Research on the Urban Ecological Space Changes under Modern Passive Industrialization Case Study of Zhengzhou City in China

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Abstract Early in the communist era, many cities in modern China experienced a special period of passive industrialization during which the construction of urban spaces laid the spatial urban foundation. During this period, the city construction was carried out rapidly under the administrative intervention of the government. The passive industrialization caused by taking economic construction as the center made the city construction deviate from the correct track and resulted in a variety of problems. Focusing on ecological space change, this paper selects Zhengzhou as an example of many similar cities in China, and analyzes the impact of passive industrialization on urban ecological spaces from the perspectives of city scale, city layout and city construction management system. The analysis results reveal that the construction of urban ecological space under the influence of passive industrialization induced a lagging characteristic, led to insufficient integrity of urban ecological space, and placed great pressure on the urban environment. Finally, the paper puts forward some methods to optimize the urban ecological space.

Keywords: Passive industrialization, Zhengzhou city, urban ecological space, Changes, modern China

1. INTRODUCTION

1.1 The passive industrialization of Zhengzhou city

Zhengzhou City, the capital of Henan Province, located in the north of central Henan Province, east longitude 112°42’~114°14’, north latitude 34°16’~34°58’, north to the Yellow River, west to Songshan Mountain; and southeast to the vast Huang Huai Plain (Fig.1). As one of the earliest cities recorded in China, the urban construction history in Zhengzhou can be traced back to the Shang Dynasty about 3,500 years ago. In the similar construction cities, especially in modern development process, Zhengzhou City’s planning and construction process has strong representation. In a few decades, it has rapidly developed from a small county to a national central city. After the reform and opening up, it has experienced a period of rapid urban expansion. In particular, after 2000, they built a new urban area larger than the original urban area in the eastern part of the city. The rapid development of the urban spatial change process is full of contradictions and conflicts. In this process, passive industrialization has a great impact on the development of Zhengzhou city, especially on the ecological foundation of urban space construction.

The connotation of passive industrialization of Zhengzhou means that the industrialization of the city in the 1950s was not the result of gradual development under the action of market rules, but realized rapid growth through the construction of large-scale national industrial projects. Passive industrialization often involves the rapid establishment of large-scale industrial bases under the intervention of the administration to deepen the industrial level (WU L, 2003). The urban expansion can be realized rapidly without conforming to certain development laws. Cities have shown a mutant and rapid development characteristic. This is also the case in the industrialization of...
Zhengzhou in the 1950s. The effect of market rules on industrial development was not obvious and the construction of large-scale industrial projects designated by the state improved the industrial level of Zhengzhou rapidly.

Zhengzhou city, as early as the 1920s and 1930s, had formed a cotton-trading center based on its convenient railway transportation and built the largest cotton textile industry system (ZHU J, 2009). In 1953, the first year of China’s first Five-Year plan, Chairman Mao Zedong chaired the National Conference on Finance and Economics. In discussing the development of the textile industry, he agreed with the analysis put forward by the Ministry of Textile Industry and believed that the development of the textile industry proposed in planning could be larger, which proposed the development target of 3 million ingots (Shi Po, 2005). At this meeting, the Central People’s Government decided to develop textile industry bases simultaneously in Beijing, Xi’an, Zhengzhou, and Shijiazhuang along the Beijing-Guangzhou line and near the cotton-producing areas.

In 1952, the Henan Provincial Government decided to move the provincial capital from Kaifeng city to Zhengzhou City (Xie X, 2011), where the industrial system urgently needed to be upgraded to meet the functional needs as the provincial capital. In this way, the passive industrialization of Zhengzhou, which was still a small county at that time, slowly commenced.

1.2 Research scope and purpose

The essence of urban passive industrialization is the imbalance of urban development law under the intervention of the state or government. This paper takes the modern passive industrialization period of Zhengzhou city construction as the time scope and space scope respectively, takes ecological space as a starting point to study the change of urban ecological space under the passive industrialization, tries to explore the change mechanism and provides theoretical reference for the optimization of urban ecological space by the government behavior of urban construction under the market economy system.

2. THEORETICAL BACKGROUND

In the period of modern passive industrialization, China’s urban planning and construction theory possessed distinctive characteristics of the times, mainly in the following three aspects.

The first is the Soviet urban planning theory model, the most prominent feature of which was strict urban functional zoning, namely the separation of industrial areas from residential areas (Hua L. 2006). In the 1950s and 1960s, the Soviet Union improved the method of urban planning and design, including the establishment of a hierarchical system of residential cultural life service systems, and the establishment of comprehensive industrial residential areas and residential area structures (Zhu W. 1990).

The Soviet urban planning model had traces of formalism prevalent in the Soviet Union. Although the urban green space in the Soviet model plan presented the characteristics of network division, the nodes and corridors of the green space system network were not clear. The scale of green space was large and the distribution of green space in a specific area was relatively concentrated. There was no secondary green space system network in smaller-scale construction land. This green space system has obvious characteristics of pursuing the plane effect. Without reserving public green spaces in small-scale plots, the public urban green space system presented a large service radius and low network density.

The second is the urban construction and management theory under the planned economy system. Urban planning under the planned economic system organizes and arranges the functions of urban construction land according to the needs of urban economic development, and abandons the optimization principles that urban planning disciplines should follow in the allocation of urban land resources (Zhou A, Hu J. 1995). Meeting the needs of economic development has become the primary principle for the functional arrangement of urban construction land, while social and ecological issues have not been the central focus for urban decision makers. Therefore, even if the urban ecological space is reserved at the planning level, due to the economic standard theory of the decision maker, ecological efficiency cannot be exerted.

The third is the idea of socialist city construction. The primary
task of socialist urban construction is socialist industrialization. The construction of urban factories, communities, etc. is carried out in a classical axisymmetric layout to reflect the grandeur of socialism. The factory residential area adopts the Soviet-style surrounding enclosure method to form a homogeneous road grid and residential building texture (Wu Y, Zheng X. 2018). This construction theory renders any diversity of urban space impossible.

Judging from the widely implemented urban planning theories, the prominent features of urban planning and construction had strong formalism, poor integrity, and a lack of details under modern passive industrialization.

3. URBAN EXPANSION AND URBAN ECOLOGICAL SPACE

3.1. Urban expansion and pressure of urban ecology

In 1953, as the new provincial capital city and the country’s cotton textile base, Zhengzhou began large-scale industrial construction (Yang J, 2008). Especially before 1960, most of China’s large-scale industries were built with the help of the Soviet Union. As the pillar industry, the construction of Zhengzhou city’s textile industry was completed from planning to construction with the help of the Soviet Union. Five large textile factories were built in five years, and some public service facilities were provided (Cui W, 2006). The area of the textile base exceeded the area of the original urban area of Zhengzhou. The construction of other large-scale heavy and light industries also led to the rapid expansion of the urban area of Zhengzhou.

The built-up area in Zhengzhou city was only 5.23 square kilometers when Zhengzhou was liberated in 1948, with a population of about 165,000. At the end of the first Five-Year Plan, the city’s built-up area increased to 40.3 square kilometers, and its population increased to 455,000 (CCZLC, 1997). Zhengzhou’s short-term passive industrialization largely triggered these increases.

However, this urban expansion is not as simple as the numbers show. The driving force of urban expansion under passive industrialization lay in the construction of the industrial system under administrative intervention, which had the characteristics of fast construction and strong symbolic significance. With sufficient funds, land, technology and equipment via Soviet aid and state investment, Zhengzhou city quickly established an industrial area that exceeded the original urban area on the city periphery. The resulting rapid increase in population density had clear pressure on the environment. The enlarged urban population increased the resource demand on the urban ecological environment, such as forest and water, to meet their survival and development (Zhang X, 2017).

The city’s passive expansion based on the construction of industrial zones differs from the organic growth of scale in the process of urban development. The urban area that grows under the influence of its own internal driving force has comprehensive characteristics. Residential, industrial, ecological, and transportation can maintain stable and balanced growth in the organic growth of the city. In the process of passive industrialization, large-scale industrial zones can quickly complete site selection and construction under the influence of the administration. According to the meaning of habitat, a specific community can adapt to a specific environment, thus ensuring the stability of the ecosystem in the area (P. R. Krausman, 1999). The various facilities cannot quickly meet the needs of newly added urban areas. In particular, the newly built artificial ecological environment cannot achieve a stable state through the coupling process with various types of urban construction within a certain period, which raises ecological problems that the rapid expansion of urban scale must face.

Although the industrial zones formed by passive industrialization provided some functions of residence, education, commerce, and ecology in the city, the proportion of industrial land was relatively large. This directly increased the proportion of the lands that can quickly produce urban pollution sources, thus increasing the pressure on the urban ecological environment. If urban environmental protection infrastructure cannot rapidly eliminate new pollutants, urban ecological problems will certainly be affected.

3.2. Adaptability adjustment of urban ecological space

Fig. 2 shows that the urban population of Zhengzhou city increased steadily and rapidly, especially during the period from the beginning of passive industrialization in 1953 to 1960 when the average annual growth rate of urban population reached 12.5%. The changing trend of urban construction investment reveals that the annual investment amount varied and the change is too large. Reflected in urban construction, the increase in urban construction in different years has different carrying capacity for the urban population in the same year. This process does not exclude the inability of new urban construction to adapt to the increase of urban population. Taking into account
the investment of large-scale urban infrastructure such as water works in unit years, after eliminating the data of years of excessive investment in urban construction, it is found that the growth rate of investment in urban construction is lower than that of the urban population, and the contradiction between urban construction and population growth remains.

The construction of the main public service facilities in the city also shows a lagging characteristic, which starts after the rapid increase of the urban population reaches a certain level. This reflects that the rapid increase of the urban population has brought certain pressure to the urban environment, thus promoting the passive adaptive change of the urban environment. The space construction conducive to urban ecological environmental protection could not adapt to the expansion speed of urban space. This lag in space construction was not fully considered in the rapidly expanding space, and the land reservation and construction time series were not reasonably arranged. The urban lagging constructed ecological space cannot form an organic and unified whole with the rapidly expanding space. The ecological space and the industrial space are relatively independent, which inevitably reduces the ability to maintain the urban ecological environment. Due to the absence of any comprehensive and systematic understanding of the characteristics and patterns of green spaces, the urban master plan does not take into account the important role of the green space system in an urban environment (Wang X, 2009). Green space resources in urban expansion areas are almost occupied by construction land, resulting in the inability of artificial ecological space to rapidly form an ecological network. The urban ecological space is only scattered across the city. The flows of material and energy in the ecosystem are hindered by the urban space, and the urban ecological stability cannot be guaranteed.

Combined with the park green space construction data of the city at that time, as of 1965, there were only three large park green spaces in Zhengzhou city, with a total area of 102 hectares. The per capita park green area was restricted to a low level of 1.6 square meters (CCZLC, 1997). The upstream and downstream industries of the leading industries were well configured as close together as possible to facilitate collaborative production among enterprises. Under the industrial priority construction concept, each

4. INDUSTRIAL LAYOUT AND ITS IMPACT ON URBAN ECOLOGICAL SPACE

4.1. Principles of industrial construction

In the context of the need to rapidly develop urban industries, Zhengzhou’s industrial construction showed distinct characteristics of the times. First, following the principle of completeness, leading industries and related upstream and downstream industries were concentrated in urban construction. Second, following the principle of industrial priority, the location and layout of industrial zones were premised on the convenience of industrial production.

Since 1953, Zhengzhou has successively built five industrial concentration areas relying on the various freight stations of the Longhai Railway and the Beijing-Guangzhou Railway.

In 1958, the state built the Zhengzhou Printing and Dyeing Plant on the west side of the textile factory concentration area to carry out deep processing of the textile factory grey cloth. In the same year, Henan Textile Machinery Factory and Henan First Textile Equipment Factory were built to deal with the production and maintenance of textile industry equipment. In order to accelerate the cultivation of cotton textile talents, Zhengzhou textile industrial school was founded in 1953, Henna First Textile Workers Technical School was founded in 1955, and Henna Textile Cadre School was established in 1956. By 1959, a textile industrial zone covering an area of about 6.7 million square meters was formed in the western suburbs of Zhengzhou, with 33,124 employees (CCZLC, 1997). The upstream and downstream industries of the leading industries were well configured as close together as possible to facilitate collaborative production among enterprises.

Under the industrial priority construction concept, each
The industrial zone was preferentially located close to a railway station. If this was impossible, an enterprise special railway line was constructed to link the factories to the railway network.

The city government also provided more convenience for the construction of enterprises. In particular, in terms of land supply, enterprises were provided with enough land to build factories and living facilities. As the distance between the units of the enterprise was minimized, all kinds of facilities of most enterprises could be constructed in only one site.

4.2. Changes of urban ecological space

As far as the layout characteristics of industrial zones are concerned, all industrial zones were formed based on railways. The layout of the industrial zones blindly pursued the convenience of transportation without considering the impact on the urban environment. The large industrial area was located in the northwest of the city, which is in the city's prevailing upwind direction, so that air pollution from the industry was mainly diluted and diffused through wind (Duan D, Tian, T, 2011). Many pollutants were directly diffused into the urban environment without any disintegration ability. The layout of the industrial area that pursued transportation advantages did not consider the natural water system and other factors that could improve the urban ecological environment. In the region, the discharge of pollutants from industrial production seriously affected the natural ecological resources of the city.

Industrial zone construction models also had certain similarities. Industrial enterprises were arranged around railway stations and connected with the national railway network through special railway lines to facilitate the transportation of raw materials and products. However, many railway dedicated lines intersect with urban roads horizontally, causing barriers to urban traffic and ecological corridors, which directly fragmented the habitat patches, reduced the habitat area, increased the marginal effect and reduced the species habitat area (Xu L, 2015). Horizontal intersections between railways and urban roads are liable to cause traffic interruptions and reduce road capacity. Due to the technical requirements of railways, urban roads often form longitudinal slopes at level crossings, and the resulting acceleration and deceleration of vehicles on longitudinal slopes increases energy consumption and pollutant emissions (Jiang D, 2010). The blockage of the ecological corridors by the railways also partially hindered the free flow of biological resources, which was not conducive to the maintenance of urban ecosystem balance.

In the early days of urban expansion, Zhengzhou city set up large-scale industrial areas near the city center. Although these industrial areas were in the suburbs, the urban planning ignored the scale expansion brought about by urban development. Because of the minimized distance between the industrial area and the city center, these industrial areas were easily integrated into the city's central area during the city's development and even surrounded by other urban functional areas. Upon the later development of Zhengzhou city, the industrial zones
established in the early days of urban expansion were fully integrated with the urban areas after decades of development. Because of their high pollution and high-energy consumption, the local government had to take more measures to offset the urban environmental problems caused by the high mixing of large-scale industrial land and cities.

Meanwhile, the government had to spend much money to realize the land relocations of the industrial areas within the urban areas through the replacement of land function. From this perspective, because of the lack of pre-judgment of urban development, the layout of the urban industrial zones limited the city development, including the expansion of the city scale and the maintenance of the ecological environment.

The construction process of the Zhengzhou Textile Industrial Zone exhibits two main characteristics: rapid construction speed and excessive concentration of industrial layout. First, the five textile factories in Zhengzhou city were built in five years from 1953 to 1957. All kinds of supporting machinery factories and schools that train textile talents were rapidly built and operated, leading to a rapid increase in the urban population, which placed tremendous pressure on the urban areas where infrastructure had not been completed. The newly built urban area had to undergo a period of mutual adaptation and integration between humans and the natural environment. Such rapid growth in urban population and area could not fully adopt humans and the natural environment, leading to conflicts between humans and the natural environment during the operation of the industrial zones. In the social context of "people are determined to beat nature", people certainly reconstructed the urban environment to ensure their survival by destroying the original structure of the natural environment, leading to the inevitable destruction of the natural environment.

The second characteristic is the excessive concentration of industrial layout. The layout of industrial lands was based on the principle of giving full play to the advantages of Zhengzhou's railway transportation. It laid various industrial enterprises out along the railway lines and around the railway stations, thereby forming concentrated industrial zones covering nearly half of the city area. Therefore, the industrial production activities in Zhengzhou city were concentrated, and more pollution emissions resulted in the relative concentration of industrial pollutants (CCZLC, 1997). Under the technological level and attitude towards the ecological environment at that time, the pollutants emitted by factories could not be completely purified. The comprehensive harm arising from the accumulation of various pollutants to the urban ecological environment was far greater than the simple addition of several hazards.

Compared with the scattered industrial layout, the highly concentrated industrial area reduced the amount of surrounding ecological green space and increased the time and distance between the pollution source and the peripheral ecological green space, which is not conducive to the decomposition of pollutants by the ecosystem.

5. IMPACT OF INDEPENDENT INDUSTRIAL ZONES ON URBAN ECOLOGICAL SPACE

In the planned economy era, State-owned enterprises usually had a certain administrative level. Even the administrative level of some large-scale enterprise leaders was higher than that of the government leaders in the regions where the industry was located. This partially weakened the government's management of enterprises and strengthened the corporate self-management authority. Under this administrative system, industrial enterprises had a relatively high independence, which was reflected in two ways: the relative independence of functions, and the relative independence of construction and management mechanisms.

5.1. Relatively independent functions of industrial enterprises

The textile industry zone, built under the direct guidance of Soviet experts, adopted the layout pattern of the factory and its adjacent and affiliated residential area. Enterprises had both...
industrial production functions and urban residents’ living functions. The residential area was close to the factory, and workers’ commuting was only required to be completed in the same factory unit. Each factory and school in the industrial area had its own resident management organization and housing and living security agency. It also equipped employees with kindergartens, elementary schools, other educational facilities, and all kinds of sports facilities (Cui W, 2016). These industrial zones were organized according to the principle of production cooperation and formed production cooperation between different industrial enterprises (Wu M, 1980). The products produced by various machinery factories and raw material factories could also be sold in the textile industry area, and the teaching activities and practical activities of textile specialized schools could be completed only in the industrial zone. The raw materials and products of textile mills could be transported directly through the railway special line in the industrial area. The textile industrial zone was actually a fully functional and dedicated urban unit. Residents in the industrial zone could easily complete work, residence, life, and education without even requiring any interaction with other parts of the city.

The communication between industrial zones and other city areas was maintained at a lower level. The complete industrial production and residential functions in the industrial zone reduced the urban traffic volume induced by the Soviet urban planning mode of separating residential land and industrial land. It reduced energy consumption and emissions somewhat, and reduced the damage to the urban ecological environment caused by workers commuting.

However, this relatively independent and complete function of industrial enterprises also partially hindered the realization of the city's integrity, including the integrity of public service facilities, infrastructure, and even the overall control of urban planning and management departments in the city's construction and development. Urban ecological resources could not be effectively and systematically planned and allocated to improve the urban space's ecological performance. Urban sewage treatment facilities could not be coordinated and planned from the whole city level to reduce the damage of pollutant emissions to the urban ecological environment. These independent industrial enterprises brought disadvantages to the protection and optimization of the urban ecological environment.

5.2. Independence of construction and management mechanism

The government provided construction land for enterprises through free allocation. Lacking experience, urban planning departments tried their best to meet the needs of enterprises without restriction (Hua L, 2006). For the purpose of cost reduction, under the guidance of the Soviet model, all cotton mills were constructed in accordance with the same planning drawings (Shi P, 2005). The construction project did not consider the difference between the land use conditions and its surrounding environment. Due to the abundance of construction land, the buildings' layout in factory areas was not very compact, and it reserved a large amount of unused land. There was even a case where the internal living area of the same industrial enterprise was larger than the factory area, such as the living area of the First Cotton Mill covers about 30 hectares while the factory area covers only about 23 hectares. The construction of the supporting residential area also adopted the typical Soviet-style layout model. In abolishing the remains of capitalism and feudalism, the concept of ‘public’ became a new focus for urban builders. The urban residential buildings appeared in the form of courtyards, and the courtyard space of appropriate scale was formed through the enclosure of individual buildings, which facilitated neighborhood communication and organized small-scale public activities (Ma N, 2017). These industrial enterprises built large courtyards through the enclosure of several buildings. Even in the middle of some courtyards, new multi-storey residential buildings
were built in later times. There were too many buildings around a yard facing east and west, which did not take into account the buildings' sun lighting needs in northern China. The buildings were mostly 3- to 4-story town houses, with a very low building volume ratio. The small building density caused the residential area to occupy an excessively large area, which directly led to the urban construction land occupying the ecological green space around the city. This is the main reason for the rapid expansion of the city.

This low-rise building model was adopted because of the construction technology and worship of the Soviet model, and also the construction land supply system. Enterprises obtained the construction land they needed from the government at no cost, so that the cost of residential construction was only reflected in the cost of the building. Building low-rise residential buildings was easier to attain a residential area that fully meets the living needs with the lowest technical cost and equipment cost.

The enclosed architectural layout provided a large and concentrated public open space. Human activities had both direct and indirect impacts on the flow of matter and energy within the ecosystem in these open spaces (J. W. 2007). However, many open spaces appeared in the form of the buildings' public space. These external spaces reduced the generation of negative space because of their high utilization rate. The negative space was the basis for the survival of species resources within urban ecosystems.

Each factory had a large area of construction land. In order to meet the daily leisure and entertainment needs of residents, each industrial enterprise built new facilities and venues for the internal residents in its factory's supporting residential area. Since there was no centralized public service facility land and public green space in this area in the city master plan, the public facilities were not shared between the enterprises. The administrative level strengthened the vertical connection between the enterprise and the higher administrative department and weakened the horizontal relationships between enterprises (Jiang W. 1993). The internal construction and management of each enterprise were separate. The five cotton spinning mills that produced the same product were concentrated public open space. These external spaces reduced the direct and indirect impacts on the flow of matter and energy within the ecosystem of these open spaces (J. W. 2007). However, many open spaces appeared in the form of the buildings' public space. These external spaces reduced the generation of negative space because of their high utilization rate. The negative space was the basis for the survival of species resources within urban ecosystems.

First: balancing the influence of administrative will and science on urban planning and construction. The imbalance between these two conflicting influences immediately appeared as a problem in China's ongoing urban construction. Avoiding the excessive intervention of formalism on urban land layout is effective for the scientific layout of urban ecological space. Second: reducing the interference of urban construction on the urban ecological background. The rapid expansion of the city during the period of passive industrialization destroyed the original ecological background and hindered the subsequent urban ecological reconstruction in the urban ecological space. This kind of urban expansion was similar to the large-scale construction of new urban areas in progress. The sponge city theory provides strong support for the construction of ecological spaces under this kind of urban expansion in order
Research on the Urban Ecological Space Changes under Modern Passive Industrialization Case Study of Zhengzhou City in China

37

to reduce the damage to the original ecological background by artificial construction through planning and engineering technical measures, and to preserve natural ecological functions to the greatest possible extent, instead of relying on artificial space construction to achieve the harmonious symbiosis of city and ecology. Third: strengthening the overall construction of urban ecological space is conducive to creating a more complete urban ecosystem network. From the perspectives of population distribution, land use layout, economic development, and ecological green space construction, instead of merely planning and constructing green land, the urban space should be considered as a whole with the goal of forming an urban ecological space network in order to maximize the ecological efficiency.

REFERENCES


Duan D, & Tian T. (2011). The New View about the Relationship of Wind Rose and Industrial Land Layout, Industrial Construction, 41(8), 14-17


Jiang W. (1993). Adapt to the market economy and cancel the administrative enterprise level, Tribune of Social Sciences in Xinjiang, No.2, 35-36


Shi P. (2005). Four Years of Cotton Textile Industry in Zhengzhou, South Reviews No.16, 42-46


Zhang X. (2017). The influence of population factors on urban ecological environment, Decision and Information, No.15, 123-125


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