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Economic Development and Agricultural Land Loss in the Pearl River Delta, China

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ABSTRACT

The Pearl River Delta is developing very rapidly in the last two decades since the adoption of economic reform and open-door policy of China in 1978. Concomitant to this development is the rapid change of landscape in both urban and rural areas. The loss of valuable agricultural land by the encroachment of urban development, especially massive construction sites from land speculation, is very severe recently. This paper examines the relationship between economic development and agricultural land loss in the Pearl River Delta, using Dongguan as a case study. It is found that agricultural land loss has been much aggravated by land speculation as a result of the property bloom in the Pearl River Delta that was induced by the property boom in Hong Kong in the early 1990s. The urban sprawl in the Pearl River Delta is also related to other economic factors, such as rural industrialization, rise of localism, influence from Hong Kong, transport improvement, and lack of land management and monitoring system. There is an urgent need to develop a sustainable land development strategy to protect the fertile agricultural land from further unnecessary losses, especially from land speculation.

Keywords: urban encroachment; urban sprawl; agricultural land loss; China

INTRODUCTION

Since the adoption of economic reform and open-door policy in 1978, China has experienced rapid economic development. In contrast to negative increases in economic growth in some developed countries (World Bank, 1993), China has achieved a spectacular annual rate of economic growth as high as 9% in 1980–1990 and 13% in 1993. Economic development has replaced ideological and political arguments as the main agenda and brought about a rapid urbanization process in China. The Pearl River Delta, located in the central part of Guangdong, is developing very rapidly since the adoption of economic reform of China in 1978. In

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the past, the delta was predominantly an agricultural area and was one of the most important agricultural regions in China. However, the landscape of the Pearl River Delta has changed much as a result of rapid economic development in the post-1978 economic reform period which introduces market forces in economic development. Many new cities have emerged from the previous agricultural counties and tremendous changes in land-use patterns have taken place within a very short period.

Guangdong Province was first selected by the central government for the experiment of economic reform (Vogel, 1989). Some special policies were put forward to implement and facilitate economic reforms, allowing more market processes to replace the planned economy. After years of experiment, the province has become the fastest growing region with regard to its annual industrial output, tertiary output and export trade (Vogel, 1989; Yeung and Chu, 1994). In 1996, the value of the gross domestic production (GDP) and the output of the export trade were US$78.8 (RMB 651.9) billion and US$ 59.3 billion, respectively[1]. It occupied the first positions in both the gross domestic production and the export trade output in the nation. This economic development is characterized and stimulated by foreign investment in the Pearl River Delta. Foreign investment is usually related to two major types of industries — processing industries ("processing, assembling, manufacturing and compensation trade") and joint ventures. Guangdong has attracted over half the amount of foreign investment and built up over half the number of processing industries and joint ventures of the whole nation.

Concomitant to economic development is rapid urbanisation and loss of valuable agricultural land in the province, especially in the Pearl River Delta. There is worldwide concern on sustainable development since the publication of the Brundtland Report in 1987 (World Commission on Environment and Development, 1987) and the Rio's Earth Summit in 1992. As food supply is a main component of sustainable development, it is important to make sure that unnecessary urban development on valuable agricultural land can be prevented as far as possible. This paper examines the magnitude and pattern of agricultural land loss in the Pearl River Delta, using Dongguan City, one of the fastest growing cities in the Delta as a case study. It also attempts to examine the relationship between economic development and agricultural land loss, especially agricultural land losses in different stages of economic development in the Pearl River Delta.

AGRICULTURAL LAND LOSS IN DONGGUAN, THE PEARL RIVER DELTA

Dongguan is located north of Hong Kong and Shenzhen and south of Guangzhou at the eastern side of the Pearl River Delta (Fig. 1). It is a new city that was upgraded from a county to a city in 1985. It has a total area of 2465 sq. km. and consists of the city proper (Guancheng) which was the former county capital before it became a city and 29 towns. 70% of the land of Dongguan is flat land. The hilly areas are mainly located at the southern side near Shenzhen where the Kowloon-Canton Railway passes through. In the past, it was mainly an agricultural area, engaging in paddy and fruit production. Since 1985, the growth of industries was very rapid which was much faster than that of agriculture. The average annual industrial growth rate was 37% in 1985–92, with some years as high as over 45%, compared with 8.5% in agriculture. Together with Shunde, Nanhai, and Zhongshan, it is considered as one of the "Four Little Tigers" of the Pearl River Delta, with an average growth in GDP of over 20% a year.

The total permanent population in 1993 was 1.39 million and there were many temporary workers from other parts of Guangdong and China working in Dongguan. As it was upgraded from a county to a city in 1985, its spatial structure

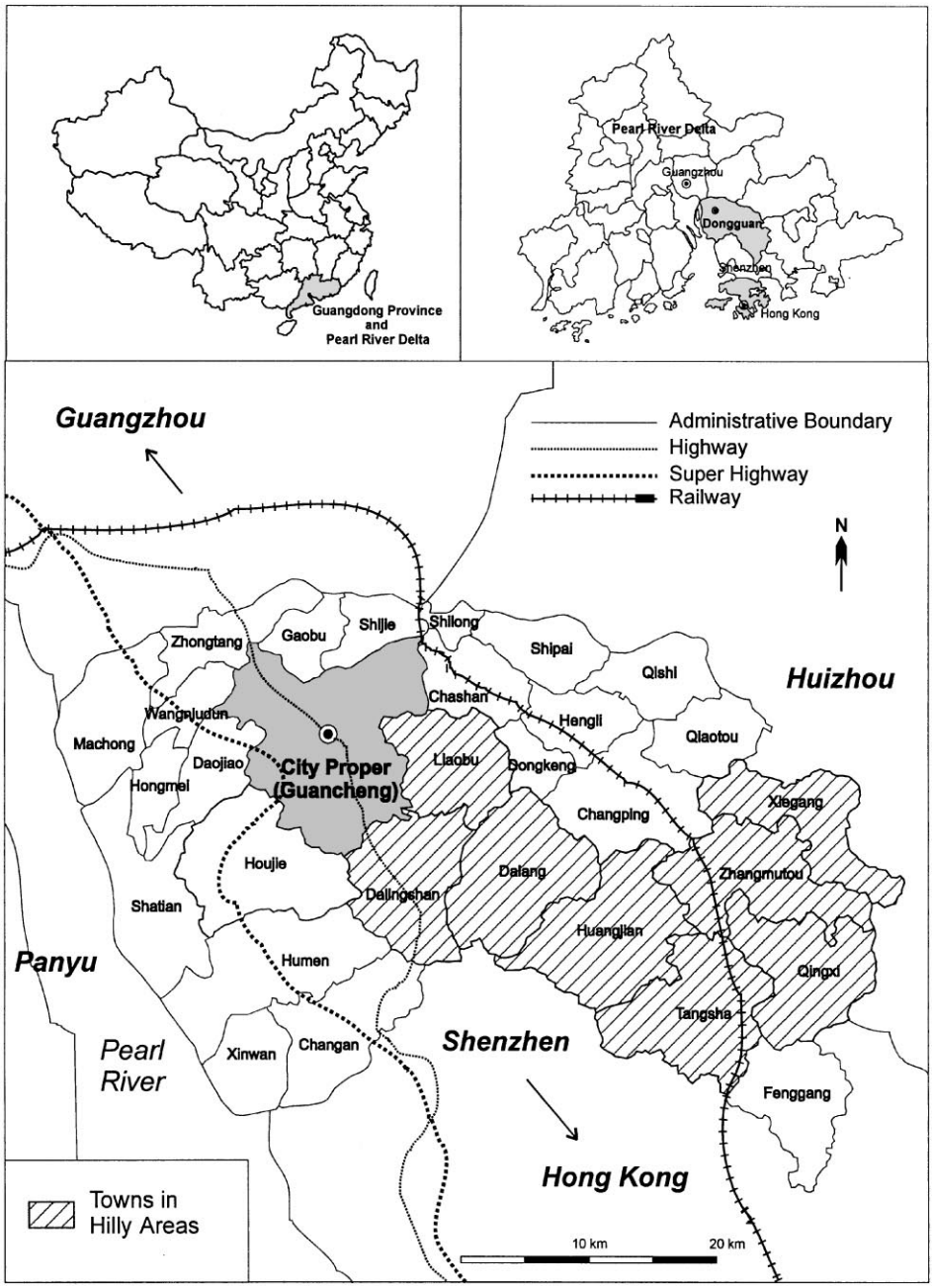

Fig. 1. City proper (Guancheng) and towns of Dongguan.

has inherited a lot of characteristics from its past history of a county when most of the developments were scattered in the towns (*zhen*) and villages (*xiang*). Because of this, the city proper is not very large compared with the city proper of large cities in China. In 1993, the built-up area of the city proper is only 34 sq. km. and only 19.41% of its total population lives in the city proper. The city proper did not have a large share of the city's population and economy (Table 1).

Concomitant to economic development was rapid urban development and the encroachment of urban development on the valuable agricultural land. Land development was especially rapid after 1990 because of the sudden property boom in the Pearl River Delta induced by the property boom in Hong Kong. Significant land-use change and loss of agricultural land can be observed in the whole city.

Table 1. City Proper of Dongguan 1993

	Total of Dongguan	City proper	% of city proper in Dongguan total
Population	1,389,232	269,693	19.41
Built-up area (in sq. km.)	185	30	16.21
Construction sites (in sq. km.)	226	31	13.72
Total land area (in sq. km.)	2,465	228	9.25
GDP (in RMB)	963,386	131,717	13.67
Industrial output (in RMB)	1,039,019	199,888	19.24
Tertiary output (in RMB)	200,131	23,017	11.50

There is difficulty in collecting land-use information of Dongguan from official sources because such data are not available. There is only aggregated official data in the Statistical Yearbooks which are often under reported. Remote-sensing method is used to estimate and analyze land-use changes in Dongguan. Multi-temporal satellite images have proven to be useful for the detection of land use change (Fung and LeDrew, 1987; Howarth and Wickware, 1981; Jensen, 1996; Martin, 1989). They are especially useful in China because official data are often under reported, incomplete and outdated. The technique can be applied to monitor the rapid expansion of urban areas and agricultural land loss in the Pearl River Delta (Yeh and Li, 1996, 1997; Li and Yeh, 1998). Three temporal Landsat TM multi-spectral images of 30 m resolution dated 10 December 1988, 13 October 1990, and 22 November 1993 were used in the study to estimate the amount of agricultural land loss. The results of the analysis of the three images show that the whole city is experiencing a fast expansion of urban areas at the cost of agricultural land. Land use changes in Dongguan was very high in this 5-year study period. 23.7% of the total area of Dongguan had undergone changes. This is much higher than the 3.2% land-use change in Hong Kong in a similar period in 1987–95 (Yeh and Chan, 1996).

Land-use changes in Dongguan in 1988–93 can be classified into two main types — the change from agricultural land (cropland and orchards) into construction sites and the change from cropland into orchards (Table 2). These changes are mainly the results of economic development in Dongguan. The change from agricultural land into construction sites constitutes permanent loss of agricultural land because it is almost impossible to convert construction sites back to agricultural land. Major changes occurred in the cropland and orchards that were in the 1988 satellite image. Satellite images show that many of them have been converted into construction sites as a result of the Hong Kong-led property boom in the Pearl River Delta in the early 1990s. Some cropland had been changed to orchards because of better economic value of fruit trees compared to that of padi. There had been a substantial decrease in cropland and a significant increase in construction sites and orchards. The largest increase in land use in Dongguan was construction sites. The total amount of construction sites had increased by an astonishing rate of 974% in 1988–93, much higher than the 13% increase in built-up areas. The proliferation of construction sites in Dongguan was mainly because of the property boom and speculation in the Pearl River Delta and Hong Kong in the early 1990s. A lot of agricultural land was cleared and converted into construction sites for housing projects and land speculation. Flat land that is suitable for agriculture is often very suitable for the construction of housing and factories, particularly those near to the urban centres and major transport routes. It was therefore very profitable to use the agricultural land with good accessibility to construct houses and factories. The total amount of construction sites in 1993 was even 4,369 ha larger than that of the built-up areas. There were 22,728 ha of construction sites as compared to 18,359 ha of built-up areas. There were major loss of agricultural land

Table 2. Land use changes in Dongguan, 1988–93 (in ha)

1988	1993							1988 total
	Cr	Ba	Co	Or	Bu	Fo	Wa	
Cr	62,628.2 (65.0%)		1,749.4 (1.8%)	31,945.8 (33.2%)				96,323.4 (100.0%)
Ba				0.2 (100.0%)				0.2 (100.0%)
Co			0.3 (0.1%)		2,115.4 (99.9%)			2,115.7 (100.0%)
Or			19,536.3 (29.8%)	45,950.8 (70.2%)				65,487.1 (100.0%)
Bu					16,243.6 (100.0%)			16,243.6 (100.0%)
Fo		136.7 (0.3%)				41,462.1 (99.7%)		41,598.8 (100.0%)
Wa			1,442.9 (8.0%)				16,593.8 (92.0%)	18,036.7 (100.0%)
1993 Total	62,628.2	136.7	22,728.9	77,896.8	18,359.0	41,462.1	16,593.8	239,805.5
Change	−33,695.2	136.5	20,613.2	12,409.7	2,115.4	−136.7	−1,442.9	
Change %	−35.0	68,250.0	974.3	18.9	13.0	−0.3	−8.0	

Notes: Cr — Cropland; Ba — Bare soil; Co — Construction sites; Or — Orchard; Bu — Built up areas; Fo — Forest; Wa — water.

because most of the land were converted from cropland and orchards and the conversion is irreversible.

When the agricultural land loss obtained from the analysis of remote-sensing images was compared with that reported in official statistical data, it was found that the loss of agricultural land was under reported by 61.3% in government statistics. The reported figure was only 38.7% of the total 21,285.7 ha of cropland and orchard that was converted into construction sites.

There was severe competition between urban development and agricultural land use in Dongguan in 1988–93 (Fig. 2). A high proportion (63.8%) of urban development as represented by built-up areas and construction sites occurred in good quality agricultural land with land suitability rating of 5 or above. This shows that there is severe competition of urban development with good quality agricultural land. Land that is suitable for agriculture is often very suitable for urban development too, especially flat lands that have good accessibility and are close to urban centres. As the income from land for urban development is much higher than that for agricultural use, without government intervention, good quality agricultural land is sold to developers for construction of factories, housing, and buildings. The property boom in the early 1990s in Hong Kong and the Pearl River Delta has converted many good agricultural lands to construction sites and built-up areas because the local governments can make more money by selling their land to developers than using their land for agricultural purposes.

Compared with other cities in the Third World where land-use changes were mainly located near the city proper, land-use changes in Dongguan did not mainly occur in the city proper but was more dispersed to other towns (Fig. 3). Taking advantage of cheap labour, land, and more relaxed environmental and development control, the towns in Dongguan were developing as fast as the city proper and a more dispersed urban development pattern has resulted. Many of these developments were sporadically located, leap-frog, unplanned development. The loss of agricultural land (cropland and orchards) to urban development (built-up areas and construction sites) mainly occurred in the town centres and along the roads,

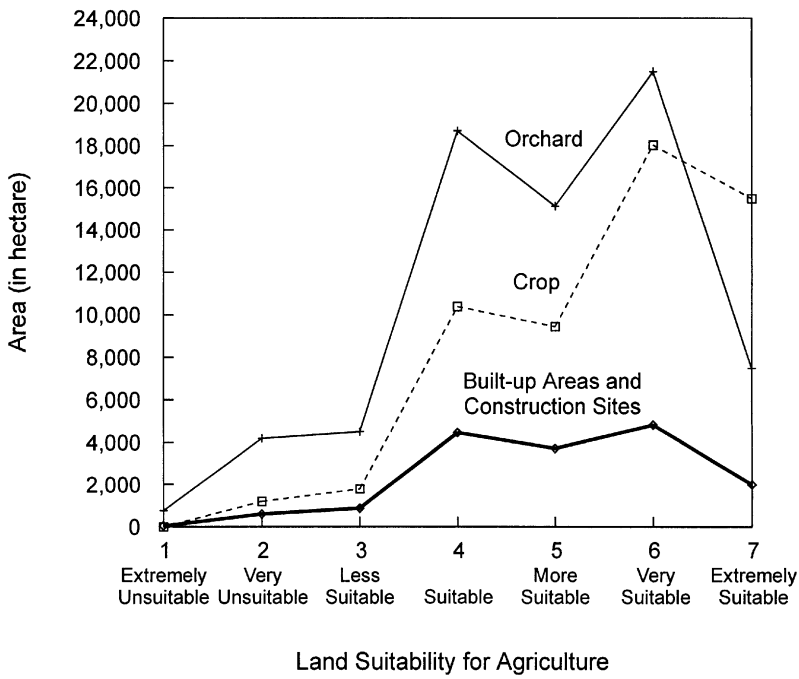

Fig. 2. Competition of agriculture with built-up areas and construction sites for good-quality agricultural land in Dongguan, 1993.

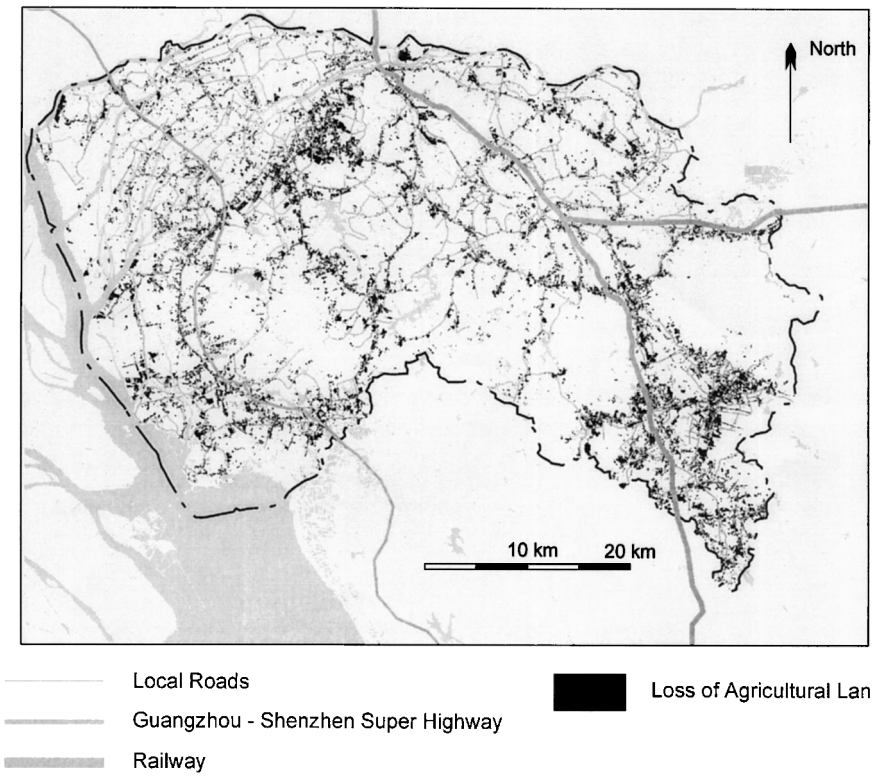

Fig. 3. Spatial pattern of agricultural land loss in Dongguan in 1988–93.

railroad and super-highway from Hong Kong to Guangzhou (Fig. 4). Towns that have greater than one standard deviation in the amount of land used for urban development (built-up areas and construction sites) in 1988–93 are mainly located near Shenzhen where a lot of property development has taken place because of the proximity to Hong Kong. There were two main clusters of towns with higher than average amounts of land used for urban development. One cluster is along the Hong Kong–Guangzhou Super Highway with the City Proper as its centre. Most of them were capitalizing the property boom by developing housing and buildings on the flat agricultural land, leading to the increase in the loss of good-quality agricultural land. The other cluster is located in the relatively hilly areas away from the delta where the Hong Kong-Guangzhou railroad (Kowloon-Canton Railway) passes through.

Although there have been worries on the loss of arable land to urban development in the Western countries, urban development in these countries has created less environmental impacts because they have larger per-capita environmental capacities. Research shows that little threat to agricultural production has been created with urban growth in these countries. For example, in the study on the amount of encroachment on rural land in the United States, Hart (1976) concludes that the amount of rural land which will likely be converted to urban use from 1976 to 2000 only accounts to 4 per cent of the nation's total land area. In New Zealand, it is found that the urban growth since European settlement represents only 4 per cent of its highly productive land (Leamy, 1974). In Canada, the same situation is also found in the study by Smit and Cocklin (1981) on the extent of future rural-to-urban land-use conversion for each of the thirty Ontario counties for the period 1976–2001. Four future urban growth scenarios are associated with the conversion, but only less than 2 per cent of the prime agricultural land of Ontario would be lost even under the "worst" scenario. In England and Wales, the same

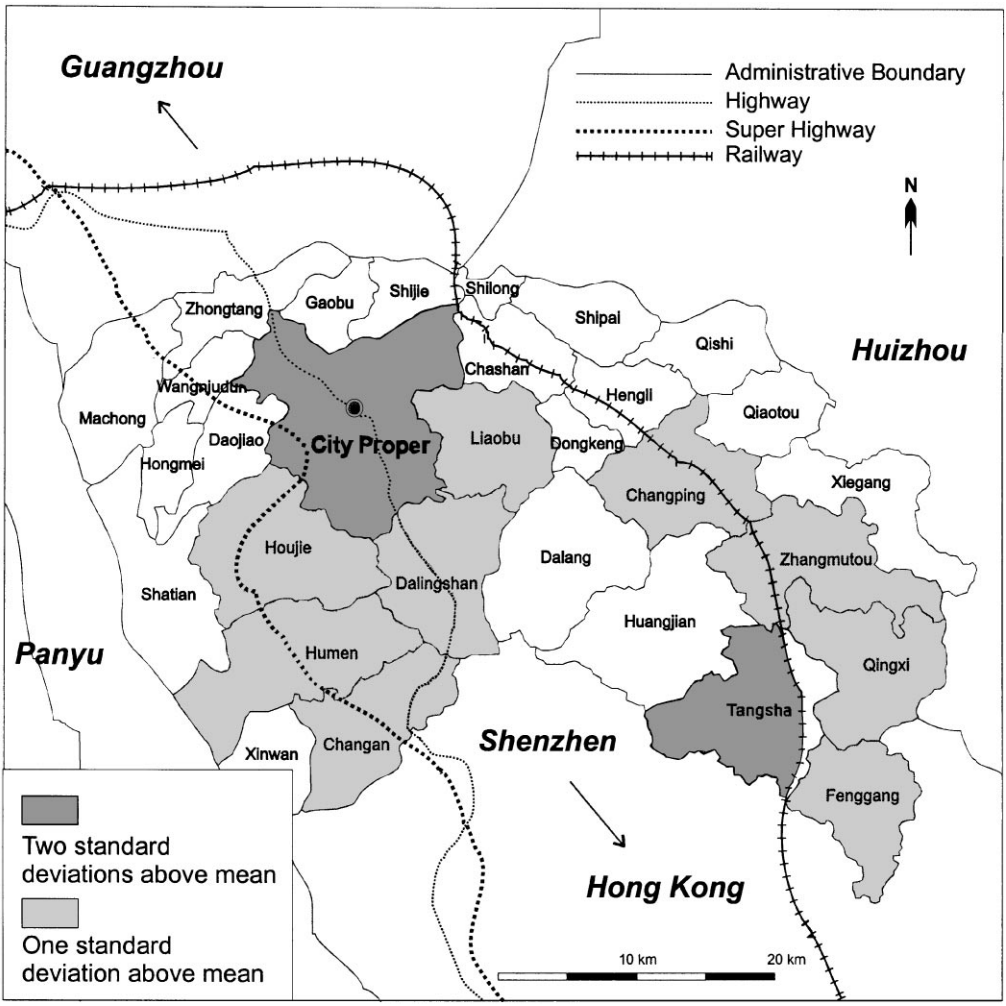

Fig. 4. Distribution of land used for urban development in the towns of Dongguan in 1988–93.

conclusions are reached with regard to the impacts from land conversion (Edwards, 1969). These researches indicate that food production in these areas are not likely to be severely affected by urban development.

However, a totally different picture is seen in Dongguan when the comparison is made between agricultural land loss in Dongguan and that in the above Western countries. The area of urban land use rapidly increased from 16,234.6 to 41,087.9 ha in 1988–1993 in Dongguan. This means that 10.4% of the total land area was converted to urban land use just within this short period of time. Moreover, most of the conversion only occurred in 1990–93. The conversion rate is much higher than the above international experience. About 17.1% of the total land area was for urban land use in Dongguan in 1993. This implies that the amount of the future land supply is not so optimistic because the urban land area seems to have occupied a large proportion of the total land area. In 1988–93, the growth rate of urban areas was 30.6% per annum, which was much larger than the growth rate of its economy of 20.6%. At the same time, the land consumption per capita increased from 128.4 to 295.8 m^2 while the nation's standard is 100–150 m^2. Ilbery and Evans (1989) report that the annual rates of land loss averaged approximately 18,500 ha during the 1960s and around 15,000 ha between 1970 and 1975 in the United Kingdom which has a total land area of 244,755 sq. km. In 1988–93, the annual rate of land loss was 4257 ha in Dongguan which has only 1% of the land

area of the UK. This means that the proportion of land loss per annum in Dongguan in 1988–93 is about 23–28 times that of the UK in the 1960s and 1970s. Therefore, very serious measures should be taken in the management of land development so that excessive consumption of land resources can be prevented. A sustainable land-use strategy is much needed to reconcile the conflicts of land use and prevent the depletion of agricultural land resources at an early stage, otherwise it will be too late.

ECONMIC DEVELOPMENT AND AGRICULTURAL LAND LOSS

Stages of economic development in the Pearl River Delta

The patterns of urbanization and agricultural land loss are closely influenced by economic development in the Pearl River Delta. Two different stages of economic development can be observed in the Pearl River Delta after economic reform in 1978. In the first stage (1978–1990), the economy is mainly influenced by the development of labour-intensive processing industries. The second stage (1990 – present) is the diversification of the economy to tertiary and real estate industries. These two stages are associated with different processes of urbanization and agricultural land loss in the Pearl River Delta.

The first stage (1978–1990)

From 1978 to 1990, Guangdong's real gross domestic product (GDP) increased at an annual rate of 12.3% in comparison with that of 8.9% for the whole nation. However, most of the progress should be attributed to the Pearl River Delta. The Pearl River Delta was designated as a Special Economic Development Zone in early 1985. It has contributed significantly to the economic takeoff of the Guangdong Province. Before economic reform in 1978, the annual growth rate of the real GDP of the Pearl River Delta was only 4–7%, but the growth rate reached 14–16% in 1978–1990, which was 2–3 percentage above that of the Guangdong Province (Liu *et al*., 1992).

The greatest stimulation to the economy of the Pearl River Delta in this stage of development was labour-intensive processing industries. Hong Kong partners subcontracted their manufacturing work to Chinese partners with the provision of necessary raw materials, equipment and techniques for the production. The Chinese partners earned processing fees by finishing the required production and turning back the processed goods to Hong Kong middlemen. In 1990, according to China's Customs Statistics, Guangdong's export earnings were US$18.7 billion which was 30% of the national total. Nearly half of them came from subcontracted processing industries (Liu *et al*., 1992). Many of these industries were located as village enterprises in the townships of the Pearl River Delta. These village enterprises were taking up agricultural land but not at a very large scale.

The second stage (1990–present)

Land reform in 1987 that re-introduced land values in China through land leasing and the charging of land use fees has created a property market and increased the rate of housing construction (Yeh and Wu, 1996). The rapid development of property market in the second stage of development intensified agricultural land loss in both urban fringe and rural areas. Influenced by the property boom in Hong Kong, there was a sudden rise in the development of real estate industry in China in 1992, especially in the coastal cities. Before the property boom in 1992, investment in real estate was limited to Shenzhen, Guangzhou, Panyu and Huizhou in the Guangdong Province. Investment in property development soon spread all over

the Pearl River Delta, and then moved to other parts of China in 1992. Both foreign investors and domestic units have been deeply involved in property development. Foreign investors usually come from Singapore, Japan, the United States, South Korea, Hong Kong and Taiwan, but Hong Kong occupies the large proportion of property investment in the Guangdong Province. In 1992, investment from Hong Kong was US$2.56 (HK$ 20) billion for land acquisition and US$0.97 (HK$ 7.5) billion for construction (Tian, 1994) (see footnote 1). There are significant speculations on the real estate development because the returns are huge.

The extraordinarily hot development of real estate has led many cities and towns into inappropriate allocation of resources, such as land resources and capital. Balchin and Kieve (1985) considered that the property market is one of the least efficient markets. Imperfect knowledge of buyers and sellers, the preference of establishments for existing sites, and the immobility of resources are some of causes of the inefficiency. These factors prevent land resources from transferring smoothly to the most efficient use. There is great demand on the conversion on agricultural land for urban development. The conversion of rural land to urban use will continue to supply the bulk of land utilization for new construction in China (World Bank, 1993). As compared with the first stage of development after the 1978 economic reform, rapid development of the real estate industry in this period, especially land speculation, has led to an increased in agricultural land loss.

Stages of economic development and agricultural land loss

Urban land consumption and its associated agricultural land loss is much related to the different stages of economic development in the Pearl River Delta. As discussed above, there are two main stages of economic development in the Pearl River Delta. One is pre-1990 that is more related to village enterprise development and the other is post-1990 which is more related to real estate development. The impacts of these two main stages of economic development can be reflected from the amount of agricultural land loss in 1988–90 and 1990–93. In 1988–90, which is the village enterprise development period, the agricultural land loss was 1253 ha. But agricultural land loss increases drastically to 20,032 ha in 1990–93 which is the real estate development period.

The impact of real estate development on agricultural land loss can be examined by finding the relationship between property development and agricultural land loss. But, there is difficulty in finding statistics on property development for each towns in Dongguan. A proxy method can be used by examining the relationship between population, industrial development and land consumption. If the relationship between urban land consumption and industrial development is constant and if there is no structural change in the economy, there should be no changes in the relationship between population, industrial development, and land consumption.

Population and industrial statistics of each town are obtained from various years of the *Dongguan Statistical Yearbook* (Guandong Statistics Bureau, various years, since 1988). Table 3 is the regression analysis results which attempts to identify the influences of economic factors on urban expansion in the three different time periods. The results reveal that there are significant relationships between industrial output and population and urban land consumption in the towns of Dongguan. It is found that the correlation coefficient r^2 decreases in the later years. This is mainly because land speculation in the property bloom period has made land development and consumption to be less related to population growth and industrial development. The values of r^2 are slightly higher in the regression between population and urban land consumption than that between industrial output and urban land consumption. This indicates that urban land consumption is more related to population growth than industrial development. This is the most likely outcome of land speculation and the increase in space and living standard as the economy

Table 3. Correlation coefficients (r^2) between population and industrial output and urban land consumption in 1988, 1990, and 1993

	Urban land consumption		
	1988	1990	1993
Gross industrial output value	0.9109	0.8792	0.8059
Population	0.9298	0.9141	0.8543

develops. The average land consumption per capita rapidly increased from 128.4 m^2 in 1988 to 295.8 m^2 in 1993. The amount of land consumption in many towns is unacceptable according to the national standard of 100–150 m^2 per person. For example, land consumption per capita in Fenggang was as high as 1,123.2 m^2 in 1993. The second stage of economic development towards real estate development has increased the amount of urban land consumption and agricultural land loss in Dongguan.

CAUSES OF AGRICULTURAL LAND LOSS IN DONGGUAN

Urban development is very dispersed in Dongguan, leading to much loss of valuable agricultural land. From the analysis of agricultural land loss, this trend is increasing in some towns. The difference between rural and urban areas is becoming blurred. Looking down from the airplane, there is development everywhere. The dispersed development is much related to the geographical location of the towns. Poorer towns in the hilly areas which are closer to Hong Kong had more dispersed development. Because of the lack of agricultural development potential and poor economic growth, they expanded into property development and created a dispersed development. The highly dispersed pattern of urban development which is not uncommon in county-level cities in China, especially those in the fast growing provinces along the coast. This is caused by rural industrialization, the rise of localism, land reform, the influence of Hong Kong, road development, and the lack of good land management and monitoring system.

Rural industrialization

The dispersal pattern is the result of rural industrialization which is a common phenomenon in China, especially in the Pearl River Delta. The introduction of the fiscal responsibility (*caizeng baogan*) system after economic reform in 1978 has great impact on the economy and the spatial organization in China. Under this system, local government had to pay a lump-sum payment of profits to the central state and the remaining profit could be used by local government for other uses (Cheung, 1994). There was much local autonomy of what could be developed. As a result, many township-village enterprises (*xiangzhen qiye*) (TVEs) that are owned by township and village communities and controlled by the respective local governments flourished in the rural areas in China (Byrd and Lin, 1990; Chang and Wang, 1994; Nee and Su, 1990). In 1993, TVEs produced 30% of the total industrial output in China. These rural industries had transformed the rural landscape in China, leading to rural urbanization (Chang and Kwok, 1990). Small towns are especially important in industrialization and the transformation of the rural economy and landscape in the Pearl River Delta (Johnson, 1992; Xu and Li, 1990). Much of the development is located next to villages where the local villagers live (Lin, 1996; Ma and Lin, 1993). Worker dormitories are constructed for workers from non-local workers from other parts of China. By building a factory within the

jurisdiction of the village, factory owners are able to save a considerable amount of land rent. These factories are often close to roads for the easy transport of raw materials and products. This leads to the scattered development in the towns, blurring the rural-urban distinction.

The rise of localism

The local autonomy and the fiscal responsibility system has given local government the freedom and incentive in developing its economy. It is highly regarded as one of the reasons for the economic success in China (Montinola, Qian, and Weingast, 1995). But, such system also has its negative effect. It has also developed into what is called the "local state corporation" (Oi, 1995) or the "Duke Economy" (Jiang, 1990; Shen and Dai, 1990) which local interest prevails over national interest. Such system has induced competition among all level of local governments. Provinces are competing against provinces, cities against cities, towns against towns and other local governments in the system. One of the results of such competition is the relaxation of the development and environmental control because local government which imposes tight development and environmental controls in their jurisdiction will face a competitive disadvantage to those that have not tightened their controls. Another result is the competition to provide a hospitable environment for investment, such as the development of infrastructure. The provision of favourable environment or the so-called "five connections and one levelling" (*wutong yiping*) — connecting roads, telecommunication, water, electricity, and port and levelling of sites — are the main methods to provide a good investment environment for developing the special economic zones which has also been commonly practised in China (Yeh, 1985). Roads are built in the town to increase accessibility and lands are levelled to provide an instant start of development projects. Many agricultural land and hill sides were levelled and developed into Economic and Technological Development Zones (ETDZs) to attract development (Yeh and Wu, 1995). Some of these ETDZs are simply land speculation, hoping that investment will come through the provision of serviced land. The proliferation of construction sites in Dongguan is the result of rising localism in the Pearl River Delta.

Land reform

Variations in land development patterns have been observed in Dongguan. Land development monitoring reveals that some towns have disproportionally higher density of land loss. The implementation of paid transfer of land-use rights and establishment of property market in China are important in triggering off rapid agricultural land loss. The use of land in China was virtually free from 1954 to 1984. Since the land reform in 1987 which allows the paid-transferred of land use rights, land has now a value and produced very significant impact on urban development.

The land reform in 1987 that re-introduced land values in China through land leasing and the charging of land use fees has created a property market and increased the rate of housing construction. Before land reform in 1987, land is owned by the government and is normally allocated free to users without any charges. Land leasing and the charges of land use fees were first experimented in the special economic zones (SEZ) on land involving foreign investments in the early 1980s (Yeh, 1985). Further land reform was carried out by the Shenzhen SEZ in 1987 in which a "Land Management Reform in the Special Economic Zone" was proposed to lease state owned land to developers through open auctions or competitive bidding. The maximum term of lease is 50 years which could be renewable through negotiation when the lease expires. Lessees were allowed to sell,

assign, transfer the land use rights. The paid-transferred of land use rights (*tudi youchang zhuanrang*) was made official in the First Session of the Seventh People's Congress in 1987.

Local officers began to realize that the 'sale' of land is an easy and effective way to increase income. In the past, there were major difficulties for local government to raise funds to improve their infrastructure in attracting investment. With land reform, local government is willing to invest in infrastructure to improve its environment and accessibility so as to increase land value. They could use the money generated from land sales to fund further infrastructure projects and start a positive circle of using income from land to further promote development. This is commonly called "using land to breed land development" (*yide yangde*). With better accessibility and infrastructure, land can command a higher price in the market. Revenue from land can now be used to fund infrastructure projects such as roads and telecommunications that are not possible before the introduction of the land market (Yeh and Wu, 1996).

Before the second stage of economic development in the Pearl River Delta, land development is mainly restricted to the development of factories, ETDZs, workers dormitories, and housing projects. Land development is much related to industrial production. But since the property boom in the Pearl River Delta that was induced by the property boom in Hong Kong in 1991, there are massive levelling of land for development and speculation of residential development which aims at the housing market for the residents in Hong Kong. House prices in Dongguan were 10 per cent of those in Hong Kong. In 1992, 69,561 housing units were being marketed and about 30,000 of them were sold in Hong Kong (Ming Pao, 4 January 1993). This is a huge amount compared to the 26,222 private domestic units completed in Hong Kong in the same year (Rating and Valuation Department, 1993). People in Hong Kong who could not join the property speculation there could afford to buy property for themselves, their families or for speculation in Dongguan.

The local governments at the town level have much freedom in the disposal of their collectively owned land. They found it more profitable to sell their land to developers or engage in property development than to grow crops and fruit trees in the property boom period of the Pearl River Delta. Some of the towns that are located in the relatively hilly areas away from the delta, near the Hong Kong-Guangzhou railway, were not doing very well in agriculture production. They quickly capitalized the property boom by developing housing on flat agricultural land, giving rise to high amount of agricultural land loss. They were able to do so because of their autonomy in land management and the lack of urban planning and loose development control. A large amount of agricultural land was levelled into construction sites for property development disregarding their impact on the environment and future generations. Many of these developments were sporadically located, leap-frog, unplanned development.

Much of the land is also for land speculation, leading to wasteful use of land resources. A developer may acquire a large piece of land beyond the needs of his normal business and sell all or part of it with a much higher price several years later. In 1988–93, the largest increase in land use was for construction sites. As estimated from the satellite images, the total amount of construction sites had increased by an astonishing rate of 968.9% in 1988–93, much higher than the 13.7% increase in built-up areas. The proliferation of construction sites was mainly due to the property boom and speculation in the early 1990s fuelled by property boom in Hong Kong. Many land were levelled for land speculation. The total amount of construction sites in 1993 was even 4146 ha more than that of the built-up areas. There were 22,613 ha of construction sites as compared to 18,467 ha of built-up areas.

Influence of Hong Kong

The development of the dispersed pattern of development in Dongguan is highly influenced by the investment from Hong Kong. Hong Kong is the major source of foreign investment in China, constituting over 60% of its total foreign investment. Guangdong, being the province right next to Hong Kong, is taking full advantage of its proximity to Hong Kong. The central government has facilitated Guangdong in attracting foreign investment from Hong Kong by designating special economic zones, coastal open cities, and open economic regions that offer preferential treatment to foreign investment in their jurisdiction. Three of the four Special Economic Zones designated in 1979 — Shenzhen, Zhuhai, and Shantou — are in the province and so are two of the fourteen Open Coastal Cities designated in 1984, Guangzhou and Zhanjiang. The Pearl River Delta Open Economic Region was designated in 1985 for attracting foreign investment. Over 87% of its direct foreign investment is from Hong Kong. In addition to direct foreign investment in setting up factories and enterprises in the form of joint ventures, co-operatives or sole-foreign investment (*sanzi qiye*), many Hong Kong manufacturers have established subcontracting arrangements and compensation trade (*san lai yi bu*) with Chinese enterprises in the Pearl River Delta and the Shenzhen SEZ to take advantage of the cheap labour and land and loose environmental legislation. Chinese partners provide the land, plant, labour, water, electricity and other basic facilities, whereas the foreign investors supply the machinery, materials, product design, and are responsible for marketing. The Hong Kong link is very important in the development of the Pearl River Delta, especially personal contacts by friends and villagers who have migrated to Hong Kong and later went back to the village to invest (Leung, 1993; Smart and Smart, 1991). The influence of Hong Kong is very important to the industrial development in the first stage of economic development and this become more important in the second stage of development with property development. Extensive land development and speculation occurs at towns close to Hong Kong and areas along major highways and railways linking to Hong Kong. This can be shown in the satellite images and the above analysis.

Road development

Accessibility, especially to Hong Kong is very important in attracting investment. Like other cities in the Pearl River Delta, Dongguan has given a high priority to improve its existing road system and construct more high-rank roads across the city. As a result, there was a sudden increase of the length of the first-class highway from only 5.5 to 151.0 km just within 1992. The improved transport system, however, allows many rural areas to be exposed to non-agricultural activities. The result is the occurrence of faster dispersal of land loss along most of the main roads which is highly noticeable in the 1993 image.

Lack of land management and monitoring system

Unlike large cities which have a long tradition and history of urban planning and land management, many new county-level cities which were upgraded from former rural counties in the Pearl River Delta do not have good urban planning management system. They also suffer from the shortage of urban planning and land management staff. The central and provincial governments have to rely on the local governments to report to them the amount of land development and agricultural land loss. They are often under reported because a lot of land may be used or "sold" illegally, with the money going to somebody's pockets. Under reporting is also due

to a poor land administration and monitoring system. Although remote sensing and GIS can provide an effective means of monitoring land development (Yeh and Li, 1997), they were not used in the Pearl River Delta. When the agricultural land loss obtained from the analysis of remote sensing images was compared with that reported in official statistical data, it was found that the loss of agricultural land was under reported by 61.3% in government statistics. The property boom also came very quickly and before the government officials could react to the situation, much agricultural land has been lost.

CONCLUSION

Rapid land development and agricultural land loss are taking place in Dongguan. 31.1% of the total area of Dongguan had undergone changes in the study period in 1988–93. This is much higher than the 3.2% land-use change in Hong Kong in a similar period in 1987–95. Agricultural land loss and urban sprawl is much related to the stages of economic development after the 1978 economic reform in the Pearl River Delta. Land loss and urban sprawl were not too serious in the first stage of development where land was mainly used for industrial development. Land was at least mainly used for the production of goods. Land loss and urban sprawl became a serious problem in the Pearl River Delta at the second stage of development which has an increasing element of property development and land speculation. The total amount of construction sites in 1993 was even 4369 ha larger than that of the built-up areas in the study area. A large amount of construction sites is for land speculation, leading to wastage of land resources and other environmental problems. Land speculation is wasteful and leads to inefficient patterns of urban development and the creation of idle land (Bryant et al., 1982; Hushak and Bovard, 1975).

Compared with other large cities in China and other cities in the Third World where land-use changes were mainly located near the city proper, urban development in the study area are more dispersed. This is mainly the result of rural industralization. Rural enterprises were able to compete with urban enterprises by making use of their cheap labour and land and more relaxed environmental and development control. The 29 towns in Dongguan were developing as fast as the city proper and a highly dispersed urban development pattern is resulted. The loss of agricultural land (cropland and orchards) to urban development (built-up areas and construction sites) mainly occurred in the town centres and along the roads, railroad and super-highway from Hong Kong to Guangzhou. These are the areas that can be accessed to Hong Kong by rail or by roads and are therefore more attractive for building housing that are geared towards the Hong Kong market.

There was severe competition between urban development and agricultural land use in Dongguan in 1988–93. A high proportion of urban development as represented by built-up areas and construction sites occurred in good-quality agricultural land. Land that is suitable for agriculture is often very suitable for urban development too, especially flat land that has good accessibility and is close to town centres. As the income from land for urban development is much higher than that for agricultural use, without government intervention, good-quality agricultural land is often sold to developers for construction of factories, housing, and buildings. The property boom in the early 1990s in Hong Kong and the Pearl River Delta has led to the conversion of many good agricultural lands to construction sites and built-up areas because the local governments can make more money by selling their land to developers than using their land for agricultural purposes.

The loss of some agricultural land is inevitable in the fast growing period in the Pearl River Delta but the amount should be minimized, especially that for land speculation. Urban development often ignores the physical characteristics of land. Locational factors (spatial use) tend to override physical attributes (Platt, 1972). Spatial land-use pattern is mainly the result from the demand from business and residential activities, and physical attributes of land do not play an important role in it. Urban sprawl is the result of the tendency to seek land which is cheaper and with better accessibility. It also does not take into considerations the physical attributes of land. Cheap land price is one of the main forces in the rapid development of the Pearl River Delta (Yeh et al., 1989). Land development is often carried out without taking into consideration the physical properties of land which are critical to agricultural production. The lack of consideration to the physical properties of land in the development of Dongguan is obvious, leading to the failure to protect the best agricultural land. Leap-frog development has proliferated in the whole of the Pearl River Delta. There is a lack of general concern on the conservation of land resources with regard to land quality.

The loss of agricultural land to urban development is alarming in the Pearl River Delta. As found by the study, per capita land consumption is drastically increasing, especially in the second stage of economic development which is influenced by real estate development and the resulting land speculation. The decrease in arable land has depleted the food production capacity of the region which used to be one of the most important agricultural areas in China. The loss of valuable agricultural land from rapid urban growth had drawn the attention of the central government. On 18 August 1994, the State Council promulgated the *Regulations for the Protection of Basic Agricultural Land* (*Jiben Nongtian Baohu Tiaoli*) that compulsorily required local governments to zone the most important agricultural land for strict protection. Local governments in the Pearl River Delta were required to zone land as agricultural protection zone. But, there was no scientific basis for zoning land for agricultural protection and, very often, these zones were arbitrary demarcated. There is no guarantee that land zoned for agricultural protection is good quality agricultural land. Land-use change information and assessment are urgently needed in order for the Pearl River Delta to sustain its development (Yeh and Li, 1997; Li and Yeh, 1998).

A sustainable land development model which guides future direction and pattern of urban growth needs to be developed to minimize the amount of agricultural land loss from urban development (Yeh and Li, 1998). Such a model can help to formulate sustainable strategy for protecting the valuable agricultural land from development and to coordinate the timing and location of land development. Further studies are needed to be carried out in other parts of the Pearl River Delta to assess the overall impact of rapid economic development on the environment in general. Studies are also needed to study the land development process in the Pearl River Delta to see whether the amount of land consumption is really necessary and its impact on the environment can be minimized. A better development control process and planning with a sustainable development objective may need to be formulated in the Pearl River Delta. A higher development intensity may also be needed to minimize land consumption.

The problems of agricultural land loss that are presented in Dongguan are not unique in China. They are very commonly found in other cities in China, especially those new county-level coastal cities which are surrounded by fertile agricultural land. If we can find a solution for Dongguan, we should be able to apply it to other cities, making them to be more sustainable.

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NOTES

[1]As at September 1997, US$1 = RMB 8.27, HK$1 = RMB1.07, and US$1 = HK$7.8.