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IIASA Interim Report
February 2002

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Interim Report **IR-02-005**

Spatial Patterns and Dynamic Mechanisms of Urban Land Use Growth in China: Case studies in Beijing and Shanghai

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February 1, 2002

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Abstract

Beijing and Shanghai are among those Chinese cities that have experienced substantial growth over the past decades. We analyze historic urban growth patterns in Beijing and Shanghai using detailed land use maps from different time points. For Beijing digital land use data are available for 1982, 1992 and 1997 with a scale of 1:100,000. In the case of Shanghai we use high-resolution data derived from earth observation for the years 1967, 1989 and 1999. With the implementation of economic reform and opening policy China introduced urban land reforms invoking major changes in urban growth dynamics. A conceptual framework of urban growth mechanisms in the Chinese context is presented. It includes driving forces and constraint factors and four mechanism of urban land conversion, namely administrative allocation, urban land market, unauthorized ("black") land market and land development for Town and Village Enterprises (TVEs). In Beijing industrial land expansion has been the dominant factor of urban growth. Land expansion for TVE's here is of particular importance. There are major divergences of actual urban growth patterns and those envisaged by development plans of the city. In Shanghai residential land increased significantly mostly at the expense of cultivated area. Road development was substantial. The high resolution of the land use data allows to present detailed land use conversion patterns.

Keywords: *Urban growth, China, Beijing, Shanghai, Remote Sensing.*

Acknowledgments

The land use data for Shanghai were developed in the project “Monitoring urban growth in the Shanghai region with Earth Observation data” conducted by GeoVille (www.geoville.com). Land use data for Beijing were mapped by the Land Resources and Real Estate Management Bureau, Beijing, China.

Dr. Shenghe Liu’s field work for this paper was supported by the Knowledge Innovation Project of the Chinese Academy of Science (No. KZCX-310). Much of Dr. Shenghe Liu’s work on this paper was done during his participation in IIASA’s Young Students’ Summer Program of the year 2001. His three-month affiliation as part of the YSSP with the IIASA-LUC project was financed by IIASA.

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Spatial Patterns and Dynamic Mechanisms of Urban Land Use Growth in China: Case studies in Beijing and Shanghai

Shenghe LIU and Sylvia PRIELER

Chapter 1. Introduction

Background

Urban land use represents an intense and complete transformation of the natural environment for its essential construction of urban fabrics including residential, industrial and infrastructure development. Urban land use expansion is driven by population growth, social and economic development. It has always been the focus of academic research as well as social and economic debates because land use growth entails high profitability and risk in economic aspect, impacts and conflicts in social and political aspect, and huge consumption of cultivated land with serious negative externalities on environmental sustainability (Fishel, 1982, Bourne,1996, Peiser,1989, Dipasquale, Wheaton, 1996). The spatial patterns and dynamic mechanisms of urban land use growth in the western industrialized countries have been well explored and documented in multi-disciplinary schools such as human ecology, spatial economics, social behavior and political economics (McDonald, 1997, Fujita, 1985). Generally speaking, urban land development in capitalist societies is driven by a market mechanism, in which individuals and enterprises are the main actors and their locational choices are constrained and motivated by the capitalist production mode of profit-making (Yeh and Wu, 1996). Recently, the negative externalities of urban sprawl have raised extensive concerns and various governmental policies on growth control or development management have been proposed (Deakin, 1989, Ewing, 1994).

In order to facilitate the governments, communities and citizens to monitor and manage urban growth in a sustainable way, a continued effort has been devoted to develop computer-based models for describing urban growth patterns, evaluating alternative development policies and simulating future urban growth (Lee, etc., 1999; U.S. EPA, 2000, Murbandy, 2000). With the substantial advances in modeling techniques and GIS (Geographic Information System) and RS (Remote Sensing) technologies, these efforts have generated a voluminous literature but few operational models (Wu and Webster, 2000).

China has experienced rapid urban growth since its economic reforms. Especially in the end of 1980s and the beginning of 1990s, there was what is called in China “great mass fever” on real estate development and establishment of Development Zones. For instance, in a single year in 1992 approximately 2000 new Development Zones have been set up in China, with a planned land occupation of 20000 km^2. This was more than the total number of established Development Zones before 1992 (Shi, 2000). While in 1980 China’s urban population was 191 million corresponding to 19% of the countries total population, in 1998, it had increased to 379 million; these are 30% of total population classified as urban population (China

Statistical Yearbook, 1999). By comparing the actual urban growth pattern in Dongguan in the Pearl River Delta of China in 1988-1993 with optimal development derived from a sustainable land development model, Yeh and Li found that the actual agricultural land loss caused by urbanization is two to nine times more than the expected (Yeh and Li, 1998).

Considering that China is among the nations with the lowest per capita land resources in the world, severe agricultural land loss caused by unplanned rapid urban growth would certainly bring about significant impacts on its future sustainable development and food security. Some international researchers began to question "Who Will Feed China" (Brown, 1995). Since then there have been extensive discussions in and outside China regarding the potential of the country to feed its growing number of people (e.g. Rozelle, 1997, Chen M., 1999, Heilig, 1999). In 1997, the central government of China issued an administrative decree to freeze the conversion of additional agricultural land into urban land use for the whole year of 1997 and 1998, in order to ensure the success of its strategy for food self-reliance (Li and Sun, 1997).

However, such a kind of administrative order may face major enforcement problems because China is still a predominantly rural society with only approximately 30% of the population living in urban areas in 1997 (Hubacek and Sun, 2001). In fact, many empirical studies have suggested that China's urbanization lags far behind its economic development and industrialization and the acceleration of urbanization is essential for the transformation of surplus rural labor forces and sustainable economic development (Fu, 1999). The Chinese government includes urbanization as one of the five major development strategies in its "Tenth five year plan" (Zhu, 2000). The State Statistical Bureau of China has estimated that the annual urbanization level of China will increase from 28% in 1995 to some 50% in 2020 (Heilig, 1997).

Thus, the contradiction between urban land use growth and the conservation of agricultural land is bound to become more and more intensive, and urban growth has to be controlled and managed smartly in order to keep the balance and realize sustainable development. Apparently, studies on monitoring and modeling urban growth in urgently needed in the Chinese context. Yet the spatial patterns and dynamic mechanisms of urban growth in China are still poorly documented and understood, mainly due to a lack of data availability and the complexity of its dynamic system. By means of two case studies, on Beijing and on Shanghai, this report intends to illustrate data requirements and to make several contributions to fill this gap.

Aim and objective

The aim of this study is twofold. On the one hand to analyze historic urban growth patterns in Beijing and Shanghai using detailed land use maps from different time points. Objectives include to describe the amount of land use / land cover conversion rates, their direction of change and growth patterns. On the other hand to develop a conceptual framework of urban growth mechanisms in the Chinese context and thus try to explain and understand driving forces and mechanisms leading to urban land conversion.

The second chapter briefly introduces data sources and methodology. In the third and fourth chapter we present findings from the analysis of the three time points of geo-referenced land use data for Beijing and Shanghai respectively. The fifth chapter presents a framework for the dynamic mechanics of urban growth and discusses it in the context of Beijing and Shanghai. The final sixth chapter comprises a discussion.

Chapter 2. Data Sources and Methodology

Beijing and Shanghai were chosen as the two case studies to explore the spatial patterns of urban land use growth and to investigate their dynamic mechanisms in China. For both cities we have land use maps for a similar time period. We distinguish three types of urban land use, namely residential land, industrial land and other urban land. The latter includes infrastructure and recreational areas. Thus when we speak in this report of urban land use, we mean all the three categories, while the term "residential", "industrial" and "other urban land" refers to the specific sub-classes within the total urban land use area.

2.1 Beijing study area

Beijing is the national political capital with a total population of more than 12 millions. Between 1982-1997, the average annual growth rate of the total population and GDP (Gross Domestic Product) for the whole Beijing municipality area (16800 km^2) is 2% and 24% respectively. In this 15 year period the per capita living floor space in Beijing increased from 5.38 m^2 to 9.49 m^2. Our case study area in Beijing municipality extends from 39° 40'N – 40 ° 20'N and 116 ° 00'E – 117 ° 00'E, including the whole areas of the Central Urban District, four near suburban districts and one rural county (Shunyi County) and parts of other eight suburban districts and counties. The case study region covers in total an area of 5752 km^2, this is approximately 34% of the whole Beijing Municipality Area. It has been the main target area of urban land use growth due to its advantageous location and plain landscape. In the period of 1982-1992, about 92% of all new development was allocated in this area.

Digital land use data for the Beijing case are derived from land use maps of Beijing for the years 1982, 1992 and 1997 with a scale of 1:100000. They were respectively mapped in the first land use survey in 1982, the detailed land use survey in 1992 and the renewed land use survey in 1997. Data are stored in polygons with about 22 thousand polygons for the land use map in 1997 and slightly less for the other two years.

2.2 Shanghai study area

Shanghai, situated in the Eastern Coastal Area of China, is a national commercial center with a total population of 13 millions. It is among the most rapid developing cities worldwide. In the period of 1989-1999, the average annual growth rate of the total population and GDP of the whole Shanghai Municipality Area (6341 km^2) is 0.3% and 11% respectively. With the introduction of economic liberalization and urban land market, the dynamic forces of urban transformation in Shanghai have shifted from the formerly rigid state control to an interplay between the state and the market (Han, 2000).

Our case study in Shanghai is limited to the inner city, with a total area of 484 km^2 covering only some eight percent of the whole Shanghai Municipality Area. The study area covered is small compared to the Beijing case study because the Shanghai land use data were derived from high-resolution satellite data interpretation. The database was developed in the project "Monitoring urban growth in the Shanghai region with Earth Observation data" conducted by GeoVille (GeoVille, 2000). The satellite data sources are:

- For 1967: CORONA-KH4, (4 m ground resolution)
- For 1989: SPOT PAN, (10 m ground resolution)
- For 1999: IRS 1C PAN / IRS 1C LISS III, Infrared Merge (5.8m / 23.5m)

The final data available to us include 25 different land use categories and have a resolution of 3x3 meters.

2.3 Methodology

Since the data sources of the case study areas differ in terms of extent and resolution, we chose different approaches to analyze land use changes in Beijing and Shanghai. Thus we attempt to make the best use of the geo-referenced data available for the different time points and also may draw some conclusions as to the potentials and limitations of identifying important features of land use changes.

In the case of Beijing data are available for a relatively large area extending beyond the urban center of the city. In large cities such as Beijing and Shanghai the urbanization process is not confined to the densely populated central areas. An analysis of the whole city agglomerate allows a better understanding for potential future development paths. Besides the extent of changes the analysis here focuses more on the spatial pattern of growth dynamics. Another advantage of a larger area is that socio-economic data collected by statistical bureaus are more easily available. In this study we only use the administrative unit boundaries to delineate the different growth patterns.

For Shanghai we have much higher resolution data than for Beijing, but for a smaller study area confined to today's urban center of Shanghai. The time period covered is also longer than for Beijing. The focus here is more on the direction of land use changes. The 3x3 meter pixel land use data allow to answer questions such as: From what former land use does the new land use come? To what other land use category has the land been converted?

A detailed analysis of land use changes is interesting from a historic perspective and one may intuitively draw some preliminary conclusions on underlying driving forces and growth mechanisms. However, the real growth mechanisms are embedded in the social, economic, political and cultural preconditions of a particular city. We develop a framework for the particular Chinese context.

Chapter 3 BEIJING

3.1 Quantity and rate of urban land use growth

Table 1 summarizes urban land use statistics and their growth characteristics derived from the three GIS land use maps for the years 1982, 1992 and 1997. Over the 15 year period 1982 – 1997, the total urban land use nearly tripled from 384 km^2 in 1982 to 1000 km^2 in 1997. The average annual growth rate was 38 km^2 during the first 10 years and then slowed down to 29 km^2 for the last five-year period 1992 to 1997. In percentage terms this means an average annual growth rate of 8% for the first period and 3% for the second.

The urban land expansion is apparently mostly driven by growth in industrial land area especially in the last five years. Between 1982 and 1992 some 65% of the overall urban land use growth was due to expansion of industrial land compared to 22% residential and 13% other urban land. During the five years 1992 to 1997 as much as 80% of the urban land expansion was due to growth in industrial land areas. While the share of industrial land in total urban land was 27% in 1982, it increased steadily to 50% in 1997, becoming the most important element in urban land use structure.

Table 1. The quantity and rate of urban land use growth in Beijing (1982-1997)

Land Use Type	Area in 1982		Area in 1992		Area in 1997		Quantity of growth Km^2	
	Km^2	%	km^2	%	Km^2	%	1982-1992	1992-1997
Urban Land Use	467	100	851	100	1000	100	384	149
Residential Land	231	49	314	37	331	33	83	17
Industrial Land	127	27	376	44	497	50	249	121
Other Urban Land	109	23	161	19	172	17	52	11

	1982 - 1992			1992 - 1997		
	Avg. annual growth area	%*	Avg. annual growth rate	Avg. annual growth area	%*	Avg. annual growth rate
Urban Land Use	38.4 km^2	100	8.2%	29.8 km^2	100	3.5%
Residential Land	8.3 km^2	22	3.6%	3.4 km^2	11	1.0%
Industrial Land	24.9 km^2	65	19.6%	24.1 km^2	81	6.4%
Other Urban Land	5.2 km^2	13	4.8%	2.3 km^2	8	1.5%

* Contribution share in total urban land use growth

3.2 Measuring the spatial differentiation of urban growth

In order to explore and understand the spatial features and trends of urban land use growth among different urban environments in multiple temporal periods, it is essential to develop some kind of comparable and comprehensive indictors of development (Murbandy, 2001). The most commonly used indictor for describing the spatial differentiation of urban growth in the current literature in China is to compare the annual urban growth area, i.e. the area of new urban development divided by the temporal units, among different orientation sectors (X. Yu, 1986, Z. Fan, J. and Cheng, 1997, Y. Zong and Y. Tang, 1999). This indictor is straightforward and simple but is strictly speaking not comparable due to the unequal areas of different orientation sectors. Shi and He proposed an indictor of intensity index, which is the average annual proportion of new urban development to the area of non-urban land in the initial year (Shi and He, 2001). However, the disadvantage of this indicator is exaggerations at near

suburban locations where the areas of non-urban land in the initial year are usually small, and of underestimates where the areas of non-urban land in the initial year are rather big.

The indicator we propose for the Beijing database is the Average Annual Growth Index (AAGI). It does not have any of the shortcomings mentioned above. AAGI of a spatial unit is defined as the average annual proportion of new urban development to its total area. In fact, it is the average annual growth area standardized by the total area of the specific spatial unit.

$$AAGI_{(i,\,(t,\,t+n))} = (U_{i,\,t+n} - U_{i,\,t})*100 / A_i / n$$

$AAGI_{(i,\,(t,\,t+n))}$	the average annual growth index of spatial unit i at the growth period of t to t+n year.
$U_{i,\,t}$, $U_{i,\,t+n}$	the areas of urban land use at the starting year t and end year of t+n of the growth period
A_i	the total area of spatial unit i

Using the township-level boundary polygons of Beijing as basic spatial units (155 in total), we calculate for each of the two growth periods, 1982 – 1992 and 1992 – 1997, the AAGIs of urban land use and its two main components, residential land and industrial land. Further we classify the resulting 155 AAGIs for the first period 1982 – 1992 into five types of spatial differentiation characteristics using the "natural breaks" classification method provided with a GIS. This method identifies breakpoints between classes using a statistical formula (Jenk's optimization). Basically the Jenk's method minimizes the sum of variance within each of the classes. For the second period 1992 – 1997 we apply the same classification as for the first one.

3.3 Spatial pattern of urban land use growth in Beijing

First we present results for urban land use growth as a whole, thus the sum of all increases in built-up land in Beijing including residential and industrial land as the most important components. Table 2 presents statistics of the AAGI calculated for the 155 townships while the figure 1 shows the respective maps.

For the period 1982 – 1992 the overall AAGI of urban land use based on the total area of the Beijing case study is 0.67. The average AAGI of all the 155 townships is 0.78 and the maximum is 3.99. Compared to the first period, AAGI decreases between 1992 and 1997, indicating that urban land use growth has become slower. The overall AAGI is now 0.52 and the average of all townships is 0.63, and the maximum is 3.85.

In the period 1982 to 1992 the distribution of the spatial differentiation types obviously takes a concentric pattern with the grade of spatial differentiation decreasing from the central urban districts to the outer. Urban land use growth here is quite agglomerative and centripetal. More than half (57% or 219 km^2) of the new urban development, represented by the two fastest development types 1 and 2, is concentrated in 44 township units. They occupy only one fifth of the total area. Most of those strong growth centers are situated in the near suburban circle with a distance of less than 20 km to the central urban district.

In the second period 1992 to 1997, the most active urban growth centers are located in the near northern suburban areas. There six of the seven township units show the spatial differentiation Type 1 indicating highest development. The majority of the new urban development takes place in the northern triangle sector and the southern converse-triangle sector while the eastern and western parts are mainly slower growth types. The northern

triangle sector comprises 40 township units located between Beijing – Changping Highway and Beijing – Huirou Highway. Its share in the new urban development is as high as 45% while its share in total area is only 23%. The southern converse-triangle sector includes 25 township units contributing 23% to the new urban development while occupying and area of only 12%. The remaining other areas, mainly in the eastern and western parts, contribute only 31% to the new urban development but occupy 65% of the total area.

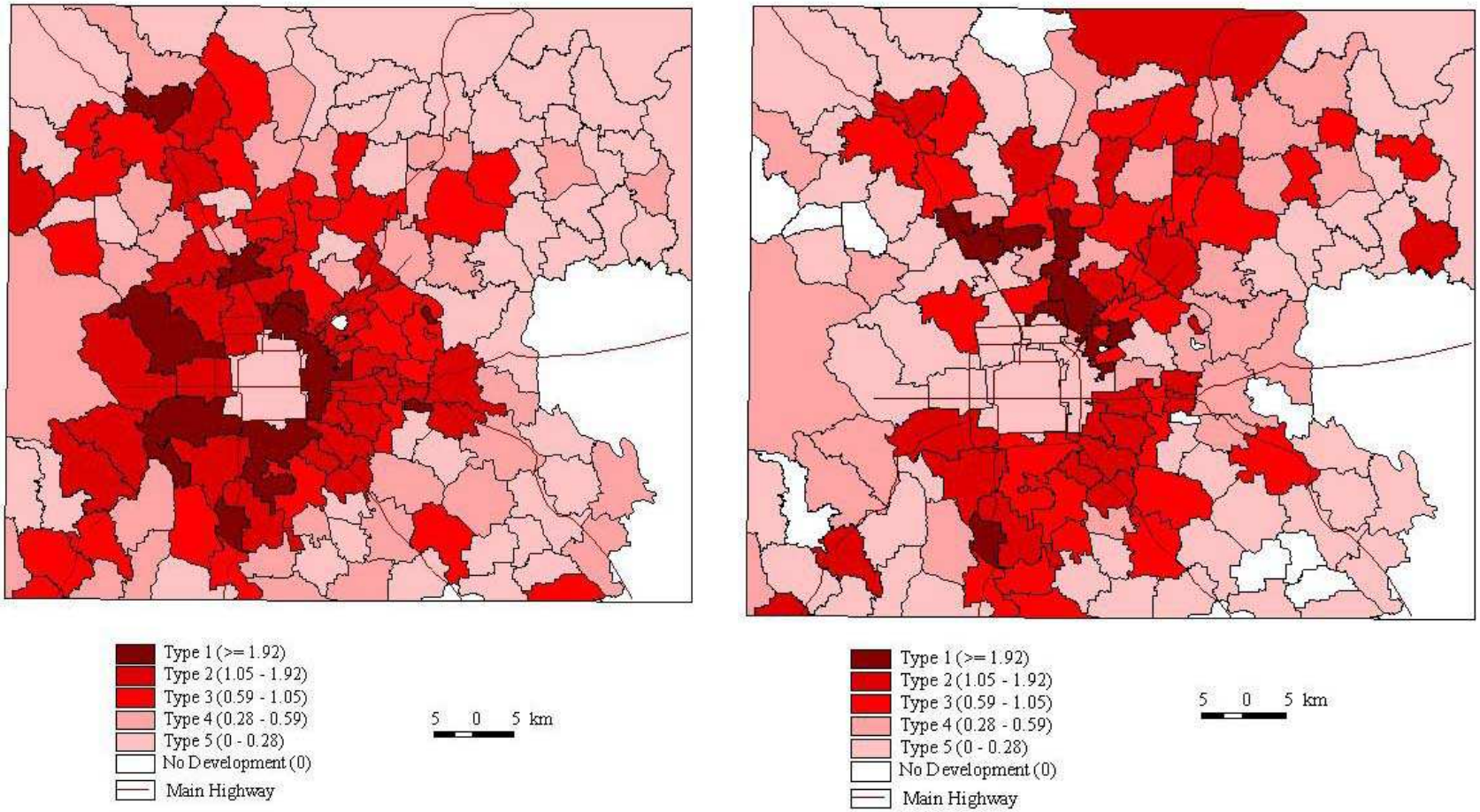
Figure 2 illustrates urban land use in the base year of 1982, new development in the first growth period of 1982 – 1992, and new development in the second growth period of 1992 – 1997. The spatial pattern of urban land use growth shows the following characteristics: First, urban land use in Beijing is sprawling outward concentrically, and has seriously encroached the planned green belt. In the 1st General Plan of Beijing drafted in 1958, a large circular sector with a total area of 314 km^2 between the central urban mass and its surrounding satellite towns has been planned as green belt and reserved for agricultural use. But from 1982 to 1992, the area of the planned green belt decreased by 38% from 260 km^2 to 160 km^2 (Zhao, 1996, Zhang, 1997).

Second, the growth centers of urban land use are actively shifting toward the northern part. The comparative analysis of spatial differentiation in Beijing in the period of 1982 – 1992 (Map 1) to that in the period of 1992 – 1997 (Map 2) shows that the spatial distribution of the most rapid growth units (Type 1) has shifted from the concentric and symmetric pattern in the first growth period to the agglomerative pattern in the northern part in the second growth period.

Table 2. Spatial differentiation of urban land use growth in Beijing

Type	AAGI	Number of units	Area of new development		Total area	
			km^2	share %	km^2	share %
Period 1982 – 1992						
Type 1	≥ 1.92	11	99	26	342	6
Type 2	1.05 – 1.92	31	121	33	865	15
Type 3	0.59 – 1.05	31	72	19	917	16
Type 4	0.28 – 0.59	30	55	14	1274	22
Type 5	0 – 0.28	50	37	9	2340	41
No development	0	2	0	0	10	0.2
Total	0.67	155	384	100	5752	100
Period 1992 – 1997						
Type 1	≥ 1.92	9	19	13	138	2.4
Type 2	1.05 – 1.92	22	52	35	754	13
Type 3	0.59 – 1.05	31	37	25	897	16
Type 4	0.28 – 0.59	27	24	16	1197	21
Type 5	0 – 0.28	53	16	11	2450	43
No development	0	13	0	0	316	5.5
Total	0.52	155	149	100	5752	100

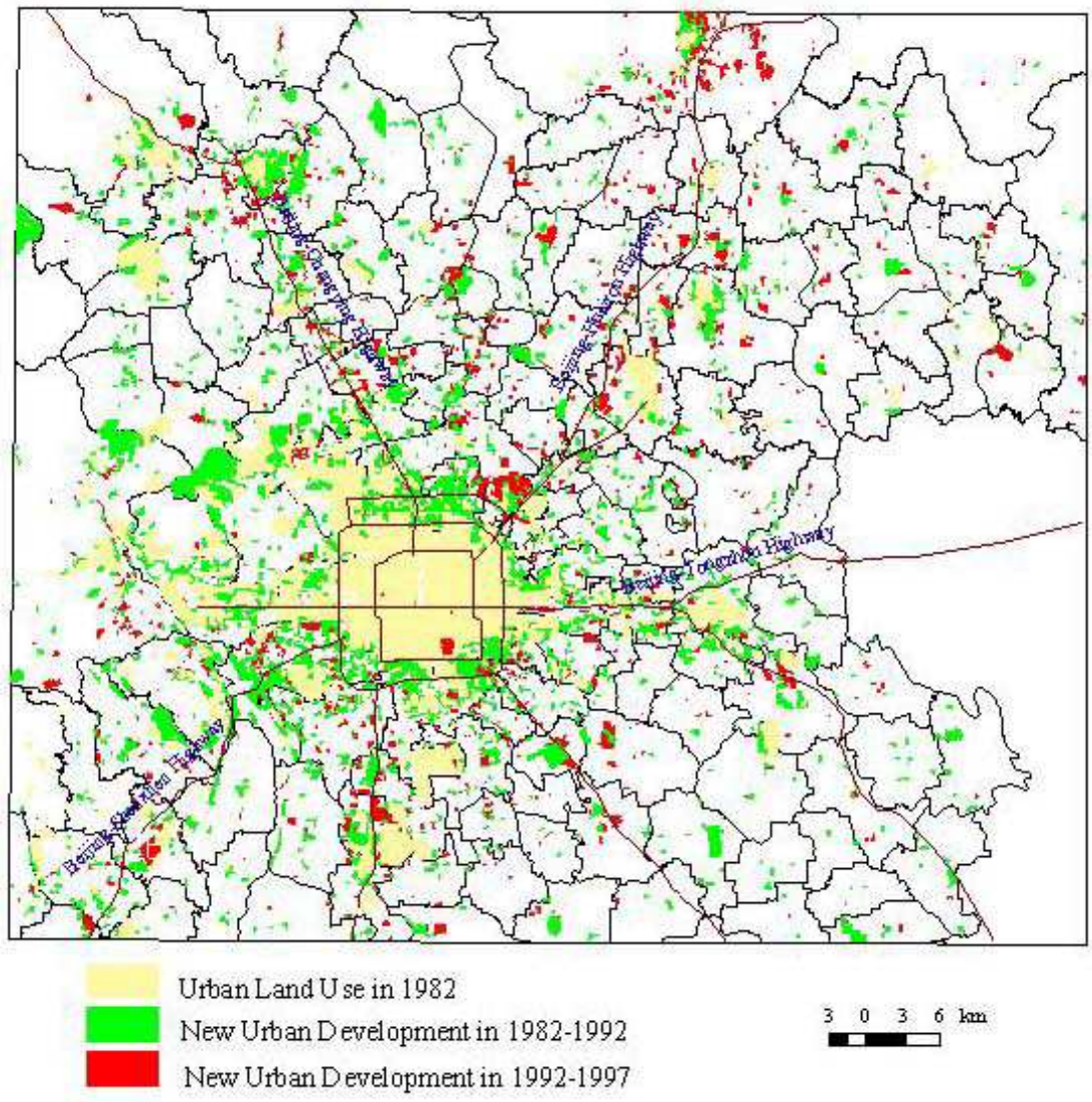
Figure 1. Spatial differentiation of urban land use growth in Beijing



AAGI for the period 1982 -- 1992

AAGI for the period 1992 -- 1997

Figure 2. Spatial process of URBAN LAND USE GROWTH in Beijing 1982—1997



3.4 Spatial pattern of residential land development in Beijing

The overall AAGI of residential land use growth in Beijing in the period of 1982 – 1992 is 0.14. The average of the 155 townships is 0.15 with a maximum of 3.28. For the period 1992 to 1997, the overall AAGI decreased to 0.06, less than half of that in the previous period. The township average and maximum is respectively 0.07 and 1.78. Obviously, residential land development has become significantly slower. Table 3 and figure 3 present maps and summaries of the AAGI typology.

In the period 1982 – 1992 new residential development is spatially highly congregated. Nearly 70% of it is concentrated in 12 township units occupying less than 8% of the total area. More than half of the total area, some 106 township units do not have any new development at all. Strong agglomerative features are also true for the period 1992 to 1997, when only 4 townships with a high AAGI (Type 2) account for 45% of the new development area. More than two thirds of the study area show no development at all.

Residential land development is highly concentrated and shows a concentric spatial pattern with the northern suburban locations being the most active area (see figure 5). In the period 1982-1992, the growth centers of residential land development are located at Dongsheng, Chaoyang and Nanyuan townships. Their average distance to the urban center is about 7.5 km and their average AAGI is 2.08, nearly 15 times the overall level.

In the second period the growth centers remain in the northern near suburban areas, but have moved a bit further outward. They are situated in Datuan, Liaguangyiug, Jiangtai and Nanmofang townships. Their average distance to urban center is about 10.8 km while its average AAGI is 1.48 and almost 24 times of the overall level in this period (table 4). This is quite similar to the static urban residential growth model (Anas, 1978), where urban development is perceived as an incremental process. In each period a developed ring is added to the existing urban periphery to accommodate population growth.

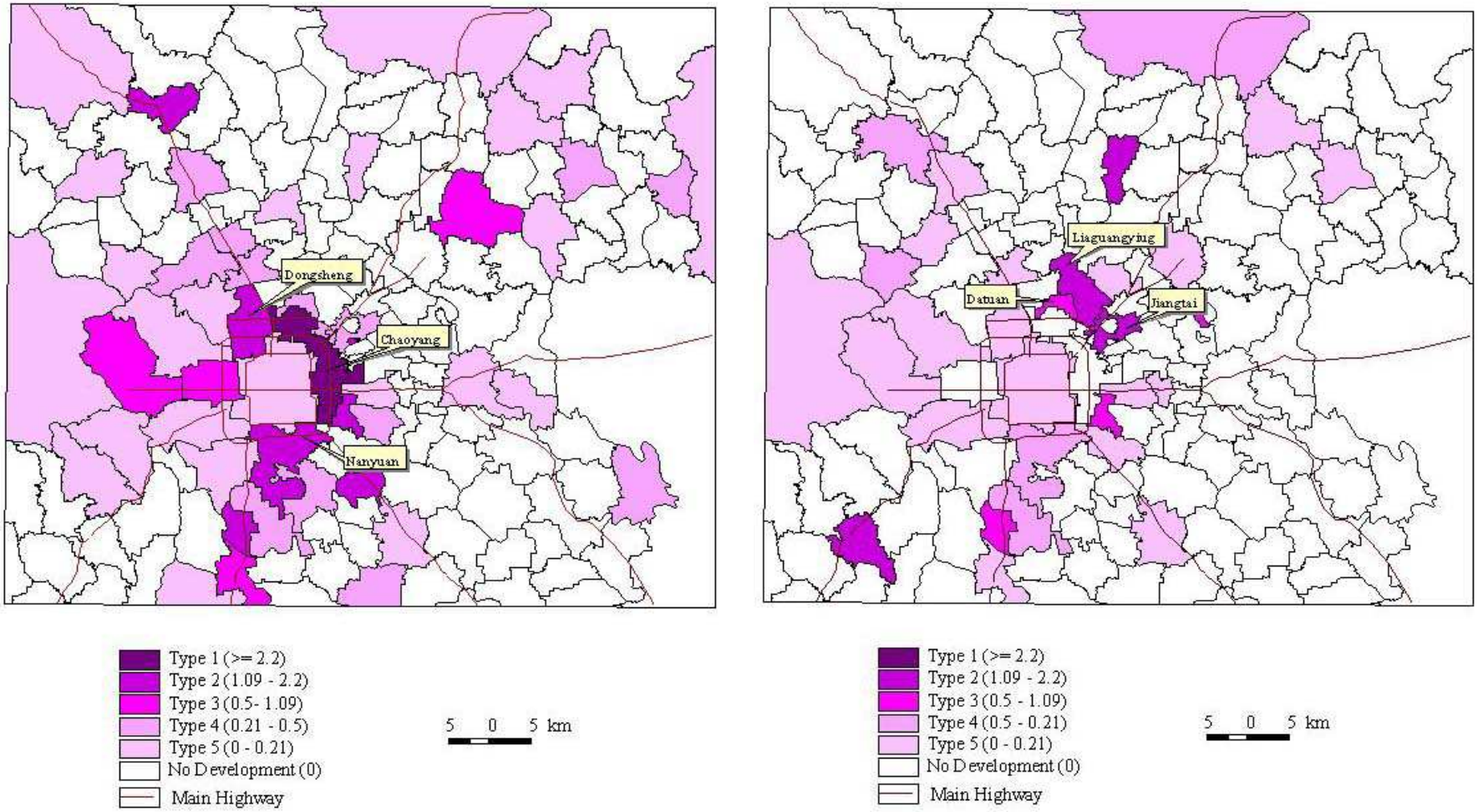
Table 3. Spatial differentiation of residential land development in Beijing

Type	AAGI	Number of units	Area of new development		Total area	
			km^2	share %	km^2	share %
Period 1982 – 1992						
Type 1	≥ 2.2	1	18.1	21.8	56	1.0
Type 2	1.09 – 2.2	6	25.7	31.0	162	2.8
Type 3	0.5 – 1.09	5	14.4	17.3	222	3.9
Type 4	0.21 – 0.5	13	11.2	13.5	369	6.4
Type 5	0 – 0.21	24	13.6	16.4	1633	28.4
No development	0	106	0	0	3310	57.5
Total	0.14	155	83	100	5752	100
Period 1992 – 1997						
Type 1	≥ 2.2	0	0	0	0	0
Type 2	1.09 – 2.2	4	7.6	44.7	107	1.9
Type 3	0.5 – 1.09	4	1.6	9.4	39	0.7
Type 4	0.21 – 0.5	5	5.4	31.8	394	6.8
Type 5	0 – 0.21	18	2.4	14.1	951	16.5
No development	0	124	0	0	4261	74.1
Total	0.06	155	17	100	5752	100

Table 4. Residential growth centers in Beijing in 1982 – 1997

Growth period	Growth center	Distance to urban center	Spatial differentiation type (AAGI)	
			1982 -- 1992	1992 -- 1997
1982 -- 1992	Dongsheng -- Chaoyang -- Nanyuan	7.5 km	Type 2 (2.08)	Type 5 (0.19)
1992 -- 1997	Datuan – Liaguangyiug -- Jiangtai	10.8 km	Type 3 (0.28)	Type2 (1.48)

Figure 3. Spatial differentiation of RESIDENTIAL land development in Beijing



AAGI for the period 1982 -- 1992

AAGI for the period 1992 -- 1997

4.4 Spatial pattern of industrial land development in Beijing

The overall AAGI of industrial land in Beijing in the period of 1982 – 1992 is 0.43, three times that of residential land in the same period. The average of all townships is 0.57 and the maximum is 3.99. For the 1992 – 1997 period the overall AAGI is 0.42, almost the same as in the pervious period. The average value now is 0.5 while the maximum is 3.01. Table 5 and figure 4 summarize the AAGI of industrialized land for the two time periods.

Table 5. Spatial differentiation of industrial land development in Beijing

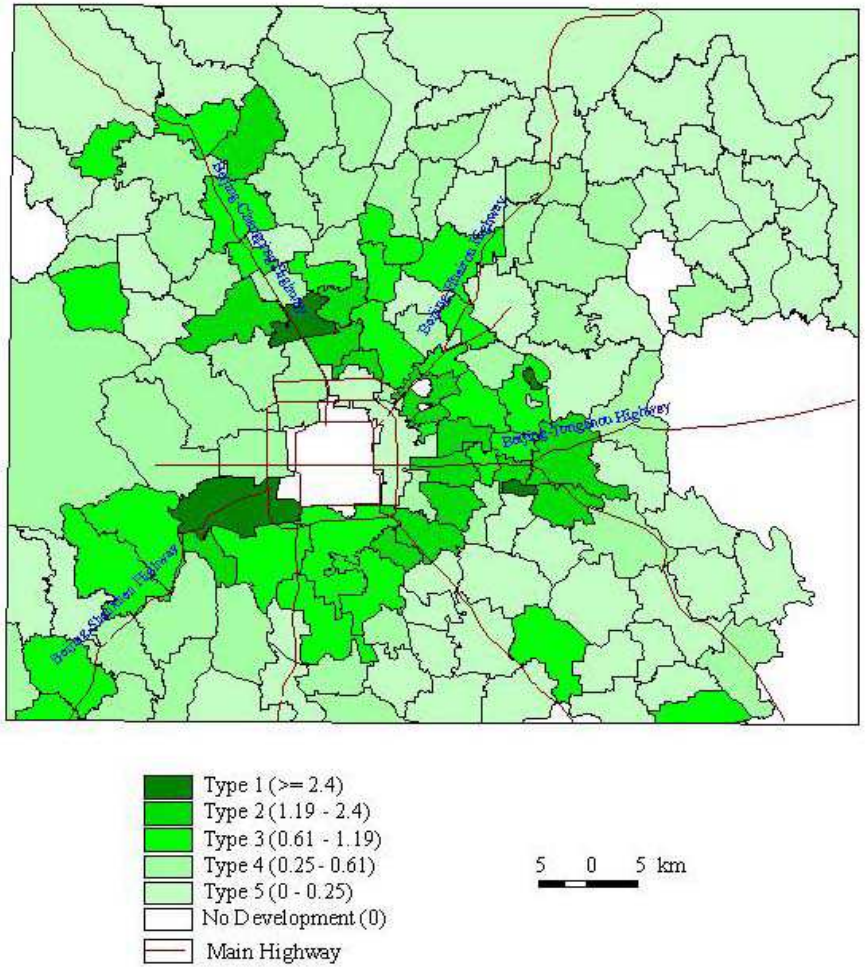
Type	AAGI	Number of units	Area of new development		Total area	
			km^2	share %	km^2	share %
Period 1982 – 1992						
Type 1	≥ 2.4	3	20	7.9	63	1.1
Type 2	1.19 – 2.4	17	52	20.9	346	6.0
Type 3	0.61– 1.19	36	94	37.7	1074	18.7
Type 4	0.25 – 0.61	34	51	20.6	1409	24.5
Type 5	0 – 0.25	59	32	12.9	2672	46.5
No development	0	6	0	0	189	3.3
Total	0.43	155	249	100	5752	100
Period 1992 - 1997						
Type 1	≥ 2.4	1	3	2.2	17	0.3
Type 2	1.19 – 2.4	18	30	25.0	389	6.8
Type 3	0.61– 1.19	30	47	38.7	1028	17.9
Type 4	0.25 – 0.61	31	26	21.9	1316	22.9
Type 5	0 – 0.25	59	15	12.2	2562	44.5
No development	0	16	0	0	439	7.6
Total	0.42	155	121	100	5752	100

In both periods we see industrial development in nearly all townships. Especially in the first period development is rather evenly scattered. The importance of extremely fast or slow development types area limited. After 1992 the spatial differentiation of industrial land development becomes a bit more distinct.

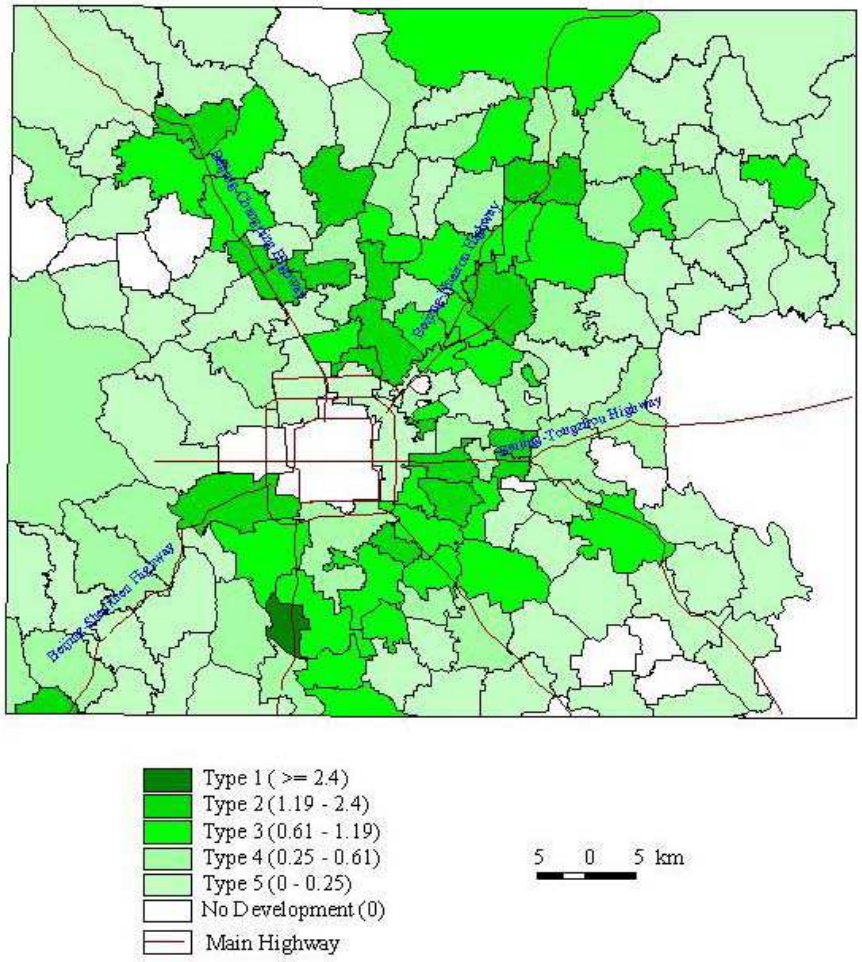
Industrial growth centers tend to cluster around major highways and form several growth axes. This becomes especially visible in the period 1992 to 1997. In general the growth axes are shifting toward the northern and northeastern parts of Beijing (Table 6). This means a restructuring of the cities traditional industrial land distribution. Industrial land development used to be planned and allocated in the southern parts, while development in northern areas was quite slow.

Before 1992 there were two growth axes in the south. The faster and more agglomerative one is the Gaopai Diao – Tongzhou growth axis, with the length of 20 km, along the Beijing – Tongzhou highway eastwards. The 1982 – 1992 industrialized AAGI there is 1.62, nearly four times higher than the overall industrialized land AAGI of 0.43. The other growth axes is the Lugou Qiao – Dou Dian direction, with a length of 33 km, along the Beijing – Shenzhen highway southwestwards. Industrial land development in this period is rather small in the northeastern part.

Figure 4. Spatial differentiation of INDUSTRIAL land development in Beijing



AAGI for the period 1982 – 1992



AAGI for the period 1992 -- 1997

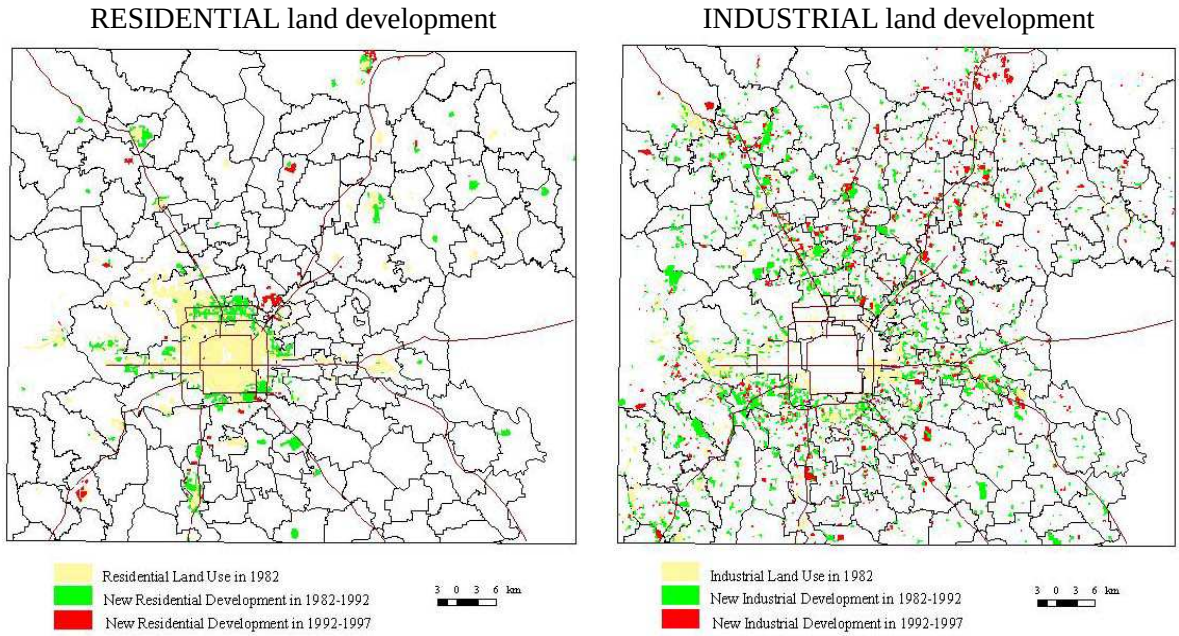
After 1992, the growth axes are shifting towards the northern and northeastern parts. The two southern growth axes from the pervious period virtually stopped extending further. They now classify into the low development Type 4 with their AAGIs decreasing significantly. Most of the new development in the southern parts now occurs in between the former growth axes. In the northern part three distinct growth axes advanced. The Beijing–Changping growth axis, the Beijing–Xiaotangshan growth axis and the Beijing–Huairou growth axis. Their AAGIs are respectively 1.09, 1.42 and 1.06, all belonging to the fast development Type 2.

Table 6. Spatial transformation of industrial land growth axes in Beijing 1982 to 1997

Growth axes	Orientation	Length km	Spatial differentiation type (AAGI)		*Change*
			1982 – 1992	1992 – 1997	
Gaopai Diao – Tongzhou	East	20	Type 2 (1.62)	Type 4 (0.64)	Decrease
Lugou Qiao – Dou Dian	Southwest	33	Type 2 (1.38)	Type 3 (0.58)	Decrease
Beijing -- Changping	Northwest	30	Type 3 (1.04)	Type 2 (1.09)	Increase
Beijing – Xiaotangshan	North	23	Type 3 (0.78)	Type 2 (1.42)	Increase
Beijing – Huairou	Northeast	45	Type 4 (0.29)	Type 2 (1.06)	Increase

Figure 5 compares the spatial process of residential and industrial land use growth. Especially in the first period, the growth centers of residential land development is highly concentrated in the city center, while industrial land expansion takes place further away from the center. Industrial land development is in general scattered all over the area with some growth axes becoming visible. Residential land development shows much more clustered features.

Figure 5. Residential and industrial land use growth in Beijing 1982 to 1997



Chapter 4 SHANGHAI

4.1 China's commercial center

Shanghai is one of China's most important and successful commercial centers with a history of intense industrialization and more recently an impressive growth in its tertiary sector. There has been a significant increase in GDP per capita. In 1998 GDP per capita in Shanghai was 28253 Yuan. This is nearly five times more than the national average (excluding Hong Kong) of 6392 Yuan and substantially more than the next two richest provinces, namely Beijing with 18482 Yuan and Tianjin with 14808 Yuan per capita GDP.

Shanghai's population significantly increased after the foundation of the People's Republic of China in 1949. Between 1969 and 1978 there was a period of slightly shrinking population, which recovered after 1978 and continued at a relatively low level (Table 7). Today population in Shanghai province amounts to 16.7 million, a 25 percent increase since the last census in 1990, when the population was 12.8 million. The increasing number of people coming into the city from other provinces is the main reason for the growth. According to the fifth population census report, about 72 percent of the increase in population is people from other provinces, while the number of registered permanent residents in the city has retained a negative growth for the eight consecutive year.

Population today is strongly concentrated in the inner urbanized area of Shanghai municipality. Population density in this region is 16378 people per km^2, with Beijing (15437/km^2), Tianjin (21519/km^2) and Hong Kong (28405/ km^2) among the highest in China. It is also high in international comparison where only some seven cities outside China exceed 17000 people per km^2, such as Seoul, Mumbai, Cairo, Manila or Delhi (Demographia, 2001). Furthermore Shanghai has a floating population of 2.5 to 3 million.

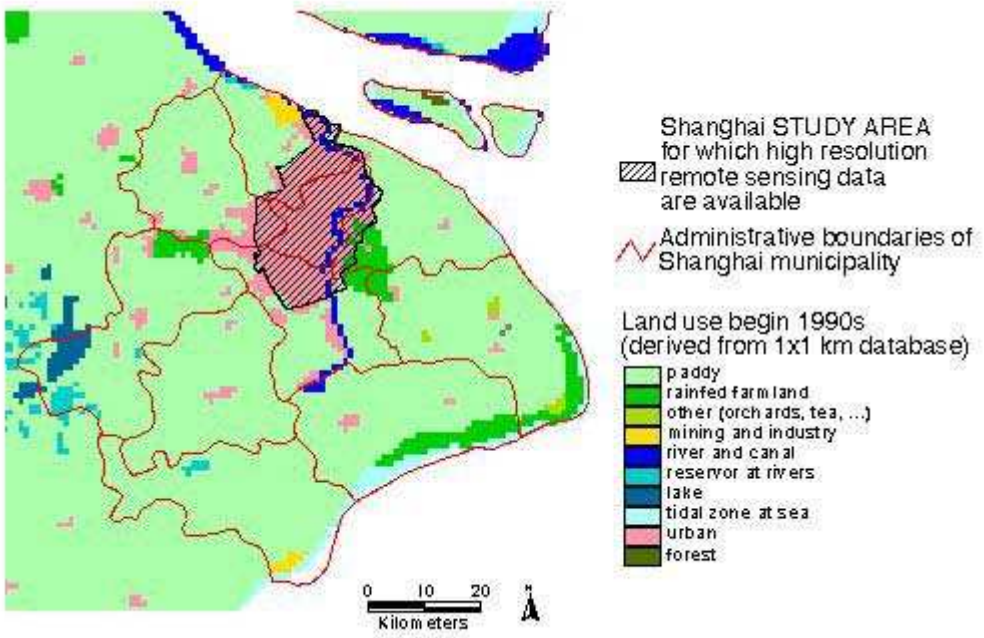
Table 7. Population in Shanghai municipality (in million) for selected years

1953	*1965*	*1978*	*1982*	*1985*	*1990*	*1994*	*1996*	*1998*	*2001*
6.20	10.94	10.98	11.8	12.17	12.84	12.99	13.04	13.08	16.74

Source: Shanghai Statistical Yearbook 2001 and "Major figures on 2000 population census of China"

The study area for which high resolution (3x3 meters) remotely sensed land use data are available extends over 480 km^2. The total area of Shanghai province (municipality) amounts to 6.340 km^2. Figure 6 presents land use data from the beginning of the 1990s for a grid cell size of 1x1 km (Liu, 1996) for the whole of Shanghai province and displays the extent of our study area. Thus we cover in our analysis the majority of today's dense urban center of Shanghai.

Figure 6. Location of Shanghai case study area in the Shanghai province



4.2 Extent of land use changes

The analysis presented here relies on high-resolution remote sensing data with a ground cell size of 3x3 meters for the years 1967, 1989 and 1999. The total analyzed area however is confined to the inner city of Shanghai amounting to a total area of 484 km^2. The database distinguishes 25 land cover categories (Table 8). The separation of the different categories reflects the potential of remotely sensed image interpretation. Figure 7 provides a reclassification of the original data featuring those categories that are mostly contributing to land use change in the study area. A map animation of Shanghai's land use at the three different time points can be found at the IIASA-LUC GIS Web pages (http://www.iiasa.ac.at/Research/LUC/GIS/jv/AnimShgLu.html).

Shanghai's extensive urban growth process is reflected in the significant increase in built-up areas at the expense of cultivated land. The growth rate was apparently especially large in the last decade compared to the 22-year period between 1967 and 1989. However, we have currently no data for the end of the 1970s or begin of the 1980s, when the economic reforms started in China. It could well be that much of the growth between 1967 and 1989 has actually happened only after 1980.

It is interesting to note that in our study area urban growth was more driven by residential area expansion than by increases in industrial and commercial area. After 1989 residential settlement area did not only expand but also became more concentrated, which is indicated by the decrease in discontinuous settlement. Cultivated land covered 48% of our study area in 1967 and nearly disappeared by 1999. In the following we will discuss in detail the most important land use change trends including a detailed analysis of the land conversion processes.

Figure 7. Distribution of major land use categories in 1967, 1989 and 1999

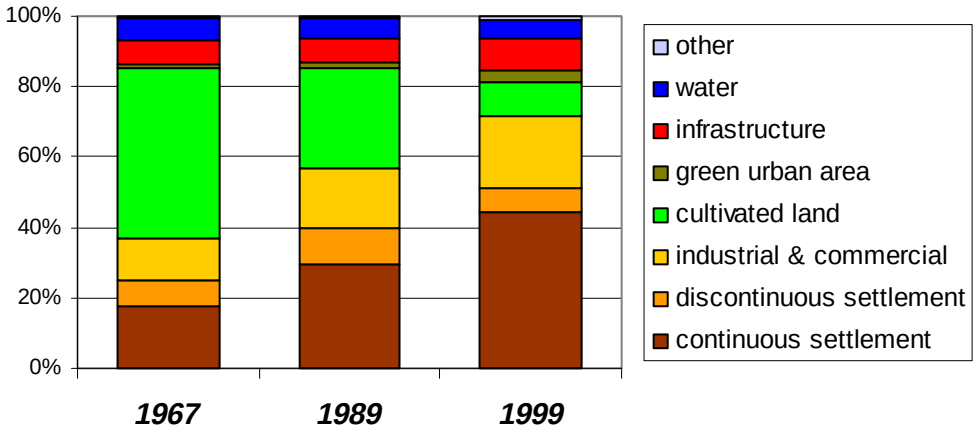


Table 8. Land use categories in Shanghai 1967, 1989 and 1999 (Area in km^2)

		1967	1989	1999
Residential	Continuous settlement	84.1	141.8	215.1
	Discontinuous settlement	36.1	49.7	31.3
Commercial	Industrial and commercial area	52.5	76.3	90.4
	Public facility	5.8	7.7	8.0
Cultivated	Cultivated land	232.8	135.8	47.5
Green urban	Green urban area	6.8	8.2	16.2
Infrastructure	Harbor	1.9	2.2	2.6
	Airport	10.3	9.2	6.4
	Railway track system	1.8	1.8	2.0
	Railway buffer	2.5	2.4	2.4
	Other road buffer	11.4	12.1	15.9
	Major road buffer	4.7	5.7	8.3
	Highway buffer	0.0	0.0	5.8
Water	Lake	0.3	0.5	1.4
	Canal buffer	4.3	2.2	0.8
	River buffer	2.7	3.0	2.9
	Broad river buffer	2.3	3.1	2.9
	Huangpu river area	19.7	19.9	19.5
Other	Other land	0.2	0.5	2.2
	Sport and leisure area	0.7	1.0	1.6
	Reclamation of land	1.4	0.2	0.3
	Tidal land	1.2	0.1	0.1

4.3 Land conversion processes and spatial pattern of urban growth

Major increases in residential areas

The net increase in the area of continuous settlement was 54 km^2 in the period 1967 to 1989 and as much as 73 km^2 in only ten years from 1989 to 1999. The majority of the newly built-up land for continuous settlement was established on former cultivated land. Especially in the ten years before 1999, conversion in areas formerly classified as discontinuous settlement becomes important (Table 9). A limited amount of areas formerly classified as Settlement

areas changed to Industrial and Commercial land, and during the 1989-1999 period also to Infrastructure.

Discontinuous settlement continued to consume cultivated land areas. However, quite some discontinuous settlement areas have been converted to continuous settlements indicating a settlement concentration process.

Residential land development is obviously the dominant driving force of urban growth in our study area region. In the first period 1967 to 1989, average annual growth of residential land amounted to 3.2 km^2, and further accelerated in the period 1989 to 1999 to 5.5 km^2.

Growth in residential area in the study area does not show a particular growth pattern. Rather it seems that over time there was a steady concentric outward extension of the city center. However, the three time points available and the rather limited study area do not allow to portray all the development dynamics. Outside our study area there has been some more development of built-up land especially in the near suburban districts of Jiading, Jinshan, Minghang and Pudong New Area, where recently the urbanization process is accelerating. There are also large-scale satellite towns in Shanghai's suburban counties, such as Jinshan and Baoshan for petrochemical and steel industries that were developed during the 1970s.

China has put special emphasis on the development and opening of Pudong New Area, one of China's "Special Economic Zones", started in the beginning of the 1990s. The aim was to create a model for a modern, multi-functional first-class city in the 21st century. Pudong is home to 1.6 million people and covers a total area of 522 km^2, of which about 100 km^2 have so far been urbanized. It is located on the east bank of the Huangpo river. Our study area includes some 90 km^2 of Pudong and thus includes the majority of the area so far developed for residential and industrial purposes. Until the late 1980s Pudong could only be reached via ferries from the city center. In 1988 a road tunnel under the river was built and in the 1990s three bridges have been constructed to foster a more extensive development in Pudong.

Increases in industrial and commercial land

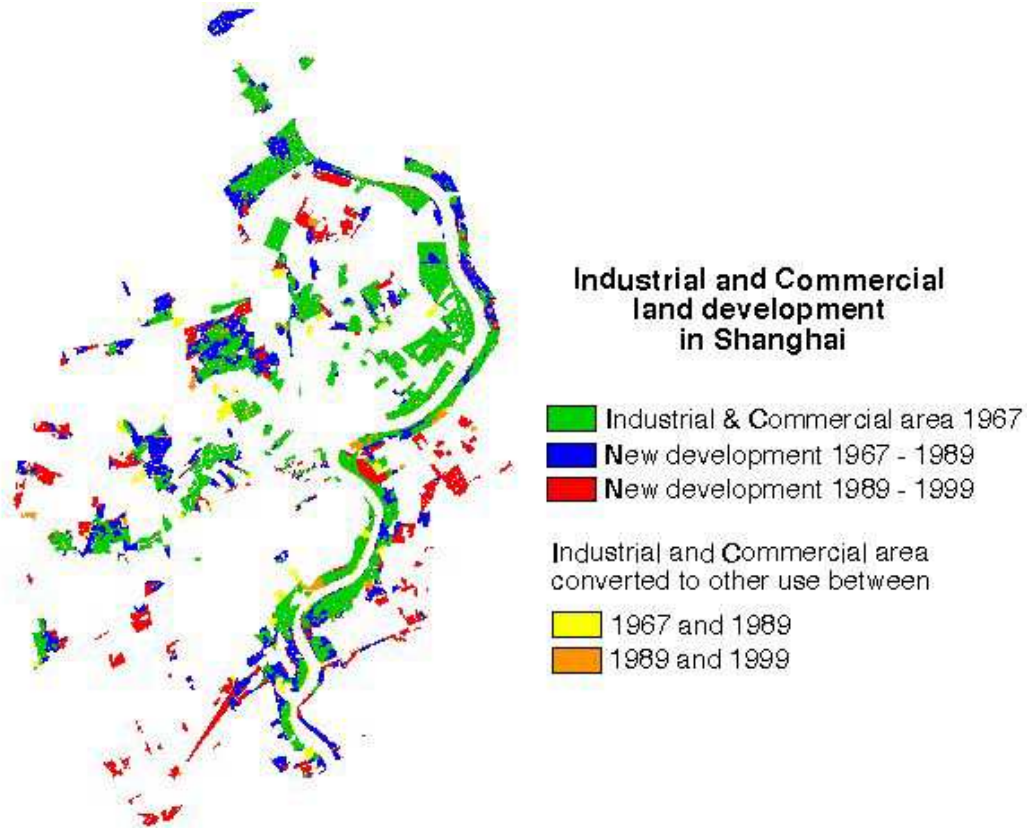
In the 1930s Shanghai was the center of finance and trade in the Far East, in 1949 light industries still dominated production. Shanghai changed under the planned economy after 1949 from a consuming city to a producing city. Industrialization played a leading role in its urbanization since it had been specifically set up as one of China's most important comprehensive manufacturing industry centers. After 1970 the share of heavy industry in total production occupied as much as 50 per cent and more. Locating heavy industry in the city center and in a ring-like structure around the city caused serious environmental problems.

In our study area industrial and commercial land areas were 52 km^2, 76 km^2 and 90 km^2 in the three years observed, translating in an average annual increase of 1 km^2 for the first period and 1.4 km^2 for the second. This is less than a third of the annual growth rates of settlement areas. To some extent this reflects the policy of Shanghai municipality to relocate polluting industries to the outskirts of the city as Shanghai has been subject to serious pollution. Only since the beginning or mid of the 1990s the level of water and air pollution has somewhat improved. Planning for Shanghai foresees a further decrease of industry, especially in the very center of the city, in favor of developing the tertiary sector.

Industrial and commercial areas tend to cluster around the big rivers. In 1967, the majority of industrial and commercial land was at the Huangpo and Wusong riverbeds. In the period 1967 to 1989 the fragmented pattern of industrial and commercial land apparently converted into a more concentrated structure. Large industrial and commercial entities have emerged especially in old central Shanghai, west of the Huangpo river.

After 1989 these central large industrial plots did not develop further. There was some expansion east of the Huangpo river in Pudong and in the northern and southern fringes of our study area (figure 8).

Figure 8. Industrial and commercial land development in Shanghai



Substantial decline in cultivated land area

In 1967 half of our study area, 233 km^2 was cultivated land. This primary farmland declined to 136 km^2 by 1989 and 47 km^2 by 1999. Thus in the ten-year period 1989 to 1999 annual consumption of cultivated land was nearly 9 km^2. More than two thirds of the cultivated land losses are due to construction of settlement area, some 15 to 20% is converted to industrial and commercial areas. After 1989 the conversion to infrastructure and green urban area becomes an important factor of cultivated land reduction (Table 9).

Increases in green urban areas

Green urban areas increased substantially from 6.8 km^2 to 8.2 km^2 and 16.2 km^2 in the three time points. New green urban areas generally stem from cultivated land. While before 1989 there was still some loss of green urban areas to industrial and commercial land, after 1989 virtually no existing green urban areas were converted to other land uses. Growth in urban green area is usually due to the construction of large open green areas in the form of parks and recreation areas.

Green area of open space is a common indicator for urban environment living conditions. In our study area we can estimate a population of about 8 million. On top of the 16 km^2 urban green area we may assume a third of our classification 'discontinuous residential' areas being green area (i.e. 10 km^2) and approximately half of 'public facility' classification to be green area (i.e. 4 km^2). Thus we use an estimate of about 3.7 m^2 per capita of green land in our project area. Objectives for the city were 4 m^2 per capita in 2000 and 8 m^2 per capita in 2010 (Demographia, 2001). Despite the definition of "green space" varies between cities, 4 m^2 per capita is a very low figure in international comparison. For example larger European cities have usually more than 20 m^2 per capita of green space to which the public has access (Inforegion, 2000).

Urged by an increasing demand to upgrade its image as an international metropolis, major plans are underway to increase access to green areas. According to city planning, the city is to construct a 500-metre wide green belt which will run outside the 97-kilometers outer-ring road and two 50-metre wide belts which will run alongside the 189-kilometer suburban ring road. Shanghai plans to plant 330 km^2 of forest around the city by 2005 (Shanghai Environment News, 2001).

Table 9. Land cover change analysis for Shanghai 1967 to 1999

CONTINOUS SETTLEMENT land GAINS from:	***1967 - 1989***	***1989-1999***
Discontinuous settlement	13.5 km^2 (22%)	27.5 km^2 (34%)
Industrial and commercial area	2.8 km^2 (5%)	1.4 km^2 (2%)
Cultivated land	43.0 km^2 (70%)	48.2 km^2 (60%)
Sum of other	1.9 km^2 (2%)	3.8 km^2 (4%)
Total gains	61.2 km^2	80.9 km^2
CONTINOUS SETTLEMENT land LOSSES to:		
Industrial and commercial area	3.1 km^2	2.5 km^2
Infrastructure	0.2 km^2	4.5 km^2
Sum of other	0.3 km^2	0.7 km^2
Total losses	3.6 km^2	7.7 km^2
DISCONTINOUS SETTLEMENT land GAINS from:		
Cultivated land	28.1 km^2	13.4 km^2
Sum of other	1.2 km^2	0.9 km^2
DISCONTINOUS SETTLEMENT land LOSSES to:		
Continuous settlement	13.5 km^2	27.5 km^2
Industrial and Commercial	1.8 km^2	2.0 km^2
Infrastructure	0.1 km^2	2.2 km^2
Sum of other	0.2 km^2	1.0 km^2
INDUSTRIAL & COMMERCIAL land GAINS from:		
Continuous settlement	3.1 km^2 (10%)	2.5 km^2 (13%)
Discontinuous settlement	1.8 km^2 (6%)	2.0 km^2 (10%)
Cultivated land	21.1 km^2 (70%)	12.3 km^2 (63%)
Sum of other	3.8 km^2 (14%)	2.7 km^2 (14%)
Total gains	29.9 km^2	19.4 km^2
CULTIVATED land LOSSES to:		
Continuous settlement	43.0 km^2 (43%)	48.2 km^2 (54%)
Discontinuous settlement	28.1 km^2 (28%)	13.4 km^2 (15%)
Industrial and Commercial land	21.1 km^2 (21%)	12.3 km^2 (14%)
Green urban area	3.0 km^2 (3%)	6.1 km^2 (7%)
Infrastructure	2.1 km^2 (2%)	6.9 km^2 (8%)
Other	3.0 km^2 (3%)	3.1 km^2 (3%)
Total loss	100.3 km^2	89.9 km^2

Major increases in infrastructure

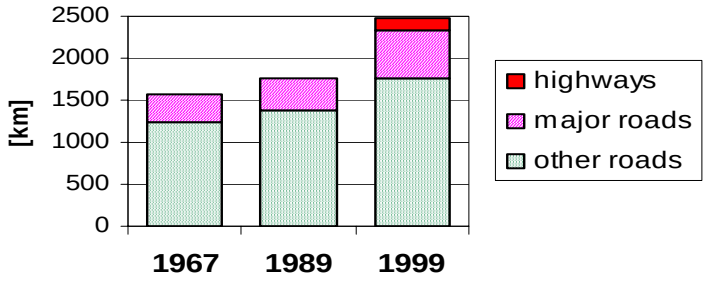
For a long time Shanghai has lagged behind investment in infrastructure considering its size and economic activity. Huge debts in urban infrastructure were accumulated during the 30 years after 1949 due to over-emphasis on "production first, life second". Only after the reform and opening policy took effect, investment in urban infrastructure showed a modest increase. In the beginning of the eighties investment in urban infrastructure was still only around 2% of GDP, in 1990 it was at 6% and increased to over 10% after 1995. Only in 1982, Shanghai drafted its first general plan since 1949, which advanced concrete principles to rationalize the city layout, establish a systematic town and set up an efficient transportation system (ESCAP, 2001)

The data in our project area show comparatively little development in the period 1967 to 1989 and we may assume that much of this construction work has occurred in the last decade of this period. The decade 1989 to 1999 in contrast shows substantial increases in the density of roads and also significant increases in major roads and highways (figure 9). An animation of the growth in road length is presented on the IIASA-LUC-GIS Web pages (http://www.iiasa.ac.at/Research/LUC/GIS/jv/AnimShgRd.html).

From the remotely sensed images road buffers of different size reflect the different road categories. For other roads the buffer is 3 pixels (9 meters), for major roads 5 pixels (15 meters) and for highways 10 pixels (30 meters). From these data the total road area was 16 km^2 in 1967, 18 km^2 in 1989, and then increased to 30 km^2 in 1999.

In contrast to roads there was virtually no development in the railway system. The harbor area increased somewhat. The number of airports has been reduced from four in 1967 to two in 1999. One of them has been converted into a public park, the other mainly to commercial area (see Table 9).

Figure 9. Road development in the Shanghai case study area



Chapter 5. Dynamic mechanisms of urban land use growth in China

In order to understand the features of urban growth patterns in China, it is essential to investigate its dynamic mechanisms, which are quite different from those in western industrialized countries, where urban land development is generally considered to be driven by the market mechanism subject to zoning based on urban planning. Individuals and enterprises are the main actors and their motives for profit-making determine the timing and locations of urban development, which is commonly referred to as the growth machine (Ackerman, 1999). However, with the rising concern of sustainable development, governments are increasingly getting involved to implement various growth control policies in order to minimize potential negative externalities of the market mechanism.

In contrast, in China urban land development used to be fully controlled by the state and municipal governments by means of an administrative allocation system. With the implementation of economic reform and opening policies since the 1980's, this system was found to be economically inefficient and inconsistent with the rapid social and economic development. A reform was issued including the introduction of a land leasing and pricing system. Thus the urban land supply system has been transformed into the current so called "two-track system", referring to the coexistence of an urban land market and an administrative allocation system. Due to the huge difference of land prices between the two systems, an unauthorized "black" land market has emerged. In addition, land development for TVEs (Township and Village Enterprises) is allowed to directly use collective land for construction without land requisition. Such diversified urban dynamic mechanisms had major impacts on the timing and spatial features of urban land use growth.

5.1 Urban land reform

In the long period of socialist planned economy, China did not have an independent management system for urban land allocation and development because land was not attributed a value and should be available free of charge. Urban land development is only an affiliated part of a planned construction project and supported by an administrative allocation system. Each planned construction project would specify the quantity and the site location of the land it needs. Once a planned project is approved by the responsible state authority, the local municipal government was supposed to ensure requisition of this land from collective farmer organizations to the state and then to allocate it to land users through administrative allocation while the approved construction project would allocate the required financial resources for land development and infrastructure construction.

Though the land users are required to pay a compensation fee to the previous tenants to cover their resettlement and damages to their normal production under the coordination of local government, it is generally called as free allocation because the compensation fee used to be quite small. Further, land use rights granted by administrative allocation do not have a limited term and are not transferable to other users or other uses. Thus, the administrative allocation of land use rights completely excludes the rent law and the market and pricing mechanisms.

Shortcomings of the administrative allocation system have been reviewed by a large body of literature (World Bank, 1993, Dowall, 1993, Tang, 1994) and can be summarized as follows:

(1) Inefficient land use. Industrial land used to take up an excessive proportion in urban land use structure and to occupy prime locations as industrial development projects were normally accorded higher priority in the socialist economic planning mechanism. According to statistics of 1990, 42.6 per cent of industrial enterprises in Shanghai, or 5639 out of the total of 13220,

were located within the 10 inner-city districts (Han, 2000). In comparison, Wu Jiang (1990) estimates that there are only 1898 industrial enterprises in the central urban districts in Beijing in 1989.

(2) Deliberate waste of land resources. As land is allocated free of charge and there are no mechanisms for transferring land between land users other than through the administrative channels stipulated by the state, it is advantageous for land users to apply for more land than required in order to avoid application problems in the future (Li, 1999, Tang, 1994).

(3) Severe shortage of funds on urban infrastructure construction. Local municipal government's financial capacity and coordination authority on urban infrastructure construction are very limited because investment on urban land development is provided by various higher-level state departments on project basis and urban land development itself can not produce any substantial revenue in the administrative system. Rather, revenue derived from urban land allocation and development is a very important component of state revenue in a market system. According to Hong Kong government statistics, the proportion of government revenue from the property and construction industry amounted on average to 33% of total revenue between 1983 and 1993 (Li, 1999). Severe shortage of construction funds will indispensably cause scarcity of urban land supply and slowdown of urban development.

With the implementation of economic reform and opening policy, the driving forces on urban land use growth become much stronger and more diversified. In 1986, the State Land Administration Bureau has been established for the overall management of urban and rural land as well as being responsible for land policy. Several economic entities, such as Foreign Direct Investment companies (FDI), joint ventures, private-owned enterprises, etc., have become new competitors for urban land use.

The administrative allocation system was not able to meet the new challenge because those new urban land users are basically not state-owned or collectively-owned and thus are not qualified to be serviced by the free allocation system. A reform of the administrative allocation system was necessary. The essence of this reform is to separate land use rights from land ownership rights. With the introduction of market mechanism, land use rights with time limits can be tradable and transferable in the market with a price or a paid fee through negotiation, tender or auction while the state still holds the ownership right of urban land. This transformation is commonly referred to as the paid-fee reform on urban land use system in China.

In the initial period, the paid-fee reform was experimented in the Special Economic Zones such as Shenzhen and some open cities such as Tianjin, Shanghai and Guangzhou and in land allocation to foreign land users. Shenzhen municipal government began to levy land use taxes in 1982 and to sell land use rights of 5 plots respectively through negotiation, tender or auction in 1987. The clause "*the right to use of land may be transferred in accordance with law*" was added to Article 10 Section 4 of the Constitution which states that "*no organization or individual may seize, buy, sell, lend or make any other unlawfully transfer of land*", and the amendment was approved by the National People's Congress in 1988, which officially announced the emergence of a urban land market in China.

Encouraged by the positive effects on improving land use efficiency and generating revenues, the paid transfer of land use rights is gradually extended to the whole country and all commercial land users. The "Provisional Regulations on the Conveyance, Granting and Transferring of the State Land Use Rights in Cities and Towns, 1991", enacted by the State Council in May 1991, aims to promote the establishment of a price mechanism and urban land market in China. "The Urban Real Estate Administration Law of the PRC" adopted at the 8th

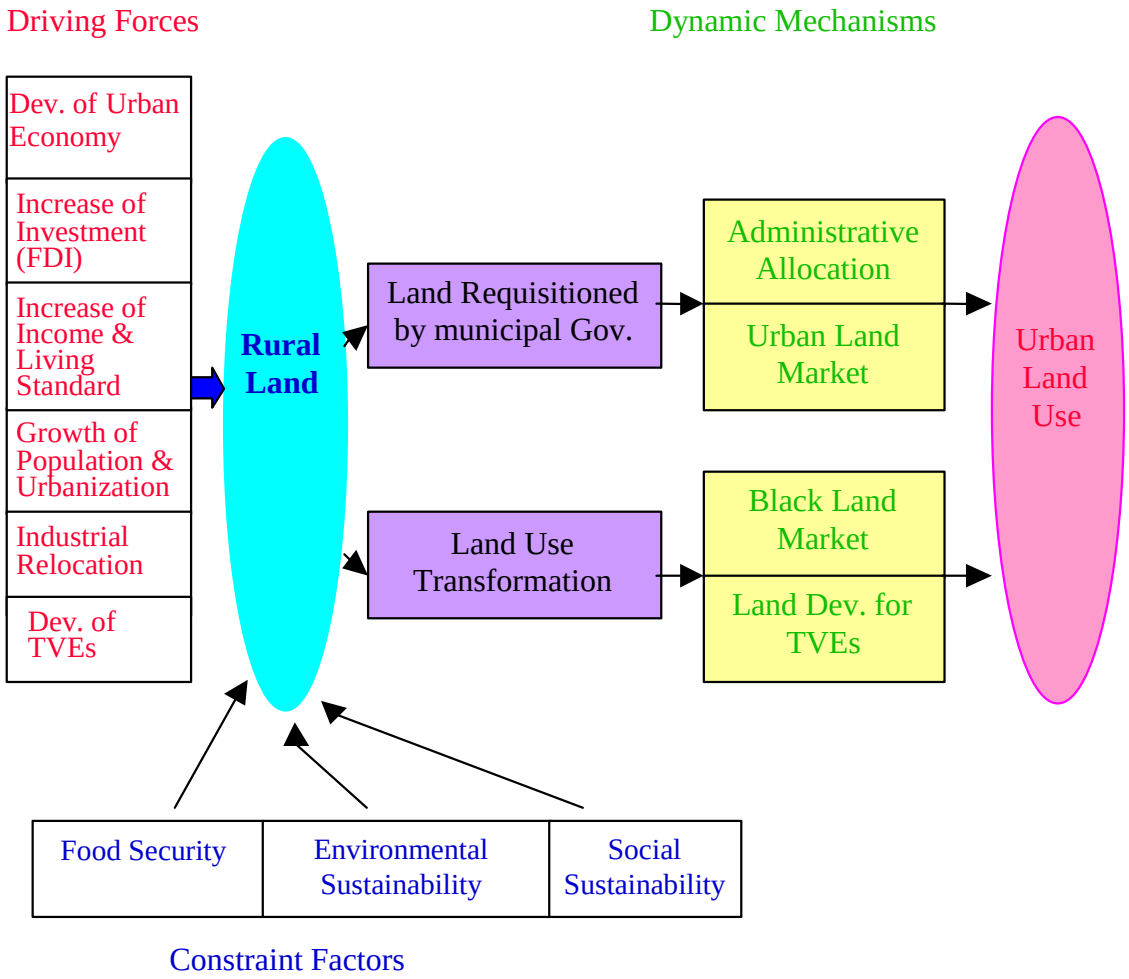
meeting of the Standing Committee of Eighth National People's Congress in 1994, legally announced the beginning of the "Two-track System", i.e. coexistence of urban land market and the administrative allocation system.

In Beijing, the paid-fee land use system was introduced rather late compared to coastal cities. For example, Beijing did not begin to collect land use taxes until the end of 1988, to rent or sell urban land use rights until in May 1992 when Regulations on the implementation of the "Provisional Regulations on the Conveyance, Granting and Transferring of the State Land Use Rights in Cities and Towns in Beijing" were issued.

5.2 A conceptual framework of urban dynamics

After examining the conversion process of rural land to non-agricultural land use, we propose a conceptual framework of urban dynamics in the Chinese context (Figure 10). Diverse driving forces, opposed and mitigated by some constraint factors related to social and environmental concerns, cause urban growth.

Figure 10. A Conceptual Framework of Urban Dynamic in China



Rural land is converted into urban land use through two channels. First, collectively-owned rural land is requisitioned by municipal governments and is converted into state-owned urban land use. It is allocated to land users either through the administrative allocation system or through urban land market. Second, rural land is developed for urban land use while it is still collectively-owned, which normally takes either of two forms: illegal urban land development ("black" land market) or land development for the construction of TVEs. The first channel can be called the formal because the use and ownership of the concerned land are both changed. On contrast, the second channel should be called the informal because the use of the land has been converted into *actual* urban land but its ownership is still registered as the collectively-owned.

5.3 Urban growth driving forces and constraint factors

Six kinds of urban growth driving forces were identified by primary data analysis and casual observations in our two case studies in Beijing and Shanghai. These are:

(1) Development of urban economic development;
(2) Increase of investment on fixed assets, including foreign investment;
(3) Increase of income and living standard in urban areas;
(4) Growth of population and urbanization, especially rural immigrants to urban areas;
(5) Relocation of industrial enterprises;
(6) Development of TVEs.

The first three driving forces are similar in the Western countries and in China. It is almost common knowledge that the rapid growth of the urban economy, investment on fixed assets, and income and living standards would certainly claim more urban land use. However, the latter three driving forces are quite specific to the Chinese context.

First, China has been experiencing a rapid growth of rural immigrants to urban areas despite of strict control policies on population migration. This trend will persist or even accelerate in the near future. The number of rural immigrants to urban areas in Beijing, or the so-called "temporary residents", increased form 180 thousands in 1982 to 1.3 million in 1997. Some large-scale rural immigrant settlements emerged in suburban Beijing in the 1980's, which are respectively called "Zhejiang Village", "Henan Village" and "Xinjiang Village", etc., according to the home provinces of the migrants (Qiu and Chen, 1999).

Second, motivated by the economic law of location rent in an urban land market, many industrial enterprises, located in the urban central district in the former administrative system, were gradually relocated to suburban or rural areas while the original central sites were transferred to use in the tertiary sector. The third "General Plan of Beijing City (1992 – 2010) " stipulates that "those factories, warehouses with low profits occupying large areas in the central urban districts, should be relocated to suburban areas, allowing their sites to be developed for the tertiary industry or housing" (Beijing Academy of City Planning, 1993). Industrial relocation started in Shanghai in 1983. By the mid 1990s, about half of the textile factories and their production lines had moved out of the inner belt (Han, 2000).

Third, TVEs have experienced an amazing development and have become the pillar of the rural economy in suburban areas. TVEs enjoy important advantages over their counterparts in remote rural areas in terms of technology, accessibility to market and labor skills, and over state-owned enterprises in terms of availability of cheap land and labor, ownership and government structure, and conditions of institutional arrangement (Perotti, Sun, Zou, 1999). In 1982, there were only 6767 units of TVEs with 402000 employees in Beijing. At that time, rural non-agricultural industries are considered to be a by-product sector of agriculture and the share in rural economic structure was 31% in Beijing (Beijing Statistical Bureau, 1983;

Beijing Statistical Bureau, 1998). With the progress of economic reform, rural non-agricultural industries grew rapidly and became a dominant component of rural economy in most suburban areas. By 1993, TVEs in Beijing increased to 45 thousand units with 890 thousand employees and by 1997 to 115 thousand units with 1.25 million employees. The share of rural non-agri industries (rural secondary and tertiary industries) in total income of all rural economic industries increased to 64% in 1982 and 84% in 1997 (Beijing Statistical Bureau, 1994; Beijing Statistical Bureau, 1998).

The most serious constraint factor to urban land use growth in China undoubtedly is the concern on loss of agricultural land and food security. Many researchers propose that the rapid industrialization and urbanization since 1980's has caused a dramatic loss of agricultural land and is undermining China's food production capacity and sustainable development (Brown, 1995, Yeh and Li, 1996). In order to keep the loss of agricultural land under control, the Land Management Law was revised in 1998 with the following key points:

- A dynamic balance of agricultural land stock should be kept at national and provincial level.
- New urban land development should strictly comply with the annual quota designated by the higher-level authority.
- The power to grant land use rights has been significantly withdrawn from local authorities.

The "Revised Land Management Law, 1998" stipulates that:

> *"When development and construction…involve the merging and conversion of agricultural land…, governmental approval at…or above the provincial level is required"* and *"Requisition of basic agricultural land requires the approval of the State Council" (Clause 39 and 40 of Chapter 4).*

Furthermore, concerns on environmental and social sustainability also have certain effects on the rate and spatial pattern of urban land use growth (Chen, 1999, Gu, 1997).

5.4 Four kinds of urban growth dynamic mechanisms

Currently, there are only two types of land ownership in China: State-owned land or land owned by peasant collectives. The "Land Administration Law of PRC" stipulates that:

> "*Land in the urban areas of the cities shall be owned by the State. Land in rural and suburban areas shall be owned by peasant collectives, except for those areas which belong to the State as provided for by law." (Article 8 Chapter 2)*

And there are only three kinds of authorized or legal dynamic mechanisms for the conversion of rural land to non-agricultural land use. These are the grant of State-owned land use rights through administrative allocation, market selling and construction of TVEs on collectively-owned land. The "Land Administration Law of PRC" states that:

> *"All units and individuals that need land for construction purposes shall, in accordance with law, apply for the use of State-owned land, with the exception of the ones that have lawfully obtained approval of using the land owned by the peasant collectives of their own collective economic organizations to build township or town enterprises or to build houses for villagers…" (Article 43 Chapter 5)*

However, illegal or unauthorized dynamic mechanisms of a "black" land market have been observed in China (Yeh and Wu, 1996, Wei, 1998). Table 10 summarizes for each of the four urban dynamic mechanisms the main actors and type of price involved.

Table 10. Different actors and prices of urban dynamic mechanisms in China

Dynamic Mechanisms	Actors	Price
Administrative Allocation	Farmer (sellers) State-owned enterprises or governmental departments (Users) Municipal government (Coordinator & developer)	Compensation fee
Urban Land Market	Farmer (sellers) Municipal government (buyer, seller, manager) Commercial land user (buyers)	Compensation fee (Municipal Gov. to farmers) Market price (Land users to Municipal Gov.)
"Black" Land Market	Farmers (Sellers) Commercial land user (buyers)	"Black" market price
Land Development for TVEs	Farmers (Suppliers) TVEs (users)	User fees

(1) Administrative allocation

The procedure and the price of administrative allocation in the "Two-track system" remains the same as that in the former planned economy, but the behaviors of its main actors have been changing when its cheap price or compensation fee become more and more tempting with the introduction of a market mechanism. Due to the same economic consideration, the demand side, the land users, are trying to acquire as much cheap land through administration allocation as possible by all means while the supply side, the farmers and rural organizations, becomes more and more reluctant to offer land.

During the transition period of land use system reform when the application range of administrative allocation was not clearly defined by the guidelines of the "Provisional Regulations on the Conveyance, Granting and Transferring of the State Land's Use Rights in Cities and Towns, 1991", it was mainly up to the local governments (apart from national key construction projects) to decide whether and how much land can be requisitioned and administratively allocated, although local governments were not supposed to make profits from the process.

The granting of land use rights through administrative allocation thus experienced a boom in the initial transition period. Local municipal governments favored fast urban growth and tended to take full advantages of their administrative power to generously grant land use rights through administrative allocation to their own affiliated enterprises and companies. Thus, their costs for land use rights could be reduced to the minimum and some surplus land could afterwards be used to make profits through real estate development. According to the statistical analysis by the State Land Administration Bureau of PRC, there was a peak of urban land use growth in the period of 1992—1993 when more than 90% of the new developments were granted through administration allocation (State Land Administration Bureau of PRC, 1998).

To standardize the administrative allocation mechanism and encourage the development of an urban land market, the Urban Real Estate Administration Law of PRC in 1995 and the Revised Land Management Law in 1998 were issued. They specify that only the following

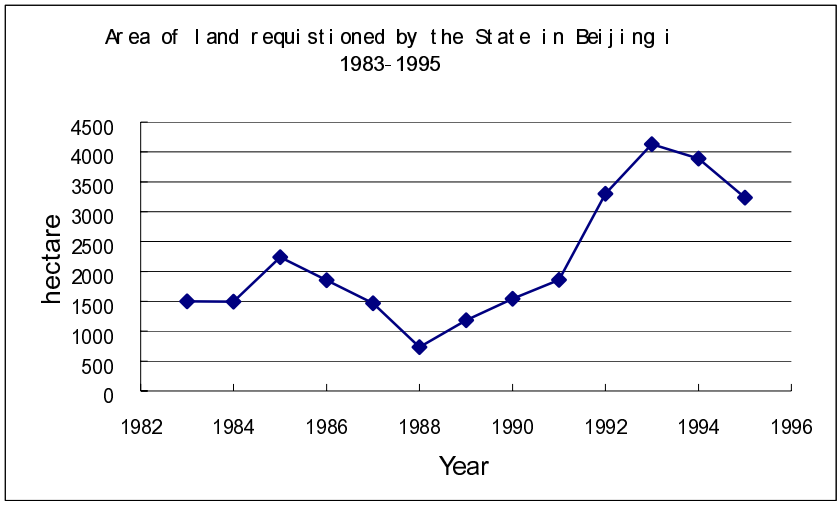
land uses qualify for administration allocation:

(a) land use for state administrative departments and military facilities;
(b) land required for basic city facilities and infrastructure or public facilities;
(c) developments related to natural resources, water facilities and transport;
(d) other purposes prescribed by law.

Apart from the users listed above, special housing projects developed for urban residents and governmental employers with low- or medium-grade incomes are granted land-use rights through administrative allocation. The sale prices of these governmental housing projects thus can be significantly lower than those of neighboring commercial real estate property and they are affordable to urban low- or medium-grade-income families. The scale and number of those governmental housing projects requires to be carefully planned to limit an overheating of prices of the real estate market. After 1995 land converted through administrative allocation gradually decreased. Figure 11 shows that in Beijing the area of land requisitioned by the State increased rapidly in the period of 1988-1993, but declined after 1995.

Administration allocation mechanism is the most important tool for municipal governments to control the spatial pattern of urban growth and to implement the general urban plan. First, the rate and spatial pattern of urban growth through administration allocation can be carefully planned and controlled by nature. Second, the development patterns of transport, city infrastructure and facilities have a strong guidance effects on location choices of the urban land market. For example, Chen insists that the serious urban sprawl in Beijing was primarily caused by its concentric spatial planning and transportation pattern (Chen, 1999). Further, the rapid growth of industrial land (two growth axes) in the southern and eastern parts of Beijing was also mainly driven by administration allocation mechanism because the southern and eastern parts are supposed to be industrial areas while the main functions of the northern and western parts are residential, offices, sports and tourism.

Figure 11. Land area requisitioned by the State in Beijing 1983-1995



Source: Beijing Land & Housing Management Bureau (1996), Beijing land statistical data 1983-1995

(2) Urban land market

With the extensive implementation of the paid fee land use system, an urban land market emerged in China. All urban development, excluding those stipulated by law to be qualified for administration allocation, are subject to purchased land use rights in an urban land market.

The common procedures are: First, according to the general land use plan or demand of economic development, municipal governments requisition the collectively-owned rural land and convert it into state-owned land through administrative orders, and the effected farmers or rural collective organizations are paid a compensation similar to administration allocation. Second, this raw land is comprehensively developed into fully or half serviced urban land by municipal governmental companies. Third, land use rights are sold by municipal governments to land users in market through negotiations, tenders and auctions. Usually, the market sale price is many times higher than the compensation price. The profits from the sale of land use rights are shared by local municipal governments and the central government. The share of the central government is 40% after 1999, and was 30% before 1999.

In China's urban land market, the behavior of buyers or urban land users is more or less the same as in any market economy while the role of local municipal governments is quite unique. Farmers or rural collective organizations still remain in almost the same role as in the administrative allocation mechanism, namely as the land supplier to the municipal government for requisition when required. Yet, now the purpose of land requisition is not only to develop land for public interest but also to sell it for own profits. As a consequence the municipal governments tend to ask for a much higher negotiation price than the compensation fee. The role of the local municipal government in this process is very unique: buyer at the beginning, developer in the middle, and seller at the end. Also, the local municipal government is assumed to be the supervisor of the urban land market.

The sale of land use rights can be through negotiations, tenders or auctions in the urban land market. In general, sale by negotiation is the most popular way of transferring land use rights in Chinese urban land market, while auction is the least popular. This is because the former gives the local authorities maximum control over land prices and development activities. Basically, there are four levels urban land market in China: national, provincial, county or district, and township, corresponding to the power hierarchy of the granting of land use rights. Among those, the function of the county or district level market is especially vital because a county or district is the basic and rather independent administrative unit in Chinese spatial economic system. Within each county or district land market, the local government has advantages over its counterpart of land users because it monopolizes the supply of local urban land. However, in a higher level market like that in Beijing or Shanghai (provincial level), the different county or district governments have to compete with each other because the location choices of land users or buyers are usually rather flexible.

The strategies of "promoting economic and urban development through cheap land" and "making revenues through the sale of land use rights" have been widely adopted by local governments since China's economic reform and opening. Local governments are anxious for rapid growth and are investment-thirsty (Tang, 1994). Often they have no other resources than the land. Its value is suddenly recognized after the paid-fee reform. Establishment of various economic and industrial development zones (EIDZ) has widely been used as a mechanism by local governments for attracting investment, particularly foreign investment, through the offer of cheap land. In 1990, there were 1874 EIDZs (ZouYeh and Wu, 1996). Then in the single year of 1992, about 2000 new EIDZs were established. In the development plans they have been assigned an area of up to 20000 km^2, which is 1.72 times the total area of the built-up land of all designated cities[1] in 1991 (Shi, 2000).

However, a large portion of EIDZs did not experience substantial development and their land is left idle. For example, there were 17 county-level or above EIDZs in Beijing up to the end of 1994 (details in Table 11). They have already occupied 21 km^2 of land while the plan was

[1] Chinese cities are administrative entities and therefore must be officially designed by the Ministry of Civic Affairs or the State Council. There exists a three-level urban hierarchy in China: the provincial-level, prefecture-level and county (*xian*) level. Each level has its set of own evaluation criteria

to requisition a total area of 59 km^2. A total amount of 1.9 billion Yuan RMB had been invested on the construction of infrastructure while the total investment on fixed assets was only 1.5 billion Yuan RMB. Obviously, over-supply of planned economic development zones and industrial zones in Beijing has caused tremendous waste of land and capital and vicious competition in the sale of land use rights. For instance, in Yongle Industrial and Economic Zone in Tongzhou, more than 0.1 billion Yuan RMB were invested in the construction of infrastructure and the area of 0.89 km^2 land was requisitioned (while its total planned area is 4.6 km^2). Yet, only two enterprises were built with an investment of 0.01 billion Yuan RMB on fixed assets. Only a few EIDZs have achieved satisfactory results, such as Changping Garden of Beijing New Technological Development Zone. The rapid increase of EIDZs wasted valuable agricultural land and caused ecological problems by changing the land cover (Yeh and Wu, 1996).

The extensive implementation of those strategies resulted in a substantial growth of urban built-up land and intensive competition for the sale of land use rights. Eventually this developed into a nation-wide massive upsurge of the establishment of industrial development zones and real estate development at the end of 1980s and the beginning of 1990s. To make things worse, the processes of negotiations are usually not transparent and are arbitrarily decided by the mayors or some powerful officials, which is bound to cause serious corruption and losses of state assets. Thus, there are more and more calls to standardize the behaviors of local governments and urban land market. The Urban Real Estate Administration Law of PRC was passed in 1995 to guide the sale of land use rights and the disposal of its revenues. The Land Management Law was revised in 1998 including removal or reduction of the local governments' power to grant land use rights.

Table 11. County or district-level Industrial Development Zones (EIDZ) in Beijing Case Study Area (1994)

Name of EIDZ	Total area of land use in planning km^2	Area of actually requisitioned land km^2	Established enterprises	Completed investment on fixed assets (million)	Completed investment on infrastructure (million)
Beijing Economic & Technologic Development Zone	15.0	3.83	83	952.64	705
Changping Garden of Beijing New Technological Development Zone	2.3	1.74	279	64.06	210
Zhang Jia Wan EIDZ	3.4	0.64	17	37.63	64
Ciqu EIDZ	2.0	2.0	10	n.d.	0.69
Yangle EIDZ	4.6	0.89	2	15.48	100
Daxing EIDZ	1.5	1.25	31	72.76	200
Niantan EIDZ	2.0	2.0	17	n.d.	5
Liangxiang Satellite Town EIDZ	2.44	0.63	6	40.10	60
Chinese TVE City	2.07	1.88	15	-	35
Agricultural Economic Development Zone	2.10	1.56	25	10	5
Huairu Tourism & Real Estate Development Zone	1.03	0.95	8	13.44	n.d.
Huairu Private-owned Economic Development Zone	2.0	0.59	56	6.47	60
Linhe EIDZ	5.1	0.7	9	98.75	120
Jixiang EIDZ	4.6	0.33	10	98.75	100
Tianzhu Airport EIDZ	3.0	0.53	17	98.75	110
Wenquan EIDZ	5.9	1.22	6	98.75	71
Total	59.04	20.74	591	150.83	1860

Ssource: Beijing Land & Housing Management Bureau (1998), Land resources in Beijing, p.153 (in Chinese).

(3)" Black" land market

The existence of a "black" land market refers to the phenomenon that farmers or rural collective organizations directly sell or transfer land use rights of collectively-owned land to land users or units for urban development without the approval of government authorities and official land requisition. This is an illegal or unauthorized land use change for urban development because:

> *"land use rights of collective-owned land are prohibited to be used for urban development through sale, transfer or rent" (Land Management Law, Clause 63), and "Collectively-owned land within a city district must be converted into state-owned land according to the relevant…legislation before the land use rights can be sold or transferred" (The Urban Real Estate Administration Law of PRC, Clause 8).*

The "black" land market is primarily caused by the huge difference between the market price and the compensation fee of the administrative allocation mechanisms. Often land management and supervision of land use are inadequate. Thus it appeals to both the buyers (land users) and the sellers (farmers or rural collective organizations) to take an aggressive strategy and make direct, unauthorized deals without the involvement of government authorities. In such a way both sides can share the profits, which would legally belong to the local and central governments. The "black" land market price is settled by private negotiations between buyers and sellers, by reference to normal market price and the risks of punishment.

In our case study area in Beijing the four near suburban districts and the mid-suburban plain districts and counties appear to have a high degree of "black" land market development. According to an investigation in four mid-suburban counties conducted by the Beijing Municipal Urban Planning Bureau in 1997, there were 30 large-scale real estate projects developed without obtaining legal land use rights. They illegally occupied more than 520 hectares of land. This year (2001), the Ministry of Land and Mineral Resources examined the implementation effectiveness of the newly amended Land Administration Law of PRC from 1998. The investigation was supported by satellite remote sensing interpretation covering the period October 1999 to October 2000. The survey identified during this one-year period some 501 newly added plots of land for construction use. Nearly half of them (233 plots) were found to be illegal land uses (Beijing Morning Newspaper, August 30th, 2001).

The illegal transaction took a variety of forms and involved various land users. Examples include real estate development by rural collective organizations; venture companies disguising urban development projects by using a project title such as regeneration of rural settlement or the construction of TVEs, direct or indirect leasing of land use rights of collective land to developers, enterprises or even governmental departments. Before 1998 the only possible punishment for such illegal land transactions were penalties. The revision of the Land Management Law in 1998 now states more explicitly:

> *"Where units or individuals assign, transfer or lease, without authorization, the right to the use of land owned by peasant collectives for the construction of non-agricultural projects, the land administration departments of the people's governments at or above the county level should order to set it right within a time limit, confiscate illegal gains and impose a fine" (Article 81 Chapter 7).*

Though the scale or number of illegal land use transactions is rather small in comparison to those through administration allocation and land market, it brings about some very serious

damages. Huge amounts of revenues are lost for state authorities. The normal urban land market and pricing mechanism is significantly disturbed, which may eventually result in inefficient land use and too fast urban growth. General development plans for cities may not be feasible any more because unauthorized urban growth could occupy areas reserved for infrastructure or transport. An investigation conducted by the Beijing Municipal Urban Planning Bureau in 1997, identified that the illegal "Tongli New Village" in Tongzhou occupied the reserved area for planned railway development and the "Metropolitan Garden" and "Jintai Villa" have been located in the planned extension lines of the Central Axial Road of Beijing.

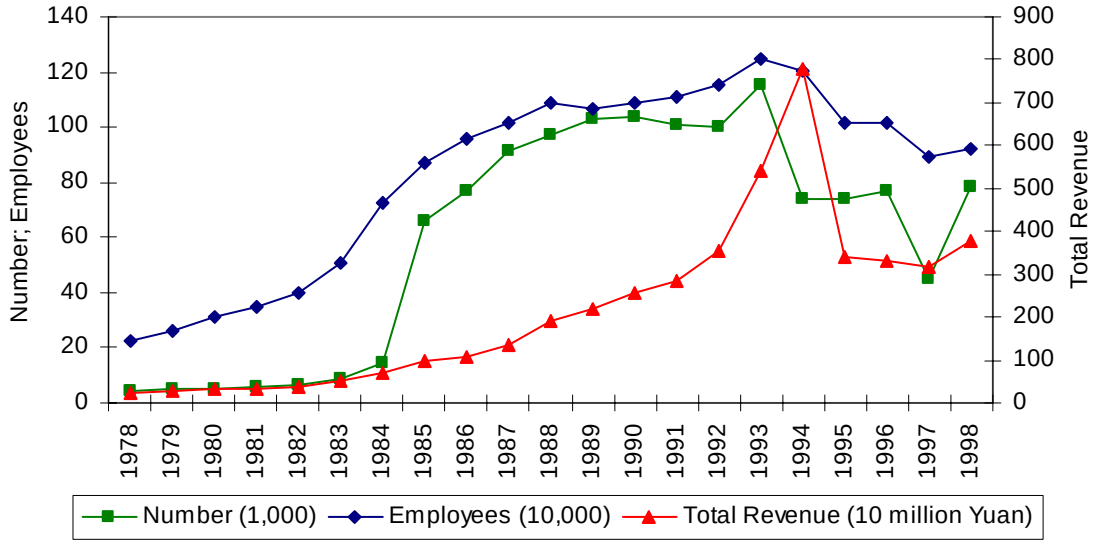
(4) Land development for TVEs

TVEs have developed rapidly since China's economic reform and opening. The procedure of land allocation to TVEs is very simple and straightforward. Since TVEs can directly use collectively-owned land for construction without land requisition, according to Land Administration Law, the township or village governments have the authority to grant land use rights within their administrative boundaries to their TVEs. Land development for TVEs is not subject to being strictly guided and controlled by urban planning. In the initial period when TVEs were collectively-owned land use rights for TVEs were free of charge.

Since the beginning of the 1990s, with progress in the privatization of TVEs and the implementation of paid-fee system reform, fees for using the land have been introduced. However, user fees are usually quite low, because local rural governments are anxious to attract capital investments and enterprises into their jurisdictions to increase non-agricultural employment. Such features of land development result in inefficient and uneconomical use of land and a scattering of land development.

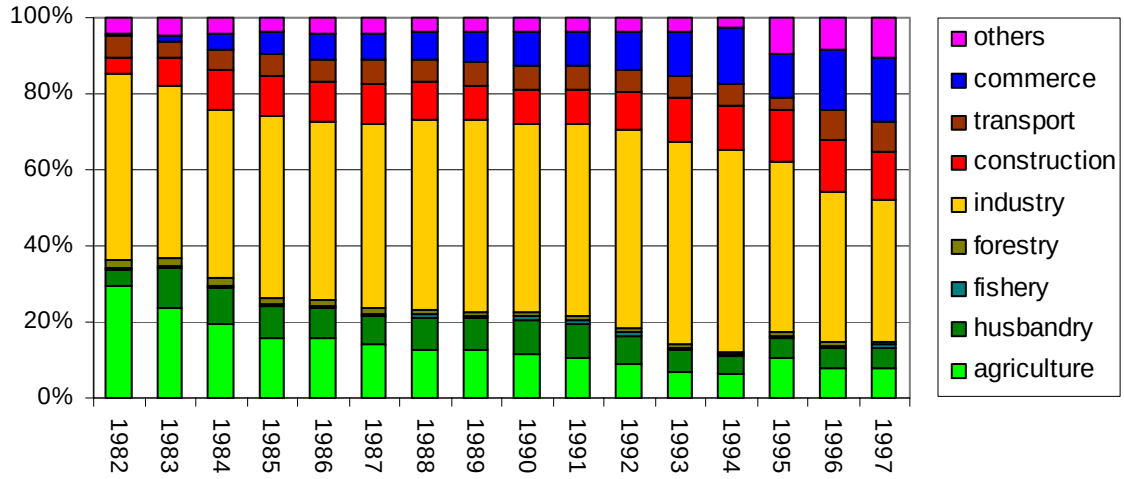
Figure 12 shows the development of TVEs in Beijing from 1978 to 1997. TVEs in Beijing increased rapidly from 14274 units with 724000 employees in 1984 to 115536 units with 1250000 employees in 1993 and then declined. However, the area of new land developed for TVEs increased rapidly in the beginning of the 1990s, especially after 1993 when the number and total revenues of TVEs began to decline. Between 1987 and 1992 the area of new development for TVEs was below 400 hectares each year. In contrast in 1993 it increased to 662 hectares, 750 hectares in 1994 and 2056 hectares in 1995.

Figure 12. Development of TVE's in Beijing



Changes in Beijing's rural economic structure are highlighted in Figure 13. The importance of rural non-agricultural industries (rural secondary and tertiary industries) in the total incomes of all rural economic industries increased from 64% in 1982 to 84% in 1997 (Beijing Statistical Bureau, 1994 and 1998).

Figure 13. Change of rural economic structure in Beijing 1982 to 1997



Due to the rapid development of TVEs and the rather unrestricted and cheap access to land, the land occupied by TVEs expanded drastically. Up to the end of 1994, 175 township- or village-level industrial development zones were planned or established in Beijing. Table 12 compares land development for TVEs with the total area of industrial land in Beijing. According to the detailed land use investigation data conducted by the Beijing Municipal Land Management Bureau in 1992, the total area of land development for TVEs was 244 km^2 and accounted for 44% of the total industrial land in the whole municipal region. This rate is somewhat smaller, about 30%, in the 4 near suburban districts of Chaoyang, Haidian, Fangtai and Shijing Shan, but rather high, more than 50%, in these far-suburban plain counties and districts such as Changping, Shunyi, Daxing, Tongzhou and Huairou.

Table 12 The area of land development for TVEs in Beijing in 1992

	Land development for TVEs [in ha]	**Total industrial land** [in ha]	**Share of TVE land in total industrial land**
Chaoyang	2181	6646	33%
Fengtai	2544	6371	40%
Shijing Shan	283	1577	18%
Haidian	1888	5523	34%
Changping	2863	5614	51%
Shunyi	2484	3319	75%
Tongzhou	2640	3958	67%
Daxing	1804	3346	54%
Huairou	790	976	81%
BEIJING total	24448	56004	44%

Source: Beijing Municipal Land Management Bureau, 1992

After 1995, with implementation of the Urban Real Estate Administration Law, urban land development through the two *formal* mechanisms, especially administrative allocation, urban land markets got gradually under control. However, the expanding *informal* mechanisms, "black" land market and land development for TVEs, are pushing urban growth on collectively-owned land to go beyond control. Motivated by local governments' high enthusiasm for rural industrialization and urbanization, land development for TVEs has not been affected much and is still expanding rapidly. Today it makes a significant contribution to the fast growth of industrial land. Considering the large share of land occupied by TVEs, we think it is necessary to control and standardize the mechanism of land development for TVEs in order to keep urban land use growth under control.

Chapter 6. Discussion

The analysis of the detailed land use maps for different time points, in two of the fastest developing cities in the last decades, highlights urban growth mechanisms and dynamics. For Shanghai the high resolution data base derived from satellite interpretation for the years 1967, 1989 and 1999 revealed detailed land use conversion processes. The most extensive conversion processes are those of prime agricultural land to residential area and to a lesser extent to industrial and commercial land. Also, there was a concentration process of residential areas resulting in a substantial decline in discontinuous settlement especially in the latter period 1989-1999. Another striking feature was the extensive road development after 1989. In the ten years the extent of major roads nearly doubled. With the Beijing data base, featuring a larger area than Shanghai, but at a lower resolution, revealed spatial patterns of urban growth and allowed a comparison with development plans for the city envisaged by the authorities.

China's rapid urban expansion since its economic reforms has raised an important question: Is urban land use growth beyond control? Answers to this question would certainly influence future land use and urbanization policies in China. At the end of the 1980s and the beginning of the 1990s China experienced the so-called "great mass fervor on real estate development and establishment of Development Zones". This, combined with concerns for food security, has forced the Chinese government to standardize and take stricter control on the process of urban land development. Some scholars, however, have argued that such an intense urban development process is an indispensable element of China's industrialization and modernization (Xu, 1999).

The two case study areas of this study certainly do confirm very rapid urbanization rates, especially around the 1990s. The case study in Beijing suggests that urban land use growth was beyond control in the period of 1982-1992, both with regard to growth rate and spatial pattern. The limited study area covered in Shanghai and less available information on past and current development plans for the Shanghai area preclude firm conclusions as to the success of the cities' growth control. However, since in our study area most of the prime agricultural land has been consumed by built-up area, the Shanghai case demonstrates the extent and speed of growth. Also the green area open to the public is quite limited compared to other large cities despite a few recently developed large recreational areas, for instance the one on the former airport.

In the Beijing case we conclude that urban growth control policies have been ineffective and incomplete. Land use conversion on collectively-owned land and land development for TVEs are still not tightly and transparently managed. The existence of a "black" land market and

inefficient land development for TVEs counteracts policy intentions and city planning. Urban land use growth in Beijing was extraordinary high between 1982-1992. The total area of urban land use in Beijing expanded by 82% in the ten years, from 467 km^2 to 851 km^2. The new development area (384 km^2) approximately equals to 3.5 times of the built-up area of old Beijing in 1949. The average annual growth rate was 38 km^2 per year, which is three times more than the highest historic growth rate of 1952-1959 (Yu, 1986). With the implementation of the central government's urban growth control and cultivated land conservation polices in the mid of 1990s, the urban land growth declined to 30 km^2 between 1992-1997.

Industrial land development has been the most important contributor of urban land use growth in Beijing. This is quite different from the situation in most western large cities where urban growth usually is driven by residential land expansion. Between 1982-1992, 65% of urban land use growth was due to industrial land expansion. The same figure for the period 1992-1997 is 81%. In Beijing the central government's growth control policies for industrial land use growth were not as effective as for residential land development. In the first growth period of 1982-1992, the average annual growth rate was 8.3 km^2 per year for residential land development and 25 km^2 per year for industrial land. A series of growth control and cultivated land conservation policies have been continuously issued and adopted by China's government agencies since 1993. As a result, the average annual growth rate for residential land development declined by 59% to 3.4 km^2 per year in the second growth period of 1992-1997. However, the average annual growth rate for industrial land development in the second growth period of 1992-1997 was still 24 km^2 per year, keeping the same growth trend as in the first period. The rapid expansion of industrial land in Beijing is primarily driven by the growth of land development for TVEs, establishment of EIDZs and outward relocation of industrial enterprises.

The spatial pattern of Beijing's urban land use growth showed a distinct concentric sprawl. This development seriously destroyed the spatial structure of "dispersed constellations" designed by the General Plan of Beijing, and also seriously worsened the regional ecological environment. The spatial structure model of the "dispersed constellations" was initiated in the 1958 General Plan of Beijing. It subdivided the built-up area of the city into the Central Urban District (or the central mass) and ten surrounding "constellations" in the periphery that were separated by extensive "green belts". This model of "dispersed constellations" was further adopted and emphasized in the 1983 and 1993 General Plan of Beijing. With the growth centers' gradually shifting from the inner locations to outside, the newly-added urban land use continually encroached upon the green spaces between the original industrial blocks and the central mass and among those "dispersed constellations". The total area of green space for isolating built-up areas in the General Plan of Beijing, was 314 km^2 in 1958, reduced to 260 km^2 in 1983, and to 160 km^2 in 1993.

The latest General Plan of Beijing, targeting the period 1991 to 2010, foresees the southern and eastern parts of the city as the main urban development areas. Located in the North China Plain there are topographical advantages to develop in these directions the urban space, economic facilities and transport communication. However, in this paper we show that despite of the targets of the General Plan, Beijing's southern and eastern growth axes were declining in the second period 1992-1997 as compared to the former 1982-1992 period.

Since a system of paid transfer of land use rights has been introduced in China, this paper describes four main dynamic mechanisms of urban land use growth: administration allocation, urban land market, "black" market, and land development for TVEs. The granting of land use rights through administrative allocation experienced a boom in the initial transition period. Local municipal governments favored fast urban growth and tended to take full advantage of their administrative power to generously grant land use rights through administrative allocation to their own affiliated enterprises and companies. The sale of land use rights had widely been used as a mechanism by local governments for generating revenues and for

attracting investment. In the end of 1980s and the beginning of 1990s, China experienced the nation-wide “great mass fever on real estate development and establishment of Development Zones”.

Severely discontented by the huge consumption of prime cultivated land and the waste of land and capital resources, the Chinese central government began to standardize and to take stricter control on the process of land requisition. With the introduction of the Land Administration Law of 1995, administrative allocation and urban land markets gradually became better controlled.

However, land use transformation on collectively-owned land, through “black” land market and land development for TVEs, have remained significant driving forces for urban growth. The “black” land market, a kind of unauthorized or illegal land use, has emerged primarily because of huge differences between land prices paid by users to local governments and the compensation fees paid by local governments to farmers for land requisition. The largely uncontrolled “black” land market results not only in huge losses of revenues for governments, but it distorts the authorized urban land market and prices and produces unregulated urban and industrial sprawl, which sometimes seriously violates the cities’ development plans.

Today, the emphasis of current growth control polices is on the standardization of administrative land allocation. A control mechanism in the form of quota has been introduced to limit the amount of land requisitioned from the rural collectively-owned land.

Very specific and unique in the Chinese context, development of TVEs is of particular importance for urban growth. The rather unrestricted nature and inexpensive features of the land development mechanism for TVEs have directly resulted in their rapid expansion, in inefficient and uneconomical use of land, and in scattered and unplanned distribution in Beijing, and even in most of eastern China, as reported by various governmental agencies and many scholars. According to Land Administration Law of PRC, TVEs can directly use collectively-owned land for construction without land requisition. The local township or village governments have the authority to grant land use rights within their administrative boundaries to their TVEs and they are not subject to be guided and controlled by urban planning. Charges for land use rights for TVEs used to be nominal and small. Motivated by local governments’ high enthusiasm for rural industrialization and urbanization, land development for TVEs expanded dramatically, even when the number and total revenues of TVEs declined. An example here includes Beijing after 1993. Land occupied by TVEs usually accounts for a substantial proportion of the total industrial land, such as 40%-60% in most suburban districts or counties in Beijing. Considering the important role of land occupied by TVEs in the composition of industrial land and industrial land’s dominant contribution to urban land use growth, it is important to control and standardize the mechanism of land development for TVEs in order to keep urban land use growth under control.

In summary, this paper clearly shows that high resolution earth observation (EO) data can be very effective in monitoring urban development activities, which is crucial especially in a condition of rapid change such as currently observed in China. Monitoring based on interpretation and classification of EO data allows to quantify the speed and spatial structure of urban growth. In a condition where informal land transaction mechanisms abound, such as in the Chinese conditions, monitoring of land use changes can help to detect violations and enforce urban land development regulations, especially in such large urban agglomerations as, for instance, the wider Beijing or Shanghai areas. Furthermore EO data help to identify conflicts with urban development plans. EO data need to be complemented with a range of other data sources, on demographic development, economic structure, environmental characteristics, regional economic context, and – last but not least – institutional and regulatory context. The latter turned out to be most important for understanding the actual and rapid urban land use changes of the recent past in two mega-cities of China.

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