THE EVOLUTION OF URBAN FORMS ON CITIES GROWING ALONG MAJ OR RAILWAYS IN ASIA: LESSONS FROM THE FIVE MAIN CITIES ALONG THE CHINESE EASTERN RAILWAY

LYU Jing; Jin Yunlong; Yin Yubo; Wang Aijia

ABSTRACT

Chinese Eastern Railway is a special railway formed in the process of historical development in northeastern China. It was built to have dramatic effects on the Northeastern Asia economy. At that time, Northeastern China became the "fastest and highest level area of urbanization" in China because of the Chinese Eastern Railway. Major cities have developed rapidly after the completion of the railway, urban spatial form also began to develop around that. The paper combined with the evolution of urban spatial form, talking Manzhouli, Harbin, Suifenhe, Changchun and Dalian as the object of research. The study based on "Landsat8 Data" obtained land cover information of five cities from 1897, ENVI and ArcGIS are used to extract the remote sensing historical image data, and through the expansion rate. To analyze the Field-scale evolution of spatial-temporal expansion and pattern in quantitative, and the driving force of the scale characteristics of urban spatial land use is analyzed, get result of the influence of Chinese Eastern Railway on the evolution of urban spatial form. Compare the results with the urban development pattern of "high speed rail era", put forward strategic suggestions for the development of cities along the railway in the future.

INTRODUCTION

The Chinese Eastern Railway is a "T" shaped Railway built by Tsarist Russia in Northeast China at the end of the 19th century. It is one of the branches of Siberian railway. The Chinese Eastern Railway has led to the formation and development of towns along the line. The railway trunk line starts from Suifenhe in the east and reaches Manzhouli in the west, with Harbin in the center. It is a length of 1481.2 km. Its branch line starts from Harbin and goes south through Changchun to Dalian, with a length of about 945.3 km.

Figure 1. Chinese East Railway Route

The process of modern urbanization in Northeast China was carried out under the birth of the Chinese Eastern Railway. Under the joint action of economy, policy, culture, immigration and other factors, a large number of nearly modern towns have risen along the Chinese Eastern Railway. The process of urbanization in Modern Northeast China also started.

BACKGROUND

As the northeast is located in the border area, the development is late, and the economic and social development is slow. Until the end of the 19th century, the urbanization development of Northeast China is still in a low level. At the same time, due to the lack of shipping connection with coastal ports, until the 1890s, the population in northern China was sparse, and the slow growth of migrant population did not change fundamentally, which restricted the development of the city. The

construction of the Chinese Eastern Railway connects the cities and towns in Northeast China with the outside world, ending the history of Northeast China's closure. The Chinese Eastern Railway has become the most important means of transportation in Northeast China, helping a large number of immigrants to enter the northeast, and the growth of population has brought preconditions for the development of cities and towns. After the construction of the railway, many cities along the line rose rapidly because of the construction of the railway.

In 2007, Harbin Dalian high speed railway began to be built, starting from Harbin in the north, passing through Changchun to Dalian in the south. Harbin Dalian high-speed railway has realized the "northeast integration", which not only greatly shortens the space-time distance between regions, but also effectively shortens the "economic distance" of different regions and accelerates the coordinated development of cities along the line.

METHODOLOGY

We use historical documents, mapping maps of the Republic of China and remote sensing images, mapping maps of the Republic of China and remote sensing images, the urban built-up area boundaries of five cities along the Chinese Eastern Railway in different periods since the 19th century are restored. According to the records of relevant markers in historical documents and referring to modern urban maps or remote sensing images, the current position of the city is analyzed and determined, according to the determined location of the landmarks, the city scope is drawn. Landsat2 / TM remote sensing images are screened for modern data (http://www.geodata.cn/), and visual interpretation and digitization are carried out in envi5.3. The boundary of urban built-up area is imported into ArcGIS to calculate the perimeter and area, which is verified according to the historical documents.

This paper selects the expansion rate, expansion intensity, compactness ratio, form ratio, circularity, compactness and other indicators (Table 1) to analyze the change process of urban scale and spatial form of each city; at the same time, it analyzes the potential factors affecting the expansion of urban built-up areas.

Index	Name	Formula	Explain
A1	Expansion rate	$V=(S_2-S_1)/T$	V is the expansion rate, S1 is the initial built-up area, S2 is the final built-up area, t is the time interval
A2	Expansion Intensity	$R=\frac{(U2-U1)}{U1}x\frac{1}{T}x100\%$	R is the expansion intensity, U1 is the initial built-up area, U2 is the final built-up area, and t is the time interval
A3	COMPACTNESS RATIO （RICHARDSON,1961）	$C=2\sqrt{\pi S}/L$	C is the compactness, s is the urban area under construction, and l is the perimeter of the corresponding city
A4	Form Ratio （HORTON,1932）	$Q=S/D^2$	Q is form ratio, s is built-up area, D is longest axis length of built-up area
A5	Circularity Ratio （MILLER,1963）	$P=4S/L^2$	P is circularity ratio, s is built-up area, l is perimeter

Figure 2. Index Factor Description

Based on the results, this paper analyzes the expansion of built-up areas in five cities in different periods after the completion of the Chinese Eastern Railway, summarizes the impact of the Chinese Eastern Railway on urban development in Northeast China, compares the urban development patterns after the completion of Harbin Dalian high-speed railway in 2012, and puts forward strategic suggestions for the development and construction of cities along the railway in the future.

FINDINGS

1. Scale change of built-up area

During the study period, all cities have been expanding outward and the scale of cities has been increasing. From 1897 to 2018, the scale of built-up areas in the five cities increased by 66.4 times on average. Among them, the largest expansion is in the urban area of Harbin. The built-up area

has increased from 4km2 to 441.7km2, which is 110 times larger. The expansion intensity of each city fluctuates greatly in different stages, but the expansion multiple is increasing. The built-up area of Changchun City has expanded 107 times, Dalian city has expanded 95 times, Manzhouli City has expanded 9 times, and Suifenhe City has expanded 10 times. The expansion times of the built-up areas of Changchun, Harbin and Dalian are much higher than those of the county-level cities of Manzhouli and Suifenhe.

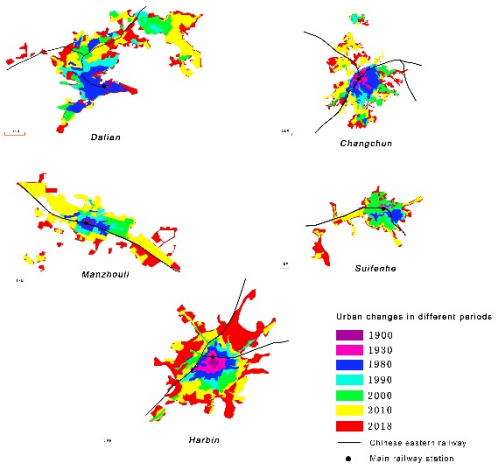

Figure 3. Urban changes in different periods

2. Expansion rate and intensity

According to the calculation results, the average expansion rate of the five cities in the study period is about 2.47km^2/y. The highest expansion rate is Changchun, with the value of 4.55km^2/y. The lowest expansion rate is Suifenhe, with the value of 0.27km^2/y. The expansion rate of Manzhouli and Suifenhe is low, but it is increasing year by year. Dalian's growth rate shows a fluctuating trend, with a significant downward trend in the past decade. Changchun and Harbin showed a rapid growth trend from 1987 to 2010, but the expansion rate continued to decline in recent ten years.

The average expansion intensity of the five cities was 64.53%. The spreading intensity of Changchun is the highest (122.15%), and the lowest is Manzhouli (6.91%). According to the results, the urban expansion intensity of Changchun, Harbin and Dalian increased significantly in the early stage of the Chinese Eastern Railway construction, but there was no obvious regional or urban level difference in the expansion intensity after 1980.

3. Compactness analysis

From the perspective of urban expansion mode, outward expansion is the dominant form. The average value of compactness decreased from 0.831 in 1897 to 0.402 in 2018, which was reflected in the process of high decrease and rise, and the compactness of urban internal construction land continued to decrease. Because the cities in the early stage of Chinese Eastern Railway construction are relatively regular, the fractal dimension of each city in this period is lower than that in modern times. Although the fractal dimension of some cities decreased in some periods, it showed a trend of rising and falling in general. From the change rate of fractal dimension, the change of fractal dimension in the later stage is lower than that in the earlier stage, and the urban boundary develops in a complicated direction.

Figure 4. Results of index factor analysis

4. Form ratio and circularity ratio

From 1897 to 1980, the shape ratio and roundness ratio of the five cities decreased rapidly, and the cities developed along the railway with obvious zonal characteristics. After 1980, the decreasing trend of shape ratio and roundness ratio slowed down, and the change was small in recent ten years. The results show that the construction of the Middle East Railway has a great impact on the morphological development of the five cities along the line. With the continuous development of the city, its shape is gradually stable and presents discrete development.

City		1900	1980	1990	2000	2010	2018
Changchun	Long axis distance (Unit: km)	2.8	15.83	18.45	19.49	27.58	41.60
	Short axis distance (Unit: km)	2.5	8.18	8.542	10.42	23.195	29.26
	Perimeter (Unit: km)	10.6	49.45	57.72	64.17	135.65	160.94
	Areal area (Unit: km²)	5.05	100.56	126.84	168.62	393.71	541.73
Harbin	Long axis distance (Unit: km)	2.2	20.11	20.25	26.07	33.37	34.14
	Short axis distance (Unit: km)	1.8	13.50	16.13	19.51	22.34	33.40
	Perimeter (Unit: km)	8.0	67.58	79.85	99.42	147.53	182.54
	Areal area (Unit: km²)	4.0	172.61	180.78	213.84	359.21	441.71
Dalian	Long axis distance (Unit: km)	2.5	18.10	30.72	40.61	45.71	46.41
	Short axis distance (Unit: km)	2.2	17.38	18.17	20.96	21.70	22.72
	Perimeter (Unit: km)	9.4	89.52	163.62	187.14	205.95	220.55
	Areal area (Unit: km²)	4.25	120.71	216.95	248.00	390.00	404.50
Manzhouli	Long axis distance (Unit: km)	3	6.17	7.65	13.15	17.96	19.26
	Short axis distance (Unit: km)	2	3.16	3.56	3.81	5.12	5.73
	Perimeter (Unit: km)	10	17.97	21.17	36.80	53.77	60.24
	Areal area (Unit: km²)	6.0	11.87	14.22	23.32	36.43	54.06

Suifenhe	*Long axis distance (Unit: km)*	*2.1*	*3.58*	*4.18*	*4.91*	*10.53*	*13.79*
	Short axis distance (Unit: km)	*1.3*	*2.95*	*3.47*	*4.48*	*6.62*	*7.95*
	Perimeter (Unit: km)	*6.8*	*13.09*	*15.18*	*18.25*	*38.47*	*59.45*
	Areal area (Unit: km²)	*2.8*	*4.49*	*5.91*	*11.59*	*19.95*	*28.33*

Figure 5 Changes of urban indicators over the years.

CONCLUSIONS

The construction of the Chinese Eastern Railway plays an important role in the economic development and population scale promotion of cities in Northeast China, which directly affects the development of urban built-up areas and promotes the change of urban morphology.

With the advent of China's "high-speed rail era", the impact on the development of cities of different sizes is different. The high-speed rail network increases the difference of regional accessibility and promotes the "city integration effect" between adjacent big cities. Big cities get better "relative accessibility", but some small and medium-sized cities do not get "absolute accessibility" improvement. The compactness of the big cities along the high-speed railway such as Harbin, Changchun, Dalian and so on decreased, showing a diffusion effect, but the expansion rate and intensity continued to increase. The compactness of small and medium-sized cities such as Manzhouli and Suifenhe, which are not covered by high-speed rail, is increasing, showing polarization effect, and the expansion rate and intensity are not improved.

With the construction of high-speed railway in the new period, the improvement of employment status along the line will bring more population gathering between high-speed railway and ordinary railway, and bring new urban active areas. At present, China's high-speed rail construction has a far-reaching impact on the urban morphology along the line. Improving the status of urban economic form and improving the accessibility of traffic will affect the characteristics of urban morphology and form a potential growth point of urban center. The emergence of the new economic growth pole will radiate and drive the overall development of the surrounding areas, and further change the urban form and pattern, which promote and influence each other.

Therefore, cities along the line should take advantage of high-speed railway development opportunities to maximize the economic effects brought by high-speed rail. Realize the combination of site construction and surrounding land development, and improve the site area catering, accommodation, parking lot, pedestrian access and other related supporting facilities. Increase the construction of municipal facilities, infrastructure and ecological environment around the site to attract high-end talents and high-end industries. It is necessary to promote the connection between high-speed railway, highway, aviation and other modes of transportation, to promote the construction of transit channels between urban high-speed railway stations and expressways and airports, and to realize the optimization and cooperation among various modes of transportation.

REFERENCES

P. Haggett Locational Analysis in Human Geography Edward Arnold Ltd. 1997, P:309.

Richardson H. W. The Economics of Urban Size Lexington, Mass, 1973.

Cole J. P. Study of major and minor civil division in pllitical geography Miemgraphed, 1960.

Gibbs J. P. Urban Rewsearch methods. New York, 1961.

Stoddart D. R. Growth and Structure of Geography Institute of British Geographer, 1967.

CORRESPONDING AUTHOR

LYU Jing, Professor, College of Architecture + Planning, Jilin Jianzhu University, Jilin Jianzhu University, No. 5088, Xincheng street, Changchun City, Jilin Province, China. 627274324@qq.com, LYU Jing.