



## Comparing urban land expansion and its driving factors in Shenzhen and Dongguan, China



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### A B S T R A C T

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China has been the engine of global urban population growth, with nearly one-third of the global urban population growth realized in China in 2000–2010. This rapid process of urbanization will continue in the coming decades based on media reports, thus raising concerns about urban land expansion and sustainable urban development in China. Using satellite images and government statistics as data sources, this study compared urban land expansion in Shenzhen and Dongguan, two adjacent and sometimes competing cities in the economically most dynamic region of China. Our data show that the two cities were similar in urban land expansion rate and intensity in 1990–2008 but Shenzhen had higher population growth and urban population density than Dongguan during the period, suggesting that Shenzhen had achieved a higher level of sustainable urban development than Dongguan. To explain this difference, we analyzed the driving factors and found that (1) Shenzhen was more successful than Dongguan in transforming its industrial structure to develop more capital- and technology-intensive industries; (2) Shenzhen had much higher total GDP and per capita GDP than Dongguan; (3) Shenzhen had benefited from a number of government policies targeted at the city's economic development; and (4) in addition to geographically adjacent to Hong Kong, Shenzhen had better transportation facilities than Dongguan, including an international airport and three container ports. Through these favorable driving factors, more people had moved into Shenzhen and, in the process, helped transform the city to become more sustainable in its urban development. The findings of this study can help us better understand urbanization in China.

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### Introduction

In a recent study of global urban land expansion of 67 countries from 1970 to 2000, China was ranked with the highest rates, from 13.3% for the coastal areas to 3.9% for the western regions annually (Seto, Fragkias, Güneralp, & Reilly, 2011). Statistics on China's percentage of urban population (urban proportion) were equally striking. It was estimated to be at 15% in 1981 at the start of economic reform (Chan & Xu, 1985), to 30% in 1995 (Zhang, 2000), to 49% in 2010 (<http://data.worldbank.org/>). China is the engine of not only global economic growth but also global urban population growth. Although China accounts for less than 20% of the global urban population at present, close to one-third of the global urban

population growth between 2000 and 2010 was realized in China (<http://data.worldbank.org/>).

Urbanization has been linked to a variety of resource and environmental problems worldwide such as habitat loss, species extinction, land-cover change, and alteration of hydrological systems (Seto et al., 2011). In China, there are at least two other concerns. First, because large amounts of agricultural lands have been converted to urban land use, food security can become an important issue in the future (Angel, Parent, Civco, Blei, & Potere, 2011; Wang & Fang, 2011). Second, given rapid urbanization and limited land resources, how to accommodate so many urban residents has become an urgent issue in sustainable urban development (Chen, Jia, & Lau, 2008; Yeh & Li, 2000; Zhao, Song, Tang, Shi, & Shao, 2011).

Many previous studies on urban land expansion have focused on its spatial patterns in cities such as Guangzhou (Ma & Xu, 2010; Sun, Wu, Lv, Yao, & Wei, 2013), Chengdu (Schneider, Seto, & Webster, 2005), Shijiazhuang (Xiao et al., 2006), and Hangzhou (Yue, Liu, &

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Fan, 2013) and in regions such as the Pearl River Delta (Seto & Fragkias, 2005; Seto, Fragkias, & Schneider, 2007; Yeh & Li, 1999). These studies used satellite images to derive land cover data and employed landscape metrics (McGarigal, Cushman, Neel, & Ene, 2002) to analyze the patterns of urban land expansion. An example is Sun, Wu, et al. (2013), which followed the categorization of infill, edge expansion, and outlying growth proposed by Hoffhine Wilson, Hurd, Civco, Prisløe, and Arnold (2003) and reported that the spatial pattern of urban land expansion in Guangzhou went through the dominance of outlying growth, edge expansion, and edge expansion and infill in 1979–2008. Seto et al. (2007) and Schneider and Woodcock (2008), on the other hand, referred to the two-step processes of diffusion and coalescence in their studies of urban land expansion in Chengdu and cities in the Pearl River Delta. Although the terminology is different, the two schemes of urban land expansion are similar: outlying growth or diffusion in the earlier stages, and infilling/edge expansion or coalescence in the later stages.

A large number of studies have also analyzed the driving factors for urban land expansion in different cities and regions of China. As a summary, these driving factors include industrial structure (Li, Zheng, & Wang, 2004; Xiao et al., 2006; Yang, Li, & Mei, 2004; Yeh & Li, 1999), population (Ma & Xu, 2010; Xiao et al., 2006), GDP (Ma & Xu, 2010; Seto et al., 2011), transportation (Ma & Xu, 2010; Xiao et al., 2006; Yeh & Li, 1999), and policy (Deng & Huang, 2004; Xiao et al., 2006; Yeh & Li, 1999; Yue et al., 2013; Zhang, 2000). In comparison, relatively fewer studies have addressed the issue of sustainable urban development. Following the concept of the compact city (Burton, 2002), Chen et al. (2008) analyzed the costs and benefits of cities' compaction (i.e., urban population density) in Chinese context from environmental perspective in 45 core cities in China and reported that population densities of these cities, except for Shanghai and Wuhan, were less than the critical density level that might maximize the aggregated environmental quality of the city. Using a compactness index for an analysis of 35 major cities, Zhao et al. (2011) proposed that acceleration in the compactness of China's cities was needed in the future to ensure an economical and sustainable way of urban land use.

This study analyzes urban land expansion and its driving factors in Shenzhen and Dongguan, two adjacent and sometimes competing cities in the Pearl River Delta. Originally a small fishing village bordering Hong Kong, Shenzhen initiated its industrial development and urbanization after it was declared a special economic zone in 1980. Now Shenzhen has the highest per capita GDP in China (excluding Hong Kong) and the status of a "global city" alongside Beijing, Hong Kong, Shanghai, and Guangzhou (Chubarov & Brooker, 2013). Like Shenzhen, Dongguan was an agricultural county before Hong Kong firms brought labor-intensive, export-oriented manufacturing activities to the area in the 1980s (Yang, 2007). Unlike Shenzhen, however, Dongguan is still largely known as a "global factory" as export-oriented manufacturing continues to be the main economic activity in Dongguan (Zhou, Sun, Wei, & Lin, 2011).

This study does not attempt to explain why Shenzhen is a global city, which is selected primarily using the criteria of economic growth and global trade (Chubarov & Brooker, 2013), while Dongguan is not. Instead, we feel that a comparative analysis of these two cities can provide useful information not only on urban land expansion but also on sustainable urban development in the economically most dynamic region of China. In the following, this study first traces urban land expansion and population growth in these two cities from 1990 to 2008 and describes the differences between them. Indices are developed to check on sustainable urban development of the two cities. Then it explores how the driving

factors, selected from the literature review and our knowledge of the study area, have impacted the urbanization process of the two cities. Unlike other previous studies, this study does not employ landscape metrics to quantify the spatial patterns of urban land expansion. Instead, we assume that the two-step process of diffusion and coalescence, which have been observed in a number of Chinese cities, can also apply to Shenzhen and Dongguan. As urbanization continues at a fast pace in China, the findings from this comparative study can help us better understand urbanization and sustainable urban development in other cities.

## Study area

### Shenzhen

Bordering Hong Kong to the south, Shenzhen is a sub-provincial city, a city governed by a province (i.e., Guangdong) but administered independently in regard to economy and law. The city has four core districts, two suburb districts, and four new administrative districts outside the city core; this study included all of them as Shenzhen for data analysis. Shenzhen has a total area of 1992 km<sup>2</sup> on hilly terrain. Many hills in Shenzhen have been leveled, however, for urban development in recent years, and land reclamation has also added new built areas along the coast of the Shenzhen Bay (Hu & Jiao, 2010). Shenzhen has an international airport, three container ports, and an extensive highway network (Fig. 1).

In 1980, China's first special economic zone was declared for a section of Shenzhen, with special tax and import–export regulations to entice foreign investment. (The Zone status has been extended to cover the entire city since July 2010). Benefited from its location next to Hong Kong and liberalized market, Shenzhen grew rapidly as a low-cost manufacturing center for exports (Zacharias & Tang, 2010). Over the past three decades, the industries in Shenzhen have shifted to computer software, information communication industry (ICT), microelectronics and components, electromechanical integration, and biotechnology. Shenzhen is an ICT hub, home to many electronic and high-tech companies, both Chinese (e.g., Huawei, TCL) and foreign-owned (e.g., Foxconn) (Zhou et al., 2011). It is also recognized as a biotechnology center, with the first firm in the world to obtain a drug license for a recombinant gene therapy (Zhang, Cooke, & Wu, 2011). The Shenzhen Stock Exchange, which is one of the three stock exchanges in China (the other two are Shanghai and Hong Kong), has further enhanced Shenzhen as a major financial center in southern China. With its modern port facilities, Shenzhen is also a major transshipment hub and logistics command center. Because of its growing position as a global trade hub, Chubarov and Brooker (2013) selected Shenzhen to be one of five global cities in China, along with Beijing, Hong Kong, Shanghai, and Guangzhou. In 2011, Shenzhen had a total population of 10.46 million.

### Dongguan

Located between Guangzhou and Shenzhen, Dongguan is a prefecture-level city with 32 districts (Fig. 1). It has a total area of 2460 km<sup>2</sup>, and the topography tilts from hills in the southeast to alluvial plains in the northwest. Unlike Shenzhen, Dongguan does not have an international airport or seaport. It had better transportation connection to Guangzhou and other inland cities than Shenzhen until the 1980s, but now it is over 80 km from either Guangzhou Airport or Shenzhen Airport.

Dongguan was a traditional agricultural county before China's open door policy. In the 1980s, Hong Kong firms brought labor-intensive, export-oriented manufacturing activities such as toys,

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