

CASE 3

Singapore

The One-System Approach: Integrated Urban Planning and Efficient Resource Use

Singapore is an island city-state at the southern tip of the Malay Peninsula (figure 3.25). With a limited land area of 700 square kilometers and a population of 4.8 million, Singapore has become developed because of innovative urban planning integrated with the efficient use of land and natural resources (CLAIR 2005; Statistics Singapore 2009).

Singapore's small size poses challenges related to the availability of land and natural resources. To optimize land use, Singapore promotes high-density development not only for businesses and commercial entities, but also for residential structures. High density lends itself to higher economic productivity per unit of land and facilitates the identification of green spaces and natural areas for preservation. Indeed, Singapore is known as the garden city. Furthermore, high-density development has translated into greater use of public transportation as major business, commercial, and residential areas are well connected to an integrated public transportation network. In 2004, public transportation as a share of all transportation modes during morning peak hours reached 63 percent. The significant use of public transportation helps reduce greenhouse gas emissions. High public transporta-



Figure 3.25 Singapore Cityscape

Source: Photo by Hinako Maruyama.

tion ridership also means Singapore has been able to recover all public transportation operating costs from fares, a feat achieved only by Hong Kong, China, and by Singapore among modern, highly developed cities (LTA 2008).

Singapore imports most of its natural resources, including food, water, and industrial materials. Careful resource planning is thus critical. For example, Singapore has adopted the comprehensive management of water resources by looping and cascading water, which represents a closed water cycle integrated into one system, rather than a water supply system based on once-through flows. Water efficiency is integrated into the activities in other sectors as a result of cross-sector coordination among

Profile of Singapore

Singapore

- An island city-state at the southern tip of the Malay Peninsula, 136.8 km north of the equator; located south of the Malaysian State of Johor and north of Indonesia's Riau Islands
- Population (2008): 4.84 million, including resident and nonresident population
- Land area: 700 km²
- Population density (2008): 6,814 people per km²
- GDP at current prices (2008): US\$181.9 billion
- Water and sewerage coverage: 100 percent
- Center of commerce and industry in Southeast Asia
- Global financial center and trading hub with one of the busiest seaports in the world



Map 3.5 Location of Singapore

Source: Map Design Unit, General Services Department, World Bank.

government departments and stakeholders. For example, new housing developments are equipped with efficient rainwater collection devices so that building roofs become water catchment areas.

Singapore has introduced various tools and incentives to manage the resource supply and demand. For example, it has implemented strategic water tariffs, creative energy policies, road pricing schemes, and a vehicle quota system. These measures discourage people and businesses from using resources beyond the city's capacity to supply them.

Singapore has demonstrated how a city may enhance economic productivity and growth, while minimizing ecological impacts and maximizing the efficiency of resource use. The strong leadership of the prime minister has been a major driver in the city-state's sustainable development, complemented by an integrated one-system approach and the active collaboration of stakeholders.

Approaches and Ecological and Economic Benefits

Singapore is committed to promoting sustainable development. The Inter-Ministerial Com-

mittee on Sustainable Development, which was established in 2008, enables integrated approaches across ministerial boundaries in the formulation of strategies for sustainable growth.

Integrated land use and transportation planning

Because of limited land resources, land use planning has been important in maintaining the quality of Singapore's environment and supporting its economic growth. Since independence in 1959, Singapore has actively expropriated land to obtain public land for public facilities, promote city redevelopment, and catalyze new development. Today, about 90 percent of land is owned by the city-state (Bertaud 2009). The city thus has strong authority over urban development plans and their implementation.

Singapore's Urban Redevelopment Authority within the Ministry of National Development is in charge of urban planning and promotes Singapore's policy of high-density development. For example, the central business district of Singapore has floor area ratios up to 13. Ongoing development near Marina Bay next to the central business district aims to produce high-density, mixed use development with floor area

ratios up to 20 (URA 2009). Marina Bay will be more than a commercial center. It will also offer housing, shops, hotels, recreational facilities, and community zones such as green areas and open spaces.

Singapore's high-density, built-up areas have enabled the preservation of open spaces, natural parks, and greenery. Around 10 percent of all land is designated as green space, including natural reserves (figure 3.26). The share of green area in Singapore, including roadside greenery, was 36 percent in 1986, but increased to 47 percent in 2007. This gain was realized despite population growth of 68 percent.

Singapore's transportation plan is coordinated and well integrated with land use planning (Leitmann 1999). Recent high-density development, such as new towns, industrial estates, and commercial areas, is well connected to the city's mass rapid transit system. The mass rapid transit network runs underground in the city center and on the surface outside the city center and in other major areas. The network is the backbone of Singapore's public transportation system. Other transportation modes, such as buses and light rail transit, are well connected to network routes at interchange stations and serve local areas. To ease transfers, Singapore introduced a distance-based through-fare structure.

The integration of the mass rapid transit, light rail transit, and bus networks helped boost public transportation's share in all transportation modes (including taxis) to 63 percent in

2004, although this represented a decline from 67 percent in 1997 that was attributable to the growing use of private cars. In addition, among major cities in developed countries, the full recovery of the operating costs of public transportation through fares has been achieved only by Hong Kong, China, and by Singapore (LTA 2008). Because the transportation system has been integrated into high-density development areas with sizable populations, it has been possible to maintain the financial viability and high-quality service of the system. People are well satisfied with public transportation¹ (LTA 2008).

Transportation measures

Singapore's Land Transport Authority was established in 1995 by integrating four separate land transport departments comprehensively to plan, control, and manage relevant policies. The authority aims to provide a high-quality transportation system, enhance the quality of the lives of citizens, and maintain Singapore's economic growth and global competitiveness.

Singapore provides incentives to control the number of private cars. In 1990, the vehicle quota system was introduced by the government to limit the number of newly registered cars to 3 to 6 percent each year. A consumer wishing to purchase a new car must apply to the Land Transport Authority to conduct an open bidding process. Car owners must obtain certificates of enrollment that are valid for a decade following registration (Leitmann 1999, CLAIR 2005).

To respond to growing traffic and congestion, Singapore introduced an area licensing scheme in 1975 to manage cars entering the central business district during peak hours. In 1998, to boost effectiveness, the area licensing scheme was replaced by the current electronic road pricing system. The new system electronically collects fees from drivers through in-vehicle units installed in cars that enter designated areas of the city center during certain periods of peak



Figure 3.26 A Green Area in Singapore

Source: Photo by Hinako Maruyama.

traffic. The system has several price options depending on road types (arterial and highway) and periods. Higher prices are applied during the most congested times. In addition, Singapore uses several other demand control measures, such as encouraging off-peak driving or park-and-ride schemes through financial incentives (Leitmann 1999, CLAIR 2005).

Taken together, these road traffic, public transportation, and mobility measures mean that 71 percent of trips in Singapore may be completed in less than an hour (IMCSD 2009). Traffic congestion is alleviated, and average traffic speed is maintained. Unnecessary vehicular emissions are thus avoided. This translates into less greenhouse gas linked to climate change. However, travel demand is expected to increase from 8.9 million trips in 2008 to 14.3 million trips in 2020. Within Singapore, 12 percent of the land is dedicated to roads, and 15 percent to housing. Moreover, it is highly unlikely that more land can be dedicated to roads to accommodate travel demand (LTA 2008). Singapore must thus accommodate increased demand through public transportation services, not automobiles.

Water resource management

Singapore is considered a water-scarce city-state despite high annual precipitation of 2,400 millimeters per year (Tortajada 2006a).² Singapore imports water from neighboring Malaysia. To reduce dependency on external water sources, Singapore is taking steps to improve water security and establish an independent water supply within its own territory. The approach Singapore has developed and implemented to achieve this aim is considered successful because of the city-state's institutional effectiveness and its highly efficient control of water demand and supply. Singapore successfully lowered its annual water demand from 454 million tons in 2000 to 440 million tons in 2004, while its population and GDP grew by 3.4 and 18.3 percent, respectively (Tortajada 2006a). Singa-

pore has shown that comprehensive water resource management is achievable using new approaches and that these approaches are financially viable.

The institutional framework that enabled the integrated approach

The Public Utilities Board (PUB), a statutory board under the Ministry of the Environment and Water Resources, manages the entire water cycle, including collection, production, distribution, and reclamation. It is the national water agency of Singapore. When PUB was established in 1963, it managed several utilities, including water, electricity, and gas. To reduce costs and improve services, PUB underwent institutional restructuring in 2001. The electricity and gas services were privatized, and sewerage and drainage functions were transferred to PUB. Since 2001, PUB has developed and implemented comprehensive and holistic approaches to the water system, rather than managing each water function individually (water supply, sewage, drainage, and so on). In this way, the water loop is closed, which enables PUB to implement the Four National Taps, a long-term strategy to ensure that Singapore has sustainable water supplies (figure 3.27). The Four National Taps are (1) water from local catchments, (2) imported water, (3) desalinated water, and (4) NEWater (reclaimed water from wastewater). By approaching the water system holistically, PUB is able to efficiently address various issues and activities, such as water resource protection, storm water management, desalination, demand management, water catchment management, private sector engagement, and community-driven programs, including public education and awareness campaigns. PUB also runs a research and development facility in which experts research water technology.

PUB's effective engagement of the private sector is a distinctive aspect. To lower costs, PUB harnesses the private sector in areas where it does not have competence or competitive

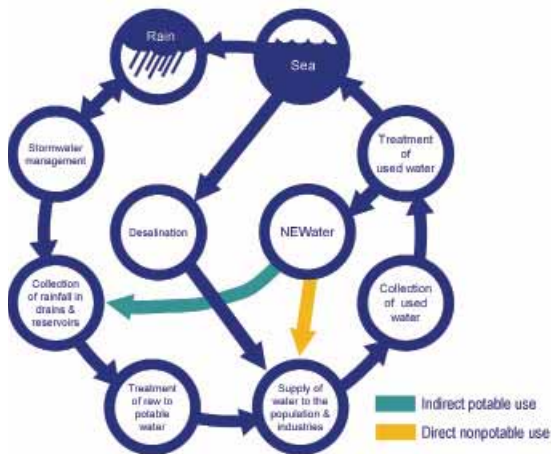


Figure 3.27 A Closed Water Loop in Singapore

Source: PUB (2008a).

advantage. For example, public-private partnerships are used in water desalination and wastewater reclamation.

Supply management

Because water is scarce, Singapore carefully manages its water supply. Sewerage covers 100 percent of the city-state area, and all wastewater is collected. Singapore has a separate drainage system to ensure wastewater and runoff do not mix. Wastewater and drainage water are recycled into the city-state's water supply.

The Four National Taps strategy considers the following as water sources (PUB 2008b):

1. *Water from local catchments* (catchment management): Rainwater is collected from rivers, streams, canals, and drains and stored in 14 reservoirs. Because storm drains are separated from the sewerage system, rainwater may be sent directly to rivers or reservoirs for later treatment to produce tap water. Reservoirs are linked via pipelines. Excess water may be pumped from one reservoir to another, thus optimizing storage capacity and preventing flooding during heavy rains. Catchment areas are protected, and polluting activities are prohibited in these areas by strict regula-

tions. By 2009, water catchment areas will have expanded from one-half to two-thirds of Singapore's land surface. Activities that generate pollution are allowed on only 5 percent of Singapore's land area; all other land is protected. Water catchments provide about half of Singapore's water needs (Tigno 2008).

To improve environmental and resource management, the government pays close attention to water catchment areas and to the locations of industrial sites. Singapore also pursues integrated urban planning. For example, PUB and the Housing and Development Board, which is under the Ministry of National Development, collaborate to enhance Singapore's water catchment areas. PUB considers rainfall an important resource, and rainfall collection and drainage systems are installed on the roofs of housing structures developed by the Housing and Development Board. Newly developed properties are equipped with rainfall collection and drainage systems. Collected water is stored in neighboring holding basins and transferred to reservoirs. This strategy allows built-up areas to participate in water catchment. Two-thirds of Singapore's land area is expected to participate in water catchment.

2. *Imported water*: Singapore will continue to import water from Malaysia under two bilateral agreements that expire in 2011 and 2061 respectively. Imported water accounts for about a third of the country's water needs (Tigno 2008).
3. *Desalinated water*: In September 2005, Singapore opened a US\$200 million desalination plant, which was PUB's first public-private partnership project. The plant can produce 30 million gallons (136,000 cubic meters) of water a day; it is one of the largest seawater reverse osmosis plants in the region. In 2007, the plant provided about 10 percent of the country's water needs (Tigno 2008).

4. *NEWater*: Used water (wastewater) is also an important water resource. Wastewater is collected through an extensive sewerage system and treated at water reclamation plants. Wastewater is purified using advanced membrane technology to produce high-grade reclaimed water, known as *NEWater*, which is safe to drink. Because such water is purer than tap water, it is ideal for industry uses that require high-quality water, such as the manufacture of precision equipment and information technologies. Each day, PUB blends 6 million gallons (28,000 cubic meters) of *NEWater* with raw reservoir water, which is later treated to become tap water. The amount to be blended will increase to 10 million gallons a day (46,000 cubic meters) by 2011. Four *NEWater* factories operate in Singapore, and a fifth plant is being built under a public-private partnership agreement. In 2008, *NEWater* satisfied more than 15 percent of Singapore's total daily water needs, and the share is expected to rise to 30 percent by 2010 (PUB 2008c, 2008d).

The water supply may be optimized if nonrevenue water or water lost to leaks is reduced. The 4.4 percent share of nonrevenue water in Singapore's water supply in 2007 was low (Lau 2008), and there are no illegal connections (Tortajada 2006a).³

PUB has built a deep tunnel sewerage system as an integral part of the water loop. Though sewerage coverage is 100 percent, the

aging sewerage network posed problems. The new system comprises deep sewerage tunnels that intercept water flows from existing sewerage pipes, pumping stations, and linked sewerage pipes. The designed lifespan of the system is 100 years. Because wastewater flows by gravity through the system to a centralized water reclamation plant (the Changi plant), intermediate pumping stations may be abolished. This removes the risks of surface water pollution caused by failures at intermediate pumping stations and the risks of damage to pumping mains. Water reclamation plants and pumping stations require about 300 hectares of land. New water reclamation plants in the deep tunnel system occupy only 100 hectares; 200 hectares of land may therefore be released for other uses. Building the system proved to be more cost-effective (by more than S\$2 billion, or about US\$1.35 billion) than expanding and upgrading existing infrastructure (Tan 2008). The system also enhances the closed water loop by collecting wastewater effectively for *NEWater* production.

Demand management

PUB has a well-planned, holistic policy for managing water demand. Tariffs rely on several rates depending on consumption level, not lump-sum proxies (table 3.2). If domestic use surpasses more than 40 cubic meters per month, the unit charge becomes higher than the non-domestic tariff. The basic water tariff has increased each year since 1997. The water con-

Table 3.2 Water Tariff in Singapore

SERVICE	CONSUMPTION BLOCK, M ³ /MONTH	TARIFF BEFORE GST, S\$/M ³	WATER CONSERVATION TAX BEFORE GST, % OF TARIFF	SANITARY WATERBORNE FEE AFTER GST, S\$/M ³	APPLIANCE FEE AFTER GST, S\$/ CHARGEABLE FITTING/MONTH
Domestic	0 to 40	1.17 (US\$0.81)	30	0.30 (US\$0.21)	3.00 (US\$2.07)
	above 40	1.40 (US\$0.97)	45	0.30 (US\$0.21)	3.00 (US\$2.07)
Nondomestic	all units	1.17 (US\$0.81)	30	0.60 (US\$ 0.41)	3.00 (US\$ 2.07)

Source: PUB Web site, <http://www.pub.gov.sg/mpublications/FactsandFigures/Pages/WaterTariff.aspx> (accessed May 2009)

Note: The U.S. dollar amounts shown in parentheses reflect the exchange rate of S\$1.00 = US\$0.69 as of June 4, 2009. Before GST (goods and services tax) and after GST indicate tariffs and fees excluding and including, respectively, the GST of 7 percent as of May 2009, rounded to the nearest cent. GST = goods and services tax; M³ = cubic meter.

Table 3.3 Water Consumption and Water Bills per Household in Singapore, 1995, 2000, and 2004

INDICATOR	1995	2000	2004
Population (1,000s)	3,524.5	4,028	4,167
GDP (US\$ millions)	84,288.1	92,720.2	109,663.7
National water consumption (millions m ³)	403	454	440
Average monthly water consumption (m ³)	21.7	20.5	19.3
Average monthly water bill, including taxes (S\$)	14.50	31.00	29.40

Source: Tortajada (2006b).

Note: m³ = cubic meter.

servation tax is levied to reinforce water conservation. In addition, a waterborne fee is charged to cover the costs of wastewater treatment and the maintenance and extension of the public sewerage system. This represents a financial disincentive on household water consumption. Consequently, as water bills are raised (inclusive of all taxes), water consumption decreases (table 3.3). The tariff system has significantly influenced water usage. Although annual water use in Singapore increased from 403 million cubic meters in 1995 to 454 million cubic meters in 2000, these demand control policies helped lower demand to 440 million cubic meters in 2004 (Tortajada 2006b).

Social considerations and awareness raising

To ensure equity, the government provides direct subsidies to lower-income families. Lifeline tariffs subsidize all water consumers, not only those who cannot afford to pay high tariffs. As such, Singapore provides subsidies only to targeted poor households. Targeted subsidies are widely considered more efficient in socioeconomic terms relative to subsidies on the initial amount of water consumed by all households irrespective of economic status. The tariff system makes clear that those who consume more water will be penalized (through basic tariffs and taxes) even more heavily than commercial and industrial uses.

Other environmental approaches

Singapore supports intense economic activity in the small island-state. Maintaining a quality

environment is thus a critical issue. The Ministry of the Environment and Water Resources issued the Singapore Green Plan 2012 in 2002 and updated it in 2006. The plan addresses six main areas: air and climate change, water, waste management, nature, public health, and international environmental relations (MEWR 2006). The plan builds on the 1992 Singapore Green Plan. Since 1992, local officials have actively tackled environmental issues by implementing various activities involving a range of stakeholders, including citizens and public and private sector entities. In 2009, the Sustainable Singapore Blueprint—“A Lively and Livable Singapore: Strategies for Sustainable Growth”—was launched by the Inter-Ministerial Committee on Sustainable Development to ensure that Singapore not only met the target set in the Green Plan, but also would go beyond this to achieve economic growth and a good living environment in an integrated way (IMCSD 2009).

Energy: To avoid overconsumption, Singapore does not subsidize energy. Electricity supplies are established by market demand and competition, and industries are encouraged to find better solutions and to be energy efficient. For improvement of cost-effectiveness, natural gas-based electricity generation has recently surpassed oil-based generation. The share of electricity produced using natural gas rose from 19 percent in 2000 to 79 percent in 2007. In addition, energy consumption per unit of GDP has been reduced, and the efficiency of electricity generation has been enhanced (IMCSD

2009). To raise public awareness about energy concerns, the government has introduced E² Singapore, a national energy efficiency plan. The government has also made investments in energy research and technologies. For example, to capitalize on Singapore's tropical location, the government promotes solar energy research with a view to reinforcing the clean energy sector.

Air pollution measures: To minimize air pollution, land use plans locate industrial facilities outside the urban area. Car emissions are another source of air pollution. The vehicle quota system and the electronic road pricing system help reduce traffic congestion, and the integrated public transportation system encourages public transportation ridership. Additional car emissions are avoided, including airborne particulate matter and greenhouse gases. In 2008, 96 percent of the days in the year showed good air quality according to the Pollutant Standards Index (IMCSD 2009).

Waste management: Rapid economic and population growth has resulted in increased waste. Because it has limited land for landfills, Singapore incinerates wastes that cannot be recycled or reused. Incineration reduces the weight and volume of waste by, respectively, 10 percent and 20 percent, and has proven to be an efficient waste treatment process (CLAIR 2005). Electricity produced from incineration provides 2 to 3 percent of the city's electricity needs (IMCSD 2009). Singapore has only one remaining landfill site, which is located 8 kilometers south of the mainland and is the city-state's first constructed offshore landfill. There is no more land available for landfills or the disposal of residue from incineration. It is expected that the life of this offshore landfill will surpass its 2040 closure because of the recycling efforts of citizens (SG Press Centre 2009). However, the city is facing waste management challenges, especially as daily waste increased by a factor of 6, to 7,600 tons, between 1970 and 2000 owing to economic growth, population increases, and improved living standards (CLAIR 2005).

To promote recycling and waste reduction, Singapore's National Recycling Program encourages various activities, and per capita domestic waste has fallen despite economic growth. In 2008, the recycling rate reached 56 percent. Additionally, government-industry collaboration has promoted reduced waste from packaging (IMCSD 2009).

River cleanup: Singapore has successfully cleaned and restored the environmental conditions of its once deteriorated rivers. In 1977, Singapore and the prime minister supported a major project to clean the Singapore River and Kallang Basin, which covers about one-fifth of the city-state's land area. Uncontrolled waste and wastewater from farms, houses not on the sewerage system, and squatters were being discharged directly into the rivers. In response, houses and other polluting activities were relocated, and efforts were undertaken to improve the physical condition of the rivers. The riverbeds were dredged; waterfront facilities were upgraded; and greenery was added to riverbanks. Government agencies, grassroots communities, and nongovernmental organizations contributed to the cleanup. The rivers were revitalized in 10 years at a cost of S\$200 million (Best Policy Practices Database). Today, the river waterfronts, including canals and reservoirs, are well preserved and maintained. These river zones act as water catchments and flood prevention areas, while providing community recreational space (for example, see PUB 2008e).

Singapore's waterways, including its rivers and reservoirs, are designed to be people friendly. The designs complement Singapore's vision as a city of gardens and water. Waterways and embankments are often recreational sites; moreover, people are reluctant to contaminate a resource they eventually drink. PUB provides educational opportunities through a visitor center and learning courses. PUB also encourages water conservation by providing tips and devices for saving water in households.

Greening: Singapore's Garden City campaign has been promoted since the 1970s to green the country by planting trees along roads, in vacant plots, on reclaimed land, and in new developments. Flowers are added, too. Since Singapore's independence in 1959, more than a million trees have been planted, and a high standard has been achieved in landscaping in the country (Leitmann 1999).

Housing

The government aims to supply affordable housing to its citizens. The Housing and Development Board plans and develops public housing and facilities in new towns. Because land is limited, high-density development and high-rise buildings are promoted for commercial, business, and residential uses. Urban renovation and the development of new and satellite towns are encouraged; 20 such towns have been constructed. New towns are connected to public transportation and Singapore's city center. In 2003, 84 percent of Singaporeans resided in publically built housing, and 92.8 percent had their own housing (CLAIR 2005). Since 1989, the Housing and Development Board has implemented an ethnic integration policy to ensure a balanced mix of ethnic groups in public housing (HDB 2009). Singapore has myriad ethnic groups, including Chinese, Indians, and Malays. The policy prevents the establishment of racial enclaves and promotes diverse communities and social integration.

Lesson Learned in the Singapore Case

Singapore faces challenges related to the scarcity of land and natural resources amid strong economic and population growth. Singapore shows that innovative and comprehensive management of land and other resources is achievable. Singapore has capitalized on its

understanding of local conditions to develop a high-density city that preserves green spaces and open spaces. Public transportation works efficiently and is financially viable and integrated with land uses. Because of Singapore's comprehensive and integrated management of resources, the city-state is successfully addressing ecological, economic, and social concerns, while ensuring sustainability and productivity.

Notes

1. According to the Land Transport Authority (LTA 2008), 86.5 percent of the population are satisfied with the bus and rail services. About 80 percent are satisfied with the overall travel times on buses and trains. About 85 percent are satisfied with the accessibility and the locations of bus stops and mass rapid transit stations.
2. For comparison, data on annual rainfall among major cities in the world show the following: Bangkok, 1,530 millimeters; Beijing, 575 millimeters; Jakarta, 1,903 millimeters; Kuala Lumpur, 2,390 millimeters; London, 751 millimeters; Manila, 1,715 millimeters; New York, 1,123 millimeters; Shanghai, 1,155 millimeters; Tokyo, 1,467 millimeters (see Statistics Bureau 2008).
3. In most urban centers in Asia, nonrevenue water accounts for around 40 to 60 percent of water supplies.

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