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Study on Planning Layout and Spatial Form of the Third-Line Construction in North Sichuan—Taking Four Cities in Northern Sichuan as Examples

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Abstract

From 1964 to 1983, as a large-scale construction activity of national defense, science and technology, industry and transportation infrastructure with the goal of war readiness, was rapidly launched in the hinterland of China, the development and evolution of the Third-line Construction ("Third-line construction" refers to a large-scale national defense, science and technology, industrial and transportation infrastructure construction activity guided by war preparedness carried out in 13 provinces and autonomous regions in the central and western regions of China from 1964 to 1983, and its development and evolution promoted the development and rise of modern industry in Sichuan, and profoundly affected the formation and evolution of urban pattern and urbanization process in Sichuan.) promoted the development and rise of modern industry in Sichuan, and profoundly affected the formation and evolution of urban pattern and urbanization process in Sichuan. Under the unified planning and deployment of the central government, most of the Third-line Construction projects in Sichuan were distributed along the main railway lines and rivers, and an industrial agglomeration belt with Guangyuan, Jiangyou, Mianyang and Deyang as the main nodes was gradually formed in the north of Sichuan. By analyzing the characteristics of Third-line Construction planning layout and the spatial form composition of the remaining factories in the north of Sichuan, the paper tries to explore the influencing factors of the layout of Third-line industrial plants in the north of Sichuan. In addition, a large number of Third-line industrial remains are used inefficiently or even abandoned, and the value of the precious Third-line industrial remains is at risk of loss and vanishing. How to better excavate, protect and inherit the

value of Third-line industrial remains is the key concern of the study of Third-line Construction. This paper introduces the relevant theoretical methods of urban morphology, and summarizes and analyzes the distribution, composition and characteristics of the building communities in the factory area by combing the spatial organization form and functional structure of the industrial relics of the third-line construction in the four cities in northern Sichuan. On the basis of the current situation of a large number of third-line construction remains, the composition and evolution of the factory space were discussed, and the influencing factors and their impact on the later urban planning and social and economic development were explored, so as to enrich the research on the planning layout and protection and utilization of the third-line construction industrial remains.

Keywords

Third-Line Construction, Industrial Heritage, Planning and Layout, Spatial Form, Protection and Utilization

1. Introduction

This paper selects the key construction projects of the third-line construction in northern Sichuan (The northern Sichuan region referred to in this article mainly refers to the main areas represented by the four cities in northern Sichuan, which are Guangyuan, Jiangyou, Mianyang and Deyang from north to south, and these four cities are the focus of this paper as the key areas of the third-line construction in northern Sichuan.), investigates the spatial distribution, existing situation and urban (cluster) construction development process of the factory area from the macroscopic perspective, and uses the theoretical method of urban morphology to summarize and refine the spatial morphological characteristics and its influencing factors from the planning and site selection, overall pattern, functional structure and building arrangement of the factory area from the planning and site selection, overall pattern, functional structure and building arrangement of the factory area in the medium view.

2. The Development and the Status Quo of the Third-Line Construction in Northern Sichuan

1) Site selection planning and construction of Third-line Construction in North Sichuan

In the middle of the 1960s, the situation at home and abroad was complicated and changeable. In order to cope with the severe and sinister turbulent situation, the Central Committee of the Communist Party China quickly made a major adjustment strategy of "Third-line Construction", divided the country into three strategic circles, and took the Third-line area as an important strategic rear area to adjust the industrial layout (Wang, 2021). After the major strategic decision of

"Third-line Construction" was made, according to the decision of the Secretariat of the CPC Central Committee in August 1964, the organizing group of the State Planning Commission conducted site selection and preliminary planning for the major Third-line Construction in the Northwest and Southwest (Ju, 2021). In the same year, the CPC Central Committee approved and issued the Outline of the 1965 Plan (draft) proposed by the State Planning Commission. The decision was made to speed up the construction of industrial, transportation and national defense infrastructure in the Third-line regions.

After repeated exploration and research, Sichuan, Shaanxi and Guizhou provinces have become the key investment areas for Third-line Construction due to their unique strategic positions, natural resources and huge industrial development space, and Sichuan has become the province with the most concentrated investment, the largest scale and the most complete industry categories due to its important strategic position. According to data, in addition to the 744 million yuan allocated by the Central Committee of the Communist Party of China in 1964, from 1965 to 1980, a total of 41.403 billion yuan was invested in the Third-line Construction in Sichuan Province, accounting for 20.17% of the total investment in the Third-line Construction in the same period, which shows the important position of Sichuan province in the national Third-line Construction (Zhou) (see Table 1 for details).

Table 1. List of central investment in National Third-line Construction CU: billion yuan (Source: The author redrew based on the material).

Provinces	1965	Third Five-Year Plan period (1966-1970)	Fourth Five-Year Plan period (1971-1975)	Fifth Five-Year Plan period (1976-1980)	Subtotal
Sichuan	19.8	132.53	136.36	125.34	414.03
Guizhou	8.95	40.45	48.9	48.89	139.19
Yunnan	8.03	41.25	46.36	55.31	150.95
Shaanxi	5.39	40.27	86.62	76.1	208.38
Gansu	9.03	43.96	54.34	48.2	155.53
Henan	6.65	38.88	75.03	96.22	216.78
Hubei	5.62	54.45	103.77	153.29	317.13
Hunan	5.77	35.55	65.92	67.64	174.88
Shanxi	5.43	32.39	57.20	74.52	169.54
Qinghai	1.98	12.16	12.29	32.95	64.21
Ningxia	1.48	10.55	17.12	17.74	42.06
Third-line construction investment	78.13	482.44	703.91	788.2	2052.68
Total national construction investment	179.61	976.03	1763.95	2342.17	5261.76

2) Site selection planning for Third-line Construction in North Sichuan

Since the promulgation of the major strategic decision on the Third-line Construction, the central government has made a series of important instructions on the guiding ideology, construction goals and planning and layout of the Third-line Construction. In the "third Five-year" plan, the central government proposed to base itself on war, actively prepare for war, put national defense construction first, actively promote the Third-line Construction, and gradually change the guiding ideology of industrial layout, which once again confirms the nature of the guiding ideology of the Third-line Construction (Chen, 2007). According to the topography of Third-line areas, Mao Zedong put forward "big scattered, small concentration" and "camp" layout (Xu & Chen, 2015). In August 1964, the national committee held a meeting of the first and second line relocation, further put forward the construction policy of "big dispersion, small concentration" and "near the mountain, dispersion and hide" (hereinafter referred to as "mountains, scattered, hole") for a few cutting-edge national defense projects.

a) Excellent strategic location

At the beginning of the founding of the People's Republic of China, the international and domestic situation was chaotic and complicated. Internationally, the two camps of capitalist and socialist countries are fighting against each other. Imperialist countries led by the United States adopted diplomatic means of political isolation, economic blockade and military threat against the New China. In addition, the chaos around the world has not completely calmed, the New China still faced great threats (Xu & Zhang, 2021). At home, in the face of the weak foundation of the founding of China and the stubborn resistance of the reactionary remnants, the central government has always maintained a high level of vigilance in the political, military and economic fields. Since the late 1950s, the differences and contradictions between China and the Soviet Union have become increasingly prominent.

Sichuan region is located in the inland hinterland of China, covering a wide range of mountainous terrain. In the north, it borders Gansu and Shaanxi provinces, with Qinling Mountains and Daba Mountains extending for thousands of miles. The east and west sides are far from the border edge, and the south has the Yunnan-Guizhou Plateau. The overall terrain of the region is transition from mountain to basin, accompanied by some hilly areas. This area is relatively closed and has terrain conditions that are easy to defend and difficult to attack, which is one of the important strategic factors for it to become a key development area of the Third-line Construction. See **Figure 1** for the location and detailed location distribution of the third-line construction.

b) Have industrial foundation

After the founding of the People's Republic of China, in order to cope with the dilemma of a very weak modern industrial foundation, extremely unreasonable industrial layout and unbalanced economic development in various regions, the government promulgated the "First Five-Year Plan" in 1955, relying on the

Figure 1. Location map of the four cities in the north of Sichuan are located in the whole country and within Sichuan.

Soviet Union to support 156 construction projects and 694 large and medium-sized construction projects in industrial construction, to concentrate forces to build socialist industrialization base (Wang, 2020). In 1955, the government designated Mianyang as an electronic industrial zone to carry out the construction of radio industrial base, and in 1957 finally selected the Pingzheng Bridge area in the north of Mianyang city as the construction site; In the same year (1955), key projects such as West Sichuan Cement Plant, Jiangyou Steel Plant and Jiangyou Power Plant were located in Jiangyou for construction (Sichuan People's Publishing House, 1999). In 1958, Deng xiaoping visited Deyang industrial zone, affirmed the important position of Deyang industrial development in the field of national industrial development, called the national machinery manufacturing "hen industry", after that, Liu shaoqi inspected the construction of Deyang industrial zone in April 1960, and gave specific instructions on its layout, construction direction and urban pattern. During the First and Second Five-Year Plan period, advanced technologies were introduced from national defense, machinery, electronics, chemistry, energy and other industries to fill the industrial gaps, which accelerated the industrial modernization process of Sichuan, the whole central and western regions, and even the whole country to a certain extent (Zhou, 2018).

Since the implementation of the Third-line Construction, in 1965, the central government identified the former Mianyang area (After the founding of the People's Republic of China, Mianyang Special Area was set up, and in 1970 it was renamed Mianyang Area, covering Guangyuan, Jiangyou, Mianyang, Deyang, Suining, Chongqing and other parts of 19 counties, with jurisdiction over 44, 000 square kilometers and a population of more than 10 million (Mianyang City Archives, 1989). It was one of the largest prefectual-level administrative areas in

China at that time.) as one of the key areas of the national Third-line Construction, the government has carried out a large number of construction sites in the former Mianyang area relying on the existing industrial base. The four cities of Guangyuan, Jiangyou, Mianyang and Deyang account for a large number and scale proportion in the north of Sichuan and even the whole Sichuan region, thus laying an important position for several cities in the process of Third-line Construction in Sichuan (Zhang, 2021). Among the 104 national key projects actually implemented during the Third-line Construction in the former Mianyang area, 33 projects in Guangyuan, 20 in Jiangyou, 33 in Mianyangand 13 in Deyang have been verified as well-documented projects in the northern Sichuan area. The specific project distribution of the four cities is shown in **Table 2**.

c) Stable transportation infrastructure

The water and land transportation conditions in the north of Sichuan are superior. As an important entrance to Sichuan, Guangyuan goes deep into the hinterland of the central Sichuan through Mianyang and Deyang by water and land routes from the north. The overall terrain of Jiangyou, Mianyang and Deyang is flat, and the transition to the north and east directions is natural and conducive to construction. Besides, there are rolling mountains around as natural barriers, so it has excellent natural construction conditions.

In order to go deep into the Third-line hinterland, the central government first started transportation infrastructure and renovation projects such as railways, highways and waterways, and carried out comprehensive layout and construction by relying on the original infrastructure during the "First and Second Five-Year Plan" period, and through the opening and navigation of important railways, highways and truck stream, various construction bases and factories and mines were connected.

Sichuan-shaanxi Highway (now National Highway 108) is an important passage from Shaanxi-Gansu region to Sichuan, passing through Hanzhong, Shaanxi and going south through Guangyuan and Mianyang to Chengdu, which was originally opened to traffic in February 1937, starting from Zitong. Baocheng Railway runs through Shaanxi, Gansu and Sichuan, starting from Baoji in Shaanxi Province in the north, passing through the Qinling Mountains in the south, passing through Guangyuan, Mianyang and Deyang on the way, and finally reaching Chengdu in Sichuan Province, with a total length of 668.198 km. The railway started construction in 1952, was completed and opened to traffic in 1956, and the whole line was officially opened to traffic on January 1, 1958. In June of the same year, the electrification transformation project was completed. It is the first electrified railway in China (Ni, 2013). Jialing River is one of the main tributaries of the upper reaches of the Yangtze River, originating in the east from Liangshuiquan Gully in the northwest of Fengxian County, Shaanxi Province, originating in the west from Nanchuan of Tianping County, Gansu Province, running through Guangyuan, Langzhong, Nanchong and Guang'an in the central Sichuan Basin from north to south, and empties into the Yangtze River at Chaotianmen Wharf in Chongqing, with a total length of 1119 kilometers. In

Table 2. Statistical table of third-line construction projects in the four cities of North Sichuan (Data source: self-drawn by the author).

Number	Region	Project
1	Guangyuan	Wuzhou Chemical Plant, North Sichuan Electronics Industry Company, State-owned Huachang Machinery Factory, state-owned Liyuan Radio Equipment Factory, state-owned Honglu Machinery Factory, state-owned Changsheng Machinery Factory, state-owned Daming Instrument Factory, state-owned Guangping Machinery Factory, state-owned Tianyuan Machinery Factory, state-owned Jianping Tools Factory, Guangyuan Radio Technical School, 4110 Hospital, state-owned Xuguang Electronic Tube Factory, state-owned Yongxing Radio Equipment Factory, state-owned Jiangling Cable Factory, Jialing River waterway improvement, Hewanchang Gas Field Gathering and Transportation Project, Guangyuan Thermal Power Plant, Ministry of Hydropower, Baozhusi Hydropower Station, Baocheng Railway Luomiazhen to Erlangmiao section of the rerouting project, Baocheng Railway Electrification Transformation Phase II project, 806 material warehouse, Yongchang Chemical Plant, State-owned Peoples Machinery Works, State-owned New Photoelectric Factory, Qingchuan Baishui Sand Gold Mine, state-owned Donghe Printing Company, Dong He Thermal Power Plant, Donghe banknote Printing Factory, Donghe Paper Factory, Donghe Precious Metal Smelter, Treasury, state-owned Wind and Thunder equipment factory
2	Jiangyou	Great Wall Steel Plant, Great Wall Steel Plant 1 Branch, Great Wall Steel Plant 2 Branch, Great Wall Steel Plant 3 branch, Great Wall Steel Plant 4 Branch, Southwest Metal Products Factory, Sichuan 438, Jiangyou Power Plant, Jiangyou Cement Factory, Sichuan Cement Research Institute, Southwest Cement Industrial Design Institute, Sichuan 25, Southwest Meteorological School, Xiaoba Warehouse, Jianye Electric Machinery Repair Factory, Beijing Iron and Steel Institute Sichuan Branch, Baocheng Railway Luomiaozhen to Erlangmiao Section rerouting Project, Sichuan Mining Machinery Factory, Jiangyou Cement Industry Technical School, Sichuan Metallurgical Geological Exploration Company
3	Mianyang	Southwest Branch of Tsinghua University, the Third Sub-branch of the State Administration of Surveying and Mapping, General Warehouse of Logistics Department of the Civil Aviation Administration of China, Advanced Aviation School of Civil Aviation of China, state-owned Fujiang Machinery Plant, State-owned Changhong Machinery Plant State-owned Huafeng Radio Equipment Factory, State-owned Fujiang Wired Power Plant, No. 7 Design Institute of No. 4 Engine Ministry, 440 Workers' Hospital, Southwest Automation Research Institute, Mianyang Institute of Grain Storage Science, Mianyang Grain Machinery Factory, PLA Railway School, Mianyang Pesticide Reserve, National Geographic Surveying and Mapping Library, Southwest Computing Center, China Air Power Test Base, Dongsheng Machinery Factory, Sichuan Institute of Building Materials Industry (Southwest Branch of Tsinghua University), Mianyang School of Building Materials Industry, Sichuan Sewing Needle Factory, Southwest Institute of Applied Magnetism, Dongfang Insulation Materials Factory, State-owned Chaoyang Machinery Factory, Shuguang Machinery Company (Headquarters of the Ninth Institute), Aeronautical Research Institute of Aerodynamics, Southwest Sulfur Research Institute, Low Speed Aerodynamics Institute, Equipment Design and test Institute of Technology, Institute of Ultra-High Speed Aerodynamics, Institute of Engine Research, Institute of Aeronautical Research, Sichuan Institute of Materials and Technology (renamed 907 Institute of China Academy of Engineering Physics in 1988)
4	Deyang	The Second Heavy Machinery Factory, Dongfang Electric Machinery Factory, Dongfang Electric Machinery Factory, Deyang Heavy Machinery Manufacturing School, Deyang Refractory Materials Factory, Deyang Construction Vocational School, Sichuan Glass Fiber Factory, Electrification Engineering Deyang Products Factory, Sichuan Weighing Apparatus Factory, Sichuan Construction Engineering Machinery Factory, Construction Machinery Repair Factory, Construction Machinery Parts Factory, Dongfang Steam Turbine Factory

1966, Jialing River Waterway renovation project was started, and the dredging and maintenance work was completed in 1975.

3) The process of Third-line Construction in North Sichuan

The construction of the Third-line in north Sichuan was consistent with the former Mianyang area. The construction period lasted nearly 20 years from 1964

to 1983, which can be roughly divided into four stages (Due to the difference in the starting time of some projects, the overall end time is slightly different. As for the start time of Third-line Construction, domestic academic generally agree that it started in 1964. As for the deadline, this paper temporarily takes the establishment of Third-line Construction Adjustment and Renovation Planning Office by The State Council on December 3, 1983 as the standard.). The first period was from 1964 to 1969. On January 31, 1964, Mianyang Special Area Support Third-line Construction Office was established. During this period, the main task of construction was to quickly build a large strategic rear base and establish a relatively complete construction system as far as possible. It is mainly under the direct leadership of the central ministries and commissions to transfer the construction of high-precision and top-secret projects, such as national defense, nuclear industry, aerospace and military electronics, safely and quickly. The second period was from 1969 to 1973. Faced with the increasingly tense international situation, the central government requires that while focusing on accelerating agricultural mechanization, a large number of industries such as steel, military, transportation, military and others should be promoted to build firm barriers for national defense and security. During this period, with the instability of the social situation, some confidential and key projects were urgently relocated, such as the relocation of No.9 Institute to Zitong, Mianyang; students and staff of radio, mechanical and metallurgical majors of Tsinghua University were moved to Mianyang to build the Southwest Campus of Tsinghua University, etc. Another part of the ownership of units was changed and transferred to the military. The third period was from 1973 to 1979. Different from the previous construction atmosphere of production, construction and safety, the construction projects in this period began to pay attention to the benefits and development prospects of the enterprise. Instead of developing too many new projects, they mainly turned to enriching and strengthening the construction of the original projects. The fourth period was from 1979 to 1983. On April 5, 1979, the Communist Party of China decided to implement the construction policy of "adjustment, reform, rectification and improvement", and began to prepare for the transformation and upgrading of the Third-line Construction enterprises (Ju, 2021). On December 3, 1983, the central government set up the Third-line Office of The State Council in Southwest China to lead the Third-line Construction adjustment and renovation work. Some enterprises in remote mountainous areas gradually moved to Guangyuan, Deyang, Mianyang and other urban areas. In 1984, the first meeting of adjustment and renovation was held, and the first batch of 121 units was proposed for adjustment and renovation. Among them, 48 units will be relocated and merged, and 15 units will produce military products for civilian use. After this, the mighty Third-line Construction gradually completed the transformation and transformation in the northern Sichuan area, the former Mianyang area and even the whole country, and this large-scale industrial construction adjustment movement guided by war readiness gradually came to an

end (Ni, 2013).

4) The status quo of the Third-line Construction remains in north Sichuan

a) Overview of the Third-line remains in the four cities of northern Sichuan

According to the research data and statistics of the research group where the author works, the remains of Third-line Construction in the former Mianyang area are mainly gathered in Mianyang, Guangyuan, Suining and other places. After site visits to the four cities of Guangyuan, Jiangyou, Mianyang and Deyang, it was found that, except for some factories of Third-line Construction projects, which have been completely preserved and utilized as far as possible or are still in production, most of the remaining factories are in the state of no specific utilization and protection, and some factories have been seriously damaged or even demolished for redevelopment. Figure 2 shows the current situation photos of some factory sites.

In addition to the plant or area and buildings that have been protected, For example, Mianyang Yuejin Road area, Southwest Applied Magnetism Research Institute (the original site is developed as 126 Cultural and creative Industrial Park), Aviation Research Institute Engine Research Institute (planned as cultural and creative park), Dongfang Steam Turbine Factory (the buildings have been protected as national earthquake heritage park and patriotic education base) and Yongchang Chemical Plant (planned to be built into a Third-line characteristic cultural tourism town) have been well preserved. For example, the production areas of state-owned Wind and Thunder Equipment Factory (756 Factory), state-owned Yongxing Radio Equipment Factory (893 factory), state-owned Huachang Machinery Factory (885 factory) and state-owned Changhong Machinery Factory (780 factory) have long been developed as residential areas. In addition, in the factory area with architectural remains, there are buildings and structures that are seriously damaged, abandoned and without owners or leased by others, and the original features are damaged to varying degrees. For example, some buildings of North Sichuan Electronic Industry Company (821 Factory

Figure 2. Photos of the current situation of part of the factory (Source: Photo taken by the author).

of the Second Machinery Department), Chaoyang Machinery Factory, the No.5 and No.10 institutes of the Ninth Research Institute and Dongfang Electric Machinery Factory are seriously damaged. Part of the buildings of Donghe Paper Mill, Donghe thermal Power Plant, state-owned Jiangling Cable Factory (608 factory) and Deyang Refractory Materials Factory were leased for other purposes, and the original features were not well maintained.

b) Distribution of Third-line Construction remains in North Sichuan

Through field visits, it is found that there are 20 remaining factories in Guangyuan, and another 6 have been completely demolished and rebuilt. There are 15 remaining sites in Jiangyou, and one site has been completely demolished. There are 30 remaining factories in Mianyang, and another 15 have been dismantled or are in production. There are 10 actual remains in Deyang, of which 4 are still in production.

In the period of Third-line Construction, the site selection of projects generally follows the guiding ideology of "backing mountains, dispersing and concealment", forming a pattern of dispersing in a large range, gathering in a small range, and distributing near small and medium-sized towns or along traffic arteries or waterways. It is not difficult to find that the existing Third-line Construction sites are mainly clustered in four core areas: Lizhou District, Guangyuan, Jiangyou, Fucheng District, Mianyang, and Jingyang District, Deyang. The surrounding factories are scattered and grouped together, which can still reflect the planning and layout ideas of the Third-line Construction period. Figure 3 shows

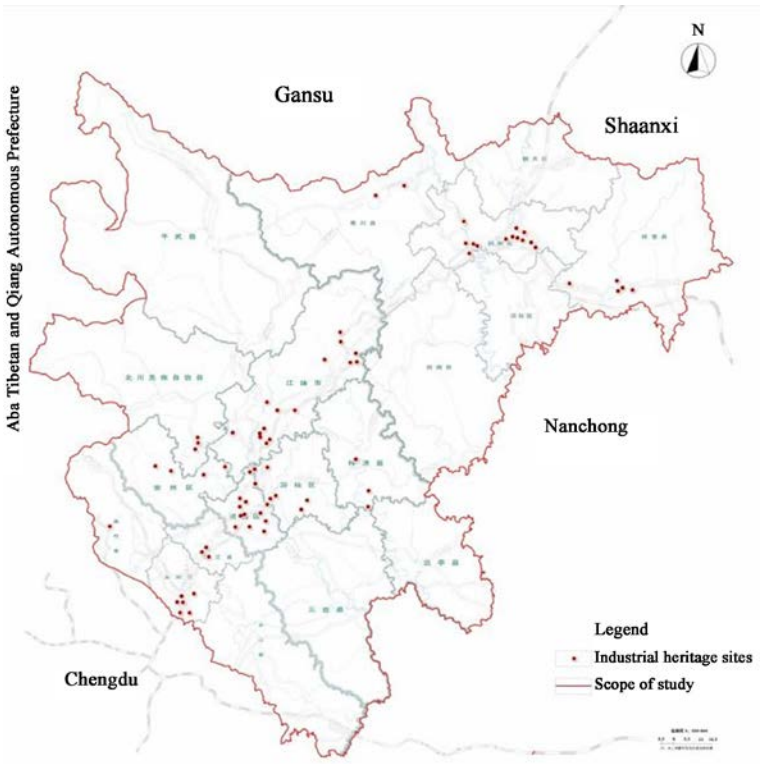


Figure 3. Distribution diagram of the remains of the Third-line Construction in northern Sichuan (Source: self-drawn by the author).

the distribution points of specific projects in the four cities in northern Sichuan.

3. Planning and Layout Characteristics of the Third-Line Construction in North Sichuan

1) On a macro level: "One belt, four cores and multiple groups"

In the planning and layout of the Third-line Construction in the former Mianyang region, three industrial aggregation belts are mainly formed, including Jialing River basin (from Guangyuan south to Nanchong and Chongqing), Fujiang River basin (from Pingwu and Jiangyou southeast to Suining and Tongnan) and Baocheng Railway line. Among them, the layout of the key projects of the Third-line Construction in the north of Sichuan is mainly based on Baocheng Railway as the axis, which gathers in the central areas of the cities along the line and disperses to the suburbs at multiple points, generally maintaining the overall pattern of "one belt, four cores and multiple clusters" (Figure 4 shows a schematic diagram of the pattern).

2) On a meso level: core aggregation and multi-point dispersion

During the Third-line Construction period, project site selection generally followed the guiding ideology of "backing mountains, dispersing and hiding". In order to make intensive use of water, soil resources and raw materials and facilitate unified management and transportation, the distribution characteristics of gathering groups were formed in a small area at the town level. This feature is particularly obvious in Guangyuan and Mianyang. Due to their outstanding

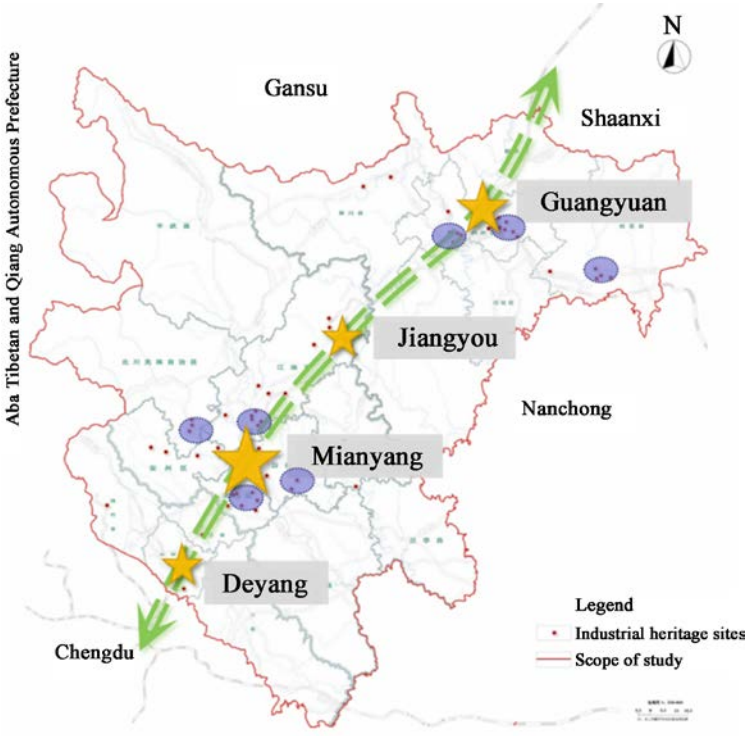


Figure 4. Schematic diagram of the overall layout of the Third-line Construction in northern Sichuan (Data source: self-drawn by the author).

resource reserves, Deyang and Jiangyou have respectively formed two major industrial clusters dominated by heavy machinery, cement and metallurgy.

Guangyuan within the Baocheng railway, Jialing River through the city, rich in water resources, mineral resources. In 1978, Baozhusi Hydropower Station was located in Sanduiba area in the lower reaches of Bailongjiang River, a tributary of Jialing River. In 1966, the first power generating unit was completed in 1998. The project is mainly for power generation, with benefits of flood control and irrigation. Up to now, it has compensated and regulated other hydropower stations in China and provided abundant irrigation water sources in Jialing River and Qujiang River areas. The mineral resources of Guangyuan are mainly refractory clay, coal, fluxing limestone, placer gold, glass quartz sand, silica fume platform, crystalline graphite and shale, which are distributed in Qingchuan, Wangcang, Shizhong District, Chaotian and Yuanba. Proximity to rich mineral resources is also an important consideration for the location of the factory. For example, Wuzhou Chemical Plant (821 Plant of the Second Machinery Department) located in Sandui Town of Lizhou District and Xuguang electronic Tube factory located in Shimizu Commune.

The water systems of river in Mianyang are all injected into Jialingjiang River via Fuljiang River, Bailongjiang River and Xihe River. Fujiang River is the main river in the city, and its tributaries include Zitong River, Anchang River and Pingtong River, etc. There are abundant mineral reserves in Pingwu, for example, manganese ore in Pingwu, sand for casting and shale for cement mixing in Jiangyou rank first in the province. Regially, Pingwu is dominated by metal minerals, Jiangyou is dominated by rock and soil minerals, and Fucheng and Youxian are dominated by shale, sand and so on. Abundant local mineral resources, water resources and the inflow of human resourses haved enabled Mianyang to obtain favorable conditions for enterprise factory construction. In 1957, Jiangyou Cement Plant was put into operation. From 1965 to 1966, Southwest Cement Industry Design Institute and Sichuan Cement Research Institute were put into operation successively. In 1968, Dongfang Insulation Materials Factory was built in Fucheng District, Mianyang. In 1969, Sichuan Institute of Materials and Technology (No. 903 Factory of the Second Machinery Department, which became 907 Institute of China Academy of Engineering Physics) was located in Pingwu Xiangyan Commune for construction .**Figure 5** shows a schematic diagram of the group.

3) On a micro level: changes in accordance with the terrain

Due to the particularity of the construction background of Third-line industry, Third-line enterprises are different from the factory construction in other periods. Most of the factory sites are located in the mountains and suburbs which are not suitable for development and construction and gradually develop into a relatively perfect production and living system. These sites are basically located in the mountains and into the ditch, far away from the existing cities, occupying less farmland and avoiding high-yield fields as far as possible. Therefore,

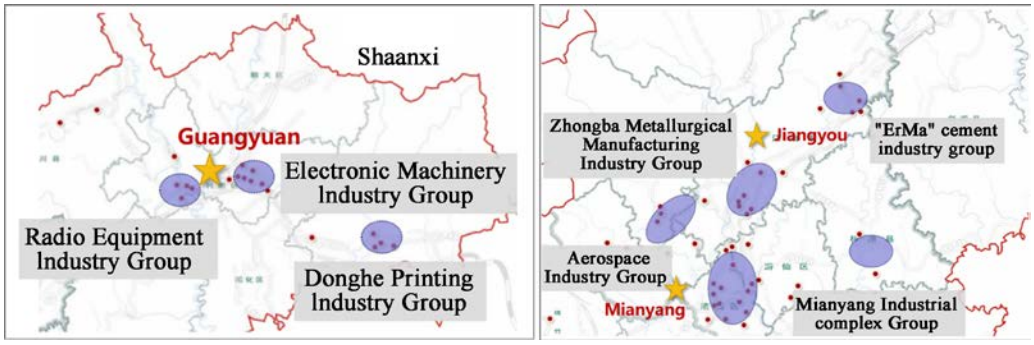


Figure 5. Distribution diagram of Third-line industrial clusters in Guangzhou-Mianyang (Source: self-drawn by the author).

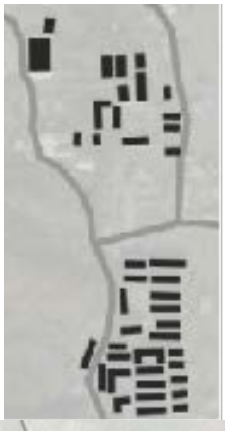
the factory site construction is often separated from the development of the surrounding society to some extent.

Through the analysis of the surveyed factories, it is found that the spatial layout of the Third-line factories in north Sichuan mainly has the following characteristics: First, the layout of the factories is based on the terrain and arranged according to the different trends in different places. Due to the urgent construction time and limited conditions, the construction of the factory in this period embodies the integrated development of human industrial civilization and the natural environment. Through constantly adapting to the terrain and terrain conditions, built Spaces with similar styles but different patterns were formed in different places. Generally speaking, the spatial layout of the Third-line factory in north Sichuan can be divided into three kinds: serial, parallel and group. The second is that the site selection of the factory closely conforms to the guideline of "mountains, scattered areas and caves". Although it is isolated from the surrounding areas to some extent, the overall style of the factory is consistent with the surrounding areas. The form is relatively free and the building height is coordinated with the surrounding houses and terrain, which can meet the needs of concealed construction on the whole. Third, due to the influence and restriction of social environment, economic conditions, construction level and other factors, most of the early-built factories are mainly built with brick and wood structure, and the construction quality is poor. In the middle and late period, the construction style is improved and changed. Table 3 shows the classification table of the plane layout types in the region.

4) Influence on the pattern of urban development in northern Sichuan

The Third-line Construction lasted nearly 20 years, and the construction projects spread all over the country, which promoted the establishment and expansion of the industrial base in the central and western regions, especially in Sichuan, promoted the development and rise of modern industries in Sichuan, and profoundly influenced the formation and evolution of the urban pattern in Sichuan. Under the unified deployment of the central government, most of the Third-line Construction projects in Sichuan are distributed along the main railway lines and rivers. As an important investment site of the Third-line Construction in

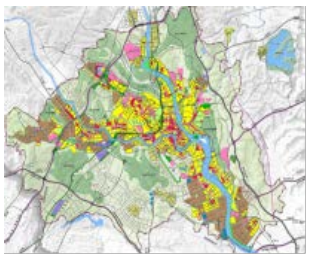
Table 3. Factory configuration, layout and Types (Source: self-drawn by the author).

Pattern of layout	Feature	Legend	Represent enterprises
In series	Factory buildings mainly depend on the terrain and are often found in areas or platforms with steep terrain and more hills. The functional area in the factory is usually connected by the public service area between the production area and the residential area, but the internal buildings are relatively clustered, which is conducive to communication. The overall pattern is parallel to the contour line or consistent with the terrain.		State-owned Tianyuan Machinery Factory, state-owned Changsheng Machinery Factory, the Sixth Institute of Nine Yuan
Parallel	The factory buildings are mainly built in narrow terrain areas considering the topographic factors. Compared with the tandem layout, the traffic time between functional areas is intensified. There are many factors causing this layout, such as strict lighting requirements or the lack of large, smooth and available construction land.	 	Huachang Machinery Factory, Guangming wireless power plant, Donghe Printing company headquarters, Deyang refractory materials Factory
Group	It is often found in hilly valley or basin terrain. Due to the relatively small and concentrated scope of construction land, it is necessary to adopt the overall aggregation type cluster or separate cluster for construction. This combination method often combines or completely separates functional areas. The two layout modes have their own advantages and disadvantages, but generally speaking, they can obtain a relatively complete and safe factory space.	 	North Sichuan Electronics Industry Company, Southwest Institute of Applied Magnetism, Deyang No. 2 Heavy Machinery Factory

Sichuan, the urban layout and structure of the four cities in northern Sichuan are also deeply affected by the planning and layout of the Third-line Construction. See Table 4 for details of the development pattern map and characteristics of the four cities.

The Third-line Construction has promoted the agglomeration and development of cities in northern Sichuan, and promoted the expansion of urban scale from the central region to the surrounding siphon. Take Mianyang City as an example, in 1952, Mianyang Zone (It has jurisdiction over Mianyang, Changming, Zitong, Luojiang, Deyang, Guanghan, Jintang (in Zhao Town), Shifang (in Fangting Town), Mianzhu, An County and other 10 counties.) was established,

Table 4. Urban development pattern of the four cities in northern Sichuan (Source: Self-drawn by the author).

City	Characteristics	Urban pattern
Guangyuan	Relying on Baocheng Railway and Jialing River as the development axis, Guangyuan focuses on developing the urban development belt in the central valley as the development axis of the city's industrial, population and urban core agglomeration, forming a development pattern of "one heart and two wings"	
Jiangyou	Relying on Baocheng Railway and Fujiang River, Jiangyou formed the urban pattern of "one belt and two pieces", and the urban space expanded to the north and south relying on Fujiang River	
Mianyang	The Baocheng Railway and the Fujiang River pass through the city, dividing Mianyang into three blocks. Influenced by the topography of high northwest and low southeast with many hills, Mianyang has formed an urban development pattern of "one heart, two axes and multiple cores"	
Deyang	In Deyang, the Tuojiang and Fujiang rivers flow through and Longquan Mountain and Longmen Mountain cluster together, forming an urban pattern of "one core, two corridors and many groups"	

until the implementation of the "First Five-Year Plan", on March 10, 1953, Guangyuan (in Jialing Town), Wangcang (in Fengjiaba), Jiange, Jiangyou, Beichuan, Pingwu, Qingchuan, Zhaohua (in Baolan Town) and other 8 counties were divided into Mianyang Zone, Mianyang District has jurisdiction over 18 counties. After entering the third line construction, Mianyang special area (After two adjustments on October 18, 1958 and March 22, 1959 (Suining, Santai, Pengxi, Yanting, Tongnan, Shehong (in Taihe Town), Zhongjiang; in 1959, Zhaohua County into Guangyuan County and Deyang County), Mianyang Zone has 19 counties.) was renamed Mianyang area. On February 4, 1976, Mianyang County established Mianyang City, the leader of Mianyang area, Mianyang area, with jurisdiction over 1 city and 19 counties. In addition, the population and regional scale of Deyang, Jiangyou and Guangyuan continue to expand, and they have initially reached the basic conditions for building the city in 1983, 1988 and 1985 (Zhou, 2014).

The Third-line Construction has promoted the consolidation and upgrading of the urban industrial foundation in northern Sichuan, and laid a solid foundation for the economic and social development and construction in northern Sichuan. During the Third-line Construction period, most construction projects in Sichuan Province were centralized based on the original industrial and urban development foundation. In the large-scale construction process of nearly 20 years, Sichuan industry gradually formed a pattern of four industrial areas, among which the northern Sichuan area formed an industrial base mainly dominated by aviation, electronics, machinery and nuclear industry (Cui, 2015). Thus stimulating the rapid economic development and population flow of the region. In addition, as the Third-line Construction focuses on national defense, energy materials, electronic machinery and other fields, it also promotes the formation and transformation of urban functions and pillar industries in north Sichuan and even the whole Sichuan region to a certain extent. At the same time, the city intensified efforts to develop modern industry, effectively promoted the balance of regional economic development and the expansion of urban construction scale, and improved the overall regional comprehensive strength.

4. Preservation and Utilization of the Remains of the Third-Line Construction in Northern Sichuan

1) The state of the remaining parts of the factory

After the adjustment and transformation of Third-line Construction in 1983, construction projects in Sichuan Province underwent transformation and upgrading or relocation, and most of the factories were left idle today (see **Table 5** for a list of the current situation of the factory area in this area). Due to the rapid transformation of the city, these factories in the countryside and mountains no longer provide production and living services for the urban development. In addition to the continuous use of a small amount of living space, a large number of Third-line industrial remains are inefficient or even abandoned, and the valuable Third-line industrial remains are at risk of loss and fading away.

Table 5. Overview of some remains of the construction of the third line in northern Sichuan (Source: the author changes according to the data).

Factory name	The status quo	Protection situation	Position	Existing state
Fujiang Machine Factory	It was converted into a company in 1995, and most of the buildings are well preserved	Included in the protection scope of historical and cultural blocks	Fucheng District, Mianyang City	Abandoned
Changhong Machine Factory	Some of the buildings are well preserved	Included in the protection scope of historical and cultural blocks	Fucheng District, Mianyang City	Abandoned
Chaoyang machinery factory	Bankbankrupt in 2003, most of the buildings are well preserved and included in the planning project	It has been included in the list of historic protected buildings	Youxian District, Mianyang City	Abandoned
Dawn machinery company	Transformed into a scenic spot	It has been included in the list of historic protected buildings	Zitong County, Mianyang City	development and utilization
Tsinghua University Southwest Branch	The original site was converted into other schools, and most of the buildings are well preserved and still in use	It has been included in the list of historic protected buildings	Fucheng District, Mianyang City	in use
Southwest Metal Products Factory	Bankrupt in 2003, most of the building is well preserved	unprotected	Jiangyou City, Mianyang City	Abandoned
Great Wall Steel Mill Second Branch	In 2004, it was acquired and converted into a company, and in 2018, it was transferred to the government for demolition and new construction	unprotected	Jiangyou City, Mianyang City	Demolition and reconstruction
Great Wall Steel Mill Fourth Branch	In 2004, it was acquired and rebuilt into a company and is in production	unprotected	Jiangyou City, Mianyang City	in use
Jiangyou cement plant	Restructured into a company in 1998, most of the buildings are well preserved, some buildings have been renovated and are now in production	unprotected	Jiangyou City, Mianyang City	Demolition and reconstruction
Second Heavy Machinery Plant	The factory is in production, and the internal buildings and machinery and equipment are gradually replaced and updated during production	Some buildings are included in the protection list of historic buildings	Jingyang District, Deyang City	in use
Dongfang Electric Factory	The factory is in the process of shutting down, most of the buildings in the production area have been demolished and destroyed, and the living area buildings are well preserved	unprotected	Jingyang District, Deyang City	Abandoned
Deyang Refractory Factory	The factory is out of production, the production area buildings are leased out, and most of the living area buildings are demolished	unprotected	Jingyang District, Deyang City	Abandoned
Oriental Steam Turbine Factory	After the 2008 earthquake, the original site was preserved as a national earthquake site	Protection as a national earthquake site park	Mianzhu City, Deyang City	development and utilization

Continued

Sichuan fiberglass factory	The enterprise was restructured into a company, the factory was in production, and the internal buildings and machinery and equipment were gradually replaced and updated in the production	unprotected	Luojiang District, Deyang City	in use
Five continents chemical plant	The factory is in production, and the internal buildings and machinery are gradually replaced and updated during production	unprotected	Lizhou District, Guangyuan City	in use
Chuanbei Electronic Industry Company	The factory is in the process of shutdown, the buildings in the production area are abandoned, and the buildings in the living area are well preserved	unprotected	Lizhou District, Guangyuan City	Abandoned
Guangming Radio Equipment Factory	The factory is in the process of stopping, and the buildings in the production area are leased out, and some of them are seriously damaged; The service buildings in the living area are abandoned and seriously damaged; It has been included in the planning of third-tier cultural and creative industry parks by the government	It has been planned as a third-line cultural and creative park	Lizhou District, Guangyuan City	development and utilization
Headquarters of East River Printing Company	The factory production area buildings and office buildings have been demolished and developed; The service buildings in the living area are abandoned	Is being demolished for development	Wangcang County, Guangyuan City	Has been dismantled
East River Paper Mill	The factory is in the process of shutting down, some buildings in the production area are leased out, and the service buildings in the living area are abandoned	unprotected	Wangcang County, Guangyuan City	Abandoned

Due to a series of unclear industrial ownership and development mode problems brought by the relocation and production suspension of enterprises, a large number of factory building remains have been neglected, and even the planning and construction schemes have been ignored. As a result, the construction remains of Third-line projects lack attention, and their utilization value is difficult to get due protection and development. In addition, as a large number of factories are located in the suburbs or even the countryside, the quality of the living environment here is generally low, the traffic conditions are backward, and the regional economic development is unbalanced, which also leads to great challenges for the subsequent survival and development of the Third-line Construction remnants.

2) Protection and utilization

The Third-line Construction has not only laid a certain social, material and economic foundation for our socialist construction, but also left us a lot of physical heritage and precious Third-line spiritual culture. The identification and protection of industrial heritage value has always been a problem that the aca-

demic circles pay more attention to. The protection and development of industrial heritage is a long-term and systematic project. The protection and utilization of industrial heritage in China is still in the pioneering stage.

The value of industrial heritage development should be from the material and non-material value to consider, currently can heritage, heritage contains material, non-material value complete protection and use development case is relatively lack, many places focus on building legacy and enterprise products, despise machinery and equipment, production process and technology, or only the "spirit" route, let the construction, equipment and other material remains disappear. Current for industrial heritage value protection utilization has had some more mature development mode, such as the construction of industrial museum, development theme tourism town or cultural park, legacy building space, reuse and shooting related documentary and film and television works, the industrial heritage value protection has played a positive role, and three line construction industrial heritage as special cultural background, form characteristics is unique kind of industrial heritage, its protection and utilization development needs more detailed classification, stratification, need a long-term and stable research process.

5. Conclusion

The development of the Third-line Construction has not only laid a solid foundation for China's national defense construction and economic construction, but also accelerated the formation of a modern urban pattern, but also left us with a series of precious spiritual wealth. In the rapid development of social economy and the transformation of urban construction, it is necessary to understand, study and disseminate the achievements of the three-line construction in a more comprehensive way. In addition, making better use of the precious wealth left over from the three-line construction is a classic problem that cannot be bypassed. Studying the history of the three-line construction, mining the historical value of the relics, and selectively protecting and reusing the relics are also the most important and fundamental pursuit of the current research. Making the past and stagnant culture, architecture and memories alive and moving will also provide different thinking perspectives and development direction for today's social and economic development.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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