

## CASE 1

# Curitiba, Brazil

### Cost Is No Barrier to Ecological and Economic Urban Planning, Development, and Management

The case of Curitiba, Brazil, shows that cost is no barrier to ecological and economic urban planning, development, and management. Curitiba has developed a sustainable urban environment through integrated urban planning (figure 3.1). To avoid unplanned sprawl, Curitiba directed urban growth linearly along strategic axes, along which the city encouraged high-density commercial and residential development linked to the city's integrated master plan and land use zoning. Curitiba adopted an affordable but innovative bus system rather than expensive railways that require significant time to implement. Curitiba's efficient and well-designed bus system serves most of the urban area, and public transportation (bus) ridership has reached 45 percent.<sup>1</sup> The city now has less traffic congestion, which has reduced fuel consumption and enhanced air quality. The green area has been increased, mainly in parks that have been created to improve flood prevention and through regulations that have enabled the transfer of development rights to preserve green areas and cultural heritage zones. As part of efforts to concentrate shops and facilities in the city center and along dense axes, Curitiba's car-free central city zone (including its main streets and recreational facilities such as parks) has become more walkable, lively,



**Figure 3.1 Curitiba Cityscape**

Source: Institute for Research and Urban Planning of Curitiba (IPPUC).

and attractive to citizens. Crime has also decreased. In addition, citizens, particularly the poor, are provided with opportunities to participate in environmental activities and educational programs.

The social, economic, and environmental elements of sustainable development in Curitiba have been facilitated by integrated land use, public transportation, and street network plans (figure 3.2). Much of the success may be attributed to the Institute for Research and Urban Planning of Curitiba (IPPUC), an independent public authority that handles not only research and planning, but also the implementation and supervision of urban plans. IPPUC has coordinated the various aspects of urban development and ensured continuity and consistency in planning processes amid turnover in city administrations. This is an illustration of successful path dependency in urban development in terms of the spatial, institutional, and cultural aspects.

## Profile of Curitiba and the Curitiba Metropolitan Region

### Curitiba

- The capital of the State of Paraná, in the south of Brazil
- Land area: 432 km<sup>2</sup>
- Population (2008): 1.83 million
- Annual population growth rate: 1.86 percent
- The city is bordered by the Iguaçu River to the east and Passaúna Park to the west.
- The city is located at the center of Brazil's largest economic corridor, which includes Brasília, Porto Alegre, Rio de Janeiro, and São Paulo, and near major cities, such as Buenos Aires and Montevideo, in other South American countries.

### Curitiba Metropolitan Region

- Consists of 26 municipalities, including Curitiba
- Land area: 15,622 km<sup>2</sup>
- Population (2008): 3.26 million
- Population growth rate: 2.01 percent

### Population Growth in Curitiba

YEAR	1960	1970	1980	1991	2000	2007	2008
Population (1,000s)	361	609	1,025	1,315	1,587	1,797	1,828
Population density (persons per km <sup>2</sup> )	836	1,410	2,373	3,044	3,674	4,161	4,232
Green area (km <sup>2</sup> per person)	—	<1	—	—	—	—	51.5

Source: IPPUC, <http://ippucnet.ippuc.org.br> (accessed January 15, 2009); data for 2008 from IPPUC (2009a).  
Note: — = not available; km<sup>2</sup> = square kilometers



**Map 3.1 Location of Curitiba**

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



**Figure 3.2 Policy Integration in Curitiba**

Source: IPPUC

## Approaches and Ecological and Economic Benefits

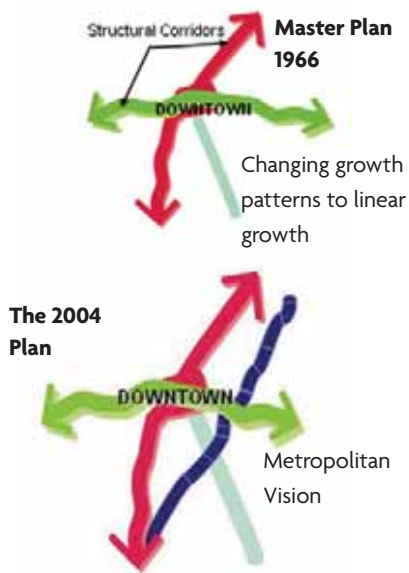
Curitiba took various innovative approaches to ecological and economic urban planning. The following are the seven major approaches.

### Innovative land use planning integrated with transportation planning

Urban sprawl and concentrated traffic in Curitiba's downtown area were anticipated because of rapid population growth. The city formulated a master plan in 1966 that integrated land use and transportation plans. Curitiba decided to direct urban growth linearly by designing structural axes radiating from the city

center (figure 3.3). Major economic activities are concentrated along these corridors, and the city appears to have a linearly formed downtown. At the same time, the city center was reinforced with high-density development (figure 3.4). The structured corridors became major public transportation routes under a bus rapid transit (BRT) system that includes dedicated lanes and bus stops nearly every 500 meters.

To realize this plan and guide linear urban growth, Curitiba implemented detailed zoning plans that reflect the master plan's strategic vision, geographical and geological constraints, water and wind directions, Curitiba's industrial profile, and urban cultural and social factors. In 2000, Curitiba had 50 types of specific zoning categories (figure 3.5). Each zoning category defines requirements related to land use, building-to-land ratios, floor area ratios, and maximum building heights. For example, in the city



**Figure 3.3 Urban Growth Axes in Curitiba**

Source: IPPUC (2009a).



**Figure 3.4 Density of Curitiba, 2004**

Source: IPPUC, <http://ippucnet.ippuc.org.br> (accessed January 15, 2009).



**Figure 3.5 Zoning in Curitiba, 2000**

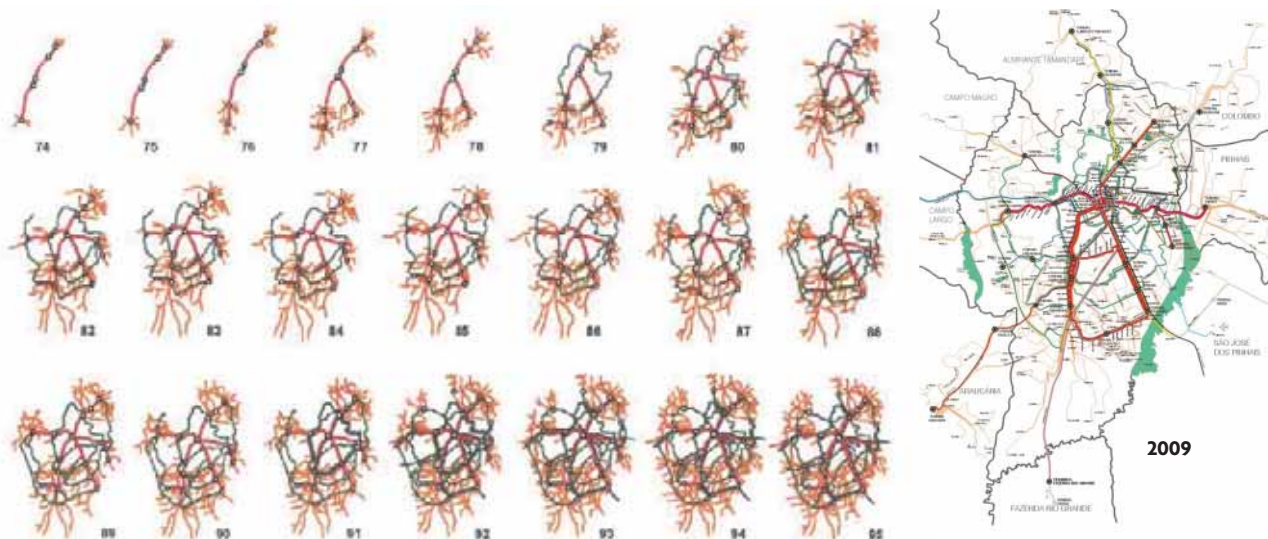
Source: IPPUC, <http://ippucnet.ippuc.org.br> (accessed January 15, 2009).

center area, the zone ZC category allows the development of residential apartments and commercial and service facilities (except supermarkets) subject to specific parameters: floor area ratios up to 5, first-floor building-to-land ratios up to 100 percent, and no limit on building heights in most areas. (However, to ensure aesthetics, buildings are normally limited to 20 floors, and some areas are subject to building height limitations to secure flight routes.) In addition, many zones facing structural axes (that is, zone SE) allow the development of residential apartments and commercial and service facilities with floor area ratios up to 4, first-floor building-to-land ratios up to 100 percent, and no limit on building heights in most areas. (As in zone ZC, buildings are normally limited to 20 floors to ensure aesthetics, and some areas are subject to building height limitations to secure flight routes; see Hattori 2004, Prefeitura Municipal de Curitiba 2000.)

To shift the land use and growth pattern into linear forms and to provide good access to transportation services, new development was

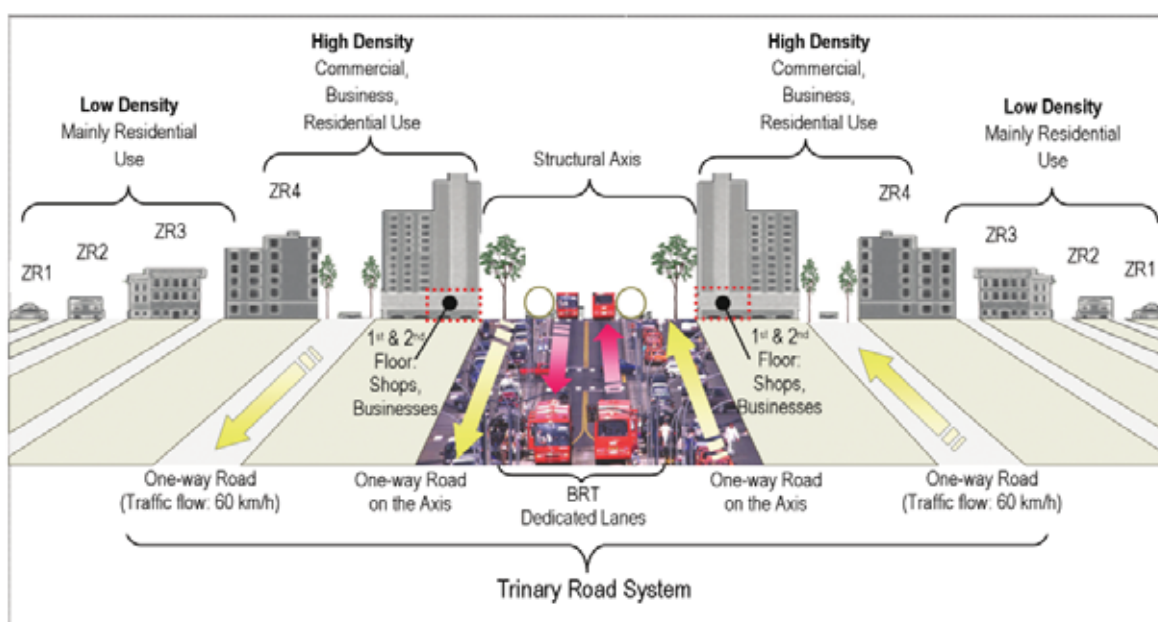
permitted only in areas reachable by public transportation. Because Curitiba was designed for people, not cars, public transportation coverage and service frequency are critical. Bus service reaches almost 90 percent of the city area, and all users may access public transportation services by walking less than 500 meters (figure 3.6) (IPPUC 2009a). Bus routes are serviced nearly every five minutes. Curitiba initially acquired land and reserved rights-of-way along the strategic axes, which enabled the city to build social housing in these areas. Subsequently, major economic activities and urban functions, including residential neighborhoods and schools, were reorganized densely along these axes.

To accommodate BRT routes and fulfill transportation needs along the axes, the city designated functions to existing roads under its trinary road system. The five major axes now accommodate both dedicated BRT lanes and roads to access buildings. Cars that do not need to access services along the axes may bypass these areas by using roads parallel to the axes



**Figure 3.6 Evolution of the Integrated Bus Network in Curitiba, 1974–95 and 2009**

Source: IPPUC (2009a).



**Figure 3.7 The Trinary Road System in Curitiba**

Source: Author compilation (Hinako Maruyama) based on IPPUC (2009a), Hattori (2004), and pictures supplied by IPPUC.

Note: km/h = kilometers per hour.

(figure 3.7). In addition, to avoid concentrated traffic in the city center, a previous mayoral administration transformed selected streets in the city center into pedestrian walkways on which cars are prohibited.

Through these measures, Curitiba’s spatial growth and urban land use patterns have been

efficiently controlled and defined. Traffic is diverted from the city center or the axes thanks to an effective mixture of land use planning and a well-conceived public transportation network. Because housing, service facilities, and job centers have been incrementally developed along the axes and linked to the BRT sys-



tem, the distances between homes, jobs, and schools have shortened, and many people travel by bus. Bus ridership as a share of all commuting trips reaches 45 percent, and 70 percent of these bus trips bypass the downtown area (IPPUC 2009b). As a result, the city has reduced car emissions and traffic congestion, thereby saving time and enhancing economic activity. A calculation based on 2002 data has estimated that Curitiba loses R\$2.55 million annually (US\$1.20 million) because of time lost to severe traffic congestion (table 3.1). Curitiba's per capita loss from severe congestion is about 6.7 and 11 times less than the corresponding losses in Rio de Janeiro and São Paulo, respectively. In 2002, Curitiba's annual fuel losses from severe traffic congestion equaled R\$1.98 million (US\$0.93 million). On per capita terms, this is about 4.3 and 13 times less than the losses in Rio de Janeiro and São Paulo, respectively (CNT 2002; Vassoler 2007). In contrast, in 2000, congestion in 75 metropolitan areas in the United States caused fuel and time losses valued at US\$67.50 billion (Downs 2004). Curitiba's fuel usage is also 30 percent lower than the usage in Brazil's other major cities (Friberg 2000). Reduced car emissions have decreased air pollution, which threatens public health. Curitiba now has one of the lowest rates of ambient air pollution in Brazil (Leitmann 1999). In addition,

emissions of greenhouse gases that affect climate change have declined.

Traffic flow has been diversified by assigning a logical and efficient road hierarchy, which has obviated the need to undertake substantial remedial works, such as widening street space (which may entail destroying buildings and disrupting neighborhoods). By making the most of infrastructure and adding new functions and traffic rules, the city has saved on construction costs. By avoiding extensive unplanned urban sprawl, its investment in infrastructure has been minimized and concentrated along the axes, and the installation of water pipes or cables into new areas has been avoided. More people now come to the city center because they are able to walk pedestrian streets, increasing the economic opportunities for local shops relative to streets with a predominance of car traffic.

### The integrated public transportation system

The construction cost of Curitiba's BRT system was US\$3 million per kilometer, which was more affordable than a tram system (a cost of US\$8 million to US\$12 million per kilometer) or a subway (US\$50 million to US\$100 million per kilometer) (Friberg 2000). Along the main axes, the BRT system functions much as a surface subway system would. Moreover, com-

**Table 3.1 The Time and Fuel Losses Caused by Congestion**

LOSS	CURITIBA, BRAZIL	SÃO PAULO, BRAZIL	RIO DE JANEIRO, BRAZIL	UNITED STATES	TOKYO, JAPAN
	2002	2002	2002	2000	1994
<i>Time loss</i>					
Total, US\$ millions/year	1.20	79.94	27.48	—	—
Per capita, US\$/year	0.67	7.34	4.51	—	—
<i>Fuel loss</i>					
Total, US\$ millions/year	0.93	73.23	13.47	—	—
Per capita, US\$/year	0.52	6.72	2.21	—	—
<i>Time and fuel losses</i>					
Total, US\$ millions/year	2.13	153.17	40.94	900 <sup>a</sup>	49,000 <sup>b</sup>
Per capita, US\$/year	1.19	14.07	6.72	—	4,100 <sup>b</sup>

Sources: For Brazil: CNT (2002), Vassoler (2007); for the United States: Downs (2004); for Tokyo: TMG (2000).

Note: Data are for reference only. Calculation methods for Brazil, United States, and Tokyo may be different and are not necessarily comparable. — = not available.

a. Average across 75 metropolitan areas. The total for these areas was US\$67.5 billion.

b. Calculation based on the loss of travel speed from 30 kilometers per hour to 18 kilometers per hour.

pared with a normal bus system, BRT run times are two-thirds less, while the costs are 18 percent less owing to several factors, including a 72-kilometer dedicated BRT lane, a fare system requiring payment before boarding, bi-articulated buses (articulated buses with three cabins instead of two), and a tube-shaped bus station that eases bus entry and exit (figure 3.8) (Hattori 2004).

The bus system is color coded and designed for various scales and levels of service (interdistrict, feeder, intermunicipal, and so on) to reach more areas of the city (figure 3.9). The bus system has adopted a flat-rate “social” fare. No matter how far a passenger rides or how many times the passenger transfers, the fare is the same. The poor tend to live in the urban periphery and need to travel long distances to commute, while the wealthy tend to live in the cen-

ter and need to travel shorter distances. About 80 percent of all residents are estimated to benefit from the flat-rate fare (Hattori 2004). Frequent high-quality services and inexpensive fares encourage people to use buses. Of all trips, 45 percent are made in buses, 5 percent by bicycle, 27 percent on foot, and 22 percent by private car, which is surprisingly low given that Curitiba has the second-highest rate of car ownership in Brazil (IPPUC 2009a).

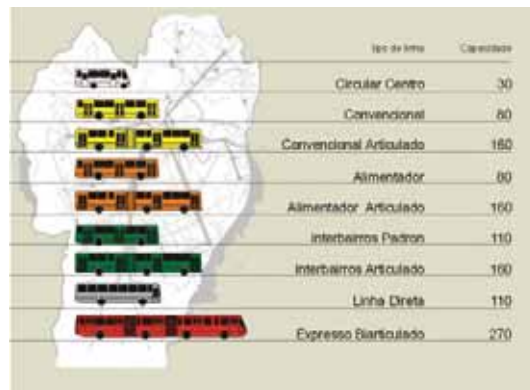
Buses running on the BRT dedicated lanes are bi-articulated, and the fleet is kept relatively young. The average age is a little more than 5 years, and no bus is more than 10 years old. The buses are well maintained and are less polluting. The greater carrying capacity of Curitiba’s bi-articulated buses (270 people) and the reduced travel times associated with the use of these buses have resulted in 50 percent less energy consumption relative to nonarticulated conventional bus services (Hattori 2004, IPPUC 2009c, ).

The BRT system pays for itself. Bus fares finance the system, generating profit for the bus companies and covering the costs of human resources and the maintenance and depreciation of buses without government subsidies. According to a law established in 1990, transportation revenue is exclusively dedicated to paying for the BRT system (Friberg 2000). In comparison, in some German cities with light rail, fare revenue covers only 30 percent of the operating costs; federal government subsidies are thus required. In the United States, subsidies for light rail are often generated through consumption taxes (Hattori 2004). The operation of the BRT system in Curitiba is managed by Urbanização de Curitiba (URBS), a city agency, but is served by private bus companies. The bus companies are paid on the basis of distance traveled, not by number of travelers; so, they are encouraged to operate even in areas with relatively few riders. Moreover, people are more motivated to use the buses because the service is frequent, affordable, and convenient.



**Figure 3.8 Bi-articulated BRT Bus and Bus Station in Curitiba**

Source: IPPUC.



**Figure 3.9 Color-Coded Buses in Curitiba**

Source: IPPUC.

### Green area enhancement and flood control

To improve the quality of the lives of its citizens, Curitiba decided to enhance the green areas and recreational facilities within the city, including parks and bicycle paths. Because Curitiba is surrounded by rivers such as the Iguaçu, flooding has been a big problem. However, instead of controlling water flow using concrete structures, Curitiba has created natural drainage systems. Riverbanks have been converted into parks where overflow water may be absorbed in the soil, and lakes have been constructed to contain floodwaters. River and rainwater flooding may be held naturally in the lakes and parks surrounding the lakes (figure 3.10). The ecosystem is thus preserved naturally. Because the park areas only gradually release flooded water that has been absorbed into the ground, rather than draining water rapidly through concrete drainage conduits into rivers, downstream flooding can be avoided. In addition, people are less exposed to flood-linked environmental hazards and diseases. Enormous expenditures are also avoided because there is less need for drainage canals, flood control measures, and flood damage repairs, including disease control measures. The cost of building parks and relocating favela (slum) dwellers has been estimated at five times less than the cost of building concrete canals (Vaz Del Bello and Vaz 2007).

Flood control areas are normally used as parks and recreational areas. Green areas have been enhanced from less than 1 square meter per person in the 1970s to 51.5 square meters per person today (ICLEI 2002; IPPUC 2009a). There are 34 parks in the city, and green areas cover about 18 percent of the urban land (Curitiba S. A. 2007). Bicycle paths are provided along the streets and inside the parks. The total length of the bicycle network is about 120 kilometers. Though park area has been expanded, the city has lacked the budgetary resources to maintain park grass. Instead of hiring mowers, sheep are kept in the parks to eat grass and provide natural fertilizer, which has reduced park



**Figure 3.10 Barigüi Park, Curitiba**

Source: IPPUC.

Note: This area was once flood prone and occupied by slum dwellers. It is now a converted 140-hectare park with a 40-hectare lake.



**Figure 3.11 Former Slums in Flood-Prone Areas in Curitiba**

Source: IPPUC.

maintenance costs by 80 percent, while enhancing the ecological image of the city.

Flood-prone land used to be occupied by slum dwellers (figure 3.11). Curitiba acquired the land, relocated the slum dwellers to better land, and provided compensation. After the park was established, the zone facing the park became neighborhoods with high-end housing. Houses with good views of the park and lake have high real-estate values; thus, property tax revenue has increased. Property taxes collected from these high-end houses have been estimated at the equivalent of the cost of park construction, including slum relocation and compensation.





**Figure 3.12 The Transfer of Development Rights for Environmental Preservation in Curitiba**

Source: IPPUC.

Many trees are found in Curitiba. There are 300,000 trees along public streets that create shade and prevent heating (IPPUC 2009b). Trees absorb pollutants and carbon dioxide. Curitiba's reserved forest areas capture an estimated 140 tons of carbon dioxide per hectare, which helps reduce negative impacts on climate change (IPPUC 2009b). In addition, the shade from trees cools buildings and the environment, which saves energy.<sup>2</sup> City regulations restrict the area of private land for development depending on the ratio of land to forest or trees. To encourage urban trees, the city offers landowners compensation for planting, such as the relaxation of floor area ratios and tax reductions. For example, the city tax is discounted 10 percent if a private landowner has one Paraná pine tree on his land. Also, rights to develop forest areas may be exchanged for rights to develop other city areas (figure 3.12). Guided by market principles, IPPUC regulates and monitors the implementation, negotiation, and transfer of development rights among interested parties (that is, private developers and landowners). As such, the city does not need to undertake relocation or assume the land acquisition costs of creating green areas or preserving historical areas.

### Solid waste management

Curitiba has several innovative programs in solid waste management. Curitiba's landfill was strained, and the city did not have sufficient revenue to build an incinerator. To slow the growth of waste, Curitiba initiated unique waste management programs that depend on citizens rather than constructing new and expensive waste treatment facilities. What is innovative is that these programs have not only reduced the growth of waste, but also offered opportunities for poor people, which is one of the critical aims of the city.

Curitiba's Garbage That Is Not Garbage Program encourages people to separate discards into recyclable and nonrecyclable waste (figure 3.13). To raise awareness of this program, Curitiba educates children to understand the importance of waste separation and environmental protection. Campaign mascots have been created, and school activities are regularly organized. One to three times a week, trucks collect paper, cardboard, metal, plastic, and glass that have been sorted at homes. This recycling saves the equivalent of 1,200 trees a day, and information displays in local parks show the numbers of trees that have been saved (Rabinovitch and Leitmann 1993). Money raised through the sale of recyclables supports social programs, and the city employs the homeless and people in alcohol rehabilitation programs in the garbage separation plant. Recycling also leads to other benefits. For instance, recycled fiber is used to produce asphalt for roads. Recycling has also eliminated piles of discarded tires, which attract mosquitoes that transmit dengue disease. Proper tire collection has decreased dengue disease by 99.7 percent (Vaz Del Bello and Vaz 2007). Nearly 70 percent of city residents participate in Curitiba's recycling program. Around 13 percent of Curitiba's waste is recycled, which greatly exceeds the 5 and 1 percent recycling rates in Porto Alegre and São Paulo, respectively, where education on waste dissemination has not translated into significant impacts (Hattori 2004).



The Green Exchange Program was also started in Curitiba's slum areas that are inaccessible to waste collection vehicles (figure 3.13). To encourage the poor and slum dwellers to clean areas, and thereby improve public health, the city began offering bus tickets and vegetables to people who brought garbage to neighborhood centers. In addition, children have been allowed to exchange recyclables for school supplies, chocolate, toys, and show tickets. The city purchases vegetables at discounted prices from farmers who have trouble selling abundant products. Through this program, the city saves the costs of arranging waste collection in slum areas, which often have inadequate roads, and helps farmers unload surplus produce. The program also helps improve nutrition, accessibility to transportation, and entertainment opportunities among the poor. Most important, slums are cleaner and have less disease incidence, and less garbage is being dumped in sensitive areas such as rivers.

### The Industrial City of Curitiba

In the 1970s, Curitiba's economy was based mainly on the service sector. To attract investment, boost employment, and reduce poverty, IPPUC decided to introduce manufacturing industries. To further this goal, the local government established the Industrial City of Curitiba on the city's west side, taking into account wind direction to avoid polluting the

central city. The industrial park has extensive green areas encompassing 4,300 hectares and is well connected to the bus network. Many employees at the industrial park live nearby and commute by bicycle. The industrial park has strict environmental regulations. Polluting industries are not allowed.

After three decades, the Industrial City of Curitiba now hosts more than 700 companies, including global firms such as information technology companies and an automaker producing BRT buses. It has created about 50,000 jobs directly and 150,000 jobs among secondary industries. About 20 percent of the exports of the State of Paraná originate in the industrial park, and the industrial park accounts for 25 percent of the industrial tax revenues (state value added taxes on sales and services) of the State of Paraná (Hattori 2004; Prefeitura Municipal de Curitiba 2009).

### Social considerations

Although Curitiba's economy is relatively well developed compared with the economies of other Brazilian cities, many poor people still live in slums. To encourage the poor to obtain jobs and to promote an inclusive community, Curitiba has adopted various innovative social approaches.

The city converted the undeveloped land under a high-voltage line in a southern area of the city into a "job line" that helps people start businesses and encourages the growth of the local



**Figure 3.13 Curitiba's Waste Program**

Source: Photos courtesy of IPPUC.

Note: The Garbage That Is Not Garbage Program (left) and The Green Exchange Program (right).

economy. Two social incubators provide training and facilities for the establishment of local business, and 12 entrepreneur sheds were created (Guimarães 2009). In addition, these facilities offer entrepreneurial capacity building. Underutilized occupied land was cleared; people were relocated; and public transportation services were commenced, which represented steps toward land recovery (Hattori 2004).

One of the largest problems in Curitiba has been slums. Those who do not have their own land occupy and settle on private land. Often, these areas become derelict, causing river pollution and fomenting crime (figure 3.14). Rather than spending time and money on relocating squatters and restoring the areas that had been occupied, the city, at low cost, purchased privately held lands that could be occupied. It then provided this land for unofficial occupancy. A formal land use zoning category was developed for such land. Thus, these areas were integrated into city plans, and residents could feel included. Simple land arrangements and water and electricity are offered because such services

risk being illegally procured if not provided, which may lead to fatal accidents. Occupants feel some sense of ownership over the land and are able to arrange roads and create quality living environments. Under city agency coordination, the value of the occupied land may be reimbursed through long-term loans. In addition, legal mailing addresses may be provided for occupiers, which helps people find jobs (Hattori 2004; Nakamura 2007).

Curitiba provides social housing in the suburbs, where land prices are relatively cheap, and in the city, especially between the city center and industrial areas (figure 3.15). Rather than encouraging groups with similar incomes to settle in neighborhoods, Curitiba encourages a mix of income groups so that the neighborhoods become inclusive. Apartments and small detached homes are provided as social housing. Poor people who can afford to purchase small detached houses are given incentives to improve the properties and their overall living environment by building additions and extensions onto their houses. In Curitiba, development



**Figure 3.14 Illegal Occupancy in Curitiba**

Source: IPPUC.



**Figure 3.15 Social Housing in Curitiba**

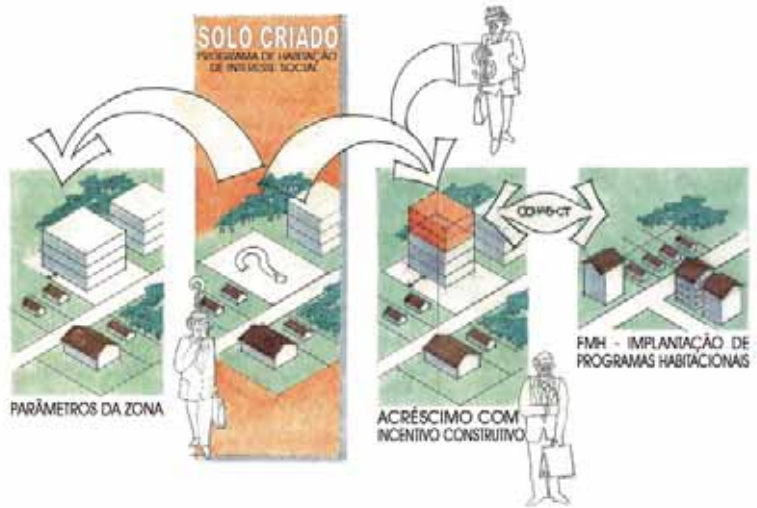
Source: IPPUC.

rights may be purchased. The money paid by developers to purchase the rights to develop sites may then be used to build social housing in other areas (figure 3.16).

City services are decentralized and are provided in major bus transit terminals. People are not necessarily obliged to travel to the city center for such services. Allowing people who live far from the city center to procure services close to home promotes equal opportunity. A flat bus fare also helps people reach bus terminals where city offices are located. In addition, city services such as educational, health, cultural, and social service facilities are distributed equally throughout the city. This system provides equal, high-quality, and accessible services to all citizens regardless of income.

### Culture and heritage preservation

Curitiba maintains an attractive and lively cityscape. This is a result of well-planned urban design and successful cultural heritage preservation. Vehicular streets in the city center have been converted into pedestrian streets to allow people to enjoy the urban cultural atmosphere (figure 3.17). Under Curitiba's 1977 Metropolitan Area Heritage Plan, 363 buildings were identified for preservation. However, because most of these buildings were on private land, managing their preservation was difficult. The city thus adopted a policy under which development or



**Figure 3.16 The Transfer of Development Rights for Social Housing in Curitiba**

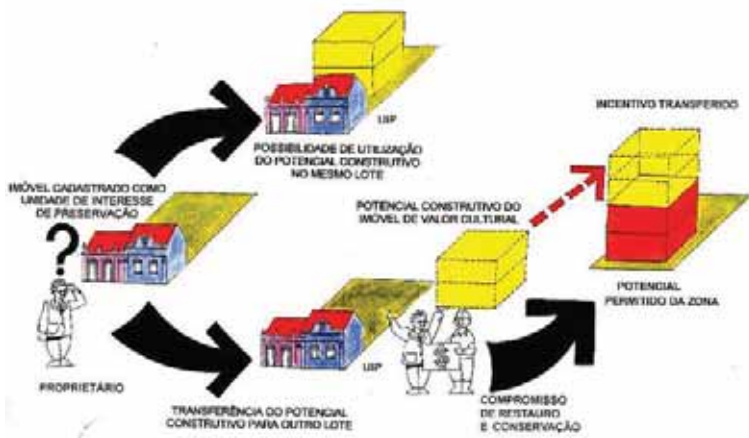
Source: IPPUC.



**Figure 3.17 Pedestrian Streets in the Center of Curitiba**

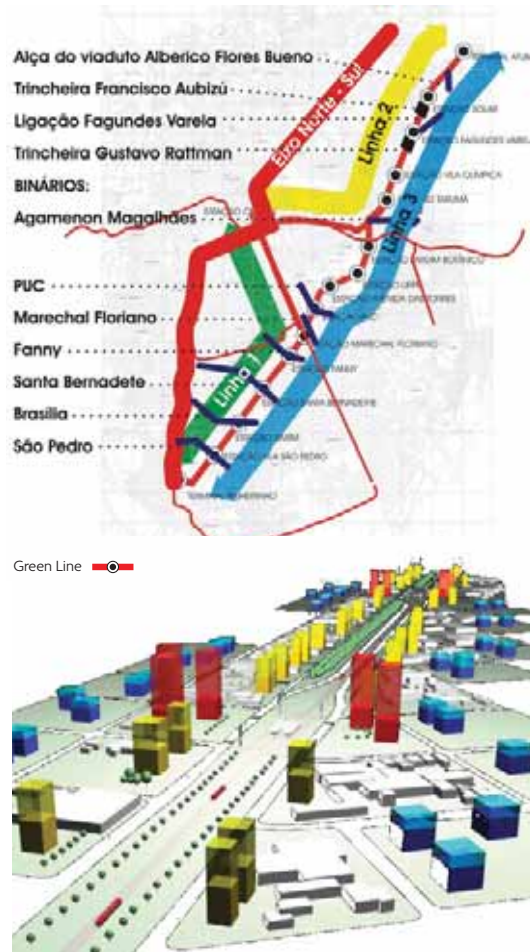
Source: IPPUC.





**Figure 3.18 The Transfer of Development Rights for Heritage Preservation in Curitiba**

Source: IPPUC.



**Figure 3.19 The Green Line in Curitiba**

Source: IPPUC.

building rights may be transferred to other areas in the city. In 1993, the city identified special preservation units. Money earned from selling development rights over these structures must be used only to preserve buildings (figure 3.18). Through these measures, the money required for preservation is mainly market generated, and the city does not need to fund preservation. In addition, Curitiba's Coresda Cidade project has revitalized 44 historic buildings in the city center, and the buildings have been repainted in the original colors. The area targeted by this project used to be crime prone and run down. However, after revitalization, people came to the area; building owners took better care of the buildings; and the crime rate fell by an estimated 30 percent. Moreover, Curitiba provides a good case of a city revitalized by heritage preservation and effective urban design. In addition, cultural facilities, which were previously lacking in the city, have been established in innovative ways. A historical gunpowder house has been converted into a theater. An opera house constructed of metal tubes and glass has been established in the middle of a deactivated quarry crater, surrounded by a beautiful landscape. A botanical garden, one of the main tourist attractions, has also been created in once neglected open space (Hattori 2004).

### Future Challenges for Curitiba

*Green Line:* Federal highway 116 used to cut through the city and impose its dangerously heavy traffic—mainly transport trucks traveling South America's economic corridor—on residents. This divided the city into two sections in an inefficient way. In response, a beltway was created to divert traffic outside the city's boundary, and a former federal highway was converted into Curitiba's sixth axis, called the Green Line. This line is expected to reduce traffic on the existing five axes. A new BRT route will be introduced, and mixed use high-density devel-

opment is planned along the Green Line to make the area more attractive (figure 3.19). Land use is being carefully planned so as not to interfere with wind circulation by creating barriers of buildings. A linearly shaped biodiversity park will also be created along the Green Line, and only indigenous plant species will be cultivated.

*Regional integration:* Because the Curitiba Metropolitan Region is growing, Curitiba now faces a new challenge: how to integrate city and regional planning. Migration from surrounding areas has resulted in housing shortages, which might lead to more slums. In addition, even if Curitiba has a good primary BRT system and integrated land use, development in surrounding areas that is unconnected to the public transportation system (such as large shopping malls) may favor car use and increased traffic. In this context, Curitiba is taking steps to strengthen its regional planning capacity and is creating intermunicipal partnerships.

## Lessons Learned in the Curitiba Case

*Leadership and continuity:* The mayors of Curitiba have focused on urban planning. Many mayors have had technical backgrounds in engineering or architecture, for example. Since the 1960s, when the Curitiba master plan was formulated, the direction of urban planning has been largely consistent across administrations. Curitiba places a premium on implementation and rapid action to address urban issues; if there is a 70 percent chance of success, the city undertakes plans quickly.

*Institutionalized planning and expertise:* Curitiba's practices affect the city in several positive ways. Curitiba's success is linked to strong mayoral leadership and people's active participation in city programs. It is also attributable to IPPUC. The integrated planning institute has been playing an important role as a municipally independent public authority that researches,

formulates, implements, and supervises urban plans. IPPUC has provided integrated, cross-sector urban planning and oversight for implementation and monitoring, while ensuring consistency amid changes in political leadership. These holistic approaches to urban planning have been brought about by the creativity of planners and their imagination and good understanding of local culture. For more than 50 years, engineers and architects have undertaken urban planning to address key urban issues in integrated ways. The work of IPPUC ensures continuity and consistency in planning processes that have extended beyond the mayoral cycles since 1966, the year IPPUC was established. Curitiba has made the most of its existing infrastructure and local characteristics without spending much money on new construction. Although Curitiba's activities have been accomplished with few budgetary resources, tremendous benefits have been generated.

*Citizen ownership and eco-consciousness:* Citizens are encouraged and are provided opportunities to comment during urban planning processes. Public hearings with the mayor are held frequently, and proposed plans are evaluated and discussed with the community. People may speak directly to the mayor and city officials. More than 250 public hearings have been held since 2005. Citizens are actively involved in planning because people have made the link between good urban planning and a better quality of life. The city provides opportunities for people to participate in other urban activities—such as collecting garbage, constructing neighborhood roads, and maintaining green areas—which strengthen citizen ownership and the maintenance of urban facilities. Children are also enrolled in environmental education activities, such as the urban waste program. Moreover, behaving in environment-friendly ways is now the norm for Curitibaanos.

*Local character:* Curitiba considers its local situation, including its budget, capacity, and social conditions, in devising urban strategies.

Taking into account municipal capacity, local officials develop innovative solutions to solve urban problems. For example, rather than waiting for adequate revenues to construct a subway, Curitiba implemented the BRT system, which proved affordable and could be implemented quickly without time-consuming construction work.

## Notes

1. The modal shares are public transport (bus), 45 percent; bicycle, 5 percent; walking, 27 percent; and private automobile, 22 percent. The data are from IPPUC (2009a).
2. For example, in Houston, Texas the process of evapotranspiration from trees has been found to cool peak temperatures by 1.1 to 5 degrees Celsius. Tree shadings provide Houston with annual energy savings of US\$26 million (HARC 2004).

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