Urbanization in China: land use efficiency issues
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Introduction

In this review of Chinese urban land use issues I am often critical of current practices and regulations. While I am convinced that well functioning markets are the most efficient tools we have to allocate land and floor space, I do not want to give the impression that cities in countries with a long tradition of markets are necessarily more efficient in all areas. Every successful city has its weak and strong points. After all, rent control, abusive zoning regulations excluding lower income households and hidden subsidies of all sorts are causing inequities and diseconomies everywhere.

I do not know any example of "best practice" which could be usefully imported into China. To the contrary, I believe that the urbanization process in China that took place since the 80s is a success story that few countries have matched. However, there is always room for improvement, and the rapidity of urbanization and change in China make it even more important to have constant feed backs on the process to modify and perfect the system as it develops. Hence the criticism, hopefully constructive, found in this report.

The Chinese government concern about the land misallocation between urban and agricultural use at the fringe of cities.

The rapid expansion of Chinese cities has required the conversion of large land areas from agricultural to urban use. The Chinese Government considers that the size and speed of the loss of scarce agricultural land is one of the major urban development issues that need to be urgently resolved.

Many government policy papers argue that the "uncontrolled" expansion of cities into productive agricultural land may create food scarcity in the future. An explicit target of 95 % grain self sufficiency has even been set up by the State Council (Chan 2007). The concern for the loss of agricultural land has been translated at the operational level by the institution of strictly enforced agricultural land conversion quotas which are limiting urban expansions.

While one may legitimately doubt whether current Chinese urbanization will threaten future food security, it is undeniable that the way land is priced at the fringe of Chinese cities raise the possibility of land misallocation between agriculture and urban use.

In market economies, it is assumed that in spite of some price distortions due to subsidies and regulations the market mechanism allocates land reasonably efficiently between agricultural and urban use.

In China, however, the price mechanism that in a market economy self-regulates the expansion of cities into rural areas does not exist. Local governments have a monopoly over land development. The price paid for farm land at the fringe of cities is not based on market price but is calculated using complex compensation formulas for crops, buildings and pensions for displaced farmers. The compensation is often idiosyncratic and is not always transparent. In particular, it does not take into account the location of the agricultural land acquired. [1]

While the acquisition cost of farm land to be developed is established through an administrative process, land once developed is increasingly sold through auctions to private builders. These builders in turn sell the apartments, office and commercial space they build at prices established through a free market.

Under these conditions it is quite legitimate to ask whether in China the quantity and the location of the urban land developed each year correspond to an acceptably efficient allocation of resource.

One obvious recommendation to answer the misallocation concern would be to "get the price of land right" by allowing farmers to sell their land directly and competitively to private developers, but that would possibly require an amendment to the Chinese constitution. This report aims to provide short and medium term solutions and therefore will concentrate on recommendations that could decrease the likelihood of misallocation without requiring a drastic change in the country constitution. In the long run, however, and in an increasingly complex economy it is difficult to conceive a solution to the land allocation problem that would not require the extension of market mechanisms – already in use in most of the Chinese economy – to land itself.

The Chinese government should also be concerned about land use misallocation within cities

While the main concern of Chinese officials is currently focused on the magnitude of the area of land converted yearly from agriculture to urban use, the way developed land is allocated between various urban users is certainly an even more important issue to be addressed quickly to prevent the creation of cities with inefficient spatial structures.

Urban land should be use efficiently; first, because inefficient land use leads to the unnecessary expansion of cities and the destruction of the natural environment and, second, because inefficient land use patterns needlessly increase infrastructure costs, transport time and pollution and more generally decrease urban productivity.

Urban productivity depends on spatial concentration which allows rapid exchanges of labor, information, good and services within and urban area. The possibility for labor and consumers to move quickly from one part of the metropolitan area to another is a key factor in the economic growth of cities. Urban productivity, therefore is very much dependant on the consistency between land use patterns and transport systems[2].

The goal of this report is to address the issue of urban land efficiency in China. Because of the diversity of Chinese cities, the differences in their economy and the local idiosyncrasy due to climate, topography and history, it is not efficient to prescribe land development quotas or impose national land use standards to prevent the waste of urban land. Reducing current land use inefficiency will require establishing self regulating

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[1] Bertaud 2006 China: Urbanization in 2 towns in Sichuan Province, Land Use and Land Pricing Issues
[2] see Bertaud 2002" Note on Urban Transport and Cities Spatial Structures" at HTTP://alain-bertaud.com

mechanism based on sound economic and financial principles adapted to local conditions. In particular it will be important to establish a regulatory framework that will take into account emerging market forces – in particular, land use regulations will have to adapt to shifting consumers' demand for land and for commercial and residential space.

The current shift from the bicycle as the dominant urban transport mode to transit will also require drastic adjustments in the way land use is regulated. The increasing use of individual cars as a mean of urban transport in the very dense Chinese cities will also require strong policy measures internally consistent with the strategic choices made for the development of Chinese cities.

A. Defining and analyzing land use efficiency in China

One of the first way to answer in a crude manner the Chinese government's concern about the loss of agricultural land caused by urbanization will consist in comparing land consumption per capita in Chinese cities with land consumption in cities in Asia and other parts of the world. The trend in land urban consumption per capita will also be analyzed.

However, many problems in Chinese cities are caused by the mis-allocation of land between different users and by land use regulations which are obsolete or often inconsistent with government stated policy. With the data available I have identified three major land use issues which may decrease the efficiency of Chinese cities in the future:

1. The regulation of Floor Area Ratio (FAR : 容积率) in large cities is inconsistent with demand for floor space and with current planned investments in public transport
2. The fragmentation of the built-up area at the fringe of Chinese cities is largely due to land conversion quota. The fragmentation of the built- up area will result in large capital and operating cost for infrastructure and transport in the future;
3. The over allocation of industrial land caused by subsidies and the structure of municipal tax revenue at the expense of residential land.

1- Land consumption in Chinese cities compared with other cities in the World

Asian cities, on average, use much less land per capita than cities in other continents. Chinese cities are among the lowest consumer of urban land per capita even when compared with other Asian cities. The median land consumption per capita among the 51 cities on the graph of Figure 1 is 149 m2 per person. The average land consumption for the 5 Chinese cities shown on the graph is 40 m2 per person, less than 1/3 of the median world consumption! Chinese cities therefore consume very little land compared to other cities of the world. In itself consuming very little land per capita is neither good nor bad. One can see from Figure 1 that many cities with very successful economies are found among the high consumers of land (Atlanta, San Francisco) as well as among the low consumers (Hong Kong, Seoul)[3]. The increase in recent years in China

[3] The land consumption data shown on the graph of Figure 1 corresponds to the census of 1990 (Tianjin and Shanghai figures are for the year 1986). In most of these cities land consumption is most

of the consumption of urban land per capita is therefore not a problem per se. Urban land is mainly an input to produce the floor space which is required for urban economic activity. However, the proportion between floor space and urban land (FAR) is an important indicator which should be monitored. In the case of China, we will see that the recent increase in land consumption was made necessary by the government policy requiring an increase of the very low residential and service floor space consumption in the 80s. This increase in floor space consumption in turn allowed the expansion of the urban economy.

Cities consuming very little land per capita require less conversion of agricultural land to expand and in general have lower Vehicle Kilometer Traveled (VKmT) per capita than cities with higher land consumption per capita. However, having a low urban land consumption creates also some liabilities and constraints, in particular in planning infrastructure and public transport, as low land consumption per capita precludes the use of individual cars as the main transport mode.

The right level of land consumption for each city has to be determined by local economic conditions and consumers preferences not by planning norms. Within cities real estate markets create different values for land corresponding to different urban locations. It is important that land use regulations recognize the need for these variations and do not dampen market signals through uniform city wide regulations.

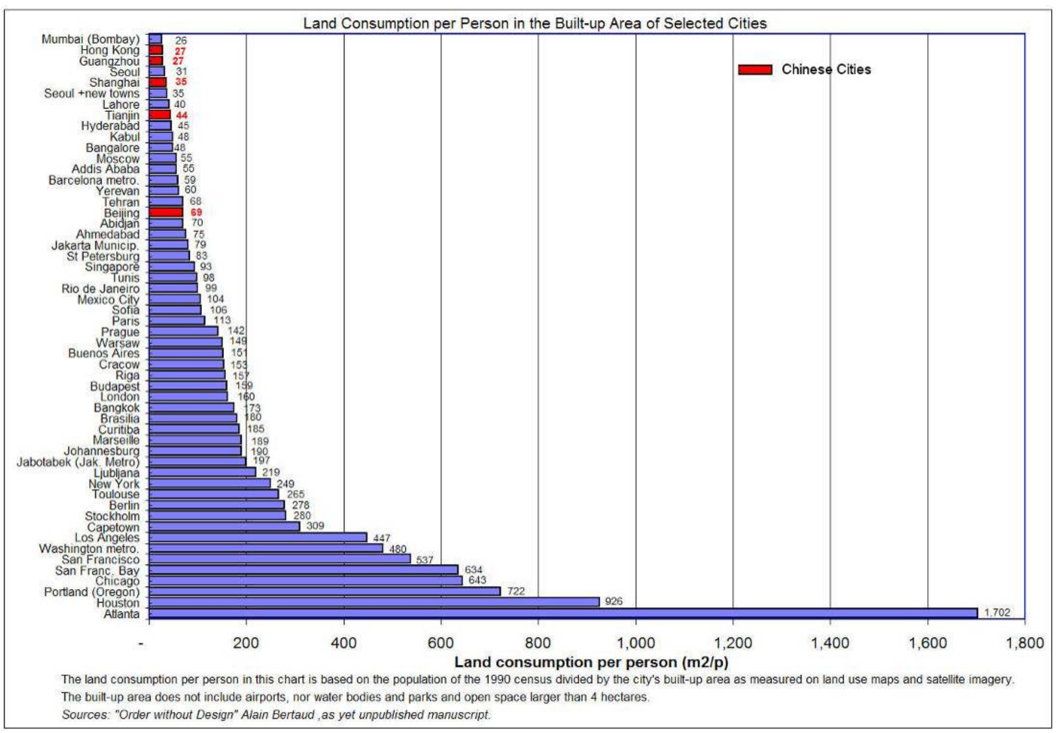

Figure 1: Land consumption per capita in 51 cities

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probably higher in 2007 than the one shown on the graph, however, the relationship between consumption between cities is most likely to have remained similar in 2007 to what it was in 1990.

Trends in urban land consumption

The increase in urban land consumption per capita in China over the last years is often considered a cause of concern and an indicator of a wasteful use of land. In reality, the increase in land consumption per person is the side effect of the successful outcome of a government urban housing policy as we will explain below.

Let us compare the land consumption data in Tianjin, between 1988 and 2000 for which comparative data are available. The population within the third ring road has increased by 22% compared to an increase of the built-up area by 63%. The built-up area per person has increased by 34%. (see Table 1). An increase in the built-up area per person over the last decade seems to be the norm in most cities of China; Tianjin seems to be a representative example in this respect.

Tianjin - increase in population and in built-up area between 1988 and 2000 within the 3 rd ring road

Year	Population	Built-up Area km2	density (people/ha)	Area of built-up land per person (m2)	Increase in population	Increase in built up area	increase in land consumption per person
1988	3,499,718	153.72	228	44			
2000	4,264,577	250.74	170	59	22%	63%	34%

Table 1: Tianjin - change in population and built-up area between 1988 and 2000

One of the government main urban policy objectives in China in the 80' and 90' was to increase the living floor area per person. At the beginning of the 80' the living floor area per person in Chinese cities was extremely low, varying for most large cities between around 4 and 6 m^2 per person. In Tianjin in 1988 the average living floor space per person in the city proper had reached around 6.5 m^2 per person. In 2000 the living floor space was 19.1 m^2 per person and it has further increased to 25 m^2 /person in 2005[4].

There is a mathematical relationship between the total residential area, the floor area per person, the floor area ratio[5] (FAR) 容积率 and the total population in a given year. The complete equation with additional land use parameters is given in Annex 1. The increase in residential land area as a function of population, floor space per person and floor area ratio can be expressed with the following equation:

$$\frac{A_{(t2)}}{A_{(t1)}} = \frac{P_{(t2)} \cdot f_{(t2)} . Far_{(t1)}}{P_{(t1)} \cdot f_{(t1)} . Far_{(t2)}}$$

Where:

[4] "Tianjin 2006 Basic Facts", Tianjin Municipal Statistical Bureau

[5] The floor area ratio or FAR is the ratio between the total floor area built on a lot and the area of this lot. For instance if the FAR=2, the floor area build on a lot of 1,000 m2 will be 2,000 m2. The FAR is not equivalent to the number of floors. In China many apartments buildings are built with a FAR of 1.5 which correspond to 5 floors as the building foot print on the ground is usually about 30%. FAR =%footprint multiplied by the number of floors.

$A_{(t1)}$ =	Area at year t1
$A_{(t2)}$ =	" *t2*
$P_{(t1)}$ =	Population at year t1
$P_{(t2)}$ =	" *t2*
$f_{(t1)}$ =	Floor space per person year *t1*
$f_{(t2)}$ =	" " *t2*
$Far_{(t1)}$ =	Floor area ratio year *t1*
$Far_{(t2)}$ =	" *t2*

We see from the equation above that an increase in percentage of residential areas would be equal to an increase in percentage of population only in the case where the floor space per person and the FAR increase in the same proportion between the dates *t1* and *t2*. For instance, in the case of Tianjin, the living floor space per person increased by 31% between 2000 and 2005, the average FAR would have had also to increase by 31% during the same period to allow the rate of growth of residential land to be equal to the rate of growth of population. In reality the FAR has probably only slightly increased as in most residential area the zoning put a ceiling of 1.8 on the allowed FAR value.
For the period shown on Table 1, the living floor area per person has increased from 6.6 m2/person in 1988 to 19.1 m2/person in 2000, or by 194%! The increase in land area developed would have been proportional to the population increase only if during the same period the FAR had increased also by 194% . If that had been the case, as in 1987 the gross FAR was about 0.8, the average FAR in 2000 would have had to be equal to 2.4[6] corresponding to apartment buildings 8 floors high. This would have been difficult to achieve as a significant part of the older housing stock in Tianjin in 2000 was still constituted by buildings of one and two floors and in general in Tianjin the FAR is restricted to around 1.8 in most residential areas.

In reality, the average residential FAR in Tianjin is estimated to have been around 1.6 in 2000, a significant increase of 88% over 1988, but not sufficient to compensate for the exceptional increase in floor space per person. As the floor area per person increased by 194% during the same period (1988-2000) the faster increase in the area of residential land compared to the increase in population is neither surprising nor a sign of waste in the use of land. In fact Tianjin city has been using land more intensively (higher floor area ratio) during this period.

The argument developed above focused on residential land only, not on the entire built-up areas of cities. However, the same argument could be developed for commercial area and administrative services: the floor space per employees and per customers increased over the years because of the spectacular development of the economy and its diversification in new service sectors. In addition, many new commercial and services activities, which did not exist in the early 80', have been requiring additional floor space – for instance, real estate brokers, commercial banks, large department stores, etc. While the FAR of non residential area increased spectacularly, especially for office and commercial buildings, it did not increase sufficiently to maintain parity between population increase and urban land increase.

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[6] Assuming a constant building footprint using 30% of the lot. In practice, higher FAR values usually require lower building footprints to allow more light and services access on the ground. With a 25% foot print the number of floors corresponding to an FAR of 2.4 would be 9.6 stories average for the entire city.

A higher increase in urban land than in population is therefore not in itself a cause for alarm, as long as the average FAR keeps increasing or at least maintain its value.

We can conclude that in China the total amount of land developed for urbanization is not excessive not only compared to other countries but also compared to the urban areas already developed in the 80s. The increase in urban land consumption per person over the last 20 years in China has been caused by a spectacular increase in the economy which required the growth of fixed capital assets, in particular the construction of additional areas of floors space for housing, office building and services. Because the average urban floor area ratio has increased over the years, it could even be said that Chinese cities are using land more sparingly than what was the case at the beginning of the 80s. The impact of floor area ratio values on land consumption will requires planners to pay more attention to the land use regulations restricting floor area ratios in the future, as discussed in the section below devoted to this topic.

2- Land use efficiency and the internal spatial structure of Chinese cities

We have been discussing land consumption in aggregate for the entire built-up area using examples from Tianjin and Zhengzhou. However, the way population and jobs are distributed within a city could also generate land use inefficiencies, even if the total amount of land developed appears on average efficient.

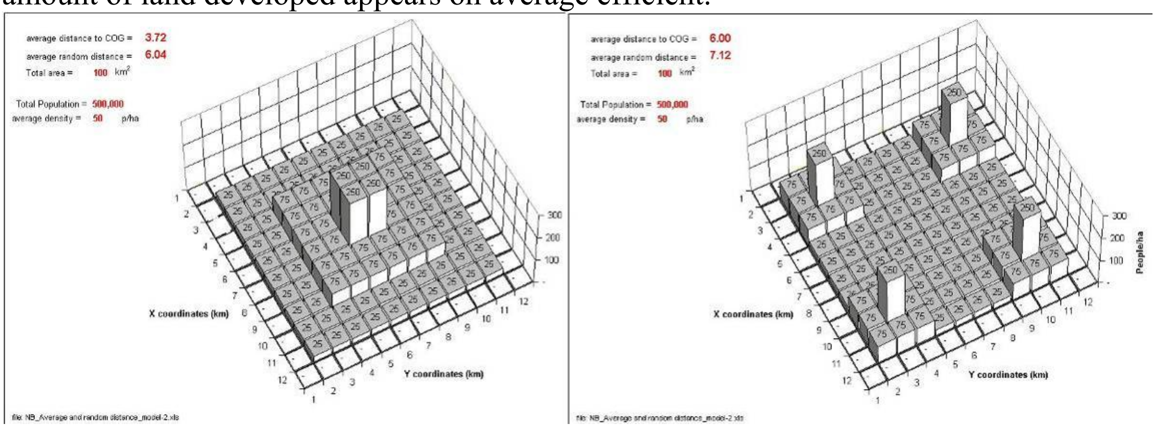

Figure 2: Schematic representation of alternative spatial distribution of densities

The pattern of densities

Residential densities vary significantly within the built-up area of cities resulting in concentration of people in some areas and dispersion in others. In general, a city's land use is considered more efficient when the pattern of densities reduces daily travel distance and as a consequence travel time. Higher densities toward the center and lower densities in the periphery significantly reduce travel distance for a given average density, even when jobs (trip destination) are randomly distributed through the built-up area. The concentration of trip destination, either in or around the center or in few concentrated areas, also reduces travel distance. The concentration of trip origin (housing) and trip destination (job and shopping) around mass transit stations reduces trip length and travel time. The pattern of densities within the built up area is therefore an important factor in achieving land use efficiency.

The schematic graphs shown of Figure 2 provide an order of magnitude of trip length differences for alternative patterns of density for a theoretical city in which population and densities are kept constant. There is a significant gain in travel distance in the city where the concentration of residential densities is closer to the center of gravity of the city whether the trips destinations are concentrated around the center of gravity or are dispersed throughout the built-up area. In the case shown on Figure 2, the increase in average trip length between alternative 1 and alternative 2 is 62 % for trips to the center and 19 % for random trips within the built-up area. The gain in efficiency between pattern 1 over pattern 2 is all the more striking because in the 2 schemes the same number of people live at the same densities not on average but at the neighborhood level. The gain in efficiency is entirely due to the different spatial distribution of high density neighborhoods between the alternative patterns. This example, although schematic, has to be borne in mind when allocating maximum FAR and therefore implicitly densities in different part of the built up area. Arbitrary decisions for maximum FAR values taken at the project level without consideration of metropolitan accessibility could prove to be very costly in terms of transport time and distance in the long run.

In cities where real estate markets have been functioning efficiently for a long time, densities tend to decrease sharply from the city center outward, resulting in a more efficient pattern of density than in cities where densities are flat or are increasing with distance from the city center (as it is the case for Moscow for instance or for other formerly Soviet cities – see Bertaud and Renaud 1998). The efficient pattern of densities within cities with a market economy is mostly self generated by market forces, FAR regulations usually mainly follow market demand.

In Tianjin the profile of densities is similar to a city with a well functioning market, although real estate markets have been introduced relatively recently (Figure 3 and 4). Trips by bicycle, which had been the dominant mode of travel during the last 50 years in both Tianjin and Zhengzhou, probably explain the current density profile. The limited range of bicycle trips provides a strong incentive to select residence located close to the city center. In addition, the existence in both Tianjin and Zhengzhou of older housing stock which could be densified by subdivision reinforced also the concentration of high densities in the center.

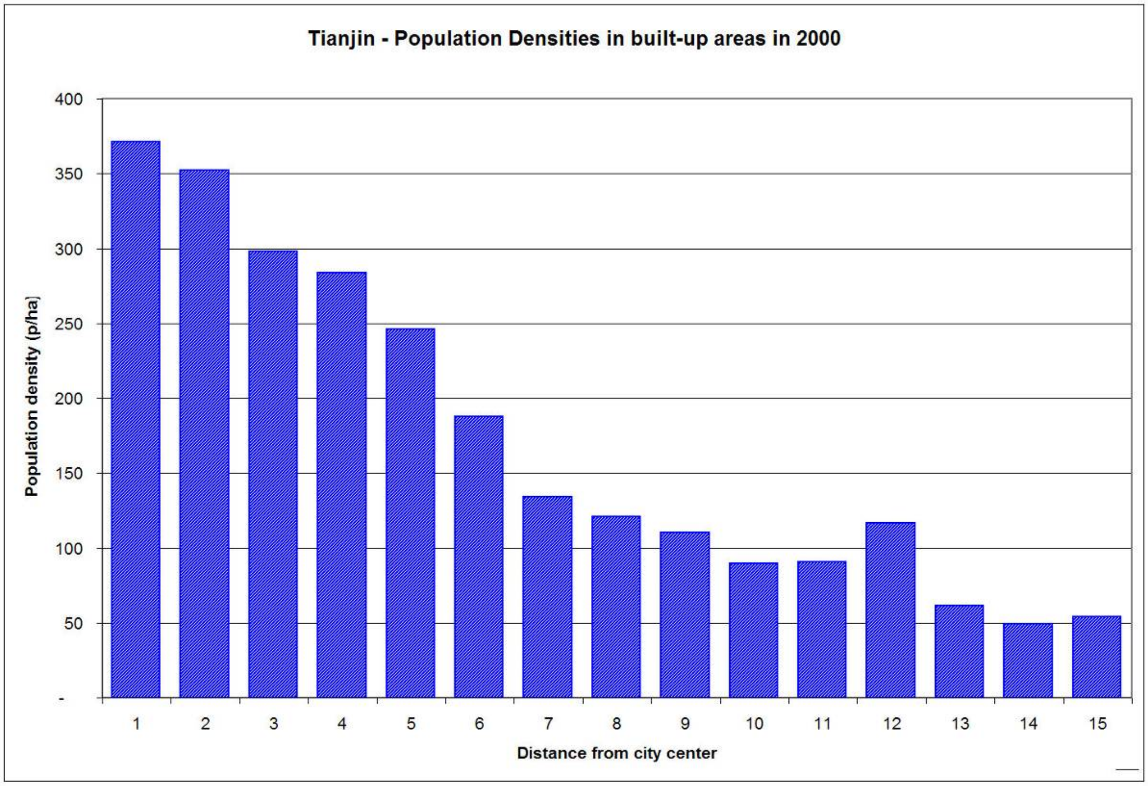

Figure 3: Density profile of Tianjin and Zhengzhou

Figure 4: Three dimensional representation of densities in Tianjin

The patterns of densities in Tianjin showing a clustering of high densities close to the center, are therefore considered efficient. The planned construction of mass transit in the 2 cities will probably reinforce this pattern in the future although, as in most cities of the world, the density in the center will tend to decrease because of higher cconsumption of floor space per resident and per job.

The data available for Tianjin shows the change in the density pattern which occurred between 1988 and 2000 (Figure 5). The overall decrease in average density during this period has already been explained by the rapid increase in floor space per person and the relatively slower increase in FAR. The decrease in population density occurred mostly within 4 km from the center where street widening programs took place in the 90's and urban renewal projects replaced some horizontal housing with office buildings. The decrease in population density in the center, paradoxically, contributed to reinforce the monocentric spatial structure of the city by replacing housing (trip origin) with office buildings (trip destination).

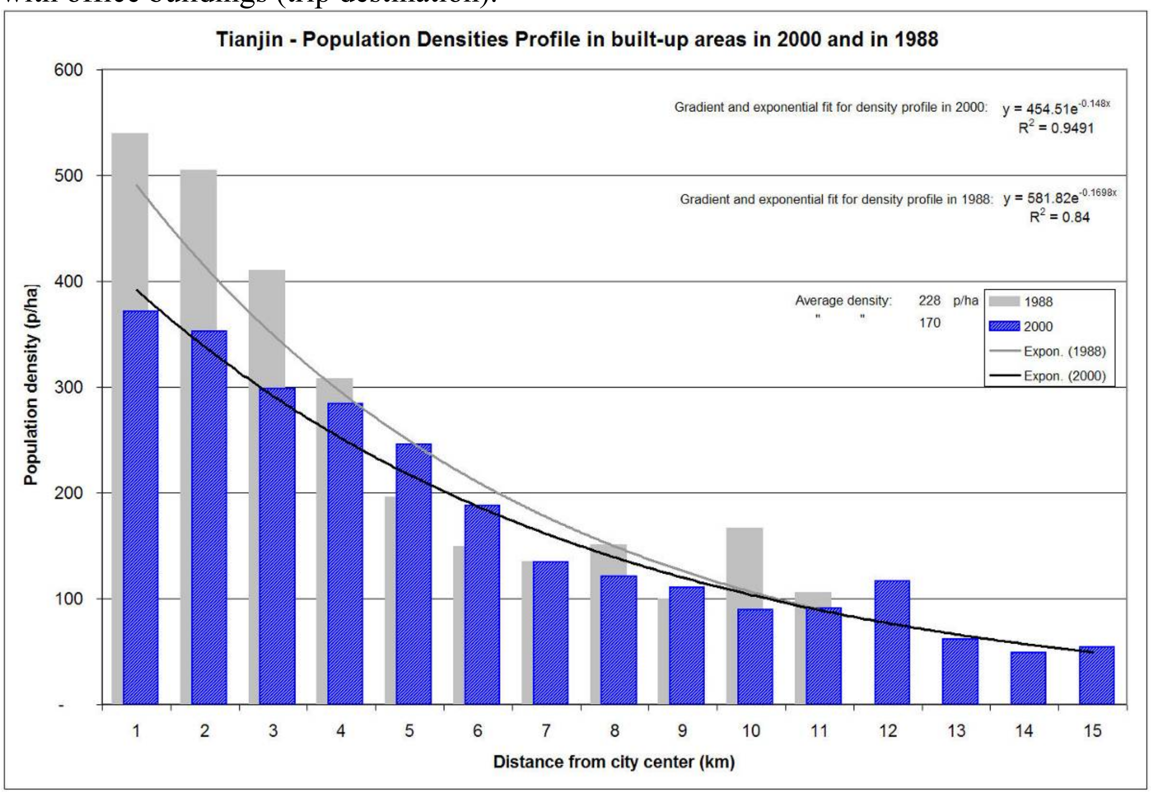

Figure 5: density profile in Tianjin at 12 years interval

The importance of Floor Area Ratio regulations in shaping an efficient spatial structure

We have seen that the values of Floor Area Ratios (FAR) have a direct impact on the total area of land a city occupies. In Chinese cities, as in most cities of the world, the permissible values for FAR are regulated. In China, the regulated maximum value of the FAR is calculated using the area of a block whose land use right has been acquired by a developer. By establishing an upper limit on the total floor area that can be built on a lot, FAR regulations are in the long run responsible for shaping the spatial structure of a city.

In addition, as we have seen above, FAR values are an important factor in determining the land consumption per person and therefore should be monitored carefully by Chinese planners.

In cities in market economies local FAR values are closely linked to local demand for floor space. FAR values are high in areas of high demand where the land prices are high and low in areas where demand for land is lower. For instance in New York City, the FAR value varies from 15 in the area of Wall Street to 0.4 in the suburbs (Figure 6). An overall zoning plan shows to prospective developers the FAR allowed in various parts of the city.

In China, by contrast, master plans are showing projected land use, but the FAR values for individual blocks are not normally part of the master plan documentation. The regulated FAR values are only shown in detail plans being drawn block by block but no overall conceptual plan exists to show the variations in FAR based on location and to our knowledge there is no explicit spatial strategy to guide the FAR values used in the detail plans.

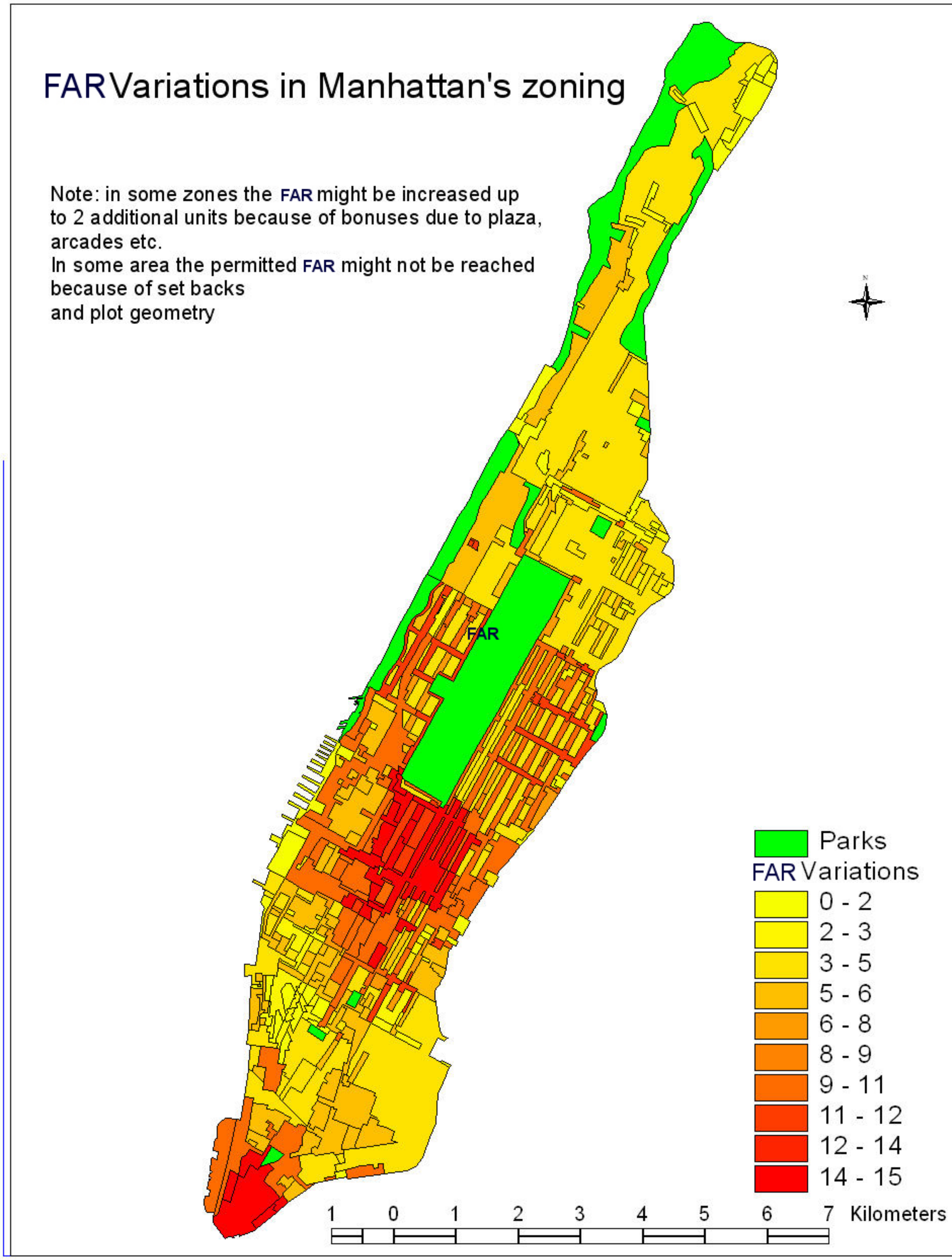

Figure 6: Map of FAR values in Manhattan

Because regulatory FAR values are not shown in master plans in China it is difficult to judge whether the current regulatory maximum values for FAR would correspond to an efficient or inefficient land use in the long run. From anecdotal evidence it seems that the regulated FAR values for new housing are mostly uniform and varying between 1 and

2 in most cities whatever the location. The sample site survey conducted in Tianjin and Zhengzhou (Figure 7) shows that most residential areas have FAR varying from 1 to 2 independently from their location in the city. Two outlier sites in Zhengzhou are the exception, one is a luxury condominium development with an FAR of 4.3 and the other is an overcrowded village enclave built informally on 4 levels and slated for demolition. The low FAR values in the suburbs are mostly farmers village, which under current practices are slated for demolition and to be replaced with apartment blocks with an FAR around 1.8.

However, it seems that in downtown areas of large cities the relatively low regulated FAR is often changed when specific projects are contemplated. This has been the case for the Zhengzhou luxury condominium with an FAR 4.3 shown on Figure 7. This pragmatic approach should be reflected immediately in the plans regulating FAR. An explicit maximum FAR is better than an FAR negotiated site by site. As we have seen, it is the general interest of the city to have FAR as high as consumers will accept.

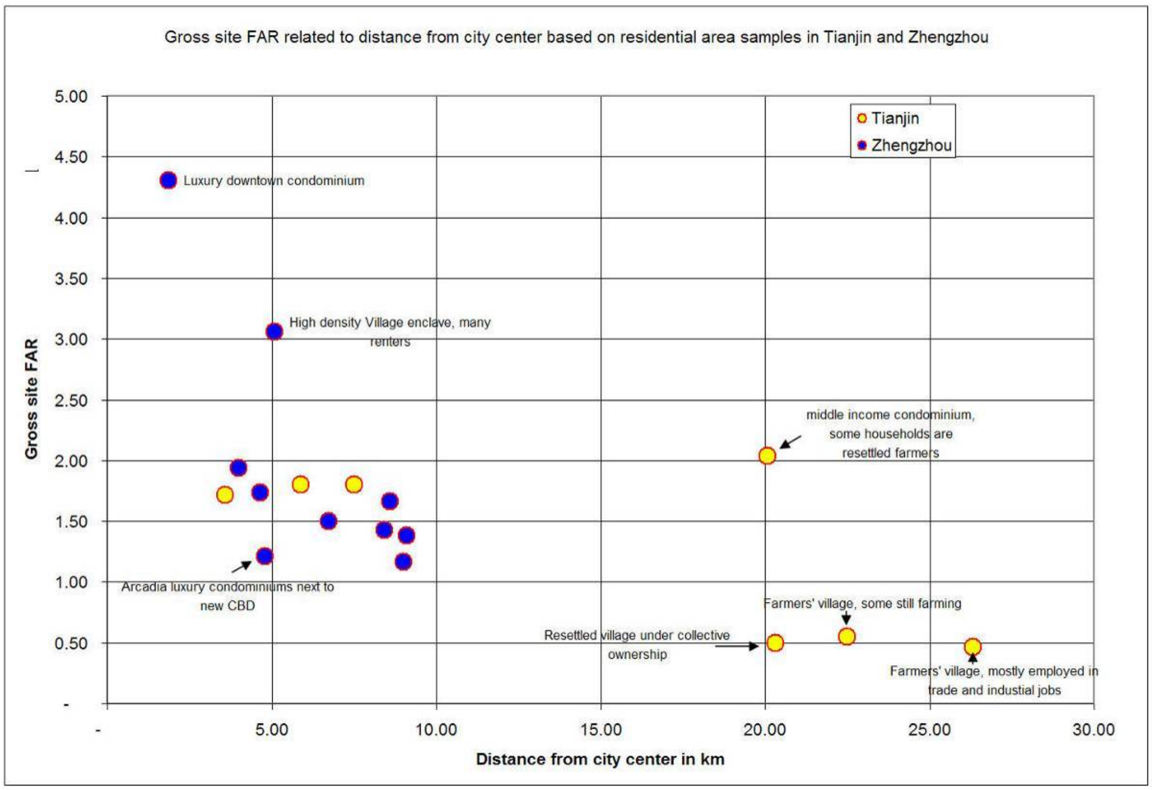

Figure 7: Variations in FAR with distance to the city center in Tianjin and Zhengzhou

In some municipalities the FAR of individual projects in downtown areas is adjusted to allow the resettlement in situ of the households displaced by the project while increasing it further to make the project financially viable. The market for developed land would work better if allowed FAR was explicit, as the value of the land depends very much on the FAR value. Higher FAR tend to increase land value but decrease the land cost per m2 of floor space.

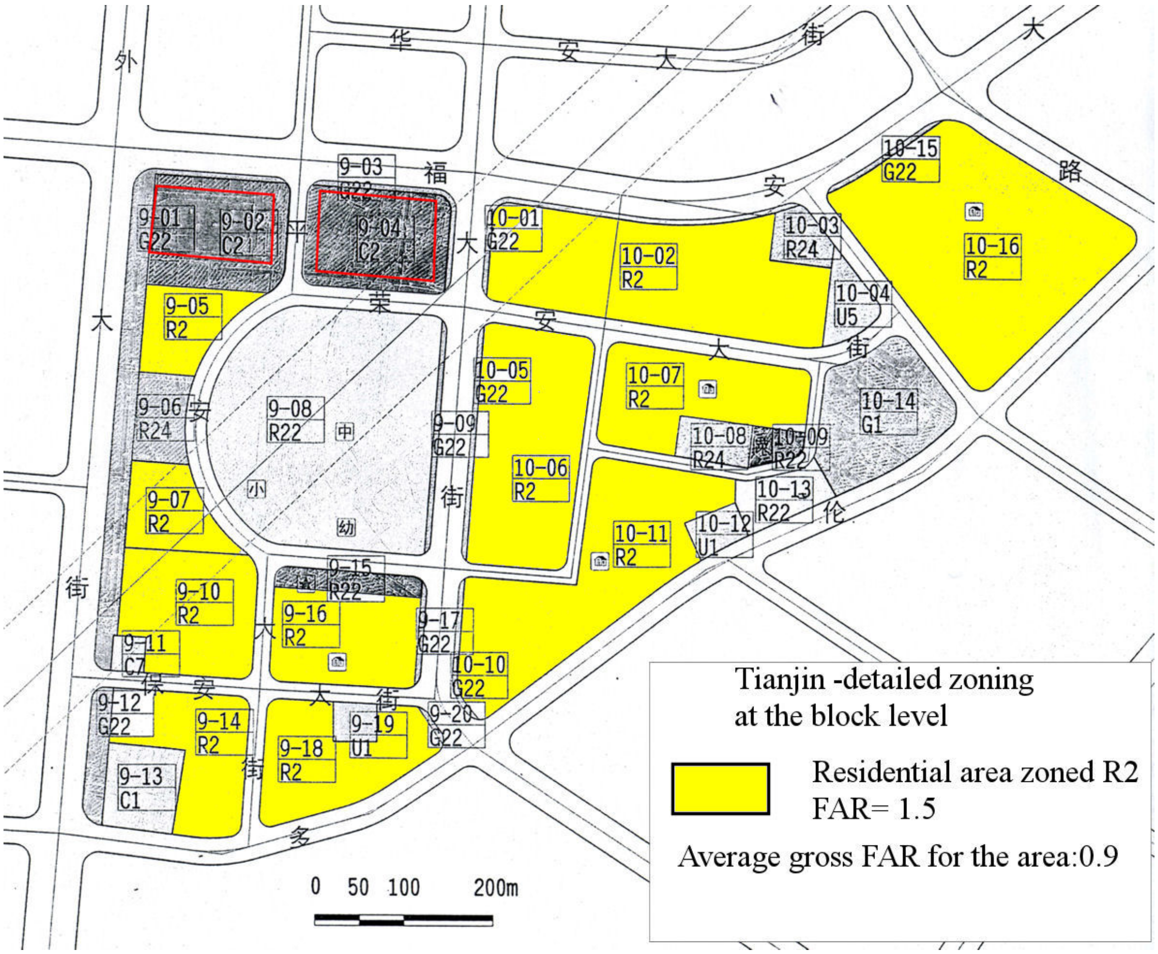

Figure 8: Tianjin detail block level showing FAR plan

A detailed plan of a few blocks in Tianjin is showing a regulatory residential FAR values of 1.5 close to the CBD of Tianjin and on the planned path of a metro line (Figure 8). This low FAR value in such a central area shows that there is no spatial policy in the regulation of FAR in Tianjin.

The long range consequence of this absence of policy is an increase in land consumption, a less efficient transit system, and higher housing prices because more land is required per housing units with low FAR.

There is no optimum FAR value for a specific location. FAR values have to be established by taking demand for floor space and land price into account, while evaluating the possible negative externalities created by higher buildings and their higher construction cost per m2 of floor space (see graph in annex 2). The low regulated FAR shown on Figure 8 , if perceived as non negotiable by developers, would normally distort land prices by lowering them where it is imposed. A low rigidly imposed FAR lower land prices because the salable area of floor space per unit of land would be lower than what normally a developer would have built to respond to market demand.

In the case of the Tianjin block shown on Figure 8, there are no obvious reasons to keep the FAR at such a low value given that the area is well served by the metro network under construction. Just as a reference, the FAR values in residential areas in similar central location would be equal to 3 in Paris, 6 in Washington DC, and 10 in New York.

Because of the priority given by the central government to minimizing the land consumption of cities, municipal planning bureaus should study as a priority the variations of FAR values which would be consistent with higher land prices and with consumer demand for well located housing and workplace. The current solution of planning for a low FAR but allowing negotiation for an higher one for individual projects might be the second best solution in the absence of planers trained to understand the functioning of land markets.

A relatively small change in the average gross FAR could over a relatively short period of time have a large impact on the area of urban land required for urban development. Figure 9 shows the alternative land consumption over 20 years for an hypothetical city of 1 million people growing at 2.5% a year, with a current gross residential FAR of 0.8 (about the same gross FAR as current Tianjin residential areas) . an increase in FAR from 0.8 to 1.3 would reduce land requirement by 158% compared to a decrease in FAR from 0.8 to 0.5. In all three hypotheses shown in figure 9 the floor consumption per person would increase from 20 m2 in the base year to 30 m2 at the end of a period of 20 years.

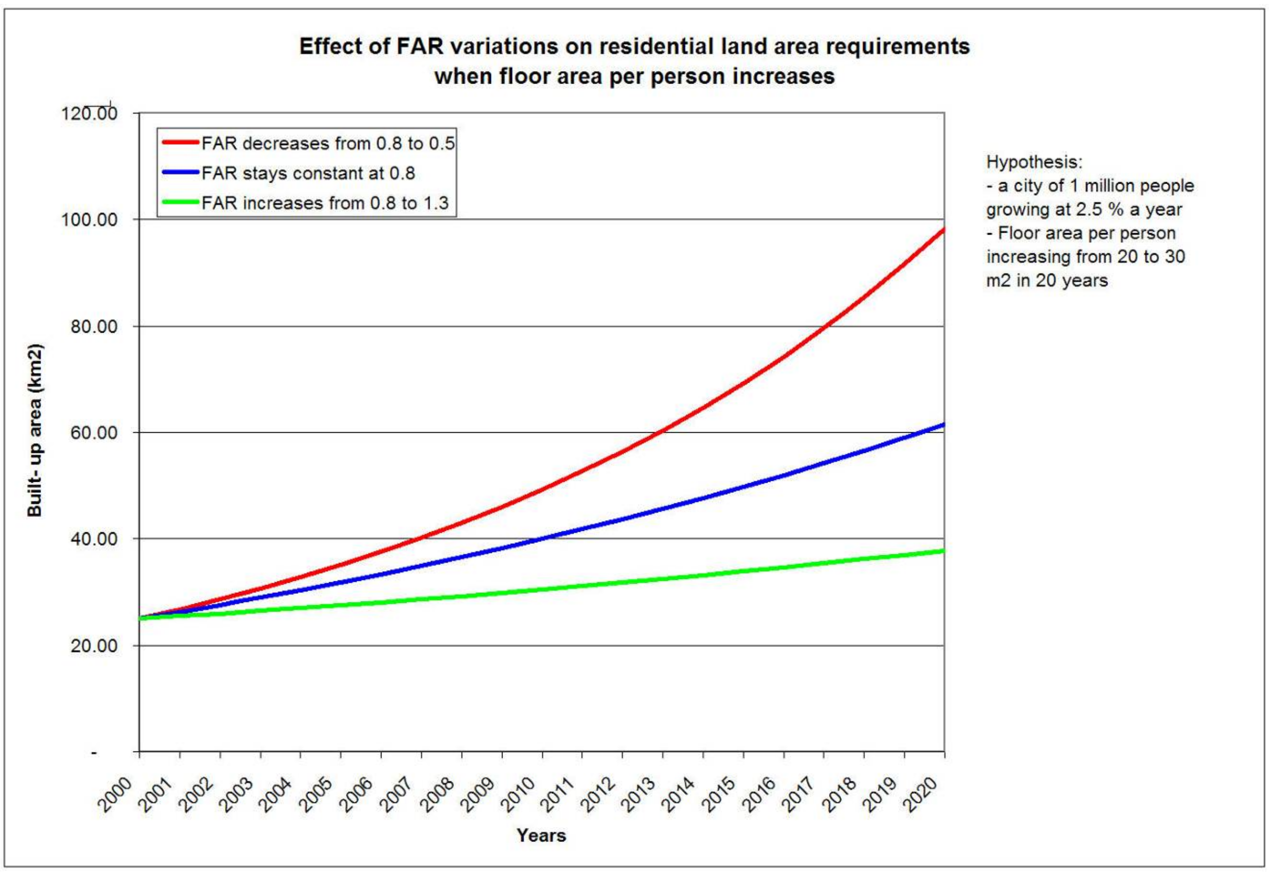

Figure 9: Land requirements under alternative average FAR scenarios

Recommendations

Because the spatial variations in the FAR values are so important for the efficiency of cities and for transport in particular, it is important that the master plan department in each city prepares the following:

a) a policy statement explaining the importance of linking FAR regulated values to accessibility in different areas of the metropolitan zone and what range in FAR values are acceptable locally;
b) a conceptual plan showing the variation of FAR within the metropolitan area to be used to guide the preparation of detailed plans;
c) current and projected net and gross average FAR[7] to be calculated at the sub-district level;
d) When calculating the current and projected built-up area – i.e. the future land requirements for a city –, the gross and net FAR should also be calculated to monitor the efficiency in land use and to avoid internal inconsistencies in urban planning projections. For instance, projections for land requirements in Chinese cities are often done by applying a norm suggested by the Ministry of construction of 100 m2 per person. However, a combination of low net FAR, large areas reserved for roads, community facilities and open space might significantly increase land requirements. Planners should use FAR and target floor consumption for housing and business to project future land consumption. The necessity to save on land conversion might then suggest to review the value of local FAR or other land use standards like the percentage of land occupied by roads.

The fragmentation of the built up area at the fringe of urbanization

While the density of Chinese cities is high by world standards, the fragmentation of the built-up area at the urbanization fringe greatly reduces the advantages provided by a high density.

In suburban areas in Tianjin as in Zhengzhou relatively high density areas are developed in a discontinuous manner, leaving large areas of vacant or cultivated land within the built up area. These un-urbanized enclaves are costly for the city. Infrastructure networks like roads, water, sewer, telecommunication and transport have to bypass these areas and as a result become more costly per hectare developed (see below an attempt at cost evaluation).

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[7] The net FAR is the regulatory maximum FAR for lots auctioned to developers, the gross FAR is calculated by neighborhood or even sub-district by adding all the area of residential and business floor space and dividing it by the entire area of the neighborhood or sub-district. The gross FAR allows to calculate the amount of land which is required per unit of floor space. The net FAR is regulatory, the gross FAR is a planning indicator.

The result of sample land use surveys conducted in suburban areas in Chengdu, Tianjin and Zhengzhou shows that on average about 34 % of the land within existing ring roads remain under agricultural use while urban development expend much farther away from the city center (see Table 2)

Agricultural enclaves in metropolitan areas served by urban infrastructure in Tianjin, Chengdu and Zhengzhou

City	% of agricultural use	Total area of sample (km2)	location
Tianjin	27%	22	Northern area inside 3rd ring road
Chengdu	32%	70	North West area between 2nd and 3rd ring road
Zhengzhou	41%	49	Western area within master plan limit 1995 -2010

Table 2: Proportion of land under agricultural use enclaved within urban area in Chengdu, Tianjin and Zhengzhou

In countries outside China, this fragmentation also exists but is due usually to either lack of infrastructure investments or to land titling problems or to speculation. None of these reasons apply to Chinese cities where the municipal authorities have a monopoly on land development and can choose which area is to be developed as a priority.

Figure 10: Fragmentation of the built up area in the northern suburbs of Tianjin

Agricultural land conversion quotas are the main cause of urban fragmentation

The current land conversion quotas have encouraged urban fragmentation at the fringe of urbanization. Land conversion quotas were imposed by the central government to respond to a widespread perception that municipal governments were developing land in excess of what was justified by economic development. Indeed, in some cities, a number of large "economic development zones" remain vacant many years after development. The distortions between the compensation price paid by municipalities for undeveloped land and the sale price of land use rights generate large profits. Municipal governments, who have a monopoly on land development, have a strong incentive to develop land to generate municipal revenue. Low interest rates for construction financing also contribute to large profits in land development projects, which typically requires long periods of costly negative cash-flow.

To prevent this apparent waste of land and infrastructure, the central government chose to impose quotas to slow down land development at the periphery of cities rather than to remove the prices and interest rate distortions which created the incentive. While the imposition of quotas had an immediate and direct effect in slowing down land development, it did not remove the incentives to develop land in a financially profitable but uneconomical way. Land conversion quotas have serious negative side effects. They distort urban shape, thus imposing large economical costs that we attempt to evaluate below.

Because the areas currently occupied by existing villages and TVEs are not considered as agricultural land, there is a strong incentive to redevelop the land occupied by villages and TVEs while avoiding the agricultural land in between. This process results in enclaves of agricultural land within the urban built-up areas which while retaining a nominal agricultural classification have lost most of their agricultural productivity because they are cut off from their irrigation and access systems and because most of the labor in adjacent villages find higher paying employment in city jobs.

The satellite image of Figure 10 showing the northern suburbs of Tianjin illustrates this fragmentation. High rise residential buildings are progressively replacing villages and TVE outside the 3rd ring road, while large pockets of agricultural land are left undeveloped within the 3rd ring road itself. This is a very costly practice, as utility networks and transport lines have to be extended bypassing large pockets of empty land. It is clear from the image of Figure 10 that the productivity of the agricultural enclaves within the 3 rd ring road must be greatly reduced by the lack of access for agricultural machine, the perturbation of the irrigation system and probably also by the lack of manpower and investments. The cause of agricultural productivity in China is ill served by the present quota system which gives only an appearance of conserving semi-fictitious agricultural land areas while lowering both agricultural and urban productivity.

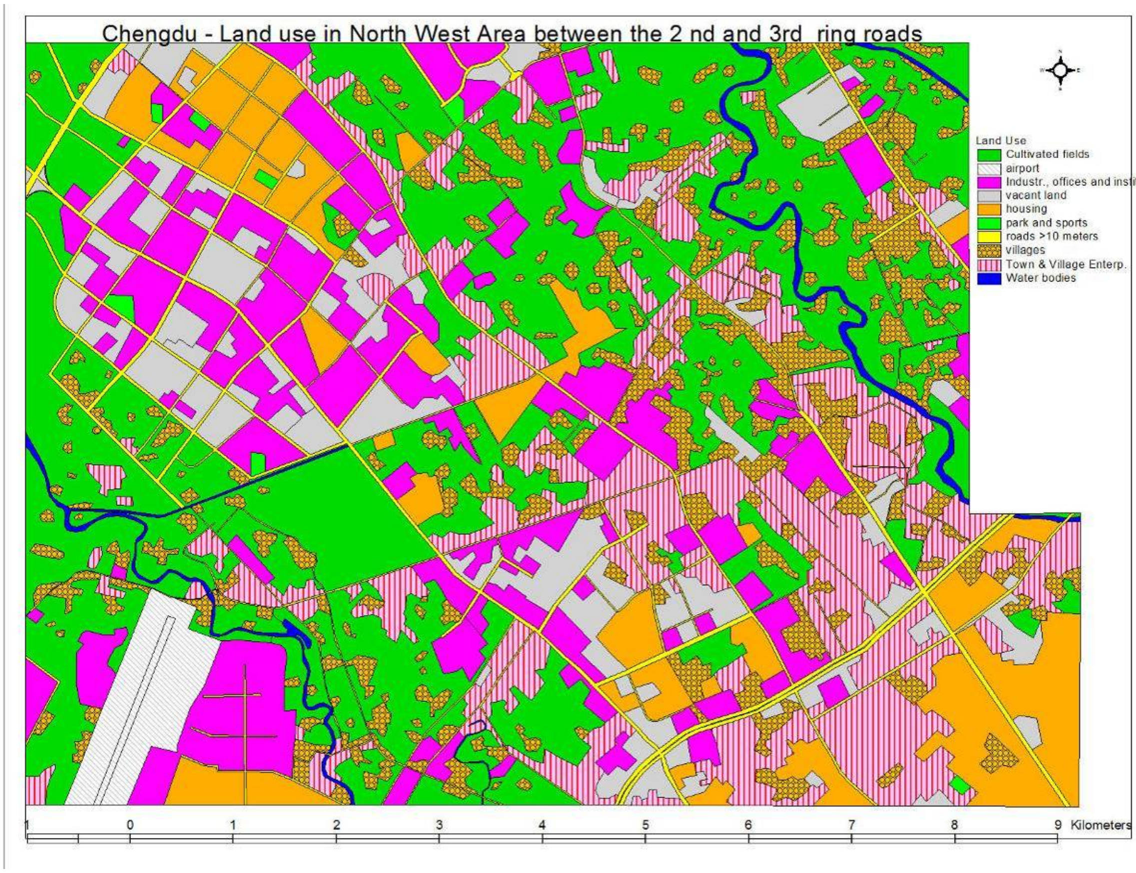


Figure 11: Fragmentation of land in Chengdu between the 2nd and 3 rd ring road

The effect of agricultural land conversion quotas is seen also in Chengdu as shown on Figure 11 (north west of Chengdu between 2nd and 3rd ring road) where agricultural land seems to be even more fragmented than in Tianjin.

Fragmentation and new primary infrastructure

Urban master plans in China usually include a large program of primary infrastructure investments and provide a land use projection in a compact shape consistent with the infrastructure investments. The record of implementing primary infrastructure is generally good, at the difference of many cities in Asia where urban development is often far ahead of infrastructure investment. However, the difficulties in converting agricultural land that have been projected for urban use by the master plan lead to an under use of already built infrastructure as is shown on the example shown of Figure 12 below.

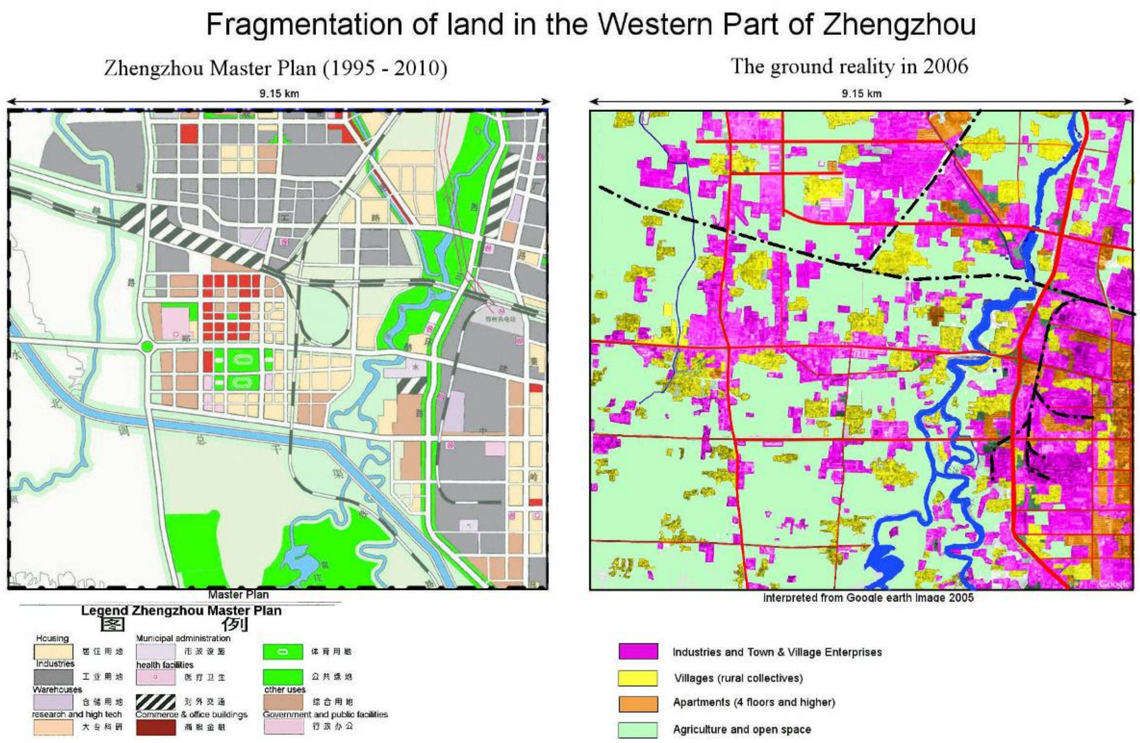


Figure 12: Master plan projected development in Zhengzhou

Figure 12 shows a comparison at the same scale of a portion of the master plan of Zhengzhou and a satellite image recorded in 2006 of the same area. This allows comparing the master plan projection to the actual land use toward the end of the planning period. The primary infrastructure projected in Zhengzhou master plan for the period 1995 -2010 has been in great part implemented. However, a large part of the land which was supposed to be developed within the infrastructure developed is still empty while the city is already expanding beyond the outer ring road i.e. beyond the master plan projection. It also appears that while a large part of the projected industrial land has been developed, the residential land projected by the master has practically not be built at all.

The issue here is not the timely implementation of master plans but the fragmentation of urbanization at the fringe of Chinese cities that leaves large areas of agricultural land served by an expensive infrastructure network while urbanization still expand further away from the city center. This process is caused in part by the agricultural land conversion quotas that do not differentiate between agricultural land parcels located close to the city center and those located further away. A reform of the quota system should encourage the urban infill of agricultural enclave, in particular those located within ring roads, to prevent the expansion of cities further away into villages and TVE areas.

The fragmentation of land at the fringe of Chinese cities is further illustrated by comparison with other cities of the world. Figure 13 shows two land use maps at the same scale of a strip of land 2km wide and 28 km long starting from the city center of Shanghai (people's park) and Paris (city hall). The expansion of both cities covers about the same distance, but in Shanghai the land developed is fragmented in small dense areas while in Paris both the urbanized area and the agricultural areas are consolidated into large contiguous areas. This pattern of consolidation allows a more efficient use of urban infrastructure and a more productive exploitation of agricultural areas. It should also be noted the large forest areas devoted to recreation in the suburbs of Paris compared to their absence in the suburban areas of most Chinese cities. The agricultural conversion quota system as currently implemented discourages the creation of natural recreational areas because public parks areas are considered as urban use and therefore their development requires to use land under the limited agricultural conversion quota.

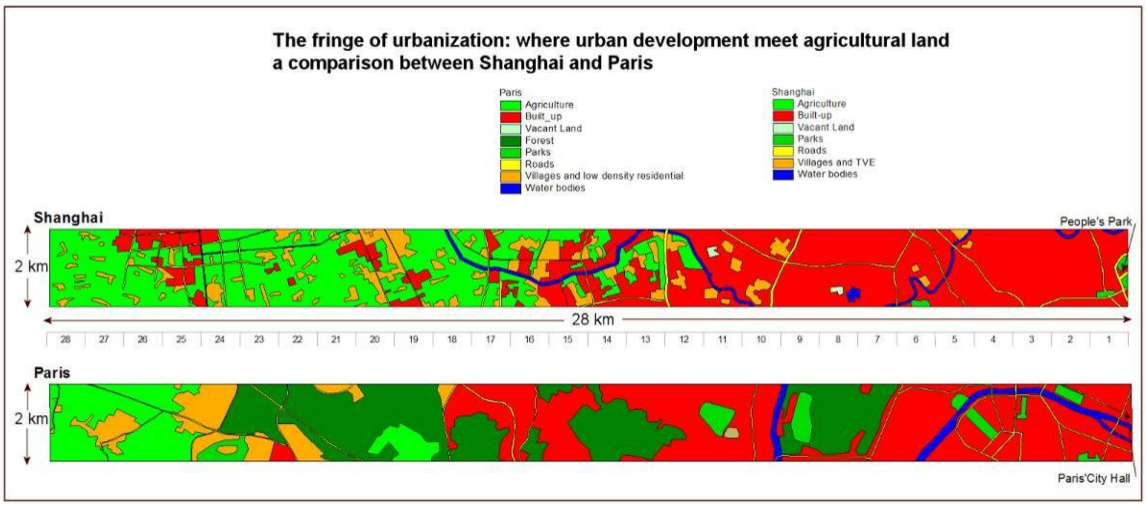


Figure 13: Comparison of urbanization fringe between Shanghai and Paris

An attempt to evaluate the cost of urban fragmentation in suburbs

The economic costs of the urban land fragmentation caused by land conversion quotas could be divided into 2 components: the additional infrastructure cost to land users and the additional transport cost incurred because of the additional urban expansion caused by agricultural enclaves.

The additional infrastructure cost to land users is evaluated in Table 3 using unit cost and land use parameters from three land development projects in Sichuan currently under implementation.

The cost of infrastructure per gross square meter is on average 150 Rmb/m2 . This cost includes only primary and secondary roads included into the master plan, and storm drain, sewers and street lighting corresponding to these same roads. The cost does not include access roads or infrastructure reticulations. On average, in most large land development project in China the ratio of salable lots over total land developed is around 60%. (40% of the land is used for roads, open space, schools and other non commercial community facilities). When the site is fully developed – i.e. without agricultural enclaves – the cost of infrastructure to be charged to users would be therefore 250 Rmb/m2 (Rmb 150/0.6). However, if some parcels of land stay undeveloped because the land quotas are not sufficient to allow its conversion, the cost of infrastructure has to be recovered from the actual urban users and cannot be recovered from farmers in agricultural enclaves. Agricultural enclaves de facto decrease the amount of salable land from which the infrastructure cost could be recovered. If we assume that the areas of agricultural enclaves represent about 34% of the suburban land developed, as it was the case in the 3 samples shown in Tianjin, Chengdu and Zhengzhou, then the "real" proportion of salable land is about 40% (instead of 60%) and the cost of infrastructure to be recovered from urban users is 379 Rmb/m2, an increase of 52 % over what the cost would have been if the land developed had been fully utilized. The proportion of agricultural enclaves may vary from city to city and with distance from the city center, but it is not unreasonable to evaluate their cost as adding about 50% to the cost of land development.

Increase in infrastructure cost due to agricultural enclaves	
Cost of infrastructure per gross m2 of developed land (Rmb/m2) [1]	150
Ratio of salable land when all land is developed	60%
Cost of infrastructure per net m2 of salable land	250
Typical Area of land left undeveloped as agricultural enclaves because of conversion quotas	34%
Effective salable land when agricultural enclaves are deducted	40%
Cost per net m2 of effective salable land (Rmb/m2)	379
Increase in infrastructure cost per m2 due to agricultural enclaves	**52%**

[1] cost corresponding to average of 3 land development projects in Sichuan (2006 prices)

Table 3: evaluation of the additional infrastructure cost caused by agricultural enclaves

Agricultural enclaves also increase the cost of urban transport. To accommodate the same population at the same density Chinese cities have to expand by an area equivalent to the agricultural enclaves' areas located within the built-up area. Consider a city of contiguous area S_0, over the years it has to expand by ΔS so that the new contiguous built-up area will be:

$S_1 = S_0 + \Delta S$

If the percentage of land occupied by agricultural enclaves is α the city built-up area including the enclaves would become :

$S_2 = S_1 (\alpha. + \alpha^2. + 1)$

The percentage increase in the area required because of agricultural enclaves would be:

$\Delta S_2 / S_1 = \alpha^2 + \alpha.$

If we assume that the built-up area is circular, the increase of the radius R_2 corresponding to the area S_2 compared to the radius R_1 of the circle of area S_1 would be:

$\Delta R_2 / R_1 = (\alpha^2 + \alpha + 1)^{1/2}$

The following numerical application provides an order of magnitude of the additional trip length generated by agricultural enclaves. Let us assume a city with a circular shape with an area of S_0=100 km2. It requires doubling its built-up area over the years to $S_1 = 2.S_0$ =200 km2. The radius of S_1 is R_1= 7.98 km. If the new built-up area includes agricultural enclaves representing α=34% of the required built up area, then the new area required would be S_2= 291 km^2 and the new radius 9.63 km, an increase in radius of 21% over the radius of S_1 (The area needed in the absence of enclaves).

The numerical example above is theoretical but provides an order of magnitude of the increase in trip length and transport network routes which are caused by the agricultural enclaves in the suburbs of Chinese cities.

Recommendations to prevent further urban fragmentation

To prevent further fragmentation of urbanization at the fringe of cities the current regulations imposing a quota on agricultural conversion should be revised. In addition, the financial incentives which makes an over supply of developed land financially attractive to the municipalities should be removed. Using market price for land taken from farmers and TVE and using a market rate of interest for financing infrastructure construction would remove much of the financial incentives in the long run. In the short run, the way quota conversions are applied should be reformed.

In a well functioning market economy the issue of agricultural conversion is usually dealt with by the land price mechanism. The state may however intervene only to protect land of exceptional values like forest or specific agricultural land already surveyed and whose boundaries are well established (this is the case for instance in the forests surrounding Paris shown on Figure 13). The fragmentation at the fringe of urbanization is usually prevented by the way land subdivisions regulations are drafted and by extending infrastructure services only progressively around existing urban areas.

In China, in the absence of price mechanism to auto-regulate the use of undeveloped land, agricultural land conversion quotas aim at preventing the uneconomic conversion of land use at the fringe of cities. As implemented, these quotas contribute to the fragmentation of land and the further expansion of cities into the countryside, which is neither desirable for agricultural productivity nor for urban efficiency. An efficient quota system would recognize the various value of land at the city fringe and would promote the consolidation in large contiguous areas of both agricultural land and urban land.

The reform of quotas could include the design of an urban perimeter which could be part of the master plan. Within this perimeter all land parcels, whether under current agricultural use or not, should be developed as a priority without requiring the use of a conversion quota. Land outside the perimeter would be protected by conversion quotas, possibly even more stringent than the current ones. In particular cities that have large areas of undeveloped land within their ring roads would have reduced land conversion quotas, until all the vacant land within existing ring road has been allocated, this would include open space for recreation. In the long run, of course, the quota system would not be required anymore and should be dismantled as soon as a functioning land market has been established for agricultural land conversion.

Over development of industrial land

The proportion of industrial land area over built-up area in cities in transition economies is usually 3 to 6 time larger than in cities with a land markets tradition (Figure 14) . In Chinese cities the proportion of land devoted to industries is around 26% of the built-up area. Tianjin with 21.7% and Zhengzhou with 23.3 % are slightly below the Chinese cities average but much above cities in market economies. Seoul use 6.9% of its built land for industries, Hong Kong 5.4% and New York City only 4%.

In market economies, industries compete with users in other sectors of the economy to buy urban land. Industries that are land intensive are pushed by economic forces either in peripheral towns or in smaller towns where land is cheaper. By contrast, in command economies, land for industries is often heavily subsidized as industrial production has often been considered to be a privileged part of the economy, while commerce and services were thought to be of minor economic importance. This explains the difference in the proportion of industrial land between cities in market economies and in transition economies.

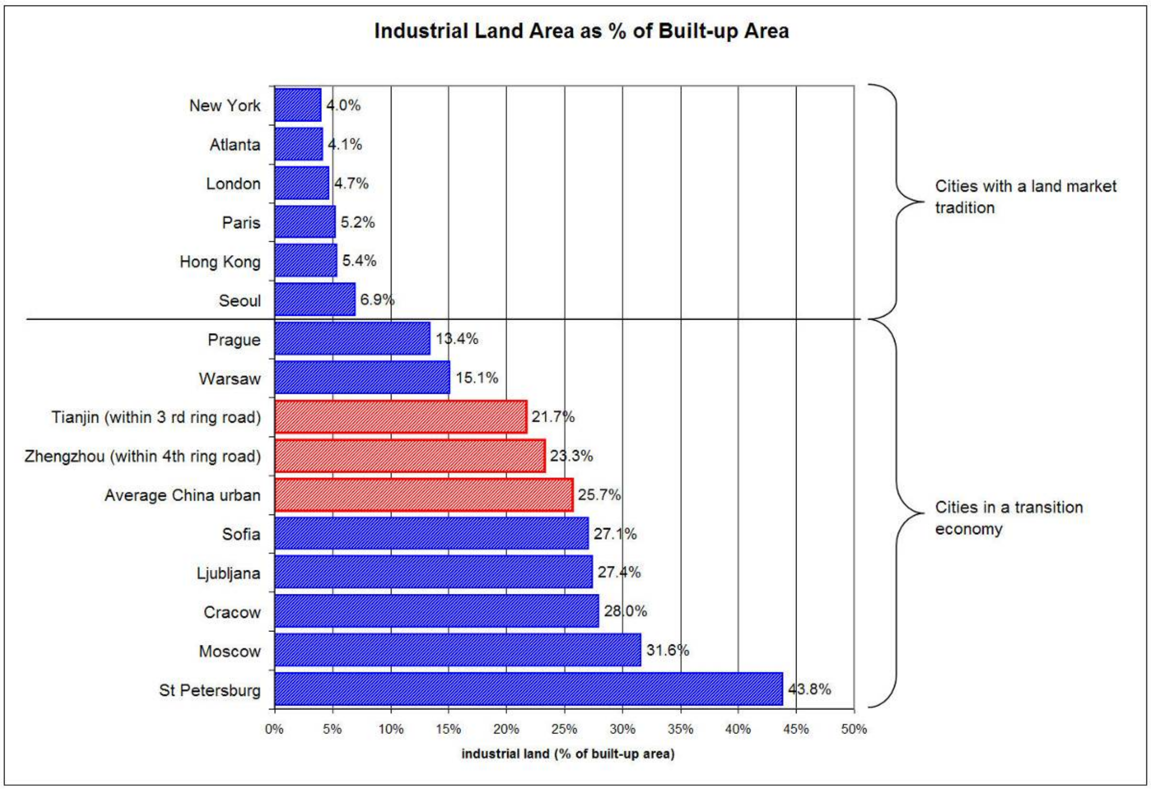


Figure 14: Industrial land area as a % of built-up areas in cities in transition economies compared to cities with a market tradition

In Chinese cities prior to the reforms started in the 80's industrial land was allocated administratively in industrial belts very close to the city center. During the period of reforms until 2005, land use rights for industrial land was usually leased at a negotiated price much lower than the auction price used for residential land. It is not until 2005 that auctions were used to lease land use rights for industrial land. It is to be expected that land sold below market price, and often below development cost, will be consumed in larger quantity than land obtained through competitive bidding. The large proportion of industrial land found in Chinese cities reflects the past practices and will take a long time to be reduced to more normal proportions.

The high consumption of industrial land in Chinese cities is a dead weight on their economy. It extends the built up boundaries beyond what would be normally needed, it also expand artificially infrastructure and transport networks. In addition, large industrial areas inside cities are blocking normal urban extensions, as it is the case in Zhengzhou where the large and lumpy industrial areas along the railway lines are making expansion in the North West area of the city difficult, decreasing land values.

Recommendations

Auctioning industrial land should reduce the problem of over consumption of industrial land in the long run. A system of systematic cost allocation and cost recovery when developing infrastructure for industrial land would also contribute to reduce the proportion of industrial land in the long run -- while not necessarily reducing the number of industrial jobs. A new set of land subdivision rules should establish clearly the direct cost recovery responsibility for all infrastructure, from Provincial government to end user. This would establish a threshold cost for land development, for industrial use as well as for other uses. This threshold cost would be the floor price for land auction. It would remove the implicit subsidies that industrial land have received so far and would therefore insure that land developed for industries correspond to the best and higher use.

In the short term, there is nothing much that the government can do to reduce the land already allocated to industries. Programs to relocate industries, either from the center to the periphery or from a large city to a smaller one has been done often successfully in the past in a number of Chinese cities. However, it would be more efficient to allow the price mechanism to trigger relocation by allowing industries to retain a part of the profit from the sale of land use rights of the land they currently occupy.

The relationships between urban spatial structure and transport efficiency

The spatial distribution of population densities and jobs in a city has to be consistent with the planned dominant mode of transport. High residential density and the concentration of employment in few areas are consistent with a high use of transit, while low density and the dispersion of employment are more consistent with individual modes of transport. The bicycle is an efficient mode of individual transport which is compatible with high densities. However the use of bicycles progressively decreases in efficiency as a dominant mode of transport when the built-up area of cities expand beyond 100 km2 because of the time needed for commuting and the space used by bicycles in downtown areas during the rush hour. In large Chinese cities, it is therefore expected that bicycles – while retaining an important role in transport – would be progressively replaced by transit as the main transport mode.

The high density of Chinese cities precludes the use of individual car as the main mode of transport in the foreseeable future. While densities have been slightly decreasing in the central part of Chinese cities in the past 20 years (see Tianjin density profile Figure 5) their density will remain more than an order of magnitude higher than European or

American cities where individual car is the main transport mode. The central government concern over land conversion at the fringe of cities will ensure that densities stay high in the future, even in suburban areas.

There is a mutual reinforcement mechanism between transport and land use. For instance, in many cities real estate prices tend to increase around metro stations, providing incentive to private developers to build at high densities making the metro system more economically viable. On the other hand, already existing low densities encourage the use of private cars and preclude the construction of a financially viable mass transit system.

High average density is not enough to allow the efficient operation of transit. The spatial distribution of densities should reflect the accessibility created by the transit network. The regulation of FAR in particular is crucial to insure that costly transit investments are fully coordinated with land use. The land use around subway or BRT stations should be the object of special studies. Planners would have to differentiate more than they do now between the land use regulatory framework and urban design. The regulatory framework – fixing maximum FAR, permissible land use, maximum heights, minimum setbacks, etc. – should be produced by municipal planners –as it is done presently. However, these regulatory land use parameters should not be considered part of "detailed design" affecting only adjacent buildings but should be part of a land use strategy for the entire city. Master plans should include zoning regulations and should show how these zoning regulations are contributing to the strategic objectives of the city. Finally, an overall zoning map, showing all the land use regulations applied in specific areas should made public and made an integral part of the master plan.

Detailed design, allocating type of building and separating public from private space within blocks should be done by the designers working for developers who are better able to use to a maximum the potential of a site.

The master plans of both Tianjin and Zhengzhou are projecting heavy investments in mass transit in the form of suburban trains, metro, light rail, BRT and buses. But to our knowledge there is no coordination between the detailed land use regulations (see the block regulations shown on Figure 8) and the transit system. Figure 15 shows the existing densities (2000 census) in Tianjin in relation to the existing and projected metro network.

In planning FAR, and as a consequence planning implied densities for both housing and employments, planners should fix themselves an objective related to transit accessibility. For example, a possible transit objective could be to adjust FAR so that to allow , say, 70% of jobs in services and 60% of the population within the external ring road to be at less than 800 m from a metro station. This could then lead to a map for maximum FAR values which would cover the entire area served by metro (example on Figure 16). Detailed FAR maps per block would still be needed to establish the exact boundaries between different zones. Within these detailed maps it should be possible to alter up or down the projected FAR shown on Figure 16 to reflect local conditions or planning objectives different from transit maximization. It should be noted, however, that regulations can impose a maximum FAR but that only the market will set the actual FAR. Regulating land for high density does not insure high densities in the absence of consumer demand. Understanding the way markets work might become one of the major priority study area for Chinese planners. Markets value amenities like access, distance to parks, distance to center, etc differently from country to country. Therefore Chinese planners would have to gain their knowledge from observing real estate market transactions in Chinese cities as they develop.

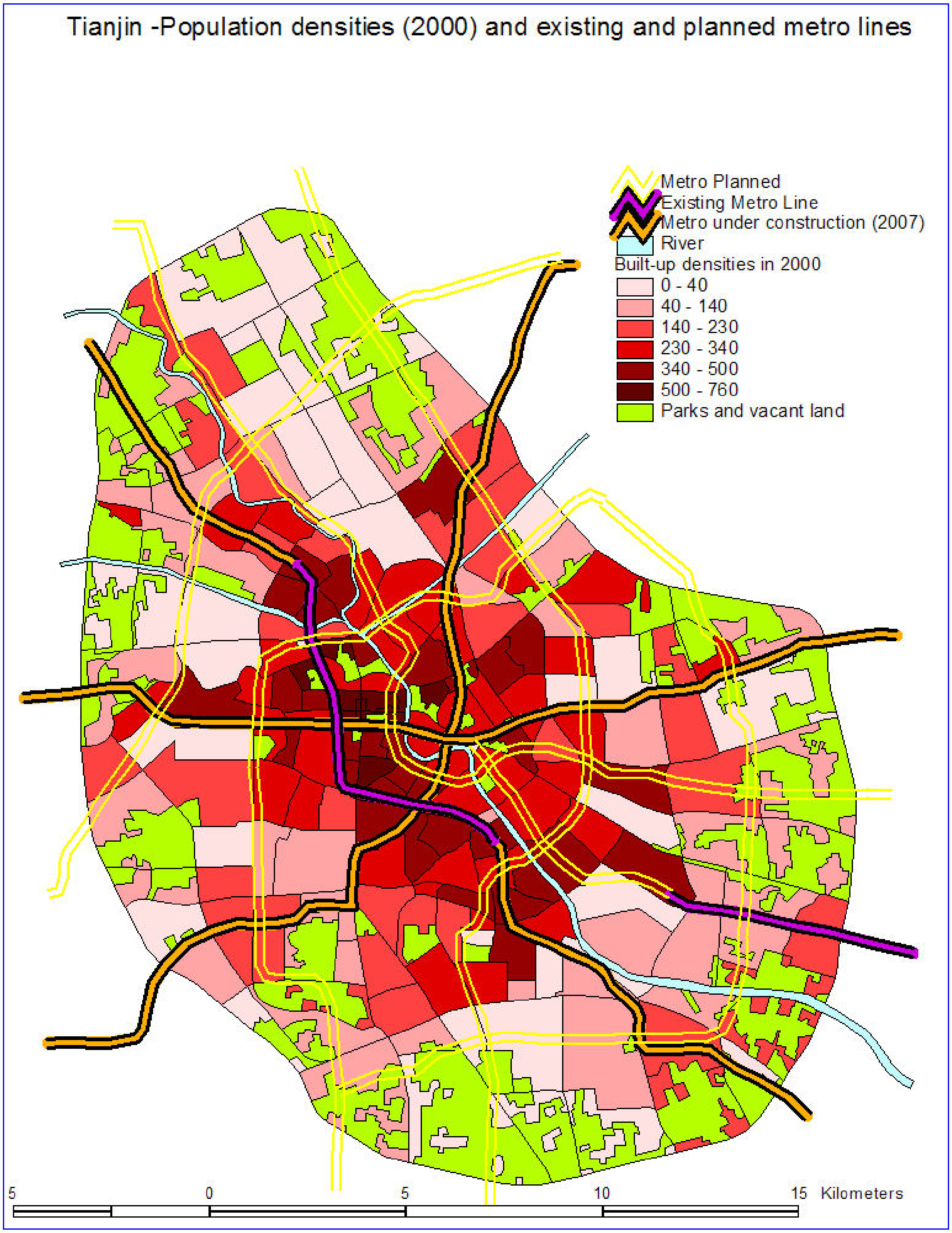


Figure 15: Tianjin Map of densities and projected metro network

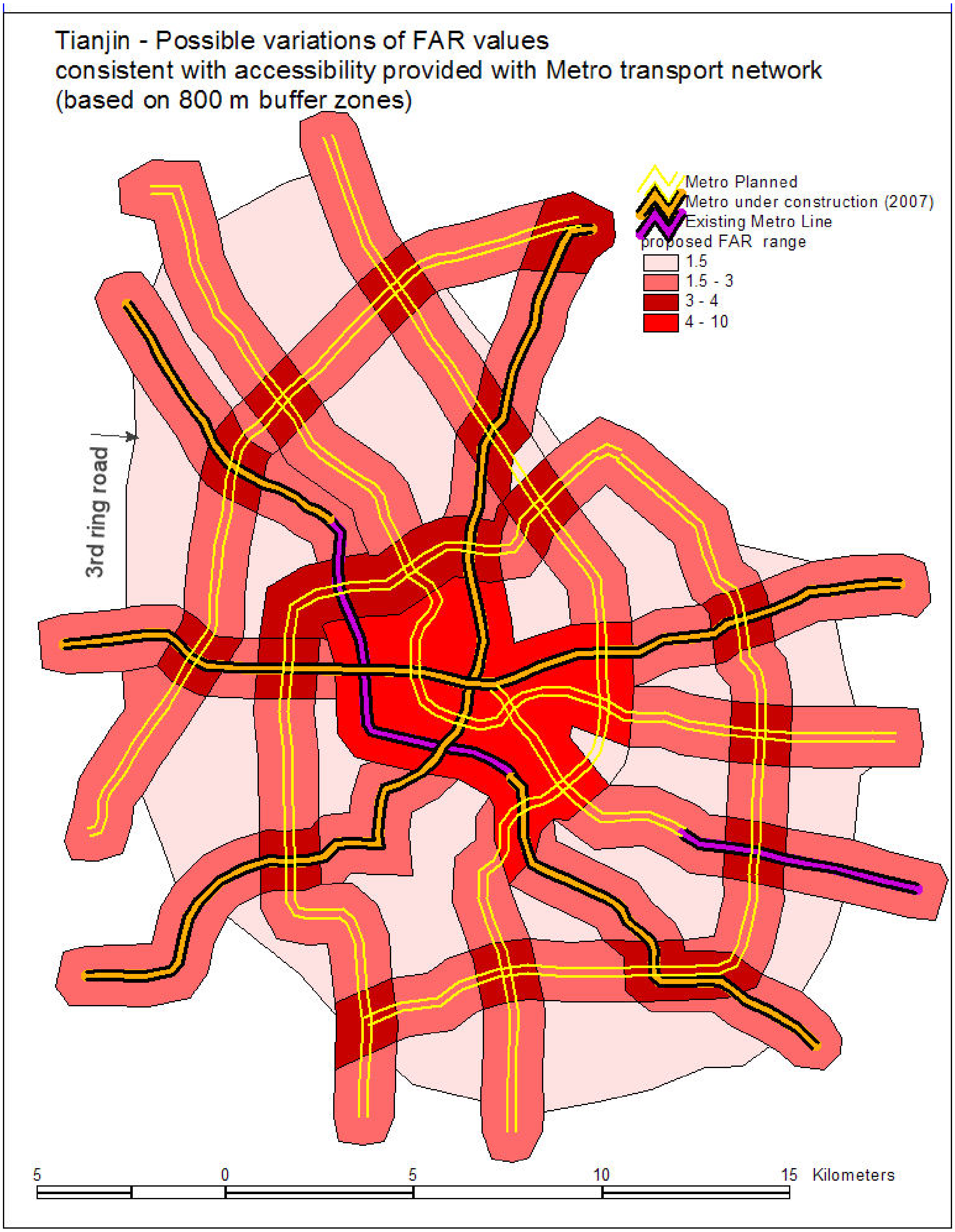


Figure 16: Possible FAR guidelines based on transit accessibility

Annex 1

Relationship between population, residential land area, and Floor area ratio

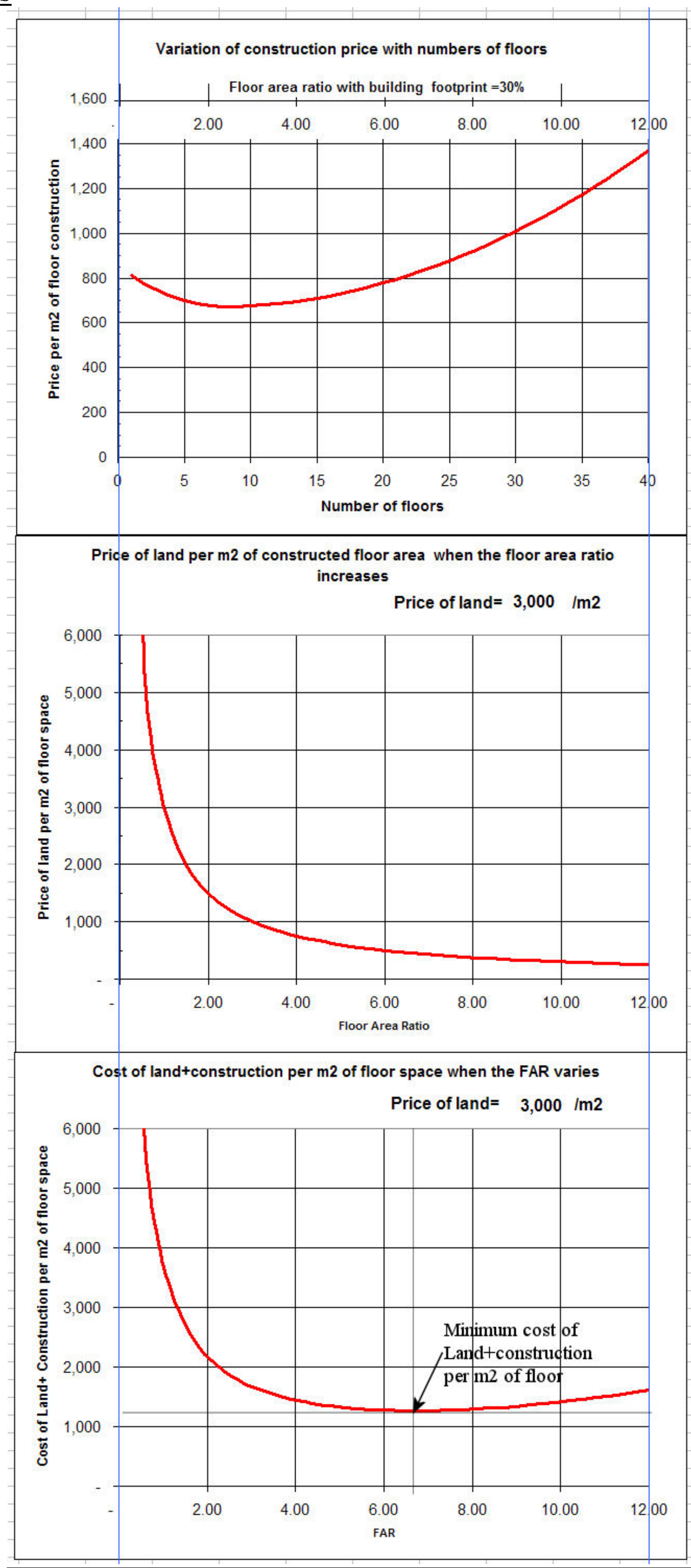
The total residential area in year t can be calculated by the following formula:

$$Ar_{(t)} = \frac{P_{(t)} \cdot f_{(t)}}{Far_{(t)} . l_{(t)} . (1 - r_{(t)})}$$

where

$Ar_{(t)}$	Total residential area at time *t*
$P_{(t)}$	City population at year *t*
$f_{(t)}$	living area per person in m2 year *t*
$l_{(t)}$	% of living area over total floor area year *t*
$r_{(t)}$	% of total residential area used by roads year *t*
$Far_{(t)}$	Floor area ratio year *t*

Annex 2 Variation of construction prices, land price per m2 of floor when the FAR varies



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