Herbal tea shop Pharmacy Greengrocery Clothing store Garbage station	15%	 Restaurant Clothing store Herbal tea shop

Table 7. The commercial space demand of Xiasha village.
Source: author.

Type	Store	Count Number	Schematic diagram
Large-sized 30-100 m^2	Supermarket Net-bar Chess and Card Room	16%	 Supermarket Chess and Card Room
Oversize >100 m^2	Farmer's market	0.5%	 Farmer's market

Continued to Table 7. The commercial space demand of Xiasha village.
Source: author.

Research on space of residential

According to the research results of the existing research, limited to 80-120 m^2 of the building base area of construction, the following three types of housing the most common, in the urban villages of Shenzhen.

(1) The middle symmetrical plane of the stairs is divided into 2 households. The indoor use area of each household is about 50 m^2, which can be used for family living. (Figure 91.)

(2) The middle symmetrical plane of the stairs is divided into 4 households. Each room has an indoor area of about 30 m^2, which is a single dormitory. The public space of the building is very cramped. (Figure 92.)

(3) the asymmetric plane of the stair wall, which is divided into 1-6 families. The indoor use area of each house is 13.2-24.5 m^2, which is the single apartment. However, because the area is too small to house functional spaces are very cramped. (Figure 93.) However Design code for residential buildings of China stipulates that the minimum residential building area is 22 m^2, obviously the building didn't meet the design code.

Above the apartment area are too small, and there is lighting, ventilation, lack of space to dry clothes and other issues. Reconstruction should be unit integration, re-division unit plane, and the building structure and equipment pipeline transformation.

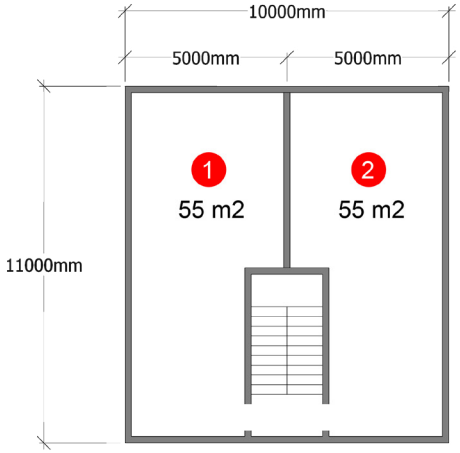


Figure 91. 50 m^2
Source: author.

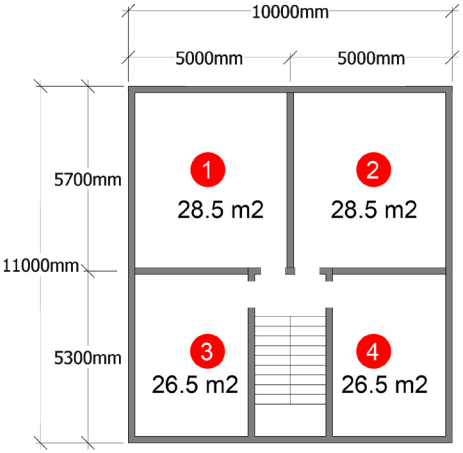


Figure 92. 25 m^2
Source: author.

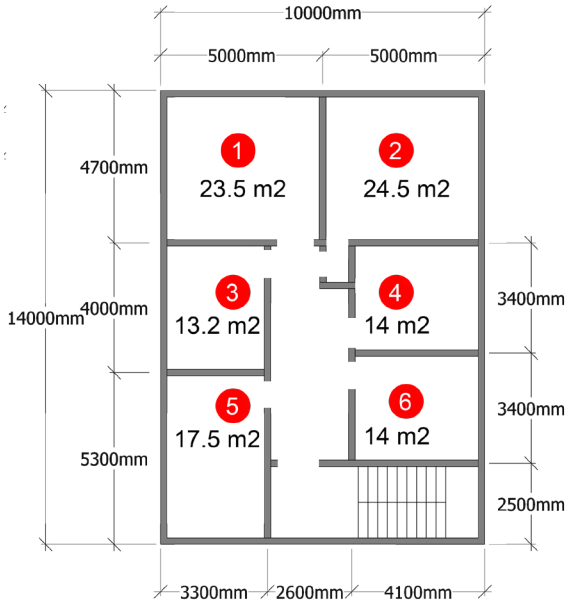


Figure 93. 13.2 - 24.5 m^2
Source: author.

Brief Summary of this Chapter

This chapter is the detailed research part of the thesis. Through the data analysis of this chapter, the following contents are obtained.

(1) What is in urban villages?

According to analysis of the above the heatmap for Baidu map data, it can be found that the population concentration in urban villages is relatively high in the morning and evening, which can be speculated that a large number of people living in urban villages of Shenzhen. According to analysis of the above the POI data, it can be found that urban villages themselves have contributed to abundance of the public facilities, especially restaurants, shopping malls and handy services for the public. According to analysis of the above the OSM data, it can be found that the building density in urban villages is very high, and the public activity grounds and the public greenbelts are seriously lacking in urban villages. Relevant statistical data are as follows: In Shenzhen city the floating population living in urban villages has been as large as 7 million, nearly half of the total population in Shenzhen. There had been 357,000 buildings in Shenzhen's urban villages, and the total building area has reached 390 million square meters. Shenzhen's urban village has a total of 88 272 shops, including 42 781 retail stores, 37 845 service industries, and 1 645 entertainment industries. Specific to Xiasha village, there are 45 667 people in the village, of which 92% are temporary resident. There are 673 residential buildings in the village, with a total construction area of 592 637 m^2, an average of 880 m^2 per building, with floor area ratio more than 3.9, and the building density is 66.9%. In Xiasha village there are commercial pedestrian streets, shopping center, hotels, the cultural square, etc. At the same time, Xiasha village has more than 800 stores and 26 manufacturing enterprises, most of the shops are engaged in catering, leisure and entertainment, beauty salons and other formats. (47.44% retail, 45.29% catering, 1.75% entertainment industry)

(2) The disadvantage of urban villages

Most of urban villages in Shenzhen City are similar to the Xiasha village. Homesteads are closely arranged and divided into a square, with an area between 80 to 120 square meters. The construction level is 7 to 9 and the building density is about 50%. The physical environment of lighting and ventilation is poor. Fire fighting does not conform to specifications; Most of the houses have no elevator, the apartment area is too small, the space is very unreasonable. The quality of the commercial service facilities is poor and the scale is small, mostly for the low-cost basic services. There is no space for green Spaces, car parks and public Spaces in the village.

(3) The advantages of urban villages

Unban villages are conveniently located in the central business district. Low rents, short commutes and convenient living in the village make the housing in the village the first choice for low-income residents. Because of the complete commercial facilities, convenient transportation and 24-hour business in the village, the commercial traffic is very high, which has made the village a very dynamic community.

(4) Why can't we full demolition for full new construction urban villages?

First of all, urban villages of Shenzhen City huge volume, completely demolished urban villages need huge costs, at the same time, buildings in the urban village with good construction quality, completely dismantle them will also have a huge waste. Secondly, full demolition them will eliminate the existing urban context and life, which is a great harm to the history and culture of the city. In addition, full demolition for full new construction, after new constructions, the rent is often raised, and the original dwellers are forced to move to other places, and then lead to separation of workplace and residence. This practice is against social justice. Nowadays, many urban villages are regenerated by "demolition" as the ultimate goal. It is undeniable that many of these urban villages do need to be demolished and replaced with new forms of living space for many reasons. But many very typical village villages can be incorporated into the lifestyle of modern metropolises in a new way, as long as they are properly remade. Like Xiasha village which is located in the city center, with convenient transportation and adjacent to the Chegongmiao CBD. It has already provided a considerable number of public services for people employed in the mausoleum, including living, shopping, leisure and entertainment. Though the buildings and public environment of Xiasha village are inferior to China's relevant design code, but we can also have a large space to change and regeneration them into a community that meets relevant standards. Therefore, "demolition" is not the main, more non-exclusive value orientation of the urban village.

4. REGENERATION STRATEGIES

4.1 Functional requirements analysis

(1) What kind of urban village does the city need?

Aesthetically, urban villages are seen as scars of the city. Politically, it is even regarded as a sort of time bomb. Urban villages are short of planning and design. Thus, their appearance has greatly damaged the image of the international city of Shenzhen. Besides, 7 million residents living in the rental housing of urban villages, where the environment and living area are lower than the standard for building design, is also a grand irony to the governing ability of the government.

In <The 13th five-year plan of urban renewal of Shenzhen city>, Shenzhen has put forward the concept of innovation, coordination, green, opening and sharing, to accelerate the construction of the urban village renewal project which arms at being a livable, modernized, international and innovative city.

In this planning, priorities are given to the comprehensive improvement for the city updating, while the function changing, expanding, local demolishing and rebuilding are also encouraged, so that the environment quality can be promoted for the purpose of building an ecological livable city. City renewal will effectively increase the number of public farewell programs such as transportation facilities, municipal public facilities, sanitation facilities, education facilities, green area and squares etc. And it will also provide indemnificatory housing sustainably. [31]

The urban village that Shenzhen government need is with decent appearance, integrated into the city management system and capable of 7 million residents. It should also satisfy the residential standard, …, and without fire hazard.

(2) What kind of urban village does the people who lives in the urban village need?

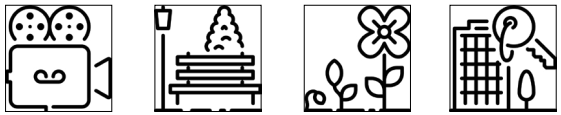
There are three main needs of the residents of the village:

The first need is living. Housing rent should be low enough; the housing should be close enough to the workplace, which can save time and cost on the way; The space of the residence should assure certain comfort level, which means that it should satisfy basic living requirements such as having good daylighting and ventilation, and enough space for drying clothes; buildings that are too high should be equipped with lifts. The second need is consumption. There should be convenient public service facilities in the village, which can meet the basic needs of life with lower cost; the business environment in the village should be improved and the service level and diversity of commercial facilities enhanced.

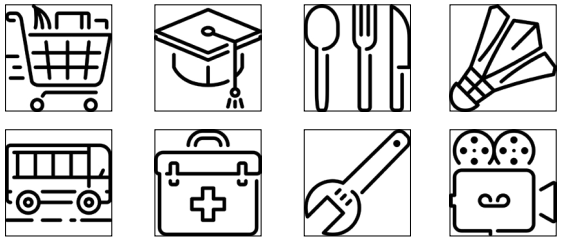
[31] SHENZHEN URBAN PLANNING AND LAND RESOURCES COMMITTEE (2016). *The 13th five-year plan of urban renewal of Shenzhen city.* <http://www.szpl.gov.cn/xxgk/ztzl/csgx135/> [Accessed: 12 Jul. 2017]

4.1 Functional requirements analysis

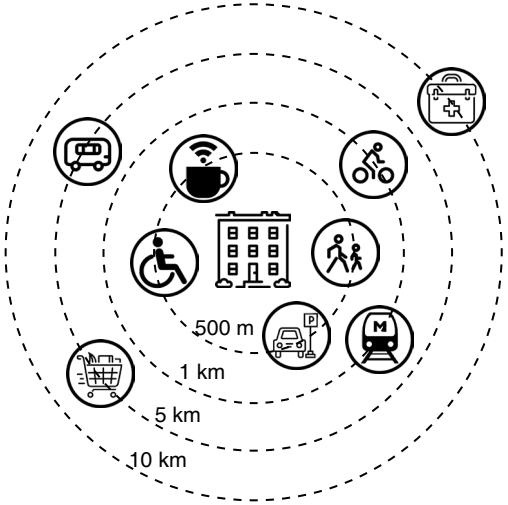
Good city image



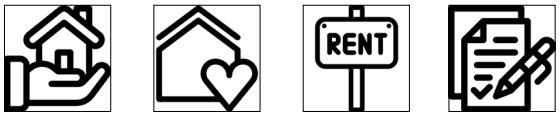
Complete municipal facilities



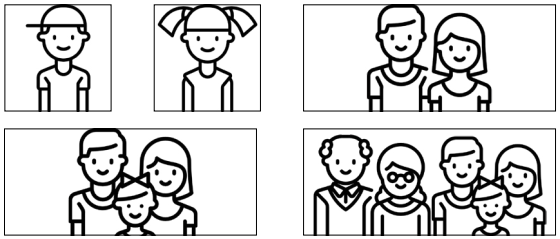
Proximity



Low-rent housing



Family evolution



High quality of life

4.2 Regeneration principle

(1) Economizing the redevelopment cost

Taking into account the economic capacity of the residents of the urban city, the reconstruction process should be economized and simplified, in order to reduce the cost and investment, thus reducing the construction cost.

The quality of constructions all over the urban villages should be assessed before the redevelopment, and buildings with bad qualities should be dismantled first. Priority should be given to redevelopment, with demolition to be complementary. The old building materials from the old buildings can be reused for new buildings.

(2) Maintaining traditional neighborhood relationship, extending city context

We should redevelop the space structure network of Xiasha village (including the vehicle and pedestrian traffic system, greening landscape system, building group relationship, function distribution adjustment, etc.) under the premise of keeping the group structure of existing buildings and the layout of blocks, while protecting its historical buildings, improving its land utilization, perfecting its village infrastructure, repairing its road and arranging greening landscape, etc.

(3) High-density, high-quality space

The reconstructed Xiasha village is still a high-density community that needs to be able to accommodate 45,000 residents. We need to improve the lighting and ventilation and other physical environment without reducing the building volume rate, and increase the green space and parking space in the village.

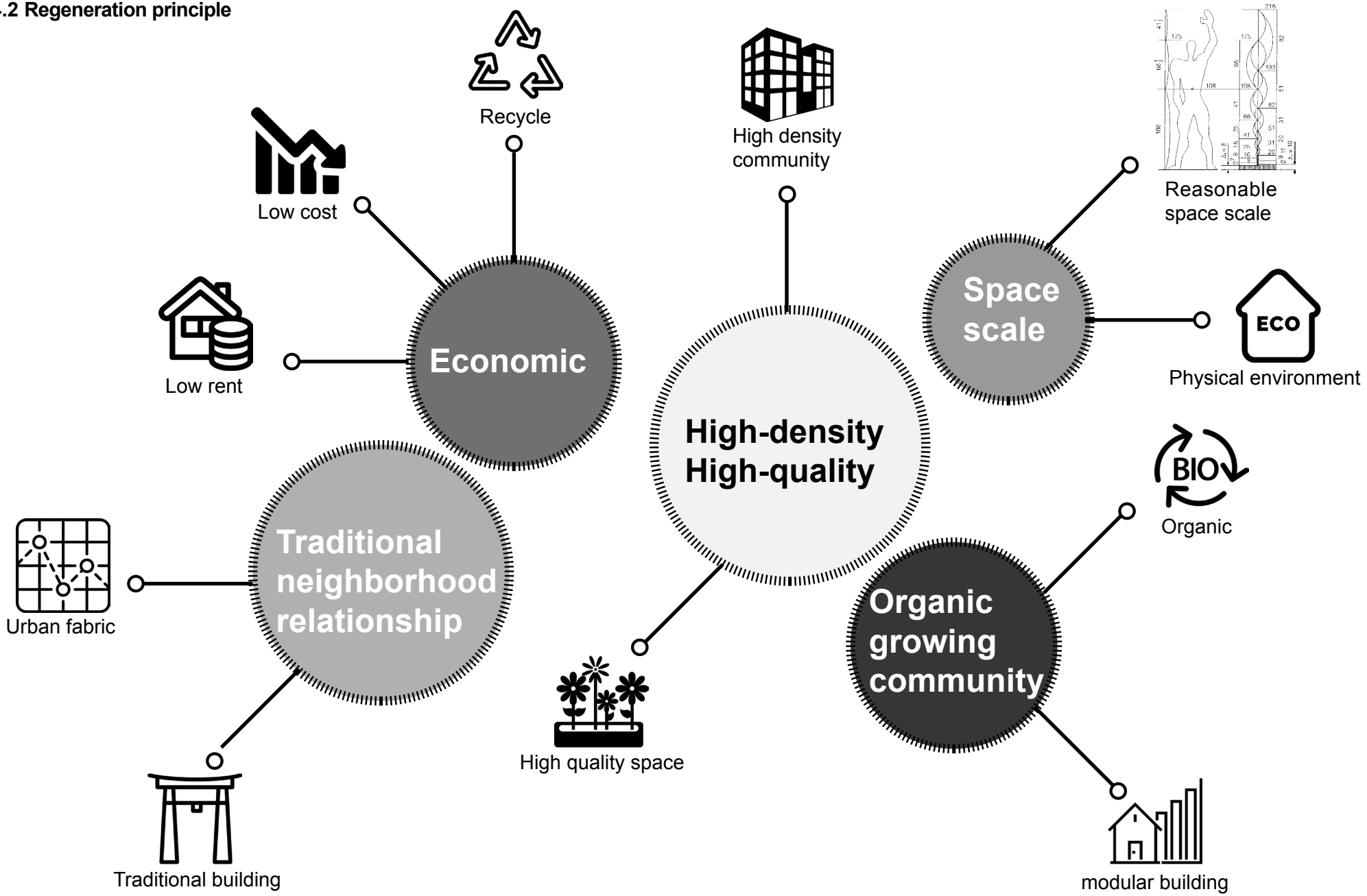
(4) The rationality of space regeneration

In the reconstruction process of a monomer building, the relevant space scale requirements of existing laws and regulations should be fully referenced. The lighting, ventilation and thermal insulation of buildings should meet the relevant design standards of building physical environment. The area of the building and the building equipment shall conform to the standard of residential building design. The renewal of the commercial facilities shall conform to the standard of commercial building design.

(5) Organic growing community

Shenzhen, as a population absorbing city, will attract more people to migrate here in the future. Our update scheme should consider the resident population expansion of Xiasha village in the future. Xiasha village need to become an organic growing community, and capable of providing more habitats and work opportunities.

4.2 Regeneration principle



4.3 Regeneration strategies

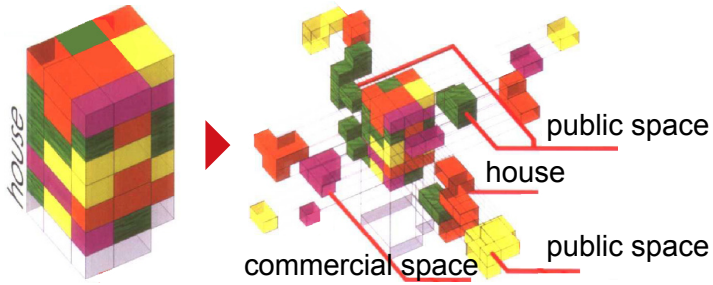
(1) Keep the group structure of existing buildings and blocks layout form of the village, demolish a part of the buildings and generate the internal courtyard to solve the problem of the daylighting, ventilation, and make the rest of the buildings have good spacing between each other. Through the addition structure, the building monomer can be integrated to eliminate the sandwich space, and multiple single buildings will be combined into a collection house. The building will be built up to ensure the high-volume rate of the community through the construction of a lightweight steel structure. This way, on the one hand, can keep the continuity and integrity of the business facade, the effective use of the wasted space on the other hand, is more conducive to reorganize the internal functions and traffic of the buildings.

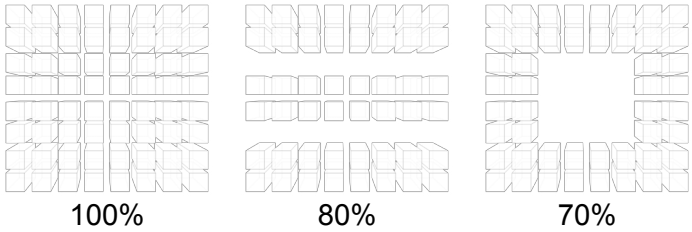
(2) Three-dimensional functional zoning and building three-dimensional traffic in buildings. The lower floor of the building is the main commercial space, the roof is the public space, and the remaining layers are the living space. The lower floor of the building, which is not in the street, can be set up as a parking lot and green space. And by replacing some residential space as public space, it can promote the communication of neighbors and improve the interactive activity of residents. Make full use of the inner courtyard and the roof space, the roof and courtyard are designed as the public space of the community in the unit of block with virescence work.

(3) Based on the original building monomer, the construction plane is integrated, and the interior space is divided according to the typical architectural plane and structure.

(4) The added layer of buildings is composed of modularized building monomer, which is conducive to the expanding of modularized building monomers as the population increases, so that more houses can be provided. Besides, modularization of building monomer has the advantage of fast construction and low cost.

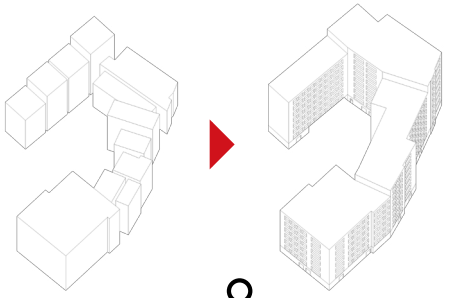
4.3 Regeneration strategies



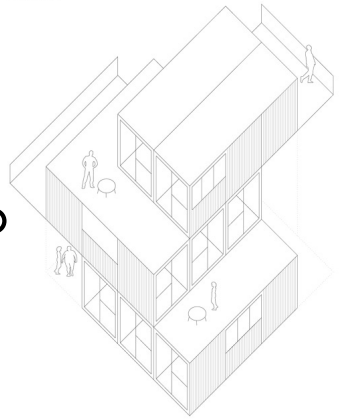


Three dimensional functional zoning

Demolish a part of the buildings and generate the internal courtyard

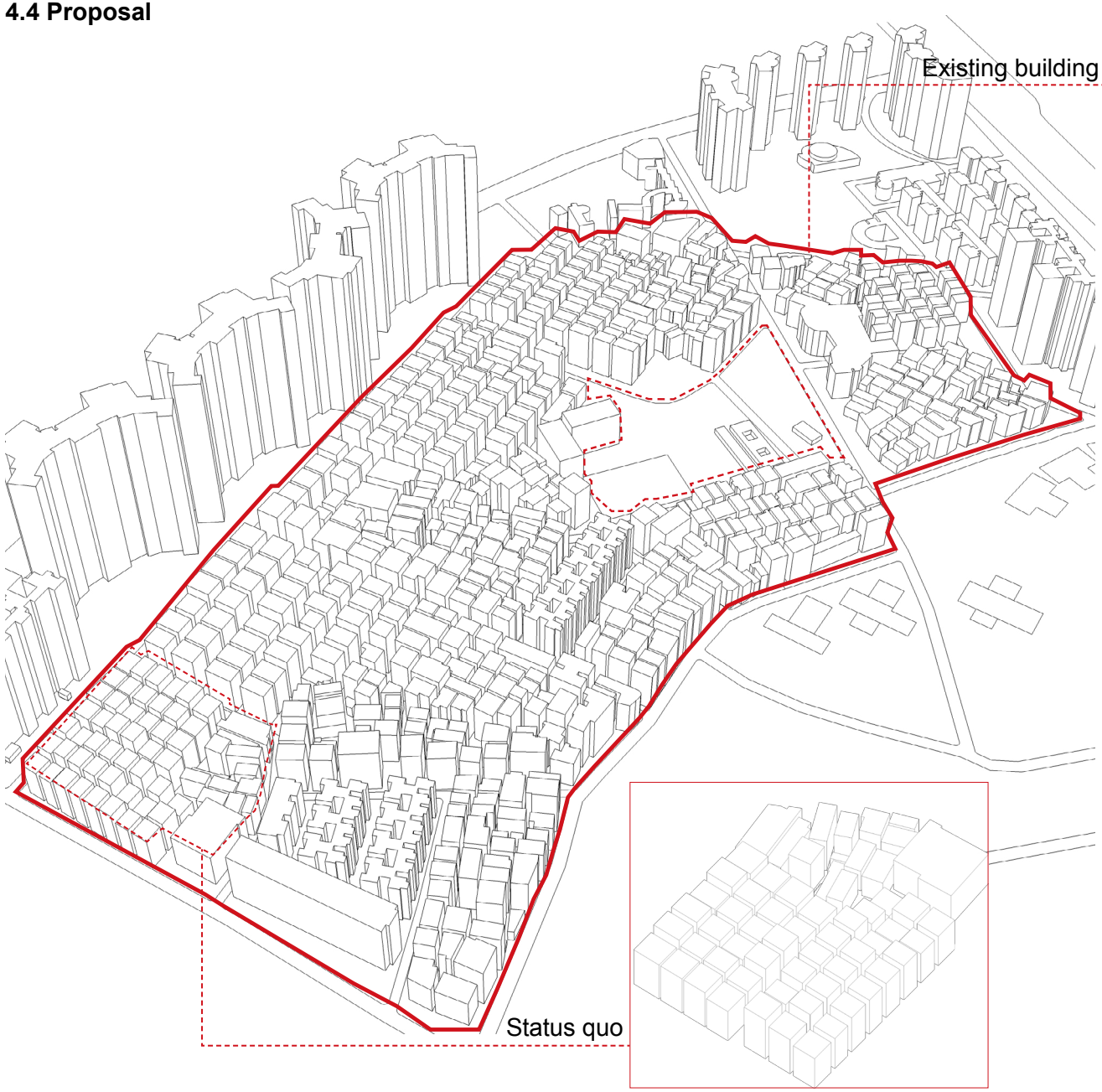


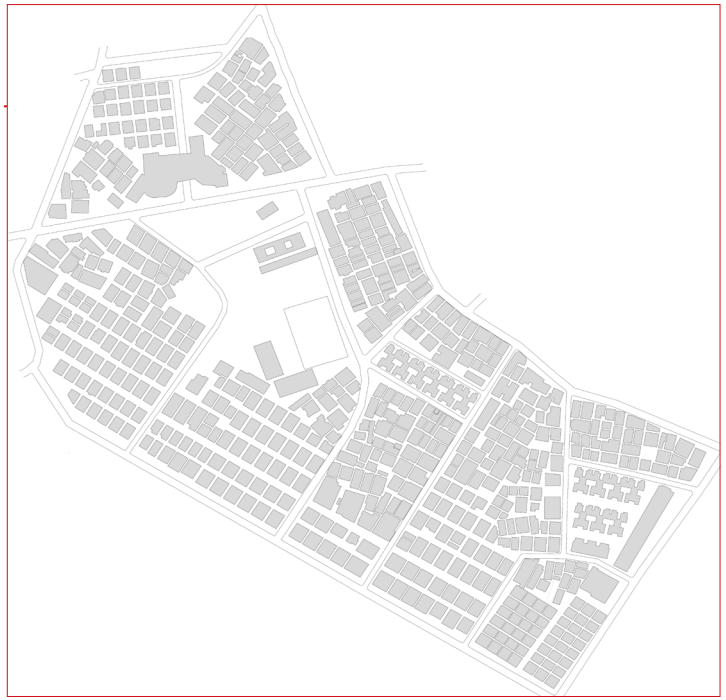
The added layer of buildings is composed of modular building



Based on the original building monomer, the construction plane is integrated

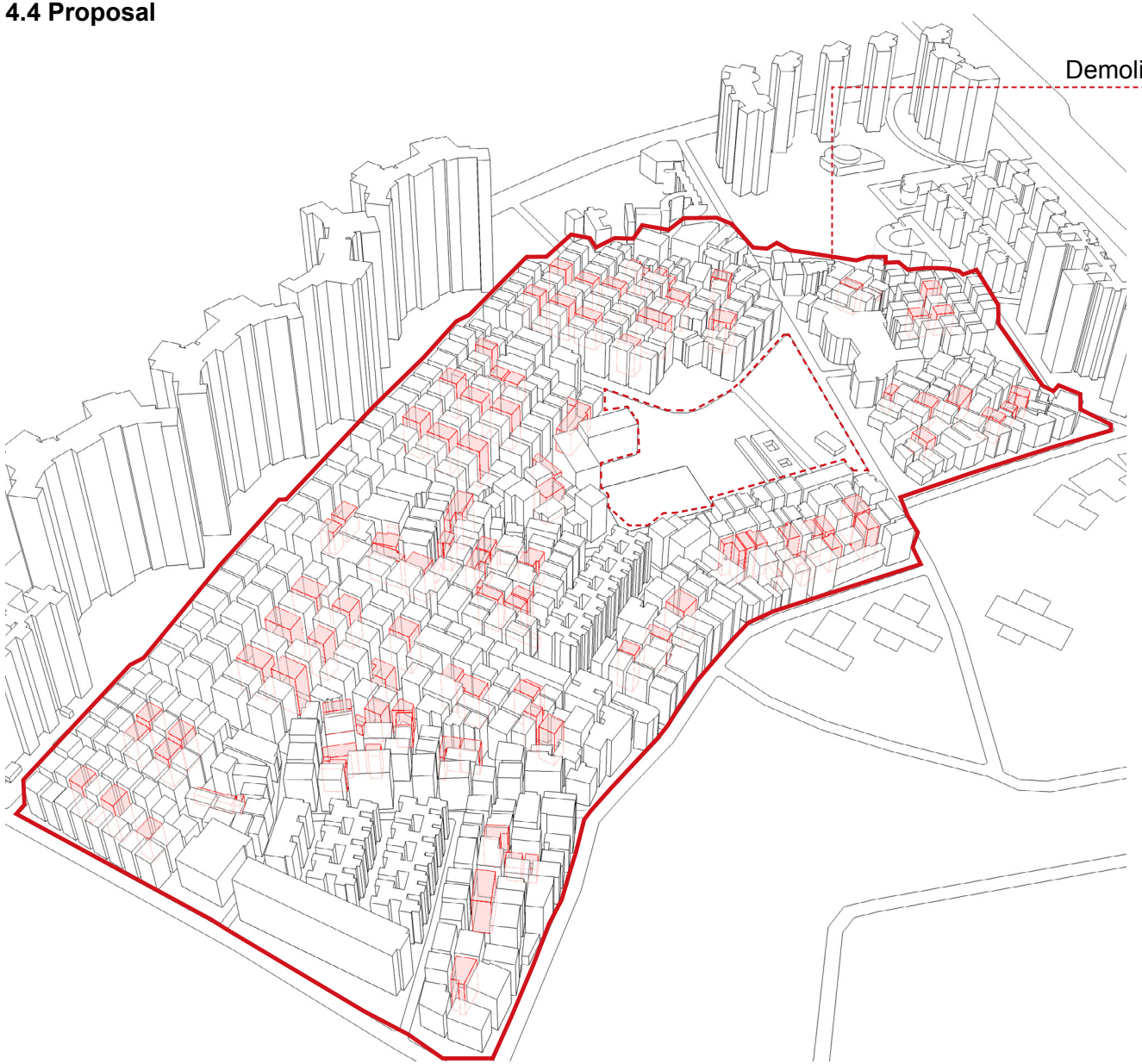
4.4 Proposal





Count Non-Structures Unit: 627
Total land-using area: 12 ha
Base area of construction: 68 000 m^2
Building density: 56.7%

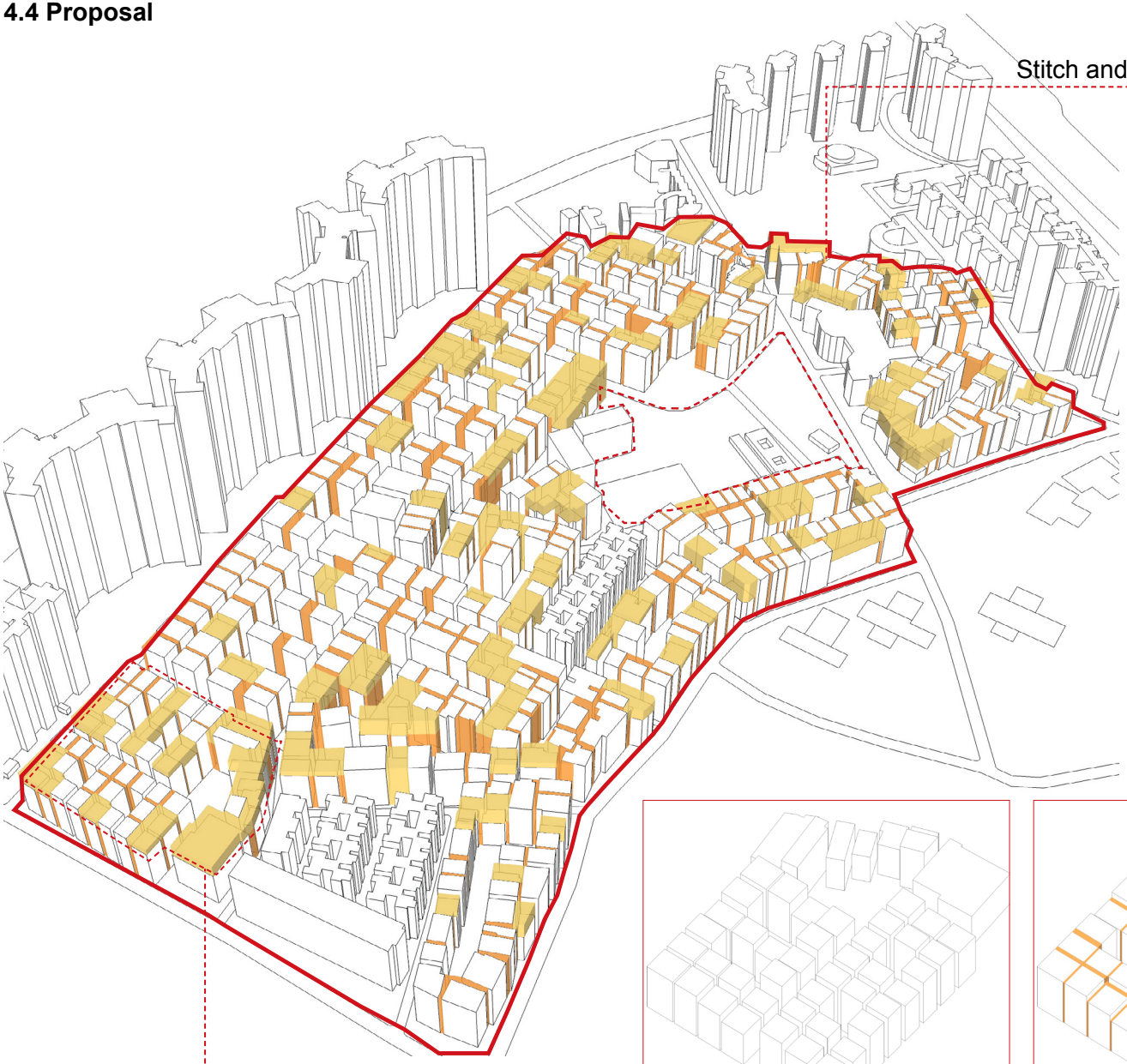
4.4 Proposal



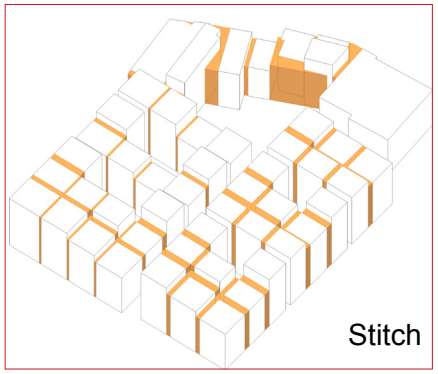
Demolition

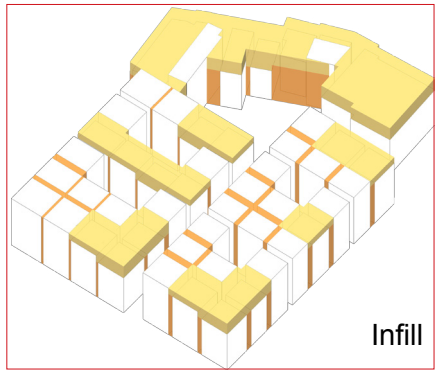
Carefully choose the low quality, smaller and center located houses to demolish. (Buildings marked with red)
Through the planning, a total of 145 buildings were demolished, 22% of the total.

4.4 Proposal

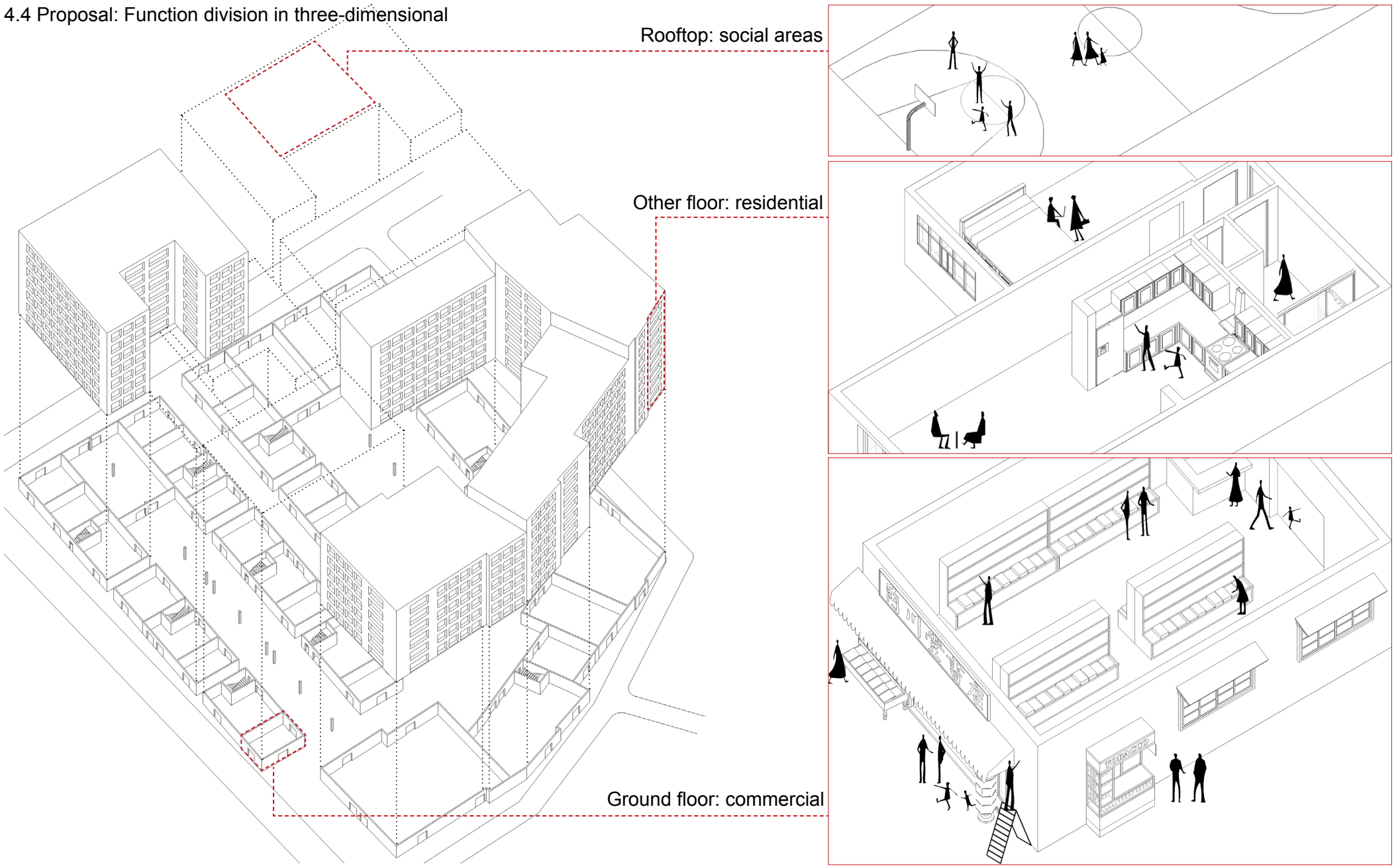


Stitch the clearance of the house, to make the dense single house into a townhouse type.
Infill the empty corners and edges with new houses. Add elevators and corridors in the inner yard of the townhouse.
Building density: 47%

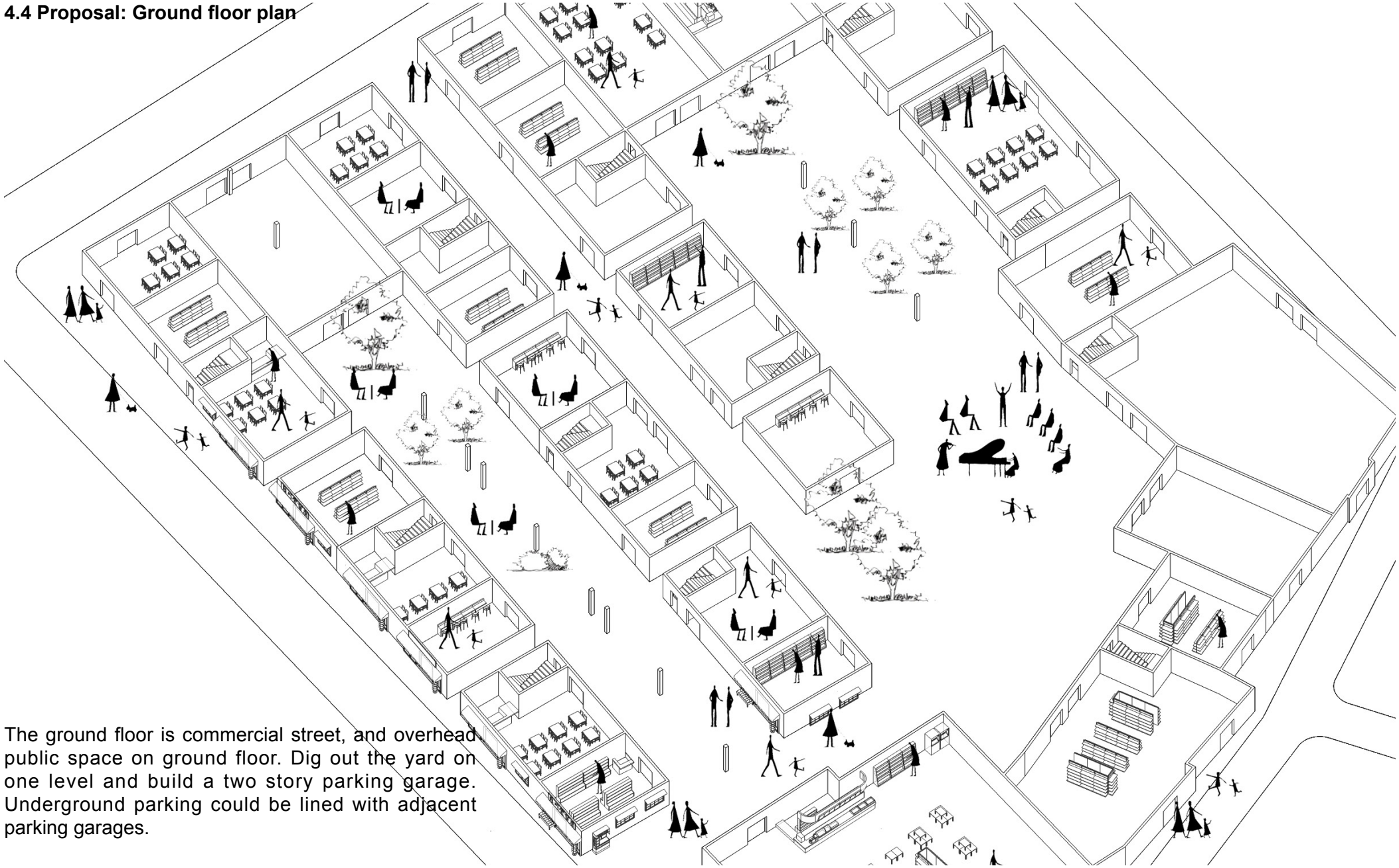




4.4 Proposal: Function division in three-dimensional



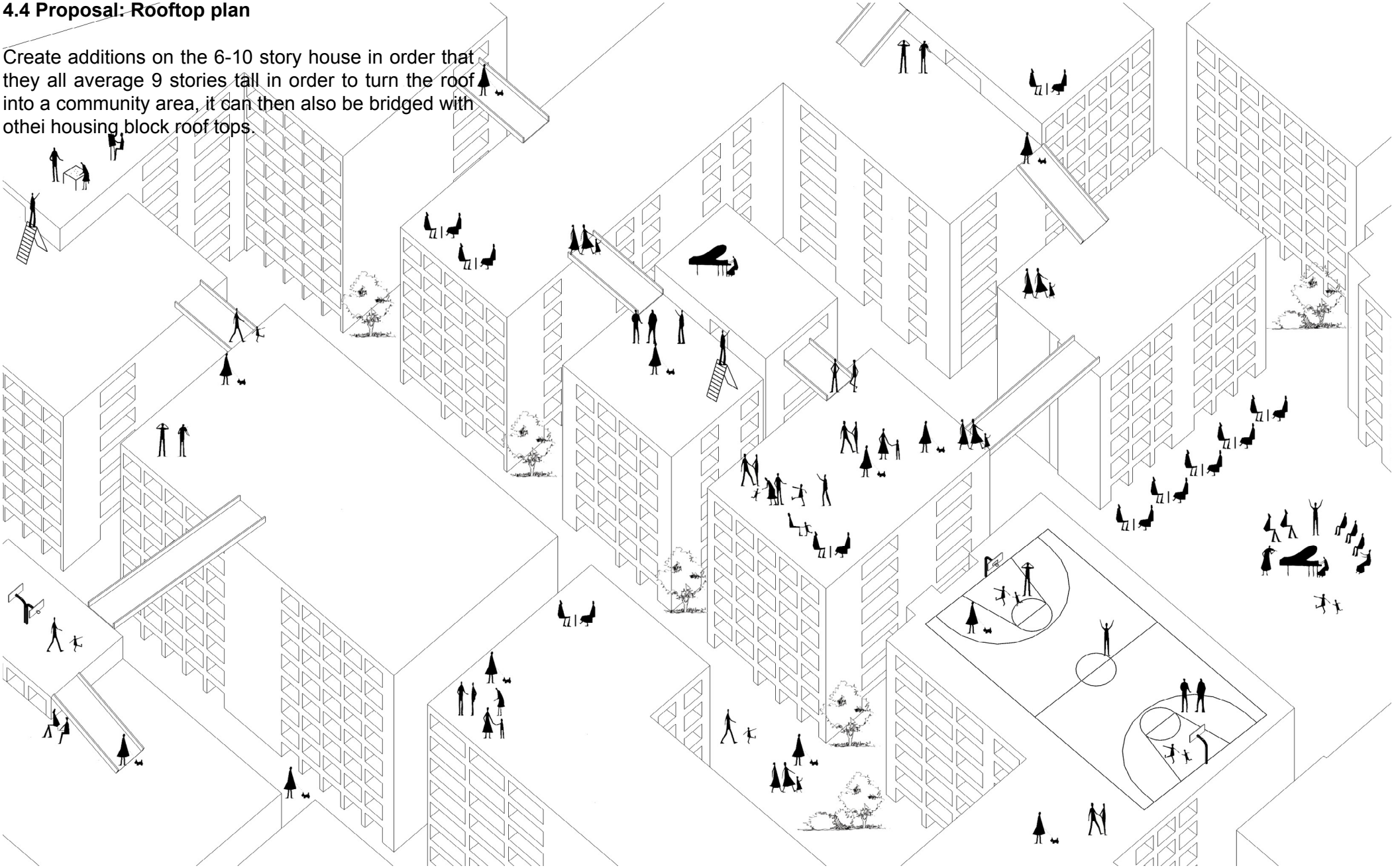
4.4 Proposal: Ground floor plan



The ground floor is commercial street, and overhead public space on ground floor. Dig out the yard on one level and build a two story parking garage. Underground parking could be lined with adjacent parking garages.

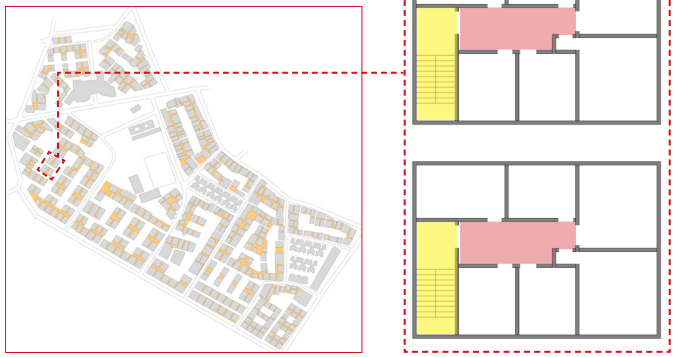
4.4 Proposal: Rooftop plan

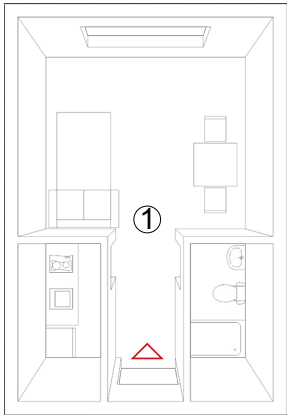
Create additions on the 6-10 story house in order that they all average 9 stories tall in order to turn the roof into a community area, it can then also be bridged with othei housing block roof tops.

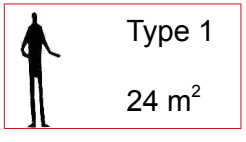


4.4 Proposal

Through the addition structure, the building monomer can be integrated to eliminate the sandwich space, and multiple single buildings will be combined into a collection house.







Type 1

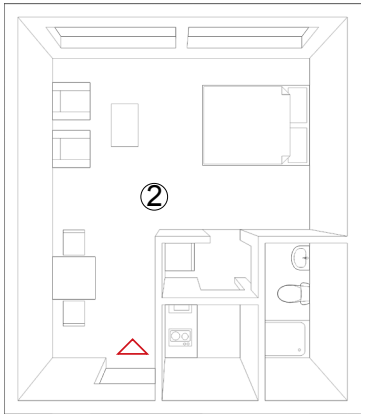
24 m²

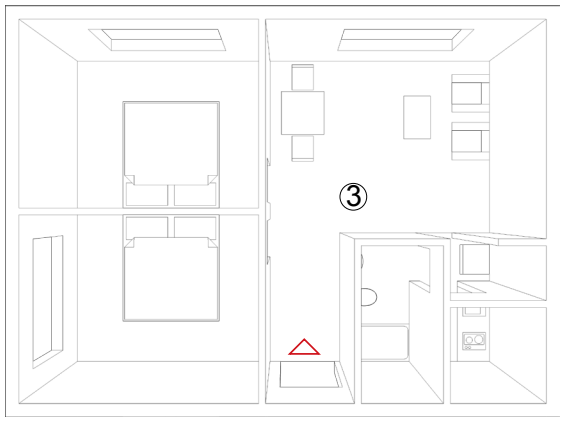
Type 2

30 m²

Type 3

48 m²





4.4 Proposal

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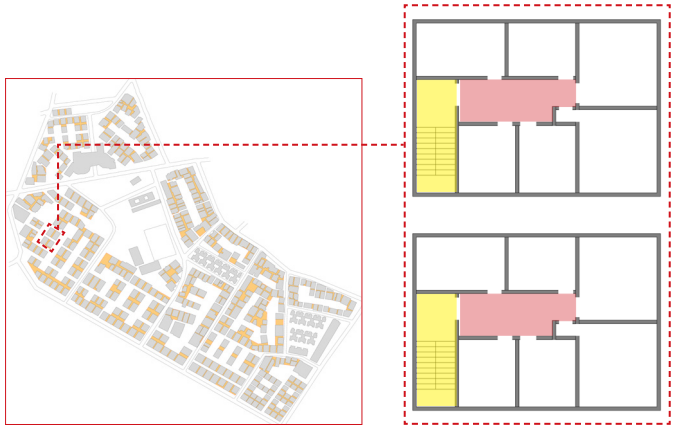

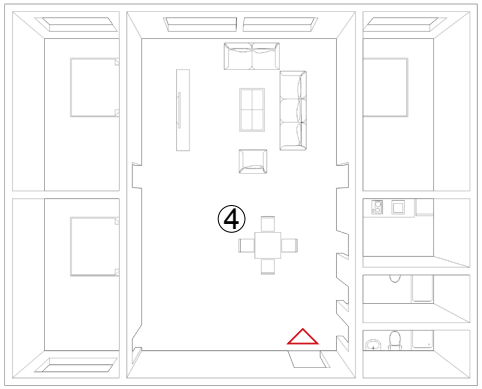

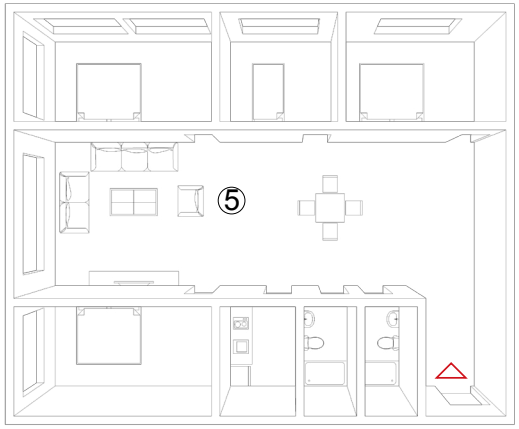

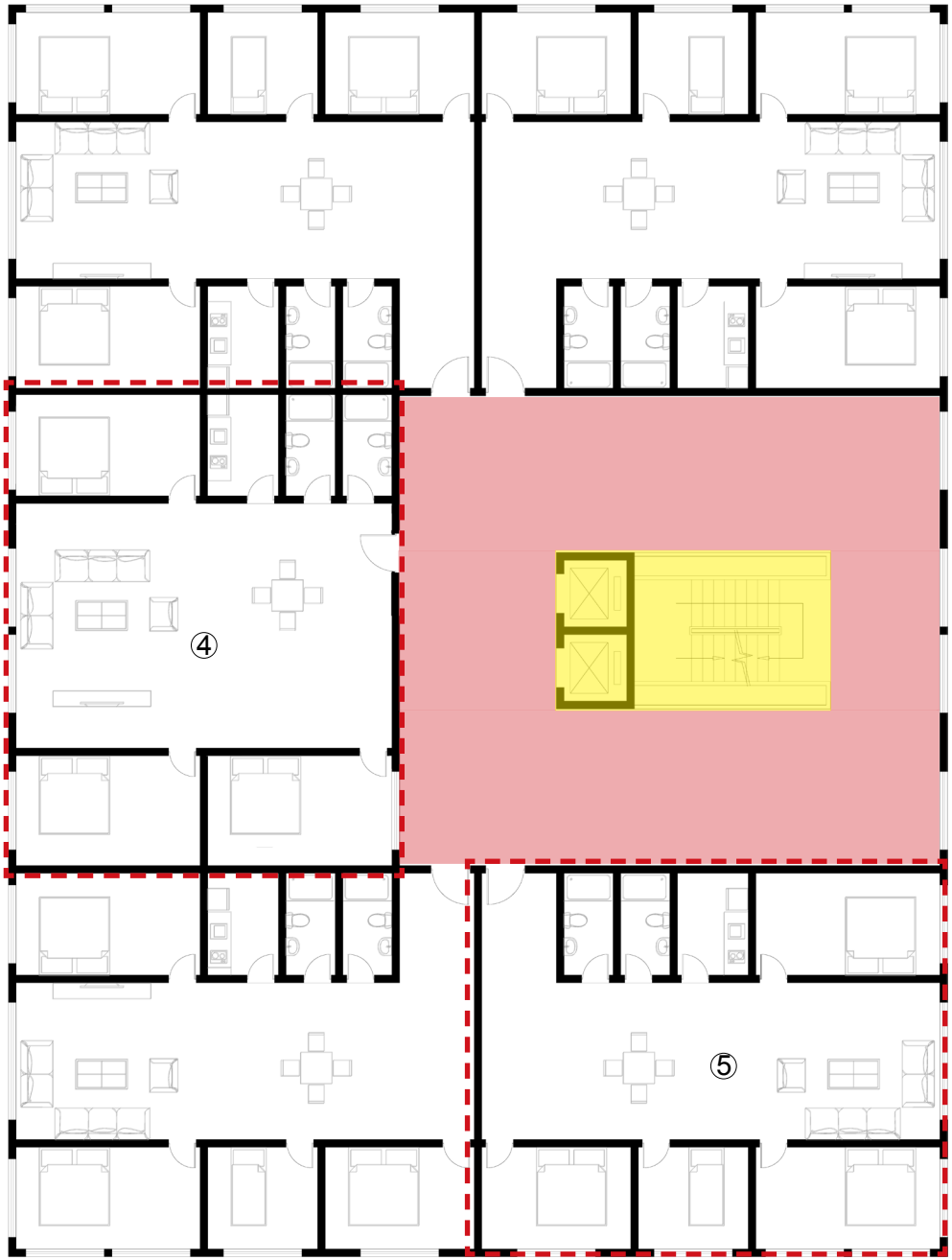

5. CONCLUSIONS

5.1 Conclusions

The aim of this study was to use of open data and big data are adopted for a quantitative research of the spatial structure of urban villages (the example of Xiasha village of Shenzhen city), from the perspective of architecture and urban planning. Based on results of the quantitative research, strategies to regeneration urban villages are proposed. Based on the above thinking, this paper studies urban villages from the macroscopic, mesoscopic and microscopic levels.

This paper has got several conclusions below:

(1) On the macro level, the spatial distribution pattern of various urban elements such as material facilities, social groups, economic activities and public institutions are analyzed by using the data such as heat map for Baidu map, POI data. It can be found that the Xiasha village is a vibrant community with a large population density, a variety of public facilities, and a very rich economic activity. The urban village is not a place where people keep at a respectful distance, but it is closely associated with the city. The urban village provides low-rent housing and a variety of life service facilities and recreational facilities for people working in CBD. Urban villages and CBD are complementary to urban functions, which jointly support Shenzhen's economic development.

(2) On the mesoscopic level, using the data of Open Street Map, the feature of urban fabric of Xiasha village are studied in detail from three aspects: "framework", "group" and "landmark". To determine the regeneration principle of Xiasha village: reducing the con-struction cost; Maintaining traditional neighborhood relationship, extending city context, it also protects and utilizes the "landmark" and traditional culture; adjust the density of the layout, and improve the lighting, ventilation and other physical environment of the building.

(3) On the microscopic level, in order to further analyze the spatial organization logic of Xiasha village, I made a more detailed typology study on the commercial space and residential space of Xiasha village. I classified the commercial space of Xiasha village according to scale, and also summarized the typical residential model of Xiasha village. So as to put forward the construction monomer composition regeneration strategy.

5.2 Shortcomings of research

Qualitative city research originated from the quantitative revolution that proposed in the 1960s. As a research tool for urban research and urban planning, qualitative city research is more scientific, objective and malleable in function than traditional research methods. The massive data of the Internet age gives us the possibility to qualitative city re-search, and also provides a scientific basis for urban planning. How-ever, on the one hand, the big data comes from the active users of the Internet, which leads to the deviation of data in crowd and geographical representation. These biases have raised questions about the credibility of the findings. On the other hand, due to some technical difficulties in data mining and data cleaning, and the data obtained from the Internet is not equal to real data, this brings some difficulties to my research.

On the macro level, If I can collect the mobile phone signaling data and public transportation card consumption records, and then cooperate with data of heat map for Baidu map, it will be more accurate to show people's commuting status in the city. I would be able to build a more objective evaluation index system and weight if I were grading the public facilities while I'm dealing with POI data.

On the mesoscopic level, because of the lack of road width information of the Open Street Map data, we cannot reach a wide range of traffic system analysis in the city. If we can collect the data of heat map for Baidu map of Xiasha village every 5 minutes, we will be able to analyze the spatial usage of the entireXiasha village. If we are able to collect all street view images of Xiasha village, and image recognition technology to analyze, we will be able to the whole Xiasha village public space quality objective grading, and put forward more accurate regeneration strategy accordingly.

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