

URBAN INNOVATIONS IN CURITIBA: A CASE STUDY

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I. Introduction

Across the globe, urban growth is occurring at an unprecedented rate and scale.¹ In 2008, the percentage of the world population residing in cities reached 50 percent. By 2050, an estimated 70 percent of the global population will live in urban centers.² Much of this growth is concentrated in “mega cities,” metropolises of over 10 million people.³ These mega cities are increasingly merging to form “mega regions,” defined as regional centers of interlinked economic and urban growth and often home to as many as 100 million people.⁴

Mega regions’ economic and cultural benefits are well documented.⁵ The world’s forty-largest mega regions cover only a fraction of the earth’s surface and contain just 18 percent of its population but produce 66 percent of all economic activity and 85 percent of technological and scientific innovation.⁶ Unfortunately, explosive growth also causes significant problems. Mega regions and mega cities face unprecedented urban sprawl, carbon emissions, and economic inequality. These problems exist both in the developed world, where a significant majority of the population already lives in urban areas, and the developing world, where the greatest urban growth is currently occurring.⁷ Each of these problems compounds the others. For instance, urban sprawl increases transport costs, raises energy consumption, and spurs resource use, thereby adding to carbon emissions

¹ United Nations Population Fund, *Linking Population, Poverty and Development* (May 2007), <http://www.unfpa.org/pds/urbanization.htm>.

² Population Reference Bureau, *Human Population: Urbanization* (2012), <http://www.prb.org/educators/teachersguides/humanpopulation/urbanization.aspx>.

³ *Id.*

⁴ John Vidal, *UN Report: World’s Biggest Cities Merging into Mega-Regions*, THE GUARDIAN (Mar. 22, 2010), available at <http://www.guardian.co.uk/world/2010/mar/22/un-cities-mega-regions>.

⁵ See, e.g., EDWARD GLAESER, *TRIUMPH OF THE CITY: HOW OUR GREATEST INVENTION MAKES US RICHER, SMARTER, GREENER, HEALTHIER, AND HAPPIER* (2011).

⁶ Vidal, *supra* note 4.

⁷ See UN-HABITAT, *State of the World’s Cities 2008/2009* (2008), available at <http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=2562>.

and economic inequality. Indeed, cities account for just two percent of the earth's landed surface but produce 70 percent of all greenhouse gas emissions, a number likely to increase as cities and populations expand.⁸

The readily apparent challenges of urban growth have attracted the attention and problem-solving efforts of academics, planners and policymakers. However, while these are global issues, policymakers tend to seek solutions from a limited number of sources. In the United States, when we do look abroad for solutions, we often turn to European neighbors for insights and rarely look beyond the high-income membership of the Organisation for Economic Co-Operation and Development (OECD) for policy ideas.⁹

U.S. policymakers' narrow focus on OECD best practices is troublesome: it ignores swaths of potentially valuable lessons, many of which may actually be more relevant to the U.S. than those currently studied. For example, Sweden is often heralded for its community development innovations and focus on environmentally sustainable development. However, Sweden's generous social spending and minimal economic inequality, coupled with the fact that its annual urban growth rate is far below that of the United States, renders many of its lessons inapplicable in the U.S. context.¹⁰

This paper seeks to turn the reader's attention from the oft-cited practices of European cities to an example further south. It highlights innovations in Curitiba, Brazil that have been successful in alleviating the interrelated problems of urban growth: sprawl, environmental degradation, and economic inequality. While perhaps less familiar

⁸ UN-HABITAT, *Hot Cities: Battleground for Climate Change* (Mar. 29, 2011), <http://www.unhabitat.org/downloads/docs/GRHS2011/P1HotCities.pdf>.

⁹ The following countries are members of the OECD: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.

¹⁰ The World Bank, *Urban Population Growth* (2010), <http://search.worldbank.org/data?qterm=urban%20growth&language=EN>.

than the examples of our OECD counterparts, the planning and development strategies employed by this Brazilian city over the past decades are equally noteworthy.¹¹ At its core, Curitiba exemplifies how the integration of land use planning, transportation infrastructure, and environmental sustainability efforts can enable a city to meet the needs of its expanding population and mitigate the negative effects of urban growth. As such, both its innovations and the foundational principles underlying them are deeply relevant to expanding metropolises worldwide.

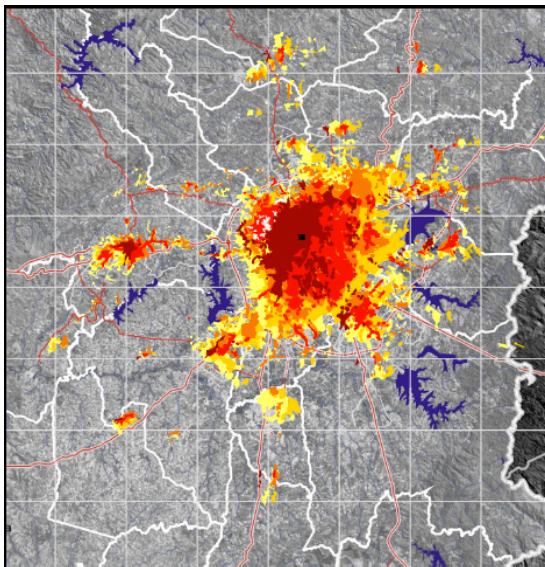
In sum, this paper aims to highlight Curitiba's innovations and illustrate their relevance to other growing cities. It proceeds as follows. The report begins with an overview of Curitiba's history and the basic framework developed to address the challenges attendant with tremendous growth. It then discusses specific practices employed by Curitiba to mitigate the negative impacts of growth and concludes by addressing how Curitiba's innovations can be applied in other urban contexts, both in the United States and abroad.

II. Urban Growth in Curitiba

Curitiba, the capital of the southern state of Paraná, is one of the fastest growing cities in South America. Its explosive growth over the past half century has required the city to demonstrate tremendous resourcefulness in tackling the accompanying problems of sprawl, congestion, environmental impacts, and social inequality. The strategies it has employed in combating these challenges are instructive for other growing cities.

¹¹ Though less known in the United States, Curitiba has received international recognition for its efforts. Curitiba won the prestigious Globe Sustainable City Award in 2010 for its excellent sustainable urban development. Press Release, *The Brazilian city Curitiba awarded the Globe Sustainable City* (Apr. 7, 2010) at <http://globeaward.org/winner-city-2010>.

The City’s metropolitan population currently numbers 3.7 million, ten times the city’s population in the mid-twentieth century, and approximately the same size as Los Angeles.¹² The city experienced an average annual growth rate of 4.6 percent for almost 50 years, transforming Curitiba from a small city to a metropolis.¹³ Its annual growth rate stabilized somewhat in past years, averaging 3.8 percent since the 1990s. Still, the cumulative effects of sustained growth required Curitiba to adapt and adjust rapidly to changing conditions, despite a municipal budget that did not expand nearly as quickly as the demands placed upon it.¹⁴



YEAR	POPULATION
1955	360.000
1965	550.000
1975	1.140.000
1985	1.700.000
2000	2.700.000
2010	3.168.707
2020	3.758.358

Figure 1: Population growth in Curitiba

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In 1943, shortly after its population growth began, Curitiba developed a comprehensive plan that focused on downtown development with long Parisian-style

¹² Institute for Research and Urban Planning of Curitiba [IPPUC], *Urban Planning Process in Curitiba 6* (2012) (on file with author); U.S. Census Bureau, *State & County Quick Facts* (2010), <http://quickfacts.census.gov/qfd/states/06/0644000.html>.

¹³ Luis Lindau, Dario Hidalgo & Daniela Facchini, *Curitiba: The Cradle of Bus Rapid Transit*, 36 BUILT ENV'T 274, 274 (2010).

¹⁴ Mike Power, *Common Sense and the City: Jaime Lerner, Brazil’s Green Revolutionary*, THE GUARDIAN (Nov. 5, 2009), <http://www.guardian.co.uk/environment/blog/2009/nov/05/jaime-lerner-brazil-green>.

boulevards radiating from the city center to accommodate increased car traffic. However, most aspects of this plan were never fully implemented, and by the 1960s, with the city's population growth in full flux, it became clear that an alternate plan was needed.¹⁵ This second plan, the "Curitiba Master Plan," provided the planning principles and framework that have guided the city's development over the past 40 years and on which the city still relies today.¹⁶ The Curitiba Master Plan stresses the link between integrated urban transportation, appropriate land uses, and environmental preservation.¹⁷ The automobile-friendly boulevards of the earlier plan were re-envisioned as commercial corridors to be serviced by public transportation; each corridor spreads outward from the city center in an axial design in order to distribute growth throughout the metropolitan area.¹⁸

In the 1960s, a regional planning association, *Instituto de Pesquisa e Planejamento Urbano de Curitiba*, was formed to support implementation of the goals identified in the Master Plan. IPPUC, or the Institute of Urban Research and Urban Planning, operates largely independent of the city's formal agencies to ensure continuity across election cycles, yet it works closely with the agencies to coordinate planning, housing and environmental policies throughout the city.

Under the direction of the Master Plan and IPPUC, Curitiba has pioneered a number of initiatives to provide services to its growing population, with the goal of integrating land use and transportation planning determining much of the scope and form of these initiatives. The next section examines these practices in greater detail.

¹⁵ Nexus Research Group [Nexus], *Curitiba, Brazil: BRT Case Study 1*, available at <http://nexus.umn.edu/Courses/ce5212/Case3/Curitiba.pdf> (last visited Apr. 14, 2012).

¹⁶ *Id.* at 2.

¹⁷ IPPUC, *supra* note 12, at 7.

¹⁸ Joseph Goodman, Melissa Laube & Judith Schwenk, *Curitiba's Bus System is Model for Rapid Transit*, RACE, POVERTY & ENV'T 75, 75 (Winter 2005/2006), available at <http://urbanhabitat.org/node/344>.

III. Curitiba's Urban Planning Innovations

A. Bus Rapid Transit

A keystone of Curitiba's master plan is the promotion of public transportation systems, which Curitiba provides primarily through a high-capacity bus system known as Bus Rapid Transit (BRT). BRT has been described as:

[A] high-quality bus based transit system that delivers fast, comfortable, and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service. BRT essentially emulates the performance and amenity characteristics of a modern rail-based transit system but at a fraction of the cost.¹⁹

Or in other words, "think rail, use buses."²⁰ Unable to afford a rail system, and struggling to deal with rapid population growth, Curitiba developed the BRT system in order to offer its citizens high-quality transportation services at a fraction of the cost of rail-based systems. Its example illustrates how municipal transportation systems can provide reliable and convenient transportation services on a limited budget. Perhaps the best evidence of the system's success is its continued popularity. While the city has one of Brazil's highest rates of car ownership, around 70% of the city's population commutes by bus, including 28% of users who previously commuted by personal automobile.²¹ As a result, Curitiba boasts one of the country's lowest rates of ambient pollution.²²

¹⁹ LLOYD WRIGHT & WALTER HOOK, INSTITUTE FOR TRANSPORTATION AND DEVELOPMENT POLICY, BUS RAPID TRANSIT PLANNING GUIDE 11 (2007).

²⁰ Scott Barton and Joseph P. Kubala, *Bus-Rapid Transit Is Better Than Rail*, Issue Paper No. 10-2003, 2 (Dec. 16, 2003), available at <http://www.jtafla.com/JTAFuturePlans/Media/PDF/BRT-LRT%20Comparison.pdf>, citing a Federal Transit Administration slogan.

²¹ *Id.*; Goodman, Laube & Schwenk, *supra* note 18, at 75.

²² United States Federal Transit Administration, Office of Research, Demonstration and Innovation, *Issues in Bus Rapid Transit* 14, available at <http://www.fta.dot.gov/documents/issues.pdf> (last visited June 15, 2012).

i. Bus Routes and Zoning

As outlined in Curitiba's Master Plan, the city revolves around five primary corridors of development that form an axis around the downtown area. Strategic zoning concentrates dense commercial development and high-rise buildings along each side of the corridors. As one moves further away from a central corridor, development loses height and density. Commercial uses give way to urban apartment buildings, which are then replaced by smaller-scale residential homes. In this way, the development corridors provide the framework for the city's pattern of growth and ensure that development is not solely concentrated in the downtown core.



Figure 2: Curitiba's Commercial Corridors highlighted in red

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Figure 3: Zoning density along the commercial corridors

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Each corridor is part of a “trinary system” of three roads, along which the BRT system operates. The central corridor consists of a central busway, which is dedicated to exclusive use by buses and has a lane of traffic operating in each direction. On either side of the busway are traffic lanes that are open to all vehicles and that allow for access to the businesses and services fronting the corridor. Running parallel about a block away from the central corridor are one-way roads that are also open to all types of vehicles and allow for rapid movement in a single direction.²³



Figure 4: Trinary Street System

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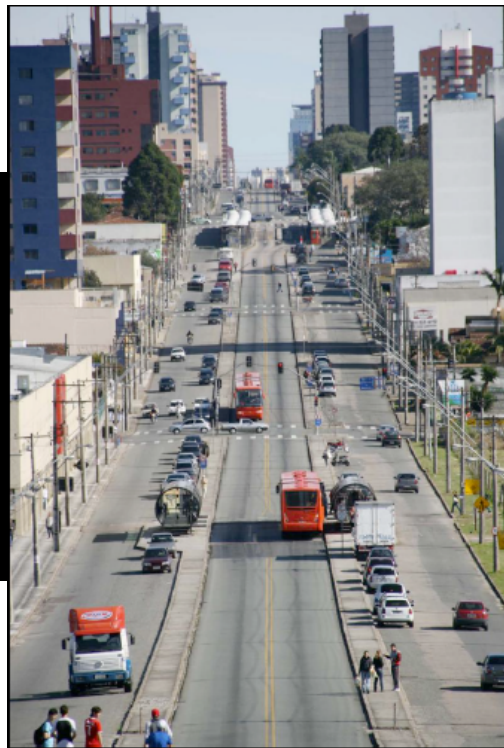


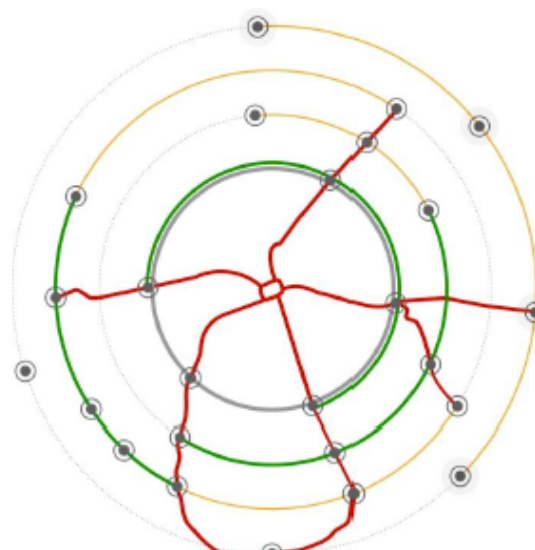
Figure 5: A dedicated busway along a commercial corridor

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²³ IPPUC, *supra* note 12, at 10.

The BRT system is adapted to this hierarchy of roads. Along the dedicated busways at the center of the commercial corridors are the *Expresso* (Express) bus routes. High-capacity bi-articulated buses run along these routes, serving the greatest number of passengers. Since they do not have to contend with other forms of traffic, the Express buses average much higher speeds than regular buses. Operating parallel to the Express line are the *Ligeirinho* (Direct) buses, which run along the one-way streets about a block from the central corridor. Both articulated and conventional buses run along these routes, making more frequent stops than do the Express buses along the dedicated busways.

Feeding into these two rapid bus lines are the *Interbarrios* (Inter-neighborhood) and *Alimentador* (Feeder) services. The buses on these routes circle the city, connecting residents in lower-density areas to the primary bus routes along the commercial thoroughfares. The city also operates a dedicated hospital bus line, connecting local health care facilities, as well as a system of school buses and a system of tourist buses. On Sundays, a free bus service shuttles residents from the downtown area to the city's parks. All of the buses are color-coded to indicate which route they follow.



Figures 7 & 8: Bus routes (regular and simplified versions).

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The BRT system is fully integrated to ensure that all city residents have access to public transportation, with the bus lines that serve lower density areas feeding into the routes that serve higher density areas. Linking density to the type of bus service offered creates further efficiency in the system, as the high-density corridors generate the greatest demand and support the use of high-capacity buses that run frequently along segregated busways. Lower-density areas are also served, but generally do not warrant the need for dedicated busways, and therefore the emphasis in these areas is on comprehensive coverage, ensuring that all residents live within walking distance of a bus stop.

ii. Transfer Terminals and Bus Stops

Transfer terminals serve to connect the feeder services with the rapid bus lines. Most of the transfer terminals include convenience stores, post offices, and other commercial services. Each city district, of which there are twelve, also has a transfer terminal called a “Citizenship Street.” The Citizenship Street terminals provide a range of municipal services in addition to the usual commercial operations, including health centers, vocational training centers, legal assistance offices, and social service centers.

Each bus route is also served by a number of smaller bus stops. These appear at 500m intervals along the Express route and somewhat less frequently in lower-density areas. Most of the bus stops along the Express and Direct routes are equipped with GPS displays that indicate in real time when the next bus will arrive. The bus stops share a characteristic tubular design and offer protection from outdoor elements. Furthermore, bus stops are raised, so that when boarding a bus, passengers are already at the appropriate level to climb onboard. This tweak reduces the time a bus needs to wait at each stop and aids mothers with prams, the elderly and wheelchair users.



Figure 9: Raised bus loading platforms

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iii. Fares and Fare Collection

Users of the BRT system purchase their tickets prior to boarding for maximum efficiency. Riders pay one uniform fare, regardless of the distance being traveled or the number of transfers. This is called the “social fare,” alluding to the fact that shorter journeys subsidize the cost of longer journeys disproportionately taken by low-income residents. This was a deliberate choice on the part of the municipal government in implementing the BRT system, and it is in keeping with the principle that the system should be accessible to everyone, regardless of physical location or socio-economic status. Fares are regularly reviewed to ensure that the “average worker” pays no more than 10% of his or her income on transportation costs, significantly lower than Americans’ average transportation costs: U.S. residents in the lowest 20% income bracket spend roughly 42% of their annual income on transportation, and middle-income Americans spend roughly 22%.²⁴

²⁴ Goodman, Laube & Schwenk, *supra* note 18, at 76. For figures on transportation costs in the United States, see The Leadership Conference Education Fund, *Where We Need to Go: A Civil Rights Roadmap*

iv. Financing and Operations

The Curitiba BRT system receives no government subsidy, and is completely self-supporting. The services are provided by sixteen private bus companies, which are contracted and regulated by the *Urbanizacao de Curitiba SA* (URBS), a government company. URBS is also responsible for regulating taxi services and public parking in the city. URBS collects all fares and distributes payment to the bus companies based on the distances they travel. Previously, the companies were paid based on the number of passengers they carried, but this led the companies to all focus their services on the busiest commercial areas, where the greatest passenger demand existed. By paying the companies based on the distances they travel, URBS is able to ensure that the companies have an incentive to provide services in less dense areas as well.

The bus companies are responsible for purchasing all of their own vehicles, for which URBS reimburses their capital costs at a rate of 1 percent per month.²⁵ The guarantee of a twelve percent annual rate of return incentivizes the bus companies to invest in new vehicles, and generally, buses in Curitiba are only used for 3-4 years, in an effort to make sure that the fleet remains clean, safe and comfortable. The city buys back the buses at the end of this period for a nominal amount, and generally repurposes the buses. “Retired” buses are used as mobile libraries, classrooms, soup kitchens and health centers, in keeping with Curitiba’s emphasis on sustainability.

for Transportation Equity 2 (Mar. 2011), available at <http://www.protectcivilrights.org/pdf/docs/transportation/52846576-Where-We-Need-to-Go-A-Civil-Rights-Roadmap-for-Transportation-Equity.pdf>.

²⁵ Leroy Demery, *Bus Rapid Transit in Curitiba, Brazil – An Information Summary*, Section 6 (Dec. 11, 2004), available at <http://www.publictransit.us/ptlibrary/specialreports/sr1.curitibaBRT.pdf>.

v. BRT Usage

The Curitiba BRT system carries about 2 million passengers a weekday, compared to the 5 million passengers who use the New York subway system each weekday.²⁶ The Express buses travel at an average speed of 20 kilometers per hour, transporting about 11,000 passengers per hour per direction.²⁷ Approximately 70% of the population relies on the system for their daily commuting needs, including many car owners.²⁸ The approval rating for the BRT system hovers at around 90%.²⁹ Perhaps the best evidence of the system's success is that while Curitiba's population has more than doubled since the system's introduction in the 1970s, traffic has declined by 30%.³⁰

The success of the Curitiba BRT system can largely be attributed to the integration of land use and transportation planning, which ensures that supply and demand are balanced. In the commercial corridors with significant demand, one finds fast moving high-capacity buses traveling along dedicated busways. In lower-density areas, there is also bus coverage, but the emphasis is on linking feeder systems to the rapid BRT lines that run along the high-density corridors. This combination promotes system efficiency, discourages sprawl, and ensures affordable public transportation access for Curitibaans of all socioeconomic classes.

²⁶ Nexus, *supra* note 15, at 12; New York Metropolitan Transportation Authority, Introduction to Subway Ridership (2011), <http://www.mta.info/nyct/facts/ridership/>.

²⁷ Nexus, *supra* note 15, at 12-13.

²⁸ Goodman, Laube & Schwenk, *supra* note 18, at 75.

²⁹ Bhavik Shah, *Bus Rapid Transit: A Sustainable Approach to Mass Transit* 18 (Nov. 25, 2002), available at <http://www.gobrt.org/VancouverWashingtonBRT.pdf>.

³⁰ International Council for Local Environmental Initiatives, *Curitiba: Orienting Urban Planning to Sustainability* 4 (May 2002), available at http://www.iclei.org.br/polics/CD/P2_4_Estudos%20de%20Caso/1_Planejamento%20Urbano/PDF106_EC77_Curitiba_ing.PDF.

B. Parks System

In addition to its Bus Rapid Transit system, Curitiba is known for its innovative use of parks and green space to improve the quality of life of its citizens and proactively address the effects of global warming. Nearly one-fifth of the city is parkland.³¹ By comparison, only 8.1 percent of the average American city is parkland.³² As of March 2012, Curitiba boasted 35 parks, 1004 conservation areas (including woods, gardens, squares, mini-gardens, and activity axes), and 78,000 square meters of natural forest, for a total of 64 square meters of green space per inhabitant. These numbers represent a remarkable increase: fifty years earlier, Curitiba had less than one square meter of green space per person.³³

Besides its obvious aesthetic and recreational value, the park system is vital for controlling increased flooding, protecting Curitiba's biodiversity and water quality, and limiting carbon emissions. Curitiba began experiencing frequent flooding in the 1950s and 1960s, due to the construction of houses and other buildings along the streams and river basins and the coverage of streams to allow for additional development.³⁴ Starting in the 1970s, while other municipalities used Brazilian federal flood control funds to construct dams, Curitiba devoted its moneys to creating a park system that preserves valley floors, river basins, and protection strips along streams in order to avoid floods.³⁵ This initiative stood in stark contrast to the deforestation occurring across Brazil during

³¹ International Council for Local Environmental Initiatives, *supra* note 29, at 4.

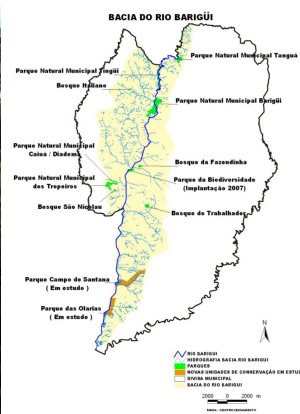
³² TRUST FOR PUBLIC LAND, CITY PARK FACTS 12 (2011), *available at* <http://cloud.tpl.org/pubs/ccpe-city-park-facts-2011.pdf>.

³³ *Id.*

³⁴ Alejandro Roman, *Curitiba, Brazil*, ENCYCLOPEDIA OF THE EARTH (Jan. 20, 2011, 10:29 AM), http://www.eoearth.org/article/Curitiba,_Brazil.

³⁵ Cassio Taniguchi, *TRANSPORT AND URBAN PLANNING IN CURITIBA* 15 (2001).

the 1980s.³⁶ Curitiba designated parkland strategically so as to divert floodwaters into the parks, which are all outfitted with numerous deep lakes and weatherproof playground equipment and picnic benches, given the expectation of flooding. Each watershed area in the city is flanked by a line of parks, whose diameter has expanded by a factor of six since the Master Plan's introduction in 1968.³⁷ The latest addition is the Linear Barigui Park, which links existing parks and creates new ones in order to revitalize the Barigui river basin. The strategic designation of parks also enables the preservation of Curitiba's tremendous biodiversity; a mix of temperate forest and Atlantic rainforest, the Curitiba metropolitan area is home to almost 4,000 species.³⁸ Finally, through the Reservas Particulares do Patrimônio Natural Municipal program (RPPNM, or Municipal Natural Heritage's Private Reserves), Curitiba protects CO2 sink holes without dispossessing landowners of their real estate by subsidizing the creation of privately owned parks. The Environmental Secretariat has identified 1,000 possible RPPNM areas, with the potential to protect 14,000,000 square meters of indigenous forest.³⁹



Figures 10 & 11: Linear Barigui Park

Curitiba Environment Secretariat

³⁶ PBS Frontline/World Fellows Project, *Brazil – Curitiba's Urban Experiment* (Dec. 2003), <http://www.pbs.org/frontlineworld/fellows/brazil1203/master-plan.html>.

³⁷ Interview with Carlos Guillem, Curitiba Environment Secretariat, in Curitiba, Brazil (Mar. 16, 2012).

³⁸ *Id.*

³⁹ *Id.*

Creating this extensive and carefully situated park system required the deployment of creative zoning and development tactics. Following the passage of Curitiba's new Zoning and Land Use Law in 2000, the city jumpstarted the preservation of the valley bottoms by institutionalizing legal instruments such as transfer rights.⁴⁰ Curitiba subsequently designated four environmental preservation areas (akin to the United States' historic preservation zones), restricted or prohibited development in those areas, then allowed owners to transfer development rights (both in Curitiba and outside) and gave them significant zoning concessions on construction in the areas to which they transferred. The Curitiba Environmental Secretariat plans to designate another ten environmental preservation areas in the next decade.⁴¹

C. Recycling

Like its transportation and park systems, the third prong of Curitiba's environmental preservation efforts – its much-heralded recycling program – combines sustainability, social inclusion, and good fiscal stewardship. Over seventy percent of the Curitiba's trash is recycled through its recycling programs.⁴² Indeed, the volume of recycled paper alone saves nearly 1200 trees a day.⁴³ Curitiba's recycling program employs both carrots and sticks. The city does not incinerate garbage, and residents must pay for garbage pickup (based on volume) as they would for electricity or water.⁴⁴ But the city also encourages participation by ensuring ease of use. Each household separates

⁴⁰ Taniguchi, *supra* note 35, at 15.

⁴¹ Guillem, *supra* note 37.

⁴² PBS Frontline, *supra* note 36. By comparison, New York City recycles just 34 percent of its waste, only slightly better than the 33 percent American average. Houston recycles a measly 2.6 percent of its trash. Adam C. Ellick, *Houston Resists Recycling, and Independent Streak is Cited*, N.Y. TIMES (July 29, 2008).

⁴³ International Council for Local Environmental Initiatives, *supra* note 29, at 4.

⁴⁴ Guillem, *supra* note 37.

organic waste and trash, plastic, glass, and metal to allow for easy pickup and processing. As opposed to charging for garbage pick up, the city picks up recycling curbside from most residences, at no cost to the household, between one and three times a week; the program is funded through sale of salvage. The pickup trucks transport recycling to one of thirteen privately run recyclable sorting parks, each of which employs homeless individuals and individuals in substance abuse recovery programs.⁴⁵ Additional proceeds from the sale of salvaged and recycled materials go towards social programs.

In the *favelas*, or shantytowns, inaccessible to recycling pickup trucks, Curitiba operates the Ecocitizens program. Originally started by the Catholic Church as an employment initiative,⁴⁶ the Ecocitizens program encourages homeless and low-income persons to collect and separate recycling from inaccessible neighborhoods. In exchange for bringing recycling to one of 92 sites, “ecocitizens” receive bus tokens, fresh fruits and vegetables, and children’s school supplies.⁴⁷ Ecocitizens remove 500 tons of recyclables a day,⁴⁸ for a total of 11,000 tons of garbage since the program’s inception.⁴⁹ The program has benefited sixty impoverished neighborhoods with 31,000 families by improving neighborhood sanitation conditions and by providing an influx of resources: nearly a million bus tokens and 1200 tons of surplus food as in-kind payment.⁵⁰ Ecocitizens’ success has prompted Washington, DC to consider implementing a similar program, and the Environmental Secretariat frequently consults with other Western cities about the possibility of adopting the program for their communities.⁵¹

⁴⁵ Another thirteen recycling plants are slated for construction by 2013. Guillem, *supra* note 37.

⁴⁶ Guillem, *supra* note 37.

⁴⁷ *Id.*

⁴⁸ *Id.*

⁴⁹ Roman, *supra* note 34.

⁵⁰ *Id.*

⁵¹ Guillem, *supra* note 37.

IV. Applicable Lessons

As discussed, the Curitiba Master Plan outlined certain general principles that have informed the city's development over the past 40 years and do so to this day. To even a casual reader of this report, these principles are obvious: they include integrated land use and transportation planning, an unwillingness to accept congestion and sprawl, environmental sustainability and preservation, close attention to the health and well-being of all its citizens, social inclusion, ease of use, and cost efficiency. Fulfilling these goals requires close collaboration between the often siloed government agencies entrusted with developing and administering the component programs, and, in that, Curitiba has been largely successful, thanks in parts to the efforts of IPPUC. One or more of these principles is readily apparent in the design and implementation of each of the innovations discussed herein, including but not limited to: the BRT system's construction and placement, the social fare, high-density zoning along the major corridors, the strategic designation of parkland to address the effects of global warming, and its recycling and related employment programs. Other cities can learn from Curitiba's example and apply these principles in their own planning and policymaking initiatives, provided the necessary collaboration exists between municipal departments.

Though recognizing the primacy of these general principles in combatting the problems of urban growth, the sections that follow explore how specific policy innovations outlined here could be implemented abroad. We also begin to identify cultural, legal, and other obstacles that might impede the export of these initiatives and in some cases suggest potential solutions.

A. Develop a BRT System

The creation of a BRT system would address many of the problems facing car-clogged and cash-strapped foreign cities burdened by rapid population growth. Curitiba's experience illustrates the BRT system's potential efficiency and ability, when well-placed and integrated with appropriate land uses, to replace cars as the preferred method of commuting. Indeed, a well-developed BRT system in an American city could move between 20,000-40,000 passengers per hour per direction, rivaling the numbers associated with many subway systems.⁵² Moreover, a BRT system can be constructed for a fraction of the cost of subway or light rail systems – a boon for municipal budgets still recovering from the recession. Whereas constructing a subway system costs between 30-160 million dollars per kilometer in the United States, a complete BRT system costs only 5-20 million dollars per kilometer.⁵³ The shorter construction times for BRT systems also increase their political feasibility. Many elements of a BRT system can be implemented within a single election cycle, while subway and light rail construction depend on continued financial and political support across administrations.

In some ways, a Curitiba-like BRT system better lends itself to less dense or still developing municipalities. As evidenced by some American mayors' failed attempts to designate bike lines or implement congestion pricing, many vested interests are vying for limited space on American roads. This logjam could make it quite difficult to solicit support for dedicated busways, particularly given citizens' experience-driven belief that buses are slow and inconvenient and the social stigma sometimes associated with riding the bus. Nor do other countries necessarily share the Brazilian belief in the social

⁵² David Henscher, *Frequency and Connectivity – Key Drivers of Reform in Urban Public Transport Provision*, 1 JOURNEYS 25, 30 (2008).

⁵³ *Id.*

function of land, that is, the idea that property rights may be limited by social and collective interests.⁵⁴ Even in countries with generous eminent domain authority, acquiring the land necessary to implement an effective BRT system – be it from existing public roadways or private property – could prove difficult in certain political climates.

For those municipalities where implementation of a BRT system is neither feasible nor desirable, Curitiba’s experience suggests potential tweaks to improve the operation and equity of existing bus systems. As discussed, Curitiba’s BRT network includes both linear and circumferential elements that avoid transportation “dead zones” where access is not available. Such “dead zones” are all too common elsewhere. Cities sometimes rely on bus networks that radiate from the city center in a series of straight lines, leaving the areas between the lines without access, or requiring passengers to take a bus into the city center and transfer in order to reach an area directly adjacent to them but not served by a circumferential bus route. These gaps in service can be particularly detrimental to low-income communities, where car use tends to be more limited, isolating neighborhoods and making the task of getting to work – or simply the grocery store – a time-consuming endeavor. Mimicking Curitiba’s integration of linear and circumferential bus lines and careful attention to eliminating “dead zones” could improve the ease and efficiency of existing bus systems and promote social inclusion.

Individual design elements found in Curitiba’s BRT system could also be implemented at minimal cost. For example, cities could create raised bus stops, to allow for quick boarding and unloading, and/or design buses with low floors, making it easier for children, the disabled, and those with prams or packages to board.

⁵⁴ Alexandre dos Santos Cunha, *The Social Function of Property in Brazilian Law*, 80 FORDHAM L. REV. 1171, 1175 (2011).

B. Integrate Land Use, Transportation, and Environmental Planning

As discussed, Curitiba strategically uses zoning both to enable densities that create demand for public transportation and to concentrate development in less environmentally precarious areas. The BRT system's high-take up rates and the city's reduced flooding demonstrate the efficacy of these efforts. Municipalities encountering similar problems could easily employ both strategies prospectively through modifications to their zoning codes. In heavily developed areas, however, the grandfathering of existing buildings would be a practical and political necessity.

C. Strategically Designate Park Land

The creation and expansion of urban parks is already a cause du jour of many urbanists and environmentalists, who cite high-cost cities like New York City (19.5% park land), Washington, DC (19%), and San Francisco (18%) as examples of the ability of green space to increase property values, decrease carbon emissions, and improve quality of life.⁵⁵ Indeed, city parks experienced something of a renaissance beginning in the 1970s and continuing into the new millennium.⁵⁶ Designating park land with an eye towards mitigating the impacts of global warming and the accompanying flooding by diverting floodwaters and preserving river basins, as Curitiba has done, would be an easy strategic tweak to ensure existing efforts maximize the environmental bang for their buck. And many cities already possess the legal tools necessary to achieve these goals. New York City, for instance, includes numerous historic preservation zones where property owners within such zones are given transfer development rights to use elsewhere

⁵⁵ TRUST FOR PUBLIC LAND, *supra* note 32, at 10.

⁵⁶ PAUL M. SHERER, TRUST FOR PUBLIC LAND, *THE BENEFITS OF PARKS: WHY AMERICA NEEDS MORE OPEN SPACE* (2006), available at http://www.eastshorepark.org/benefits_of_parks%20tpl.pdf.

(often with significant zoning concessions) if historic covenants prohibit their proposed construction. Similarly, cities could create environmental preservation districts in precarious areas, restrict or forbid development there, and allow owners to transfer their development rights. Though the designation of such zones is likely to encounter opposition from current landowners, the prevalence of historic preservation districts and covenants demonstrates the feasibility of environmental analogues. Tax credits or other subsidies for private environmental preservation, as for historic preservation, are another option, albeit a more costly one.

D. Implement Comprehensive Recycling Programs

Municipalities worldwide already employ recycling programs. But Curitiba's example suggests potential tweaks to increase existing programs' take-up rates, minimize costs, and promote social inclusion. As discussed, Curitiba's recycling program uses both carrots and sticks to maximize participation: residents must pay for garbage collection but receive free curbside recycling with pickup multiple times per week. Other municipalities could price their services accordingly; in addition to increasing recycling, the switch might also increase municipal revenues. Likewise, in many cities, homeless individuals already gather recyclables in order to earn pennies from the manufacturing company. Other cities could adopt Curitiba's model and subsidize these efforts in order to collect recyclables in low-density or inaccessible areas in a cost-effective way. Such initiatives would have the added benefit of providing much needed employment for hard-to-serve populations. For these reasons, among others, cities like Washington, DC, are considering adopting similar programs.

V. Conclusion

By prioritizing smart transit, strategic land use, environmental sustainability, and social inclusion, Curitiba has effectively addressed the problems attendant in its fifty-year growth and paved the way for a less congested, ultra sustainable, and more equitable next half century. Its lessons and policies – particularly its transportation network, parks system, and recycling program – are primed for export and increasingly relevant in this age of emerging mega cities and mega regions. Hopefully, other municipalities will be inspired by its example and adopt its principles and/or innovations for more sustainable, efficient, and socially inclusive development.