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Abstract

Dispersed urbanization, urban planning and management instruments such as zoning, and urban expansion zones, have become increasingly consistent in leading cities toward an uncertain and chaotic future. The urban perimeters of municipalities have been used increasingly in favor agents of the reproduction of unequal urban space, aggravating the process of socio-spatial segregation, the formation of urban gaps and real estate speculation. Inherent to this process, infrastructure, one of the most important components of urban land and one of the most costly for local governments, has become increasingly dispersed and obsolete in the midst of the disordered occupation of the citys land. Based on the above, this paper aims to analyze the phenomenon of urban sprawl in the city of Londrina by means of geotechnologies and to identify the impacts that the form of land occupation the city has employed may cause on the current and future scenario of the municipality in general. To this end, thematic maps were drawn up from multiple sources, which, allied to a review of the literature, indicate that the municipality of Londrina exhibits intense characteristics of the phenomenon of urban sprawl, leading to consequences for territorial ordering and the egalitarian spatial distribution of essential services to the population.

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Urban Sprawl and the Challenges for Urban Planning

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ABSTRACT

Dispersed urbanization, urban planning and management instruments such as zoning, and urban expansion zones, have become increasingly consistent in leading cities toward an uncertain and chaotic future. The urban perimeters of municipalities have been used increasingly in favor agents of the reproduction of unequal urban space, aggravating the process of socio-spatial segregation, the formation of urban gaps and real estate speculation. Inherent to this process, infrastructure, one of the most important components of urban land and one of the most costly for local governments, has become increasingly dispersed and obsolete in the midst of the disordered occupation of the city's land. Based on the above, this paper aims to analyze the phenomenon of urban sprawl in the city of Londrina by means of geotechnologies and to identify the impacts that the form of land occupation the city has employed may cause on the current and future scenario of the municipality in general. To this end, thematic maps were drawn up from multiple sources, which, allied to a review of the literature, indicate that the municipality of Londrina exhibits intense characteristics of the phenomenon of urban sprawl, leading to consequences for territorial ordering and the egalitarian spatial distribution of essential services to the population.

Keywords: Urbanization; Geotechnologies; Urban Planning; Urban Gaps

1. Introduction

Brazilian urbanization has specific dual characteristics: on the one hand is the formal city and on the other, the informal one, both of which result from the lack of territorial planning and ordering.

The formal city is the one composed of areas equipped with infrastructure in which public investments are concentrated, while the "informal city" is characterized as the region where growth is disordered and unplanned, and where the lack of infrastructure and the socio environmental differences are alarming.

Rolnik (2001) [1] stated that institutionalized urban planning in Brazil dates back to the 1970s. This is the period when the chasm in the evolution of the urban landscape in medium-sized and large cities became obvious. On the one hand there was "urbanity", the attempt to install territorial ordering and infrastructure, while on the other was the illegal installation of homes, lack of organization and social vulnerability, with urban gaps scattered throughout the territory.

Those model of urban occupation commonly found in Brazilian citiesis the conspicuous materialization of the hegemonic interests of the agents that produce urban space, such as real estate agents.

Despite major advances achieved in urban legislation as a result of the Federal Constitution of 1988, and later, through the City Statute and numerous instruments available for effective and coherent urban planning and management, some of these instruments are widely used in detriment to others.

Urban expansion zones and the urban perimeter, for example, are important instruments that, in theory, can control the city's encroachment into rural areas, preserving the latter and making the best possible use of the infrastructure installed in already occupied areas. However, these instruments are notoriously used to create urban gaps for the valuation of land, which has become one of the major producers of value and accumulation of capital in cities.

In Brazil, it is common to use the expansion of urban zones to allocate social interest housing and middle and low-cost housing projects in locations far removed from the consolidated city center. Thus, the infrastructure installed in certain regions serves as a factor for land valuation, while the city outskirts suffer for the lack of or poor quality infrastructure, as well as difficulties in transportation due to the precarious system of public transport to the regions where jobs are concentrated.

All these characteristics, resulting primarily from the form of urban occupation, define what many American researchers (especially urban engineers) call urban sprawl,

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i.e., urban scattering or a physical dilution of urban space that occurs discontinuously (leapfrogging) over space, aggravating social segregation and generating countless environmental impacts.

This paper reports on a study of the concept of urban sprawl as it applies to the city of Londrina in the state of Paraná, Brazil, comparing it to American urbanization in terms of its spatial establishment. In addition, the consequences of the current model of land occupation and the instruments that govern it are discussed, indicating how they can exacerbate a dual city model with intense social segregation.

2. Concepts of Urban Sprawl

Burchell (2003) [2] defines sprawl as low density occupation, leapfrog development characterized by unlimited expanses. In other words, expansion develops in significantly residential or non-residential forms in relatively untouched environments. In almost every case, this development is of low density, leapfrogging over the development of another region (such as farmland, or at borders with other municipalities) and becoming established in a peripheral area, whose location indicates it is unlimited (BURCHELL, 2003: p. 2) [2].

For Burchell (2003) [2], urban sprawl is characterized by the dispersion of urban occupation, which rapidly reaches rural areas and is qualified mainly by the low population density of these areas, which extend beyond the consolidated city center.

The phenomenon of urban sprawl usually occurs outside of the center of services and available jobs, thus separating the places where people shop and work, and even where they study, from the place where they live.

One of the principal indicators of the phenomenon of urban sprawl is the creation of large urban gaps; as well as the decentralization of public lands and the lack and/or inability of local governments to control the value of real estate for fiscal purposes. This precludes equitable property taxing, *i.e*., it enhances social inequalities since the levying of property taxes (such as the Brazilian IPTU) does not accurately reflect the socio-spatial and economic situation of the population.

3. Characteristics of Urban Sprawl

The main characteristics of urban sprawl in Brazilian cities originate from the creation of new housing lots by the municipal administration or by public and private companies for low-cost housing projects and from the establishment of high-end suburbs—high-end gated communities, all distant from the consolidated city center.

This urbanization model far removed from the consolidated city center not only divides social classes but also generates some specific characteristics of occupation. Low-cost housing projects or areas of unregulated occupation, like in several American cities, according to Carbonell (2005) [3], have concentrated in the surroundings or proximities of perimeter roads (a phenomenon also observed in small municipalities).

The impacts of this occupation model affect both the rich and the poor. However, the effects on low-income populations are more marked, since they live far removed from the consolidated city center where shopping, services and job opportunities are concentrated. In addition to socio-spatial segregation, this model causes restricted access to public infrastructure, such as public transport, which is essential for the daily commute of this population to their places of work—which are often located in central areas.

In the case of higher income populations, although they own cars and transportation between locations is facilitated because streets and roads are usually better structured, they face not only highway congestions but also high levels of CO_2 emissions, directly impairing the environmental quality of cities.

Limonad (2007) [4] states that the form of occupation of the different social classes along urban fringes is characterized by low density peripheral areas and is a world wide phenomenon, except for a few agglomerations in the United States.

In this mode of occupation, urban gaps, which are common to all these situations, are characterized by areas not divided into lots. These gaps occur frequently and are mainly under the control of real estate agents. Although they are located in areas with complete infrastructure, they are used for land speculation and valuing. With regard to this, Aurand (2007) [5] states that:

> "[...] Landowners with speculative vocation wait for their unexploited land to increase in value while their surroundings are occupied (Clawson, 1962; Mills, 1981). This pattern of development leads to noncontiguous occupation which ends up covering a much larger area than necessary." (AURAND, 2007: p. 42) (*Our translation*)

Lowdensity areas, which are characterized mainly by buildings for people living alone (singles), for couples or small families (couples with an only child, for example), are usually located far from commercial centers, such as shopping malls (AURAND, 2007: p. 42) [5] and are where the social class that most uses such services resides.

From the standpoint of commercial use, the low density of regions that concentrate "retail corridors," usually around expressways within the urban perimeter or on streets specializing in services, also generates strong impacts since, to reach such services, the population must travel by car or public transport, as indicated by Ojima

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(2008) [6]:

> "[...] the aspects that are considered as negative effects of the models of dispersed urbanization include the intensive use of private cars, especially for individual use. Although this characteristic can be defined as both a cause and a consequence, the truth is that the lower the population density, the greater the tendency for the population's spatial movement for everyday activities (OJIMA, 2008: p. 4) [6]".

In addition to low density areas, the diffusion of the boundaries of urban expansion are also effects of sprawl, characterizing a phenomenon of peri-urbanization that extends the urban area towards its outer boundaries (OJIMA, 2008) [7]. In other words, land occupation extends towards urban fringes, thus reducing agricultural areas and often harming areas of environmental preservation, where it is practically impossible to determine whether the region is urban or rural. These areas,

> "[...] which were traditionally dedicated to farming activities, are now being used for industrial activities (especially for industrial agriculture), or for low density residential occupation. Thus, the borders that heretofore relatively clearly divided urban from rural areas are becoming increasingly blurred. In this context, the debate about the criteria that define urban areas and rural areasis intensified as these boundaries become blurred by new forms of land use and occupation in peri-urban areas." (OJIMA, 2008, p. 6) [7]

In metropolitan areas, the advance of occupation into areas bordering other municipalities, for example, may cause major impacts if instruments of urban planning, such as zoning, are not used jointly.

According to Ojima (2008) [7], border areas usually concentrate both industrial and residential occupations, usually low-cost, and in most cases do not respect the instruments of urban policy of the neighboring municipality, leading to major environmental and especially neighborhood impacts.

Table 1 was created to systematize the main characteristics of the urban sprawl phenomenon. This chart was adapted from the template proposed by Aurand (2007, p. 59) [7], to which were added the concepts of several authors (EWING, 1997 [8]; BURCHELL, 1998 [9]; DOWNS, 1998 [10]; DUANY, 2000 [11]; BURCHELL, 2002 [12]; ORFIELD, 2002 [13]) applied to the Brazilian reality. This chart characterizes:

- **Urban sprawl as a pattern of land use**—refers to the form in which the occupation occurs, regardless of its use (residential or commercial).
- **Urban sprawl as a consequence of the pattern of land use**—refers to the effects caused by a given form of land occupation, such associo-spatial segregation and environmental pollution resulting from the use of transportation.
- **Urban sprawl as the result of government structure/actions**—refers to the institutional base that allows such land occupation policies to exist; also characterized by difficulties within the spheres of government (Executive vs. Legislative, for instance) in reaching a consensus about the application of regulatory tools for urban land use, such as zoning and urban expansion. It can also be characterized by the lack of metropolitan articulation for land use ordering in border areas.

4. Materials and Methods

Thematic maps were used to visualize the form of occupation and its impacts. These maps were produced using the ArcGIS 9.3 software of the Environmental Systems Research Institute—ESRI, based on cartographic data from IPPUL—Institute of Research and Urban Planning of Londrina, ITCG—Institute of Land, Cartography and Geosciences of Paraná, and IBGE—Brazilian Institute of Geography and Statistics.

Table 1. Characteristics of urban sprawl.

Urban sprawl as a pattern of land use	Urban sprawl as a consequence of the pattern of land use	Urban sprawl as the result of government structure/actions
Development of low density regions, especially with individual homes (singles)	Loss of areas destined for agriculture and/or farms; urban gaps	Decentralized planning/Difficulty in articulating at metropolitan level
Segregationist land use and occupation	Low-cost housing projects and high-end gated communities located at dispersed points; urban gaps	Fragmentation of competencies between jurisdictions with respected to planning (e.g., zoning)
Dispersed urbanization (noncontiguous development)	Dependence on transportation (mainly cars) for daily travel; urban gaps	
Development of retail corridors		
Development of urban areas in rural perimeters ("rurban" areas)	Intermunicipal conflicts; environmental and neighborhood impacts	Difficulty in articulating at metropolitan level

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The urban expansion map was created from data provided by IPPUL based on the evolution of housing lot developments by decade, from when it started (approximately in the 1930s) up to the years following 2000. Together with the layers of urban expansion were added the urban gaps, which were also provided by the same institute in order to demonstrate the predominance of lands-not utilized along the period of land occupation.

The data of the demographic density map were spatialized according to the IBGE's sectors of the year 2000 census. The database of the sectors themselves added demographic density data processed by IPPUL (2006), which had to be converted into inhabitants per hectare.

The cartographic projections of all the databases were adjusted to the Transverse Mercator Projection and the-map datum utilized was SIRGAS 2000, Zone 22S since this is the one used by the Londrina Municipal Administration.

5. Urban Sprawlin Londrina, Parana, Brazil

Londrina is located in Brazil's southern macro region, in

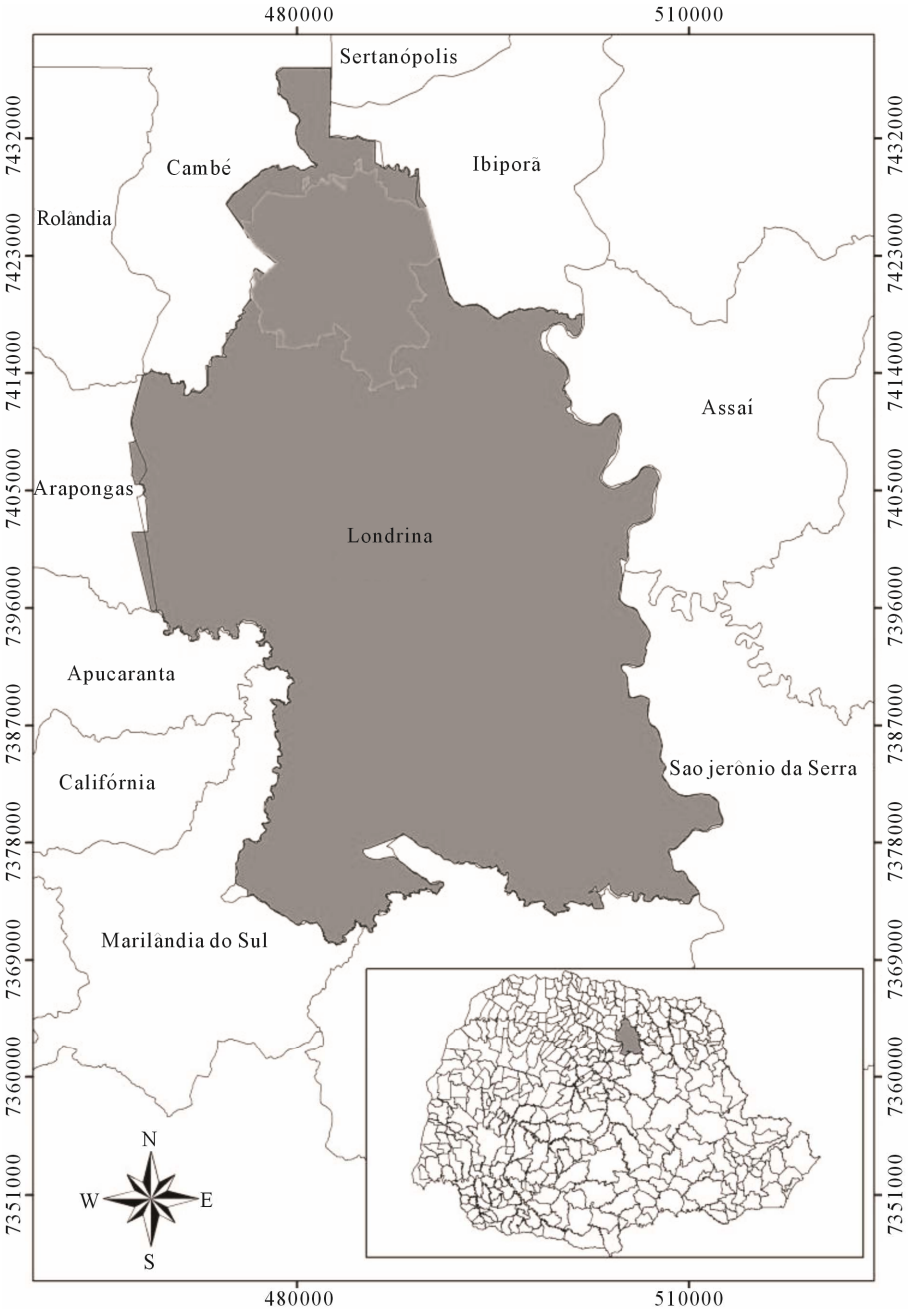


Figure 1. Location of Londrina.

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the north central Paraná meso region in a position considered is geo-economically strategic in demographic and physiographic terms and from the standpoint of its regional, state and interstate highway system (**Figure 1**).
Colonized by the North Paraná Land Company, Londrina was actually founded on August 21, 1929 in an area known as Três Bocas, but the city was only officially created five years later on December 3, 1934 by State Decree 2.159 and was established a week later, on December 10, marking the municipality's anniversary.

Planned for a population of only 20 thousand, Londrina' surban area grew rapidly, mainly due to the development of the coffee economy. Its growth boosted the commercial sector, and the city's high rate of economic development placed it among the largest cities in the interior of Brazil. Thus, the population, which was basically rural, migrated to the urban area, following the national trend, and resulted in intensive urbanization.

Urban occupation in the city of Londrina started in the central area in the early 1930s. According to Fresca (2009) [14] "The construction of the central area should be seen as following a dual route: the first was the physical construction of the city, *i.e.*, deforestation, division into lots, construction of streets, buildings, houses, etc."

Beginning in the 1950s, the occupation of the surroundings of the city center (initial period) expanded to regionswhere lower income neighborhoods were concentrated. Around the 1960s there was a stronger movement towards the occupation of sparse regions, and although some empty spaces were later urbanized, large urban gaps remained (**Figure 2**).

As can be seen, starting in the 1960s, land occupations became sparser, characterizing the beginning of the phenomenon of urban sprawl in the city of Londrina. The occurrence of this phenomenon during this period coincided with that in numerous metropolises in the United States, as reported by Carbonell (2005) [3].

Razente (1983) [15] stated that the marked urban expansion that took place in the 1960s resulted from the construction of Igapó Lake, the airport and the BR-369 highway, aiding dispersed occupation due to the real estate speculation favored by both the lake and the highway due to the construction of industrial units and low-cost housing in their surroundings.

During the same decade, Londrina, with the help of consultants from São Paulo, drew up its technocratic Urban Development Master Plan, with strong emphasis on the road network and zoning. This led to a process of strong stimulation of scattered occupation from the center towards peripheral neighborhoods (CASARIL, 2009) [16].

The consolidation of highway BR-369 and the institution of zoning gas a regulatory tool for land occupation led to the establishment of factories along the highway. Casaril (2009) [16] states that:

> "... industrial plants were allocated to peripheral areas to the north of the city, in the proximities of highway BR-369, abandoning the locations in the central area. As for the residential neighborhoods, the plan [urban development master plan] perpetuated socio-spatial segregation, maintaining the low-income areas at the periphery while privileging areas destined for the middle and high-income population to spaces with better urban equipment." (CASARIL, 2009: p. 76) [16]

In this context, Albuquerque (2005) [17] and Casaril (2009) [16] state that the central region was elected, among three regions set apart by zoning, for the concentration of retail businesses, extending it to other regions—such as the north (which today consists of a sub-center) for commercial activities that required more intensive transportation (such as the wholesale market).

Despite the stimulation of commercial business along the center-north axis, the southwest region later also began to concentrate certain types of retail business, especially after the construction of the Catuaí Shopping mall, starting in the late 1980s, as well as private universities.

The construction of the universities and shopping mall gave rise to numerous real estate lots for high-end gated communities, thereby creating new urban gaps in the center—south axis, containing complete but underused and often obsolete in frastructure.

The housing boom increased during this period, with a rising demand for single type homes, according to Casaril (2009) [16]:

> "... another type of building appeared with the so-called kitchenette apartments containing a bedroom, bathroom and kitchen, which began to be built next to the State University of Londrina. These apartments were destined to meet the huge housing demand of large numbers of students arriving yearly in Londrina, most of them originating from other cities in the states of Paraná and São Paulo." (CASARIL, 2009: p. 83) [16]

After the 1970s, the population boomed and, following the national trend, the rural exodus increased, causing the rural population to drop from 42.60% in 1960 to 11.52% in 1980 and to a mere 6.00% in mid-1991, as indicated in **Table 2**.

Starting in the 1980s, verticalization gained ground, with an intensive increase incivil constructiondespite the nationwide economic crisis. Passos (2007) [18] states that:

> "After 1986, there was a marked increase in the number of buildings going up, far exceeding the numbers recorded previously, and including three consecutive years during which the numbers exceeded

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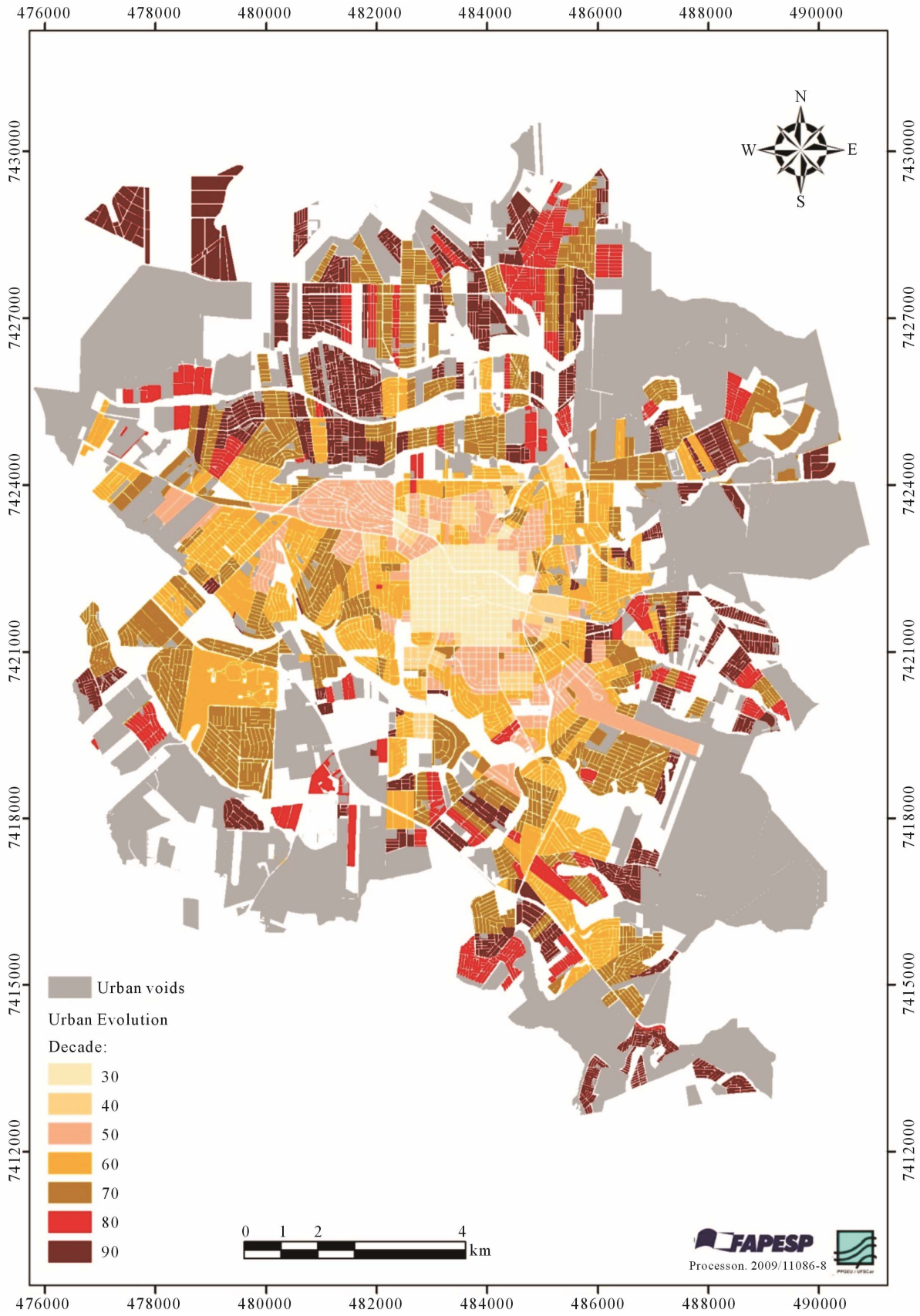


Figure 2. Urban expansionin Londrina, state of Paraná, Brazil.

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Table 2. Demographic data of Londrina, Paraná.

YEAR	RESIDENT POPULATION						GEOMETRIC GROWTH RATE[(1)]
	Urban		Rural		Total		
	Number	%	Number	%	Number	%	
1950	34,230	47.93	37,182	52.07	71,412	100.00	-
1960	77,382	57.40	57,439	42.60	134,821	100.00	6.60
1970	163,528	71.69	64,573	28.31	228,101	100.00	5.40
1980	266,940	88.48	34,771	11.52	301,711	100.00	2.82
1991	366,676	94.00	23,424	6.00	390,100	100.00	2.36
1996	396,121*	96.19	15,679*	3.81	411,800*	100.00	-
2000	433,369	96.94	13,696	3.06	447,065	100.00	2.02

SOURCE: IBGE—Demographic Censuses of 1950, 1960, 1970, 1980, 1991 and 2000; 1996 Population Count; *extracted the population of Tamarana. Former district that has been separated from Londrina.

> the entire previous decade, with 147, 136 and 177 buildings erected in 1987, 1988 and 1989, respectively." (PASSOS, 2007) [18]

Starting at this time, an unequal urban configuration began to be established, with the city center and the low-cost housing projects in the north region containing the highest demographic density to the detriment of numerous regionsdevoid of any occupationor with low to medium density occupation contiguous to the central area, equipped with public infrastructure, constituting urban gaps in the interstices, as indicated in **Figure 3**.

The establishment of unregulated land occupations scattered around the periphery of the city, as in the south-region (steeply sloped) and areas of permanent preservation in the east and north regions, gradually marked a cityof unequal density. Thus, the infrastructure installed in neighborhoods adjacent to the central are a began to serve regions with little demand due to the low number or even the absence of inhabitants resulting from the large urban gaps. In contrast, the peripheral regions containing a high population density ended up with incomplete or nonexistent public infrastructure.

6. Challenges for Urban Planning

Numerous attempts have been made to define sprawl in urban settings. While some authors attribute the phenomenon only to metropolitan areas, others prefer broader definitions.

A common thread in the various approaches, according to Frumkim & Frank (2004) [19], is that sprawl is characterized as a form of occupation incorporated to the pattern of land use and occupation and to urban transport. In addition to these, other authors include in this definition the high activity in central areas; accessibility to the public transport network; residential density; and the variety of residences, jobs and services at the neighborhood level.

Each of these categories influence the urban shape, which may be compact (according to density); of mixed use (residential, commercial, etc.); the perception of the place (the strength and vibrancy of activity in the central areas) and connectivity (access between one region and another).

These characteristics of the phenomenon of urban sprawl, which initially concentrated in American citiesand later spread to the compact cities of Europe, also occur in Brazil and bring up pertinent questions: Why does sprawl matter? How can it be controlled?

In addition to the impacts described earlier herein, the European Environment Agency (2006) states that sprawl matters principally due to the high cost of electricity and land, as well as high greenhouse gas emissions, which may, above all, cause public health problems, especially in urban agglomerations.

The question is: how can dispersed urbanization be controlled? How can one control the spatial fluidity of social groups that are not aligned with the spatial fluidity of the capital and seek their reproduction and survival? What mechanisms should be employed to develop effective urban environmental management?

Notwithstanding the similarity of Brazil's urban shapes with others around the world, the search for solutions to control urban sprawl in Brazil based on international cases would obviously be misguided, considering the numerous differences in the organization of federal and finance systems and the availability of resources for urban policies.

While the United States has programs such as Smart Growth, which allocate millions of dollars for the acquisition of land for environmental preservation and fiscal

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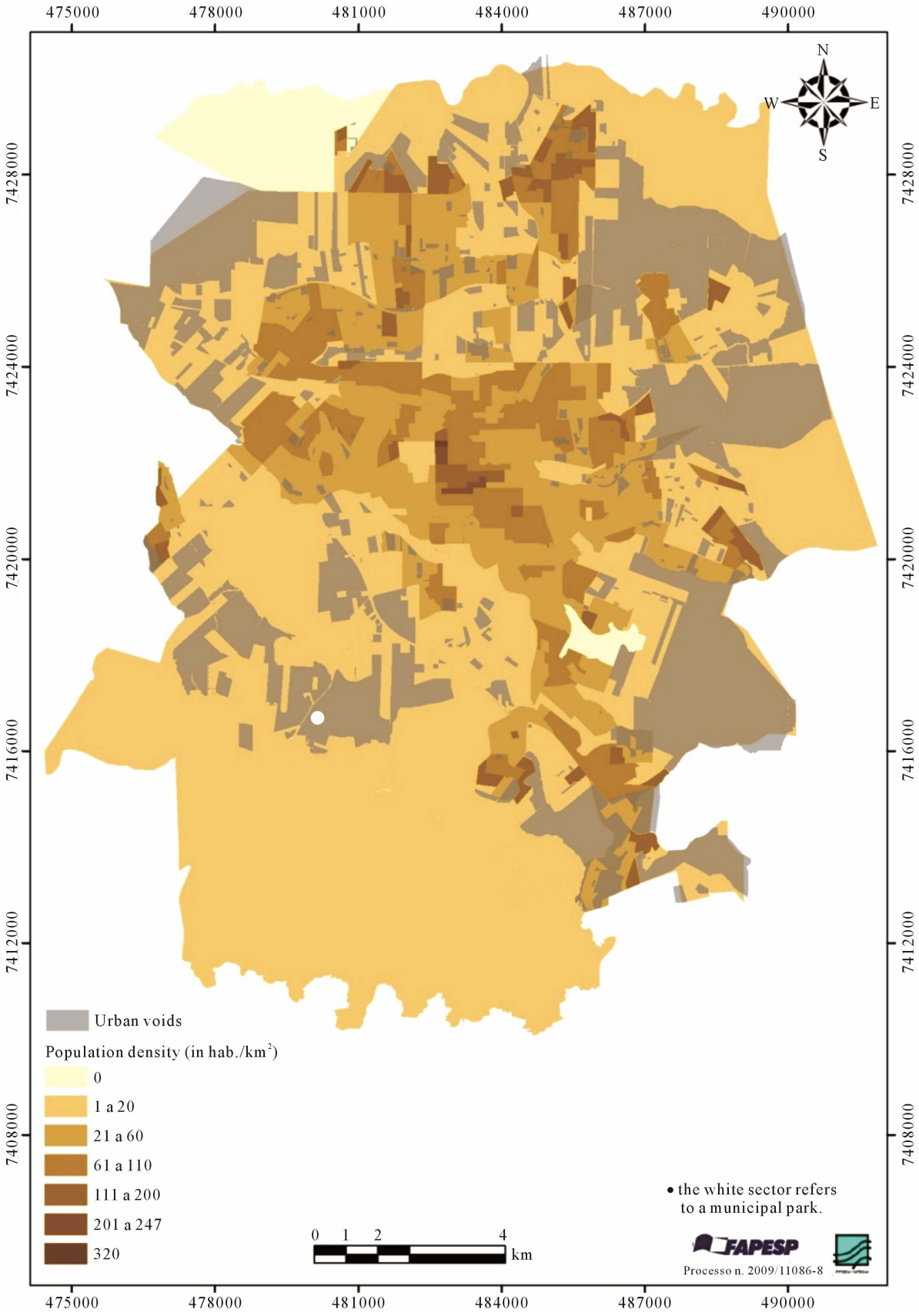


Figure 3. Demographic density, by IBGE sector, in Londrina, Paraná.

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incentives for the purchase of homes, Brazil faces problems at the very foundations of urban planning and its policies.

Hence, planning in Brazil, whatever the proposed public policy may be, automatically involves the drawing up of Master Plans, as discussed by Oliveira (2006) [21]:

> "In Brazil, planning has always involved the elaboration of plans and controls. Historically, one finds that numerous plans have been drawn up and continue to be drawn up: triennial, decennial, economic, pluriannual, for development, regional, master plans, etc. We have a culture of planning, which is aimed at foreseeing and organizing the future, as if this were possible to achieve in a rational and predictable manner." (OLIVEIRA, 2006: p. 282) [21]

Specifically in the urban environment, planning takes place mainly through Master Plans, which should be the main mechanism of control of urban sprawl, based on the indices and quotas specified in zoning laws.

However, notwithstanding the thousands of Master Plans that exist in Brazilian cities, why does this mechanism continue to fail to control urban expansion?

This problem can be attributed to various causes, as was broadly discussed by Villaça (2000, 2005) [22,23]. One of them is the extreme unpreparedness of municipal technicians in the development of their Master Plans, which often (almost always) end up being outsourced to consulting firms that allocate the development of these plans to a single professional—usually an urban architect.

And the problem begins precisely at this point. How can a city be zoned so as to control dispersed urbanization if the technical staff has a single point of view and is unprepared for this complex task?

The same zoning formula is found in numerous municipalities: the concentration of central retail corridors, with zoning becoming increasingly inflexible for retail and services the further removed it is from the center. And it is precisely at this point that one of the problems of sprawl occurs: the extensive use of transport.

The use of mixed zoning is becoming increasingly rate in Brazilian cities, unlike cities such as Montreal, Canada or several cities in the state of Maryland, US, which have vertical enterprises containing services, retail business and residences.

Thus, flexible zoning, which is understood here as zoning that encompasses different types that do not cause urban environmental impacts, is one of the challenges to be overcome by planners, as well as their autonomy in executing projects without political interventions.

At this point it is worth pointing out another challenge for the Brazilian case: the housing problem. The large-scale construction of low-cost housing, which usually follows a pattern (far away from the city center, all of them at the outer edges of the urban area), is also conducive to urban sprawl and poses a challenge for urban planning.

In the search to solve the housing problem, technological innovations should be investigated, such as the use of recyclable wastes for construction and the reuse of buildings and/or empty lots in central and boundary areas, doing away with the notion of large housing lot projects destined for low-cost housing, which is promoted principally by government programs aimed at stimulating the construction of "owned" homes.

Lastly, the greatest challenge for all Brazilian urban planners is to attempt to monitor and control the implementation of urban policies originating from our famous and "perfect" plans and projects, to prevent corruption from becoming the main actor in the process of planning our cities.

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