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The influencing factors of urban land expansion in Changsha

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Abstract: This research systematically analyses land-use map of Changsha city in different periods of time. The spatial form and structural evolution was analysed by studying indices such as city land-use structure proportion, expansion intensity, economic flexibility, population flexibility, changing compactness index and so on. The dynamic mechanism of urban land expansion has been discussed by integrating the regional social economy development situation and many aspects such as the physiographical surrounding, population and economic development, traffic infrastructure, planning and regional development tactic and system innovation. The research indicates that the urban land expansion speed and intensity have steadily increased in Changsha from 1949 to 2004. The expansion form has been from a single external expansion to a combination form of external and internal expansion, from a circular or linear continuous form to a blocky or agglomeration shape. Overall, the urban land expansion of Changsha city is a phasic, diversified and complex process. And no matter what the stage is, it is an organic system containing multiple speed, pattern and shape, which are driven by multiple impetuses. The dominant feature at different stages was highlighted because of the balance and fluctuation between different forces, and the existing urban land border and shape have resulted from the joint efforts of these phasic forces.

Keywords: Changsha; urban land expansion; influencing factors; dynamic mechanism

1 Introduction

As a large complicated system, the city experiences various processes of growth, renewal and decline, with the flow and transfer of capital, information, population and technology inside and outside the system. In this complicated and dynamic evolution process, urban expansion is becoming less controllable and the use of urban land is facing severe pressure, with the coming of the overlapping periods of three peaks of population growth, urbanization and industrialization. Therefore, it is essential to strengthen the study on exploitation and expansion of urban land. Foreign countries began their studies on the topic at the end of 19th century, but the systematic theoretical study began with the ecological genre in the

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1920s, which later developed into diverse study methods and theoretical groups of historical morphological genre, location economical genre, social behavioural genre and political economical genre (Liu *et al.*, 2001; Liu, 2002).

From the 1990s, with the aggravating urban expansion, how to inhibit this has become the focus of the study. Theoretical trends of neo-urbanism, sustainable development, smart growth, and compact development came to public attention (Randall *et al.*, 1999; Mike *et al.*, 2003; Yu *et al.*, 2004; Zhang, 2001). The relevant study in our country started relatively recently. Not until the 1980s, with the implementation of local land use taxation, rapid development of real estate and the fast expansion of urban land, did the exploitation of urban land attract the attention of all classes in society (Liu *et al.*, 2001). In the 1990s, due to the extroverted land exploitation, low efficient landuse, severe damage to suburban farmland, many scholars recommended controlling urban size, reasonably deploying usable land, improving the efficiency of urban land exploitation and economizing the urban land exploitation, however, their analysis mainly focused on a phenomenal level.

From the 21st century, with methods from typology, system and ecology and with instruments of GIS and RS now available, the study on the processes and causes of urban land expansion has been furthered. Scholars such as Liu Shenghe, Wu Chuanjun, Zhou Jianmin have made systematic analyses and evaluations on the basic methods and theory of urban exploitation of the West (Liu *et al.*, 2001; Liu, 2002), which are of use for reference in our country. Scholars of Zhu Yingming, Yao Shimou, He Liu, Cui Gonghao, Guan Chiming and Ma Qiang developed their analysis on summarizing the models of urban land expansion from a spatial perspective (Zhu *et al.*, 2000; He *et al.*, 2000; Guan *et al.*, 2004; Ma *et al.*, 2004). Scholars of Chen Shunqing, Zhang Tingwei, Tan Minghong, Li Xiubin, Zhang Xiaoping and Liu Weidong focused their attention on the influencing mechanism of urban land expansion (Chen, 1999; Zhang, 2001; Tan *et al.*, 2003; Zhang *et al.*, 2003). Scholars of Li Shujuan, Zeng Lei, Zhu Zhenguo, Li Xiaowen, Wang Guanxian, Wei Qingquan and Liu Shenghe took cities such as Nanchang, Baoding, Shanghai, Guangzhou and Beijing as their subjects and made sample analysis of processes, spatial shape and influencing mechanism of urban land expansion (Li *et al.*, 2004; Zeng *et al.*, 2004; Zhu *et al.*, 2003; Li *et al.*, 2003; Wang *et al.*, 2002; Liu *et al.*, 2002; Yuan *et al.*, 2005). All in all, the study on urban land expansion in our country mainly uses foreign theories and ideals for reference and focuses on analyzing its courses and causes. In the meantime, the selected study subjects are mainly from the coastal cities in the east and a small number of interior metropolises. The study on introducing mechanisms and measures is comparatively weak. The thesis will take Changsha, a city in the central part of China as an example and will analyze the dynamic features of its urban land expansion, and discuss the influencing factors and functioning mechanism of urban land expansion, so as to provide ground for the orderly regulation of urban land.

2 Survey of the location and data sources

2.1 Survey of the location

Changsha city, situated at the joint of the Yangtse River economic zone and South China economic circle, is the political, economic, cultural and communication center of Hunan

province and in the meantime the nuclear city of the economic union of three cities of Changsha, Zhuzhou and Xiangtan, so it has an outstanding locational advantage. The city covers an area of 556 hm² and governs five districts of Furong, Tianxin, Yuelu, Kaifu and Yuhua. Screened by Yuelu Mountain, belted with Xiangjiang River, the city is distinguished with its Hu–Xiang culture, civilization arose from the Dongting Lake and Xiangjiang River. Changsha is a typical scenery city with mountains and rivers. Since 1949, Changsha has turned on new faces with its system functioning well, its size expanding and its economy developing. In 2004, the urban part had a population of 2,024,700. The exploited land covered an area of 135.84 km². GDP of the urban part reached 68,042,620,000 yuan with per capita GDP of 29,482 yuan

2.2 The data sources and methods

The thesis has made a systematic analysis on the features of Changsha's land expansion from the perspectives of chronological sequence, spatial form, structural evolution, through the specific study on the indices of structure proportion, expansive intensity, population elasticity, economy elasticity and increasing density with reference to the relevant data of overall plan and statistical annals, based on the graphics of land exploitation of Changsha's urban land in 1949, 1965, 1978, 1989 and 2004.

3 Space and time character of urban land expansion in Changsha city

3.1 Characteristics of time evolution

From 1949 to 2004, urban land expansion went through four phases: Phase 1 from 1949 to 1965; Phase 2 from 1965 to 1978; Phase 3 from 1978 to 1989; and Phase 4 from 1989 to 2004. In 1949, urbanised Changsha covered 670hm², most of which was concentrated in patches at east bank of Xiangjiang River. Up to 1965, urban construction area increased to 2093 hm², which is mainly characterized by orbicular expansion spreading from old urban area to its periphery. Construction began to extend to the west side of Xiangjiang River though the east side boasted the major expansion orientation. From 1965 to 1978, constrained by the Cultural Revolution and development policy of cutting down scale of old urban area, expansion speed in old urban area relatively slowed down while the city developed south-eastwards. In this period, the Xiangjiang Bridge was put into use (in 1972) which played an important part to break through unilateral expansion of east bank of Xiangjiang River and the expansion developed westwards. Industrial construction area was the major part in the first two phases. From 1978 to 1989, in-filling of existing urban spaces took the major part. Residential development (25.41% of the new areas) and public facilities (23.50% of the new areas) increased significantly. Though the proportion of the newly increased residential land decreased, it still took up 23.49% of the new urban area. The period 1989–2004, saw the most rapid urban development with an annual increase of 395 hm² with residential development and public facility taking the most part of the new construction areas (31% and 22% separately), areas for green belt and square increased at the fastest space while industrial construction area evidently decreased compared with that in 1989.

As a whole, the pace and intensity of urbanisation increased and became more rational in

Table 1 Characteristic indexes of urban land-use extension of Changsha city

Phase	Annual expansion rate of urban construction area (hm ² /a)	Intensity index of urban area expansion	Population elastic index of urban area expansion	Economic elastic index of urban area expansion	Index of change of compactness
1949–1965	88.934	0.16	2.48	---	0.10
1965–1978	229.36	0.41	3.22	---	2.25
1978–1989	315.43	0.57	1.46	4.51	1.59
1989–2004	394.78	0.71	1.25	5.00	0.59

Data source: Statistical Annals of Changsha and picture of current urban land use

Instructions: (1) Intensity index of urban area expansion: Refers to percentage of construction expansion area to total urban areas. The annual average intensity index is made to standardize annual expansion rate of total urban area so that it becomes comparable.

(2) Population elastic index of urban area expansion: The annual increase rate (%) of exploited area to that of urban population is a standard for rationality of urban land expansion.

(3) Economic elastic index of urban area expansion: Annual increase rate of secondary and tertiary industries/that of urban construction area which serves as a measure to weigh land use benefit of the new areas.

(4) Compactness and index of change of it: Compactness is urban area/minimum circumcircle area to measure the order of urban land use. The index change of it is a ratio of compactness of the initial time to the end.

Table 2 The structure change of urban construction land of Changsha city (%)

Time	Ratio down				Ratio up			No evident rule	
	Industrial land	Public facility	Storage	External transport	Green belt	Square	Habitation	Public facility for government	Others
1979	27.76	25.74	4.85	4.27	3.18	2.05	21.28	3.00	7.88
1989	26.17	24.91	4.62	4.26	4.50	5.77	22.82	2.67	4.29
2004	16.63	23.28	2.72	2.79	8.77	10.34	25.56	3.27	6.64

Data source: Annals of total layout in Changsha

Table 3 The proportion of main construction land in foreign cities (%)

Type	Habitation	Industry	Storage	Public facility for government	External transport
Overseas metropolises	20–25	15–17	5–15	10–12	18–20
Developed countries	>30	5–10	3–9	20–30	3–9

Data source: Reference (Li, 2004).

a planned way (Table 1). (1) Annual land expansion speed increased from 88.93 hm²/a of the first phase (1949–1965) to 394.78 hm²/a of the second phase (1989–2004); (2) intensity index of urban expansion increased by phases with 0.71 in the 4th phase, being 4.4 times that of the first phase; (3) structure of land use tended to be rational (Table 2), lands for industrial storage, external transportation and public facility took fewer proportions, while habitations, green belts, roads and squares took more proportions, but compared to that of the developed countries (Table 3) there is still some gap; (4) the organization of the whole process of urban expansion was weak with population elastic index above rational level 1.12, especially it was as high as 2.48 and 3.22 in the first 2 phases. In the third phase, it became slow down with land expansion developing in a rational direction; and (5) the benefit of land use in the urban land expansion process is relatively high with economic elastic index increasing from 4.51 to 5.00.

3.2 Spatial structure character of urban land expansion in Changsha city

There are three modes of urban land expansion: Simplified external space expansion, sim-

plified internal fill and a combination of the two. External space expansion expands outward around the city center and presents diverse shapes of spot circle conglomeration or axis (Figure 1). In terms of configuration, urban land expansion of Changsha was originally by way of simplified exterior space expansion which was later combined with interior fill. Besides, it has developed from continuous expansion in the shapes of rings or axes to non-continuous counterpart in the shape of spots and concentration. Despite that this kind of expansion represents a transition from disorder to orderliness; and from extensive type to intensive type; but no matter whether it expands in the shape of circling outward or broken spots, they all belong to the low-level urban expansion which is done out of control (Liu *et al.*, 2002).

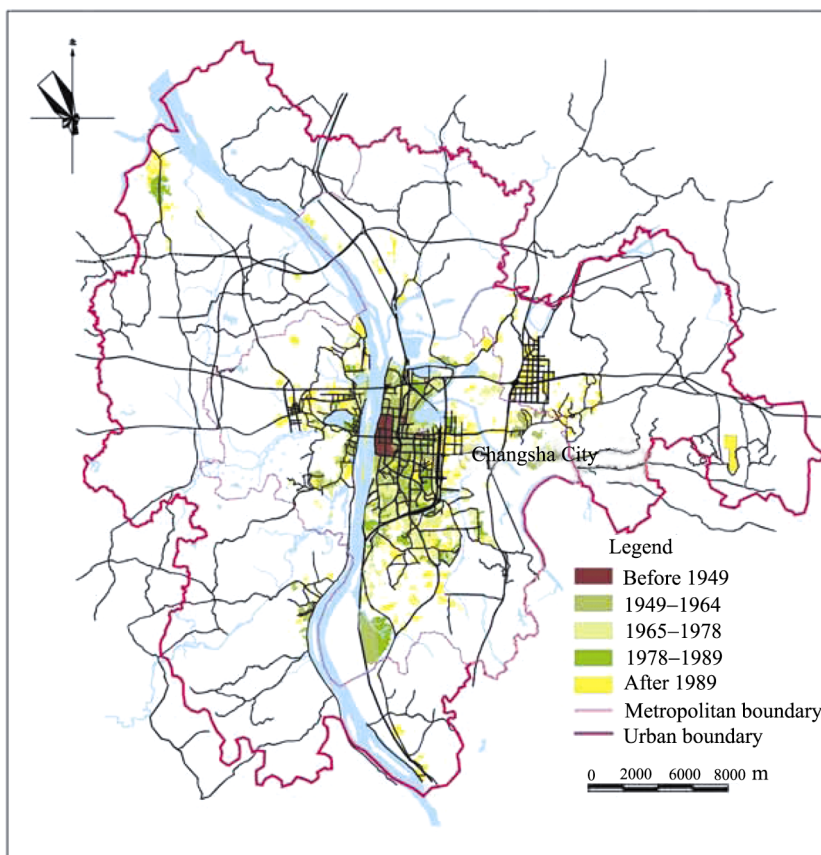


Figure 1 The map of urban construction land spatial evolution of Changsha city in 1949–2004

The mode of land expansion directly influences urban configuration. Overall speaking, since the establishment of new China in 1949, the old urban area (original shape in 1949) was made as growth point with axes of Xiangjiang coastal zone and National Road 319 going through. With the southeast quadrant (Xiangjiang River as vertical axis and National Road 319 as horizontal axis) as the major expansion surface, land expansion developed in the shape of ellipse. The east bank of Xiangjiang River took 70% while southeast took 50% of the growth. After 1990, urban formation became annular and trend of axes expansion was obvious, even newly-developed patches can not get off support of the key axis.

The urban compactness index is an important standard to reflect urban expansion formation (Table 1). In 1949 (the first phase), the layout of urban construction land was compact with dispersed expansion as the major type and the compactness index was only 0.1; in the second phase, it was as high as 2.25, the urban area became more compact; in the third phase, the compact trend slowed down; and after 1990, urban construction land spread around quickly. In terms of configuration, a new development zone which made compact index go down again was formed.

4 The analysis of the factors of Changsha's land expansion

4.1 The geographical surroundings

The geographical surroundings are the basic factors which limit the expansion. The urban area of Changsha surrounded by massifs lies in the section where Xiangjiang River and Liuyang River join. Yuelu Mountain in the west and the knolls in the northeast form natural barriers which dictated that the city area should be expanded towards the southeast to some extent. The central part of Changsha city is on a flood plain. Thereby, the rich water resource and the convenient water transportation attracted early city construction and urban development along the river.

4.2 The motivation of the population and economy

The growth of population and the development of economy are the basic motivations of expansion. On one hand, the development of economy needs more land; on the other hand, the flow of rural migrants has placed extra demands on the city and the constant ignorance of the transformation of the existing city intensifies the problem of the expansion. Through the analysis of the main socio-economic target data and the city construction land in typical years (1949, 1965, 1978, 1990, 1995 and 2004) by means of SPSS, it can be established that the urban built-up area is closely related to the urban population size, the investment of urban fixed assets and the average income of the citizen, to be more exact, the related ratios can respectively be 0.97, 0.90 and 0.94.

With the development of economy, the mode of economic growth and the conversion of industrial structure have brought forward new request of the spatial replacement of the land function. Since the 1990s in particular, the "two steps back to get three steps advanced" industrial structure and the scaling up and colonizing of industry have reduced the area of the industrial land, instead, new development zones mushrooms in the suburban area. Meanwhile, the improvement of the citizens' financial condition and the increasing concern about the living condition have activated the market of the commodity house. Since 1990, the residential land has taken up 31% of the area of the expansion. But limited by low average income, the sale of low-priced residence is the leading role. Considering the benefit of the development of real estate, the land used for residence is mainly found on the suburban fringe.

Both the process of the transformation of industry and people's residence demand low-cost land, high benefit and fast increment of the land. The spatial changes of the land price have speeded up land use change. Since the application of priced land system, the sup-

ply of land has become a commercial process instead of the previous planning distribution, which helped the price of the city land be reasonable. According to all the former achievements of the standard price of urban land, the price of the land varies according to the distance to the urban center: the farther the land is from the center, the cheaper its price will be. Hence, the urban expansion focuses on the suburban district for its low-priced land, which in turn leads to effectively uncontrolled and disordered expansion of the boundary of the city. The most expensive commodity land lies always in the Wuyi Road section (the downtown section), while the most expensive residential and industrial land transfers to the surrounding areas, especially the industrial land. The grading difference of benefit drives the industrial and residential land far away from the downtown, thus forming the “commercial—residential—industrial” land mode. Moreover, at the end of the 1990s, with the development of the urban traffic and new development zones, the areas around the new zones and communication lines have experienced growth. The land price starts its wave peak in the suburban area and changes from gradual decreasing tendency with the single peak to twisting tendency with several wave peaks (Figure 2) (Chen, 1999). Meanwhile, external expansion turns to extend mainly in the shape of axes and concentration.

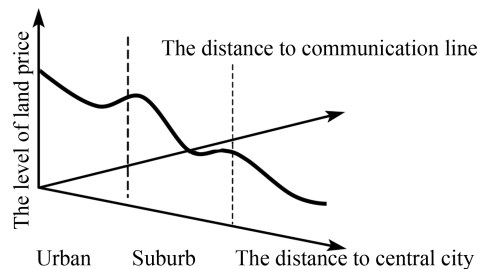


Figure 2 The multi-peaks curve of land price
Data source: According to Alonso model and reference (Chen, 1999)

4.3 Transportation

Generally speaking, the main transportation artery of a city is also the active economic growth artery, so the shape expansion of a city follows the development of its transportation. The network of transportation functions as a guide to the expansion of the city. The transportation construction of Changsha city has undergone a staged process: water transportation only—traditional network of road transportation—new network of highway and circular routes. Now a stereo transportation network of water, air and land has been established including “six bridges and three circular routes”, “eight vertical and eight horizontal routes” and “one airport and two ports”. The perfection of the transportation network makes it more flexible for the expansion of the city. The displacement of Beijing–Guangzhou Railway (1958) and the completion of both the Xiangjiang Bridge (1972) and Changsha Railway Station (1977) played a key role in the expansion of Changsha city. Since 1980, large scale city construction attached importance to route construction and enlargement of the city area was in full swing. The transportation network mainly including the water transportation of Xiangjiang River, National Road 319, National Road 107, Beijing–Zhuhai Highway, Changsha–Liuyang Highway, Beijing–Guangzhou Railway, Shijiazhuang–Changsha Rail-

way and Huanghua Airport prompted the urban space of Changsha to multiple directions from single direction along the river to along both river and roads. The highway system makes it much easier to reach the remote areas and speeds the expansion along the river and roads, thus forming an uneven low-density expansion pattern. The construction of transportation of ring roads encourages the land expansion in a circular pattern. Under the impact of transportation convenience, industrial land in particular has been expanded along the transportation axis. Most of the industrial land lies out of the first ring road.

4.4 The readjustment of administrative regions and the relocation of the administrative center

The expansion of city area will be influenced to an extent by the boundary and the numbers of the administrative regions as well as the frequency of the readjustment. The boundary invisibly limits the direction of the expansion. If there are too many administrative regions, the directions of the expansion will be disordered and a large amount of land in the boundary areas between regions will be wasted. If the readjustment is too frequent, the expansion will not last long. Before 1978, the Changsha municipal government readjusted its administrative regions quite frequently which resulted in turbulence during the expansion period. Yuelu District, established in 1960, had its urban area extended to the west of the Xiangjiang River. The establishment of suburban area (in 1957 and 1962) and the cancellation (in 1959) made the expansion of the city unstable. By the end of 1978, the urban area has had five jurisdictions, covering an area of 352 km². In 1996, the jurisdiction was readjusted: Furong, Tianxin, Yuelu, Kaifu and Yuhua districts were established and meanwhile the suburban area was cancelled. By doing so, the limitation of the development of the expansion was removed and the construction speeded up. The relocation of the administrative center caused the displacement of the expansion of the construction land. The westward movement of the Changsha municipal government in 2001 and the southward movement of the Hunan provincial government in 2004 made these two places attractive to the citizens, enterprises and businesses. Besides, the movement of the county seat of Changsha county to Xingsha Town from the urban area in 1996, made the economy there develop rapidly and laid a good foundation for the expansion to the east.

4.5 Strategy of regional development and planning

Generally speaking, urban planning guides the direction of urban development and a good plan also reflects the city's developmental tendency in the planning stage, therefore, the influence of urban planning and urban development interacts. In the process of interaction, the expansion of the city land changes as the plan does. All the plans of 1960, 1978 and 1990 and the readjustment of the plan in 1998 tried different developing ideas guiding and controlling the expansion. The 2003 plan took a new idea (Table 4). Besides, the general land use planning on the scope of urban construction area in some way influenced the expansion.

The urban planning and the general land use planning are the influencing factors at the moderate level. Since 1990, the influences on Changsha's expansion that cannot be ignored have included the strategies of regional development which are macroadjustment and control managements such as "one point one line" development in Hunan Province; the construction of the economic union of the three cities of Changsha, Zhuzhou and Xiangtan; the

developmental patterns of city which are the micro-managements such as developmental zone in Changsha city and the construction of university city. The “one point one line” development made the core position of Changsha more outstanding, and the growth more rapid in a belt-shaped pattern along the route of Xiangjiang River and Beijing–Guangzhou Railway. The regional planning of the city union of the three cities of Changsha, Zhuzhou and Xiangtan aims at building a spatial frame of the face-to-face development of Changsha, Zhuzhou and Xiangtan, which is good for the key development turning to the east and the south. The coming of the upsurge of developmental zone pushes forward the transformation of developmental mode which is reasonable and effective relatively. There are two national developmental zones and seven provincial developmental zones with a total area of 4067.63 hm², accounting for 75% of the increment of urban land use after 1990. The agglomerations of Xingsha, Gaotangling, Pingtang, Hanpu and Laoxia grew up just in such a manner. The construction of university city in the west of Xiangjiang River is an important factor driving the development of urban part in the west of Xiangjiang River.

Table 4 The survey of Changsha urban planning and urban planning adjustment

Year of completion	Plan-ning deadline (year)	Target year of plan-ning	City control scale		Main point of spatial structure	Influence on the ex-pansion
			Land scale (km ²)	Pop scale (10 ⁴ people)		
1981	1980–2000	2000	72	85	The constructions of the key projects	The internal fill of the land for infrastructure; the transportation construction lays the foundation for the expansion
1990	1990–2010	2010	155	160	“One principal, two wings, two agglomerations”; the development of new zones and the reformation of the old part	To guide the expansion of agglomeration type
		2005	156.7	165	“The double centers, multi-agglomerations”,	Expand the scale and stress the expansion in the west of Xiangjiang River
1998	1998–2015	2015	225	225	“One river and two banks, culture in the west and market in the east”	
		2010	230	210	“One principal, two subordinates and four agglomerations”; Control the scale of central city and promote balanced development.	
2003	2003–2020	2020	350	350		Guide the construction of the mode of compact expansion

Data source: Annals of Overall Planning of Changsha City

4.6 System and the innovation of the system

Before the transference from the centrally planned economy to the market economy, the government action, which played a much more important role than the market, decided the changing procession and pattern of the city space. Though, with the development of market economy, the function of the administrative mechanism and the market mechanism have reached a new balance, the land use planning system and the reform of it still had its abso-

lute control on the development of the city. Since 1949, with the reform of the national system, the strategy of the development of Changsha city, the system of land use, the system of household registration and the system of housing saw their perfection in the process of development (Table 5). The establishment of the system of land use at a payable rate in 1980 and the formation of the 1st- and 2nd-rated markets for transferring and selling the right to use the land did not only hasten the speed of the expansion but also helped it rationalize with high profit. In the 1960s, the pace of urbanization quickened with the lifting of the limitation on migrants from the rural area, the cancellation of the restriction of the city development which was made in the Culture Revolution, and the reform of the household registration system. Since 1990, the innovation of housing has triggered the rapid development of the market of real estate. The removal of urban residence from the center, to some extent, is a reflection of the prosperity, convenience of transportation, the price of land, and the movement of administrative center, to name just a few.

Table 5 System innovation of Changsha from 1949 to 2004

	1949–1965	1965–1978	1978–1990	1990–2004
Economic system	Plan primarily		Transition of planned economy to market economy	Market primarily
Household registration system	Formation stage of household registration system (no limitation to the transfer of residence)	Self-strengthening stage of household registration system (limitation to the rural population to migrate to the urban area)	The reform stage of household registration system 1980s: The allowing rural inhabitant settling down in towns and the inhabitant identification card system	advancing gradually 1990s: Urban household registration system reform (allowing farmers to settle down in cities)
Urban development policy	Constructing with proper priority, proceeding steadily	Controlling the scale of the big cities, developing small ones	“Controlling the scale of the big cities, developing medium cities reasonably, developing small cities positively” (1980)	“Controlling the scale of the big cities strictly, developing medium and small cities reasonably, developing small cities positively” (1997)
Land use system	Free, unlimited land circulation system, the administration transfers		Experimental stage of paid, limited and allotted land legal system	Overall promoting stage of paid, limited and allotted legal system
Housing system	Housing assignment in kind by work unit		Proposing the housing commercialization reform. Changsha becomes one of the experiment sites to buy houses with subsidies.	Overall implementing housing system reform on housing assignment in cash, public housing selling, housing public reserve fund and affordable housing

5 The urban land expansion formation and mechanism in Changsha city

The urban land expansion is a phasic, diversified and complex process and no matter at which stage, it is an organic system containing multiple speeds, pattern and shape, which are influenced by multiply impetuses. The dominant feature at each different stage was highlighted because of the balance and fluctuation between different forces, and the existing urban land border and shape were formed under the joint efforts of these phasic forces. The

space-time characteristics and the influencing factors of urban land expansion in Changsha were analysed. Because of the influence of factors such as population growth, economic development, traffic infrastructure, planning and regional development tactics and system innovation, urban land expansion speed and intensity progressively increased, the expansion form is changeable and the tendency has become increasingly rational from 1949 to 2004. The phasic characteristic occurs in the process of the formation of the city space shape, the main cause is the main influence factors that are different in different stages (Figure 3). The population growth and economic development drive the development of urban land; the stage difference of the developing speed directly influences the land expansion speed and intensity. The development is guided and limited by any programs at any time. The guiding direction and important points are changeable, the limit of natural conditions cannot be overcome at any time, they make the development of urban land more rational. Just like the economy, planning and natural condition, the other related factors have different uses in different periods of time. The urbanization of rural population, the regulation of industrial structure and administrative mechanism mainly influenced the circular urban expansion from 1949 to 1990. The large-scale construction of the traffic infrastructure made the expansion have obvious characteristics of linear development along the main communication artery from 1978 to 2004, and from 1990 to 2004 with the movement of the administrative centers, and the construction of the development areas provided the motive force to the group expansion of the urban land. Circular expansion, linear extension and group development have together led to the formation of the present shape of Changsha. And shapes of these three kinds of expansions have the organic superimposition temporally, and they are all the results of various factors driven by the leading factor.

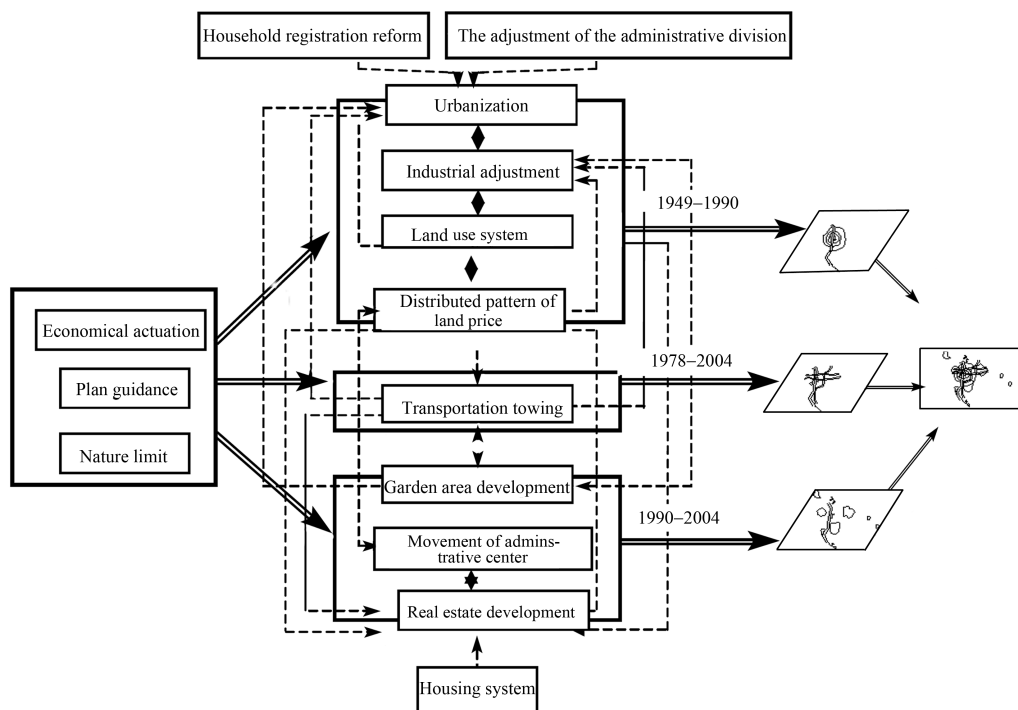


Figure 3 Urban land expansion shape and mechanism of Changsha city

6 Conclusions

Some conclusions are drawn as follows:

(1) From 1949 to 2004, land expansion of Changsha city has experienced four phases. During these periods, the intensity and pace of the expansion of the construction area became faster and the structure of land use became organized. As lands for industrial storage, external transportation and public utilities took fewer proportions, habitations, green belts, roads and squares took more proportions. On the whole, elastic index for population and economy in the realm of urban land expansion presents in a rational direction.

(2) In terms of configuration, urban land expansion of Changsha experienced a simplified exterior space expansion which was later combined with the interior fill. Besides, it has developed from continuous expansion in the shapes of rings or axes to a non-continuous development process in the shape of spots and concentration. In a word, the simplified expansion configuration is gradually changing to the complex type.

(3) Urban land expansion in Changsha is a phasic, diversified and complex process which is greatly influenced by many factors such as population growth and economic development, transportation infrastructure construction, layout and regional development strategic instruction, institutional innovation. Domination and orientation of each factor varies in different phases so that space, mode and shape of expansion vary. From 1949 to 1990, influenced by urbanization of rural population, industrial structure adjustment and administration system, ring-shaped urban expansion play a dominant role. From 1978 to 2004, large-scale transportation infrastructure construction made it evident that expansion of urban land area presented the belt shape along the trunk lines. From 1990 to 2004, the movement of the municipal government and construction of an R&D zone encouraged expansion in concentration shape. Current urban land expansion in Changsha is an organic agglomeration of components which are from different periods and in different shapes.

(4) Space and shape of land expansion is closely related to the factors mentioned above and the related systems. Therefore, on the basis of urban growth rule itself, we should make full use of mutual restraint and acceleration. Meanwhile research about control system of rational growth of urban land should be strengthened. To sum up, the focus of our future study is to establish a rational urban land expansion management system.

References

- Chen Shunqing, 1999. Theoretical study on urban growth and land value increment. *Geo-Information Science*, (1): 12–18. (in Chinese)
- Guan Chiming, Cui Gonghao, 2004. Research on spatio-temporal distribution of Chinese cities in the past over 100 years. *Areal Research and Development*, 23(5): 28–32. (in Chinese)
- He Liu, Cui Gonghao, 2000. Study on the urban spatial expansion of Nanjing City. *Urban Planning Forum*, (10): 56–60. (in Chinese)
- Li Shujuan, Zeng Hui, 2004. The expanding characteristics study of built-up land use along the urbanization gradient in quickly urbanized area: A case study of Nanchang area. *Acta Ecologica Sinica*, 24(1): 55–62. (in Chinese)
- Li Xia, 2004. Spatio-temporal analysis of land use patterns in the development corridor of the Pearl River Delta in 1988–1997. *Journal of Natural Resources*, 19(3): 307–315. (in Chinese)
- Li Xiaowen, Fang Jingyun, Pu Shilong, 2003. The intensity and modes of urban land use growth in Shanghai.

- Journal of Natural Resources*, 18(4): 412–422. (in Chinese)
- Liu Shenghe, 2002. Spatial patterns and dynamic mechanisms of urban land use growth. *Progress in Geography*, 21(1): 43–50. (in Chinese)
- Liu Shenghe, Wu Chuanjun, Shen Hongquan, 2002. A GIS based model of urban land use growth in Beijing. *Acta Geographica Sinica*, 55(4): 407–416. (in Chinese)
- Liu Shenghe, Zhou Jianmin, 2001. Western theory and method in urban land-use research. *Foreign Urban Planning*, 1: 17–19. (in Chinese)
- Ma Qiang, Xu Dunchu, 2004. Smart growth policy and urban spatial expansion in China. *Urban Planning Forum*, (3): 16–22. (in Chinese)
- Mike Jenks, Rod Burgess (eds.), 2003. Compact cities: Sustainable urban forms for developing countries. *Journal of Housing and the Built Environment*, 18(4): 287–391.
- Randall Arendt, Growing Greener, 1999. Putting Conversation into Local Plans and Ordinance. Washington, DC: Island Press, 15–45.
- Tan Minghong, Li Xiubing, Lu Changhe, 2003. An analysis of driving forces of urban land expansion in China. *Economic Geography*, 23(5): 635–639. (in Chinese)
- Wang Guanxian, Wei Qingquan, 2002. The infect of land supply in the exption of urban space form in Guangzhou. *Tropical Geography*, 22(1): 43–47. (in Chinese)
- Yu Wenbo, Liu Xiaoxia, Wang Zhu, 2004. The American new planning movements after urban sprawl and its apocalypse. *Human Geography*, 19(4): 55–59. (in Chinese)
- Yuan Lili, Huang Lujun, 2005. Analyses of the driving mechanism of the evolvement of urban land spatial structure. *Urban Studies*, 12(1): 64–69. (in Chinese)
- Zeng Lei, Zong Yong, Lu Qi, 2004. Spatial temporal feature of urban land extension in Baoding City. *Resources Science*, 26(4): 96–103. (in Chinese)
- Zhang Jingxiang, Cui Gonghao, 2000. Growth principles of urban spatial structure. *Human Geography*, 15(2): 15–18. (in Chinese)
- Zhang Tingwei, 2001. The urban restructuring of Chinese cities in 1990's and its dynamic mechanism. *City Planning Review*, 25(7): 7–14. (in Chinese)
- Zhang Wen, 2001. Smart growth in the United States of America. *Urban Research*, (5): 19–22. (in Chinese)
- Zhang Xiaoping, Liu Weidong, 2003. Role of development areas in urban spatial changes in China types and dynamics. *Scientia Geographica Sinica*, 23(2): 142–149. (in Chinese)
- Zhu Yingming, Yao Shimou, Li Yujian, 2000. On the urban spatial evolution in the process of urbanization in China. *Geography and Territorial Research*, 16(5): 12–16. (in Chinese)
- Zhu Zhenguo, Yao Shimou, Xu Gang, 2003. Urban expansion and its spacial growth management in Nanjing. *Human Geography*, 18(5): 11–16. (in Chinese)