Assessing the Transportation Consequences of Land Use Transformation in Urban China

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**ABSTRACT:**

This paper assesses the accessibility and mobility consequences of urban land transformation in expanding Chinese cities. It defines transportation-land use connections in China’s context and analyzes the accessibility and mobility uncertainties associated with current urban development themes, including the formulation of CBD, the development of satellite communities and the evolution toward multi-center layout. This article points out that appropriate accessibility and mobility objectives are not well considered in land development, and current development themes tend to lengthen trips and lead to increased congestion in the context of growth and motorization. A strong national leadership is needed to help city governments integrate accessibility and mobility objectives into urban development.

Keywords: Accessibility, Mobility, Land development, China

1 Introduction

Chinese cities are in rapid expansion and structural transition as a result of important changes in wealth, social structure, and land and housing reforms (Zhou and Ma, 2000; Deng and Yan, 2005). Urban population in China grew by 180% during the 17 years ending in 1999. Motorization is growing at around 15 percent per year. The urban land uses are adjusting at a rapid rate, propelled by the land and housing reforms and driven by an economic boom.

The shape of the result at future stages of change, however, is still hard to foresee. One thing that is quite clear is that Chinese urban dwellers have been taking more daily trips and logging many more vehicle kilometers traveled over the past 25 years, and these will continue to increase across the foreseeable future. First, China shares many common features of the developing world in terms of growth, motorization and congestion (Gakenheimer, 1999). Current economic growth and wealth increase has been a major
factor driving both urban land change and motorization. Second, the transition of land use from a planning economy to a market economy has its own transportation effects. This comes not only from the density changes, but also the location of different land uses relative to each other. Taking the changing workplace-residence relationship as an example, a recent study finds out that the spatial separation between workplace and residence has increased significantly in the process of housing relocation. The relocation has lengthened commuting time by 30% and increased motorized modes from 25% to 41% (Yang, 2006). Given the current severe congestion in big Chinese cities, it is important, therefore, to assess the potential accessibility and mobility consequences of current urban development trends.

There are both reasons for fear and reasons for positive expectation as it is still unclear where Chinese cities will evolve. Ma and Wu (2005) point out that the resulting urban form in China will not closely resemble cities elsewhere in the world, nor will they converge on a single widespread Chinese pattern. A primary reason is that different city governments tend to respond to similar driving forces with local varied development strategies. The outcome in land use patterns, urban forms or urban spatial structure, therefore, will be different among those cities. The uncertainties in the future will be further manifested once we consider that today’s China has only about 40% of its population urbanized. The Chinese governments still have much flexibility to direct the growth of urban spatial structure with infrastructure investment strategies, land development guidance and taxation, three policy tools widely used by nations around the globe (Bertaud, 2004).

The purpose of this article, therefore, is not to draw conclusions on the transportation impacts of Chinese urban forms, but to examine the major land development themes across China in terms of its potential accessibility and mobility consequences in a mature future. Based on this, we briefly discuss preventive remedies.

2 Conceptualizing Transportation Impacts of Land Use Change in Urban China

2.1 Measurement of Land Use patterns

There are several useful ways to analyze the distribution of human activities over urban space. The single most prominent measure in this discussion will be residential density. Many Chinese metropolitan areas average 200 to 250 persons per hectare, with local urban densities rising to much higher figures. Mega-Cities like Shanghai and Beijing are among the densest urban areas in the world. But the density of the traditional Chinese city is not congenial to car ownership and is changing rapidly.

Portions of land occupied by particular land uses are another dimension of concern. For example, lower than 10% of urban land was used for road infrastructure in most pre-reform cities. As a response to today’s congestion, the allocation of land for transportation infrastructure and service has been improved considerably, evidenced by extremely wide roads and big squares in many Chinese cities (Ren, 2005).
More important, there is a series of locational concerns that are basic to the question of land use and access. That is, what uses are changing places in distance from the city center and distance to one another. Relevant terms include land use mix, job-housing balance, and urban spatial structure.

2.2 Physical and Social Dimensions of Transportation-Land Use Connections

Land use patterns are long term factors that set the background for individual travel behavior. Transport demand and land use are connected inherently because transport is needed only when activities at other localities attract trips. They are connected in two ways. First, the physical land use configuration determines the available travel options of origin and destinations. Land use density, land use mix, and spatial separation of living, working and entertainment activities all have consequences in transportation. Any land use adaptation that further separates the trip ends of the traveler’s regular trip set can potentially increase travel demand. A lower density, a lower job-housing balance, a higher degree of dispersal means a long trip distances.

Second, the rising income, the changing life style and the widespread of car ownership all affect how people utilize a given physical pattern of land use. This is a social dimension of transportation-land use connections. In an increasingly affluent economy, the availability of increased mobility through new auto ownership, better roads, reduced traffic, or better public transport can free people from the closest available opportunities and seek better chances farther away. Worldwide data make both dimensions clear. Personal trip rates grow with affluence. Auto ownership and trip length grow with reduced residential densities and homogeneous suburbanization (Newman and Kenworthy, 1999). In China, the social dimension of the motorization pathway is also emerging as household income rise in the context of increased income gaps among different households (Gakenheimer, 2005).

2.3 Land Use Transformation in Expanding Urban Areas

Land use changes in China can be conceptualized broadly from two perspectives - expansion and transformation. Expansion happens when rural-urban migration and rising household income demand for more spaces for more urban services, large housing units and thus expanded urban boundaries. Structural transformation happens when location patterns of urban activities change, guided by institutional and regulatory reforms of land and housing. This change also occurs with changing wealth, tastes and particularly transportation technologies.

The expansion of the Chinese cities in the past 25 years is more impressive than their economic growth, evidenced by the conversion of rural land use in suburban and peri-urban areas. In Beijing, for example, urban land area has tripled in the last two decades (Liu and Prierler, 2002). This expansion of urban activities into new suburbs can be examined from the perspective of housing demand. Many new housing quarters have
been developed at the urban periphery, in order to accommodate the increasing demand for larger housing units from an increasing urban population.

This expansion can be also viewed from the industrial point of view. Webster et al. (2003) find Hangzhou on its third stage of peri-urbanization. The first stage was based on township and village enterprises, the second was based on new industrial zones accommodating transnational companies and others associated with direct foreign investment. Now the third stage results from relations with large-scale international purchasers buying directly from local companies. Employees in the region are moving into more productive roles through these transitions. Space is being urbanized rapidly as the area moves from phase to phase. During 1991 to 2001 the loss of agricultural land was 4.78 times the rate of local population growth.

While expanding outward, cities do not simply replicate its old fabrics in the new areas. Fundamental structural changes have happened at the regional scale as well as at the neighborhood level. The region level changes include the formation of CBDs in the central cities, the redevelopment of old urban cores, the creation of various development zones in the suburbs, and the evolution toward a multi-city layout. In addition, the breakdown of work-unit compounds and consequently the change of neighborhood fabrics represent a fundamental structural transformation in terms of how land and urban functions are organized at the neighborhood scale. This land use transformation, rather than a simple urban land expansion, is the focus of this article. Next, we present China’s major themes of land use transition and assess their transportation implications in both physical and social dimensions.

3 Assessing Transportation Effects of Land Use Transformation

3.1 Tearing down the Work Unit Complex

The pre-reform urban settlement included state or collectively owned enterprises that contained their own housing and commercial facilities along with their production activities. This was partly guided by the planning idea to build more efficient socialist cities. The work unit compound atomizes the structure of trip sets, making most trips short, leaving little need for major business centers.

The land and housing reforms introduced in the early 1980s have altered this fabric primarily in two formats. First, in established urban areas, particularly the urban cores, the government has implemented relocation plans to improve land utilization. Many state owned enterprises have moved their production activities into the new suburbs, although the employees may still live at the same localities for the reasons such as urban amenities and schooling opportunities for children. Second, in most cases, new enterprises no longer stick to the traditional work unit model of workplace and residence. Housing demand is to be met by the housing markets. More and more employees are seeking cheaper housing at locations far away from their workplaces.
The transformation of the work unit compound would not be possible without the expansion of urban activities into new suburban localities. In the industrial urban regions, suburban development booms not only by the new industries from foreign countries, but also because of the migration of production activities from central to peripheral locations. The development of housing on large parcels of land in the suburbs also helps accommodate not only the newly urbanized population, but also the outward movement of residences from the central city where industrial and residential land is redeveloped into high rise offices, retail centers, or expensive multi-story housing.

Speaking of the transportation consequences, the pre-existing workplace-residence tie is broken not only physically but also socially. First, the spatial separation between workplace and residence is increasing. Many new bedroom communities are far away from the existing built-up areas and employment, entertainment, education and shopping opportunities. Although improved transportation and other education, service, and recreational opportunities are expected as part of the development, the time gap could be significant. On the social dimension, the desire for large and better housing at cheaper prices, and the demand for industrial location at the suburbs, when aided by the more mobile transportation options, are loosening the linkage between transportation and job-housing balance. When the state owned enterprises move the production activities out of central city, the major consideration is to find cheap land on the outskirts and cash back the improved land value at the central location. When a household moves to a new location, housing ownership or housing condition improvement is the major reason. In an early survey of household relocation, households reported moving for one or several reasons, but neither job change nor life cycle was the primary reason for relocation (Yang, 2006). The implication is clear. Households and manufacturing firms are sacrificing transportation for cheap and comfortable real estate properties.

3.2 Transition of Central City Districts and Formation of CBD

Chinese cities have warmly hugged the concept of a western-style central business district after the land reforms. Redevelopment of the central city has never stopped in the desire for a competitive central city. The effort not only focuses on the development of core commercial activities for expected efficiencies, but also creates a more marketable image. Shanghai, for example, has more skyscraper than the New York City (Ren, 2005).

A closely relevant theme of planning and development is the industrial relocation and the redevelopment of declined housing in the central city. Declined urban localities, or those with a different role in the emerging economy, are being renewed in many cases (of which central business districts are a single case type). They are in some cases causing controversy because of residential displacements or the destruction of historic structures. These projects will surely create efficient land use at access-sensitive locations, as it has been the government’s argument for the redevelopment. However, their overall impact on urban access is difficult to assess in general. To the extent that they replace low-density industrial land with residence their impact may be positive to access. To the extent that they replace intown housing with core business uses they produce strong radial access...
paths that have positive effect on the one hand, but they may (and often do) force in-town residential uses to the periphery, imposing long radial trips.

3.3 Development of Satellite Communities and New Development Zones

The concept that urban sprawl should be limited by planting anchor institutions at key exurban locations and inducing growth to surround these foci is very widespread internationally. Chinese planners had applied this idea to urban development long before the land reforms. In Beijing, for example, twelve satellite communities were planned many years ago, emulating the model of “Garden City”. Universities or big state owned enterprises are located there as the anchor for attracting additional urban activities.

These ideas are further pursued after the reforms, when economic growth becomes a very important function of local governments. Cheap land at the periphery is generally used as the resource to attract investment into the ex-urban localities, namely new development zones. The development zones may come with different titles such as industrial parks (high-tech, ecological, exporting), or university towns/cities. These new development zones can hold up to 200 thousand people, at the scale of a middle sized city. By 2004, China had 6747 new development zones with a planned land area of 37.5 thousand sq km (Ren, 2005).

With rapid urbanization of new urban activities and decentralization of existing activities, even bigger satellite cities are planned in the suburbs. Shanghai, for example, has planned several satellite communities with over one million people each. These satellite cities are expected to be large enough to provide self-sustainable functions of working, living, education, shopping and entertainment. Nanjing has also undertaken this effort to structure new urbanization.

The consequences of these satellites to access need to be individually considered. They may successfully produce cores of mixed uses that encourage shorter local trips, or they may become residential areas where amenities attract residents whose trip sets still include many distant destinations. The final balance as to whether travel is significantly reduced or not would depend on the details of the occupying population and the evolved destination sets within the specific satellites. The final account is whether the satellites have the character of independent and inclusive communities or are more simply a form of modified sprawl.

A Landsat based study of urban growth in Chengdu (Schneider, et al, 2003) suggests perhaps a prototype case with both positive and negative features. The study notes that industrial parks are developed near airport and major highways. A significant number of people commute along the radial traffic corridors into and out of urban core on a daily basis. It is still difficult to assess whether trips to other parts of the city will attenuate as these parks mature. Their transport efficiency impact is therefore ambiguous. The municipality has announced two very large “new towns in town”. There has been significant in-filling of land at the edges of city and in the suburban industrial towns. These should have positive consequences.
In a more limited form of this satellite initiative, some new development zones are created to accommodate only specific functions relocated from urban core. In Qingdao, for example, Sifang Locomotive moved from the central city to a suburban town that is about half hour driving away from the central location. With employees still left in the central city, this enterprise has to provide work-unit bus for everyday commuting. The transportation implication of this initiative is obvious.

The transportation implication of the new industrial development zone also depends on its labor pool, particularly the share of rural immigrants without urban hukou. On the one hand, because of financial and hukou limitations, floating labor is often housed at high density residential locations in employers’ premises (such as buildings under construction) or in modest buildings at the urban periphery. The resulting transportation demand is low. This is the case in many suburban localities in the Pearl River Delta region. On the other hand, some rural Hukou holders may be unwilling to be urbanized because of a desire to keep the current land ownership. The selection to keep a rural residence and an urban job implies rigid commuting (Xu, 2001). The transportation impacts of the emerging land development pattern, therefore, is subject to the influence of the hukou requirements on the immigrant population and their paths of upward social mobility in the future.

3.4 Multi-center City Layout

The most dramatic form of land transition may move cities into entirely new urban spatial structures. Chinese cities traditionally adopt single-center layout. The most famous debate for a multi-center layout for Beijing happened more than 50 years ago, ending in spite of it with the prevalence of the single-city layout. Today, the single-center layout has been criticized for its association with high traffic density in the urban core. The concentration of offices and commercial activities has generated intense vehicle trips that cannot be handled by the expanding road network (Zhao and Tian, 2004).

The evolution toward a multi-center layout is happening in many other Chinese cities today, even though traffic may not be a big concern there. For example, in Foshan, a recent plan proposed to move some central functions to a new and less crowded place elsewhere in the metropolitan area. A similar plan has been proposed in Gaoming, one of the urban districts in Foshan. In Yongzhou, a mid-sized city, the municipal government has successfully moved the administrative functions to a new locality that is about 30 km away from the previous location. According to Ren (2005), over 1000 city governments have relocated to new localities in the past two decades. These actions are very important to urban evolution because they suggest a new hub in the expanding city.

Among cities with over one million people, Qingdao is well on its road to a multi-center metropolitan region. This coastal city has had a booming economy since the liberalization of the national economy in the 1980s. The expansion of the city, however, is much confined by its geographical situation. Surrounded by coastal waters and a mountain, the central city has a developable strip only on one side of the urban core. In order to
overcome the problem of geographical confinement the city is acting to create a three-center city: the existing urban center at the harbor and two more, Huangdao and Hongdao. The plan includes a series of new transport infrastructure investments that link these centers together. Research on American cities suggests that the multi-center layout appears to be better choice for transportation efficiency compared to dispersed patterns (Yang, 2005). The prospects for its performance in China are of great interest.

3.5 Land Allocation for Motorized Accessibility

The pursuit for motorized accessibility is evidenced in both the booming of the automobile industry and the construction of the highways. Largely due to the accessibility provided by sequences of circumferential highways in many of the metropolitan areas, large Chinese cities are developing in a visibly concentric form with several variations (Li and Yu, 1995).

Changes in land allocation has been pursued to improve motorized accessibility, including cutting through big work unit campuses to improve local traffic circulation, or simply allocating more road space to motorized transportation. The argument for more road space generally refers to urban land allocation in the American or European cities where automobile ownership is much higher. It is now a normal practice to allocate about 20% of the total land for road transportation (Yongzhou Institute of Planning and Design, 2005a; 2005b). Major trip destinations such as shopping centers and recreational centers now provide parking and auto-access on site.

The result of intensive urban highway construction has an obvious short-term congestion relief benefit. However, the long-term effect is arguable. It is doubtful that these highways can sustain a high mobility in the long run because of substantial latent demand. They may well coax development in directions not easily served by public transport by encouraging outward movement of development. Urban growth is notably following transport corridors out in the direction of cities in the western world – and this following, sprawling linear development can eat up much of the increased capacity. Nevertheless, it is apparent that fast urban economic growth obligates government to provide more roads.

Further more, strategies supporting motorized accessibility appear to jeopardize the non-motorized transportation. During the past decades, increasing right of way was given to those on motor vehicles. In the course of road expansion projects within established urban areas, only motor vehicle ways were widened, while sidewalks and bicycles were narrowed in most cases. Even worse is the elimination of some bike lanes in many road reconstruction and traffic management projects and the prohibition of bicycle use on some roads. With this land allocation trend, the security of non-motorized transportation decreases. In 2004, over 100 thousand people died in auto accidents, a high proportion of them non-motorists. More generally, the lowered density and widened streets make walking less attractive, which in turn also make public transit less attractive as access to transit requires a certain amount of walking.
In reviewing all above development themes, it is evident that many of the reasons for decentralizing urban activities or adjusting central locations are not related to the quest for greater access. Among the location selection criteria by individuals or firms are minimizing land/real estate cost and seeking parcels of large size. Particularly, the voluntary change of housing location is not an agile response to the decrease in accessibility but a response to housing improvement opportunities that may be associated with significant loss in accessibility. For some relocated households, the time gap between the availability of housing opportunities and service opportunities can be significant. In some cases large project dwelling units have been substantially sold out to urban dwellers, in anticipation of the future availability of these services, but long before public transport has been supplied or local social and commercial services are provided, among the urban development objectives by the city government are promoting local economic growth and maximizing fiscal revenue. The relationship between transportation and land development has been considered. However, the focus was not to adjust land development for a better transportation future, but to provide motorized accessibility for opening up more land for urbanization and economic growth. Even though land development has been subject to comprehensive government review and the new landscaping appears to have a much better regionally coordinated pattern, this review does not intend to produce a satisfactory result in access or congestion relief among all other diversified objectives (Yang and Cao, 2007).

Given all above facts, land use transformation tends to leave travel behavior and land development out of correspondence with one another. In the context of rapid motorization and more frequent and lengthened trips, the result can be severe urban congestion, if new planning action is not implemented in a timely manner.

4. Land Use Control for Transit and Non-Motorized Transport

Land use transformation outlined above is necessary in the evolution from a planning economy to a market economy. For example, China’s metropolitan expansion is strongly affected by road infrastructure investment. According to Lin (1999), economic development in Panyu, a suburban county in Guangzhou, is preceded by the improvement in transportation infrastructure that has created a transactional environment conducive to the inflow of foreign capital and the growth of export, manufacturing, and agricultural production. In addition, many land development initiatives can contribute to the competitiveness of China’s metropolitan areas in the globalized economy (Walcott and Pannell 2006).

The real challenge to China’s city governments and planners, therefore, does not lie in how to check these trends, but how to integrate accessibility and mobility elements into the existing land development process. Given the large population and limited land size in China, the idea choice for urban China is compact and transit friendly cities rather than American style automobile oriented urban landscaping. Bertaud (2004) estimates that a car needs about 40 sq meters of space for operation and parking. In Atlanta, Georgia, for example, that amounts to very little of the space per person (1666 sq meters per person).
But in China, with the urban density target of about 100 sq meters per person, that 40 meters would require a great part of the urban space per person.

In the process of spatial decentralization that accommodates the demand for space and housing, planners may have to take seriously the position that decentralization should not be permitted to remove amenities from non-motorized transport users (Schipper and Ng, 2004) and strong regulation should be in place to make sure that the spatial constraint is strong enough to curtail sprawling development to survive a strong public transit system. The following land use patterns can be considered to support transit ridership and non-motorized transportation (NMT).

First, suburban localities should retain relatively high densities. High-density can potentially reduce trip distance and make NMT more viable. On average, density in the Chinese city is still high enough to sustain a viable transit ridership. But there is a danger of going to the other extreme in the new development, which accommodates quite low-density development, based perhaps partly on the belief that a lower density will lower traffic intensity. This belief is problematic because lower density would reduce traffic intensity only when travel distance and travel mode are constant. This is unlikely to be the case.

Second, development should be clustered in sufficient scale to make the clusters largely self sufficient for residents’ full trip set. By accommodating new development in the existing centers and corridors, land use mix and job-housing balance can be improved. A better transit in terms of higher frequency and short line haul time can operate more efficiently. In addition, clustered development makes trip chaining easy.

Third, the provision of local personal service centers (shopping, government services, education, and recreation) should keep up with the pace of industrial and housing activities. The time gap should be shortened. Low development priority should be assigned to land parcels where nearby service opportunities would not follow in the near future.

Fourth, in large parcel development, connection between transit stops and major buildings should be well designed. Large parcel development tends to put transit stops well outside the parcel and access to transit stops decreases for many residents live inside. Planners should give attention to designing a friendly physical environment for the pedestrian and bicyclist. Uninterrupted trails and bike lanes should link major buildings with transit stops. China has announced its transit priority strategy. With the building environment favorable to NMT, transit service improvement can be more effective in generating additional ridership.

While stable reduction of auto dependence depends in the long run on wise land development strategies and transport investment decisions, worldwide experiences suggest that their performance alone in reducing auto dependency is limited. Complementary fiscal policies that directly control the use of motor vehicles should also be in place (Energy Foundation, 2005). Chinese cities, of course, have been taking
important steps in this matter. A few of these actions include restraint or pricing of parking, pedestrianization, high vehicle registration and road use charges, restraint of vehicles registered in other jurisdictions, and congestion pricing. These complementary actions are very important to synergize with land use actions to reduce auto dependency.

In a political culture favors centralized control, this important objective at the local level cannot be achieved if proper national policies are not clearly stated and well monitored. Those national policies of course will consider the various objectives of land use planning, not just its mobility and access implications. But they must not lose track of these critical transport foci of planning. Broad topics include how to relieve the city governments from attracting competing investors with cheap land, and how to loosen the local government from the performance evaluation dominated by economic development, how to refine the land use and transportation investment strategies, how to monitor the land and road space utilization, and how to educate the next generation of transportation-land use planners who will pay attention to the long-term energy, environmental and social consequences of urban growth pathways.

5 Conclusions

In developed nations where urban settlement is already established and automobile ownership is already high, land use strategies for congestion relief tend to be extremely expensive. China, however, is still in a period of rapid urbanization and motorization. It is important to know the potential transportation consequences of current land development themes and design strategies to correct their drawbacks without seriously compromising their virtues.

It is clear that land development is generally under the control of the city government even though the development outcomes today or in the future may or may not be desirable evaluated with measures of accessibility or mobility. It is also important to acknowledge that some side transportation impacts, such as decrease in access, is unavoidable as economic growth rather than congestion relief or accessibility improvement is the major objective when city government initiated the land development themes examined in this article. An integration of access and mobility goals into the existing development processes is practicable as it only adds neglected elements into the process rather than alter the process significantly. What is recommended in this article, therefore, is as modest as the role of urban transportation planning in today’s rapid growing urban China. The importance of the recommendation, however, will grow as congestion and air quality become the priority items in the mayor’s agenda.
Acknowledgement

An earlier version of the paper was written for the Flagship Series on Transport, Energy and Environment in China. The author wants to thank the Energy Foundation for its support.

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