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Study on the influences of industry transformation on the sustainable development of resource-exhausted city space

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Abstract

Resource-exhausted cities, a special type of cities relying heavily on resource economy, take on some distinct characteristics in the development of industrial structure and urban space. The resource-oriented industrial structure has determined the loose and mixed layout of urban space, the structural imbalance of major functional land use, the crisscrossing pattern of towns and villages and the unreasonable spatial development sequence. The existing urban spatial pattern can no longer meet the demand of urban development. Considering that the evolution of the spatial structure of resource-exhausted cities is a slow process lagging behind industrial transformation, this paper analyzes the industrial transformation manifested in urban spatial structure and reveals the mechanism through which the industrial transformation affect the sustainable development of urban space, so as to provide guidance to improve the coordination and harmony of urban spatial structure and industrial structure, further promote the smooth transformation of resource-exhausted cities and achieve the sustainable development.

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1. Research Background

1.1. The predicaments and complicated development environment of resource-exhausted cities during the period of rapid urbanization

Currently, China is experiencing the rapid development of urbanization. Against a background of sustainable economy growth and urbanization, a type of cities are developing difficultly or even facing

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survival crisis, that is the resource-exhausted cities, which emerge on exploiting natural resources and now face industrial transformation. There are totally 118 resource-based cities relying on coal, forest, oil and others in China, among which 44 cities are listed successively as resource-exhausted cities. In recent years, due to the impacts of gradual exhaustion of resources, the increase of mining costs, the supply-demand changes of resource products as well as the increasingly sharp and rooted contradictions, the resource-exhausted cities are confronting with various complicated predicaments, which have severely hindered their sustainable development. The predicaments are mainly manifested in the following aspects: the crisis of resource and environment upon which the cities develop; the deterioration of living and ecological environment; the highly simplified and unbalanced industrial structure; the sharp contradiction between the management system and the interest mechanism. Resource-exhausted cities have become the “problem cities” in China’s sustainable development.

1.2. Contradictions between urban development and urban spatial patterns of resource-exhausted cities under low-leveled industrial structures

Since ancient times, the social and economic development has always been the internal cause of the advancement of urban spatial pattern. The resource-oriented industrial structure has determined the loose and mixed layout of urban space, the structural imbalance of major functional land use, the crisscrossing pattern of towns and villages and the unreasonable spatial development sequence. The existing urban spatial pattern can no longer meet the demand of urban development in the following aspects. First, while the demand of urban construction land keeps increasing, the land is still divided into pieces by mining covered areas, subsidence areas, railways and high-tension cables. The highly dispersed urban spatial pattern leads to the low efficiency of urban land use, thus hindering the city from developing into a regional center with powerful attracting and radiating force. Second, the city functions are in disorder. The facts that the residential land, the public service facilities land and the industrial land are mixed together and that industrial land is scattered randomly make it hard for the cities to establish cooperative relations and to achieve scale merit, thus becoming disadvantageous for the transformation of city industrial patterns from the extensive mode to the intensive mode. Third, influenced by traditional land use patterns, enterprises and organizations of each leveled use land so randomly that the city is mixed with the mining areas of mixed functions in current city layout, which not only increases the costs of the construction and the operation of city supporting facilities, but also causes the waste of the land, thus becoming unfavorable for city’s unified management. Fourth, the contradiction between resource exploitation and city construction becomes increasingly sharp. Many cities are mixed with mines, and some cities and towns are even located in the mining areas. Such city layout has led to the predicament of “construction-mining- moving”, thus influencing citizens’ living and life quality.

2. Analysis of the evolution of spatial structures of resource-exhausted cities during the period of industrial transformation—taking Jiaozuo City as an example

2.1. Development of industrial structures and urban space in Jiaozuo

Jiaozuo City develops on the basis of coal industry and its coal mining history can date back to the middle of the 19th century. Although resource industry once played a dominant role in national economy, the benefits of the resource-based industry sharply fall down and other problems like city unemployment and pollution also appear with the gradual exhaustion of coal resources. Under such background, Jiaozuo begins its hard and enduring industrial transformation. In 1999, Jiaozuo announced clearly to transform the city industrial pattern and develop vigorously the tourism. In May 2008, Jiaozuo was listed officially

by the country as one of the first national pilot projects of resource-based city transformation. This significant opportunity accelerates the industrial transformation of Jiaozuo and further promotes the fundamental changes of industrial structure of Jiaozuo.

Since its founding in 1956, Jiaozuo has formulated successively four overall plans, from which the development processes of its industrial structure and urban space can be seen. (Table 1, Fig 1)

Table 1. Formation of four comprehensive planning of Jiaozuo

	Planning duration	Acreage (Sq.Km.)	Population (Ten thousand)	Urban nature	City industrial function	Developing direction	Urban spatial structure
First	1955-1962	6.0	9.2	Industrial city	Coal	East, south	Consisting of downtown and two industrial towns of Zhongzhan and Macun
Second	1980-2000	22.8	26.7	comprehensive industrial city	Coal, electricity, chemicals	East, north	A central city, four satellite towns (Zhongzhan, Macun, Jiulishan, Xifengfeng)
Third	1995-2010	90.0	90.0	Regional central city	Energy, chemicals, metallurgy, building materials, tourism	South	Based on north-south old and new towns, grouping city land layout structure formed by subsidence areas, ancient city ruins, high-pressure passageway and main canal of North Water Diversion Project
Fourth	2008-2020	140.0	140.0	Northwest regional central city of central plain city agglomeration, international landscape tourist city	Energy, aluminum industry, resource processing and new material production, landscape tourism, logistics	West, South	Grouping network urban spatial structure with primarily centralized compact layout and moderately decentralized patterns

It can be seen from the analyses above that the industrial structure of Jiaozuo has experienced the transformation from coal-based industry towards multi-economic industries relying on technology and tourism divided by the third urban overall plan of Jiaozuo, and the city function has changed from the original city of coal industry towards the comprehensive industrial city, tourism city, landscape city and the city of transportation junction. Besides, the urban spatial structure has also undergone the changes from dot-based spatial structure of concentrated blocks towards the grouping network spatial structure with primarily centralized compact layout and moderately decentralized patterns.

2.2. Features of the city layout under the different industrial structure

Resource-based economy is a growth engine for forming and developing resource-exhausted cities and it is also a main motivation of pushing changes of the urban spatial structure. Limited and non-renewable

resources determine changes of urban spatial structure and industrial development of resource-exhausted cities, which are produced by resource exploitation and dominated by resource-based industries. During the formation, development and transition of the resource-exhausted cities, the industrial structures of cities move from a low level into a higher level, which directly affects the changes of the urban spatial structure. Based on the above analysis, the correspondence of the functional structure of urban industries and the development model of the urban spatial structure in Jiaozuo is summarized abstractly during the development of the resource-exhausted cities. (Table 2) In terms of the urban development of Jiaozuo, its development of the urban spatial structure experiences three stages:

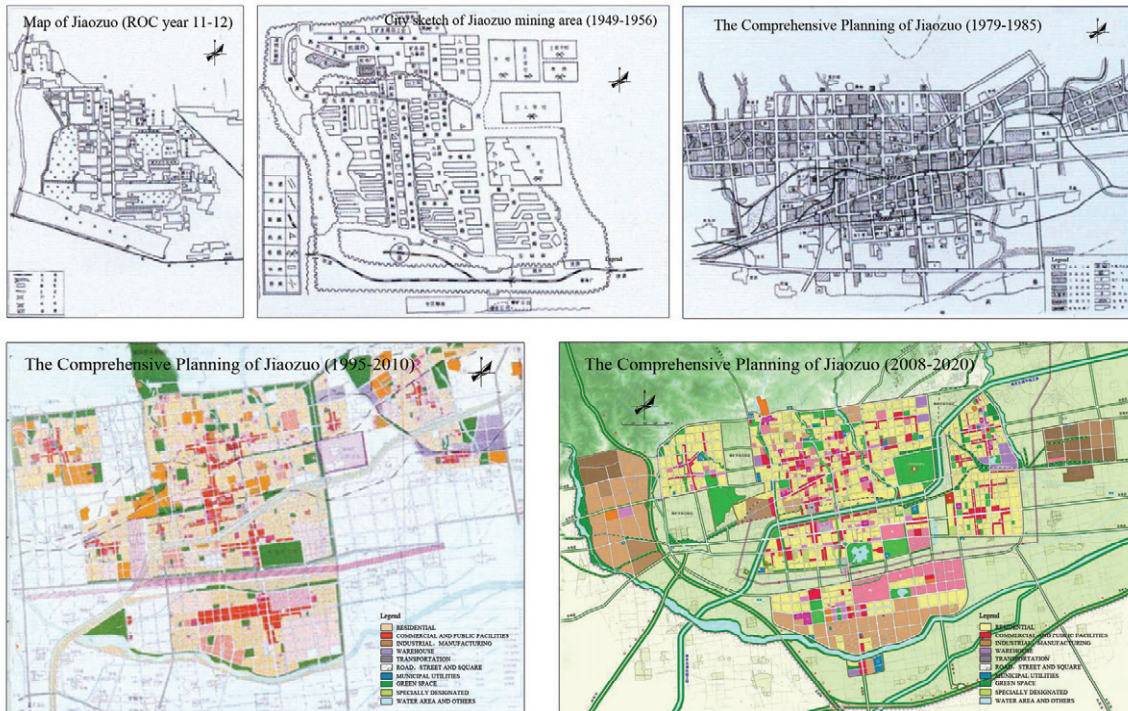


Fig. 1. Evolution of urban spatial structures of Jiaozuo

- The formative period—the spotty urban spatial structure of centralized clumps before 1956
- In the formative period of resource-based cities, the mining was invested because of the rich mineral resource when the traffic and the market demand were provided. Then an embryo of the city was formed. In this stage, the industrial structure was mainly based on the resource extraction and the rough processing and the industrial structure was single. The city layout was determined by the resource. The residential areas were arranged incorporated the resource industry. The urban infrastructure and the service facility began. The urban spatial structure took on a spot of centralized clumps at that time. The scale was small and scattered.
- In 1956, before Jiaozuo officially became a provincially administered city, Jiaozuo Mining Area was built relying on small towns. At that time, the cities were only small mining towns with small-scale centralized clumps. The expansion of space was the continual development with layers.

- The development period—the group urban spatial structure between 1956 and 1995

During the development period of resource-based cities, the resource-led industries grew increasingly and produced a series of industrial chains related with the resource-led industries in all fields. The non-resource industries developed in some degree and the urban industrial structure was devoted to diversified development. There was a need to establish new mining areas when the resource was extracted completely or needed to be enlarged in those established areas. Then, with the industrial scale expanding, some new residential areas appeared near the new mining areas. A comprehensive functional unit was made up of new residential areas, production areas and service areas to make cities extend by means of groups.

In 1956, Jiaozuo Mining Area officially established as Jiaozuo City. The first overall plan determined that Jiaozuo City was an industrial city dominated by mines and two industrial towns were planned in Zhongzhan and Macun near the mining areas. The second overall plan confirmed the development goal of Jiaozuo as a comprehensive industrial city. The economy of Jiaozuo stepped into a period of a stable and rapid development. The metallurgy, machines, building materials and chemicals, etc developed gradually. The urban land of the central area extended to the east and south. Zhongzhan and Macun improved in a large scale and gradually formed a grouped urban structure of “one city and two towns”.

- The transition period—based mainly on the centralized layout and moderate scattered urban spatial structure of group-network.

The resource-based industries were replaced by other industries while the resource was exhausted. The urban industrial structure became comprehensive low-leveled. The urban industrial function changed. Then, the city developed dominated by a centripetal pattern. Those adjacent residential areas developed in opposite direction along communication lines. The group-network urban spatial structure finally formed and the urban compactness was improved.

After 1995, the spatial extension of Jiaozuo continued to extend. In 1999, located in the south of the urban center, the High-Tech Development Zone of Jiaozuo was approved of founding. In 2003, the government institutions such as the municipal committee, the municipal government, moved here and became a new administrative service area. Meanwhile, Zhongzhan and Macun gradually extended to the central urban area along the railway line, connected with the central urban area together and constituted a new central urban area with the High-Tech Development Zone. However, there were some non-urban development lands, such as farmlands and villages, between Zhongzhan and Macun and the original central urban area affected by subsidence areas and geological conditions. Therefore, the urban spatial structure was dominated by the centralized layout and moderate scattered group-network.

Table 2. The stage-correspondence of the industrial structure of resource-exhausted cities and the urban spatial structure

The stages of city development	The industrial structure	The urban spatial structure
The formative period	The single industrial structure, based mainly on the resource exploitation and rough processing, the lagging non-resource-based industries	The urban spatial structure of a spot of centralized clumps
The development period	The dominant resource-based industries, a series of industrial chains generated matched with resource-based industries in all fields	The group urban spatial structure relying on the resource exploitation
The transition period	Transformed into a comprehensive industries from a single type, from a low-leveled to a high-leveled, the declined resource-led industries, the emerging comprehensive industries	The co-existing centralized type and scattered type, the balanced group-network urban spatial structure

3. The mechanism of the industrial transformation towards the sustainable development of the resource-based urban space

The urban spatial structure gradually forms in the long-term political, economic, social and cultural factors. The industrial transformation is a key factor of influencing the sustainable development of the urban space. The urban spatial layout of resource-exhausted cities is based on the distribution of resource and the established residential areas of the resource industries. With the resource exhausting, the distribution of resource weakens the limitation of the urban spatial structure and the urban industrial structure faced the transformation. The adjustment and upgrading of industrial structure causes the changes of the industrial space; at the same time, it also brings the changes of staffs, equipments, funds and technology. In the specific regions, it reflects the changes of the urban spatial structure and affects the sustainable development of the urban space.

In terms of resource-exhausted cities, the mechanism of industrial transformation towards the sustainable development of the urban space mainly reflects in following aspects:

3.1. Promoting the changes of the city function

The adjustment of the industrial structure is a process of optimizing the urban spatial structure. The internal mechanism of the urban spatial structure changing is a demand of continuously adapting the changeable city function. The city function is essentially determined by the urban industrial structure, namely the contradictory movement of “the industrial structure—the city function—the urban spatial structure” determines the development and changing of the urban spatial structure. During the industrial transformation of the resource-exhausted cities, the city function should be re-located. The expansion of the city size, the division of the city function and the industrial structure, the development of the urban space and the conflicts of the subsidence areas should be arranged.

3.2. Causing the adjustment of the site layout

The urban spatial structure reflects the urban industrial structure and the industrial determines the urban spatial distribution and the conditions of the land use. The spatial shifting of industries can cause the shifting of the living, the traffic and the service area to make the urban site layout change. Guiding the shifting of industries reasonably contributes to optimizing the urban site layout.

The resource-exhausted cities are mainly based on the resource exploitation and the processing. The layout feature of resource determines the layout of the urban space. The scattered distribution of resource leads to the scattered layout of cities. In those cities dominated by the resource exploitation and the processing, the industrial land accounts for a large proportion, so the cities are planned surrounding the industrial land; in those cities dominated by tourism and service, the urban public service is dominant. During the industrial transformation, the industrial upgrading will bring the adjustment of the industrial space. Optimizing the original industrial space and the emerging industrial space will promote the adjustment of the site layout.

3.3. Guiding the development of cities

With the dominant position of leading industries changing during the transformation of resource-exhausted cities, the urban spatial structure continuously adjusts and optimizes. The urban industrial structure develops to the diversification. Different leading industries have different demands of funds, technology and locations. Due to the particularity of the production process, the demands of locations and

sensitivity are different. The industrial layout has different demands for the urban space to accordingly form different spatial structure models and guide the development of cities.

3.4. Advancing the optimal allocation of land resource s

During the transformation of resource-exhausted cities, the leading industries change into the comprehensive service industries from the resource industries and the processing industries and the organizational type of industries develops to the concentration, which promotes the formation of industrial zones and towns and strengthens the concentration degree of the urban space. The layout of emerging leading industries has important effect on the urban spatial structure. Different industries have different affordability for the differential rent, so a new industrial layout will produce in the urban space to contribute to optimizing the land resource and develop the potential benefits greatly.

4. Conclusion

During the development of resource-exhausted cities from the formative period to the transition period, the industrial transformation is a key factor of affecting the sustainable development of the urban space. In different stages of the industrial development, the closeness of links between the industrial internal structure and industries is different. With the changing of industries from a low level to a high level, the industrial spatial concentration is more powerful. The industries develop to the concentration from a scattered type and the urban spatial development will gradually move to a balanced development model of a relative concentration.

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