Introduction

There has been great expectation in Brazil that the decline in the rate of population growth of São Paulo’s Metropolitan Area would positively impact this metropolis, reducing the need for public investment in urban infrastructure and social policies. This local hypothesis relates to some extent with the so-called “urban transition theory”, which assumes that with the long-term reduction of the rural-urban migration, cities could achieve a more sustainable pattern of development (Liví-Bacci and De Santis, 1998; Martine, 2001).

In fact, between the 1970s and the 1990s, the rate of population growth declined remarkably in São Paulo Metro Area, from 4.5% to 1.7% a year, reaching the national average. Different demographic projections, such as the one produced by the State of São Paulo Bureau of Statistics (Seade) project a stable population for the Metro Area in the near future (Waldvogel et al., 2003). However, the expectations of a more sustainable development have not being fulfilled in the case of São Paulo. This happened because while the center of the city is significantly losing population, the peri-urban areas are still growing very fast (more than 6% per year between 1991 and 2000), with the population living in such areas rising from 19% to 30% of the Metropolitan Area. As a result of this urban dynamics, the region still demands strong public investments in terms of transportation and other urban infrastructure, followed by considerable environmental impacts.

Overall, the most general argument presented in this paper is that the connection between population growth and urban environment should not be considered in an abstract form, as if all urban environments and institutional contexts were the same. The interplay between population and environment must be considered in “concrete
territories”, with all their social and environmental diversity and their institutional complexity. In the case of Brazilian Metropolitan areas, we propose that particular dynamics of the land market - affected by land use regulations, as well as public policies (i.e., transportation and housing) - strongly influence the urban sprawl dynamics and its environmental impacts.

In view of these elements, the first objective of this paper is to understand the evidence on urban sprawl and present an operational definition of peri-urban region, discussed in section 1. In section 2, we intend to argue that such sprawl is producing an important land use transformation, inducing the destruction of the natural environment around the Metropolitan Area and the contamination of water sources. Additionally, urban sprawl leads to the occupation of parks and environmentally protected areas, such as the Atlantic Forest Biosphere Reserve and Billings/Guarapiranga Water Reservoirs in the South of São Paulo’s Metropolitan Area, or Serra da Cantareira’s Forest Reserve in the Northern part of the city.¹

In section 3, we will try to discuss why this intra-urban dynamic is happening by comparing spatial patterns of population growth and real estate investments. We intend to show that – surprisingly – the city is losing population exactly in the same places where real estate investments are growing more significantly.² Finally, we also present a brief conclusion trying to explore the arguments presented here from the point of view of the urban policies.

1. Urban sprawl and peri-urban areas

Map 1 below presents the spatial distribution of the rate of population growth of the census survey areas (“áreas de ponderação”) the urbanized area of São Paulo comprised by 21 municipalities.³ It is possible to observe that the demographic growth of this region has been very unevenly distributed in the past decade. While the central

¹ Satellite images (Landsat TM 1991, Landsat ETM 2000 and SPOT 2004) are used to build urban environmental indicators – i.e., vegetation index and land cover change (forest coverage reduction, urban sprawl) – at a local scale (districts, census tracts and census sample areas). See Annex 1.
² Most of these analyses benefit from the GIS database developed at the Center for Metropolitan Studies (CEM-Cebrap), where census data (1991, 2000), satellite images, real estate data, etc. are all available in GIS format. The authors used Maptitude, Envi and Arcview as their GIS software. See, www.centrodametropole.org.br
³ The Metropolitan Area of São Paulo is an official definition that includes 39 municipalities. The 21 municipalities considered here are the ones that form a continuous urban area with 92% of the total
areas of the most important municipalities of the region – including São Paulo (center), Guarulhos (Northeast), ABC (Southeast) and Osasco (West) – have lost population in absolute terms, there are areas located in the outskirts of the city that have grown very fast.

**Map 1**


The areas located in the external ring of the region have had presented a significant growth rate, often higher than 5% a year. We can also observe that there are practically no census areas in the central portion of the city that present positive growth. In operational terms, we are assuming that the peri-urban region corresponds to the census areas that presented a rate of demographic growth above 3% a year between 1991 and 2000. Peri-urban could have been otherwise defined by alternative variables, such as presence of sanitation or residential floor per inhabitant. Choosing the rate of population of the Metro region.

The only exceptions are the areas where the shantytowns of Paraisópolis and Heliópolis are located. Those are the largest shantytowns of São Paulo.
demographic growth is a defining variable was due to its importance in pointing out to to the dynamics of urban transformation over time.\(^5\)

Contrary to the American medium-high income urban sprawl (Duany, Zyberk and Speck 2000), the demographic growth of the Brazilian peri-urban region occurs due to the extension of existing poor areas, almost all located in the suburbs in the case of São Paulo (Torres, 2002). Most “traditional” poor areas present now low demographic growth. From the point of view of public policies, the distinction between poor areas with fast or slow growth is critical. While the peri-urban areas must build its infrastructure – i.e., streets, schools, healthcare facilities and basic sanitation –“old” poor suburbs have much of this equipment already in place. In those areas, social policy refers to other elements, such as the improvement of local education, housing and access to labor markets and credit.

In terms of the high and medium income areas of the city, almost all are losing population, the only exceptions being Alphaville and Vila Andrade - both in the western part of the region. This connection between population growth rate and average income in different areas of São Paulo is not necessarily universal, but related to recent demographic trends of the city (Torres, 2004).

In aggregate terms, the recent demographic change of São Paulo may be considered rather awkward. While the region as a role was growing in moderate terms (1.4% a year in the 1990s), the central negative-growth areas were losing population quite fast (-1.3% a year). In contrast, peri-urban fast-growth areas were growing at the impressive rate of 6.3%  (Table 1).

<table>
<thead>
<tr>
<th>Date</th>
<th>Population (thousands)</th>
<th>Growth Rate 1991-2000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative growth areas</td>
<td>Slow growth areas &gt; 0 &amp; &lt; 3%</td>
</tr>
<tr>
<td></td>
<td>1991</td>
<td>6738</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>5992</td>
</tr>
<tr>
<td></td>
<td>Growth Rate</td>
<td>-1.30</td>
</tr>
</tbody>
</table>


As a consequence, the population in negative growth areas has decreased from 6.7 to 6 million inhabitants between 1991 and 2000. In slow growth areas, it has

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\(^5\) The level of 3% is arbitrary, but reasonable if we intend to characterize areas of strong growth. It means two times faster than the growth rate of the population of the area considered here (1.4% a year).
increased from 4.9 to 5.5 millions while in the peri-urban (fast-growth) areas it raised impressive 2.1 million inhabitants (from 2.8 to 4.9). In 2000, this area represented 30% of the total population of the region. Without such contribution, the urbanized region of São Paulo would have kept its population stable in the 1990s.

As mentioned, intense demographic variations of this kind have important consequences for public policies. The expectation that a slower population growth rate would reduce the pressure over the offer of public services is only partially true. The persistent horizontal growth of the city requires a continuous extension of the network of public services to the peri-urban areas, even when the equipment located in the central areas are not used to its full potential. It is also important to notice that this region corresponds to an average extension of 70x60 km and the transportation system is crowded and expensive. In other words, it is not realistic to imagine that peri-urban residents would easily access services only available in central areas (Torres, 2002a).

Besides having the highest population growth rates of the city, the peri-urban areas also unsurprisingly show the worst socioeconomic indicators, with high levels of poverty, illiteracy and unemployment. Table 2 shows that the average family income in the slow growth areas is more than twice the one observed in the peri-urban areas, with the income per capita of the average family almost three times higher. This table also shows that such income differentials are associated with high levels of unemployment and illiteracy. This poor and illiterate peri-urban region also concentrates the largest proportion of black population (44%). This differentials are additionally expressed in terms of sanitation indicators, such as water supply, garbage and sewage collection.

Table 2
Socioeconomic and sanitation indicators of the Urbanized Area of São Paulo, 1991-2000

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Groups of Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative growth areas</td>
</tr>
<tr>
<td>Average family income (*)</td>
<td>14,62</td>
</tr>
<tr>
<td>Per capita family income (*)</td>
<td>4,65</td>
</tr>
<tr>
<td>Unemployment rate (**)</td>
<td>15,06</td>
</tr>
<tr>
<td>Illiterate head of households</td>
<td>3,56</td>
</tr>
<tr>
<td>Proportion of blacks (%)</td>
<td>19,54</td>
</tr>
<tr>
<td>Water (%)</td>
<td>99,82</td>
</tr>
<tr>
<td>Sewage (%)</td>
<td>95,84</td>
</tr>
<tr>
<td>Garbage (%)</td>
<td>99,81</td>
</tr>
</tbody>
</table>

Source: IBGE, Demographic Census de 2000.
Notes: (*) In minimum wages (~US$100 in 2005).
(**) It does not correspond to the official unemployment estimates, due to a different methodology adopted by Brazilian Census.
Such an urban sprawl has also significant environmental consequences in terms of transportation and pollution. On the one hand, peri-urban housing means longer journeys and increase in air pollution; on the other, poor peri-urban areas also mean lack of sanitation and pollution of river and streams (Torres, 2002a) as well as deforestation and destruction of natural landscapes that still surround São Paulo. We further discuss this issue below.

2. Urban Sprawl and Environmental Degradation

One of the most significant environmental impacts of the urban sprawl of São Paulo is reflected on the massive destruction of the green belt of Atlantic Rainforest surrounding the city. The Atlantic Rainforest is one of the most endangered eco-systems in the world. Different studies on deforestation estimate that less than 10% of the original forest remains are preserved in Brazil, and the rate of destruction is still high (Fundação SOS Mata Atlântica, 1998).

São Paulo’s Atlantic Rainforest greenbelt has been partially preserved – especially on its Northern and Southern parts - mainly because the topography of remaining areas does not allow for its agricultural exploitation. The South Region is part of the water sources protection area, and has intensified its already high population growth in the last decade. More recently, the North of São Paulo has also been growing fast around the fringes of the Cantareira mountain range.  

The so-called “law of protection of water sources”, from 1975, has not been able to limit the urban expansion around the major lakes and forest remains in the Southern part of the metropolis. On the contrary, the law has produced a decrease in land prices, which led to a raise in illegal occupation and the consequent pollution of the water sources and deforestation (Marcondes, 1996). In a buffer of 1km around the two major lakes (Guarapiranga and Billings), for instance, the population has grown from 554 thousand in 1991 to 881 thousand in 2000, or 4.3% a year.

The most important and preserved remnants of the Atlantic Rainforest are located in the farthest Southern portion of the Metro Area. In the North, the public parks of Cantareira and Jaraguá - sponsored by the State government - also includes important

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6 The expansion of such areas relates to both illegal occupation by shantytowns and illegal developments, and legal settlements (small farms and industry) (Marcondes, 1999).

7 This data was calculated with the use of a Geographic Information System (GIS).
remnants of native forest with medium to advanced stages of forest succession. Both the Western and Eastern areas of the city are less protected by the presence of parks and reserves (PMSP, 2002).

A recent green coverage study conducted by the government of the city of São Paulo using satellite images, indicated that the city has lost 53.4 km² of any kind of green coverage in the last decade (PMSP, 2002). The greatest part of this deforestation (56%) was concentrated in only 10 of a total of 96 districts, all located in the poor suburbs, with a high rate of population growth also happened.  

In other words, the urban sprawl was followed by a significant destruction of the remaining forests in the metro area, with little respect for the restrictive environmental legislation that forbids any deforestation of the Atlantic Rainforest – Bylaw 750/93 (Marcondes, 1999). Those green areas are part of so-called the Atlantic Forest Biosphere Reserve, which is part of one UN initiative (Lino, 1992), and key for different ecological dynamics, since they serve as ecological corridors and routes for migratory species. They also play a fundamental role in the conservation of water sources.

Not surprisingly, the city has an important deficit of public spaces and green areas, a situation unlikely to be reversed since in the most consolidated portions of the city there are very few public areas available for building new parks. The available maps of green coverage show that half of the city districts present no significant forest coverage in terms of both the trees planted along the street network and of parks or squares (PMSP, 2002). In poor suburbs several public areas were invaded and turned into shantytowns and illegal settlements.

In 1991, the municipalities of the Metropolitan Area considered in this study still presented forest coverage of 1.23 thousand square kilometers. It represented 35.7% of the metropolitan area, being located mostly in preserved areas and strategic sites for the protection of water reservoirs. By 2000, the remaining forest in the same municipalities accounted for 1.17 thousand square kilometers (34% of the region). Surprisingly, such data indicates that São Paulo Metropolitan Area still presents a significant forest coverage.

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8 Those districts are the following: Jardim Ângela, Parelheiros and Grajaú in the South; Tremembé, Perus, Anhanguera and Jaraguá in the North; and Iguatemi, Cidade Tiradentes and São Rafael in the East.

9 See section 3.
However, this data also indicates an important net loss of forest cover (57.2 square kilometers) during the 90s, with a rate of forest loss of 4.7% in nine years. Although such deforestation could not be considered very high when compared with the rate of destruction of other Brazilian areas such as the Amazon (PRODES-INPE, 2004), as mentioned before it is quite important for São Paulo both because of the previous loss and because of the strategic services it provides for the metropolis in terms of protection of water sources and reduction of the air pollution.

In Map 2 we present the distribution of forested areas in São Paulo in 2000, highlighting the areas that suffered higher levels of deforestation during the 90s (more than 2% of its area within the decade). In geographic terms, most of the deforestation took place in the same far suburbs that had grown significantly in the 90s.

Map 2
Forest Coverage and Areas with High Level of Deforestation. Urbanized Area of São Paulo, 2000


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10 Such estimate simply subtracts the forested areas accounted for in 1991 from the ones in 2000. Therefore, it also includes forest plantation and forest regeneration.

11 See Map 1.
One can see that the center of the city is almost completely deforested. On the other hand, large parts of the suburbs are still covered with their original vegetation. We did not considered in this account pasture or grassland, although secondary and reforestation areas is also included in this estimate. It is also important to notice in Map 2 that the areas highlighted - with more than 2% of deforestation in the 90s - showed a total population of 1.7 million in 1991 and it totaled 2.8 million in 2000, a rate of growth of 5.3% a year. Although this kind of ecological data may not precisely establish the connections between population growth and deforestation, it is clear that most of the deforestation occurs in areas with very fast growth rate (see figure 1).\footnote{We are trying to test such arguments using a space regression model (Anselin, 1996), but we still have to complete the data set for variables related to the existence of parks and reserves. As a preliminary exercise we present in Annex 2 a regression showing that population rate growth and deforestation are}

**Figure 1**


Notes:  
1) Each point refers to a census survey area.
2) The percentage of forest loss was calculated for each area.
3) Pearson correlation coefficient $r = 0.426$
The figure shows that there are very few situations in which high rate of deforestation occurs in the negative and slow growth areas, and that almost all deforestation has happened in the fast growth (peri-urban) areas. However, it is also important to consider that not all peri-urban areas present high rates of deforestation, with some of them even showing forest regeneration. In this context, public intervention should consider a target approach, focusing the eastern portion of the city, for instance, which concentrates an important share of forest loss.

At the table 3 below, we interpret this forest data employing the same geographic divisions previously used for analyzing these demographic trends.\(^\text{13}\)

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Changes in the land cover between 1991 and 2000. Urbanized Area of São Paulo.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Groups of Areas</strong></td>
<td><strong>Negative growth areas</strong></td>
</tr>
<tr>
<td>Area (excluding lakes)</td>
<td>630.54</td>
</tr>
<tr>
<td>Urban area 1991 (km²)</td>
<td>533.06</td>
</tr>
<tr>
<td>Forest coverage 1991 (km²)</td>
<td>22.33</td>
</tr>
<tr>
<td>Proportion of urban land 1991 (%)</td>
<td>84.54</td>
</tr>
<tr>
<td>Proportion of forested land 1991 (%)</td>
<td>3.54</td>
</tr>
<tr>
<td>Urban area 2000 (km²)</td>
<td>538.85</td>
</tr>
<tr>
<td>Forest coverage 2000 (km²)</td>
<td>22.85</td>
</tr>
<tr>
<td>Proportion of urban land 2000 (%)</td>
<td>85.46</td>
</tr>
<tr>
<td>Proportion of forested land 2000 (%)</td>
<td>3.62</td>
</tr>
<tr>
<td>Change in urban area 1991-2000 (km²)</td>
<td>5.79</td>
</tr>
<tr>
<td>Change in forested area 1991-2000 (km²)</td>
<td>0.52</td>
</tr>
</tbody>
</table>


In 2000, almost 50% of the fast growing (peri-urban) areas are still forested, particularly in the North and the South. In slow growth areas, 20% of the territory presented forest coverage, while negative growth areas present showed a forest coverage of only 4%. Ironically, the rate of population growth is strongly positive in the forested areas and negative in the denser urban areas. Furthermore, more than 85% of all forest coverage of Sao Paulo`s Urbanized Area are located in peri-urban areas, with more than one thousand square kilometers.

Between 1991 and 2000, the peri-urban areas presented a net loss of almost 50 km² of forest coverage, which represent a reduction of 5% of the original 1991

significantly correlated even when using controls for other variables, such 1991 forest coverage (R²= 36%).
coverage. In other parts of the city, such loss was less significant, including a small
grow in the forest area of the central parts of the city (negative growth areas). On a
whole, almost 5% of the forest coverage that existed in 1991 was destroyed by 2000, a
trend that will most likely continue in the near future.

One can also see in Map 2 that the region in which the most important water
sources for São Paulo are located – the reservoirs of Billings and Guarapiranga in the
South of the city – also present both significant deforestation and rapid population
growth. As mentioned before, the consequences of such dynamics are a concern and
subject to extensive debate by the local press. The annual investment needed to preserve
such reservoirs is impressive, and other alternatives would imply, for instance, bringing
water from Vale do Ribeira, located further down South. Such an expansion of the water
network would demand huge public investment due to distances and topographic
difficulties involved.

Most of these awful trends are related to the logic of the land markets. Should
the population growth happen in denser areas, much of the current damage could be
reduced. In our point of view, only a significant change in the dynamics of local land
markets could allow a more sustainable pattern of growth. We discuss this issue below.

3. Urban sprawl and land markets

Between 1995 and 2003, there was a significant residential real state investment
in São Paulo, with private companies launching more than 7.5 thousand residential
projects, including nearly 400 thousand residential units, 3 million square meters of area
and almost 10 billion dollars in private investments.\textsuperscript{14} Such projects refer to those by
private companies only, not including the investment made by families and individuals
themselves. Surprisingly, the bulk of such investment happened in areas that lost
significant amount of population between 1991 and 2000. Evidence of this argument is
presented in Map 3.

In other words, there seems to be limited connections between the private
companies production of housing and the strong dynamic of population growth in the
far suburbs. The housing built by private companies were offered almost exclusively for

\textsuperscript{13} See Annex 1 for technical procedures.

\textsuperscript{14} See Embraesp 1985-2003, which register all new real state investments advertised in newspapers.
high and medium income families. Only 11% of such projects referred to houses or apartments of less than 50 square meters of residential area, which could be considered more cost effective for low-income families. Even in this case, most small apartment projects were located in rich areas, and sold as hotel-flats, not affordable for the poor. Overall, the projects by private companies were never intended to be sold to poor dwellers, since their lack of income made them unaffordable for both acquisition and rental purposes.

**Map 3**


Although we have few individual data to support such an argument, the ecological data presented here also works as evidence in this case because there are almost no private companies investing in the fast growing poor suburbs. Table 3 summarizes the data available on this issue.
Table 4

<table>
<thead>
<tr>
<th>Groups of areas according to population growth rate, 1991-2000</th>
<th>Number of occupied households 2000</th>
<th>Population density (Pop./km²)</th>
<th>Average family income (1)</th>
<th>New private investment in residential area per household (2)</th>
<th>New investment per household (3)</th>
<th>Investment per group of areas (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-8 to -1.5%</td>
<td>622918</td>
<td>7484</td>
<td>22.90</td>
<td>12.84</td>
<td>5.55</td>
<td>37.51</td>
</tr>
<tr>
<td>1.5 to 0%</td>
<td>1213558</td>
<td>10749</td>
<td>15.15</td>
<td>7.17</td>
<td>2.49</td>
<td>32.80</td>
</tr>
<tr>
<td>0 to 1.5%</td>
<td>916966</td>
<td>10836</td>
<td>11.17</td>
<td>7.09</td>
<td>1.63</td>
<td>16.19</td>
</tr>
<tr>
<td>1.5 to 3%</td>
<td>605315</td>
<td>10943</td>
<td>9.54</td>
<td>3.57</td>
<td>1.16</td>
<td>7.60</td>
</tr>
<tr>
<td>3 to 5%</td>
<td>466761</td>
<td>7961</td>
<td>6.97</td>
<td>3.26</td>
<td>0.60</td>
<td>3.04</td>
</tr>
<tr>
<td>5% and more</td>
<td>801623</td>
<td>8715</td>
<td>6.23</td>
<td>1.98</td>
<td>0.33</td>
<td>2.86</td>
</tr>
<tr>
<td>Total</td>
<td>4627141</td>
<td>9526</td>
<td>12.42</td>
<td>6.16</td>
<td>1.99</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Notes: (1) Expressed in number of monthly minimum wages of 2000. In 2004, one minimum wage corresponded approximately to 90 dollars. (2) Total residential area (square meters) produced between 1987 and 2003 divided by the number of households in 2000. (3) Total investment (US$) between 1987 and 2003 divided by the number of households in 2000.

In fact, these data shows that the rich areas (those that are losing population) receive the largest amount of private investment (70%). with poorest areas (that are growing more than 3% a year) receiving only 6% of the total investment between 1985 and 2003. In other words, there is no private investment in poor areas, especially considering the size of the population and its growth rate. These trends also indicate an increasing of the already high level of residential segregation (Torres, 2004).

In the 90s, the Metro Area received additional 96 thousand households every year. On average, the investment provided by private companies as presented above was responsible for only 23% of such increase. The public housing projects were almost insignificant, which means that most of the new housing has been built by families and individuals in very far away suburbs. This indicates that the pattern described in the 70s - of poor urban dwellers living in self-constructed houses in the so-called “peripheries” of the city - is still true for São Paulo in the 90s (Kowarick, 1979).

15 The total number of households (occupied or not) reached 3.8 million in 1991 and 4.7 million in 2000 in the 21 municipalities considered in this analysis. It represents a growth rate of 2.3% a year.
16 The data available is quite controversial and incomplete. Considering only the City of São Paulo (that accounts 60% of the population of the Metro Area), the average production of new households by the city government was less than 4 thousand per year between 1989 and 2003 (Marques and Saraiva, 2004). This amount does not include the investment in urban regularization and shantytown urbanization.
Although private and public housing projects represent less than 30% of the offer of new house units in the 90s, it is not necessarily true that this pattern of growth—with all the city growth happening in the “periphery”—must continue. There is right now a significant amount of non-occupied land in central parts of the Metro Area—especially in the old industrial belt as well as along some railroad corridors, as shown in Map 4.

Map 4  

This land has not been occupied both because high prices and lack of public policies that could redirect such available land to low income dwellers and housing projects. Taxation, for instance, could be more extensively used to stimulate vertical building and punish vacant lots. Current zoning regulations also prohibit tall buildings in large, high income, low density neighborhoods, significantly restricting the possibility of other families to live in areas that have full infrastructure.

In other words, in the case of São Paulo it seems quite clear that the urban sprawl shows a stronger relation to land market dynamics (and the role of the
government) than with the demographic dynamics per se. Quoting Sabatini (2001), who studies the segregation patterns in Chile, we can also say for São Paulo that “the land market is in the eye of the storm”.

3.1 The Role of the Informal Markets

Informal settlements are yet another important dimension of this process. Due to the lack of affordable housing, the poor population ends up living in different types of informal settlements, such as slums, irregular developments and shantytowns. A recent study by the Secretariat for Housing of the city of São Paulo estimates that at least 25% of the city’s households are either in shantytowns or in illegal developments (Sehab, 2003). However, illegality and/or informality in São Paulo should be even higher since it also refers to a more complex arrangement of land use regulations: building norms, environmental constrains for land occupation, infrastructure regulation on neighborhood development, zoning, and property rights (Figure 2).

FIGURE 2: Forms of regulation and of housing occupation in São Paulo

<table>
<thead>
<tr>
<th>REGULATIONS ON LAND USE, ENVIRONMENT AND INFRAESTRUCTURE</th>
<th>REGULATIONS ON PROPERTY RIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Legal</strong></td>
<td><strong>Illegal</strong></td>
</tr>
<tr>
<td>A Regular housing areas</td>
<td>B</td>
</tr>
<tr>
<td><strong>Illegal</strong></td>
<td>C</td>
</tr>
<tr>
<td>Irregular developments</td>
<td>D</td>
</tr>
<tr>
<td>Slums</td>
<td>Shantytowns</td>
</tr>
</tbody>
</table>

Source: Adapted from Lim (1995: 525). See also Torres (2002b).

As a consequence, only a small part of the city - which has also been called “the legal city” (Situation A in Figure 1) - can be to some extent comparable to a city of a developed country (Grostein, 1987). Private investments usually happen in such legal city. It explains why the bulk of private investments have happened in central areas of São Paulo. Most shantytowns and illegal settlements are located in poor suburbs and in peri-urban areas (Map 5 and Table 4).\(^\text{17}\)

\(^\text{17}\) Unfortunately, we only have data for the city of São Paulo to support this argument.
One can see that shantytowns are much more frequent in the peri-urban areas (19.3% of the local population) than in the central negative growth areas (4.3%). The same pattern occurs with illegal settlements, which represent almost 24% of the population of peri-urban areas while only 10% of the population of central areas. In the poor slow growth suburbs, the percentage of population living in shantytowns and illegal settlements is 15.5% and 17.4% respectively.

Illegal occupation accounts for 43% of the population living in peri-urban areas of the city of São Paulo. In a few words, illegal occupation of the poor peri-urban areas seems to be part of the same process that induces the strong rate of population growth and deforestation. Although we base our arguments in ecological data, there is a strong rationale to support such arguments.
Table 5


<table>
<thead>
<tr>
<th>Groups of Areas</th>
<th>Negative growth areas</th>
<th>Slow growth areas &gt; 0 &amp; &lt; 3%</th>
<th>Fast growth areas &gt; 3% a year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population living in shantytowns</td>
<td>208,478</td>
<td>527,462</td>
<td>430,283</td>
<td>1,166,223</td>
</tr>
<tr>
<td>Population living illegal settlements</td>
<td>470,112</td>
<td>591,009</td>
<td>529,862</td>
<td>1,590,983</td>
</tr>
<tr>
<td>Total</td>
<td>678,590</td>
<td>1,118,471</td>
<td>960,145</td>
<td>2,757,206</td>
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<tr>
<td>% Population living in shantytowns (*)</td>
<td>4.34</td>
<td>15.50</td>
<td>19.27</td>
<td>11.18</td>
</tr>
<tr>
<td>% Population living in illegal settlements (*)</td>
<td>9.80</td>
<td>17.37</td>
<td>23.72</td>
<td>15.25</td>
</tr>
<tr>
<td>Total (%)</td>
<td>14.14</td>
<td>32.87</td>
<td>42.99</td>
<td>26.43</td>
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</tbody>
</table>

Source: IBGE, 2000 and Secretariat for Housing of the City of São Paulo, 2002.

Note: (*) Percentage of population living in shantytowns or illegal settlements in relation to the total population of the group area.

In the case of São Paulo, there are diverse institutional barriers for the provision of proper infrastructure and social services in irregular and/or invaded areas. This high level of irregularity “justifies” the non-provision of social services, or to limit their potential availability. Even when the State decides to invest in irregular settlements, it is more difficult to find proper site location for social equipment in irregular or illegal land. Moreover, the State must follow complex legal procedures in order to appropriate private land. It takes more time to find proper land for public equipment close to illegal developments and shantytowns. Sometimes the State decides not to invest in these areas due to the risk of losing public investments made in such places – which may be later appropriated by their private owners. Lawsuits against public administrators that do not follow the complex set of standard procedures may also happen in regard to land use regulations (Maricato, 1996; Torres, 2002).

Different authors have argued that informal land use is a major issue for developing countries. Some defend the regularization of land property and the simplification of norms and regulation as important preconditions for further social and economic development in this kind of urban area (World Bank, 1999). However, the links between land use and social policies need to be addressed more extensively

18 “Only well functioning land markets can provide an adequate supply of housing, and maintaining these markets is another task that deserves attention from the public sector. Providing universal registration and establishing clear property rights to all urban land will require strengthening existing institutions. Ill-defined land rights render land useless and discourage the redevelopment of entire portions of a city. But simply providing security of tenure creates incentives to improve housing and infrastructure dramatically. To avoid adding to the backlog of problem housing and neighborhoods, new development must meet basic – but not excessive – compliance standards” (World Bank, 1999: 146)
because public services must be present even when land regularization is not in force. In the case of Brazil, some of these services are even considered to be constitutional rights.

4. Conclusion

The general argument presented here was developed as follows. We have first shown that the demographic growth of the city is very uneven. While the center of the city is losing population, its farthest suburbs are growing fast. Associated to this observation, we have also noted that those areas are the poorest and with less infrastructure of the region. They present high levels of deforestation and informality in terms of land use. The high concentration of social, environmental and legal problems in the far suburbs makes them a very ill-suited area for population growth, which ironically insists to go on there.\(^{19}\)

Second, it is important to notice that it is not the case to blame the poor migrants that move to this least structured suburbs. They are the first to be affected by the degradation of the environment, not only due to their exposure to environmental hazards and vectors of contagious diseases, but also because their places of residence are less protected in terms of equipment and/or construction patterns that avoid such hazards.

The logic that produces the urban sprawl in metropolitan areas such as São Paulo is quite complex, and related to the role of different branches of the government (regulation, taxation, infrastructure, housing policy, etc.) and to the role of private companies. Most likely, this sprawl would be happening even with a zero population growth scenario.\(^{20}\)

Therefore, the most significant issue here is how to change such unhappy trends. The idea that land use regulation could cope with such problems is quite naïve, since it has not been able to proper regulate illegal settlements in São Paulo. Urban environmental legislation, for instance, is many times victim of such logic. The “law of water sources protection” in avoiding land occupation is just one tragic example of the failure of a series of attempts to enforce land regulation.

\(^{19}\) In other words, we totally agree with Martine (2001) that density should be stimulated in order to revert such trend.
References


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20 In fact, it is already the case of the city of São Paulo that is growing quite slowly (0.8% a year between 1991 and 2000).


PRODES -INPE. 2004. Monitoramento Ambiental da Amazônia por Satélite. [www.inpe.br](http://www.inpe.br)


Annex 1- Procedures for generating land cover estimates

In order to produce land cover indicators, we have used the following satellite images for the Metropolitan Area of São Paulo:

1. Landsat 5 TM (Thematic Mapper), orbit point 219/076 – October 23, 1991
2. Landsat 7 ETM+ (Enhanced Thematic Mapper Plus), orbit point 219/076 - September 21, 2000.21

We adopted the software ENVI 4.0 to process such images. Initially, we have registered the 1991 image, procedure later applied to 2000. These images were geometrically corrected and registered with reference to the vector cartography of rivers and streams for the region (scale 1:10,000).

We used different digital image processing procedures to enhance the images regarding its vegetation, i.e., contrast enhancing, color composites, filters for special frequencies and mathematic operations for image classification. The color images that have presented best results for visual interpretation were the ones produced with the TM4, TM5 and TM3 bands and channels red (R), green (G) and blue (B). We produced the color composites in 1991 and 2000, keeping the same contrast for both of them.

Since the main objective was to identify basic green coverage, we chose not to use NDVI (Normalized Vegetation Index). The legends were based on TM4, TM5 and TM3 bands for 1991, which guided the mapping classes adopted here. We have produced the following classes: urban areas, water, exposed soil, grassland (pasture, etc.) and forest. We have made no attempt to discriminate primary forest, secondary forest of planted vegetation, since it was not the paper’s objective.

Having produced such classes, we started the classification based on different samples. Our basic source of information has been aerial photographs (scale 1: 8,000) of significant targets. Based on the largest sample possible (at least 5,000 pixels) in the two color composites (1991 and 2000), we started the process of supervised classification.

We used the classification algorithm known as Maxver (maximum likelihood), following Richards (1986). After such initial classification, we used different filters 21 These dates refer approximately to the 1991 and 2000 census reference dates.
such as “clump” and “sieve”. Such procedures were adopted for the images of both 1991 and 2000.

In order to test classification accuracy, we used a confusion matrix generating a Kappa coefficient of 0.9466 in 1991 and 0.9442 in 2000. Such coefficient varies between 0 and 1, and the best classifications are those closest to 1. The Kappa coefficients we have obtained are satisfactory, and we accepted the classification (Richards, 1996). The classified images were transferred to the ArcGis 8.1. where the images were converted to a grid format and than analyzed for each census survey area for 2000.
Annex 2: Spatial Regression Model

Dependent Variable:

- PDVARBUST9    Deforestation between 1991 and 2000 (%)

Explanatory variables:

W_PDVARBUST9    Deforestation in neighborhood areas (Queen Contiguity)
TAXDESEM      Unemployment rate (2000)
PSUBNORM     Population living in shantytowns in 2000 (%)
TAXA91_0    Population rate growth 1991-2000
PVARBUST91    Forest coverage in 1991 (%)

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<th>Coefficient</th>
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<td>W_PDVARBUST9</td>
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<td>PVARBUST91</td>
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<td>0.00669473</td>
<td>-4.253822</td>
<td>0.0000210</td>
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REGRESSION DIAGNOSTICS

DIAGNOSTICS FOR HETEROSKEDASTICITY

RANDOM COEFFICIENTS

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DIAGNOSTICS FOR SPATIAL DEPENDENCE

SPATIAL LAG DEPENDENCE FOR WEIGHT MATRIX: pesos_mod1.GAL

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