

Driving Mechanism of Urban Sprawl in Chinese Context from the Perspective of Domestic and Overseas Comparison

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Abstract—Many cities in China have been experiencing serious urban sprawl since the 1980s, which pose great challenges to a country with scarce cultivated land and huge population. Because of different social and economic context and development stage, driving forces of urban sprawl in China are quite different from developed countries. Therefore, it is of great importance to probe into urban sprawl driving mechanism in Chinese context. By a comparison study of the background and features of urban sprawl between China and developed countries, this research establishes an analytical framework for sprawl dynamic mechanism in China. By literature review and analyzing data from national statistical yearbook, it then probes into the driving mechanism and the primary cause of urban sprawl. The results suggest that population increase, economic growth, traffic and information technology development lead to rapid expansion of urban space; defects of land institution and lack of effective guidance give rise to low efficiency of urban land use. Moreover, urban sprawl is ultimately attributed to imperfections of policy and institution. On this basis, this research puts forward several sprawl control strategies in Chinese context.

Keywords—China, driving forces, driving mechanism, land institution, urban expansion, urban sprawl.

I. INTRODUCTION

URBAN sprawl, as a kind of irrational development mode, first appears in developed countries, initially in the US, then brings about extensive concern among European countries since the 1960s. The term “urban sprawl” was firstly put forward by Whyte in 1958 [1]. Since then it has been defined and used by a number of foreign scholars [2]-[5]. Nevertheless, there is no authoritative or generally accepted definition because it is difficult to be measured.

Generally speaking, urban sprawl includes a series of problems, such as outward expansion of cities and their suburbs, decline of central cities, low-density development of suburb and rural areas and reliance on private cars. The consequences of this kind of urban spatial growth has been summarized by Dieleman and Wegener, including 1) decline of urban central areas; 2) dependence on automobiles, followed by growth of vehicle miles travelled, traffic congestion and deterioration of air quality; 3) reduction of open space and

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scenic spots in metropolitan areas and suburbs [2].

Policies, including revitalization of inner cities, designating urban growth boundaries and so on, have been raised and implemented in American and European nations, in order to weaken the negative effects of urban sprawl [3].

After the 1980s, with rapid urbanization process and economic growth in China, land development in some urban fringe areas has been out of control. Urban built-up areas of megacities, Beijing, Hangzhou, Nanjing and so on, extended rapidly [4]-[6]. It is worth noting that driving forces of urban sprawl in China are quite different from those in western developed countries. In order to study the dynamic mechanism of urban sprawl in Chinese context, practical situation and macro background should be taken into consideration comprehensively. It would provide reference and ideas for controlling and regulating urban sprawl, which play an important role in guiding China's urbanization process.

II. LITERATURE REVIEW

Overseas studies of the dynamic mechanism of urban sprawl date back to the 1960s. Scholars attribute urban sprawl mainly to transportation, people's preference of living, market and government. Firstly, improvement in personal mobility gives rise to urban sprawl. Automobiles improve overall mobility, making remote regions more accessible, providing the prerequisite of urban sprawl [7]. Furthermore, improvement in traffic conditions also makes contribution to sprawl by a series of means. For example, ribbon developments can be seen along the rail transit lines. Meanwhile, as the development of expressway systems, it is inappropriate for land parcels to be used for farming and housing, giving rise to an unattractive heterogeneous land use morphology [8]. In addition, urban sprawl can also be identified as a result of citizens' migration, who spontaneously move to suburban areas for higher living quality. In fact, people's preference of living has been greatly affected by social changes in the US and European nations. Specifically speaking, people's continually increasing demand for spacious living in suburban areas is closely associated with the increasing affluence in developed countries, which has undoubtedly made contribution to urban decentralization [9]. Meanwhile, cultural factors also influence people's preference. Most British people are willing to live in suburban areas or small towns with relatively low density [10]. Therefore, it is not easy to haul them back to more crowded city center areas [10]. Besides, a majority of scholars conducted studies on dynamic mechanism of urban sprawl from the perspective of

economics. Through research of the connection between urban population, land rent and resident income, it is put forward that market forces and market failure are the main reasons for sprawl [11]. The influence of land speculation on decentralized development has also been paid great attention to by many researchers [12], [13]. Scattered development is the result of land speculation, to gain price margin through purchasing land and selling it at a higher price later [14]. Finally, urban sprawl is also regarded as the result of governments, enterprise groups and citizens completion under land regulation policies. Urban sprawl of American cities is mainly attributed to the benefit game between government policies, city residents and developers [15]. Actually, federal taxation, government funds for water supply and sewage treatment facilities, federal housing program and low gasoline prices seemingly weaken the external cost of urban spatial expansion, greatly distorting

individual decisions in the market.

Domestic academia has been involved in the study of urban sprawl lately. Since 2005, scholars have made theoretical analysis or empirical research on dynamic mechanism of urban sprawl in China. Driving forces in individual cases are even more complicated and specific. Table I demonstrates main domestic studies of dynamic mechanism of urban sprawl. Based on these studies, driving forces of urban sprawl can be divided to three aspects: economic, technological and institutional reasons. Economic reasons include economic growth, foreign investment, construction of development zones, and so on. Technological reason mainly refers to motorization. Policy and institutional factors are considerable for generating sprawl in China, which is quite different from developed countries.

TABLE I
REVIEW OF DOMESTIC REPRESENTATIVE STUDIES OF DYNAMIC MECHANISM OF URBAN SPRAWL

Author	Year	Driving forces	Research Method
Chen [16]	2007	Defects of land system	Theoretical analysis
Chen [17]	2009	Motivations: economic growth caused by local government competition, foreign investment, low-end manufacturing and export-oriented development strategy Institutional cause: lack of inter-regional financial compensation mechanism; restrictions of household registration system; insufficient coverage of social security and relief systems	Theoretical analysis
Huang et al. [18]	2009	Economic growth, population growth, construction of development zone, motorization, suburbanization of housing and real estate development, macroeconomic guiding role of urban planning	Qualitative empirical research on Changchun
Liu [19]	2010	Social cultural value; market factors; policy and institutional factors	Qualitative empirical research on Beijing
Sun et al. [20]	2013	List in order of importance: industrialization, investment; demographic urbanization, market requirement; transportation	Quantitative empirical research on Changchun, Jilin
Su et al. [21]	2013	Construction of great projects, motorization, large scale real estate development at urban fringe, adjustment of administrative division	Qualitative empirical research on Guangzhou
Wang et al. [22]	2015	Private transport	Quantitative empirical research on 247 prefecture-level cities
Deng, Wang [23]	2018	High speed railway construction	Quantitative empirical research on 35 prefecture-level cities
Liu et al. [24]	2018	Land finance	Quantitative empirical research on 285 prefecture-level cities

In general, in the study of urban sprawl dynamic mechanism in China, we draw lessons from western research, and emphasize the role of market, government and institution. With developed free market economy in foreign countries, the role of government on land development is much weaker. Therefore, it is undoubtedly more appropriate to give an analysis of the role of economics, which would be the breakthrough point to understand the causes of urban sprawl. However, China fundamentally differs from western countries in policy and institution. Therefore, institutional research inevitably becomes the core of dynamic mechanism study in China.

III. ANALYTICAL FRAMEWORK

As is shown Table I, researches of qualitative and quantitative analysis, covering single or multi-cases have been conducted, providing abundant references to understand driving mechanism of urban sprawl in China. However, as far as we know, there are few systematical studies on dynamic mechanism of urban sprawl [16], [17]. In this regard, based on former studies, a hypothetical analytical framework of sprawl dynamic mechanism can be established through a comparison

study of the background and features of urban sprawl between China and developed countries.

As we all know, China is in the stage of rapid urbanization. At the same time, national economy has been growing rapidly. These situations are quite different from developed countries. Urban built-up areas expand inevitably to meet the demand of population growth and economic development. This could partially explain the reason why urban sprawl of Chinese cities is characterized by high density with intensive center, compared to low density with simplex land use type in foreign countries. In this regard, population growth and economic development provide the initial driving force for urban spatial expansion, however, will not eventually result in non-intensive land use and excessive expansion of urban space. If urban spatial expansion is not effectively regulated and guided, low-density and decentralized development of urban sprawl will occur.

Many foreign and domestic scholars have simultaneously emphasized the role of transportation mode on urban sprawl [7], [8], [18], [20]-[22]. There is no doubt that technical progress brings new vitality to urban spatial growth. As car is the product of the industrial age, information technology is the

product of the information age. Such factors are supposed to be the catalysts of urban sprawl. Motorized transportation greatly reduces average travel time, enlarging urban scale and reshaping our cities. Meanwhile, popularization of information technology changes production mode and lifestyle, promoting the transformation of traditional industries, and enabling urban spatial development to be free from spatial distance limitation. In general, the development of mobile transportation and information technology has profound influence on urban morphology and structure, and the potential of urban spatial expansion could be greatly activated.

Finally, defect of policy and system is identified as the root of urban sprawl in China. Because of deficiencies of land system and inadequate supervision and implementation of urban planning, huge economic interests resulted from land transfer are coveted by stakeholders. In order to build image projects and quickly earn land transfer income, local governments dominate large-scale land acquisition on the periphery of urban built-up areas. For the sake of huge profits from real estate industry, developers recklessly occupy cultivated land and carry out large-scale real estate development in suburban areas, which greatly accelerates land urbanization process in China, resulting in low efficiency and extensive use of urban land.

IV. DISCUSSION

A. Initial Driving Forces of Urban Sprawl: Urban Population Growth and Economic Development

a. Rapid Growth of Urban Population

With relatively high urbanization rate, urban population remains stable in developed countries. Urban sprawl is usually accompanied by decentralization with autonomous migration of high-income groups to suburbs in pursuit of better living condition. However, urban sprawl in China is not the result of decentralization at present stage. China's urbanization rate reached 58.5% by 2017 [25]. China is in the stage of large-scale and rapid urbanization. Central city is still the first choice for the majority of Chinese people to live because of more employment opportunities and better infrastructure [25]. It is argued that the central built-up area of Beijing is still experiencing an overconcentration of human activities with the process of outward extension [26]. Income gap and living standard difference between urban and rural region have prompted a large number of rural-urban migrants. Since the 1990s, the gradual reform of household registration system in China has enhanced the mobility of rural residents to cities. Urban population growth has brought about the demand for housing, public facilities, transportation and so on, promoting the construction of urban housing, commerce, roads and other facilities, which has caused outward expansion of urban space. In other words, urban spatial expansion in China is to meet the increasing urban population and gradual spillover of human activities to a large extent. Therefore, rapid growth of urban population is one of the initial driving forces of urban sprawl in China.

It is worth noting that land expansion in response to current

urbanization process can be regarded as normal urban spatial growth [27]. In this regard, urban sprawl in China should focus on inefficient urban land use and excessive expansion which is inconsistent with the growth rate of urban population. According to China Statistical Yearbook [25], the growth rate of built-up area has always been faster than that of urban population in China from 2006 to 2015 (Table II). This indicates that urban spatial expansion caused by urbanization process has not been effectively guided and controlled. Consequently, inefficient land use mode has led to urban sprawl.

TABLE II
GROWTH OF URBAN BUILT-UP AREA AND POPULATION OF CHINA FROM 2003 TO 2015 [30]

Year	2006	2009	2012	2015
Urban built-up area	33660	38107	45566	52102
Growth rate of urban built-up area	18.9%	13.2%	19.6%	14.3%
Urban population	58288	64512	71182	77116
Growth rate of urban population	11.3%	10.7%	10.3%	8.3%

b. Rapid Economic Development

With rapid economic development, the demand for urban land is increasing. Some scholars have proved the close relationship between economic growth and urban sprawl by empirical research [28], [29]. For one thing, industrial development, as the most important part of urban economic development, promotes urban land expansion by agglomerating industries. Since the Industrial Revolution, industrialization has driven various production factors to concentrate in cities. Due to agglomeration effect and scale effect, industrial categories are gradually increasing and scale of production is expanding, which has led to urban built-up area growth and urban spatial expansion. Afterwards, industrial structural transformation in the process of economic growth has also given rise to urban land expansion. Urban industries have gradually been dominated by tertiary industry instead of secondary industry. In this case, under the pressure of rising rents in city centers, secondary industries have moved outward to the suburbs in order to reduce costs, followed by construction of residential areas and infrastructure, causing urban land expansion finally. In addition, many scholars have qualitatively analyzed the important role of suburban real estate development on urban sprawl [18], [21], [28], [29]. Real estate industry has experienced more than 30 years' development, with its hot spots spreading from southern coastal economically developed cities, such as Hainan, Guangzhou and Zhuhai, to major and medium-sized cities throughout the country. Total investment in real estate development has been rising steadily, accounting for more than one fifth of the total investment in fixed assets in the past years (Table III). Vigorous and stable development of real estate industry, as one of the pillar industries, has made tremendous contribution to national economy. However, continued overheating of real estate market promotes urban sprawl in the form of physical buildings. Large-scale residential construction projects in urban fringe have occupied agricultural land, having negative effect on natural ecological

environment, also resulting in waste of land resources.

TABLE II
REAL ESTATE INVESTMENT OF CHINA FROM 2006 TO 2015 [30]

Year	2006	2007	2008	2009	2010
Investment in Real Estate Development	24524	32438	40441	49358	64877
The proportion of investment in Real Estate Development in Total Investment in Fixed Assets	22.3%	23.6%	23.4%	22.0%	23.3%
Year	2011	2012	2013	2014	2015
Investment in Real Estate Development	81686	99159	118809	131348	134284
The proportion of investment in Real Estate Development in Total Investment in Fixed Assets	26.2%	26.5%	26.6%	25.7%	23.9%

B. Catalyst of Urban Sprawl: Motor Traffic and Information Technology Development

a. Motor Traffic Development

There is a close relationship between traffic mode and urban form. Traffic form shapes cities by affecting the accessibility of land. As we all know, because almost all daily activities had to be completed on foot, ancient cities were compactly constrained to very small scale. The mobility of automobiles increases the accessibility of land, make remote areas more appropriate to live and work. It can be said that private cars have shaped the scattered form of modern metropolis, which greatly exacerbates urban sprawl.

Continually investment in urban road construction and the increase of motor vehicle ownership are important factors for urban sprawl in China. Continuous outward extension of city roads expands the scope of access. Meanwhile, popularity of cars has greatly changed the way people travel and redefined the boundaries of cities. In China, the investment in urban road construction is gradually increasing, with roads' length increasing from 241,000 km in 2006 to 365,000 km in 2015 [30]. Moreover, road area per capita has also maintained an upward trend (Fig. 1). A more significant increase can be seen in the average number of cars owned by urban households, from 4.3 in 2006 to 30.0 in 2015 [30] (Fig. 2).

Actually, there is an interactive relationship between private cars ownership and urban spatial expansion. At first, the increment of car ownership and the widening of people's travel range provide the prerequisite for urban sprawl. Afterwards, with the expansion of urban space, enterprises that are not sensitive to locational conditions move out in order to reduce costs, which is accompanied by a massive wave of real estate development in the suburbs. Travel distance of working, living and other daily activities becomes longer. More people have to buy private cars to improve commuting convenience. By empirical study of prefecture-level cities in China, it is argued that private car consumption significantly intensifies urban sprawl [22]. In addition, rapid rail transit has brought new vitality to the traditional mode of transportation, and has become a new driver of urban sprawl in China. Rail transit construction has become the focus of urban infrastructure construction in many big cities at present and even in the future, and plays a vital role in traffic mode revolution and urban spatial form transformation. Rail transit raises the land value

and attracts more development and construction along the line. Besides, it increases the accessibility of lands along the line, reducing travel time cost so that residents would be willing to move to more remote areas near the suburban metro line with lower housing prices but convenient transportation. It largely promotes urban sprawl as well.

In general, traffic mode and road construction have great effect on urban spatial structure, urban scale and the direction of urban development. However, it is worth noting that although motorization and road construction provide the precondition for rapid urban spatial growth, it will not necessarily cause a series of problems, such as low density or leaping development.

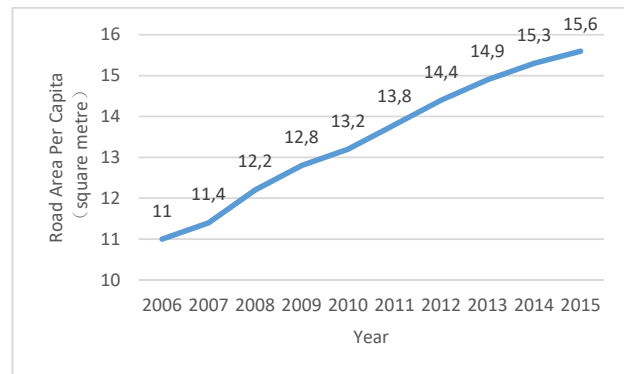


Fig. 1 Road area per capita from 2006 to 2015 [30]

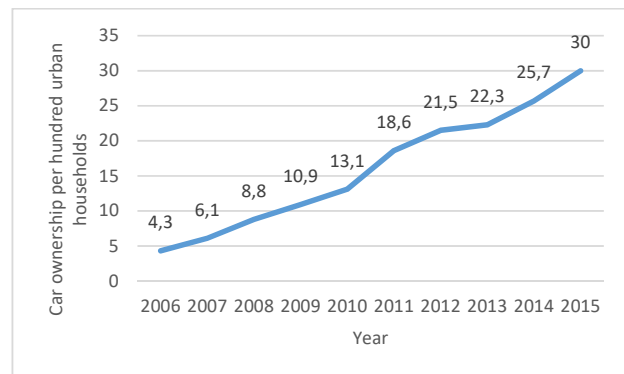


Fig. 2 Car ownership per hundred urban households from 2006 to 2015 [30]

b. Information Technology Development

After the information revolution among western countries in the 1970s, human beings entered the information society rapidly. Since the 1990s, the informationalized tide characterized by digital revolution and popularity of Internet has exerted a tremendous impact on human society. With rapid development of information technology, great changes have taken place in human activities operating mode and urban functional structure, resulting in transformation of urban agglomeration and diffusion pattern, and renewal and expansion of urban spatial structure [31], [32]. The impact of information technology development on spatial structure is embodied in the following aspects:

At first, information technology has gradually changed people's way of living and working, prompting human activities to spread to suburbs or villages. The emergence of e-commerce and online shopping enabled businessmen to distribute logistics services in low-rent suburbs in order to save costs. Popularization of the Internet and modern office equipment, such as computers and fax machines in families make SOHO (Small Office/Home Office) to be a fashionable working mode. SOHO people are able to get rid of the constraints of traffic and spatial distance, and begin to pursue living in suburbs with less pollution and more pleasant environment. Moreover, information technology has a strong penetration, which has led to the transformation of traditional industries and the renewal and expansion of urban functional areas [32]. Information industry provides information technology and information services for traditional industries, thus promoting the transformation and upgrading of traditional industries. The development of electronic communication and IT technology promotes the separation of enterprise production base and management department. Production bases are scattered to remote suburbs, and administrative departments are gathered in city center.

Finally, site selection of information industry is generally not limited by locational conditions, so it is often located in areas with pleasant environment and abundant intellectual resources [33]. The construction of large-scale information industry parks has a profound impact on the urban form. Large-scale agricultural lands are transformed to construction lands because of these specialized parks. At the same time, production factors are driven to transfer to city suburbs, resulting in urban sprawl consequently.

To sum up, the arrival of the information age, just like the arrival of the industrialized era, will inevitably have a tremendous impact on urban spatial structure. Urban spatial expansion breaks through the constraints of distance with the development of information technology. City functions expand to the suburbs and even more remote areas. As a result, it is obvious that urban morphology and structure present a trend of diffusion.

C. Root of Urban Sprawl: Defects of Policies and Systems

a. Defects of Land System

Land system causes a substantial difference in dynamic mechanism of urban sprawl between China and developed countries. It is argued that the "traffic-oriented" urban sprawl in European and American countries is the result of automobile revolution, while the decisive driving force of the "land-oriented" urban sprawl in China is the defects of land system [16].

Land Management Law of the People's Republic of China in 1988 clearly stipulates that "the right to use state-owned land and collectively owned land can be transferred according to law" and that "the state implements the system of compensated use of land owned by the State according to law" [34], which symbolizes the establishment of paid use and market transaction system of urban land. In other words, urban land belongs to the state; meanwhile, land use rights could be

transacted in the market. Moreover, rural land can only be traded in the primary land market when it is converted into state-owned construction land through the only legal way of "state expropriation". Local governments expropriate rural collective land at low prices, and transfer it to developers at higher prices in the land market to obtain financial revenue. Because huge profits can be obtained in this process, a large number of rural collective lands have been expropriated for urban development, which also aggravates urban sprawl.

Many Chinese scholars analyze the dynamic mechanism of urban sprawl from the perspective of "land system", and attribute the root of urban sprawl to defects of land system. It is argued that local governments wish to obtain financial revenue through land use rights transfer under the new tax distribution policy [27]. At the same time, decentralization of power after the economic system reform endows local governments with decision-making rights on land use and local finance. Furthermore, the demand for urban land has increased because of population growth and foreign investment. On account of market demand and local governments' willingness, more agricultural lands were converted to urban land, which eventually leads to urban sprawl. The "dualistic" land market structure formed after the reform of land use system can be regarded as the main reason for urban spatial expansion in China [35]. For one thing, the enormous profits for local governments through expropriating rural collective land for urban construction have promoted the "enclosure" land development. On the other hand, peasant collectives and state-owned units that acquire land through allocation have formed a "black market" of land transactions in order to obtain huge benefits by converting agricultural land to non-agricultural land or by construction land transfer. It had a substantial impact on urban spatial expansion in China.

b. Guiding Role of Urban Planning and Failure of Planning Management

1. Guiding Role of Urban Planning

As an important public policy, urban planning should embody public value. However, urban planning in China usually lacks of publicity, and only expresses the will of government departments. It has often become a tool for local governments to promote local economic development and establish performance projects. Many cities have put forward development goals that do not conform to the law of urban development. This kind of urban development model is impractical and the desired effect of planning is difficult to achieve, resulting in waste of urban infrastructure.

Large-scale projects, such as development zones, new towns, university towns located in the urban fringe, as a way of promoting economic development by local government, have given rise to urban land expansion to a large extent. These new projects largely reflect the will of government departments with the participation of state power. According to Chinese development zone audit notice catalogue in 2018, since the reform and opening up, China has approved more than 2500 national development zones, not to mention countless development zones at provincial level [36]. These projects

usually are located far away from urban built-up areas at the expense of cultivated lands. Its agglomeration effect attracts a large number of people, aggravating disorderly expansion of urban space.

2. Absence of Urban Planning Management

The imperfection of urban planning management system leads to confusion in planning management and urban construction. On one hand, departments' functions overlap with each other, and the relevant laws do not link up enough or even contradict with each other, which greatly affect the implementation of urban planning. There is no enough connection between the compilation and implementation of urban master plan and other related plans such as land use master plan and regional plan, which often leads to the failure of arable land protecting goal in land use master plan. On the other hand, there is no uniform standard for the approval of planning schemes. Sometimes, there is no plan to restrict project approval, or even the planning itself has not been approved through legal way. What's more, urban planning is subject to arbitrary and frequent changes by administrative departments. All these make planning lack of institutionalized and legalized management, being vulnerable to various external factors. It is common to neglect land use planning at the cost of cultivated land. Urban construction is out of control. As a result, cultivated land resources are seriously lost, which contributes to urban disorderly spread.

V. CONCLUSION AND RECOMMENDATION

Urban sprawl is not equivalent to urban spatial expansion. In fact, the word "sprawl" itself has almost always represented a negative attitude [37]. Therefore, the use of "sprawl" to describe the state of urban development is sufficient to show that urban sprawl is irrational.

Under the macro-environment of accelerated economic development and urbanization in China, it is very important to distinguish rational urban spatial expansion from excessive urban spatial spread. Rural-urban population migration and economic growth in the process of urbanization are initial driving forces, which will undoubtedly lead to urban spatial expansion. Motorized transportation and information technology have deeply influenced urban morphology and structure, providing the precondition for the rapid expansion of urban space. However, if urban spatial expansion is ineffectively regulated and guided, urban space will enter a state of disorderly spread. Therefore, urban sprawl in China is not only reflected in urban spatial expansion or built-up area increasing, but also in extensive use and non-intensive development of urban land. In other words, urban sprawl in China is a kind of urban spatial expansion which is inconsistent with the speed of urbanization and economic development.

Urban sprawl in western countries is the product of free market, so urban growth management mainly aims to intervene in market allocation of urban space resources [38]. Compared with developed countries, urban sprawl in China is more affected by policy and institutional factors. The defects of policies and systems can be seen as the root of urban sprawl.

Land system in China has made great contribution to the upsurge of land development driven by interests. Prevalent "enclosure" movement and large-scale illegal construction are caused by the absent publicity and inadequate planning management. Therefore, urban sprawl control in China should focus on the improvement of land use mode and policy system. Some suggestions are listed below:

- Optimize land use structure, properly enhance urban land use intensity, and give preference to stock land optimization rather than constructive land extension, to achieve efficient and intensive use of urban land.
- Propel land system reform, promote market-oriented land management, reform land expropriation system, and avoid the upsurge of interest-driven land development.
- Adjust planning ideas to realize gradual transformation from incremental planning to stock and decrement planning; improve planning management and coordination mechanism; implement public participation, regional coordination, dynamic planning and feedback mechanism; improve the scientificity and authority of planning, and positively implement planning.

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