

Shenzhen, China

Rail + Property for Transit-Oriented Development

Jiawen Yang and Jiangping Zhou



WORLD BANK GROUP

Editors

Shagun Mehrotra, Lincoln Lewis,
Mariana Orloff, and Beth Olberding

SHENZHEN

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Cover design: Oliver Uberti
Typesetting: Puntoaparte

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Citation—Yang, Jiawen, and Jiangping Zhou. 2020. “Metropolitan Shenzhen: Rail + Property for Transit-Oriented Development.” In Volume II of *Greater Than Parts: A Metropolitan Opportunity*, edited by Shagun Mehrotra, Lincoln L. Lewis, Mariana Orloff, and Beth Olberding. Washington, DC: The World Bank.

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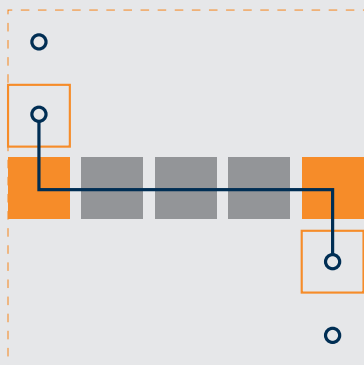
Editors

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CASE STUDY 9: METROPOLITAN SHENZHEN

Rail + Property for Transit- Oriented Development

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The Synthesis Report offers a range of integrated solutions (Mehrotra 2020).

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ACKNOWLEDGMENTS

THIS WORLD BANK REPORT was produced by a team led by Shagun Mehrotra and comprised of Anna-Maria Eftimiadis, Lincoln Lewis, Bruno Bonansea, María Pomes-Jimenez, and Miguel Ruiz at the World Bank, and Mariana Orloff, Robin King, and Beth Olberding at the World Resources Institute (WRI). Excellent research assistance was provided by Hamza Atumah, Maya James, Julian Lark, and Avnish Dayal Singh.

Overall strategic guidance was received from World Bank's Sameh Wahba (Global Director, Global Practice for Urban, Disaster Risk Management, Resilience, and Land), Ede Ijjasz-Vasquez (Regional Director Sub-Saharan Africa, Sustainable Development), Maitreyi Das (Practice Manager, Urban Global Programs), Peter Ellis (Global Lead, Sustainable City Infrastructure and Services), Xueman Wang (Senior Urban Specialist and Program Coordinator of the Global Platform for Sustainable Cities, GPSC), and WRI's Ani Dasgupta (Global Director, Ross Center for Sustainable Cities).

The team is deeply grateful to the reviewers for the insightful comments and deliberative discussions beyond the formal review process. Peer reviewers included Alope Barnwal (Global Environment Facility, GEF), Rafeef Abdelrazek, Chyi-Yun Huang, Annie Gapihan, Qingyun Shen, Yuan Xiao, Anjali Mahendra (WRI), and Jessica Seddon (WRI). The team also deeply appreciates the thoughtful advice of Professor Peter Newman at the report's framing stage.

In addition to the core report team, case study contributors were: Myriam Ababsa, Hazem Abdelfattah, Antar AbouKorin, Ahmad Z. Abu Hussein, Abudlrahman Alsayel, Laura Azeredo, Madhu Bharti, Amartya Deb, Jaya Dhindaw, Amy Faust, Natalia Garcia, Wiwandari Handayani, MaryGrace Lugakingira, Jorge Macias, Felipe Montoya, Luiza Oliveira, Bintang Septiarani, Rukuh Setiadi, Jiawen Yang, and Jiangping Zhou. Specific authorship acknowledgements are mentioned within each case and the authors thank those who were interviewed for the cases.

Valuable technical contributions and comments were provided by Karina Acevedo (Annex B), Brenan Gabriel Andre, Spandana Battula, Mary Donovan, Lina Duque, Peter Griffiths (Annex C), Robert Mansour Harrison, Dany Jones, Ryan Kemna, Jeffery Dean Lawrence, Christiana Nikola Reichsthaler, Apoorva Narayan Shenvi, Adeel Abbas Syed, Vickie Taylor, Oliver Uberti, and Matthew Woundy (Annex D).

The report benefited from discussions, thoughtful insights and suggestions from several colleagues who have specific expertise and locational experience,

including Lina Abdullah, Mohamed Bakarr (GEF), Venessa Alexandra Velasco Bernal, Ashok Das (University of Hawaii), Narae Choi, Eric Dickson, Somik Lall, Kevin Milroy, Vincent Roquet, Katia Herrera-Sosa, Steffen Soulejman Janus, Jad Raji Mazahreh, Alex Ortiz, Gayatri Singh, Horacio Christian Terraza, and Mariko Yamamoto.

Data contributions were graciously provided by: Thomas Esch, Daniela Palacios Lopez, and Mattia Marconcini (German Aerospace Center, DLR); Pir Mohammad and Ajanta Goswami (Indian Institute of Technology, Roorke); and Antar AbouKorin and Abdulrahman Alsayel.

Excellent administrative and production support was generously provided by Elizabeth Acul, Adelaide Barra, Lucie Albert-Drucker, and Cinthia Donantchat. The writing process greatly benefited from Marc DeFrancis' manuscript editing. Jacqui Lewis and Mary Paden copyedited the report. Typesetting was performed by Puntoaparte's Mateo Zúñiga, Andres Barragán, Sarah Peña, María Rojas, and Carmen Villegas.

The contributors graciously acknowledge GEF's Sustainable Cities Integrated Approach Pilot program which supported the production of the report. This program is a broader partnership between GEF, World Bank's GPSC, participating countries and cities, project-implementing agencies, and Resource Team organizations (comprising WRI, C4O, and ICLEI Local Governments for Sustainability). WRI contributed to the report and case studies through the grant "Urban Networking to Complement and Extend the Reach of the Sustainable Cities Integrated Approach Pilot" which is managed by the World Bank's Anna-Maria Eftimiadis. The case study of Dammam was supported by the Kingdom of Saudi Arabia through the Reimbursable Advisory Services project managed by World Bank's Hazem Abdelfattah.

The editors and authors thank the wider World Bank and WRI teams, and others not specifically mentioned here, who contributed to the concerted efforts to publish the report and its extensive case studies. ■■■



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Rail + property for transit-oriented development

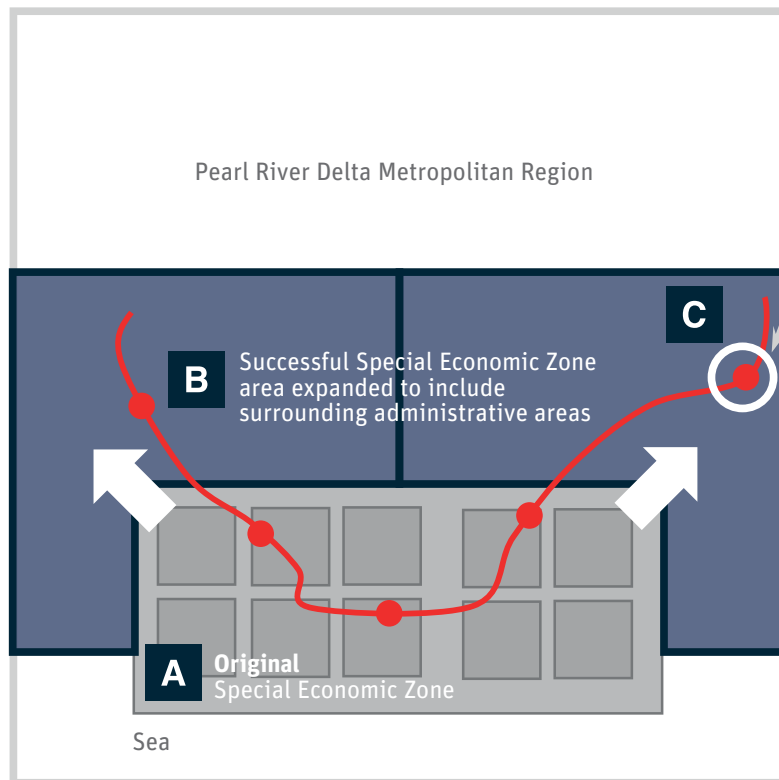


Figure 1
Integrated
planning model

Source: Mehrotra 2020.

Learning from Hong Kong SAR China's low-fare yet profitable metro model, Shenzhen has scaled up *Rail plus Property* development as a means to finance an extensive rail network.

KEY FINDINGS

1 The expansion of the special economic zone (SEZ) to cover Shenzhen's whole territory coupled with provincial legislative power consolidated its efforts in integrated planning for the whole metropolitan city. Shenzhen pioneered the integration of transport and land development planning, providing a blueprint for other Chinese cities to move from cash to land contributions to fund metro projects. However, its ability to learn from neighboring Hong Kong SAR, China was also a significant asset.

2 As public land ownership enables local governments to capture land value uplift, integrating transport and land is strategic to city finances, but also creates tension between protecting agricultural land and local economic development. Transit-orientated development (TOD) and rail plus property (R+P) planning developed in Shenzhen offers urban mobility and associated financing solutions. However, China's current institutions favor state-owned-enterprises, particularly those owned by city governments.

3 The integration of transit investment, land development, and finance has not only enhanced city government's ability to deliver metro projects but also enabled better outcomes for urban transport, land preservation, and emissions reduction.

IDEA IN BRIEF

Cities can integrate in phases, utilizing a combination of national strategic economic development programs, such as the expansion of special economic zones or industrial parks, and metropolitan infrastructure initiatives like mass transit.

Shenzhen scaled up its successful Special Economic Zone's integrated planning by incorporating adjoining urban areas into one metropolitan region. The city is stitching together fragmented super-sized urban blocks with an extensive metro rail network financed by a rail-plus-property (R+P) model that integrates transport, real estate, and land development.

The city collaborates with its metro rail authority to jointly profit from increases in property value along new rail lines. Metro rail auctions real estate development rights to private developers around train stations to maximize revenue. High-intensity development around the metro has the added benefit of cutting down the use of carbon-intensive cars and reducing sprawl.

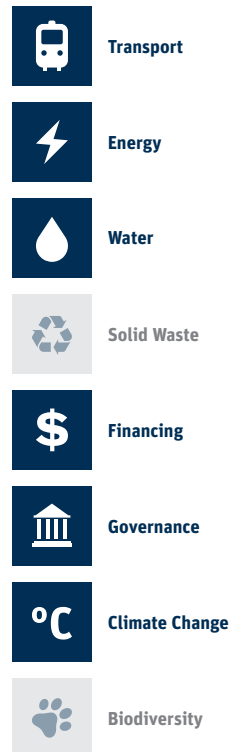


Figure 2
Sectors addressed
by the case

The Metropolitan Context

THE MEGACITY OF SHENZHEN is one of four first-tier cities in China, especially known for its innovation and tech industries. Shenzhen is viewed as China's model city for showcasing the country's policy of reform and opening-up. Its growth and relationships with neighboring jurisdictions over the past four decades shows a history of regional cooperation.

Shenzhen is located in the Greater Bay Area, also known as the Greater Pearl River Delta, which surrounds the Pearl River estuary where the river flows into the South China Sea. The Greater Bay Area is a megalopolis that includes China's Hong Kong Special Administrative Region (SAR), the Macao SAR, and nine delta cities: Dongguan, Foshan, Guangzhou, Huizhou, Jiangmen, Shenzhen, Zhaoqing, Zhongshan, and Zhuhai. This area has witnessed unprecedented growth during the past few decades, transforming from mostly agricultural land into a global economic center.

DESIGNATIONS OF THE SHENZHEN REGION

In the 1970s, Shenzhen was the county seat of the then-rural Bao'an County, with a land area of 1,997 square kilometers. In 1979, Bao'an County was renamed Shenzhen City, and in 1980 its interior portion (328 square kilometers) was classified as a special economic zone (SEZ) when it was still a small town focused on farming and fishing. One reason Shenzhen was designated an SEZ was its proximity to Hong Kong SAR, China, a former colony of Great Britain. In the early 1980s, many manufacturing activities moved from Hong Kong to the Shenzhen SEZ and other parts of the delta, attracted by cheaper land, labor, and operating costs, accelerating regional cooperation within the Greater Bay Area (Hong Kong SAR 2017).

Hong Kong, SAR China and the government of Guangdong Province have explored opportunities to facilitate Greater Bay Area cooperation to enable even more growth (Hong Kong SAR 2017). In the north, west, and east, Shenzhen shares boundaries with Dongguan and Huizhou, two prefecture-level cities in Guangdong Province that have increasingly enjoyed the spillover effects of Shenzhen's fast development.

China does not have an official definition for "metropolitan area." The geographic scope of Metropolitan Shenzhen today can be delineated in two ways: first, based on its concentrated metropolitan population, or second, based on the regional interconnections among local governments. Following the first approach, the City of Shenzhen itself can be viewed as a metropolitan area, boasting a jurisdiction of 1,997 square kilometers and a total population of more

than 13 million. Its four inner urban districts— Futian, Luohu, Nanshan, and Yantian—form the central part of this area and the entire area is known as the Shenzhen Metropolitan Area (SMA).

Under the second approach, the region consisting of Shenzhen, Dongguan, and Huizhou has been named the Shenzhen-Dongguan-Huizhou Metropolitan Area. In this area, Shenzhen is the “primate” city. This term was coined to encourage intergovernmental collaboration and was not based on commuting flow patterns; in fact, few workers from Dongguan and Huizhou commute to Shenzhen’s inner-city area.

This case study focuses on the Shenzhen Metropolitan Area as defined in the first approach.

POPULATION DENSITY AND GDP

Table 1 presents the population, density, and GDP statistics of the SEZ, SMA, and greater metropolitan area. The SEZ portion of Shenzhen, which was set up in 1980 comprising the four central districts, is the most developed area in the SMA. Covering 328 square kilometers, it has a very high population density of nearly 12,000 persons per square kilometer (1.84 times the average density of the SMA) and a high GDP per capita (1.44 times higher than in the SMA). The large Shenzhen-Dongguan-Huizhou Metropolitan Area covers more than 16,000 square kilometers. Compared with the SMA and SEZ areas, it has a lower population density and GDP per capita.

TABLE 1. SHENZHEN POPULATION DATA

SCOPE	POPULATION (THOUSANDS)	AREA (KM ²)	DENSITY (PERSONS/KM ²)	GDP (\$ BILLIONS) ^a	GDP PER CAPITA (\$ THOUSANDS)
Shenzhen Special Economic Zone (SEZ)	4,410	328	11,984	166	37.8
Shenzhen Metropolitan Area (SMA, 10 districts)	13,026	1,997	6,523	339	26.0
Shenzhen- Dongguan-Huizhou Metropolitan Area	26,284	16,061	1,636	512	19.5

^a Here and throughout this chapter, all dollar amounts refer to US dollars.

Source: SSB 2018; GSB 2018.

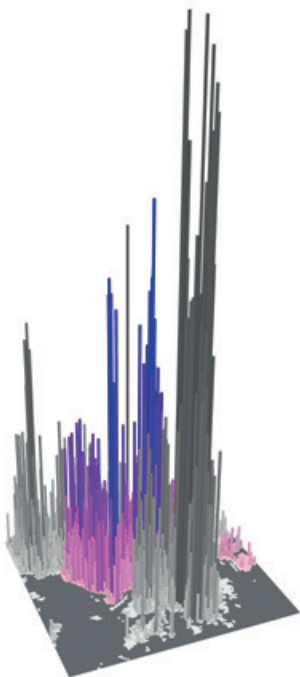


Figure 3
3D population
density diagram

Population density is uneven in the SMA (see Maps 1 and 2). Futian and Luohu districts, two of the four inner districts of Shenzhen, are the densest and the most developed. The central part of Nanshan district is also highly developed with many high-tech firms and related services. In recent years, the northern part of Shenzhen's central axis (i.e., the Longhua district) and the western part of Longgang district) experienced significant population growth, partly because of the introduction of metro services that link them with the central part of the SMA.

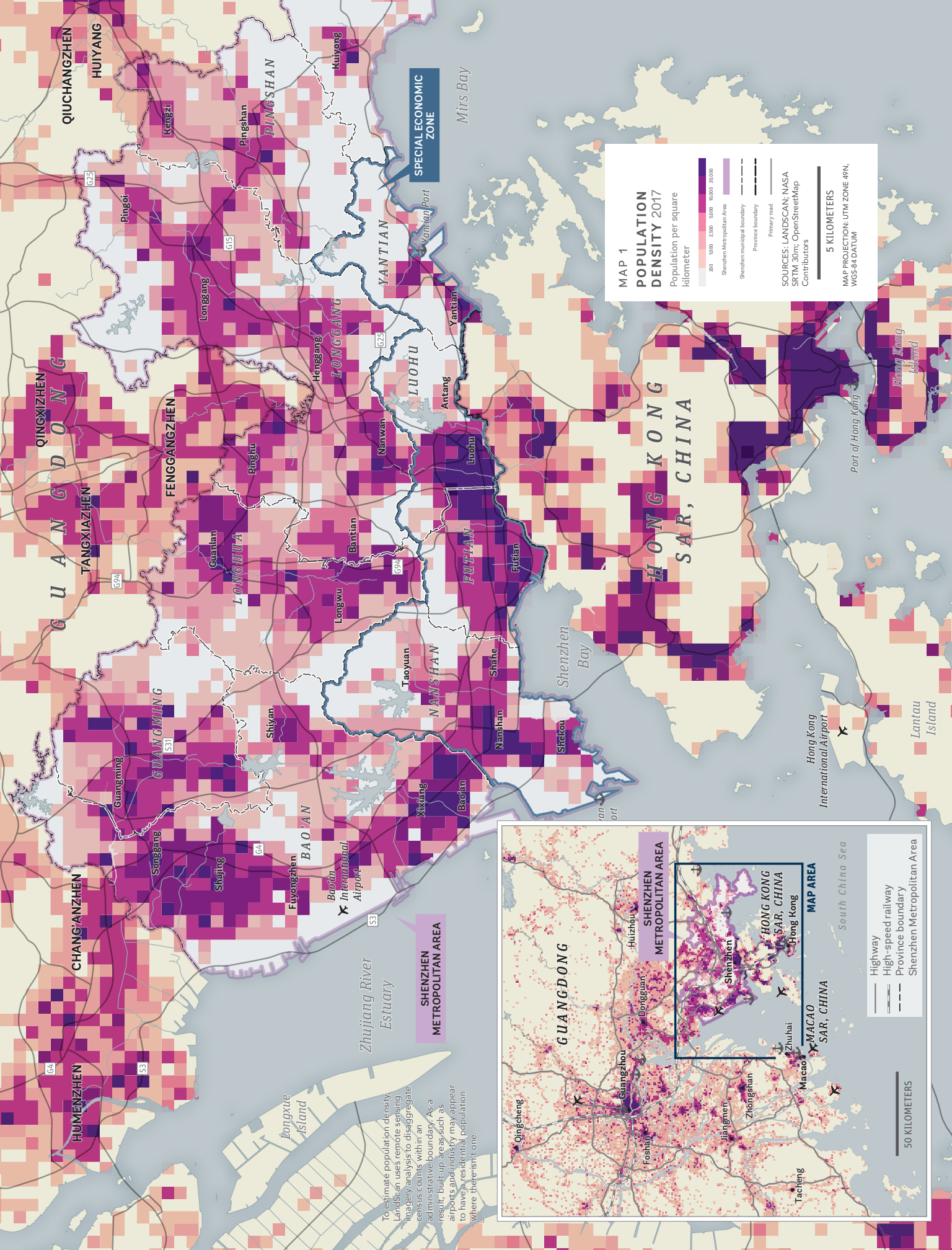
The urban expansion of Shenzhen follows a “ribbon development” pattern. Major regional transport corridors were instrumental in urban expansion. By the 1990s, the central city was highly developed and by 2020, most areas in the eight districts, excluding Dapeng and Yantian, were densely populated.

The administrative jurisdictions of city service providers follow the municipal boundaries of Shenzhen City. Within the city, the subdivision of service supply may or may not follow the district boundary, as illustrated by the example of water supply service (see Map 3). The 10 districts in Shenzhen are served by five subdivisions of water supply: western coast, central, mideast, east, and eastern coast (SPNRB 2017).

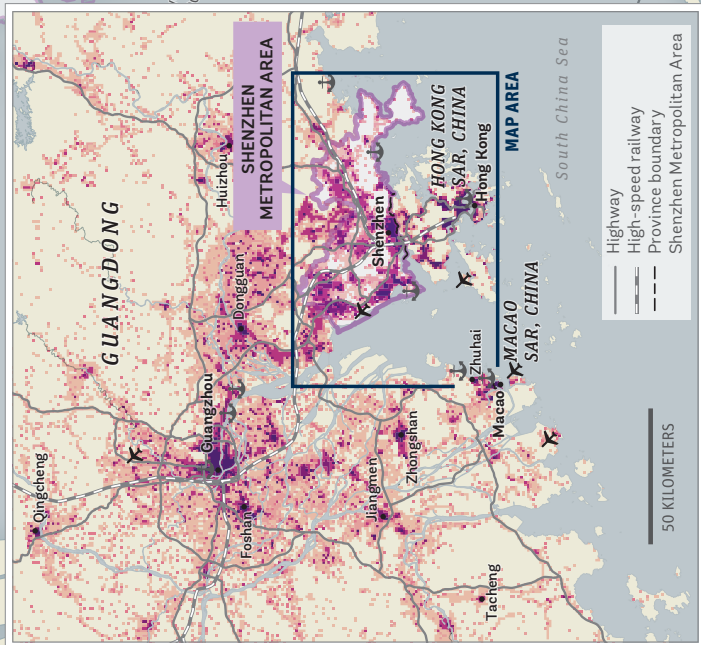
After 40 years of development, the SMA has a relatively complete transport network. Intercity highways and intracity expressways link some built-up areas. The SMA has eight metro lines with 167 stations and a total length of 285 kilometers. Most of these stations are concentrated in the central districts: Luohu, Futian, and Nanshan (see Map 4).

SPECIAL ECONOMIC ZONE STATUS

The most significant factor accounting for Shenzhen's tremendous progress stems from its role as one of China's special economic zones, a status that grants Shenzhen preferential treatment (Box 1). This privilege was initially limited to the inner area of Shenzhen and then expanded to the whole municipal territory. Similar government consolidation has happened in many other Chinese cities, with similar planning integration processes. ■■■



To estimate population density, Landsat uses remote sensing imagery analysis to disaggregate census counts within an administrative boundary. As a result, built-up areas such as airports and industry may appear to have a residential population where there isn't one.



Shenzhen is one of China's first and largest SEZs, established in 1980. It remains the pacesetter of its economic liberalization policy.

BOX 1. URBAN INNOVATIONS

Establishment of the Special Economic Zone

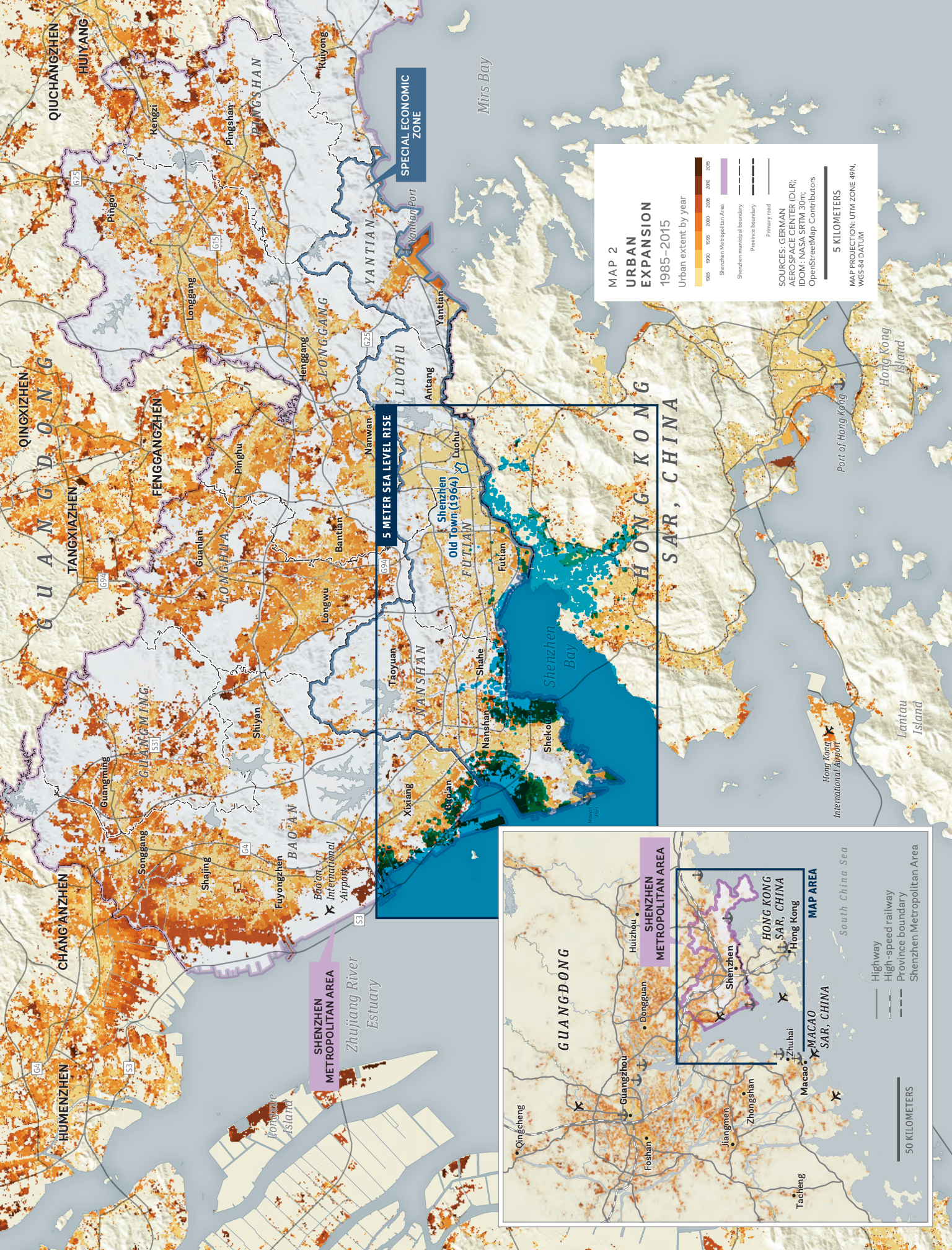
In the four decades since 1978, China's Reform and Opening-up Policy has sparked rapid economic growth across China. The four special economic zones (SEZs), of which Shenzhen is the largest, are considered to be the pacesetters of this policy. Special preferential policies and flexible institutions to promote export-oriented economic development are first piloted in SEZs. Because of its proximity to Hong Kong SAR, China, Shenzhen was selected as one of the first SEZs in 1980 and so far, Shenzhen is China's most successful SEZ.

Local legislative power

The SEZ of Shenzhen was granted provincial legislative power by the National People's Congress in 1992. Usually, such power is given only to a provincial government. With this power, the SEZ can formulate local regulations according to actual situations and development needs, as long as the regulations do not conflict with national laws. Local legislative power provides Shenzhen with great institutional flexibility. According to a recent statement by the Director of the Standing Committee of Shenzhen People's Congress, Shenzhen has enacted more than 400 regulations or regulation-related decisions since 1992, of which 167 are still in effect. These regulations have made great contributions to Shenzhen's prosperity and stability.

Elimination of the former SEZ boundaries

When it was first established in 1980, the Shenzhen SEZ covered the four central districts of Shenzhen, namely Futian, Luohu, Nanshan, and Yantian, all adjacent to Hong Kong SAR, China. Over the years, this SEZ prospered, significantly outperforming other areas in Shenzhen. This economic gap in the area was considered a major challenge for many years. In 2010, the SEZ was extended to all of Shenzhen, which enabled the city government to expand SEZ policies to non-SEZ areas and enhance its planning and development control. Currently, the whole territory of Shenzhen is unified under the same set of development plans. Similar government consolidation has happened in many other Chinese cities, with similar planning integration processes (Yang and Li 2014).



MAP 2
URBAN EXPANSION
1985-2015

Urban extent by year

- 1985 1990 1995 2000 2005 2010 2015

Shenzhen Metropolitan Area

Shenzhen municipal boundary

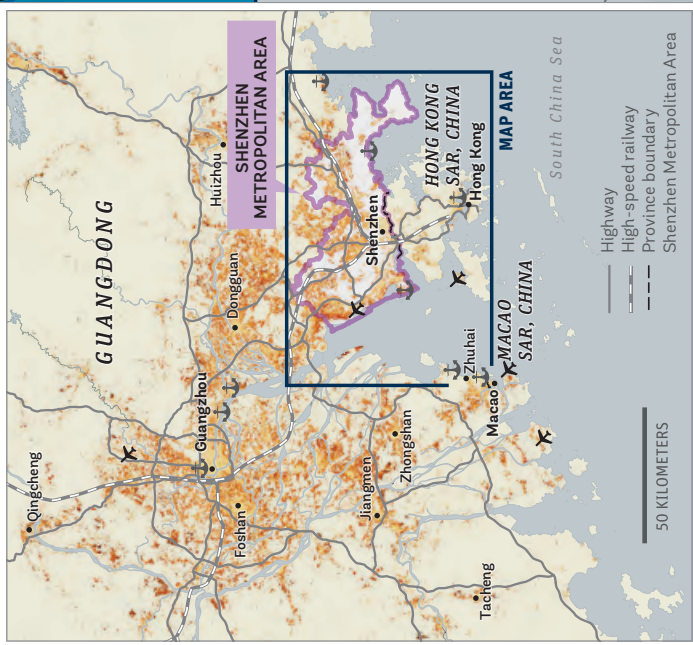
Province boundary

Primary road

SOURCES: GERMAN AEROSPACE CENTER (DLR); IDOM; NASA SRTM 30m; OpenStreetMap Contributors

5 KILOMETERS

MAP PROJECTION: UTM ZONE 48N, WGS-84 DATUM



Integration

HOW INTEGRATED PLANNING IS DEFINED AND ADOPTED

WITH ITS HISTORY as a planned economy, China has considerable experience in integrated planning, though it has not always been called “integrated planning.” The closest term for such an integration mechanism in China may be “comprehensive or unified planning.”¹ The former term points to the practice of including into a comprehensive plan as many relevant sectors as possible. The city masterplan is a typical example. The latter term denotes a practice that keeps relevant plans separate but emphasizes their consistency. This practice was promoted to solve inconsistencies between land use plans and city masterplans, which eventually led to the unified spatial planning practice of today.

Although it describes integrated planning practice in general, this case study focuses on the integration of transport and land, which China has recognized as significant for economic development. Since China opened its economy, its local governments have striven to impress higher-level government leaders with their economic development. To do that, they have primarily relied on land lease revenue to finance infrastructure and local economic development. In addition, they have often used transportation and other infrastructure investments to trigger higher land lease values.

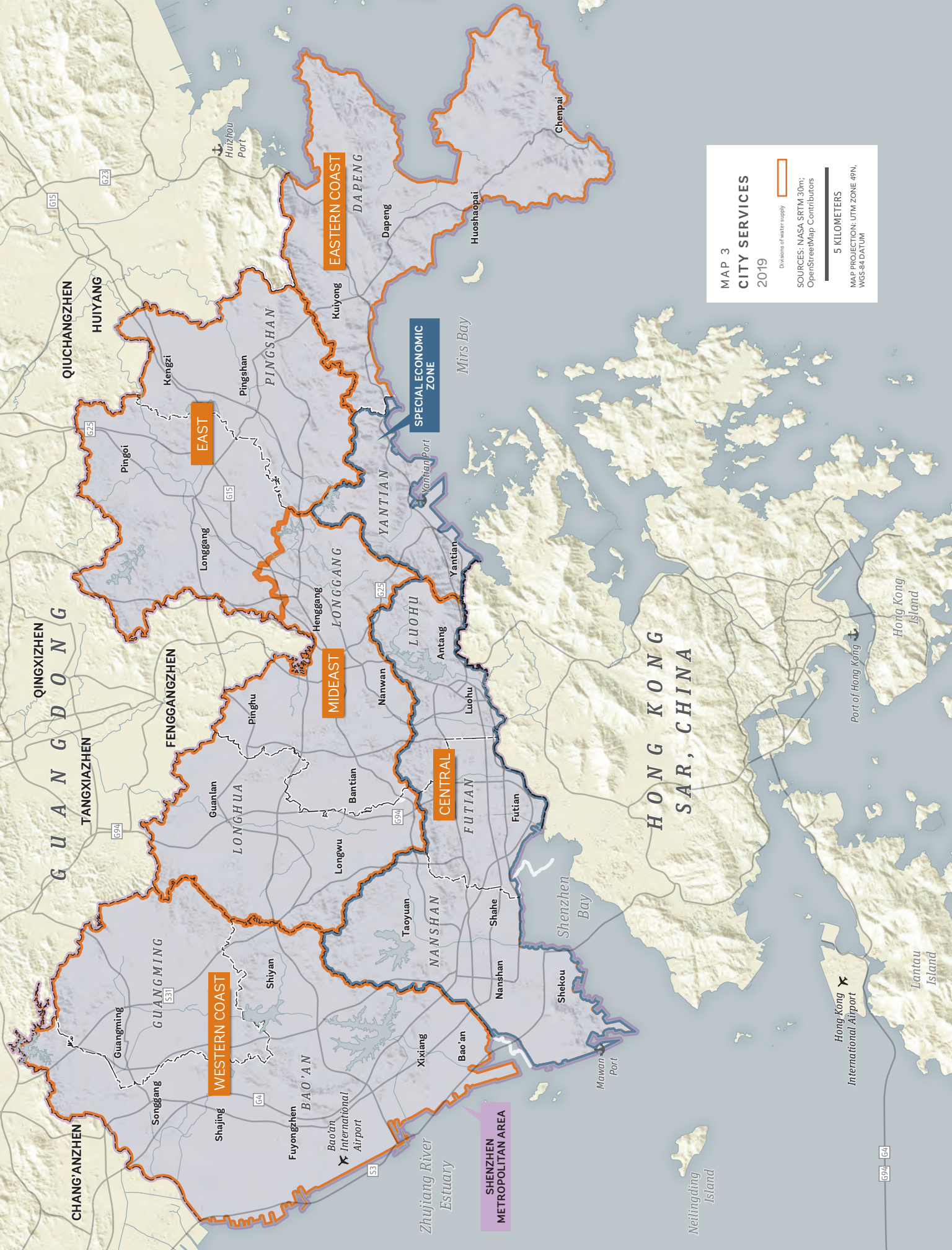
Public land ownership in China enables local governments to garner the appreciated land value stemming from infrastructure investment to capture at least the short-term benefits of the transportation investment. A plan that carefully integrates infrastructure investment and land development therefore helps the local government garner more resources for local economic development (Wu 2015).

In Shenzhen, constraints in land supply together with rising automobile ownership and traffic congestion led to a transit-centered development strategy, which emphasized transit investment and high-density development. As a result, integrated planning efforts have focused on managing land development, metro investment, and the integration of the two along metro lines and around stations.

THE CITY’S PLANNING FRAMEWORK

The baseline for urban development planning in Shenzhen is characterized by three separate but relevant plans: the Shenzhen Economic and Social Development Plans (ESDP), the Shenzhen Land Use Plan, and the Shenzhen City Master Plan.

¹ Comprehensive planning is referred to as *zhonghe guihua* in Chinese and unified planning as *duogui heyi*.



MAP 3
CITY SERVICES
2019

Divisions of water supply

5 KILOMETERS

SOURCES: NASA SRTM 30m;
OpenStreetMap Contributors

MAP PROJECTION: UTM ZONE 49N,
WGS 84 DATUM

The overall urban planning system in Shenzhen can be described as “three levels and five stages”.

ESDPs are plans that set goals for national or local economic and social development in the long term (20 years), medium term (10 years), and short term (5 years), to guide land use plans and masterplans. They are compiled by the Municipal Development and Reform Bureau or Commission and approved by the local People’s Congress, after consulting with officials and representatives from different functional areas at both the municipal and provincial governments.

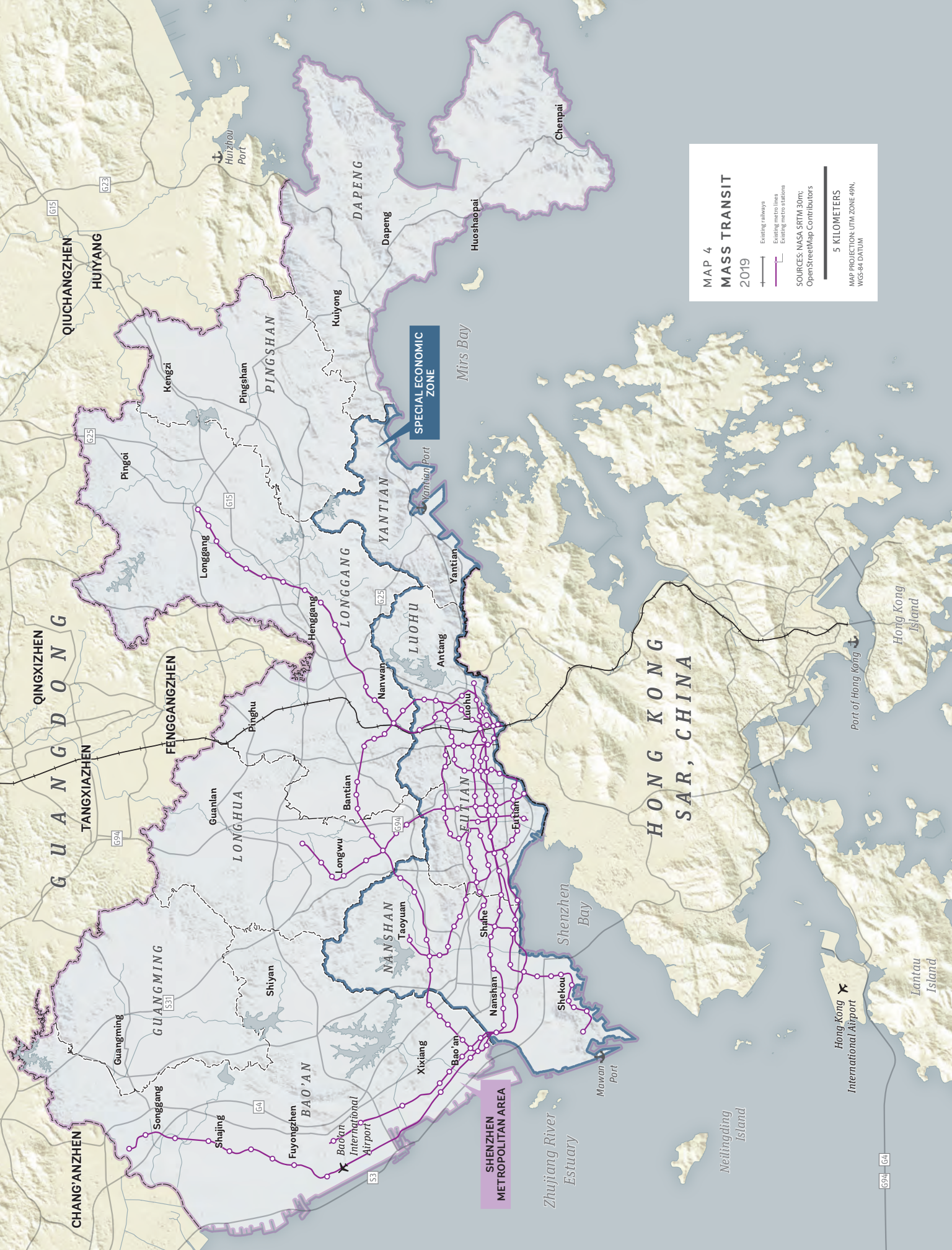
Municipal land use plans are overall plans for land use that meet the requirements in a wide array of areas: the national economic and social development goals (set in various ESDPs), national and provincial land consolidation plans, local resource conservation and environmental protection rules, land supply quotas (set by the central government), and various construction projects within the local jurisdiction. Usually, a municipal land and resource agency oversees the local land use plan. Sometimes, a joint agency—combining the land, resource, and planning agencies—will produce both a land use plan and a masterplan for a city. In the SMA, for instance, the Shenzhen Bureau of Planning and Natural Resources is responsible for both land use plans and city masterplans.

Most details regarding masterplans, such as their content, processes, and responsible agencies, are defined in the Urban and Rural Planning Law of China. At the municipal level, the Bureau of Urban Planning is responsible for leading the effort to draft masterplans. However, the functional-area plans (also called sector-based plans) are often the responsibility of other specialized bureaus. The road and public transport plans, for instance, are the responsibility of the local transport bureau. This can be considered as a horizontal division of labor among different bureaus.

The Shenzhen Master Plan is comprehensive, and it covers much of the content of the Shenzhen ESDP, the Shenzhen Land Use Plan, and even conventional public policies at the municipal level. Its content and format are specified in two documents:

- *Regulations on Urban Planning of Shenzhen*, which specifies various plan components and related outputs in Shenzhen; and
- *Shenzhen Urban Planning Standards and Guidelines*, which specifies various technical standards for plan making, is based on the *Regulations on Urban and Rural Planning of Guangdong Province*, the *Regulations on Urban Planning of Shenzhen*, and other relevant laws and regulations.

The overall urban planning system in Shenzhen can be described as “three levels and five stages” (see Figure 3). The three levels are the city (metropolitan) level, the subcity (submetropolitan area) level, and the local level. The five stages are the Shenzhen Master Plan at the metropolitan level, the submetropolitan plan, the local/district plan, the Statutory Graphic Standard, and the Shenzhen Layout Plan.



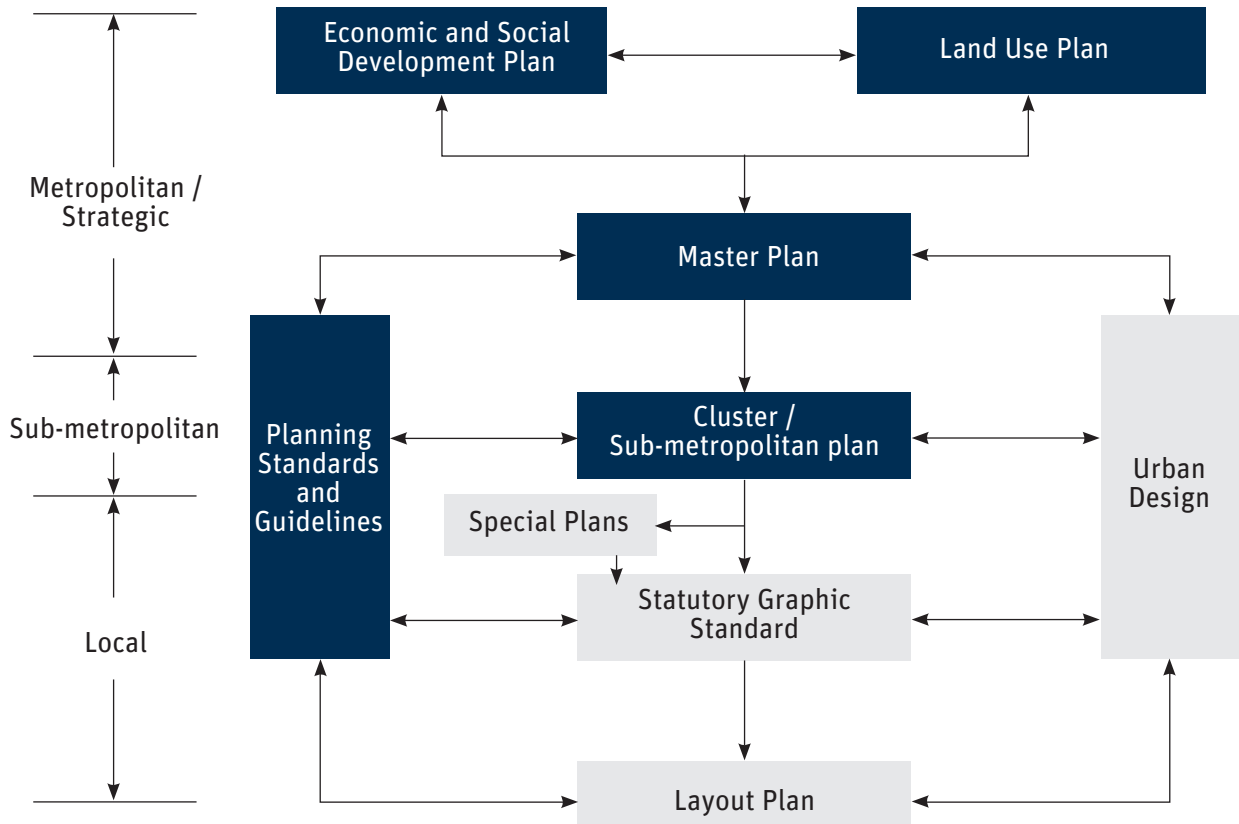
MAP 4
MASS TRANSIT
2019

- Existing railways
- Existing metro lines
- Existing metro stations

SOURCES: NASA SRTM 30m;
OpenStreetMap Contributors

5 KILOMETERS

MAP PROJECTION: UTM ZONE 49N,
WGS-84 DATUM

Figure 4 Three-level and five-stage urban development planning in Shenzhen

Source: Li and Wang 2007, adapted and translated by Jiawen Yang.

To ensure compliance with ESDPs, both land use plans and masterplans also follow the temporal horizons of 20 years for the long-term plans, 10 years for medium-term plans, and 5 years for short-term plans. Both the long-term plans and the medium-term plans set up strategic goals and guidance for the future. Short-term plans outline the interventions to be made and projects to be carried out to ensure that the goals in the long-term plans are met. For cities designated as nationally important, including Shenzhen, the State Council (the central government) requires these masterplans to pass a mandatory review led by the relevant central ministry.

City masterplans—that is, plans designed at the municipal level—are overall arrangements for the development of cities or towns including details on land use layout, comprehensive transport systems, infrastructure such as water, sewage, and electricity, and services such as schools and hospitals. These plans serve as platforms for the horizontal integration of all infrastructure sectors in the urban development process. When they are being drafted, the municipal bureaus of relevant sectors are invited to review them and provide input.

The cluster plans, statutory graphic standards, and layout plans cover the same set of information as masterplans but with smaller geographic coverage,

and they all go through a similar horizontal integration process. If conflicts or necessary improvements are identified, the team will discuss them with the bureau responsible for the respective plans to ensure that planning documents kept by different bureaus are synchronized.

PROCESSES, FINANCING, AND IMPLEMENTATION MECHANISMS

Over the past four decades, these three types of plans—ESDPs, land use plans, and masterplans—have changed significantly in Shenzhen, and so have the corresponding agencies responsible for them. Two separate agencies used to be responsible for land use plans and masterplans, but in recent decades the two were merged into a single entity responsible for both kinds of planning, which makes plan integration more feasible. Of course, the merger of those bureaus does not solve all problems, as full horizontal coordination is hard to achieve.

Vertical coordination is also needed, because the bureaus need to both address the concerns of the local government and also follow the rules and specific requirements of their respective supervisory entities at the provincial and national levels. For example, the amount of developable land for each city is specified in an upper-level plan by the province or national government. This land quota is typically viewed as a constraint by the local government, which oversees economic development and must respond to local demand for more land.

Multiplanning integration for land management

The amount of land available for urban development or redevelopment determines local governments' ability to use land-value-capture mechanisms. As a result, local governments always try their best to expand their base for land development, something that is closely watched by the central government. The battle between the local governments' efforts to maximize the use of land and the central government's efforts to protect basic agricultural land eventually led to the integration of ESDPs, land use plans, and masterplans, not only in Shenzhen but also in all other cities in China in recent years.

Economic and social development plans forecast local development trends, which are then used to estimate the local demand for land. The land use plans then specify the amount of land that can be supplied for future urban use. The planning follows a top-down approach, as the quota for developable land is specified by higher-level governments, that is, the central and provincial governments. The masterplan at the city level must resolve issues between land demand and supply. Usually based on optimistic assumptions about the future, the city specifies where development will happen and, thus usually requests a higher land quota.

Even though it would be logical to expect coherence among the three plans because they are prepared for the same local government, they are usually based on different rationales and can forecast different results. A common conse-

quence of this mismatch is overdevelopment of land at the local level. In China, city population growth tends to be forecast to happen faster than it actually occurs. This has helped local governments increase their land quota, which may not be efficiently utilized (Li and Wang 2007).

BOX 2. TIMELINE FOR SHENZHEN'S INTEGRATED PLANNING EFFORTS

The major events that provided the basis for Shenzhen's integrated planning efforts that led to more effective land development management are described below.

Shenzhen's first masterplan (1986). The sector-based plans covered only the four SEZ urban districts (Zhang 1999; Zou 2013). It assembled components of land use, transport, sewage and electricity, which were planned separately by specialized government bureaus such as the transport bureau and electricity bureau. The coherence of this masterplan was limited as there were few regulations regarding coherence across sectoral bureaus.

Merger of land and planning bureaus a single entity (1989). Shenzhen's Land and Resource Bureau and Planning Bureau were merged in 1989 into a single Planning, Land, and Resource Bureau. This merger aimed to facilitate the integrated planning of land use and city development and had been made possible through the special local legislative power granted by the central government (Wang and Xiang 2009). This was a significant move toward integrated planning, which became more institutionalized than ever when the responsibilities of local masterplanning and land use control were established under a single agency.

Central government approval of expanded development into non-SEZ areas (1991). Shenzhen received the central government's approval to expand its development areas into what were then non-SEZ areas (Zhang 1999). This approval made more land available for Shenzhen's economic development. The Planning, Land, and Resource Bureau was empowered to take a citywide approach with new plans. It began to employ GIS techniques to provide benchmarking for planning in different bureaus. Conflicts between other relevant plans such as the ESDP and land use plan began to emerge (Tan 2015; Wang and Xiang 2009; Zhang 1999; Zou 2013).

Creation of a separate bureau for planning (2004). In 2004, the Planning, Land, and Resource Bureau was divided into two bureaus: Land, Resource, and Housing Management Bureau and the Planning Bureau (Zhou 2013). This move was made in the belief that too much responsibility for the Planning, Land, and Resource Bureau would easily lead to decision-making mistakes (Huang 2012). As a result, land use plans and masterplans became divided

in two separate units again. But shared review processes across the two plans were introduced to ensure consistency. Both land use plans and masterplans are required to be coherent with the ESDP. Land Use Plans at the district level were added to enhance coherence between the land use plan and the masterplan (Tan 2015; Wang and Xiang 2009; Liu and Liu 2011).

Merging of separate bureaus into a single bureau (again) to cover both planning and the management of land, resources, and housing (2009). The Land, Resource, and Housing Management Bureau and the Planning Bureau were merged again, this time into an Urban Planning, Land, and Resource Commission. The new commission took responsibility for making, monitoring and organizing reviews of land use plans and masterplans (Zhou 2013).

Reorganization of Shenzhen's administrative structure to better manage urban development outside the non-SEZ area (2010). Within the then Bao'an and Longgang Districts, Shenzhen created four special urban districts: Dapeng, Guangming, Longhua, and Pingshan (Wang 2013; Zou 2013). The SEZ policy was expanded to cover every corner of Shenzhen. Comprehensive development planning was introduced for the new districts. Efforts for integrated planning increased. The Municipal Development and Reform Commission and the Urban planning, Land, and Resource Commission oversaw sectors and institutions that were included in the integrated masterplan. Sectors and institutions were expected to agree on development sequences, key issues, strategic management, and objectives for future development before detailed plan making. They were also required to share data on the same geographic information system (GIS) platform. Relevant plans were required to have a strategic component and an implementation plan (Wang 2013).

The central government's requirement that city masterplans and land use plans be integrated into a spatial planning framework (2018). Planning authority over the spatial planning (framework) was assigned to the local bureau managing land and natural resources. This requirement applied to all cities in China but had little impact on Shenzhen, where plans largely followed Shenzhen's past practice. Shenzhen will work on integrated spatial plans like all other cities and phase out formerly separated land use plans and masterplans at the city level.

Integrated planning in the transport sector

For a period, transport planning in Shenzhen was siloed and managed by different institutions. Responsibilities for rural, intercity, and water transportation were assigned to the Bureaus of Transport, whereas responsibilities of urban transport were assigned to the Commission of Construction and the

Planning Bureau. Thus, confusion often arose when urban areas expanded: the relevant sectors or bureaus were unsure of their respective responsibilities. Comprehensive urban transport planning that synthesized transport-related plans drafted by separate entities across different levels of government was not required by law in China. Leaving the initiative to local municipalities to decide whether an integrated multimodal transport plan was needed resulted in a lack of integration. (Yang and Fang 2015).

As with multiplanning integration for land management, described earlier, Shenzhen introduced an institutional reform for transport planning and management ahead of the central government's requirements. In 1996, Shenzhen created an urban transport management headquarters to oversee and coordinate urban transport planning, financing, and implementation and to ensure that urban transport development followed the policies, the city's masterplan, and the budget. In 2001, the city created a comprehensive urban transport commission, based on successful experiences, with responsibilities for almost all transport modes and services, including roads, urban transit, waterways, seaports, railways, urban rail, airport, freight logistics, and postal services. Starting in 2005, comprehensive transport planning was conducted every five years to coordinate different transport modes, regardless of which entities were involved (Zhang et al. 2010).

A significant change came in April 2008, when China's central government decided to move the responsibility for urban road transportation planning and management from the Ministry of Housing and Urban–Rural Development to the new Ministry of Transport. Part of the reason for the move was to consolidate the planning and management of different modes of urban transportation such as road transportation, subway, buses, and private motorized transportation. Following this announcement, all city governments were required to create a comprehensive transportation policy-making commission or bureau. Shenzhen had made the required change in 2001, five years in advance.

The connection between transport investment and land development has always been under the scrutiny of the Shenzhen municipal government. In 2006, Shenzhen set up a transport planning framework consistent with that of the masterplans. Like masterplanning, this effort includes planning at five levels: comprehensive transport planning, a cluster transport plan, a special plan for component transport modes such as rail transit, a district transport plan, and a transport layout plan; as well as implementation plans for the short term (three years) and every year (Zhang, Yuan, and Chao 2016; Zhang et al. 2010). All the innovations described here paved the way for an integration of metro investment and land development.

TOOLS AND SECTORS INVOLVED

As a city facing severe land constraints, Shenzhen's development has followed a high-density development pattern. The vitality of the city depends on a well-functioning and extensive metro system. Significant efforts were put into planning for transit-oriented development and for "rail and property" (R+P) development, both of which can foster integration between land development and rail transit at especially around rail stations.

Transit-oriented development

Transit-oriented development is an integrated strategy for compact, mixed-use, and pedestrian-friendly development connected to transit stations. Setting up a transit-oriented development planning mechanism based on master and transport plans is a fundamental step to ensuring that planning contributes to future urban vitality. Shenzhen's transit-oriented development program includes citywide development strategies, submetropolitan and route-level development planning requirements, and design guidance for station-level development. Suitable areas have been identified for metro alignment, station placement, and transit-oriented development, although these locations may or may not follow the density criteria (Zhang et al. 2010; Zhang et al. 2011; Shao et al. 2011; Yang et al. 2016).

With transit-oriented development, land development can be tailored for denser development around rail stations, which provides the opportunity to capture the increasing land value that comes from the infrastructure investment and that can in turn be used to finance infrastructure and sustain ridership. In mainland China, because land is publicly owned, the city government can use the land lease revenues from relevant parcels to fund rail transit construction and provide operational subsidies. This mechanism helps lower the pressure for the government to fund expensive metro projects with tax revenues.

Transit-oriented development is an integrated strategy for compact, mixed-use, and pedestrian-friendly development connected to transit stations.

Rail and property development

R+P as a development practice is relevant to the concept of transit-oriented development. While the latter refers to the planning practice that emphasizes clustered development around transit stations, the R+P model goes a step further by creating a joint development of transit infrastructure and real estate and by allowing the metro operator to participate in the relevant real estate projects (Tang et al. 2005).

The term R+P was first used to describe the involvement of the Hong Kong Mass Transit Railway Corporation (MTRC) in real estate development around stations. The R+P model has been used in Hong Kong SAR, China as a value-capture tool to finance railway infrastructure. Under the R+P model, the MTRC acquires the right to develop land around or above each railway station at the market

price based on the “greenfield” site value and sells or leases the completed development projects at the market price after the rail station is built (Cervero and Murakami 2009). Due to the accessibility and agglomeration benefits brought by railway projects, MTRC can capture the land value increment (Chang and Phang 2017). This approach is well suited to financing rail infrastructure and advancing transit-oriented development in the rapidly growing cities of mainland China, where many cities, including Shenzhen, have imitated this joint development model. ■■■

■■■ Implementation

THIS SECTION FOCUSES on the implementation of an integrated planning approach in Shenzhen. As transit-oriented development, it involves the articulation of land use and transportation projects, and the additional infrastructure required to provide the necessary services for the additional population that transit-oriented development projects are expected to attract to live near metro stations.

The first two metro lines in Shenzhen, known as Line 1 and Line 4 (the first portion), started operation in 2004, making Shenzhen the fifth city to operate a metro system in mainland China. That project was carried out by the Shenzhen Metro Corporation. However, transit-oriented development planning and R+P projects involve the participation of many government units and relevant corporations. For this reason, the Shenzhen municipal government created the Rail Transit Development Headquarters for policy-making and charged it with synchronizing the actions of relevant stakeholders.

MAJOR PLAYERS IN THE R + P PROGRAMS

The creation of the R+P programs in Shenzhen benefited significantly from the city’s proximity to Hong Kong SAR, China and the involvement of MTRC in the planning and investment from the beginning of Shenzhen’s metro development. Besides Shenzhen’s city government, the other two major players in this project were the local metro operator, Shenzhen Metro Corporation, and Hong Kong MTRC. A history of how these players interacted to produce transit-oriented development in Shenzhen is given in Box 2.

Shenzhen Metro

Shenzhen Metro, which was established in 1998, is completely owned by the Shenzhen municipal government. It has established a comprehensive system of rail construction, rail operation, property development, and asset management.

More recently it has begun planning to expand its business beyond urban rail and get involved in intercity and national railway development. In 2016, Shenzhen Metro claimed to be the first rail transit operator in mainland China to make a profit (SZMC 2017). By 2018, its net profit was \$1 billion and its annual operating income was \$1.6 billion (SZMC 2018). In 2019, it had about 19,000 employees and an average daily ridership of 4.3 million. Its registered capital was about \$6.2 billion, its total assets were \$54.3 billion, and its net assets were \$33.3 billion (SZMC 2019).

Shenzhen Metro had completed 270 kilometers of rail track and 189 stations by 2020, including Shenzhen's metro Lines 1, 2, 3, 5, 7, 9, and 11 as well as the southern section of Line 4. It has developed interchange hubs such as those at Luohu, Futian, Shenzhen North Station, and Shenzhen East Station. At present, it is working on completing Lines 6, 8, and 10 and extensions to Lines 2, 3, 5, 6, and 9. It operates all metro lines in Shenzhen except for Line 4, which is operated by Hong Kong MTRC.

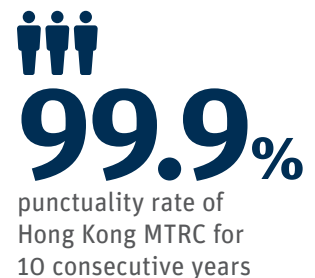
As a real estate developer, Shenzhen Metro has obtained development rights for 12 land parcels, with a total floor area of 4.5 million square meters. About 75 percent of this area is still under construction. Seven projects are either in use or ready for sale. In 2018, Shenzhen Metro was ranked in second place in its development capability among all real estate developers in Shenzhen. It was also recognized as a "Shenzhen Real Estate Social Responsibility Benchmarking Enterprise" for its involvement in public housing and other social activities (SZMC 2019).

Hong Kong MTRC

Hong Kong MTRC is one of the few profitable rail transit companies in the world.² Its annual passenger volume reached 2 billion in December 2018. As a metro operator, Hong Kong MTRC has achieved a punctuality rate of 99.9 percent for 10 consecutive years. In the past 10 years, Hong Kong MTRC has actively expanded its international business, with projects in mainland China that include Beijing as well Shenzhen. It has obtained railway operation franchises in the United Kingdom, Sweden, Australia, and Macao SAR, China.

The R+P practice was introduced to Shenzhen by Hong Kong MTRC. When the Shenzhen Mutual Government began to plan for its metro rail, it invited Hong Kong MTRC to share its expertise, the municipal government eventually invited Hong Kong MTRC to develop and operate Metro Line 4 and develop the Tiara block, a real estate project that sits atop Line 4's train depot.

On January 15, 2004, Shenzhen Mutual Government and Hong Kong MTRC signed the Initial Agreement on the Investment, Construction and Operation of Shenzhen Rail



99.9%
punctuality rate of
Hong Kong MTRC for
10 consecutive years

² Hong Kong MTRC is public traded and the Hong Kong SAR, China government serves as the biggest shareholder. But it is treated as a private and overseas company by the regulations of Chinese government.

Transit Line 4. Shenzhen Metro Line 4 adopted the build-operate-transfer model. Hong Kong MTRC has a 30-year franchise for Line 4 (until 2040).

Line 4 was constructed in three stages. In the first stage, four stations and 4.5 kilometers of track were completed by December 2004. In the second stage, 16 new stations and 16 kilometers of track were completed by 2010 and began operation in June 2011. The third stage, which will extend the line to the east, is under construction now. Line 4 has become one of the most important and busiest metro lines in Shenzhen. Its average daily ridership is around 630,000 passengers, making it Shenzhen's most profitable line as well.

Hong Kong MTRC opened a branch office in Shenzhen, which is responsible for the investment, construction, financing, and operation of Line 4. The Tiara block on the train depot is the first and only R+P project run by Hong Kong MTRC in mainland China.

INSTITUTIONAL ARCHITECTURE

The implementation of R+P in Shenzhen is led by the Shenzhen Mutual Government, which has helped to overcome the most significant barrier, namely access to financial resources, by pooling various resources to support metro development and enabling metro operators to participate in real estate development.

Metro developments are complex civil work projects that require communication among many government units, in this case the Shenzhen municipal government's Budgetary Office, the Planning and Land Bureau, the Transport Commission, and the Development and Reform Commission. The metro lines typically connect the territories of different districts, so the relevant district governments are also involved. To streamline communication among stakeholders, Shenzhen Mutual Government created the Rail Transit Development Headquarters, which coordinates the various aspects of rail transit planning, design, investment, financing, construction, operation, and supervision. The secretary of the headquarters is responsible for communicating with all relevant stakeholders (Zong, Qin, and Lin 2011). The headquarters has an engineering office and an inspection office, responsible of communicating with the engineering firms for construction and inspection. When a new metro line is ready for operation, the infrastructure is handed over to the operational division of Shenzhen Metro. This example of institutional design illustrates one of the ways in which multisectoral and interjurisdictional coordination has occurred in Shenzhen for transit-oriented development (Xu 2012).

Under the Rail Transit Development Headquarters' guidance, metro planning and land development are well coordinated. As discussed earlier (see Figure 3), Metro planning in Shenzhen happens in three levels and five stages. The three levels are system, route, and station, and the five stages are rail network planning, strategy research, construction planning, route design, and station development (Zong, Qin and Lin 2011). Metro network plans are considered in conjunction with city masterplans. Land use specifications (for example,

floor-area ratios) are also adjusted to better capture the additional value created by the metro investment, increasing the allowed density of the parcels.

The city masterplan is the platform on which to integrate all other relevant infrastructure and services, such as water, electricity, education, and health. The integration of the metro plan with the city planning process also ensures appropriate horizontal integration with other sectors.

The R+P, which adds property development to the basic work of metro projects, is another layer of complexity. The greatest challenge is to enable the metro operator to obtain land development rights. Under China's policy of public land ownership in urban areas, the Shenzhen Municipal Government would transfer the right of way for metro infrastructure to the metro corporation free of charge, regardless of how much Shenzhen Municipal Government pays to assemble those land parcels. However, the R+P model implies that some land development rights will be used for noninfrastructure purposes, such as housing, offices, and retail space. According to the regulations of the central government, the land development rights of those "market" categories can be transferred from Shenzhen Municipal Government to the developer only through a competitive procedure involving bidding, auction, or listing.

The Shenzhen municipal government followed these central government rules in the early stages of metro development. To ensure that the metro corporation would obtain land parcels in a competitive setting, some conditions were required. For example, the selected developer was required to have experience and expertise in metro operations.

In 2013, the Shenzhen municipal government upgraded its practice to a land contribution procedure. Under this practice, the government appraises the market value of the targeted land development right, then transfers that right to Shenzhen Metro free of charge. This transfer is then recorded as a government investment in Shenzhen Metro. The state-owned Shenzhen municipal government Assets Supervision and Administration Commission, which works on behalf of the Shenzhen municipal government, performs the duties of the investor. The Shenzhen Development and Reform Commission is responsible for making annual investments and a financing plan. The Land Preparation Bureau creates lists of land parcels according to the annual investment and financing plan.

SUSTAINABILITY

The earliest R+P project in Shenzhen is the Qianhai Depot project. The land development rights for this project were obtained by Shenzhen Metro in 2009. Since then, Shenzhen Metro has obtained 12 additional land parcels. Four were obtained through bidding, auction, and listing, while the other eight were obtained by land value contribution, as described in the preceding section. Those 12 projects have a total land area of 109 hectares and a total floor area of 4.8 million square meters or 477 hectares (Table 2).

One impressive item is the existence of public housing in those real estate projects. Shenzhen Metro has provided 22,420 units of public housing in total, sited on top of the Qianhai Depot, the Shekou West Depot, the Henggang Depot, and the Tanglang Depot. The total floor area is 1.9 million square meters, 38.8 percent of the total floor area (Yang 2015).

TABLE 2. SHENZHEN METRO REAL ESTATE PROJECTS ABOVE TRAIN DEPOTS

Mode of land acquisition	Plot	Land area (hectares)	Floor area (hectares)	Land price (\$ billion)	Inclusion of public housing?	Project name
Directional bidding, auction, and listing	Qianhai Depot	33.72	80.79	0.11	Yes	Qianhai Era
	Tanglang Depot	4.36	26.15	0.29	Yes	Langlu Home
	Shekou West Depot	6.37	11.03	0.11	Yes	Longrui Home
	Shenda Station	0.98	9.78	0.10	No	Technology Building
	Total	45.43	123.75	0.75		
Land value contribution	Qianhai hub	20.01	133.01	2.04	Yes	Qianhai hub
	Henggang Depot	14.62	32.2	0.17	Yes	Kam Sheung Garden
	Mangrove Bay MTR Station	6.83	45.2	0.94	No	Mangrove Bay
	Chegong Temple Hub	0.66	11.58	0.29	No	Huitong Building
	Shenzhen North station	3.96	31.59	0.42	No	Huilong Business Center
	Shenzhen North station					Huide Building Project
	Antuo Mountain Parking Lot	13.55	53.34	1.29	No	Antuo Mountain
	Tanglang F Block	4.28	12.77	0.26	No	Tang Lang
	Total	109.44	477.44	6.15		

Source: Websites and news releases of Shenzhen Metro.

Shenzhen Metro developed relatively small projects, such as the Shenda Station project, by itself. For larger projects, Shenzhen Metro partnered with other real estate developers. The Tanglang Depot project was developed by a joint venture with a real estate developer. The Henggang Depot and Qianhai Depot projects were contracted to a third party. In 2018, Shenzhen Metro became the largest shareholder of Vanke Group, one of China's biggest real estate developers. Since then, real estate projects have typically been carried out by joint ventures between Shenzhen Metro and Vanke.

PRIVATE-SECTOR PARTICIPATION

Private-sector participation has been sought in China to relieve the government's fiscal burden on infrastructure investment. It is also viewed as a means to improve projects' operational efficiency (Papajohn et al. 2010). To encourage public-private partnership in metro development, the central government makes an exception to the upper limit of 60-percent debt-to-assets ratio. If the project is trusted to a corporation under a franchise, this upper limit can be removed. So far, Hong Kong MTRC is the only private participant in mainland China's metro development. Both the successes and failures in mainland China can help inform the public-private partnership environment.

R+P projects are complicated. The Tiara project mentioned earlier is a legacy of a much larger planned R+P program. In 2005, Hong Kong MTRC and Shenzhen municipal government planned to carry out an R+P program along Line 4 involving 80 hectares of land. This initial agreement was rejected by the central government, which was worried that too much land had been handed over to Hong Kong MTRC. Eventually, Hong Kong MTRC received only 8.9 hectares of land for the Tiara project.

Starting from its involvement in Shenzhen, Hong Kong MTRC has tried to expand its R+P business to other Chinese cities, including Shenyang, Tianjin, Beijing, Chengdu, and Hangzhou (Table 3). In these cases, Hong Kong MTRC created a joint venture with a local state-owned enterprise (SOE) that received a franchise of 20 to 30 years from the city government. None of these plans has yet materialized. Some of them reached the stage of a formal contract but they were discontinued for various reasons (Ke et al. 2011).



Shenzhen's Futian District, landmarked by the Ping An Finance Center, which is the city's tallest skyscraper, illustrates its capacity to integrate transportation, land, property development, and green space.

Source: BINGFENG WU/
Moment via Getty Images.



TABLE 3. HONG KONG MTRC'S R+P EFFORTS IN MAINLAND CHINESE CITIES

CITY /YEAR	NATURE OF CONTRACT	PROJECT	GROSS FLOOR AREA (M2)	CURRENT STATUS	DEVELOPER
Shenyang /2009	Cooperative development agreement	The real estate surrounding Shenyang Metro Lines 1 and 2	-	Discontinued	Shenyang MTR.: MTRC shares accounted for 49%; Shenyang government accounted for 51%
Shenzhen/ 2011	Formal contract	Shenzhen Metro Line 4 (Tiara)	About 206,167	Completed	MTRC (Shenzhen)
Tianjin/ 2013	Formal contract	Land use right of the North Canal Station, Tianjin Metro Line 6	About 60,000	Discontinued	Tianjin City Railway Port Construction Co. Ltd.: MTRC accounts for 49%; Tianjin Underground Railway Group Co. Ltd. accounts for 51%
Beijing/ 2017	Letter of Intent	Property development of the Beijing Metro Daxing Line North Extension, Nanzhao Road Depot	-	No progress	-
Chengdu/ 2018	Memorandum of understanding	Joint development around stations along the Chengdu Metro	-	No progress	-
Hangzhou/ 2018	Memorandum of understanding	Joint development at the Hangzhou West Railway Station	-	No progress	-

Source: News releases of Hong Kong MTRC and relevant city governments.

This difficulty might be attributed to city government's leadership changes and the relatively low price of real estate in Chinese cities compared to that in Hong Kong SAR, China. Based on a survey conducted in both mainland China and Hong Kong SAR, China, one study found that the factors that should be considered to establish partnerships between Hong Kong and the mainland include equitable allocation of risks, judicious government control, transparent and efficient procurement process, project economic viability, and available financial market (Cheung et al. 2012).

Another factor that helps explain the difficulty of completing these projects is the competition from local SOEs. For example, after it completed Line 4, Hong Kong MTRC made no progress in Shenzhen, but the R+P practice it had deployed has nevertheless been widely used in Shenzhen. Although both Shenzhen Metro and Hong Kong MTRC say they want to work on more projects, Shenzhen municipal government has favored its own SOE. Among the 35 mainland cities with metros in operation, more than 20 have implemented joint development projects, all with the local SOE as the developer. For example, Shenzhen Metro built and operates Shenzhen Metro Line 6 and will develop Changzhen depot block. Tianjin Metro is undertaking Tianjin Line 6's property development.

The success of SOEs in the R+P projects can be explained in alternative ways depending on perspective. For example, a personal relationship between the leaders of the SOE and the city government (Wang, Zhu, and Chen 2017) is one plausible explanation, while another is the ability of SOEs to qualify for bank loans to finance expensive infrastructure projects (De Jong et al. 2010). Also an SOE has an advantage in that during project implementation, it has the opportunity to renegotiate the contract with the city government with updated cost and revenue information. Of course, this relationship between the city government and local SOEs may also raise issues of accountability and transparency.

RISK MANAGEMENT

A major factor could be the different ways risk management is dealt with by state-owned and private businesses. The profit-driven Hong Kong MTRC must have access to enough land around a metro station to develop and sell it for a profit, whereas Shenzhen Metro, which does not need to turn a profit, can accept much less land.

The key question for a R+P project is the amount of land the city government must give to the developer to make the project financially viable. This decision is always based on imperfect information. Whereas the engineering cost of the project can be estimated with a certain confidence, the future profit from the real estate market is much more difficult to estimate and depends on the land supply that the local government controls. Packaging metro and real estate projects together further increases this complexity.

Hong Kong MTRC is an overseas corporation listed in the Hong Kong Stock and Security Market, which implies a conservative risk appetite. To lower project risks, it tends to seek more land than the local metro corporation. However, local government leadership tends to be hesitant to allow this, since too much land for Hong Kong MTRC might trigger rent-seeking questions and endanger political careers. By contrast, the local SOEs are much more flexible, usually willing to sign a contract even if their internal estimates point to an insolvency, as well as to incorporate social needs such as public housing into their projects.

BOX 3. THREE STAGES OF METRO PLANNING

Shenzhen is ready to start its fourth stage of rail transit development. The funding for the expensive metro projects has moved from cash contribution to land contribution, and this has also paved the way for the integration of transit investment and land development. Table 4 summarizes the stages.

TABLE 4. STAGES OF INTEGRATED PLANNING IMPLEMENTATION

	FIRST STAGE	SECOND STAGE	THIRD STAGE
Length of line	About 22 km	About 157 km	About 255km
Total investment (US\$)	0.24 billion	1.54 billion	3.15 billion
Investment and financing model	Government contribution: 70% (cash) Enterprise finance: 30%	Government contribution: 50% (cash) Enterprise finance: 50%	Government contribution: 50% (land) Enterprise finance: 50%
Integration development	Rail separated from land	Transit-oriented development	Practice of R+P
Rail network planning and design	Engineering-led	Planning-guided	Planning-guided

Source: Yang 2016; and related materials.

The first stage: Lack of integration (by 2005)

In 1996, the Shenzhen municipal government made its first plan for a metro system. The plan included nine metro lines, which were included in the second version of the city’s masterplan. The alignment of the metro lines and station placement was mainly based on criteria such as engineering feasibility and cost control but not closely coordinated with land development. When the first 22 kilometers of track were constructed, Shenzhen Metro received a large cash grant from Shenzhen municipal government’s general revenue, which was 70 percent of the total investment. It financed the remaining 30 percent with a bank loan, for which Shenzhen municipal government provided a guarantee.

The second stage: Transit-oriented development as a value-capture tool (2005–11)

The appearance of transit-oriented development as a widely accepted concept in China comes from not only its transport benefits, but also from its potential as a value-capture apparatus (World Bank 2018). The more Shenzhen municipal government's land parcels around metro stations appreciate in value from metro investment, the higher the capability of Shenzhen municipal government to fund the metro investment. Therefore, in metro planning practice in China, city governments tend to place some metro stations in underdeveloped land parcels. The sales of land right around those stations contributes to the government revenue (Yang et al. 2016). Since the metro system is funded by the city government, a value-capture mechanism therefore is built into the public land ownership.

This value-capture mechanism not only has impacts on station placement, but also on development density in the station areas. Parcel value depends on its building potential (including floor area). As a result, development density bonuses, ranging from 20 percent to 80 percent of the baseline density, have been typically granted to land parcels in proximity to stations. However, with this approach, the city government was able to fund only 50 percent of the total investment cost in cash.

At this stage, the city government began to experiment with the R+P model. The major purpose was to replace cash contributions with land contribution. MTRC's Tiara project in Hong Kong SAR, China was the experimental example.

The third stage: Rail and property (R+P) development (2012–18)

Shenzhen municipal government favors the R+P model because it relieved the government from the need to provide cash contributions to metro projects. The land development rights obtained by the metro corporation can be used to leverage a bank loan. Shenzhen Metro also supports this approach because it is eager to get involved in the booming real estate market. To enable a smoother transfer of land development rights from the city government to the metro corporation, the city government implemented the approach of land contribution. During this stage, the city government still funds 50 percent of the total cost, but only in the form of a land contribution. This R+P approach enables the metro corporation to develop real estate projects above the stations, over the train depots, or in proximity to a station exit. Those projects are well designed and integrated with the metro infrastructure.

Even within the transportation area, there is little coordination between bus and metro authorities. Bus stops are not coordinated with metro stops.

The central government of China has strict entry standards for cities interested in constructing metro systems, primarily driven by a desire to lower city governments' fiscal uncertainties. The two most representative and authoritative documents for the control of urban metro system issued by the central government of China are the "Notice of the General Office of the State Council on Strengthening the Construction and Management of Urban Rapid Rail Transit,"^a issued in 2003, and the "Opinions of the General Office of the State Council on Further Strengthening the Planning and Construction Management of Urban Rail Transit,"^b issued in 2018 as an amendment to the former.

Both documents have minimum requirements on municipal annual revenue. In 2003, the required minimum amount was \$1.4 billion, which was increased to \$4.2 billion in 2018. The minimum GDP requirement has also increased, from \$14 billion to \$42 billion. The 2018 document also requires that the urban population be a minimum of 3 million and that the planned metro line have a predicted peak daily volume of at least 0.7 million riders per kilometer of track at the beginning of metro operation. Finally, the city government's contribution should be more than 40 percent of the total assets, and the government cannot use debt to finance that 40 percent. After the introduction of the 2018 regulation, a few metro projects that did not meet the 40 percent asset requirement were suspended. Cities that were warned by the central government for their debt risk also had their metro projects postponed.

In addition, the central government made a few stipulations regarding social justice or environmental issues, called "risks to social stability." In August 2012, the central government's "Interim Measures for Social Stability Risk Assessment of Major Fixed Assets Investment Projects of the National Development and Reform Commission"^c stipulated that the feasibility study report of urban rail transit projects, including heavy and light rail, should include a risk analysis of social stability.

The Shenzhen Metro, which is responsible for the metro development and operation, tends to be subject to relatively soft budget constraints. As explained earlier, the corporation is completely owned by the Shenzhen municipal government. As long as the expenditure is assessed to be reasonable, the city government will cover all finance deficit.

Notes:

^a Office of Central Government notice no. 81.

^b Office of Central Government notice no. 52.

^c Issued by the National Development and Reform Commission as No. 2492.

GLOBAL ENVIRONMENTAL BENEFITS: OUTCOMES AND SCALE-UP

Metro investment and transit-oriented development have been widely recognized as types of projects that generate positive environmental outcomes, including global outcomes such as a reduction in greenhouse gas emissions. They reduce automobile trips by substituting private trips with trips using public transportation. The cluster of urban activities around metro stations further reduces automobile ownership and driving by improving access to metro services and to urban amenities throughout the city.

Reducing greenhouse gas emissions by restructuring transportation systems and land use density to encourage mass transit ridership, as well as carbon-free mobility such as walking and bicycling, is one of the four major steps cities can take to slow climate change, as described in the synthesis report`.

Below we describe the environmental benefits of Shenzhen's metro investment.

Compact development and land preservation

Shenzhen is a densely populated area of only 1,997 square kilometers. Half of this area is under preservation because of its topography, including steep slopes and water bodies. The remaining half supports a population of about 20 million. This limited supply of land makes land preservation more challenging in Shenzhen than in other top-tier Chinese cities such as Beijing, Shanghai, or Guangzhou. The investment in metro systems and the clustering of urban activities around stations are vital to the future of the city.

Shenzhen's database of buildings records every building in Shenzhen, with information on building footprint, year of construction, amount of floor area and usage category. It is used to illustrate development around stations. The map in Figure 4 shows the buildings around the Hongshan metro station, which is on Line 4. The maps have a one-kilometer radius. The station, which opened for service in 2011, was built on land that was undeveloped before metro construction. By 2018, the land around the station was almost fully developed with high-rise buildings.

The ability of the metro stations to attract development can be calculated with a citywide analysis. Using the Gradient Promotion Decision Tree model, we estimated the nonlinear relationship between the volume of newly added floor area in relation to its distance to the nearest metro station. As can be seen in Figure 5, the building increment decreases with distance, and the influence reaches a plateau at 1.4 kilometers. This shows that the implementation of transit-oriented development policy in Shenzhen has had the expected effects on construction and density.

Reducing greenhouse gas emissions by restructuring transportation systems and land use density to encourage mass transit ridership, as well as carbon-free mobility such as walking and bicycling, is one of the four major steps cities can take to slow climate change

Figure 5 Built-up area around Hongshan metro station, 2008 vs. 2018

Source: Created using data from Shenzhen Land and Resource Bureau Database of Buildings 2008; 2018.

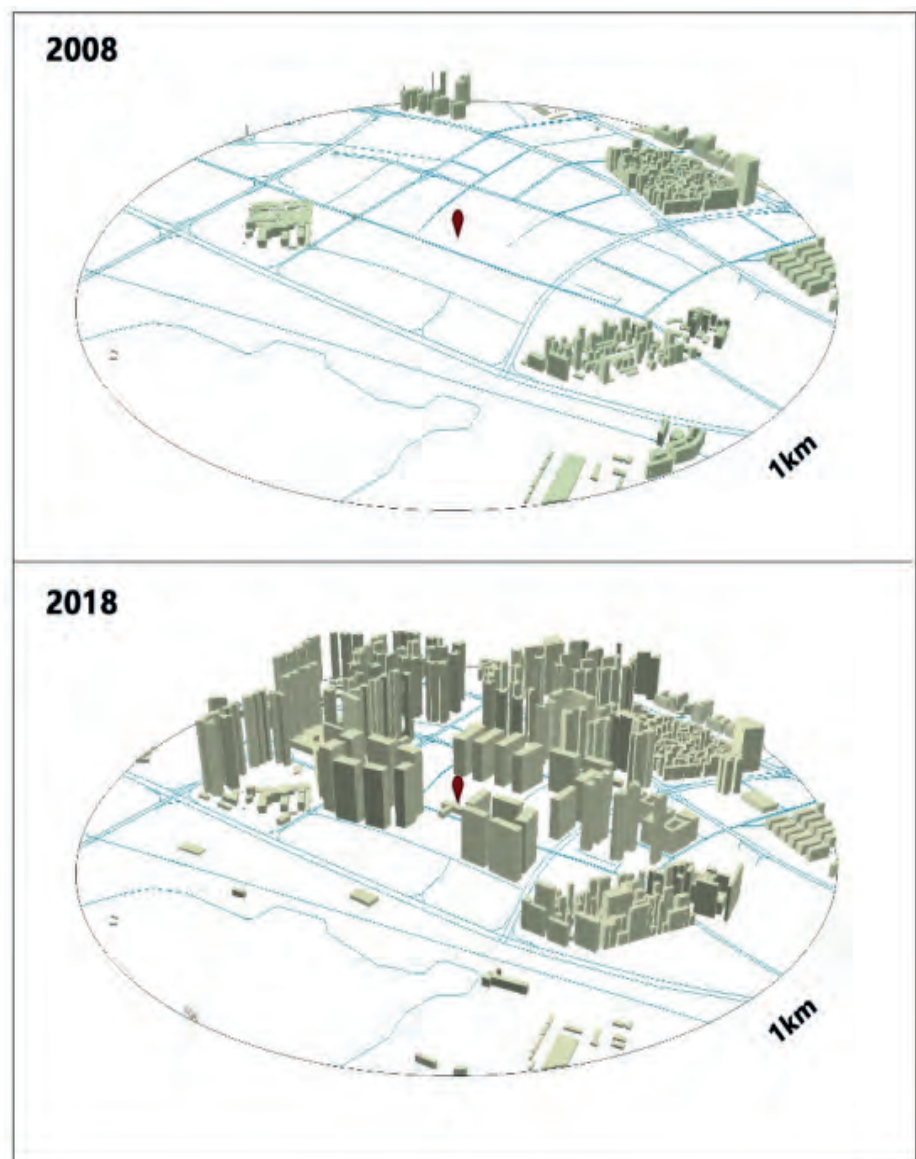
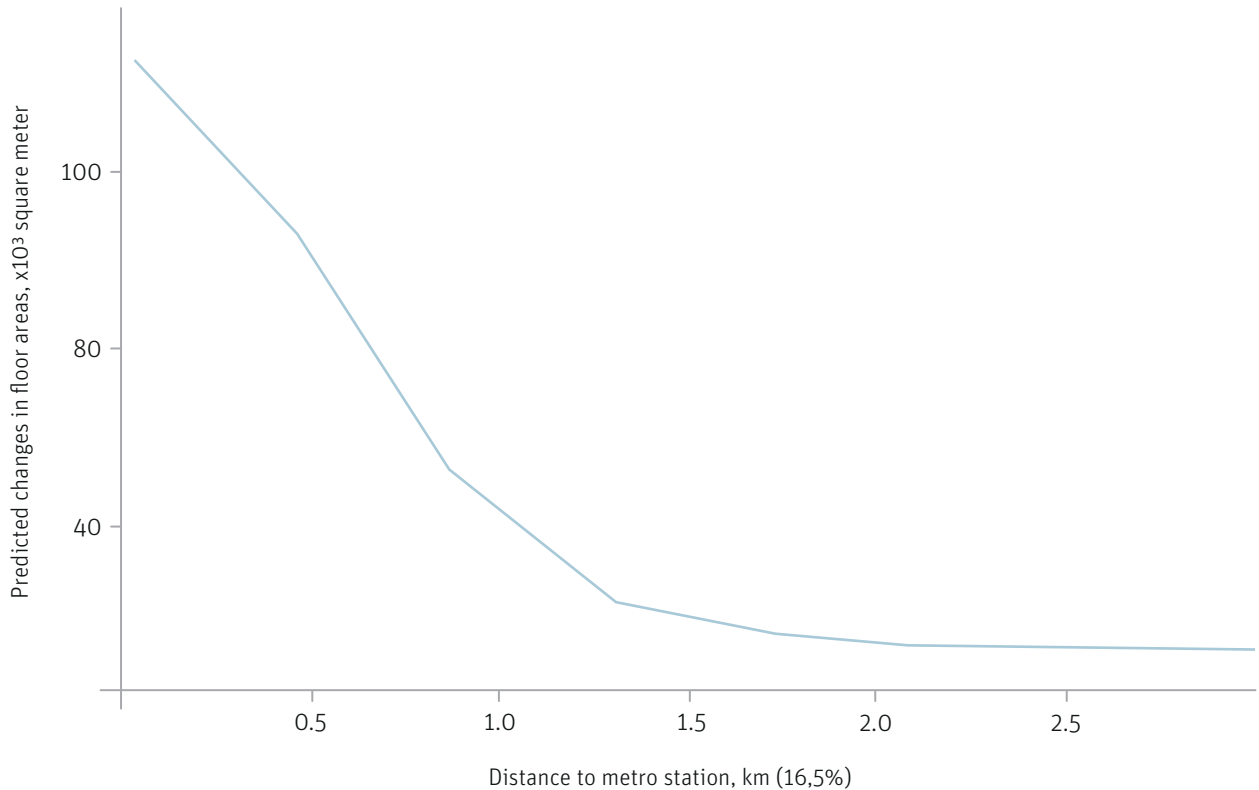


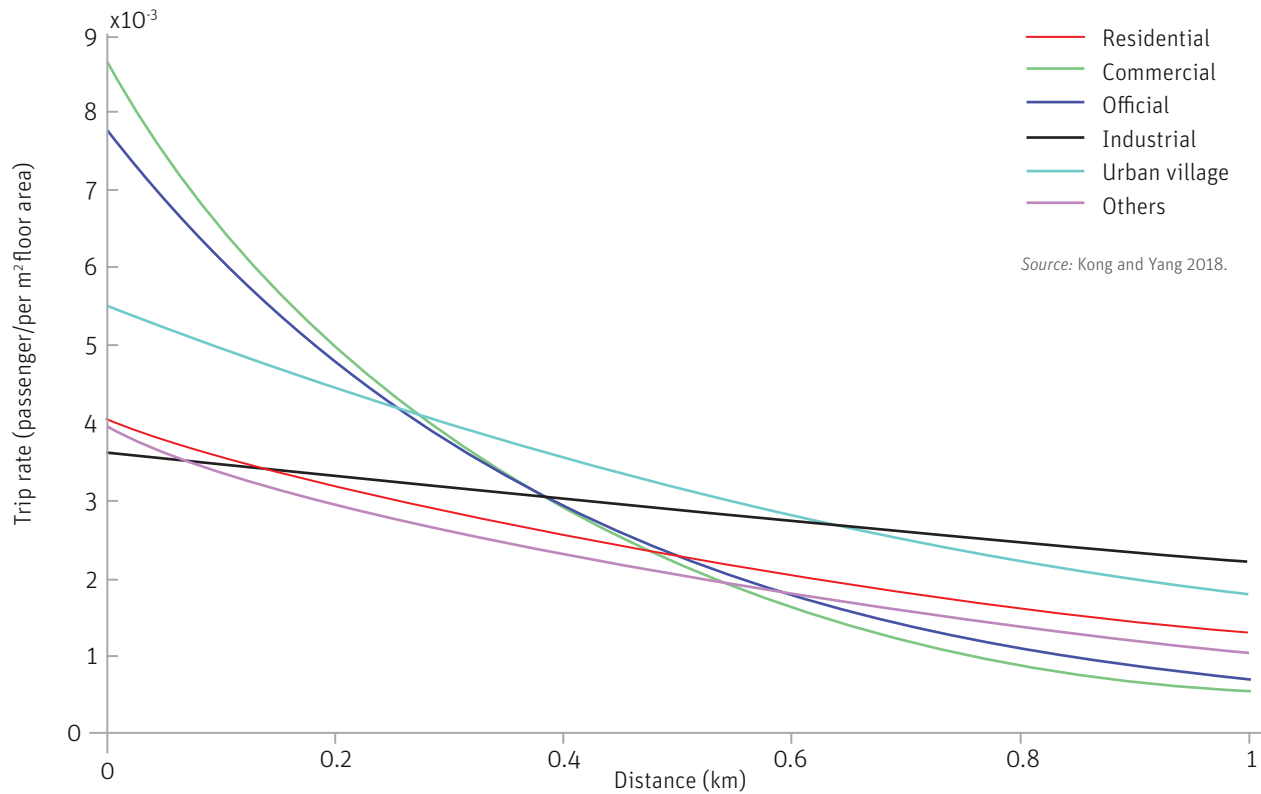
Figure 6 Distance to metro station and floor area variation

Reduction in automobile trips

In 2018, public transit ridership made up more than 60 percent of motorized trips in Shenzhen during rush hours. The average daily metro ridership reached 5.19 million, which is 49 percent of the total public transit ridership. This increasing share of metro ridership should be attributed to the metro investment and transit-oriented development.

Modelling estimates illustrate how the clustered development around metro stations might affect metro ridership. We related metro's ridership data (station by station) with different ratios of floor area around the station. After controlling for other relevant variables such as the number of bus lines at station proximity, we found a clear distance-decay effect in the rate of trip generation by different types of building usage (Kong and Yang 2018). When the walking distance to a metro station increases, the trip generation rate for metro ridership decreases. Comparing different types of buildings, the generation rate for commercial and retail (e.g. restaurants and entertainment) buildings decreases much faster. (Figure 6) This relationship between the metro trip generation rate and distance to metro stations indicates that high-density development clustered around stations will significantly increase metro ridership. 🏠

Source: Created using data from Shenzhen Land and Resource Bureau, Database of Buildings 2008; 2018.

Figure 7 Distance-decay of trip generation for metro ridership

Financing

WHEN PLANNING FOR METRO projects in China, city governments have sited metro stations in relatively underdeveloped places, with an expectation that development would quickly follow once station locations were announced and the metro was in operation. Behind this planning practice is a pressure to fund metro projects with land lease revenue (Yang et al. 2016). This practice has expanded in Shenzhen as the investment needs for metro development have increased.

COMPOSITE COMBINATION OF REVENUE RESOURCES FOR METRO INVESTMENT

Before the land value-capture approach was adopted, metro financing in Shenzhen was mainly circumscribed by “cash” contributions. During the first stage of metro investment, Shenzhen municipal government covered 70 percent of the \$0.24 billion total cost for the 22 kilometer system with cash from its general revenue. The system’s second stage expansion included 157 kilometers

of track at a total cost of \$1.52 billion, but in this case 50 percent was covered by cash contributions from the local government.

Despite enjoying relatively high revenues, Shenzhen municipal government is feeling the fiscal pressure stemming from its heavy and continuous metro investment, with the total cost for the third and fourth stages of the system's expansion being much higher than earlier costs. For example, metro construction of the third stage is estimated at \$3.13 billion. High upfront expenditures on engineering and construction would curtail fiscal space available for other expenditure items. It was in this fiscal context that Hong Kong MTRC was engaged and an R+P approach was established.

Direct investment from overseas

In earlier decades, foreign direct investment served as a big stimulus for China's economic development. Hong Kong MTRC became the natural choice when Shenzhen opened its metro system for overseas investment. The company was selected to construct Metro Line 4 and operate it for 30 years, after which the metro line will be transferred to Shenzhen municipal government. While Hong Kong MTRC met the service standards set by the local government, its construction costs were significantly lower than Shenzhen Metro's own estimate (Luan et al. 2014).

Hong Kong MTRC and Shenzhen municipal government then signed a memorandum stating that MTRC would continue to work on Line 6. For this new project, the company and the municipality would form a joint venture in which Hong Kong MTRC would take 49 percent of the ownership (Luan et al. 2014). Unfortunately, Hong Kong MTRC did not reach an agreement on the government's contribution to the project, and it eventually withdrew, leaving Shenzhen Metro to carry out the Line 6 development by itself.

Borrowing from financial markets

The Shenzhen Metro also obtained funds for metro construction from the financial market. Since 2010, Shenzhen Metro has used a financial lease to make \$0.4 billion by selling expensive equipment. Besides, Shenzhen Metro has a \$5 billion quota for commercial paper and super and short-term commercial paper.³ A medium note of \$1.4 billion has been issued to get money from the financial market. Shenzhen Metro has also obtained a quota of \$1.4 billion for an enterprise bond, which is one of the longest-term financing tools.

Shenzhen Metro also received a cross-border loan of \$0.2 billion in Hong Kong SAR, China because of the relatively low financing cost there. It also received \$0.79 billion for six metro projects from a special bond issued by the China

³ A SCP (super and short-term commercial paper) is defined as a bond with a term of 270 days (9 months) or shorter that is issued in the inter-bank bond market by a nonfinancial corporation that has enterprise capacity and a high credit rating, usually AAA.

Development Bank and the Agricultural Development Bank of China (SZMC 2019). The Shenzhen Metro has built a preferred financing model to balance financial sources among capital market instruments, export credits, and bank loans to obtain money at a lower cost (SZMC 2019).

EVOLUTION OF R+P BASED FINANCE

China's public land ownership provides the opportunity to use a land value-capture approach for metro financing. Shenzhen municipal government can capture appreciated land value stemming from metro investment, with land lease revenue. This approach requires the city government to collect land lease fees from the land developer first and pass them to the metro corporation. The switch toward R+P is a new approach to finance metro investment with land development rights. The exact format of operation depends on how the land development right is transferred. The metro corporation receives land development rights with directional bidding, auction, and listing. Figure 7 describes the flow of the benefits.

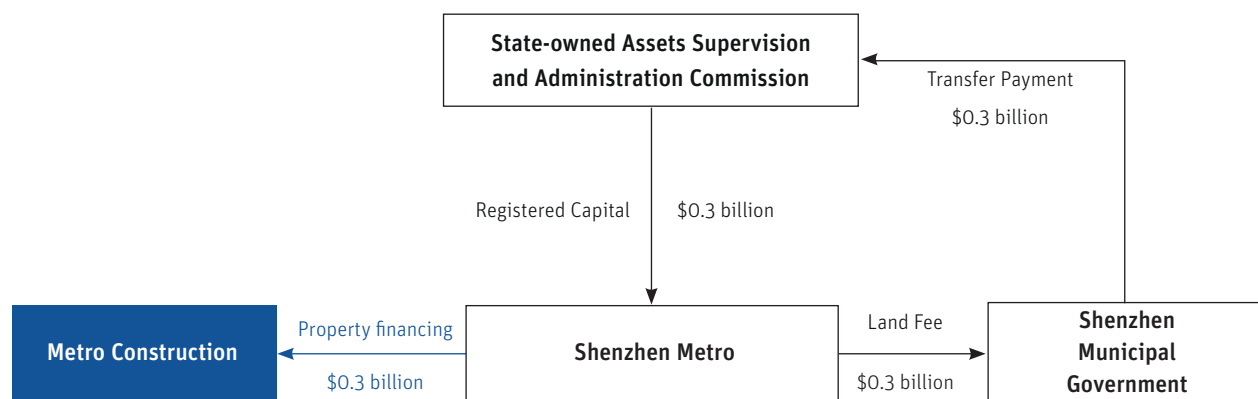


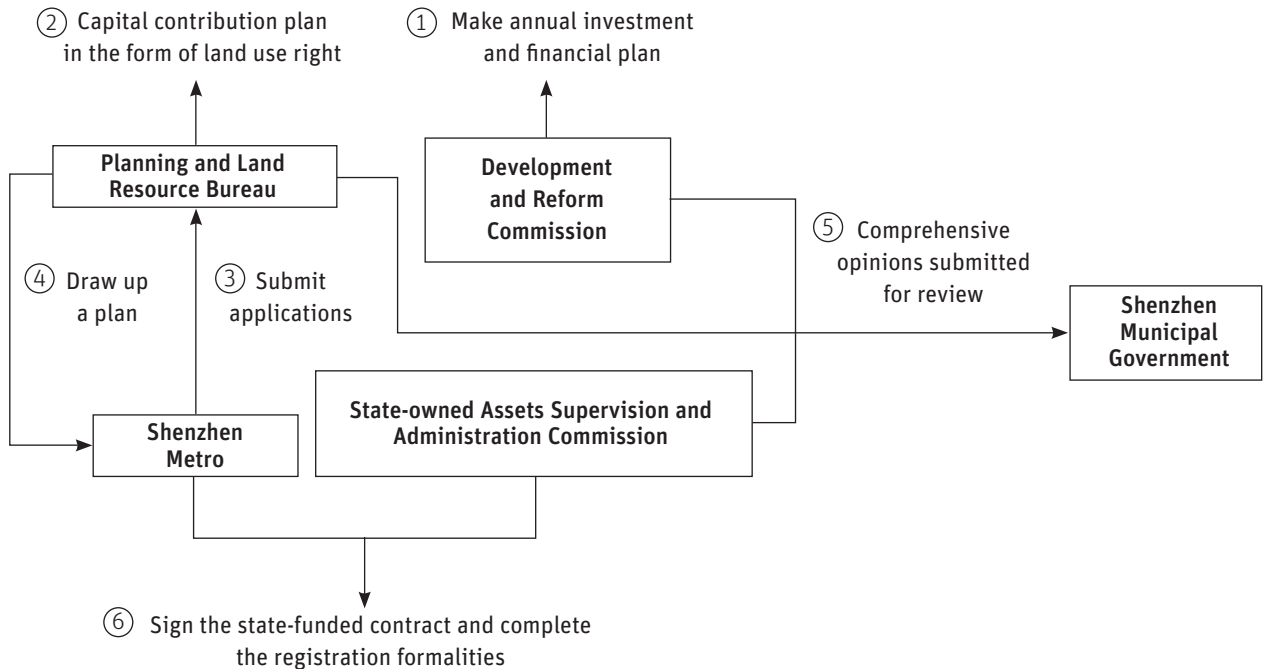
Figure 8
Returning land
lease fee for metro
investment

Source: Yang et al. 2016,
adapted by World Bank.

Note: It is assumed that the
estimated land value is ¥2
billion (\$18,560,000.00).

First, Shenzhen municipal government picks up the parcel to be transferred to Shenzhen Metro. After Shenzhen Metro wins the land development right, it pays Shenzhen municipal government a fee to lease the land. Shenzhen municipal government transfers this money to the State-owned Assets Supervision and Administration Commission, which represents Shenzhen municipal government on SOE investments. The State-owned Assets Supervision and Administration Commission then invests this amount into Shenzhen Metro.

To ensure the metro corporation could win the parcel, the bidding process requires the bidder to have expertise in metro operation. But this method may be suspected of violating relevant regulations for land markets. The circular flow of a big amount of money fulfils a central government regulation but is unnecessary from a pragmatic perspective. For these reasons, the land value contribution approach (in Figure 8) was viewed as more direct and more efficient and is the selected method in Shenzhen today.

Figure 9 Land value contribution for metro investment

As Figure 8 describes, in the land value contribution approach, the appraisal agency estimates the market price of the land, and then Shenzhen municipal government transfers its land development right to Shenzhen Metro and receives a corporate share in return. The land development rights can then be used to leverage bank loans. The proceeds of the development projects can be used to fund the construction of the metro line and to subsidize its operation. This direct approach helps to alleviate the financial pressure on both Shenzhen municipal government and Shenzhen Metro.

Source: Yang et al. 2016, adapted by World Bank.

THE BALANCE SHEET OF SHENZHEN METRO

In 2016, Shenzhen Metro's total gross revenue reached \$1.75 billion and its net profit reached \$5.6 million. In 2017, its total gross revenue exceeded \$2 billion and its net profit reached \$6.6 million (Shenzhen Metro 2018), showing an impressive growth rate. To a certain extent, Shenzhen Metro has achieved self-financing, but it is worth noting that its debt ratio has increased to 40 percent, and it still faces very large debt pressure, as Shenzhen is still expanding its metro network. In addition, the \$6.6 billion profit includes an investment income of \$1 billion from Shenzhen Metro's development partner Vanke, one of China's biggest real estate developers, which is not a stable income.

For comparison, Hong Kong MTRC's total revenue and net profit in 2016 was \$5.8 billion and \$1.3 billion (MTRC 2017) and in 2017, \$7.1 billion and \$2.1

billion respectively (MTRC 2018). Hong Kong MTRC's total revenue and net profit are several times that of Shenzhen Metro's because it not only serves Hong Kong SAR China but also has a few markets in mainland China and other countries. In terms of the composition of Shenzhen Metro's revenue, transport operation accounts for 25 percent, and revenue from property development is 65 percent. For Hong Kong MTRC, transport operation accounts for more than 30 percent, and property development revenue accounts for 50 percent (Table 5).

TABLE 5. COMPARISON BETWEEN SHENZHEN METRO AND HONG KONG MTRC

	SHENZHEN METRO	HONG KONG MTRC
Total gross revenue, 2016	\$1.75 billion	\$5.8 billion
Net profit, 2016	\$5.6 million	\$1.3 billion
Transport operation as percent of revenue	25%	36%
Property development as percent of revenue	65%	50%

Source: Shenzhen Metro 2018; MTRC 2018.

A further comparison of the margins suggests that Shenzhen Metro's rail operation is not as profitable as that of Hong Kong MTRC. The margin of rail operation for Shenzhen Metro is -35 percent and property development is 63 percent, while Hong Kong MTRC's has a 9.1 percent margin from rail operations, and 80 percent from property development. This comparison suggests that there is large room for Shenzhen Metro to improve its rail operational efficiency.

Caution is advised in assessing the operational efficiency of China's metro systems and the profitability of its R+P programs. The amount of government subsidies should not be used as a straightforward indicator for assessing performance of the Shenzhen Metro because the system is not designed to eliminate subsidies or make profits. Although the R+P programs in Hong Kong SAR, China are designed to make Hong Kong's MTRC operation self-sustaining, their counterparts in mainland China have been used, from the very beginning, to finance metro investments and relieve city governments' fiscal pressure. Land parcels were capitalized to replace city governments' cash contributions, rather than to use real estate revenue to subsidize metro operations, even though the model has that potential.

Typical metro corporations in mainland China shoulder many nontransportation social functions. For example, Shenzhen Metro provides a significant percentage of floor area for public (rental) housing on behalf of the city government. It is also asked to provide employment opportunities for special groups,

including veterans. Social functions like these naturally increase the cost of Shenzhen Metro. The increase in development activities around the metro line allows the metro corporation to provide increased social functions. As a result, it is not accurate to look at the metro corporation's operational efficiency based only on the amount of the subsidies. ■■

■■ Conclusion

Massive urbanization and rapid motorization have brought significant challenges to urban China. The need to reduce urban–rural disparities, to connect passengers and goods across city boundaries, and to streamline multimodal movement has motivated China to upgrade its planning institutions and policies (Yang and Fang 2015).

As the pressure to mitigate the traffic and environment impacts of urban growth becomes central and investments in expensive metro systems soar, China has furthered its efforts in integrated planning, especially in transport and land use.

SHENZHEN WAS A PIONEER OF INTEGRATED PLANNING IN CHINA

Today, 35 Chinese cities have metro systems. Most of these cities have adopted measures to promote transit-oriented development, with development density bonuses granted to projects in the proximity of metro stations. In addition, more than 20 of those cities have adopted a rail-plus-property (R+P) development model. The feasibility and effectiveness of this planning and development choice needs to build on preexisting institutions and policies for integrated planning, particularly institutions for transportation planning and land development planning.

In past decades, Shenzhen has served as a role model for other Chinese cities, partially benefiting from its special legislative power awarded by the central government. Shenzhen started implementing integrated planning and management for different transportation modes years ahead of the central government's regulation on the matter, which now requires all city governments to create a multimodal decision-making center. Shenzhen has also exercised a joint municipal bureau for land use plans and city masterplans, two decades ahead of the central government's requirements to consolidate these two plans with a unified spatial planning framework and a consolidated decision-making center.

The City of Shenzhen, therefore, stands as a pioneer not only in industrial and technological development, but also in China's planning innovations. The city itself is a metropolitan area, defining metropolitan boundaries by the commuting

The need to reduce urban–rural disparities, to connect passengers and goods across city boundaries, and to streamline multimodal movement has motivated China to upgrade its planning institutions and policies.

Shenzhen's experiment with R + P shows how infrastructure development, land development, and the finance sector can work together for transportation and environmental benefits.

shed of the people travelling to the core city area for work. The establishment of the SEZ four decades ago helped to develop the core area of Shenzhen City. The consolidation of the former SEZ and non-SEZ areas has since helped the city government strengthen its planning and development control over the former non-SEZ area and to employ a unified framework for planning and development control over the whole metropolitan city. While Shenzhen follows national procedures in planning practice, particularly in its practice in integrated transport and land use planning, the city has also innovated in infrastructure finance and land development, which has inspired China's central government as well as other local governments.

R+P AS A DEVELOPMENT PRACTICE OF INTEGRATED PLANNING

The R+P practice in Shenzhen was introduced by Hong Kong MTRC. But Shenzhen soon created its own version of R+P projects, conditioned on China's land institutions for land ownership and the transfer of land development rights. Shenzhen Metro has partnered with real estate developers to work on various real estate projects, either above metro facilities or in proximity to metro stations. This practice not only helps to densify developments near stations but also helps to fund metro development and public housing. It also boosts transit ridership and preserves green space.

Shenzhen's experiment with R+P shows how infrastructure development, land development, and the finance sector can work together for transportation and environmental benefits. While the transport and environmental impacts are relatively easy to understand, the underlying financing model requires a bit more analysis. From the government perspective, there is a trade-off between land and cash contributions. The city government needs to fund metro investment. In a business-as-usual scenario, the city government would fund the metro system with cash from its general revenues. However, the practice of public land ownership in China enables the city government to replace cash contributions with land development rights. The market value of the granted land development right can then be used to leverage bank loans, which fund the engineering cost of the metro and the associated real estate projects.

From the perspective of the metro corporation, participation in the lucrative real estate market allows it the possibility of evolving from a subsidy-dependent transit corporation to a profit-making entity. In the early stage, Shenzhen Metro created its own real estate division, Shenzhen Metro Real Estate Group Co., Ltd. As the real estate project has become more complex and more market-oriented, Shenzhen Metro has become the largest shareholder of Vanke, one of China's largest real estate developers. The development activity has thus been shifted to

Vanke, with Shenzhen Metro itself focusing more on property management and creating Shenzhen Metro Property Management Development Co., Ltd.

City governments in mainland China used to employ the combination of operational revenues and local government subsidies to fund metro operations. In recent years, they have seen the positive effects brought about by transit-oriented development and R+P programs. The integration of transit investment, land development, and finance has not only enhanced city government's ability to move metro projects forward but also enabled better outcomes for urban transport, land preservation, and emissions reductions.

REPLICABILITY

Shenzhen's practice of integrated transport and land development has been followed by many other Chinese cities, with adjustments to their respective local contexts. Most Chinese with metro systems have adopted practices similar to transit-oriented development. Those cities include Beijing, Shanghai and Guangzhou. The model followed by Shenzhen Metro might be replicated in other countries with state control of land and state-owned companies

To better understand the replicability of the R+P model in mainland China, one needs to understand the differences between the Hong Kong SAR, China version of R+P and its counterpart in mainland China. First, Hong Kong MTRC's gradual withdrawal from real estate development in Hong Kong does not suggest that R+P will lose its popularity in mainland China. The political situation in Hong Kong SAR, China is different. After years of R+P practice in mainland China, Hong Kong MTRC has been under pressure to step down its efforts in the real estate market and focus on metro operation (Aveline-Dubach and Blandeau 2019). The for-profit Hong Kong MTRC competes against other real estate developers who view its participation in the real estate market as unfair because it receives preferential treatment from the government.

Metro corporations in mainland China are not under pressure to make a profit from the development of transit or of residential/commercial properties near stations. In fact, many develop public housing alongside market housing. They may receive a land parcel through a bidding procedure, rather than get a negotiated price. These metro corporations are still developing their capacity as transit operators, and typically they partner with local developers for the real estate component of the R+P projects.

It is also worth noting that the stagnation of Hong Kong MTRC's R+P programs in mainland China does not suggest that R+P is losing favor in Chinese cities. As mentioned earlier, about two-thirds of cities with metro operations have tried their own R+P programs. ■■■

Shenzhen's practice of integrated transport and land development has been followed by many other Chinese cities, with adjustments to their respective local contexts.

Density

Figure 10
POPULATION DENSITY, 2000

Municipal
Maximum: 46,417 people/km²
Minimum: 1 person/km²
Average: 792 people/km²

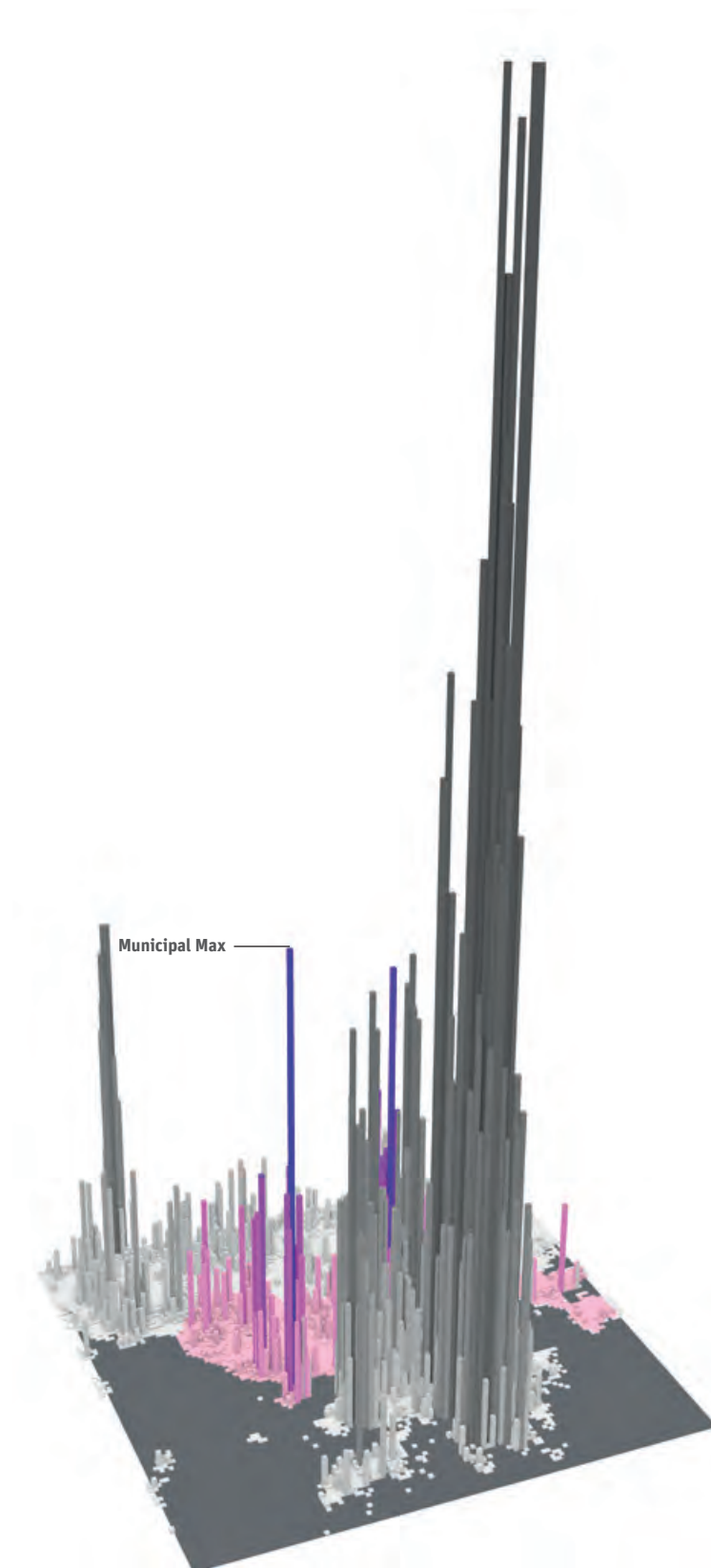


Figure 11
POPULATION DENSITY, 2017

Municipal
Maximum: 85,690 people/km²
Minimum: 1 person/km²
Average: 4,409 people/km²

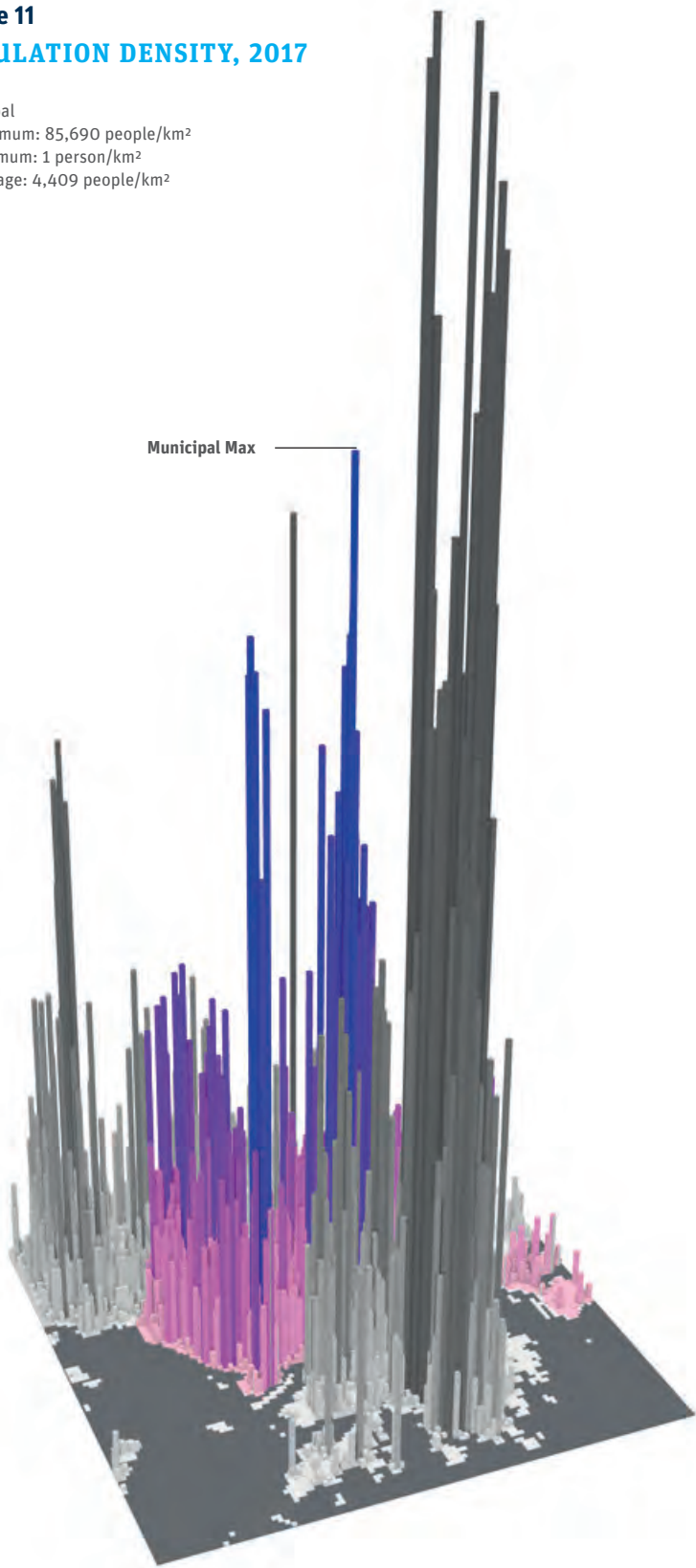
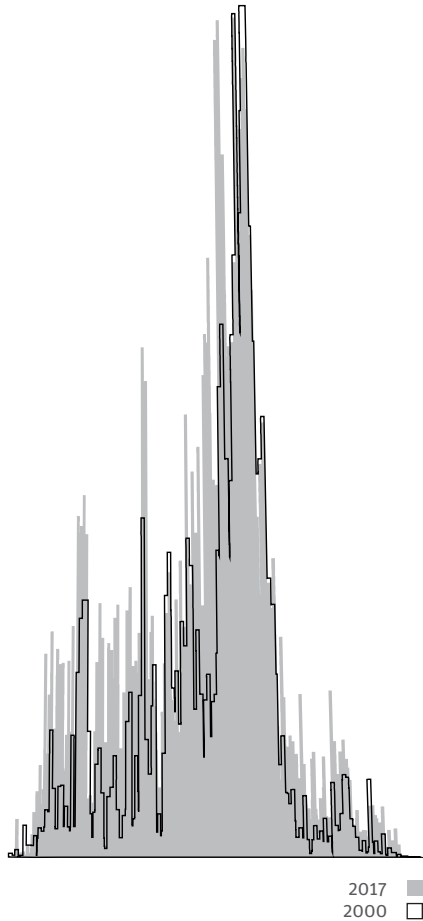


Figure 12
Overlay of density levels, 2000–2017



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ABBREVIATIONS

ESDP	economic and social development plan
GIS	geographic information system
MTRC	Mass Transit Rail Corporation
R+P	rail plus property
SAR	Special Administrative Region
SEZ	special economic zone
SMA	Shenzhen Metropolitan Area
SOE	state-owned enterprise
SMG	Shenzhen municipal government
TOD	transit-oriented development

Currency exchange rate: 1 USD = ¥ 7.14 (September 2019).

A Metropolitan Opportunity

How rapidly growing cities utilize integrated planning to decarbonize urbanization

Cities are the source of over 70 percent of the world's greenhouse gas emissions. Cities are also the engines of the global economy, concentrating more than half the world's population. By the year 2050, two-thirds of the world will be urban, with cities accommodating an additional 2.5 billion people over today's total. Nearly all of this urban growth will occur in developing countries. This concentration of people and assets also means that the impacts of natural disasters, exacerbated by the changing climate, may be even more devastating, both in terms of human lives lost and economic livelihoods destroyed. Earth is on a trajectory of warming more than 1.5°C unless important decarbonizing steps are taken.

Often urban policymakers prescribe integration as the solution to steering urbanization towards decarbonization to achieve greater global and local environmental benefits. However, little is known about the struggles—and successes—that cities in developing countries have in planning, financing, and implementing integrated urban solutions.

Greater Than Parts: A Metropolitan Opportunity presents nine diverse metropolitan areas as individual case studies each with a selection of urban innovations. From the analysis, the report derives models, poses guiding questions, and presents key principles to provoke and inspire action by cities around the world.

The main objective of this report is to understand how developing and emerging economies are successfully utilizing *horizontal integration*—across multiple infrastructure sectors and systems—at the metropolitan scale to deliver greater sustainability. Integrated planning processes extending well beyond city boundaries are examined to determine how they have been financed and implemented. The report's primary audience is therefore city decision makers, their financiers, technical advisers, and practitioners most interested in applying integrated approaches to sustainable urban planning in capacity-constrained environments.



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