

# A Morphological Study on the Urban Inner Fringes, in Case of Nanjing

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**Keywords:** Inner fringe belts (IFB), Urban morphology, Urban architecture.

**Abstract:** Nanjing is a metropolis located in Yangtze River Delta on the eastern coast of China, with a population of 8 million and a built-up area of nearly 700 square kilometres. Similar to many Chinese metropolises, Nanjing's rapidly city expansion by leaps and bounds has transformed the metropolitan area into an amalgamation of different and discrete pieces. Gaps between those pieces are the inner fringes, which have differences with the traditional ones.

This research focuses on this special urban morphology, which aims to describe its formal features and to understand its historical evolution. In metropolitan scale, historical city maps and satellite images are collected and carefully studied, expected to restore the urban expansion process and the evolution of inner fringes. Some key elements, like railway, administration boundary, in shaping the inner fringes are identified. In local scale, typological and morphological studies are conducted to a typical case. It gave us a chance to put IFB under scrutiny and to reveal its dynamics, heterogeneity and driving factors in local context and fine scale. In conclusion part, characteristics of IFB in Chinese cities is summarized and the structural potentials and urban values of inner fringes are also pointed out, which would contribute and enlighten the renewal of them in the future.

## 1. Introduction

One major characteristics of metropolitan is unbalanced development. Different regions expand, or contract, or stagnate in different periods resulting in a new type of mixed land use. Frequently, it is named as "fringe belt (FB)" and it is called as "inner fringe belt (IFB)" if it located inside urban area. IFB can be formed within just a few decades, whose edges and interiors can remain stable for a relatively long time.

For a long time, the research of the IFB is based on the study of urban history. The concept of "Fringe Belt" is firstly identified by H. Louis (1936) in a study of Berlin, divided Berlin into the three circles by marginal zones. Then, it is refined by Conzen M.R.G. (1960) and Whitehand J.W.R. (1967) in a study of Alnwick, "A belt-like zone originating from the temporary stationary or very slowly advancing fringe of a town and composed of a characteristic mixture of land-use units initially seeking peripheral location".

Fringe belts constitute a major element in the internal structure of cities (Whitehand, 1988b, pp. 54-55) especially where a fixation line has had a powerful constraining influence. In these ar-

areas with irregular forms and low land use density, it is difficult to develop a set of standardized management plan (von der Dollen, 1990, p. 321). "The urban fringe-belt is characterised by spontaneity instead of planning. It is typified by the singular relocation of individual functions from the centre to the periphery". Von der Dollen argues that a fringe belt is not created where cities have expanded by administrative act, since "decisions on users, reasons for removal and space requirements are here made at the lowest, individual level, whereas city expansion requires a legal act". He thus defines fringe belt as both form and process. There is also a problem of scale and quantity.

At the transformational stage of the urbanization in China, it has changed from incremental development to stock development of land use. There are more and more studies on the application of Conzen theory about Chinese cities. However, firstly, it should be noted that the urbanization pattern in western countries is dominated by market economy, with enterprises play a vital role in it, which is different from China's urbanization pattern (transforming urban marginal rural land into urban land). The process of urbanization in China is more affected by government intervention and planning system. Therefore, when we use Conzen theory about analysis Chinese cities, we should consider the differences of the basic conditions. Secondly, the China's big cities expand in different ways and forms. There are "superimposed" expansion plain cities represented by Beijing, similar to Berlin in the circle form. There are also hilly cities composed of pieces, which are widely distributed in the long Delta, like Nanjing and Hangzhou.

Nanjing is a metropolis located in the Yangtze River Delta on the eastern coast of China, with a population of 8 million and a built-up area of nearly 700 square kilometers. Nanjing's rapid expansion is also influenced by city walls and widely distributed hills. The core of the old city is limited by the ancient city wall. The existing ancient city wall of Nanjing was built in the Ming Dynasty, which is the longest, largest and best preserved ancient city wall in the world. It changed the old system of square or rectangular city wall of the past. On the basis of the construction of Kang City in the six dynasties, the city was built according to the trend of Nanjing mountain range and water. As a typical hilly city in southern China, the construction and development of Nanjing is limited by hill and river, both in ancient time and in modern time. With the development of transportation technology, the metropolitan areas gradually get a close network of each other; within the city, different groups separated by rivers and hills. Over the past few decades, they expand fast and collide with each other, creating gaps between the pieces, the IFBs. Compared with the traditional IFB, the shape of these areas is more fragmented, disorderly, chaotic, whose causes are more specific. We hope to take Nanjing as an example to develop a method to study the IFB on the fine scale to a certain extent. And Nanjing is also a city where we live and work, making it easy to study on the field.

Firstly, in metropolitan scale, historical city maps and satellite images are collected and carefully studied, expected to restore the urban expansion process and the evolution of IFBs. Some key elements, like railway, administration boundary, in shaping it are identified.

In local scale, typological and morphological studies are conducted to a typical case. It gives us a chance to put IFB under scrutiny and to reveal the its dynamics, heterogeneity and driving factors in local context and fine scale.

In conclusion part, the characteristics of IFB in Chinese cities are summarized and the structural potentials and urban values of inner fringes are also pointed out, which would contribute to the knowledge of IFB in southern China and enlighten the renewal of them in the future.

## 2. Urban expansion and evolving of IFB in metropolitan scale

Looking back at Nanjing from 1984 to 2018, firstly, we looked for the important historical events of the city to identify the important steps of urban expansion. Secondly, we initially selected the following important time nodes. Thirdly, we went through the corresponding satellite pictures, urban plans and other related materials, eventually we got a linear backtracking history to reproduce the process of urban expansion (Figure 1). For that, we can see how the IFB is formed and developed in the process of its leaping expansion process. The aim is to recognize the IFB at the macro level, from the perspective of the metropolitan area.

In 1984, expansion of the main urban area is mainly limited to the city wall. The edge of Chengbei area laid next to the north city wall, which connects the Yangtze River Port and Nanjing West Railway Station, begins to develop by freight transportation.

In 1990, it started to expand upon the east side of the city wall called Chengdong District. Meanwhile, Dongshan Town, as the future Jiangning district, started growing fast with the economic development of reform and opening up.

In 1997, the Chengdong District along the east side of the city wall kept growing along the new intercity expressway (Huning expressway connected Nanjing and Shanghai), as well as Qixia District growing near the Nanjing West Railway station. With the high-speed construction around the city developing, (Chengxi highway alongside the west city wall and Chengdong highway going through the east side of the main city), two new plates start to grow and to connect, Hexi District with Qixia District and Yuhua District.

In the 21st century, the rapid construction of modern transportation system and infrastructure started, began to upgrade to modern cities. Important infrastructure and main pieces were rapidly formed during this period of time. As provement, satellite maps also show that the scope of regional construction changes dramatically. Therefore, we increase the density of interception time nodes to once every three years.

In 2002, along the west city wall, the city west highway connected Qixia district to the north and on the south side, it grows with Hexi district. Chengdong high-speed linked to the main urban area, Yuhuatai and Jiangning District, so as the Jiangning District began to grow rapidly (The State Council approved the abolition of Jiangning County and the establishment of Jiangning District in Nanjing in 2000, with the former administrative area of Jiangning County as the administrative area of Jiangning District. District people's government in Dongshan town. Jiangning District has developed rapidly). With the completion of the north highway of the city (Xuanwu highway), across the north side of the Purple mountain, a new city piece is formed on the east side of the purple mountain, Xianlin district.

In 2005, the Chengdong District along the east side of the city wall kept growing along the new intercity expressway (Huning expressway connected Nanjing and Shanghai), as well as Chengbei District growing near the Nanjing West Railway station. Another economic development zone based on industrial development started near the north railway. With the high-speed construction around the city developing, (G42 highway and south inner-ring highway) two new pieces start to grow, Hexi District and Yuhua District.

In 2009, with the improvement of the inner ring and outer ring of Nanjing expressway network, the outer area of the city expanded rapidly. The economic development zone of the north of the city, Xianlin district and Jiangning district are expanding rapidly.

In 2012, Nanjing South Railway Station was completed and opened to traffic in an all-round way. The center of railway passenger transport in Nanjing was transferred from Nanjing Railway Station to Nanjing South Railway Station. Banqiao District in the south of

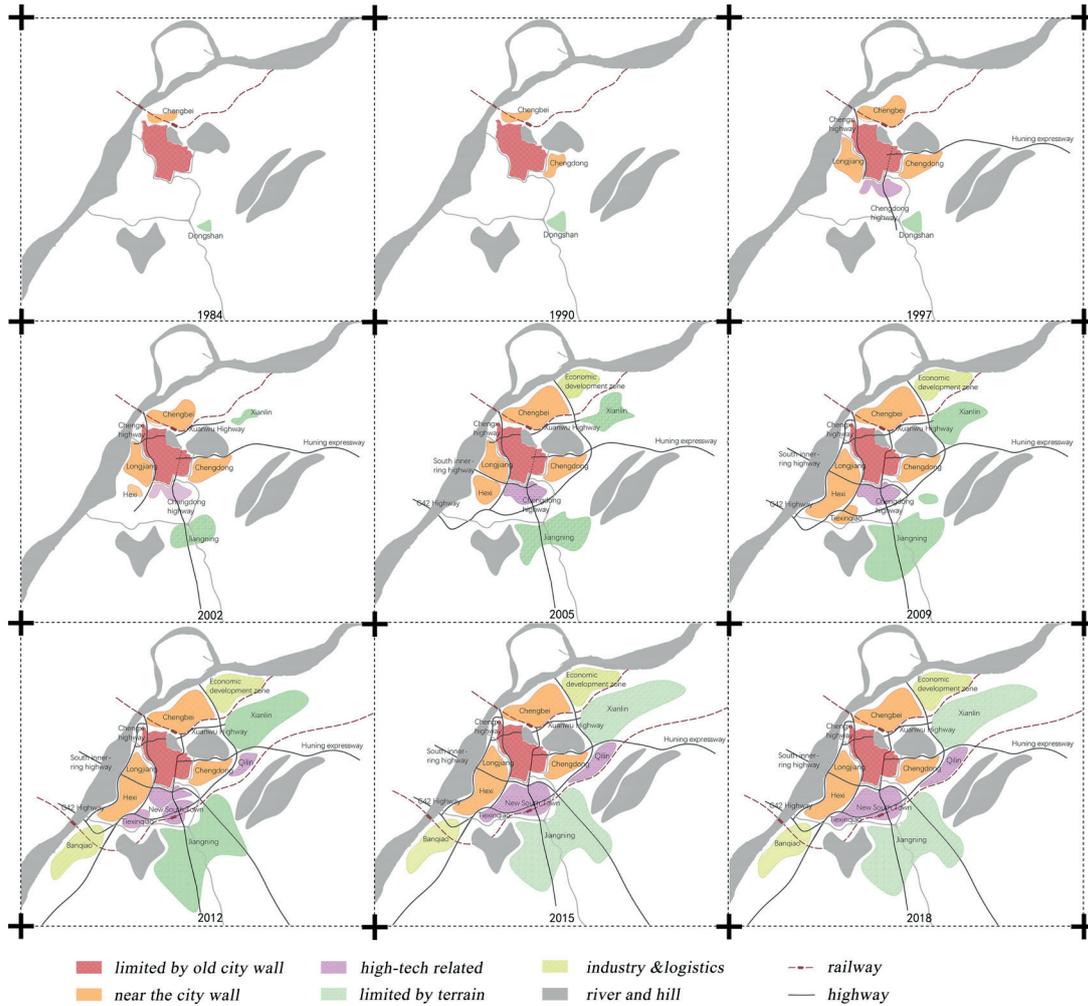


Figure 1. Urban expansion and shaping of IFB in Nanjing since 1980's.

Nanjing developed rapidly with logistics transportation as an industrial core. Jiangning District expanded rapidly along Chengdong highway. So far, the distribution of pieces in Nanjing today is generally formed.

In 2015, Xianlin District, Jiangning District and Banqiao District continue to expand along the outside of the city, while the Yuhuatai District as a high-tech district expanded rapidly, Qilin High-tech District along the East Road and Dongshan started to grow in belt form.

Today, with the construction and relocation of important urban infrastructure, all the IFBs are basically formed. We see a lot of fragmented, scattered IFBs: a section between the north city wall and the Nanjing West Railway Station, which is mainly composed of dwellings, industries and warehouses; an IFB consisting of airports and green spaces (near Daming Road); another one composed of highways, viaducts and residence. Further more, in the formation of most IFBs, we can see two dominant elements, green terrain and large urban infrastructure.

At the same time, I would like to explain that the various types of IFBs do not exist in Nanjing alone, but widely exist in southern China in the process of rapid urbanization in recent decades. Therefore, we carry forward case study of the IFB to the next level, to moderately develop and try to build a discourse system, to describe the form, formation process, scale and quantity of the inner edge.

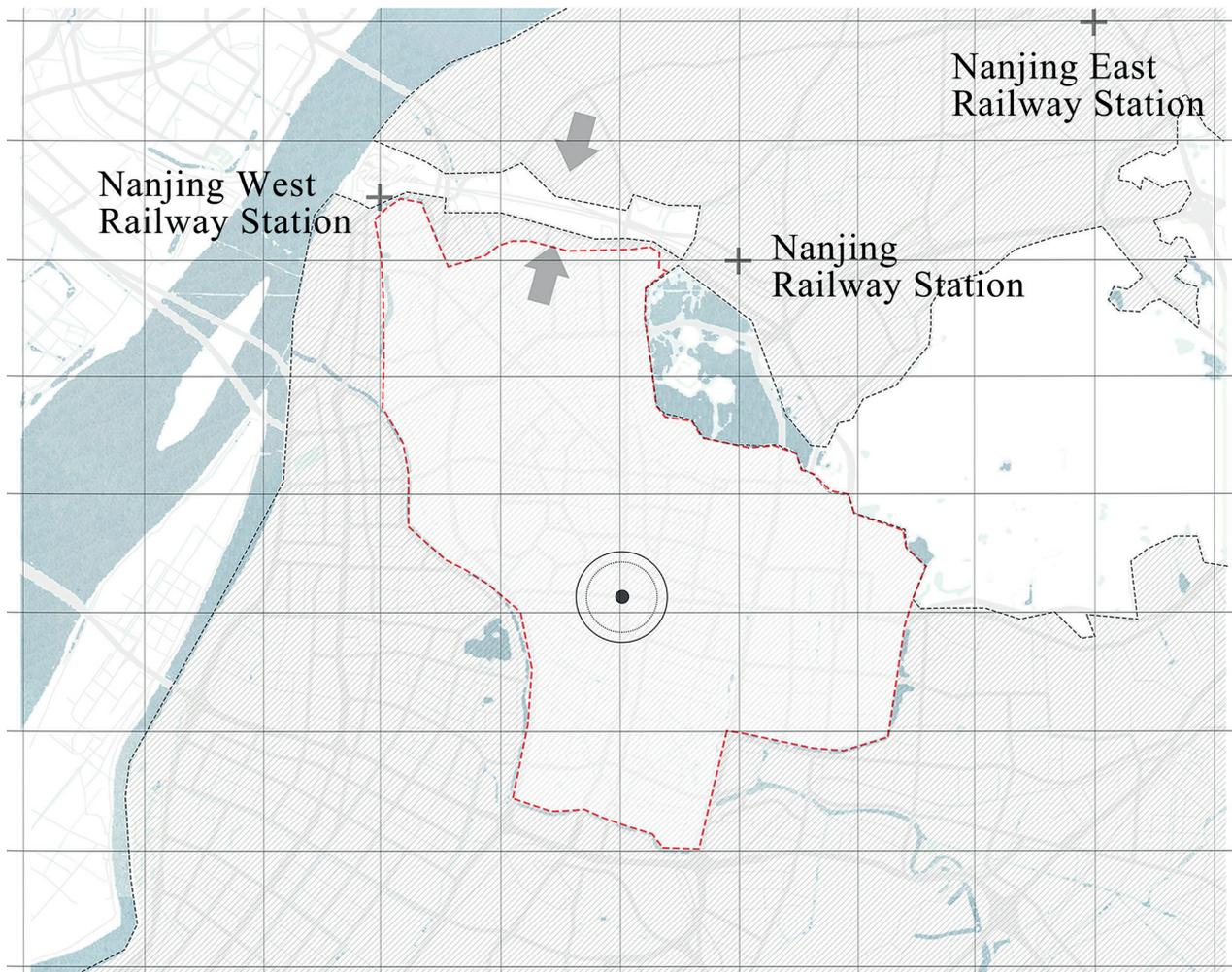


Figure 2. Site location of a typical IFB for the case study in fabric scale.

### 3. Case study of a typical IFB in fabric scale

The formation, consolidation process of the IFB has been influenced by natural and artificial elements. Taking the IFB with large-scale infrastructure as the main influencing factor, we select the inner edge zone of Nanjing West Railway Station at the junction of Chengbei district and main city area as a case study. Because it exists for a long time with available ample historical material and it is a typical inner edge belt that changes with the construction of large-scale infrastructure.

#### 3.1. Site location

The site is located outside the north city wall to the intercity railway line area and the Zhongyang Gate to the Nanjing West Railway Station section.(Figure 2) Located at the junction of the main city and the Chengbei Industrial Zone, the Chengbei District is mainly composed of an industrial zone and an economic development zone that expands to the northeast. The main city is limited to the Ming City Wall. The inner edge is between these two plates. At regional traffic level, the north line of the intercity railway , bearing the Nanjing Railway Station passenger transport and the Nanjing West Railway Station freight transport) passes through the

entire edge zone to separate the land; at the urban level, the urban expressway and secondary branch road network again repair the two plates in series.

### 3.2. Historical evolution

The Xiaguan Wharf was established in the Ming Dynasty. Between the outside of the city wall and the Xiaguan Wharf, a group of Ming government troops was stationed (Figure 3-a).

From the late Qing Dynasty to the Republic of China period before 1949, more docks opened by the Yangtze River in Nanjing, as business and trade went prosperous, the government invested more in train and factories. The industry was initially developed. Nanjing West Station completed, which is the start of the growth of the inner edge in this section.

After the founding of the People's Republic of China (1949-1978), Nanjing Railway Station and Nanjing Yangtze River Bridge were completed. Railways diverted in the late twentieth century. The passenger flow of Nanjing West Railway Station was declining. It gradually turned into a freight-oriented transportation mode, when a large number of storage houses were built with the railway station.

After the reform and opening up (after 1978), the development of railways and highways brought a great flow of people to Nanjing Station, which drove the nearby commercial and hotel industries, when the western and central sites had a certain development.

In 2013, Nanjing West Railway Station officially launched the eastward migration plan, the freight function gradually disappeared, the original station area will be transformed into a heritage park, the eastern and central sites began to decline, when the nearby residential areas grew.

### 3.3. Significant element in Fringe-belt growth

As an important infrastructure that splits city pieces, the railway, it leads the rise and fall of the region. Further, the landscape texture in the site is the companion of railway changes. Therefore, we go back to the railway planning history in Nanjing to get a better understanding how the rise and fall of Nanjing West Railway Station drive the change of site in the IFB.

The Shanghai-Nanjing Railway in Nanjing was built in the 31st year of Qing Guangxu (1905). In 1908, Nanjing West Railway Station and Nanjing East Railway Station (Yaohuamen Station) were completed. The Beijing-Shanghai Railway opened to traffic, as we call the station as Nanjing Station of Shanghai-Nanjing Railway. In 1909, the Jingshi Railway was completed, promoted transportation within ports and cities. In 1911, the Pukou Railway Station was completed, connecting the railway network on both sides of the Yangtze River. In the 16th year of the Republic of China (1927), the station was renamed Nanjing Xiaguan Station. In 1937, Zhonghuamen Station was completed and the Ningwu Railway opened. In 1958, the Jingshi Railway was basically demolished. In 1968, the Nanjing Xiaguan Station was renamed Nanjing West Railway Station. In the same year, Nanjing Railway Station and Nanjing Yangtze River Bridge were completed and put into use at the same time, when the Nanjing Railway Network completed the first upgrade. In October 2004, Pukou Railway Station stopped passenger transportation. In 2011, Nanjing South Railway Station and North Square opened. The passenger transportation center moved to Nanjing South Railway Station. In March 2012, Nanjing West Railway Station stopped passenger transportation and planned to relocate. In August 2014, the new North Station and the North Square of Nanjing Railway Station opened. In October,

Zhonghuamen Station stopped passenger transportation. In January 2015, Nanjing South Station South Square was opened and Nanjing Railway Network completed the second upgrade.

The importance change of Nanjing West Railway Station in the whole railway system of Nanjing is closely related to the development of urban economy. Railway, as an important large-scale infrastructure, for Nanjing, combined with port and wharf transportation, originated from the north side of Nanjing. Later, due to the upgrading of the railway (the development of high-speed rail), the railway passenger transport center moved to the south of the city (Nanjing South Station), driving the economic development of related industries near the railway station, followed by the decline of Nanjing West Railway Station. There is a similar situation in many Chinese cities. The original old station has been replaced by the new high-speed rail station, but it continues to operate, lagging behind in all aspects of development, but facing the possibility of upgrading. Therefore, we should consider the new possibilities and opportunities that will bring to the surrounding areas in urban planning.

### *3.4. Fringe-belt growth and change*

In the process of site function transformation and policy change, we can see that the spatial area dimension of the inner edge goes with the change of infrastructure. It starts from a point of Xiaguan wharf, later the influence area of the site grew with the construction of the railway of the Republic of China. The scope of railway lands and its related area also expanded with the new railway line connected with both sides of the Yangtze River by going through the Nanjing Yangtze River Bridge.

At the beginning of reform and opening up, the railway lands expanded to the maximum. (Figure 3-b) And then, with the completion and contraction of Nanjing Station, the West Station was abandoned in the process of upgrading the railway infrastructure system. After the opening of the Nanjing South Railway Station, the transport function on the south side of the city developed, going with declining of the transportation and warehouse function on the north side, resulting in functional replacement.

### *3.5. Urban fabric shaping in several decades*

We try to figure out the building age of the site based on field research and literature, divided it into the 1970s, 1980s, 1990s, 2000s and 2010s according to the age of construction (Figure 4-a). Because of the different construction function and building density of different ages, it presents obvious texture characteristics related to railway construction in several ages. The houses built in the 1970s and 1980s mainly existed on the high-density narrow texture near the west station, with the large shopping malls and warehouses on the east side. In the 1990s, the housing texture mainly showed massive middle-level residential areas. In the 21st century, the main increase is the residential texture dominated by compact high rise.

According to the site historic urban fabric, the site texture is interpreted into an amalgamation of texture pieces, including the clue (railway site), channel, block, grain, box, blanks, pending, flat, artificial texture and natural texture (Figure 4-b). On the one hand, the texture between the city wall and the railway line is denser and more diverse than it on the north side of the railway, on the other hand, the texture segment on the north side of the railway line is larger. Generally, it shows that the site is divided into a heterogeneous, fragmented pieces of combination. They appear on the site, unlike the mature area of a city, it has existed for hun-

dreds of years without being merged, which proves the heterogeneity and particularity itself. Therefore, once again we see the leading role of infrastructure in texture and pattern.

### 3.6. Building typologies

The buildings in the fragment are continuous in a long time and the speed of its change is slow, but the function used on the fragment may change flexible. We continue to observe the interior of the debris to clarify how the collection of fragments of such a large area maintains its own operation over a long time. In order to achieve this goal, we try to summarize the architectural form and functional replacement type.

There are three main types of building form of the site: residential building-commercial building and others including warehouse, department and factory (Figure 4-c). Each type of architecture shows a different architectural style in different ages and blocks. Of the dwelling types that extant here, middle-level and high-rise residential buildings are wildly spreading. There is a type of high-rise residential buildings combined with a commercial related ground floor and some two-story single-family dwellings are mainly distributed over shantytowns. For commercial buildings, it shows the characteristics of scattered distribution of small houses facing street, some combines with semi-outdoor, most of them are small in scale and mainly exist on the first floor. Others, such as warehouse, are mostly one or two floors room, spread in the narrow texture of dense buildings.

For the building functional type replacement of the site, we can see that the logistics warehouse, which was developed with the change of the railway, was partly replaced by commerce, dwelling and hotel function brought by the flow of people. With the migration of the original logistics warehouse function coming with Nanjing West Railway Station, the building is vacant and the function is replaced spontaneously. There are three logistical warehouse inside the site, including the Nanjing West Station cargo yard, coal port No. 6 logistics centre and iron flow warehouse. Nanjing West Station cargo yard, which was originally used as a storage base for good, is now attached to the south side of Nanjing Station for warehouse, parking, logistics and dwelling. Coal Port No. 6 is now used for warehouse, logistics and parking, iron flow warehouse is now basically continuing the original logistics and warehouse functions.

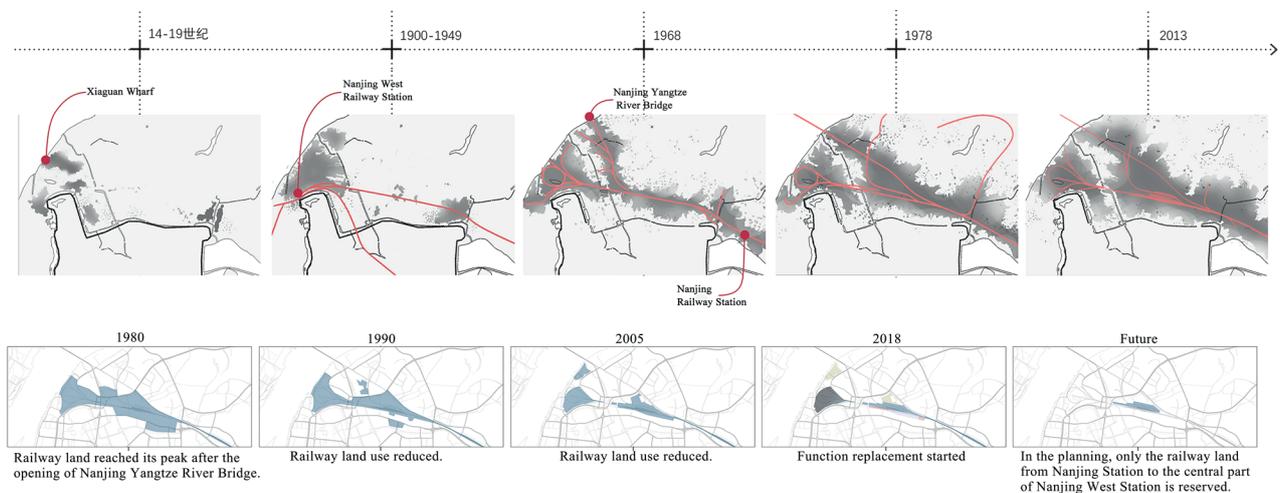


Figure 3. The historical evolution of the case study site (a: above, the general trend of the evolution. b: below, the shrinking of the lands occupied by railway since 1980).

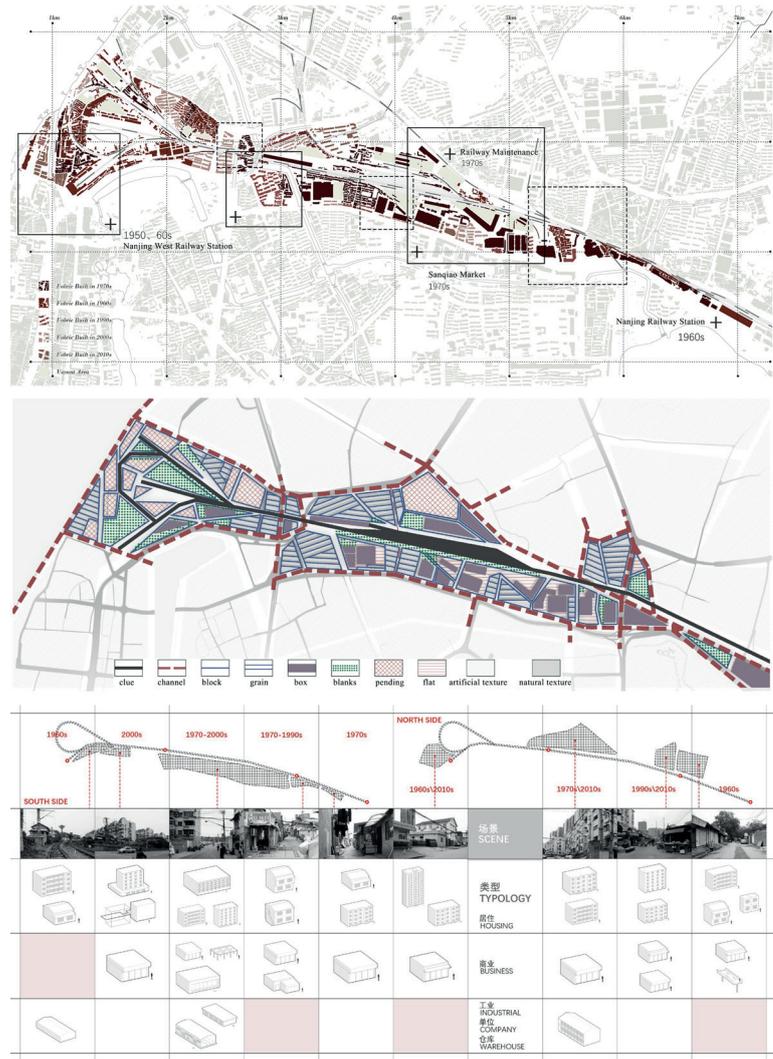


Figure 4. Morphological study of the site (a: above, building fabrics with various ages. b: middle, the amalgamation of fragmented urban fabrics. c: below, building types on the site).

Under the background of the evacuation of the original functions and the vacant buildings, the huge structure of infrastructure and dilapidated huts coexist and form a heterogeneous urban landscape. Walking into the inner side of these urban landscapes, many fragmented crevice are used to the maximum extent and new functions are closely attached to these fragments, for example, huts close to railway, vegetable fields next to garbage dumps, converted hotels in shopping malls and warehouses and free space in underground passageways. It provides a low-cost rest space for migrant workers and low-income people by noisy, low-standard living environment. To some extent, those functions purely exist for survival, with nothing to do with the cultural significance and form diversity of architecture.

The Nanjing West Railway Station IFB provides us with a relatively complete case of in-depth understanding of the IFB. We see its birth, slow formation, accelerated development, gradual apoptosis of the life process. The railway plays a leading role in it. After the linear form of the railway is separated from the urban body, a large number of irregular fragmentation plots are formed along the railway line. Because of the influence of administrative division, it has become a blind area of planning, which has contributed to its spontaneous growth of a great extent. These factors lead us to see a kind of edge zone landscape which is different from the mature establishment area in terms of disorder, heterogeneity and fragmentation. On the other hand, with the structural transfer of railway facilities, it can be expected that this IFB will

be less and less affected by railway infrastructure. The withdrawal of the railway will return a considerable amount of land to the city. At present, with the increasing shortage of land stock in inner urban areas, it has great potential for development and renewal.

#### 4. Conclusion

Compared with the traditional concept of IFB, that in China is different, which is determined by different patterns of urban expansion. Beijing and Nanjing represent two typical patterns of it. One is growing layer upon layer represented by Beijing, another is growing by leaps and bounds represented by Nanjing. The expansion pattern of metropolitan such as Berlin analyzed by Conzen is similar to that of Beijing. The plain provide favorable conditions for circle expansion because of less topographical obstacles. In this mode of expansion, with economic cycle and industrial development, it is easy to form the IFB in a circular layered distribution. However, there are other urban development models in Chinese cities, such as Nanjing, the hilly city in southern China, this kind of city does not have the condition of circle growth, it is restricted by the hilly and watery topography. In this circumstance, city pieces grow by leaps and bounds, forming IFB in the gaps between the pieces, which shows the characteristics of patches overall.

In this case study of Nanjing, we see three major factors of IFB shaping, hilly and watery topography, city walls and transportation infrastructure. The influence of those factors of urban expansion and IFB formation does not exist alone, but closely linked together. For example, the topography as the basic condition affected the site selection of the city wall of the early construction period of the city. Now, the city debris cut by hills and rivers influences the distribution of infrastructures. At the same time, there are transportation infrastructures like highway built along the city wall, which implied the new transportation infrastructure routines are largely defined by the old ones.

We have noticed that the IFB of Chengbei area dynamic changed with railway evolution. The planning of the railway system is decided by the Ministry of Transport instead of city government, which makes the land occupied by railway is not easy to be managed by urban planning. The railway system in China is in dramatic upgrading nowadays. With railway land' growth and decline, IFB connected with it goes in a rapid continuous emergence, integration and dissolution process, which produce different heterogeneity and disorderly urban landscape. To some degree, this kind of heterogeneity has certain value to enlighten architecture and urban planning professionals to explore new possibilities of urban forms.

At the present stage, the urbanization mode in Chinese cities, has changed from incremental development to stock development. The stock of land in urban region has become limited. IFB covers a large area inside the city, which has great potential for urban renewal and reuse. In this paper, we have studied the morphological characteristics and affected factors of IFB, which could be a knowledge base for the land re-use of IFB in the future.

#### 5. Acknowledgements

This paper was supported by a grant from the National Natural Science Foundation of China (51538005). Thanks to Meng Tang, Wenxuan Zhan, Peipei Jin and Xinyu Xia, for providing the research material for the case study. Figure 2,3,4 is processed on the basis of it.

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