OPEN SPACE CONSERVATION AND LAND USE CHANGEIN BEIJING AND TIANJIN, CHINA

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ABSTRACT

Globalization is driving urban growth at an unprecedented rate and scale in rapidly evolving economies, presenting a range of new urban planning challenges. China's limited arable land resources are diminishing due to urban growth. In Beijing and Tianjin, urban growth is restrained by green belts, yet urban sprawl occurs, reducing the quality of life for urban citizens with concomitant effects on the environment. Despite their proximity, the two cities have not grown toward each other as much as they might have done. There is less urban growth along the railway than the highway, although private car ownership is rapidly increasing. Would the quantity and quality of open space be better conserved and the quality of urban space be enhanced if urban land were located closer to major transport arteries.

INTRODUCTION

Cities in Europe were dense clusters within walls. With the Industrial Revolution they rapidly became overcrowded and congested, leading to concerns over human health and safety. Thus, access to green space became important for urban citizens. Coupled with the increased difficulty of access to the countryside due to city expansion, the need arose to bring the countryside into the city in the form of parks. Green space continues to play an important role in cities, and access to it is associated with quality of life. In New York, for example, properties bordering Central Park belong to the most expensive. For most people, the price of the park-side property translates into a wish for a house in the countryside. Kevin Lynch wrote in 1981 “Many people if asked to describe the ideal house of their fantasy, will sketch one from whose front door one steps onto a lively urban promenade, while at the rear there is only silent countryside” (Oswald and Bacchini, 2003, 47). The need to commute to work however causes the majority of these houses to be in an environment which resembles neither cityscape nor countryside.

For centuries, urban planning thought has been orientated towards Europe where cities are small. The idea that cities should be limited in size was already familiar in ancient Greece (Mumford, 1961,180-5). Urban growth containment took on new meaning during the Industrial Revolution. Around 1900, Ebenezer Howard advocated building Garden Cities and stated that cities larger than a certain size would be unable to provide life-maintaining functions for their inhabitants (Mumford, 1961, 516). Abercrombie, who designed the green belt of London, said in 1948 “Let us assume that a maximum population has been decided for a town” (Hall, 2000, 357). Thus, urban planning thought in Europe has been greatly occupied by the idea of the finite city.

Globalization is driving urban growth at a rate and scale in rapidly evolving economies which is unprecedented in Europe. Consequently, Asian megacities face new urban planning challenges. Cities are using up increasing amounts of resources and are degrading the ecosystems which support them. Tokyo, for example, has an ecological footprint which is 1.55 times the size of Japan (Rees, 2004). Also, Asian megacities have different characteristics to European cities, such as a mixture of urban and rural land uses (Yokohari, Takeuchi, Watanabe, and Yokota, 2005; Murakami, Zain, Takeuchi, Tsunekawa, and Yokota, 2005).

Urban planning tools derived in Europe are implemented in Asia, but not always with success. The green belt concept is one of the most commonly applied concepts to Asian megacities. In Seoul, which is considered to be a city where the green belt was implemented successfully, sprawl has occurred on the other side of the green belt (Yokohari et al., 2000). Tokyo also had a green belt concept, as stated in the 1939 Tokyo Greenspace Plan. But when economic growth pressures increased on the urban fringe after the 1950s, planning departments had little success in implementing it (Sorensen, 2002, 160-2). In Bankok, Western planning ideas have been superimposed on a wet rice-cultivated landscape, giving little benefit to the urban periphery. The outer ringroad is conceived at the scale of Abercrombie’s 1948 Green Belt Plan for London, but this measure for urban containment is not effective in Bankok, which is already marked by a vastly dispersed urban fringe (McGrath and Thaitakoo, 2005). The idea of self-sufficient cities within ecologically defined regions is not aligned with the increasing dependency of urban growth upon non-local forces (Lo and Marcotullio, 2001). However, due to land use mixture, Asian cities have potential for self-sufficiency in terms of food. Urban agriculture is a means of producing safe and fresh food (Yokohari et al., 2000) inside the city, and can also be a source of employment. Across Chinese cities, 85 % of vegetables consumed by residents are produced within those cities (Grazzini and

Doron, 2005).

THE URBAN RURAL RELATION IN CHINA

China's urban planning has a profound impact on the world. China occupies about 7 % of the world land area but supports almost a quarter of the world population (Han and He, 1999). Only about 10 % of China's land area is arable. The amount of arable land is decreasing due to factors such as desertification, soil erosion, and the expansion of built-up areas around cities. While arable land was diminishing by 1 % a year in the 1980s, the population continued to increase by more than 1 % a year (Chang and Kwok, in Kwok, Parish, Yeh, and Xueqiang (eds.), 1990, 148). The most fertile arable land is located in the coastal regions where the largest amount of urban growth is currently taking place.

Ideally in history, a Chinese city would have been built in a square or rectangular form. However, this clear boundary did not signify a separation from the land. Chinese cities were administrative centers of an area which included urban, suburban and rural areas (Xu, 2000, 59-82), planned to be in harmony with nature. After 1950, urban planning was based on the Soviet system (Chishaki (ed.), 2001, 76). Both Marx and Engels regarded the city as an evil entity, the scene of the worst possible living conditions for people under capitalism. Stalin however disagreed. He proclaimed that large cities would not only survive but that there would be more new cities. The Chinese made selective use of the ideas of Marx, Engels and Stalin (Sit, 1985, 8-9). But the failure of the Great Leap Forward (1958-9) showed that the focus on developing heavy industry and existing large cities, which were on the coast, would not work in a largely rural and agrarian country like China. The Communist Party thus placed emphasis on a good urban rural relation, proclaiming the elimination of the Three Great Differences between industry and agriculture, mental and manual labor, and city and country, and aimed to develop cities in the interior of the country (Lin, 2002). The funds for industrial development were however transferred out of the agricultural sector over a period of 30 years using artificial pricing, signifying a dualism and segregation of the urban and rural (Xuan, in Kwok et al., 1990, 67). Under Mao, the prevention of the growth of large cities was quite effective, so that in the late 1970s Chinese cities were still relatively small.

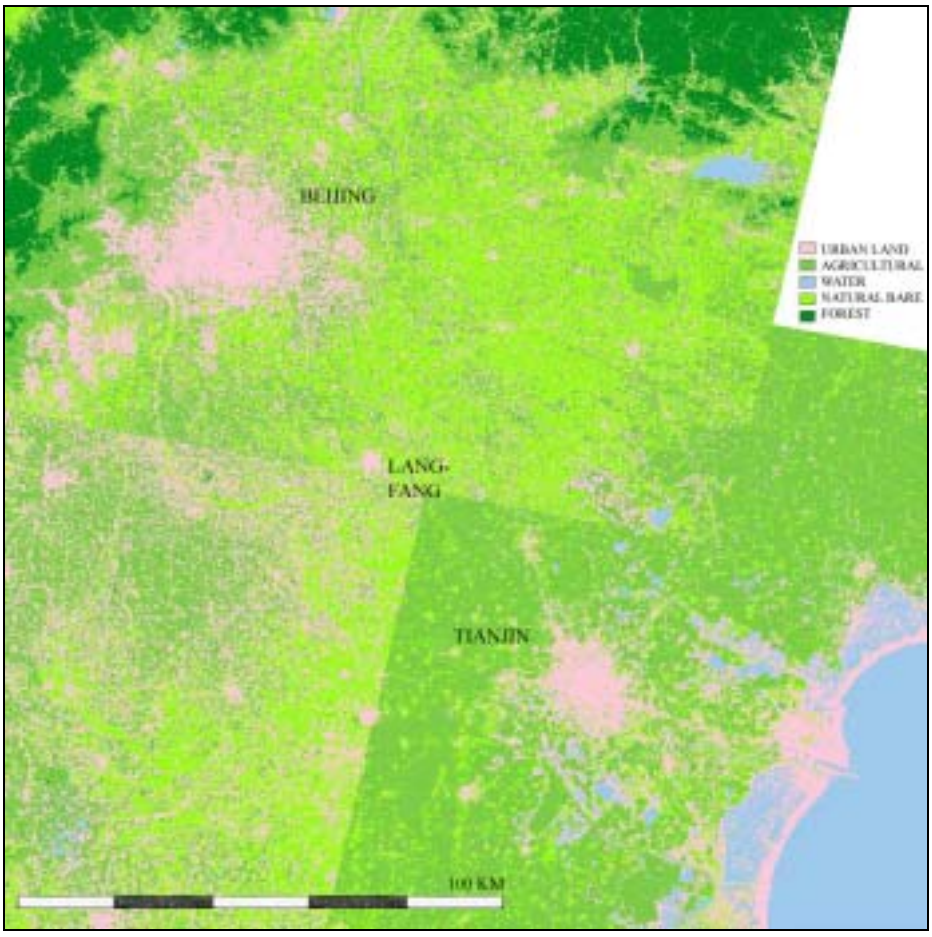
After Economic Reforms in 1978, the focus shifted back to the coast, and in 1984, 14 coastal cities were chosen for development with the Open Door Policy, which consequently underwent massive urban growth. Land use reform with the 1986 Land Administration Act was not initiated until the state recognized the need to protect agricultural land, and set up the State Land Administration Bureau to control land conversion (Yeh and Wu, 1998). However, general academic consideration of China's agricultural land protection issues did not emerge until the mid 1990s (Skinner, Kuhn, and Joseph, 2001). In 1994, the Ordinance for the Protection of Primary Agricultural Land had to be implemented (Li and Yeh, 2004), which bans the use of agricultural land for city expansion unless substitute land is found at another location. But in practice this is rarely the case (GTZ, 2005). The 1989 National City Planning Act provided urban planning with a first legal basis, and incorporated various countries' systems. City planning is divided into two levels: an Overall Plan and a Detailed Plan, and is administered by the Ministry of Construction (Chishaki (ed.), 2001, 78). However, Detailed Plans are only prepared for the city proper, and rural land is administered by the Ministry of Land Resources, established in 1998 (Ho, 2005). Although land reform was initiated to protect agricultural land, urban sprawl seems to have emerged after land reform (Yeh and Wu, 1998). China has aspects of a controlled as well as a market economy. The state owns the land and has large-scale influence on urban development, but land use rights can be leased. Thus, the conservation of agricultural land is in direct conflict with the aim of

providing large plots of land to investors. The administrative complexity of the urban planning system (Ho, 2005) as well as the conflict of interests, lead to massive urban sprawl. Studies revealed that coastal cities, especially the largest ones, lost more farmland than other cities (Han and He, 1999). Nevertheless, the change in land use policy was the main factor that caused the low rate of increase of urban land expansion in the Beijing Tianjin region in the second half of the 1990s (Tan, Li, Xie, and Lu, 2005).

URBAN GROWTH IN BEIJING AND TIANJIN

Beijing and Tianjin are located in the north-east of China and are two of China's four centrally administered municipalities. Beijing is approximately 100 km inland from Tianjin, which is located on Bohai Bay (see Figure 1). The Beijing Tianjin region has undergone massive urban growth over the past decades. Alone between 1990 and 2000, the urban land area in the Beijing Tianjin Hebei region expanded by 71 %, whereby 74 % of new urban land area was converted from arable land (Tan et al., 2005).

Figure 1. LAND USE MAP OF BEIJING AND TIANJIN IN 1999-2002 (ERDAS IMAGINE 8.7).



Besides being the national capital, Beijing strives to become a major industrial base despite the proximity to the major industrial centers Tianjin and Tangshan (Sit, 1985, 75). In 1952, it was amongst the key cities targeted for new industrial initiatives, and from 1949 to 1978, Beijing recorded the fastest industrial growth among its peers (Wei and Yu, 2005). In the past two decades, Beijing has made massive investments in infrastructure (Ding, 2004), and has aimed to develop into a global city since the 1992 masterplan (Wei and Yu, 2005). From 1992 to 2002 the Beijing settlement area increased by 25 % while agriculture land decreased by 32 % (Li, Wang, Paulussen, and Liu, 2005). Much development has been taking place in Beijing in recent years in preparation for the 2008 Olympics (Ding, 2003). Beijing currently has approximately 8'000 construction sites (International Herald Tribune, August 29, 2005).

Beijing has expanded in different directions in the last decades. In the 1980s it spread in a west-east direction, in the 1990s in a north-south direction, and in the 2000s towards the north-east and south-east

(Ma, Zhou, Niu, and Nakagoshi, 2005). The hills to the west and north of the city limited the expansion in those directions. After 1998, the government developed a huge new residential area and new train line in the north of Beijing. The area was chosen for development because it was basically a rural area until then, and, located close to the university district, was to become the 'silicon valley' of Beijing. The south of Beijing is worst polluted due to the wind direction and was therefore not favored for development. Beijing has fragmented at both landscape and urban type levels, the main driving forces of urban sprawl being infrastructural and housing construction (Ma et al., 2005). The south-east of Beijing, towards Tianjin, witnessed the slowest physical growth until the 1990s (Ding, 2004; Ma et al., 2005). Beijing is still in the position of major increase in housing development and urban growth (Chen, Ganesan, and Jia, 2005).

Tianjin, on the other hand, has developed mainly towards the sea. In history, Tianjin was the gate to Beijing and the most important industrial centre in northern China. In 1860, Tianjin was opened up as a treaty port (Wei and Jia, 2003). In the 1930s, Tianjin was the second largest centre of industry and commerce, and by 1947 the second largest Chinese city (Hershatter, 1986, 10-16). However, in the 1950s, Tianjin was de-emphasized in industrial allocation because it was strategically less important than Beijing and Shanghai, and state investment declined until in 1958, Tianjin was demoted from its status as a centrally administered municipality and became a local city controlled by Hebei Province. Its economic status declined further until, in the mid 1960s, oil was discovered in Tianjin. Partly due to this, Tianjin regained its status as a centrally administered municipality in 1967, and was selected in 1984 as one of the 14 coastal cities to be developed. In 1985, the Tianjin masterplan concentrated future industrial development in the coastal Tianjin Economic-Technological Development Area. In 1991, the Duty-Free District for international trade and export-processing purposes was established. In 1993 master planning of the Binhai District, also along the coast, began, which was approved as a national-level open district in 2001, and by 2010 is projected to account for 50 % of Tianjin's GDP. Due to major focus on the coastal region, most foreign direct investment is in the Tianjin Economic-Technological Development Area and has little impact on the city proper. In addition, foreign investment has stagnated since the mid 1990s. Despite the proximity, Tianjin has not profited from Beijing's infrastructural and economic growth, such as easy access to the international airport, and few tourists come to Tianjin (Wei and Jia, 2003).

Regional planning in the Beijing Tianjin region so far has aimed to contain the two cities and keep them from merging. Beijing and Tianjin are connected by two major transport arteries, the railway, constructed around 100 years ago, and the highway, which was built in the 1980s. The 1992 Beijing masterplan shows a first green belt. Currently, a second green belt between the 5th and 6th ringroad is planned for Beijing. In addition, a network of green wedges, parks and green corridors is proposed in order to limit future urban expansion, and the Beijing Tianjin highway is planned as a greenway (Li et al., 2005). In the 1990s, Tianjin also adopted a green belt concept (Leitmann, 1994), in the form of a 50 m wide strip of trees along its ringroad. In addition, two green buffers are planned between the two cities (Li et al., 2005). Thus there is a total of five green belts and buffers between Beijing and Tianjin. Nonetheless, Beijing and Tianjin are connected by a 100 km long development corridor (Li et al., 2005). Most masterplans are overtaken by development, for example the 10 satellite towns planned for Beijing merged with the city after only a few years. The current masterplan shows another ring of satellite cities even further away from the core of Beijing (GTZ 2005). Also, a new airport is being planned between the two cities in order to reduce the load on Beijing's international airport, as well as a new highway and a new railway connection.

RESEARCH QUESTION AND METHODOLOGY

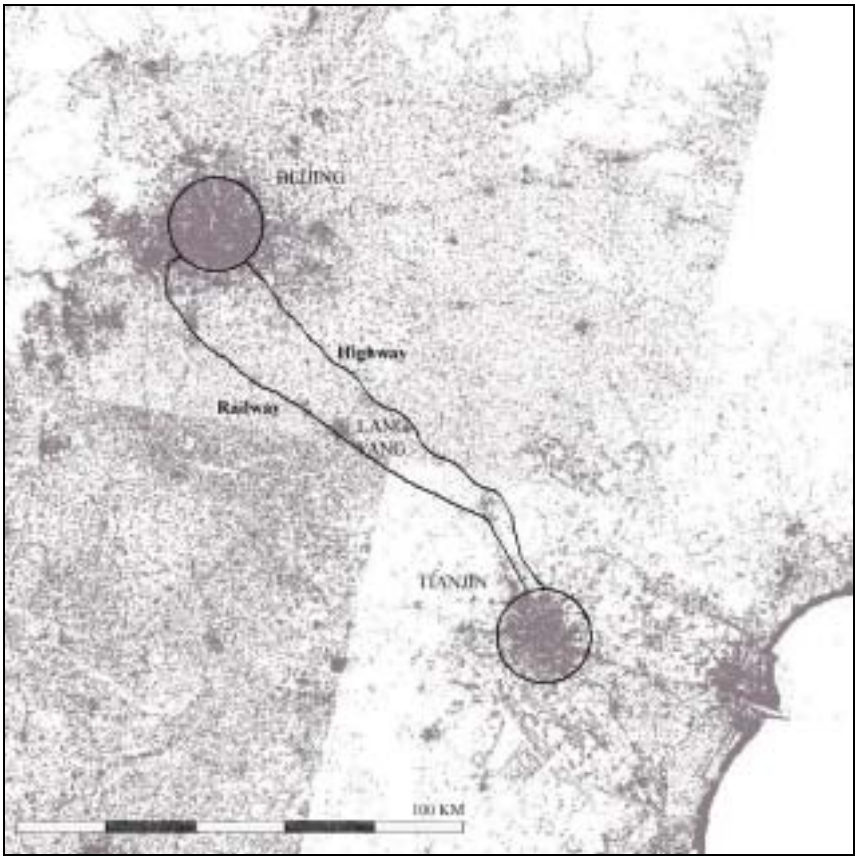
Concerns over human health and safety in cities today once again necessitate bringing the countryside into the city. There is a lack of studies into how the living environment of people is changing in rapidly growing megacities, and few planning theorists concern themselves with the physical city (Fainstein, 2005). In urban studies on China, there is a noticeable gap between mainstream theoretical geography and empirical area studies (Lin and Wei, 2002) and fieldwork is urgently needed to determine the key features of the suburban landscape (Ma, 2002). Many large-scale building projects are government-driven, making it difficult to obtain data. Relatively little is known about whether Chinese urban expansion is excessive or inefficient. Most development takes place in the urban fringe on agricultural land (Deng and Huang, 2004). Building on these so-called green field sites is more attractive than densifying existing urban areas due to lower land construction costs (Edgington, 1986). Such urban expansion is often not preceded by the building of roads and services, which are difficult to add later, thus making such urban development inefficient (Sorensen, 2002, 348-54). What is urban sprawl in the Beijing Tianjin region and how can it be measured?

In a study of Manhattan, Leslie Martin and Lionel March demonstrated that the present open space provided by the block by block form is just a series of traffic corridors. They showed that the tower form is the least efficient building form in terms of land use and that the courtyard form could accommodate the same amount of floor area but would allow for substantial free space (Martin and March, 1972, 19-39). Linear city form along waterways or roads is nothing new, but it was first explicitly proposed by Arturo Soria y Mata in 1882 in Madrid (Lynch, 1981, 376). Martin and March went on to expand the idea to a larger scale, using Ebenezer Howard's cluster of Garden Cities forming a City Federation as a theoretical example. But March illustrated in 1967 that the normal pattern of urban development is never purely the 'blob' form in the landscape as in Howard's model nor the 'lines' in the landscape proposed by Soria y Mata, but that 'blob' cities tend to join together through linear development along main roads, leaving agricultural areas enclosed (Echenique, 1994). Although he states that linear city form is rarely implemented except at smaller scales, such as in commercial strips, Kevin Lynch concedes that its recurrence indicates that there is substance to the idea which merits further consideration. A linear urban development may have many advantages related to transport, such as economy in land utilization, commercially viable public transport and high accessibility for residents in spite of low private car ownership rate (Tong and Wong, 1997). Furthermore, urban density is one of the most important factors in determining a city's level of car use and energy use (Kenworthy and Hu, 2002).

An increasing amount of area in cities is covered by roads. The length of highways in Beijing increased 19-fold between 1949 and 1991, from 164 km to 3'276 km (Sit, 1995, 266), and to 14'359 km in 2002. The average annual increase between 1978 and 2002 was 3.3 %, whereas the national average was only 1.7 % (Wei and Yu, 2005). In 1985, privately owned cars were almost unknown in China (Sit, 1985, 47). The number of motorized vehicles, however, multiplied 164-fold, from 2'328 in 1950 to 384'451 in 1990 (Sit, 1995, 266). Today, the number of privately owned automobiles in Beijing is approaching 3 million (International Herald Tribune, August 29, 2005). In Tianjin, bicycles accounted for around 90 % of all passenger trips, facilitated by the city's spatial compactness. However, between 1986 and 1989, the amount of cars increased by 10 % every year (Leitmann, 1994). Beijing is already very congested. If China reaches the same level of individual motorization as Western nations such as the United States, the consequences for the environment will be disastrous (Kenworthy and Hu, 2002). If public transport is not within walking or cycling distance, the private car is the only alternative.

Many studies have been conducted on Beijing, but few on Tianjin. The subject of this study is the urban growth being driven by Beijing and Tianjin as the two major urban centers of a region, and focuses on where the largest amount of urban growth is expected to have taken place, namely along the major transport arteries connecting the two cities, the railway and the highway (see Figure 2). The transport arteries are treated primarily as means of public transport, access to which is deemed to be a major factor in determining the characteristics of urban sprawl. Would the quantity and quality of open space be better conserved and the quality of urban space be enhanced if urban land were located closer to major transport arteries?

Figure 2. URBAN BINARY MAP OF BEIJING AND TIANJIN SHOWING 10 KM RADIUS AROUND EACH CITY CENTER AND THE RAILWAY AND THE HIGHWAY CONNECTING THE TWO CITIES (ERDAS IMAGINE 8.7).



METHOD AND FINDINGS

The data used to analyze land use change at the regional scale since Economic Reforms in 1978 is Landsat remote sensing satellite imagery which was downloaded free of charge from the Earth Science Data Interface of the US Geological Survey website. Three time periods were chosen in order to analyze land use change in the Beijing Tianjin region in the last thirty years, which are spaced at approximately 10 year intervals, namely 1978-9, 1991-3 and 1999-2002, subject to the availability of imagery. Three images are needed to cover the entire region for each period, but a third image for the 1978-9 period was not available. The images used for the period 1978-9 are Landsat MSS with a resolution of approximately 57 m x 57 m of 20th September 1978 of Beijing and 29th May 1979 of Tianjin; for the period 1991-3 Landsat TM with a resolution of approximately 28.5 m by 28.5 m of 17th June 1991 of the Beijing Tianjin region, 7th of September 1992 of Beijing and 15th of June 1993 of Tianjin; and for the period 1999-2002 Landsat ETM+ with a resolution of approximately 28.5 m by 28.5 m 1st of July 1999 of Beijing, 1st of September 2001 of Tianjin and 22nd of May 2002 of the region.

In the Beijing Tianjin region, seedlings for rice cultivation are planted between May 15th and June 15th, and the paddy fields are flooded in April. Fields are drained in the last week of September and rice harvested from October 1st to 10th. The images chosen for this analysis all correspond to the period when the paddy fields are flooded. The first period, from 1978-9, represents the status quo at the time of Economic Reforms. The second period, from 1991-3, accords to the land use change which took place up to the 1994 Ordinance for the Protection of Primary Agricultural Land, after which the pattern of urbanization is expected to have changed. The third period, 1999-2002, represents the most recent available Landsat imagery. Using Erdas Imagine 8.7 the images were classified into 5 land uses by supervised classification: urban land, agricultural land, natural bare land, water, and forest, and quantitative as well as qualitative characteristics of the land use mixture analyzed.

In order to attain an initial understanding of the volume of land use change, the Beijing Tianjin region is defined here as the area inside a 20 km distance of a straight line drawn from the center of Beijing to the center of Tianjin. This distance is chosen because the railway and the highway both fall inside this area. The land use change inside the region is then compared to the land use change in Beijing and Tianjin cities. Beijing has a second, third and fourth ringroad and is now in the process of building a fifth. Beijing's third and fourth ringroad very roughly delineate two rectangles which are approximately 12.9 km by 12.4 km and 18.4 km by 17.6 km respectively. Tianjin has one ringroad which is an oblong shape which is about 15 km in width at the narrowest point and 26 km long. A 10 km radius, which covers an area of approximately 315 km2 for each city, was deemed appropriate in giving an impression of the land use change within the inner city areas. The urban growth in the region is then compared to that having taken place along the railway and the highway. Because access to public transport is the focus of this study, land use change is examined within a 2 km buffer, which represents a walking or cycling distance. Next, the urban growth at urban nodes along both the railway and the highway is compared to that having taken place along the length of the transport arteries.

Urban land increased by a factor of 2.5 between 1978-9 and 1991-3, and by a factor of 1.9 between 1991-3 and 1999-2002, that is from 389 km2 to 992 km2 to 1,944 km2 in the three time periods respectively. Due to the fact that one image is missing, approximately 641 km2 are not covered in the 1978-9 period. Agricultural land increased from 1,682 km2 to 2,560 km2 between 1978-9 and 1991-3, and then decreased to 2,155 km2 between 1991-3 and 1999-2002. Natural bare land decreased from 2,807 km2 to 1,989 km2 between 1978-9 and 1991-3, and had further decreased to 1,502 km2 by 1999-2002. Water coverage was 33 km2, 72 km2 and 50 km2, and forest coverage 99 km2, 38 km2 and 1 km2 in the respective periods. The area covered by water and forest is very small and has been omitted from the rest of the analysis. Urban land has increased in the Beijing Tianjin region mainly at the cost of natural bare land.

Tianjin grew more slowly in terms of urban area than Beijing and was smaller in urban area than Beijing in 1999-2002. The two cities were initially more similar in urban area, namely 136 km2 in Beijing and 110 km2 in Tianjin, but urban land area increased in Beijing from 43 % to 89 % to 92 % and in Tianjin from 35 % to 49 % to 75 % inside a 10 km radius in the respective periods. The urban growth of the two cities also took place outside a 10 km radius, therefore for comparison, at a 20 km radius, 16 %, 50 % and 64 % of Beijing and 12 %, 18 % and 39 % of Tianjin was urban land in the respective periods. Beijing's urban area grew most between 1978-9 and 1991-3, whereas Tianjin experienced a larger increase in urban area between 1991-3 and 1999-2002.

Agricultural land inside a 10 km and a 20 km radius decreased in Beijing, whereas in Tianjin, agricultural land decreased at 10 km but increased at a 20 km radius. Agricultural land in Beijing decreased from 11 % to 5 % and then increased to 6 % in the respective periods and increased from 29 % to 35 % and then decreased to 24 % at a 20 km radius. In Tianjin, at a 10 km radius, agricultural land decreased from 24 % to 22 % to 12 %, but at a 20 km radius increased from 35 % to 37 % to 42 %. Natural bare land, on the other hand, decreased in both cities, in Beijing from 44 % to 5 % to 2 % inside a 10 km radius and from 49 % to 13 % to 11 % at a 20 km radius, and in Tianjin from 36 % to 24 % to 11 % inside a 10 km radius and from 50 % to 40 % to 15 % inside a 20 km radius.

Table 1. AND USE CHANGE IN THE BEIJING TIANJIN REGION AND IN BEIJING AND TIANJIN CITIES

Square km	*1991-3*			*1991-2002*		
1978-9	**URB**	**AGR**	**BARE**	**URB**	**AGR**	**BARE**
BJ TJ REGION	+ 603	+ 878	- 818	+ 952	- 405	- 487
10 KM	+ 145	-18	-124	+ 9	+ 1	- 10
BEIJING						
TIANJIN	+ 44	- 4	- 36	+ 81	-32	- 43
20 KM	+ 426	+ 74	- 475	+ 180	- 145	- 22
BEIJING						
TIANJIN	+ 80	+ 23	- 127	+ 262	+ 65	- 305

In comparing the Beijing Tianjin region to Beijing and Tianjin inner cities, the proportion of the sum of the urban land located inside a 10 km radius of Beijing and Tianjin cities compared to the urban land located in the whole region decreased from 63 % to 44 % to 27 % in the respective periods of analysis. An increasing amount of urban land was located in the region between the two cities and not in the cities proper. Where in the area between the two cities did this urban growth occur?

There is more urban growth along the railway than along the highway throughout. Due to the missing image in the 1978-9 period, approximately 77 km2 are missing from the highway buffer. Along the railway, urban land increased from 19 km2 to 66 km2 to 157 km2, and along the highway, urban land increased from 7 km2 to 39 km2 to 110 km2. That is, inside the 2 km buffer, 4 %, 14 % and 34 % along the railway and 2 %, 9 % and 27 % along the highway were covered by urban land in the respective periods. Agricultural land on the other hand increased along both transport arteries between 1978-9 and 1991-3, and then decreased between 1991-3 and 1999-2002, whereby the decline along the highway was greater. Whereas agricultural land was 178 km2, 220 km2 and 206 km2 along the railway in the respective periods, it was 138 km2, 235 km2 and 162 km2 along the highway. Natural bare land however decreased along both transport arteries, with the exception of a slight increase along the highway between 1991-3 and 1999-2002. Natural bare land was 266 km2, 178 km2 and 102 km2 along the railway and 182 km2, 131 km2 and 134 km2 along the highway.

Table 2. LAND USE CHANGE ALONG THE RAILWAY AND HIGHWAY INSIDE A 2 KM BUFFER

Square km	*1991-3*			*1991-2002*		
1978-9	**URB**	**AGR**	**BARE**	**URB**	**AGR**	**BARE**
RAILWAY	+ 47	+ 42	- 88	+ 91	- 14	- 76
HIGHWAY	+ 32	+ 97	- 51	+ 71	- 73	+ 3

Of the increasing urban land in the Beijing Tianjin region, 37 %, 56 % and 73 % respectively was located outside a 10 km radius of Beijing and Tianjin cities. Of this, a constant amount of 19 % was located inside the 2 km buffer along the railway and highway throughout the respective periods. The urban growth being driven by Beijing and Tianjin, the two main urban centers in the region, did not densify along the two main transport arteries connecting the two cities.

Nodes at which to measure land use change along the railway were chosen as the railway stations and towns directly on the railway shown in map TPC G-10 A at scale 1:500’000 of 1987 by the US Defense Mapping Agency Aerospace Center, St. Louis, Missouri. A total of 9 nodes was found. As there was no major road in its place before the highway, villages located in the path of the highway when it was constructed may have been cleared away in order to make space. Thus, as no map detailed enough to show the exits, toll stations or urban clusters along the highway could be found, nodes were chosen by first locating all points at which the highway intersects another road or a river in the 1999-2002 satellite image and overlaying these nodes with a map of the L500 series at scale 1:250’000 of 1955 compiled by the US army, Washington DC. Nodes coinciding with a settlement were chosen for analysis, resulting in a total of 9 nodes.

The nodes were examined at a 2 km radius, approximately 12.5 km2. Data for four nodes along the highway was not available in the 1978-9 period due to the missing image (see Figure 4). Node 1 is closest to Beijing and node 9 closest to Tianjin. The 2 nodes closest to Beijing of the railway were largest in urban land in 1978-9, with all other nodes being less than 1 km2 in urban land. In 1991-3, node 4, Lang-fang, now the largest urban cluster along the railway, had grown to be the second largest node, at 7.6 km2 of urban land. Except for these three nodes, all other nodes remained at less than 1.6 km2 of urban land. By 1999-2002, the three nodes closest to Tianjin, had grown to around 3 km2 of urban land, whilst the two largest nodes, the one closest to Beijing, and Lang-fang, had grown to around 10 km2 of urban land, and nodes 2 and 3 had also grown substantially, but nodes 5 and 6 remained at around 0.5 km2 of urban land. Along the highway, the 2 nodes closest to Beijing were largest in urban land in 1978-9, at 0.8 and 0.5 km2 respectively. By 1991-3, these nodes had grown to 8.4 and 4.5 km2 of urban land respectively whilst all other nodes remained at below 1 km2 of urban land, and by 1999-2002, the two largest nodes had grown to 9.8 and 7.7 km2 of urban land respectively whilst all other nodes had urban land at between 2 and 3.7 km2 except for the node closest to Tianjin, which remained at less than 1 km2 of urban land.

Along both arteries the nodes closest to Beijing underwent the largest amount of urban growth. But whereas along the railway the largest town between Beijing and Tianjin grew most in terms of urban land and those nodes in the center between the two cities almost did not grow at all, along the highway, all the nodes grew almost evenly, except for the two closest to Beijing, which grew more, and the one closest to Tianjin, which grew least.

Along the railway, more urban land is located farther away from the nodes. Although the sum of the urban land located at the nodes along the railway is higher than the sum of the urban land located at the nodes along the highway, namely 7 km2, 25 km2 and 45 km2 along the railway, and 2 km2, 15 km2 and 37 km2 along the highway in the respective periods, the percentage of the sum of urban land located at the nodes to the amount of urban land along the length of the artery is higher along the highway than the railway, namely 39 %, 39 % and 29 % along the railway, and 27 %, 40 % and 34 % along the highway in the respective periods of analysis.

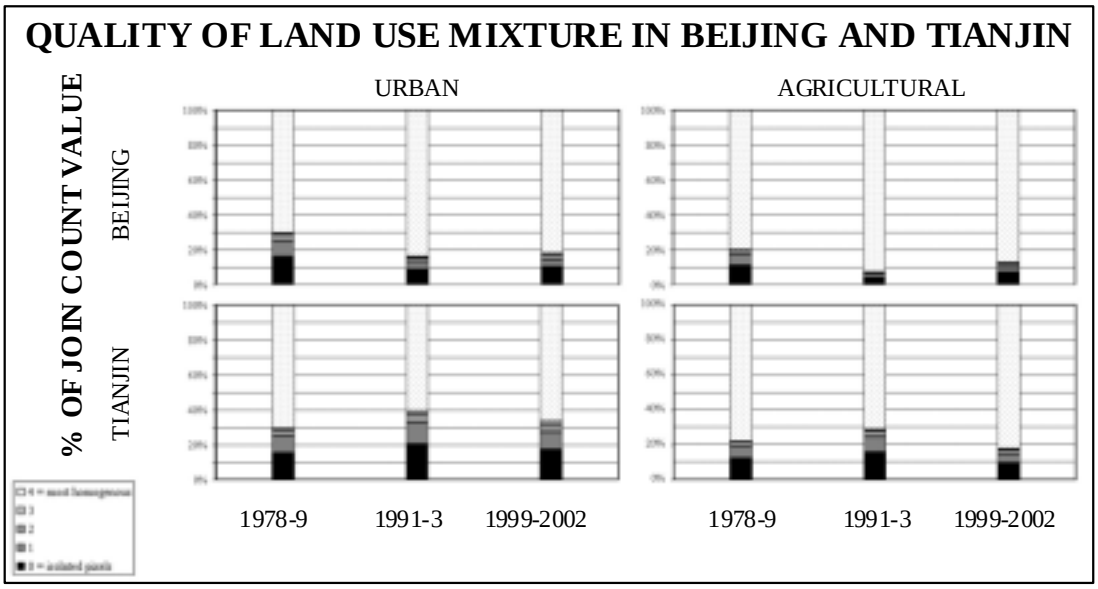
In terms of agricultural and natural bare land, the pattern differs between the railway and the highway and also differs from the pattern observed along the entire length of the two arteries. Agricultural land along the railway increased between 1978-9 and 1991-3 and then remained more or less constant until 1999-2002, agricultural land along the highway was almost the same in 1978-9 and 1999-2002 but had increased approximately 2 fold along the entire artery as well as in the sum of all nodes in 1991-3.

Natural bare land along the railway however decreased consistently along the entire artery as well as in the sum of all nodes to approximately a third of its initial amount, whereas along the entire length of the highway natural bare land was 182 km2, 131 km2 and 134 km2, and 32 km2, 30 km2 and 49 km2 in the sum of all nodes in the respective periods. Thus, along the entire highway, the amount of natural bare land decreased, whereas at the sum of all nodes, natural bare land increased.

The quality of the land use mixture was assessed using a join count method. A pixel is surrounded by 8 other pixels. If a pixel is touching pixels of the same land use class on four sides, the join count value is 4, ie most homogenous. If the pixel is isolated, ie not touching a pixel of the same land use class on any side, then the join count value is 0. A decrease in the percentage of join count value 4 means that a land use is becoming more fragmented. As this study is primarily about urban and agricultural spaces, and the degree of fragmentation of these spaces, the qualitative part of this study focuses on these two land use classes. In order to find the join count value, a binary image of urban land and 'everything else' was recalculated using a join count model. The same was done for agricultural land.

In terms of the quality of the land use mixture, the Beijing Tianjin region has become less homogenous in terms of urban land, join count value 4 in terms of urban land being 90 %, 86 % and 63 % in the three respective periods. Join count value 4 in terms of agricultural land, however, was 66 %, 70 % and 69 % respectively. Whilst urban land was increasing, urban land was becoming more fragmented, whereas agricultural land increased between 1978-9 and 1991-3 had then decreased by 1999-2002 without much change in the complexity of its mixture with other land uses. However, agricultural land was only 66 % join count value 4 to start with, that is compared to the urban land it was as fragmented at the beginning as the urban land was by 1999-2002. Also, agricultural land had between 16 and 19 % isolated pixels throughout, whereas urban land had only 2 % isolated pixels by 1999-2002.

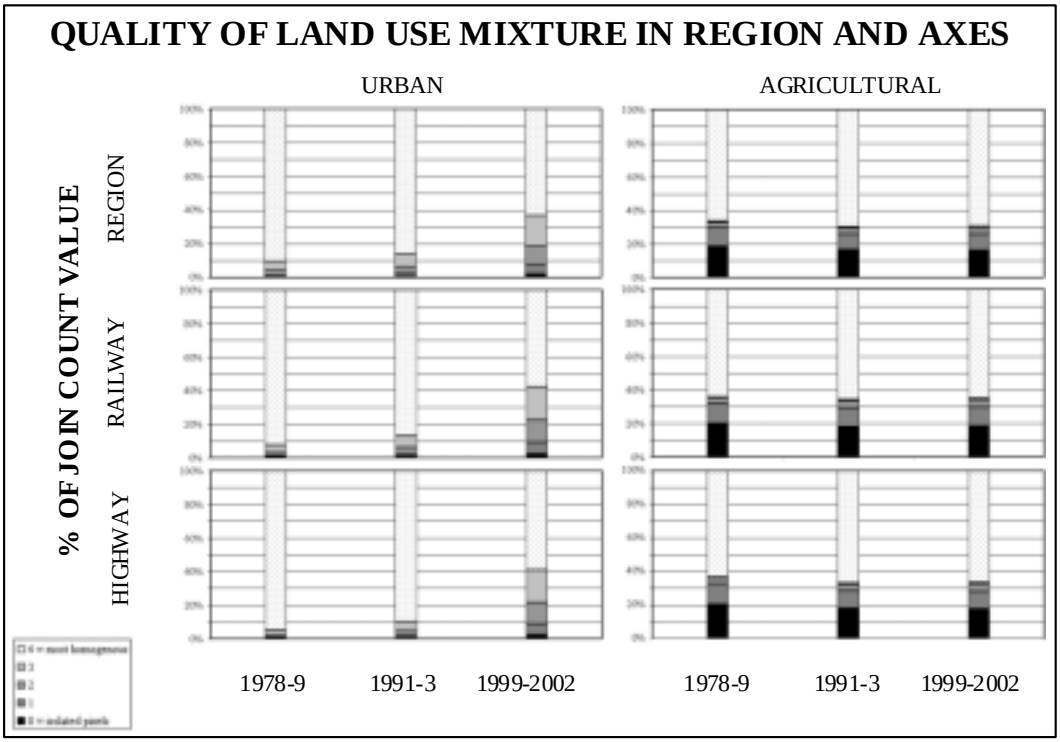
Figure 3. QUALITATIVE ANALYSIS OF LAND USE CHANGE IN BEIJING AND TIANJIN.



Whereas in Beijing homogeneity of urban land increased and then decreased, and the number of isolated pixels decreased and then increased slightly, the opposite is true of Tianjin, where homogeneity of urban land first decreased and then increased and the number of isolated pixels first increased and then decreased. With agricultural land, the same pattern is observed. Tianjin may be in a later stage of urban development than Beijing as the values of the two cities fluctuate in different periods. Although it

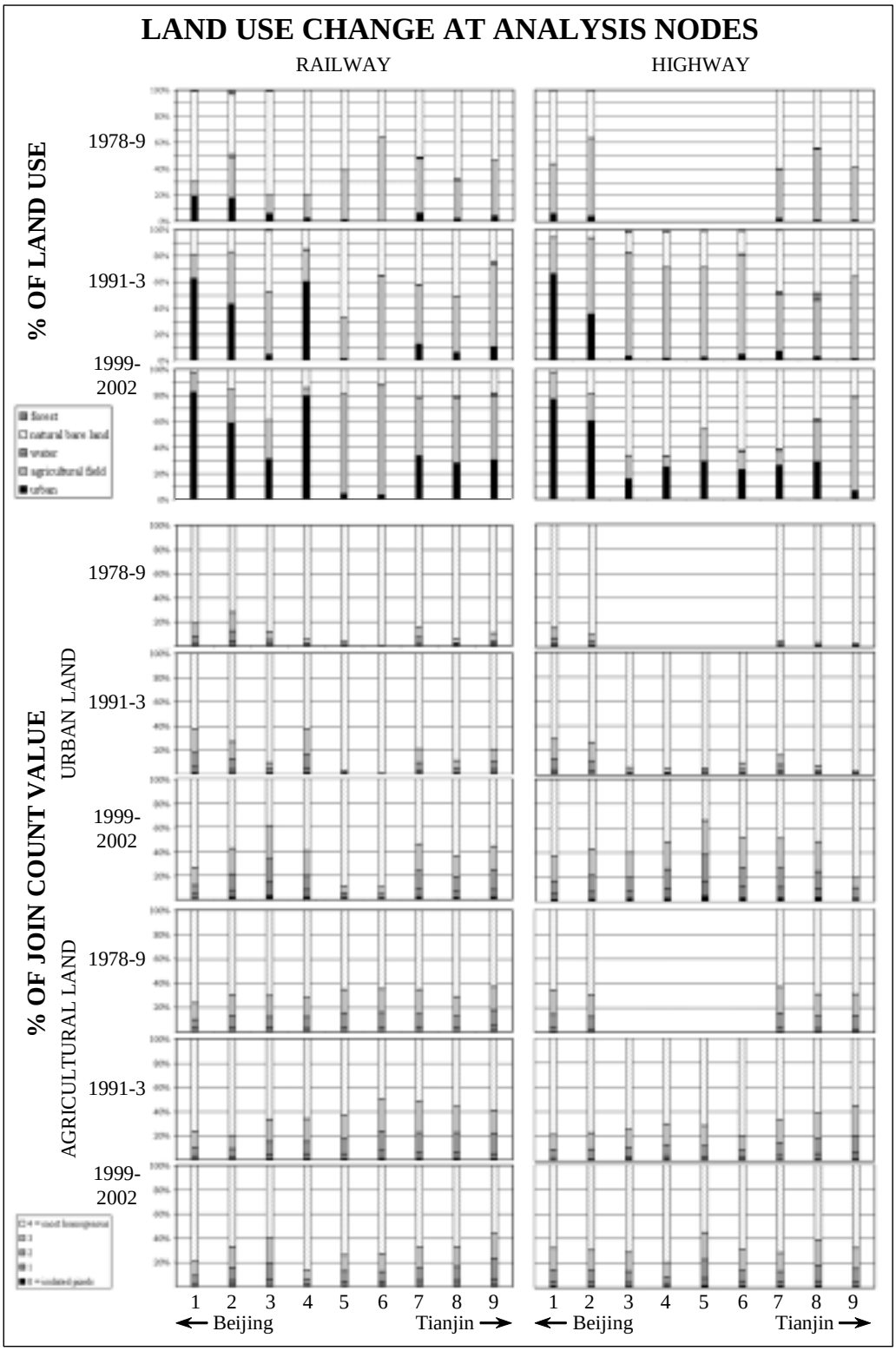
was a larger city sooner historically, it grew less rapidly in more recent decades. In terms of urban land as well as agricultural land, although it is less built up, Tianjin is more fragmented than Beijing.

Figure 4. QUALITATIVE ANALYSIS OF LAND USE CHANGE IN THE BEIJING TIANJIN REGION AND ALONG THE RAILWAY AND HIGHWAY LINKING THE TWO CITIES.



The join count values along the lengths of both the railway and the highway are almost the same as those for the entire region in terms of urban as well as agricultural land. But at the nodes, the values fluctuate. The nodes at which homogeneity decreased most in terms of urban land are those which experienced the largest increase in urban land within a period, and not those experiencing the largest amount of urban growth overall. Also, a smaller decrease in agricultural land seemed to contribute to less fragmentation in terms of urban land. Thus, nodes 1 and 4 along the railway had grown most by 1991-3 and were most fragmented by 1991-3, but between 1991-3 and 1999-2002, node 3 along the railway grew the most and by 1999-2002 was more fragmented in terms of urban land than all other nodes. Along the railway the three nodes closest to Tianjin increased similarly in terms of urban land in the respective periods, but whilst node 8 increased in terms of urban land by a similar amount to node 3 in both 1991-3 and 1999-2002, it was far less fragmented by 1999-2002, the difference being that it had a larger and increasing percentage of agricultural land whereas in node 3 had less agricultural land proportionally. In terms of urban land along the highway, all nodes had a similar increase in urban land except those closest to Beijing, which grew most, and that closest to Tianjin, which grew least. However, nodes 5 and 8 for example had grown similarly in urban land by both 1991-3 and 1999-2002, but at node 5 the join count value 4 of urban land had decreased much more by 1999-2002 than at node 8, the difference again being that at node 8 the decrease in the amount of agricultural land had been less. Nodes 1 and 2 increased most in terms of urban land in the period 1991-3, but retain the 2nd and 4th highest values of urban land join count value 4 by 1999-2002 out of the 9 nodes. When observing the sum of all nodes, the highway is more fragmented in 1999-2002 than the railway in terms of urban land.

Figure 5. QUANTITATIVE AND QUALITATIVE ANALYSIS OF LAND USE CHANGE AT THE ANALYSIS NODES ALONG THE RAILWAY AND THE HIGHWAY.



Agricultural land join count values are much more evenly distributed along both the railway and the highway than urban join count values, with join count value 4 being at around 60 % or more with only few exceptions. Along the railway, nodes 1 and 4 had increased most in urban land by 1999-2002 and these have the highest percentage of join count value 4 and also the smallest amount of agricultural land by 1999-2002. Node 6 on the other hand had the largest amount of agricultural land in all three periods and

the lowest amount of urban growth, but had the lowest percentage of join count value 4 in terms of agricultural land by 1991-3. Along the highway, nodes 1 and 2 closest to Beijing had increased most in terms of urban land in the 1991-3 period, but both nodes still had the highest percentages of join count value 4 in terms of agricultural land in 1991-3 and their respective percentages of agricultural land decreased by approximately 10 % each. Node 5, which had the lowest percentage of join count value 4 in terms of urban land by 1999-2002, also had the lowest percentage of join count value 4 in terms of agricultural land by 1999-2002. In all periods and along both arteries, join count value 4 in terms of agricultural land seems to be decreasing with increasing proximity to Tianjin. However, the node with the largest amount of agricultural land along the railway was most fragmented in terms of agricultural land in 1991-3, whereas the node along the highway which was most fragmented in terms of agricultural land by 1999-2002 had increased most in urban land in that period and was also most fragmented in terms of urban land in 1999-2002.

DISCUSSION

Many Asian megacities are located in deltaic lowlands on a river. Beijing is not situated on a river but on an arid flat plain. In Bankok for example, the river acts as an organizing principle, and urban growth has also distinctly followed main traffic arteries. Both Beijing and Tianjin seem to have grown more in other directions than along the main transport arteries connecting them. From the highway, it seems that between Beijing and Tianjin lies only scenic countryside. Has curbing urban growth along major transport arteries contributed to sprawl elsewhere?

The railway and the highway are two different forms of public transport. The railway is used by the majority of commuters between the two cities. However, there has been a huge increase in the use of private cars. Because of the proximity of the two cities, more commuters with private cars will be able to settle along the highway, which has the potential for many more ‘exits’ than the railway. If urban growth along the main transport arteries is however further contained, private car owners will have the possibility of moving further away from main roads, necessitating the building of new roads.

Literature portrays the fear that cities will grow together and turn into vast concrete expanses. But apart from the centre, a city like Beijing is already a vast expanse of concrete. Beijing is quite a safe city, but for how much longer? People living in huge housing developments no longer necessarily work together. Without the planning of sufficient open space with specific functions for people to meet, what will remain to connect them? Despite attempts to curb urban growth, globalization continuously nurtures market forces. Viable solutions which combine economic, ecological and social considerations are needed.

REFERENCES

Chen, H, S Ganesan, B Jia (2005), ‘Environmental challenges of post-reform housing development in Beijing’, *Habitat International*, vol. 29, p. 571-589

Chishaki, T (ed.) (2001), *City planning in Asia*, Kyushu University Press

Deng, F F and Y Huang (2004), ‘Uneven land reform and urban sprawl in China: the case of Beijing’, *Progress in Planning*, vol. 61, p. 211-236

Ding, C (2003), ‘Land policy reform in China: assessment and prospects’, *Land Use Policy*, vol. 20, p. 109-120

(2004), ‘Urban spatial development in the land policy reform era: evidence from Beijing’, *Urban Studies*, vol. 41(10), p. 1889-1907

Echenique, M H (1994), ‘Urban and regional studies at the Martin Centre: its origins, its present, its future’, *Environment and Planning B: Planning and Design*, vol. 21, p. 517-533

Edgington, D W (1986), ‘Tianjin city profile’, *Cities*, vol. 3(2), p. 117-124

Fainstein, S (2005), ‘Planning theory and the city’, *Journal of Planning Education and Research*, vol. 25, p. 121-130

Gaubatz, P (1999), 'China's urban transformation: patterns and processes of morphological change in Beijing, Shanghai and Guangzhou', *Urban Studies*, vol. 36(9), p. 1495-1521

Grazzini, F and G Doron (2005), 'Urban Agriculture: Small, medium, large', *Architectural Design (Food and the city)*, John Wiley & Sons Ltd., Chichester, England

GTZ Gesellschaft für Technische Zusammenarbeit (German Development Cooperation) (2005), 'Sustainable urban development in China', Beijing Office

Hall, P (2000), Cities of tomorrow: An intellectual history of urban planning and design in the twentieth century, third edition, first published 1988, Blackwell Publishers Ltd., Oxford

Han, S S and C X He (1999), 'Diminishing farmland and urban development in China: 1993-1996', *GeoJournal*, vol. 49, p.257-267

Hershatter, G (1986), *The workers of Tianjin, 1900-1949*, Stanford University Press

Ho, P (2005), 'Credibility of institutions: Forestry, social conflict and titling in China', *Land Use Policy*, article in press

Kenworthy, J and G Hu (2002), 'Transport and urban form in Chinese cities', *DISP* (Zurich), vol. 151, p. 4-14

Kwok, R Y W, W L Parish, A G O Yeh, X Xueqiang (eds.) (1990), *Chinese urban reform; what model now?*, M.E. Sharpe, Inc., Armonk, New York

Leitmann, J (1994), 'Tianjin; urban environmental profile', *Cities*, vol. 11(5), p. 297-302

Li, F, R Wang, J Paulussen, X Liu (2005), 'Comprehensive concept planning of urban greening based on ecological principles: a case study in Beijing, China', *Landscape and Urban Planning*, vol. 72, p. 325-336

Li, X and A G O Yeh (2004), 'Analyzing spatial restructuring of land use patterns in a fast growing region using remote sensing and GIS', *Landscape and Urban Planning*, vol. 69, p. 335-354

Lin, G C S (2002), 'The growth and structural change of Chinese cities: a contextual and geographic analysis', *Cities*, vol. 19(5), p. 299-316

Lin, G C S and Y H D Wei (2002), 'China's restless urban landscapes', *Environment and Planning A*, vol. 34, p. 1535-1544, guest editorial

Lo, F-C and P J Marcotullio (2001), *Globalization and the sustainability of cities in the Asia Pacific region*, United Nations University Press, Tokyo

Lynch, K (1981), *Good city form*, Massachusetts Institute of Technology

Ma, L J C (2002), 'Urban transformation in China, 1949-2000: a review and research agenda', *Environment and Planning A*, vol. 34, p. 1545-1569

Ma, K, L Zhou, S Niu, N Nakagoshi (2005), 'Beijing urbanization in the past 18 years', *Journal of International Development and Cooperation*, vol. 11(2), p. 87-96

Martin, L and L March (1972), *Urban space and structures*, Cambridge University Press

McGrath, B and D Thaitakoo (2005), 'Tasting the periphery: Bankok's agri- and aquacultural fringe', *Architectural Design (Food and the city)*, John Wiley & Sons Ltd., Chichester, England

Mumford, L (1961), *The city in history*, Harcourt, Brace & World Inc., New York

Murakami, A, A M Zain, K Takeuchi, A Tsunekawa, S Yokota (2005), 'Trends in urbanization and patterns of land use in the Asian megacities Jakarta, Bangkok, and Metro Manila', *Landscape and Urban Planning*, vol. 70, p. 251-259

Oswald, F and P Baccini (2003), *Netzstadt; designing the urban*, Birkhäuser, Basel

Rees, William (2004), proceedings of the University of Tokyo - United Nations University / Institute of Advanced Studies U.S Japan Urban Ecosystem Initiative Research Workshop, UNU Centre, Tokyo, February 2004

Sit, V F S (1995), *Beijing; the nature and planning of a Chinese capital city*, John Wiley & Sons Ltd., Chichester, England

(1985), Chinese cities: the growth of the metropolis since 1949, Oxford University Press

Skinner, M W, R G Kuhn, A E Joseph (2001), 'Agricultural land protection in China: a case study of local governance in Zhejiang Province', *Land Use Policy*, vol. 18, p. 329-340

Sorensen, A (2002), *The making of urban Japan*, Routledge, London, New York

Tan, M, X Li, H Xie, C Lu (2005), 'Urban land expansion and arable land loss in China - a case study of Beijing Tianjin-Hebei region', *Land Use Policy*, vol. 22, p. 187-196

Tong, C O and S C Wong (1997), 'The advantages of a high density, mixed land use, linear urban development', *Transportation*, vol. 24, p. 295-307

Wei, Y D and Y Jia (2003), 'The geographical foundations of local state initiatives: globalizing Tianjin, China', *Cities*, vol. 20(2), p. 101-114

Wei, Y D and D Yu (2005), 'State policy and the globalization of Beijing: emerging themes', *Habitat International*, article in press

Xu, Y (2000), *The Chinese city in space and time*, University of Hawaii Press

Yeh, A G O and F Wu (1998), 'The transformation of the urban planning system in China from a centrally planned to transitional economy', *Progress in Planning*, vol. 51(3), p. 165-252

Yokohari, M, K Takeuchi, T Watanabe, S Yokota (2000), 'Beyond greenbelts and zoning: a new planning concept for the environment of Asian mega-cities', *Landscape and Urban Planning*, vol. 47, p. 159-171