

## **Environmental Justice and Waste Management:**

Location of landfills and socioeconomic conditions in São Paulo  
(SP, Brazil)

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Lund University Centre for  
Sustainability Studies



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## Abstract

Environmentally safe disposal of urban waste is a global concern that recently gained a new dimension through the lens of Environmental Justice, with a growing literature showing correlation between the placement of waste facilities and disadvantaged groups in society. This thesis seeks to verify whether landfills in the city of São Paulo are located in regions where socially and economically vulnerable groups live, in order to promote the inclusion of the concept of environmental justice in the solid waste management planning process. This thesis also questions the role that the presence of a landfill poses to the socioeconomic conditions of the surrounding population and the reasons behind why they live close to landfills. São Paulo (SP, Brazil) was chosen as the case study and the research strategy is based on a mixed methods approach: literature review, production /analysis of GIS maps and field visit. One community in the vicinity of CTL Leste landfill was studied in detail, in which field observations and application of semi-structured interviews were used as data collection strategy to gain insights from the case study area. The data from interviews were analysed statistically and through content analysis. The two maps created with ArcGIS software showed that most of the landfills of São Paulo are located mainly in areas occupied today by economically disadvantaged populations, although many sites were not urbanized at the time of landfill implementation. The field visit confirmed social conditions of the residents and provided insights about the effect that the landfill has on these conditions. It is fair to say that the presence of a landfill itself is not the main cause of the precarious socioeconomic conditions of the surrounding inhabitants; instead, the city dynamics makes populations that are already socioeconomically vulnerable accept to live in the vicinity of landfill sites. It is confirmed a case of environmental injustice, in which an already more vulnerable population are being exposed to additional environmental risks. It is concluded that the concept of environmental justice may help the process of policy making and regulatory practices to better protect disadvantaged populations, in order to guarantee that the presence of a landfill does not further expose an already vulnerable population to an additional type of risk, environmental risk.

**Keywords:** environmental justice, waste management, landfill, São Paulo, Brazil, sustainability science

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# 1 Introduction

Waste is an unavoidable by-product of human activities and its environmentally safe disposal is a global concern that has increased in recent decades due to the growth of production (Bhada-Tata & Hoornweg, 2012), excessive generation (Ekström, 2015), mismanagement (Guerrero, Maas, & Hogland, 2013) and lack of final disposal areas (Jacobi & Besen, 2011). Managing solid waste properly is necessary because several adverse impacts will continue until its full decomposition or stabilization, during which time, contamination of atmospheric, water and soil resources is a critical risk (UNEP, 2005). Leachate may pollute groundwater and surface water and the burning of solid waste, not properly collected and disposed of, can produce air pollution (Bhada-Tata & Hoornweg, 2012). Further, improper disposal can also become a breeding ground for insects, vermin and scavenging animals (Bhada-Tata & Hoornweg, 2012). Besides the numerous environmental impacts related to waste management, the lack of or failure of good waste management practices can also affect public health (UNEP, 2005). Several epidemiological studies reported evidence of adverse health effects produced by waste activities, demonstrating an association between human illnesses and proximity to waste facilities (Giusti, 2009). The disproportionate exposure of these effects to minority and low-income communities characterizes what is called environmental injustice. This emerging body of scientific literature is showing an association between socio-economic status and differentiated exposure to waste, in which waste facilities are often located in areas inhabited by more deprived residents and ethnic minorities (Martuzzi, Mitis, & Forastiere, 2010). Environmental Justice evolved so both as a political discourse and through academic studies, often focusing on local distribution of pollution, risk and race (Walker, 2009).

Environmental Justice research is often related to the chicken-egg controversy: which came first, the hazardous facility or the minority/low income community? (Pastor, Sadd, & Hipp, 2001). The presence of a local environmental problem may result in declining property values that attract lower-income households (Bullard, 1996). On the other hand, the placement of landfills in areas inhabited by more deprived residents or residents of ethnic minorities may have been a result of decisions of facility owners or government (Mohai & Saha, 2015). This thesis does not aim to answer this controversy. Intentional discrimination is a complex subject that may require time series data and/or suitability analysis studies to be properly discussed. Regardless of what came first, the research focus is the community impact, i.e. if populations with precarious economic and social conditions are also being exposed to environmental risks due to their proximity to landfills.

Cities in developing countries tend to have limited capacity to provide essential public infrastructure services for solid waste management. Although waste management practices are improving, safe environmental disposal and the provision of good urban waste facilities is still a huge challenge in Brazil (Jacobi & Besen, 2011). It was found that the concept of environmental justice is rarely discussed or considered in the country. For example, the Brazilian legal framework for solid waste management established several innovative mechanisms, such as detailed municipal waste management plans, well managed landfills with new technologies, introduction of shared responsibilities and ambitious disposal reduction targets and measures (PNRS, 2012). In some perspectives, the country is reaching its sustainable development goal in the waste management sector (Jacobi & Besen, 2011), however environmental justice is less stressed, if at all discussed behind those sustainability achievements.

The city of São Paulo has a detailed municipal waste management plan and modern landfills with innovative technologies, such as methane capturing and electricity generation (São Paulo, 2014). However, there is no mention of environmental justice or discussion about equity in the placement of waste facilities in the Municipal Plan of São Paulo. Despite being recent (released in 2010), the issue about the areas designated as landfill sites and their location are not discussed, nor how it may unequally affect its inhabitants. According to Rammê (2012), the concept of environmental justice is recent in Brazil and studies adopting this concept are growing. Even though several authors relate the placement of waste facilities and vulnerable populations (Bullard, 1996; Martuzzi et al., 2010; Morato, 2008; Pastor, Sadd & Hipp, 2001; Rammê, 2012; Watson & Bulkeley, 2005), no study was found visually demonstrating this relation in the city of São Paulo.

This thesis seeks to verify whether landfills in the city of São Paulo are located in regions where vulnerable populations (socially and economically) reside, in order to promote the inclusion of the concept of environmental justice in the solid waste management planning process. It also questions the role that the presence of a landfill has on the socioeconomic conditions of the surrounding population and the reasons why they undergo living near to landfills. Demonstrating cases of environmental injustice is essential in order to avoid systematic biases in policy-making and change regulatory practices to better protect disadvantaged populations (Kumar, 2002). Further, discussing the location of landfills may help to demonstrate the vulnerabilities that populations residing in these areas are facing, whereby encouraging more efficient government measures.

## **1.1 Research aim and question**

The research aims to relate the location of landfills and social and economic conditions of residents in order to establish possible cases of environmental injustice in waste management. The relation between economic status, urban expansion and landfill locations are analysed through the production of two maps, using the city of São Paulo (SP) – Brazil, as a case study. Social and environmental contexts were studied in detail for one community in the vicinity of CTL Leste landfill, through primary and secondary data.

The research questions are:

- How does the location of the landfills in São Paulo relate to the economic status of their surrounding inhabitants? Was this relationship influenced by the urbanization process of the city?
- What role does the landfill presence have in determining the social conditions of the surrounding population?

## **2 Background**

### **2.1 Waste and relevance to sustainability science**

Every year, around 1.3 billion tonnes of municipal solid waste are generated globally (Bhada-Tata & Hoornweg, 2012). Historically, global resource extraction has increased by 36% since 1980 and is expected to increase to 80 billion tonnes by 2020 (OECD, 2008). The change in urban population and consumption patterns are factors that may explain the reasons behind the growth in the generation of solid waste in cities (Rozenberg, 2013). Nowadays, more than half of the world's population live in urban centres and an increase of 72% in this rate is expected by 2050, which means 6.3 billion people will be living in urban areas at this time (DESA-UN, 2012). It also means an increase in waste generation, since the rates of waste generation per capita in rural areas tend to be lower than in urban areas (Rozenberg, 2013). In fact, solid waste is an urban issue (Bhada-Tata & Hoornweg, 2012). Consumption is also a motor of waste production: an increase in consumption leads to an increase in waste generation (Ekström, 2015). Consumption became a kind of status indicator in our consumer society, where products are discarded in an increasingly rapid rate. As a result of the increase of urban populations and their consumption patterns, the quantity of solid waste is increasing exponentially.

Waste management is a challenge for every country, regardless of its level of development (Bhada-Tata & Hoornweg, 2012). On one hand, an efficient waste management system is a challenge for developing countries due increasing waste generation, lack of understanding and knowledge (Guerrero et al., 2013) and scarcity of financial, human, and other critical resources (UNEP, 2005). Because these limitations and the low priority that waste management often has on political agendas (dos Muchangos, Liu, & Li, 2014), open dumpsites and landfilling are the most common options for disposing of waste in developing countries (Rozenberg, 2013). On the other hand, developed countries have better waste management systems and infrastructure, but they generate higher quantities of waste per capita (compared to the developing countries) (UNESCAP, 2000). Developed countries also face challenges such as balancing energy recovery and recycling and decoupling economic growth from waste production (ISWA, 2013). In any case, the consequent volume of waste produced is a challenge for municipalities and solid waste management is often the largest budget item for cities (Ekström, 2015). Dealing with this amount of solid waste is complex and every waste disposal option have pros and cons. Densely populated cities where landfilling is the major option for disposal have scarcity of available land (Bhada-Tata & Hoornweg, 2012), whereas cities that compost their waste experience challenges related to high operating and maintenance costs (UNESCAP, 2000). In the past, dumps and ocean dumping were considered a good solution and contributed to making waste invisible (Ekström, 2015). Nowadays, there are several options for the disposal, such as waste to energy technologies (e.g. incineration), landfilling, recycling and others advanced technologies (heat treatment, composting and anaerobic digestion and others). However, a single technology cannot solve the waste management problem as a whole (Zaman, 2010).

Sustainability science then appears to help to equate such complex factors through interdisciplinary studies (Kates et al., 2001), which may be especially useful in discussing on who should bear the burden of waste disposal. Although waste management is a topic with global concern that has increased in recent decades, Boone (2010) affirms that justice often is neglected or even ignored as sustainability principle. One of the reasons may be because sustainability is a future-oriented science, whereas environmental justice tends to focus more in the present and past. But for this very reason, sustainability research could benefit from environmental justice studies, applying so the lessons learnt from past struggles to future plans. On the other hand, sustainability science can approach very well the complex challenges of waste management, such as the placement of waste facilities. Choosing a location to implement a landfill is a complex process that can be justified by several reasons and includes elements from both physical environment and socioeconomic system (Lino, 2007) . In this sense, sustainability science could help to link different disciplines and balance

social and environmental demands. As stated by Kates et al., (2001), sustainability science requires interdisciplinary research and integration of global and local process, which would in fact be very well used in the field of environmental justice. More than that, use sustainability science to analyze cases of environmental justice can provoke a shifting from a simple 'blaming' to a applicable and transforming 'framing' of a more just future.

## **2.2 Environmental Justice**

Environmental problems are often treated as politically neutral, with emphasis on technological, legislative and behavioural aspects, without consideration of the causes of social inequality (Acselrad, Mello, & Bezerra, 2009). The Environmental Justice movement established itself against this ideological construction and represents in some way a reframing of environmental issues (Alier, 2007). It can be seen as an alternative to two other main visions of environment: 1. The preservationist vision, in which a romantic vision and "cult of wild" aims to preserve a wild and fragile nature from human action and 2. The eco-efficiency vision, articulated around the notion of sustainable development and market mechanisms, based on the valuation of externalities, efficient environmental management and cycles of production and consumption that keep the economy running (Alier, 2007). In this way, environmental justice assumes environmental conflicts as a consequence of economic growth and social inequality (Acselrad et al., 2009; Alier, 2007), unequally affecting some social groups and geographic areas. According to Bullard (2005), this inequality is related to the hegemonic logic of capital accumulation and therefore incorporates social inequalities of race, ethnicity, gender and class. Thus, environmental justice demonstrates that social and power inequalities are at the root of environmental degradation and directly affects the disproportionate condition of social and environmental vulnerability.

Environmental justice can be defined as the equal distribution of environmental bads or goods, whether related to negative outcomes from certain practices (Watson & Bulkeley, 2005), such as energy plants, mines or waste facilities; or related to access to a healthy environment in terms of clean air, water, soil and even environmental policies and protection for all groups in society (Bullard, 2005). The Environmental Justice movement emerged in response to industrial and governmental practices and policies considered unfair and even illegal, in which some households, schools and workplaces had differentiated exposure to chemicals, pesticides and others toxins, disproportionately affecting some groups of society (Bullard, 1996). The concept of environmental justice was developed along with the raised voices of black communities in the U.S. in the 80's, when hazardous waste facilities were often located near to these communities (Agyeman, 2002). As a result, environmental justice

and waste management are topics intimately linked. From the 1990s, the Environmental Justice movement has expanded to other nations, including developing countries. But whereas the North American movement is noted by local struggles against environmental racism and in favour of minority groups, arising from industrial activities (Watson & Bulkeley, 2005), in developing nations the focus has been on environmental impacts that threaten the poor in several aspects, aligned with what Alier (2007) called "environmentalism of the poor" or "popular environmentalism".

There is a vast literature showing the correlation between the placement of waste facilities and disadvantaged groups in society. According to the research compilation of Martuzzi et al. (2010), waste facilities are often placed near to marginalized areas (according to residents' ethnicity, income, social class, education and employment rate). In general, minority groups are subjected to social discrimination, making them an easy choice for the placement of landfills (Bullard, 2005). Other research indicates that the placement of a landfill in a certain location transforms the whole area, eventually making it a minority neighbourhood. The presence of a waste facility often diminishes the land value and decreases liability, which results in an exodus of middle class and "move-in" of lower class populations (Pastor et al., 2001). There is also a belief that minority groups tend to trade increased health risk for an affordable living, making landfill surrounding areas a minority dominated locality (Pastor et al., 2001). These two lines of thinking are known as the chicken-egg controversy of the Environmental Justice research and, as discussed before, is not the focus of this thesis.

### **3 Methodology**

In order to relate the location of landfills to social and economic conditions of residents, the city of São Paulo (SP, Brazil) was chosen as a case study. The study was carried out during the years of 2016 and 2017, although is also provided some historical perspective of up to 40 years ago. This thesis has mainly a qualitative approach and the research strategy is based on a mixed methods design: production/analysis of maps, field visit and literature review. The data used comes from multiple sources. Primary data was collected via semi-structured interviews to residents of a community locate near to one landfill of the city and field observations. Secondary data derived from official documents, previous studies and governmental databases. This section is divided in three main parts. First, the city of São Paulo is characterized and justified as case study. The next sections clarifies both, primary and secondary data sources and analysis techniques. Finally, methodological limitations are discussed.



### 3.1 Location of study area: São Paulo (SP, Brazil)

The city of São Paulo (SP, Brazil) was chosen as a case study. According to (Lewis-Beck, Bryman & Futing Liao, 2004), case studies are useful because they allow an intensive examination of a particular phenomenon, in which a large amount of information can be collected through a wide array of different data sources and analytic strategies.

São Paulo is located in the south-eastern region of Brazil, in the state of São Paulo (Figure 1), near the Tropic of Capricorn at a latitude of approximately 23°21' and longitude 46°44'. The city is considered one of the prominent poles among the other megacities of the planet, with influences beyond the regional and global spheres (Ramires, 2015). São Paulo is the sixth most populous city in the world, with almost 12 million inhabitants. It has the largest industrial park in the country and, in 2012, represented in 12% of Brazil's GDP.



**Figure 1.** Location of the city of São Paulo, SP, Brazil

In Brazil, landfilling is the dominant final destination of solid waste. According to data from the Brazilian Institute of Geography and Statistics, 36,2% of solid waste is destined to sanitary landfills, 37% to controlled landfills and 22,5% to open dumps. Composting corresponds to 2,9%, recycling to 1% and incineration only 0,5% of waste management strategies (IBGE, 2008). In São Paulo, this proportion is almost the same, although the percentage of recycling

is growing, now reaching almost 7% (São Paulo, 2014). The city of São Paulo has 3 landfills in operation and 15 closed sites, which began operating in the city in the 1970s.

Because São Paulo has so many landfills scattered throughout the city, a spatial analysis of their locations allows the establishment of potential relations of environmental injustice. It is recognized that cases of environmental injustice are complex and difficult to be firmly prove because they may contain many factors involved, especially those related to the chicken-egg controversy. The analysis of a few cases can be biased and weak in evidence. However, the analysis presented in this thesis includes a considerable number of cases (18 landfills), which also justifies the choice of the city as a case study. The author was born and raised in São Paulo, having access to sources and data in Portuguese. Since the author has Portuguese as her native tongue, this has minimized the efforts related to the language, such as translation and interpretation. Portuguese fluency was also an important skill to have during field visit and interviews.

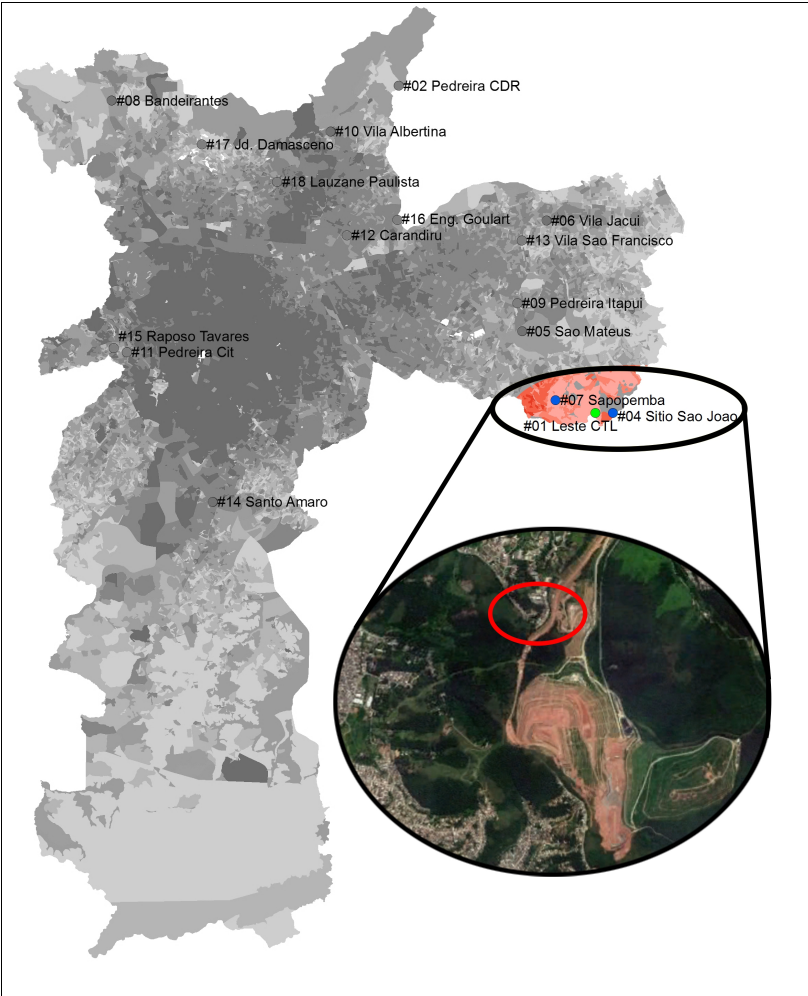
## **3.2 Data sources and analysis**

The data used in the mixed methods research strategy comes from multiple sources. Primary data was collected through field observations and semi-structured interviews with the inhabitants of a community near to one landfill of the city. The answers of the interviews were presented in a table and the qualitative data demonstrated through a content analysis. Secondary data, which provided the theoretical basis for the analysis and background about the landfills, comes from literature review. The relation between economic status, urban expansion and landfill location are analysed through the production of two maps of the city of São Paulo using ArcGIS as software. The sources for the maps were derived from governmental databases and previous studies.

### **3.2.1 Field visit: observations**

On April 15, 2017 was held a field visit to the surrounding of the landfill East Treatment Centre, known as CTL Leste, on April 15, 2017. During the field visit, data was collected by conducting semi-structured interviews with residents and gathering field observations. CTL Leste is one of the three active landfills of the city of São Paulo. Located in the extreme East side of the city (as seen in Figure 2), it occupies an area of 1.123.590,00 m<sup>2</sup> and receives the solid waste generated by more than 6 million inhabitants (CPEA, 2013). This landfill was chosen for the field visit because it receives a significant amount of waste and is located

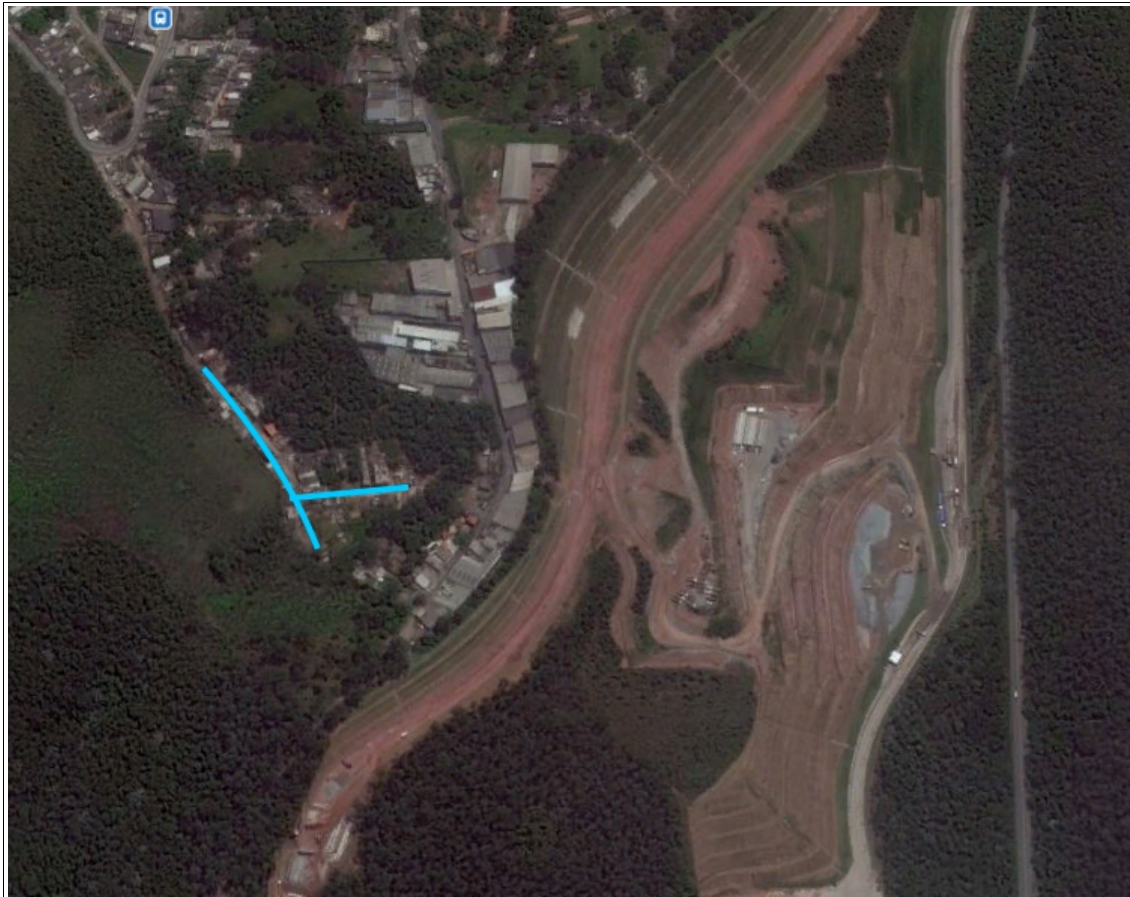
within the city limits of São Paulo. Of the other two active landfills in the city of São Paulo, one is located outside the city's boundaries (Caieras) and the second (Pedreira CDR) receives a much smaller quantity of waste. Further, CTL Leste is the most recent landfill of São Paulo and is situated near to a closed landfill (Sítio São Joao), which further justifies the choice of the field visit.



**Figure 2.** Location of field visit: surrounding of CTL Leste landfill, in the extreme East of the city of São Paulo

The main aim of the field visit was to collect primary data about the profile of the inhabitants in an area surrounding the landfill site, assessing so their motivations for living there and the impacts that the landfill has on their lives. The visit occurred on a sunny Saturday morning on 15 April 2017 and the nearest residential area to the landfill site was chosen for data collection. Located in the northern part of the landfill, the community called 'Terceira Divisão'

was visited following a route as detailed in Figure 3. The area has as a central point the coordinates 23°37'37"S 46°25'46"W.



**Figure 3.** The route of the field visit, in blue, to the community "Terceira Divisão"

*Source: Google Earth, adapted*

In the visit to the surrounding of the CTL Leste landfill, field observations were used for data collection. According to Lewis-Beck et al. (2004), field observations can be used to validate and/or extend data obtained using other data collection methods. For this thesis, in particular, it was very useful to observe the environment conditions of the community and their social context. Besides the observations made during the walk through the defined route in the 'Terceira Divisão' community, the external area of the landfill was also visited in a car ride, as can be seen in Figure 4. This served to understand the size of the landfill, its actual proximity to residential areas and a noted direct impact (bad smell). The qualitative data from field observations were collected through paper-based recording, with observations being recorded as they are being made. For the analysis, qualitative methods such as writing detailed descriptions were used.



**Figure 4.** Photo of the field observation on the landfill area and waste disposal area of CTL Leste landfill

### **3.2.2 Field visit: key informants interviews**

Semi-structured interviews were conducted with 16 the residents of the community 'Terceira Divisão'. According to Lewis-Beck et al. (2004), this type of interviews are less time-consuming than unstructured interviews and ideal when there is only one opportunity to interview, as was the case for this study. Further, in this interview method is possible keeping open mind during data collection, which allows additional questions and new topics to emerge depending on the responses (Lewis-Beck et al., 2004). For these reasons, semi-structured interviews proved to be the ideal method for data collection. The interviews were conducted in the native language of the residents (Portuguese), which helped to establish a degree of trust and openness with them. Each interview had an average duration of 10 minutes.

To facilitate these interviews, a guide was created. The interview guide contained a structured order of topics to be asked in the same way for all interviewees, but it is not a sequenced script of standardized questions. Some flexibility was possible, especially

regarding about how and in what sequence questions were asked. Initially, personal informations about the residents was asked, such as name, age, occupation, gender and race (self-declared). The guiding questions of the interviews (translated from the original in Portuguese) are presented in Figure 5.

- *“Do you live here in the region? How long have you been living here?”*
- *“Did you move here before or after the landfill?”*
  
- If the answer was 'before':
- *“Do you remember being consulted about the construction of the landfill?”*
- *“Do you think the landfill has brought more good or bad things?”*
- *“Has the region got better or worse here?”*
- *“Has life here got better or worse?”*
  
- If the answer was 'after':
- *“Why did you move here?”*
- *“Where did you live before?”*
- *“Did you know that there was a landfill here?”*
  
- The last questions finished the interview:
- *“What impact does the landfill have on your life?”*
- *“If you had option, would you live elsewhere? Why?”*

**Figure 5.** Guiding questions of semi-structured interviews (translated from original in Portuguese)

In total, 16 residents were interviewed. The sample was selected by convenience sampling, i.e. participants who are readily available and willing to answer were selected. In practical terms, the interviewees were found along the walking route (as defined in Figure 3), where they were sitting on the sidewalk, by the windows of their homes, or walking down the street. Figure 6 illustrates one interview being conducted at the door of a residents's home.



**Figure 6.** Photo of an interview being made to two residents of 'Terceira Divisão' community

The interview data regarding the profile of residents was presented in a Table containing their responses. The qualitative answers were analysed through content analysis, in which the contextual qualitative data was categorized in order to identify consistent patterns and relationships between variables or themes (Lewis-Beck et al., 2004).

### **3.2.3 Secondary sources of data**

In order to answer the research questions, two maps were created, both using ArcGIS 10.5 as software for data overlay. Geographic Information Systems (GIS) have become an important tool to support evidence of environmental injustice (Kumar, 2002). With GIS, demographic characteristics of one region (such as income distribution) can be spatially correlated with the location of pollution hotspots (e.g. landfills), allowing for the identification of environmental injustice cases.

Map 1 relate the evolution of urban areas in São Paulo and location of landfills. It was created overlaying an existing map of the evolution of urban expansion of São Paulo (from (EMPLASA, 2003), along with the location of its landfills. This map served as basis for understanding the context of the urbanization of the city at the time the landfills were placed. A existing map of the evolution of urban expansion was found in pdf format on the

municipality website, which then had to be georeferenced to be used for overlay with the landfills of Sao Paulo, added as points on the map using ArcGIS.

Map 2 shows the income distribution of the city and the location of landfills. For this map, a shapefile of the city of São Paulo was used as the main base, where each census sector of the city is represented as polygons. Census sector is the smaller scale possible to be used and refers to a territorial unit established for the purpose of cadastral control, usually meaning the equivalent of a couple of quarters. Data about the average monthly income per capita was obtained from 2010 Census and for each sector was attributed the corresponding value (in BRL). The income per capita was calculated by sum of the monthly income of all persons with at least 10 years old living in a private households, divided by the total of people living in these households. In ArcGIS software, a vector map was created with a gradient of five classes for the values of income per capita: less than 469 BRL, between 470 BRL and 606 BRL, 607 BRL and 819 BRL, 820 BRL and 1566 BRL and more than 1567 BRL. These break values were defined by a classification method available in ArcGIS called Quantile. According to currency conversions calculated in March 2017, the income values ranged from 151 USD to 506 USD. Finally, the landfills were added as points on the map. The map created translates how income is distributed throughout in the city and the localization of 18 landfills in Sao Paulo.

For the elaboration of the maps, the data used was mainly secondary data:

- Shapefile of the state of São Paulo, including cities, districts, boroughs and census sector boundaries.
- Average income per capita (in BRL) by census sectors of the city of São Paulo. The numbers are from the 2010 Census and were downloaded from data provided by the Brazilian Institute of Geography and Statistics.
- Waste facilities locations: the addresses of the waste facilities were collected from the municipality website (AMLURB, 2017) and Leo (2006). The coordinates were obtained using Google Earth and with the help of maps produced by Silva (2001).
- Map of “Urbanized areas according to expansion periods, from 1881 to 2002”. Pdf format, from EMPLASA (2003).

For the literature review, the main authors used for the review of waste management were: Bhada-Tata & Hoornweg (2012), Jacobi & Besen (2011), Rozenberg (2013) and UNEP (2005). For environmental justice, the main authors reviewed were: Alier (2007), Bullard (1996 & 2005), Martuzzi et al. (2010), Pastor et al. (2001), Watson & Bulkeley (2005) and Acselrad et al. (2009). The analysis also includes historical data and a characterization of the



landfills in the city of São Paulo. This data was taken from official documents, such as AMLURB, (2017), São Paulo (2014) and Instituto POLIS (2009) and previous studies (master and doctoral thesis) of waste management in São Paulo: Leite (2005), Leo (2006), Stuermer, Brocaneli & Vieira (2011), Silva, (2001) and Cavalcante (2014).

### **3.3 Methodological limitations**

The mixed methods design used as research strategy for this thesis has advantage of addressing more comprehensively the topic and integrating different data sources. However, some methodological limitations exist and are discussed in this section.

For the elaboration of the maps, it was essential to obtain the exact location of the landfills of Sao Paulo and it configured an important issue of data collection. There are not a single and reliable source of data that systematically present all landfills existing in the city, neither on municipality website nor in previous studies. National and municipal waste plans present a limited list of the active or recently closed waste facilities, but the landfills listed are often only the so-called sanitary landfills. The other kind of landfill, the controlled landfills, is excluded and ignored in these documents. Previous Brazilian studies of waste management (master and doctoral thesis) have a more complete list of the landfills in the city. The eighteen landfills considered in this work and their location are the result of a compilation of data from several sources. The data and location of the three landfills in operation and other five closed ones came from the municipality website (AMLURB, 2017) and from the municipal waste plan (SAO PAULO, 2014). The data about existence and address of other 10 landfills came from Table 2 of Leo (2006, p. 126) and Table 3 of Silva (2001, p. 41). The following studies also cover waste management in the city of Sao Paulo and corroborated this data about the city's landfills: Cavalcante (2014); Leite, (2005); Stuermer, Brocaneli, & Vieira, (2011).

It is recognized that many more landfills could exist in Sao Paulo, especially since there is no official source about their existence. Before the establishment of controlled landfills, many other open dumps existed and tracking them would be important, although virtually impossible. This thesis relied heavily on secondary data and the lack of further studies on such old open dumps and controlled landfills is an important methodological limitation. This information gap could mean a more restricted analysis, so that the existence of other landfills and open dumps not listed are an important source of information not considered, which in turn could influence the analysis of the results as a whole.

The duration of the field visit of only one day is recognized as a limiting factor of the study. Due to limitations of time and transportation, the data collection by interviews and field observations had to be done in only one community in just one day, which may have influenced the results. The data would be more reliable if another community around the landfill had also been studied in detail. Time also limited the number of respondents and a larger number of interviews could have provided more insights about the inhabitants of landfills surrounding. Interviews by itself could also be questioned as a source of data, once responses may not be accurate. Influenced by personal values and impressions, respondents may deliberately lie to make them appear better/worse than they are, or even tell the researcher what they think the researcher wants to hear. Further, the format of semi-structured interviews produces only partial interpretive understandings. However, as other methods have been used, this was not a problem. Finally, the diagnosis of environmental conditions had to be made only through field observations and impressions and perceptions of residents, which is admittedly a limitation of data collection. The collection of data through field observation also may imply in a great influence by the researcher's expectations about what to see.

The production of maps facilitated the visualization of the data and provided material for discussion, however some limitations are presented. First, income per capita had to be used as the indicator of socio-economic status because the complexity of defining a socially excluded population or minority. The definition based on economic status is affordable and, due to the availability of data, the monthly income per capita of a household was used as indicator. Second, the map of income distribution has census sectors as scale, which allowed a more careful and detailed analysis but also meant a problem in the overlay of income data and shapefile. The shapefile of the city of São Paulo has boundaries of 18.911 census sectors, identified by a geocodes of sixteen digits. The 2010 Census provided data for 18.364 sectors, also identified by the same geocodes. These geocodes made possible to overlay the data accurately, however, 547 census sectors (2,89%) existing in the shapefile did not have corresponding data in the 2010 Census. These census sectors were assigned a value of 0 and they are represented in grey on the map. It caused some inaccuracy in the analysis of the results, but the percentage of error was considered acceptable.

Finally, it is recognized potential sources of interesting data for the study that can not be used. Interviews with landfill managers or decision-makers at the time of implementation of the landfill would provide informations about the motivations for such localization, as well as the relation with surrounding residents. The use of further historical data of the time of landfill

opening could also have helped in the search for more accurate answers, but perhaps the compatibility of such data with current data would not be possible.

## **4 Results**

### **4.1 Waste management in São Paulo**

In the last decades, the waste management in São Paulo has evolved considerably. In the year of 1869, a private company was hired for the first time to carry-out household collection of urban solid waste. Until this point, waste was haphazardly disposed of in open air places without any environmental or sanitary control. In 1950, the Pinheiros incinerator came into operation, but until 1972 the majority of the municipal solid waste was, in fact, packed in metal buckets (Silva, 2001). Mixed wastes were buried in ditches, without concern for sanitation, groundwater contamination, air pollution or any other environmental and social issues. As the population grew and consequently increased the volume of waste generated, new solutions were implemented, such as the construction of landfills far away from the urban centre (São Paulo, 2014). In fact, the significant population increase of São Paulo made it necessary to structure the disposal and final destination of its urban waste (Stuermer et al., 2011). From incinerators and open dumps, the solid waste final disposal were replaced by so-called controlled landfills, that did not present the sanitary structure of the current landfills (Rizzi, 2011).

Landfills can be categorized in two main kinds: sanitary landfills and controlled landfills. A controlled landfill is a form of final disposal for solid waste that presents some improvements in the sanitary conditions in comparison to open dumps, e.g. partial control of the vectors of pollution and contamination. However, the areas are not waterproofed, thus leachate percolation and the consequent water contamination may still occurs (Leo, 2006). Further, there are no additional environmental controls such as gas capture, sewage blanket and drainage systems (Cavalcante, 2004). In turn, sanitary landfills (sometimes expressed only as landfills) aim to minimize environmental impacts and possible harm to public health, based on engineering principles and specific technical standards (Cavalcante, 2014). Sanitary landfills include treatments to decrease soil impermeability and garbage covering by successive layers of soil, thus minimizing the proliferation of odour, ensuring environmental protection and avoiding the contamination of soil and rivers (Leo, 2006).

Although not all currently active, the city of São Paulo has 18 landfills that have been in operation since 1974. Of them, eight were controlled landfills and other two (Santo Amaro and Vila Albertina) started to operate as controlled landfills and were later transformed into sanitary landfills. It was determined through research on the municipality website and utility companies websites that only 6 landfills in São Paulo have some kind of geotechnical and environmental monitoring activities, such as control of global stability, percolated fluid production, disposal of the manure generated and variation in gas production (Leite, 2005). Besides the three sanitary landfills in operation included in the analysis, São Paulo has four other active waste disposal centres that receive inert waste. Since this kind of waste is not the focus of the thesis, those disposal centres were not included in the analysis.

#### **4.1.1 Landfill locations in São Paulo**

For the elaboration of the two maps, it was required data regarding the precise location of the landfill sites in São Paulo, from the first controlled landfills in 1974 to the most recent ones. Table 1 presents the chronology of the landfills (by year of opening), type of landfill (controlled or sanitary), date when they started and finished operating and geographical coordinates. It also brings an identification number used in the maps presented in the next sections and landfill operators.

Table 1 also elucidates how waste is managed in Sao Paulo. Until the mid-2000s the collection and disposition of waste (including the allocation of landfills throughout the city) was responsibility of the municipal public administration and the costing related to it was provided by municipal budget funds, although with an increasing outsourcing of services (Instituto POLIS, 2009). In 2002, due to a strategy adopted by the new administration, occurred a change in the waste management model. Seeking to ensure greater investments in the system, the waste management of the city began to be carried out under a concession regime (Jacobi & Besen, 2011). The concessionaires (or utility companies) became responsible for investments and improvement of the system (final disposal, treatment and selective collection), including the implementation of new landfills, transshipment units and recycling centers, and to carrying out monitoring and recovery actions in closed landfill sites (SAO PAULO, 2014). The utility companies LOGA and ECOURBIS were created with the specific purpose of offering specialized services of collection, transportation, treatment and final disposal of waste for each part of the city (northern and southern parts, respectively) (LOGA, 2017). Formed by a group of companies, both were founded in September/October

**Table 1.** Chronology of the landfills of São Paulo, by year of opening

<b>Id map</b>	<b>Waste facility</b>	<b>Type</b>	<b>Opening</b>	<b>Closure</b>	<b>Operator</b>	<b>Geographical coordinates</b>	
<b>#01</b>	Leste CTL	Sanitary landfill active	01/2010	In operation	ECOURBIS	23°38'06"S	46°25'34"W
<b>#02</b>	Pedreira CDR	Sanitary landfill active	01/2000	In operation	Estre Ambiental	23°24'39"S	46°33'41"W
<b>#03</b>	Caieiras CTR	Sanitary landfill active	02/1999	In operation	Essencis	23°20'39"S	46°46'20"W
<b>#04</b>	Sítio São Joao	Sanitary landfill closed	12/1992	10/2009	Public, monitored by ECOURBIS	23°38'11"S	46°24'51"W
<b>#05</b>	São Mateus	Sanitary landfill closed	02/1984	01/1986	Public, monitored by ECOURBIS	23°34'44"S	46°28'35"W
<b>#06</b>	Vila Jacui	Sanitary landfill closed	03/1981	08/1988	Public, monitored by LOGA	23°30'11"S	46°27'35"W
<b>#07</b>	Sapopemba	Sanitary landfill closed	11/1979	02/1984	Public	23°37'34"S	46°27'13"W
<b>#08</b>	Bandeirantes	Sanitary landfill closed	09/1979	03/2007	Public, monitored by LOGA	23°25'16"S	46°45'31"W
<b>#09</b>	Pedreia Itapui	Controlled landfill closed	12/1978	11/1979	Public	23°33'35"S	46°28'47"W
<b>#10</b>	Vila Albertina	Sanitary landfill closed	03/1977	01/1993	Public, monitored by LOGA	23°26'31"S	46°36'29"W
<b>#11</b>	Pedreira Cit	Controlled landfill closed	02/1977	01/1978	Public	23°35'36"S	46°44'53"W
<b>#12</b>	Carandiru	Controlled landfill closed	01/1977	03/1977	Public	23°30'47"S	46°35'49"W
<b>#13</b>	Vila São Francisco	Controlled landfill closed	06/1976	07/1976	Public	23°31'01"S	46°28'37"W
<b>#14</b>	Santo Amaro	Sanitary landfill closed	04/1976	02/1995	Public, monitored by ECOURBIS	23°41'39"S	46°41'16"W
<b>#15</b>	Raposo Tavares	Controlled landfill closed	07/1975	08/1979	Public	23°35'25"S	46°45'25"W
<b>#16</b>	Eng. Goulart	Controlled landfill closed	04/1975	01/1979	Public	23°30'10"S	46°33'44"W
<b>#17</b>	Jd. Damasceno	Controlled landfill closed	02/1975	12/1976	Public	23°27'03"S	46°41'48"W
<b>#18</b>	Lauzane Pta.	Controlled landfill closed	02/1974	11/01/74	Public	23°28'36"S	46°38'42"W

**Source:** author's elaboration, with data from Leo, 2006; SAO PAULO, 2014; Silva, 2001; AMLURB, 2017; Jacobi & Besen, 2011

2004, just after winning the concession agreement (LOGA, 2017; ECOURBIS, 2017). The utility company LOGA administers the northern part of the city and serves about 6.1 million people. They send the solid waste collected to two private landfills: Caieiras (outside city's borders, operated by Essencis company) and CDR Pedreira (operated by Estre Ambiental company) (LOGA, 2017). The utility company ECOURBIS administers the southern part and serves 4.2 million people. ECOURBIS also implemented and operates the private landfill CTL Leste, to where almost all of the waste collected by them is send (ECOURBIS, 2017).

With the change in the management model, a new waste management municipal authority was created. Replacing the former autarchy LIMPURB, the Municipal Authority of Urban Cleaning (called AMLURB) became the body responsible for organizing and supervising the provision of urban cleaning services, as well as managing the concession contracts. AMLURB is who oversees the operation of landfills, conducts policy for the sector, regulates and monitors the activities of the operators and their financing (SAO PAULO, 2014). It would be up to them, in practice, to discuss and define new areas for waste disposal. However, there is no indications or information about the planning of new landfill sites. This seems to be a result of the change in the management model. To support the services under concession, in 2004 it was introduced a tax proportional to the amount of waste generated per household, replacing partially the financing by municipal budget funds. However, the tax was abolished in 2006 for political reasons and the possibility of annulment of the concession contracts was even discussed at the time, which ended up not happening (Jacobi & Besen, 2011). The impact of this measure compromised the quality of services under concession and the waste management of the city as a whole. The source of funds was diminished and no new investment was made by the utility companies, what meant the exhaustion of all public sanitary landfills of Sao Paulo, without any new construction plans. The city's solid waste has always been destined to public landfills, however after the closure of the two last landfills (Bandeirantes in 2007 and Sao Joao in 2009), the solid waste of Sao Paulo had to be disposed of in private landfills.

The selection, management, operation and termination of use of landfill sites follows specific criteria and engineering guidelines (SAO PAULO, 2014). It was not found, however, transparency about the criteria used to define the location of landfills in the Sao Paulo over time, specially in relation to the older landfills of the city. When the first landfills started operating (in the 1970s and 1980s), there were no environmental legislation in practice and government decisions were much less inclusive. Controlled landfills were built in areas where open dumps already existed, with no feasibility and environmental impacts studies

associated (Silva, 2001). At the time, there was a belief that natural attenuation was enough to prevent health and environmental effects and little or no specific caution was taken (Cavalcante, 2014). With the increase of waste generation and consequent increase in the landfills proportions, the allocation of them became an issue important. The process became more comprehensive and started to include other actors in the decision-making (Jacobi & Besen, 2011), although popular participation is still minimal and controversial. However, the change of the city's waste management structure (for the concession model) gave a new dimension to this issue. In the past all landfills were public (as is possible to see in Table 1) and the decision of where to build them should, at least in theory, respect the public will. The existence and operation of private landfills can change the logic.

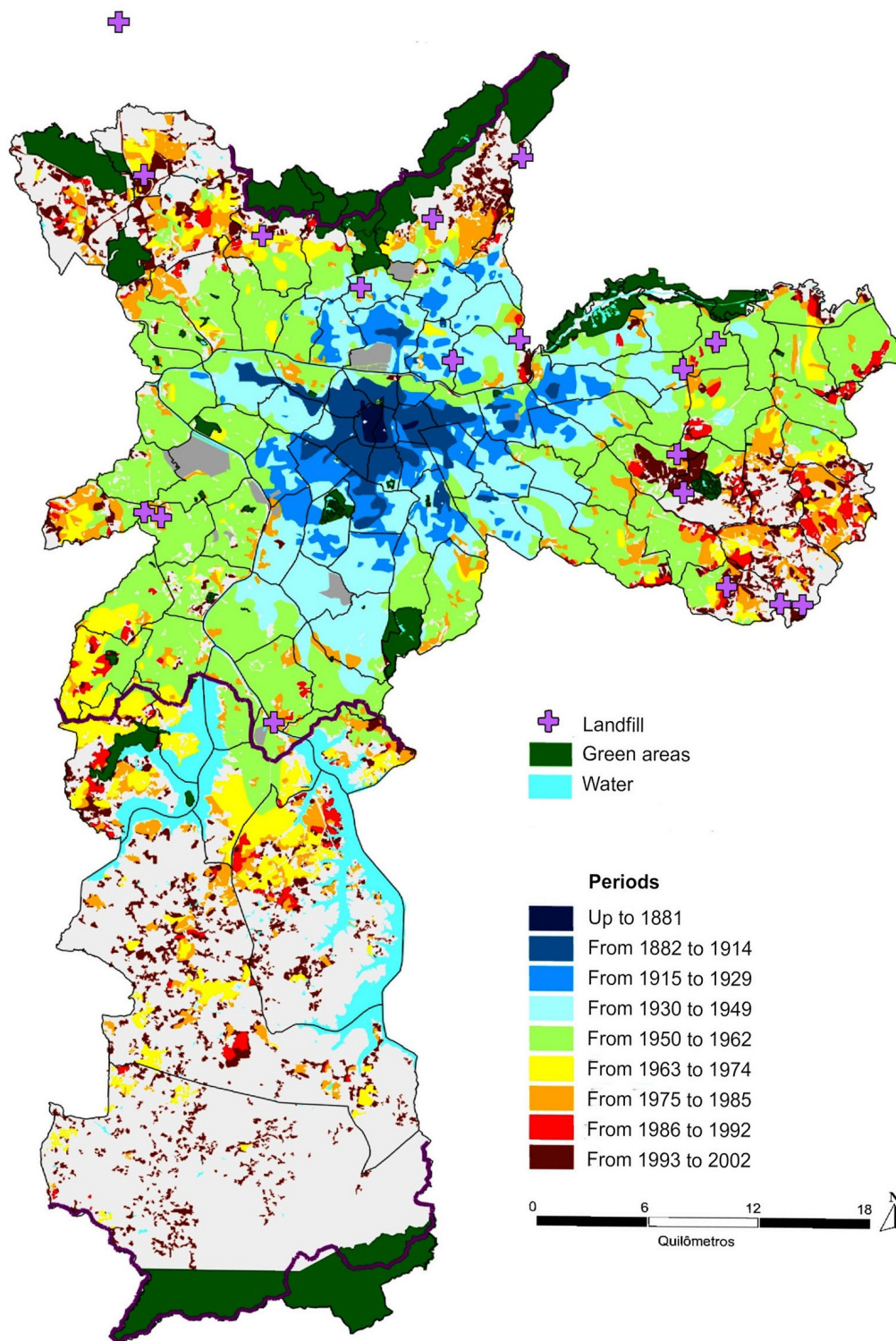
The change to concession regime and financing of waste management in the city of Sao Paulo ended up having influence in the places where the waste has been deposited, and this also means implications for environmental justice. Such issues will be further discussed in the Discussion section.

#### **4.2 Map 1: Evolution of urban areas and location of landfills in São Paulo**

In order to understand the city dynamics, the consequent role that the presence of a landfill has on the socioeconomic conditions of surrounding populations and whether this relationship was influenced by the urbanization process of the city, proved to be essential to first determine the context (urbanized or not) of the areas in which the landfills were located at the time of their opening. Map 1 presents the location of the landfills of São Paulo overlaid with an already existing map of the evolution of urbanized areas. This map shows the periods of urbanization represented by different colours, from 1881 to 2002. Since the visualization of the map as a whole does not allow for a more accurate analysis of the exact area (and colour) in which the landfills are located, a table was generated. Table 2 presents the colour of the area in which each landfill is exactly located on the map and the corresponding map caption. Using the data regarding the year in which each landfills was inaugurated, it was possible to determine if the landfill was placed in a region that was already urbanized or not. The history of the urbanization of the city is also presented, based on data collected through the literature review.

# Urbanized areas by period of expansion

## Sao Paulo, SP (Brazil)



Map 1. Evolution of urban areas (1881-2002) and landfills location in São Paulo (SP, Brazil)

Source: adapted from EMPLASA (2003)



**Table 2.** Landfills of São Paulo and period of urban expansion

<b>Id map</b>	<b>Waste facility</b>	<b>Type</b>	<b>Opening</b>	<b>Location in map (colour/period)</b>	<b>Analysis</b>
#01	Leste CTL	sanitary	01/2010	Not covered	-
#02	Pedreira CDR	sanitary	01/2010	Not covered	-
#03	Caieiras CTR	sanitary	02/1999	Outside city borders	-
#04	Sítio São Joao	sanitary	12/1992	Gray (not urbanized yet)	No urbanized yet
#05	São Mateus	sanitary	02/1984	Gray (not urbanized yet)	No urbanized yet
#06	Vila Jacui	sanitary	03/1981	Red (1986-1992)	Before urbanization
#07	Sapopemba	sanitary	11/1979	Orange (1975-1985)	Before urbanization
#08	Bandeirantes	sanitary	09/1979	Yellow (1963-1974)	After urbanization
#09	Pedreia Itapui	controlled	12/1978	Orange (1975-1985)	Before urbanization
#10	Vila Albertina	sanitary	03/1977	Red (1986-1992)	Before urbanization
#11	Pedreira Cit	controlled	02/1977	Light green (1950-1962)	After urbanization
#12	Carandiru	controlled	01/1977	Light blue (1930-1949)	After urbanization
#13	Vila São Francisco	controlled	06/1976	Light green (1950-1962)	After urbanization
#14	Santo Amaro	sanitary	04/1976	Orange (1975-1985)	Before urbanization
#15	Raposo Tavares	controlled	07/1975	Light green (1950-1962)	After urbanization
#16	Eng. Goulart	controlled	04/1975	Light green (1950-1962)	After urbanization
#17	Jd. Damasceno	controlled	02/1975	Yellow (1963-1974)	After urbanization
#18	Lauzane Pta.	controlled	02/1974	Light blue (1930-1949)	After urbanization

The urban geographical space of São Paulo was shaped by the expansion of industry (Morato, 2008). São Paulo emerged from the coffee economy, predominant in Brazil in the 1800s, which and quickly transformed the city into an industrial city. After this period of industrialization, the population grew dramatically, from 240,000 inhabitants in 1900 to more than 11 million in 2012 (Alier, 2007). At the end of the nineteenth century, together with the population growth and expansion of urban areas, the process of social segregation of space with the differentiation of uses and occupation of certain areas in the city began (Ripoli, 2015). Areas such as valleys bottoms and erosive and sloping lands were occupied and remaining areas of Atlantic forest were deforested. At the same time, the government was not able to implement housing policies and other sectoral policies, including control over the use and occupation of the territory (Ramires, 2015). As result, the expulsion of inhabitants with lower purchasing power in the peripheral regions occurred, in which the disadvantaged population moved to tenements in central areas, favelas, encroachments and irregular habitations in the

peripheral areas of the city (Ripoli, 2015). This disorderly process has increased demand for water, energy, transportation, sanitation, health, education, housing, etc. The urbanization phase was also not accompanied by social equity because, according to Ramires (2015), it created specialized places to meet the needs of capital, disarticulating space and promoting territorial inequalities. In fact, São Paulo has a high concentration of income and social inequality (Ripoli, 2015), which reflects the socioeconomic patterns in the territory.

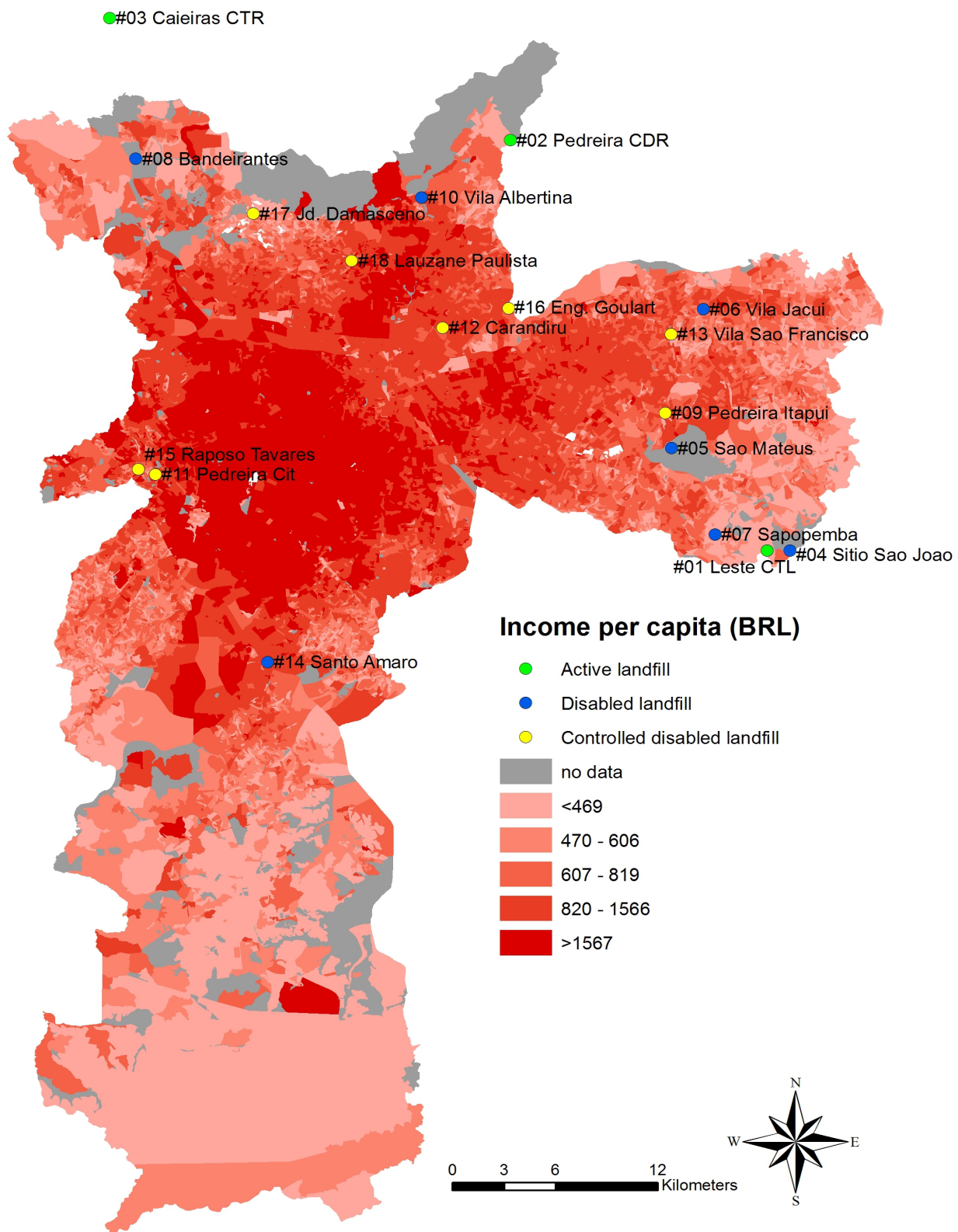
These two processes together, center-periphery urban expansion and occupation of the peripheries by inhabitants with low purchasing power, has created a deep connection with the location of the landfills and the social conditions of the inhabitants of the surrounding areas. This connection will be further discussed in the Discussion section.

### **4.3 Map 2: Income distribution and location of landfills in São Paulo**

To answer directly the first research question, a map of income per capita distribution and the location of the landfills of the city of São Paulo was produced using ArcGIS software. It can be visualized as whole in Map 2 and the zoomed-in representations of certain regions in Figures 10, 13, 16, 17, 18, 19 and 21 are also used in the next sections)

It is possible to see a pattern of income distribution in which central areas in the city have a higher level of income per capita, while peripheral areas mostly have lower levels. In general, both closed and active landfills are located in the extreme peripheral areas of the city, in which five are in the northernmost part (#02, #08, #10, #17 and #18) and another seven in the easterly part (#01, #04, #05, #06, #07, #09, #13). The other five landfills are located in the central-south part of the city (#11, #12, #14, #15 and #16) and one outside the city boundaries (#03). Since the landfills are located in peripheral areas and these are poorer areas, the vast majority of landfills in São Paulo are located near to socio-economically deprived population. This can be clearly seen for the points #01, #02, #04 #07, #13 and #17, located in or nearest to the lighter colour in the scale, which represents the lowest value of income (less than 469 BRL). The points #06, #08, #09, #10, #15 and #16 are located also in or nearest to areas of the poorest classes, while the remaining points belong to areas of richer classes, at least in this general analysis.

# Active and disabled landfills and income per capita in Sao Paulo (2010)

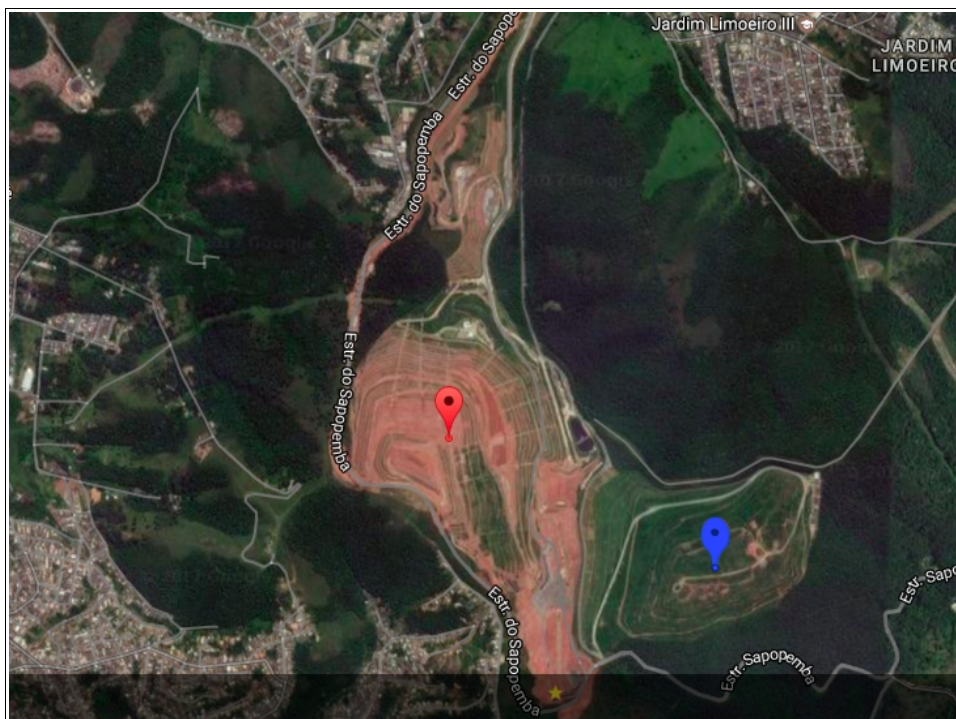


**Map 2:** Income per capita distribution and location of landfills in São Paulo (SP, Brazil)

Source: author's elaboration

#### 4.4 CTL Leste landfill

In order to provide data to answer the second research question "What role does the landfill have in determining the social conditions of the surrounding population? ?", one community in the surrounding of the CTL Leste landfill was visited. The East Treatment Centre, know as CTL Leste or CTL Floresta, is the most recent sanitary landfill in the city of São Paulo, inaugurated in January 2010. Operated by the utility company ECOURBIS, it occupies an area of 1.123.590,00 m<sup>2</sup> and receives the solid waste generated by the southern and eastern part of the city, serving more than 6 million inhabitants (CPEA, 2013). CTL Leste is located in the district of São Mateus, east zone of the municipality and adjacent to the site of the Sítio São João landfill, closed in 2009. In Figure 7, the CTL landfill is in red and São Joao in blue. It is estimated that the landfill will receive more than 26 million tons of solid waste until its closure (Cavalcante, 2014).

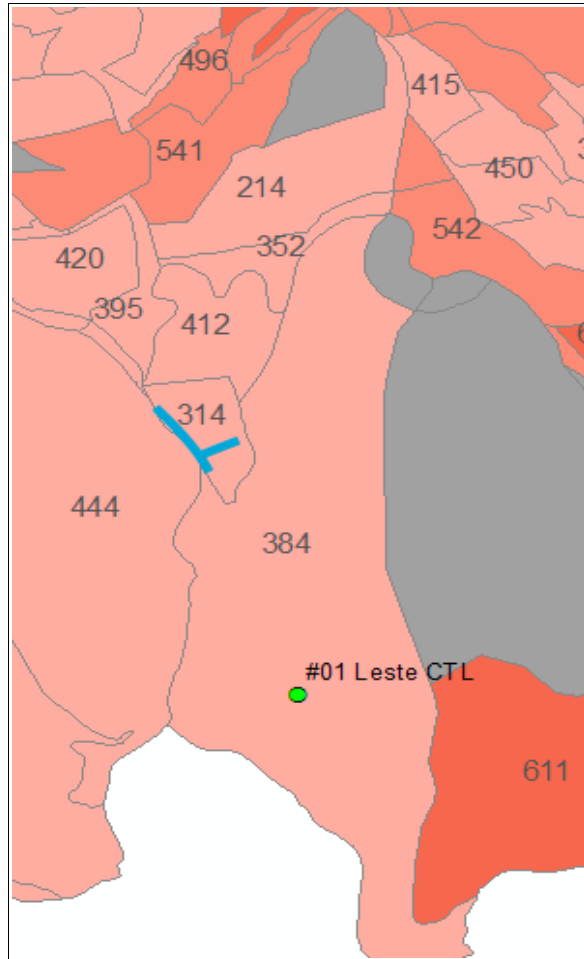


**Figure 7.** Aerial photograph of CTL Leste (in red) and São Joao (in blue) landfills and surrounding

*Source: Google Earth, adapted*

During the field visit it was studied one community called 'Terceira Divisão', located in the vicinity of the landfill. The income per capita (in BRL) of the census sectors of the surrounding are represented in Figure 8, in which the route followed during the visit is also

marked in blue. Although called by some as 'Terceira Divisão', this is not a name known by all residents and, according to observations made during the field visit, there is no sense of community established. No literature was found about its occupation history or the motivations behind the name. The community also has no defined physical boundaries, but as can be seen in Figure 3 (in the methodology section), the area is basically a single main street alley, with a perpendicular secondary street.



**Figure 8.** Income (in BRL) of census sectors around CTL Leste landfill. In blue, route made during field visit

*Source: author's elaboration*

#### **4.4.1 Profile of community 'Terceira Divisão'**

16 residents were interviewed during the field visit, using convenience sampling. The semi-structured interviews were conducted in the native language (Portuguese) with support of guiding questions (Figure 5). The data about the profile of residents is presented in Table 3 and the qualitative answers were presented in a content analysis table in the next section.

**Table 3.** Interviewees profile, based on answers of respondents

Respondent (name initial letters)	Age (years)	Gender	Race (self- declared)	Occupation	How long have you been living here?		If you had option, would you live elsewhere?
					Before landfill. Did you was consulted about the construction?	After landfill. Do you knew about the landfill existence?	
(1) E.	38	male	pardo	waste picker	8 years. Not consulted		yes
(2) M.J.S.	47	female	black	cleaner		2 years. Did not know	yes
(3) A.	22	male	pardo	service sector		3 years. Did not know	yes
(4) M.F.	33	female	black	recycling	23 years. Not consulted		yes
(5) Ac.	33	female	black	service sector		7 years. Did not know	no
(6) I.M.S.	43	female	black	housewife		5 years. Did not know	yes
(7) W.J.	17	male	pardo	employed	17 years. Not consulted		yes
(8) Al.	32	female	black	housewife	8 years. Not consulted		yes
(9) R.	26	female	pardo	service sector	8 years. Not consulted		no
(10) Re.	29	female	white	employed		2 years. Did not know	yes
(11) C.	24	male	white	employed		2 months. Did know	yes
(12) N.	59	female	white	housewife	23 years. Not consulted		yes
(13) J.	24	male	pardo	service sector	23 years. Not consulted		yes
(14) Alz.	38	female	pardo	employed		1 year. Did not know	yes
(15) F.	31	female	black	waste sector	22 years. Not consulted		yes
(16) M.	27	female	parda	employed	8 years. Not consulted		yes

Figure 8 (previous section) provides data about the economic status of the population of the community studied: the community is located in only one census sector which has a value of monthly income per capita of 314 BRL (equivalent to 96 USD). As can be seen in Table 3, 5 people are unemployed (32%) and 3 are housewives (19%). Three people work in the waste sector as waste pickers and garbage collectors and 1 person works as a cleaner. Four other people work in the service area. The vast majority of respondents are self-declared black or pardo (mixed race) and only 3 people are white. The results regarding age demonstrate that the sampling was representative, thus making the answers to the other questions more reliable.

One of the main questions asked during the interviews was how long the residents had lived there. As Table 3 illustrates, more than half of the interviewees (9 of 16) already lived in the region before the construction of the landfill, which occurred in 2010. Of the respondents who moved to the area after the landfill opening, 5 of them did not know about the existence of the landfill at the time they moved to the area. When asked about where they lived before moving to the vicinity of the landfill, the following neighborhoods were cited: Jd. Santo André, Antonio Vilela, Jd. Elba, Sapopemba, Nova Conquista and São Mateus.

All of the 9 people who already lived in the region before the landfill stated that they were not consulted or even communicated with at the time of the landfill construction. F., a 31-year-old waste picker who has lived there for over 22 years said (translated from Portuguese):

*“We were not consulted at all. People in uniforms and identification badges came one day here on our street, did some measurement on the floor. The next week they put some wooden fences and then left, never coming back. They did not say anything to us, they did not even say us good morning”*

The last question posed during interviews was *“If you had the option, would you live elsewhere?”* With the exception of two people, the majority of the answers (88%) were *“yes, of course!”*. The data presented in this section will be analysed in the Discussion section.

#### **4.4.2 Content analysis of interviews and field observations**

The interviews also provided data about health and environmental impacts perceived by the respondents, other social conditions, how living in proximity to the landfill affects their lives and the main reasons for living there. A content analysis was carried-out on the interview data and the results are presented in the following table (Table 4):

**Table 4.** Content analysis of interviews

Theme	Main answers
Perception about the landfill's role	It is good for whole population but not good for us
	Bad, government should find a new place for us to live
	Some jobs were created because of the landfill
	No difference in my life
Impacts in human health	Bed smelling
	Noise from garbage trucks
	Respiratory diseases
	Allergy to contaminated water
	Kids get sick often
Environmental impacts	Vultures and flies
	Gas explosion
	Flash flood and flooding
	Air pollution
Social conditions	Unpaved streets
	No public lighting
	No public transportation
	Precarious public services (daycare, hospitals)
Reasons to live there	Can afford the rent
	Able to buy a house here
	It was an unoccupied area and we invaded
	Live with relatives
	Don't have other option

Some responses that emerged during the interviews could be confirmed from observations made during the field visit. Along the field visit route, many types of housing could be seen. Most of them can be considered precarious, made of wood, bricks and without visible



foundation structures. Many houses were built on top of other houses, as is possible to see in Figure 9. Few of them were actually made of brick.



**Figure 9:** Photo of houses in precarious conditions in the community 'Terceira Divisão'



**Figure 10.** Photo of unpaved muddy street observed during field visit

A common complaint made by almost all respondents refers to the conditions of the street, which is not paved. It was possible to observe this in the field, as can be seen in Figure 12. In fact, the condition of the street affects the quality of life of the population. The unpaved street accumulates water throughout its length, with much mud present. At some points, there was accumulation of household waste and it is possible to state that such standing water could be a source of disease vectors. Further, it is important to note that in the previous week, it did not rain in the region, which indicates that during rainy periods, the situation could become even worse, as reported by the residents. It was observed children playing in the street, with bare feet directly in the mud (Figure 11).

It was also observed that there was no public lighting in the street and some residents reported the existence of untreated sewage released from a few houses. However, it was not possible to confirm this and visit such houses. It was also noted that there are no bus stops nearby. Respondents also reported a lack of other public services, such as hospitals, schools and day care, although it was not possible to verify this by observation and this was not the main focus during the field visit.



**Figure 11.** Photo of kids playing on the mud floor in 'Terceira Divisão' community

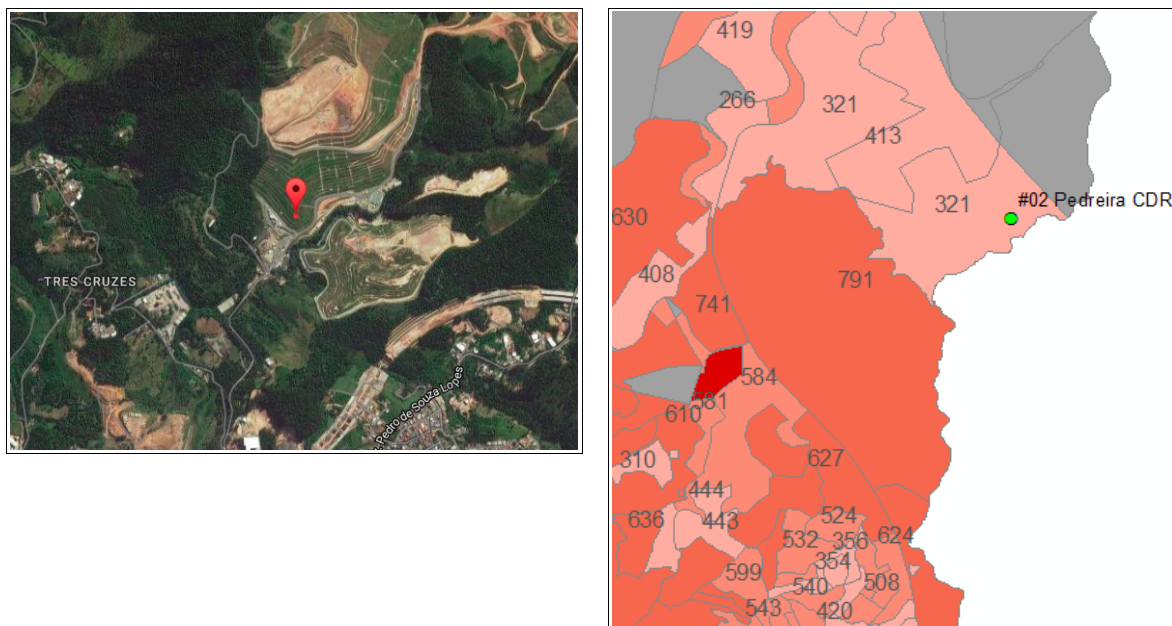
## **4.5 Other landfills**

This section presents details and data of other five landfills of the city of São Paulo, in order to illustrate essential cases for the discussion. The landfills are selected based on the criteria of representativeness: another active landfill, 3 closed sanitary landfills and 1 closed controlled landfill. They cover the whole period of the city's waste management history, from year 1974 to the year 2000. The location of the landfills are presented in zoomed-in sections of the Map 2 (section 4.1.2) and aerial photographs. Data about the history and operation of the landfills are also presented.

### ***4.5.1 Waste Disposal Centre Pedreira***

The Waste Disposal Centre Pedreira, known as CDR Pedreira, is one of the three active landfills in the city of São Paulo. Located near to the extreme border of the city, the area was previously the site of an old quarry, which speaks to the origins of the name of the landfill (in Portuguese the word quarry means 'pedreira'). In 1950, the site was used as an open dump for residential waste, being transformed into a sanitary landfill only in the year 2000. Because the installation of the landfill predated the legislation for control of pollution sources, the landfill was not subject to any environmental license (Cavalcante, 2014). CDR Pedreira started to operate in 2000 and its closure was planned for the year 2015, but today the landfill is still receiving solid waste.

Figure 12 shows the surrounding of the CDR Pedreira and its income distribution (values in BRL). The area is dominated mainly by green areas and has two regions where the population lives, one in the south and one in the southwest. Because the landfill is located very near to the border of the municipality of Guarulhos, there is no income data available about the residential area of the southern part (showed as white on the map).



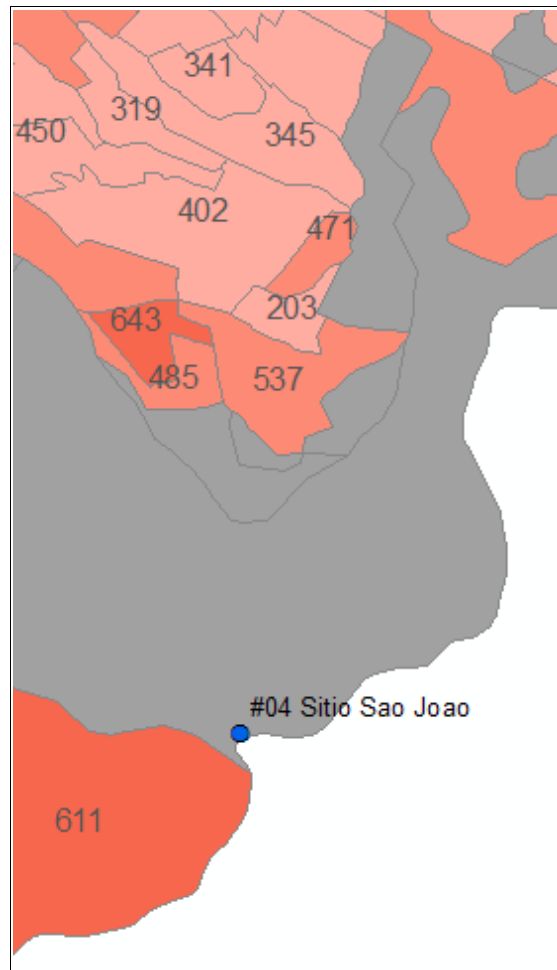
**Figure 12.** Aerial photograph and income (in BRL) of census sectors around CDR Pedreira landfill

*Source: Google Earth and author's elaboration*

#### **4.5.2 Sítio São Joao landfill**

Occupying an area of 1.020.000m<sup>2</sup>, the landfill of Sítio São Joao is the most recently closed landfill of São Paulo. Located in the southeast region of the city, next to the active landfill CTL Leste, Sítio São Joao landfill began to operate in 1993 in a region of dense native forest, which required the deforesting of 600.000 m<sup>2</sup> of forest. As a compensatory measure, the municipality replenished the vegetation in an equivalent area (UMAH, 1990). The estimated initial life of the landfill in the project was 8 years, but after requests for extensions, readjustments and licensing, the landfill of Sítio São Joao operated for seventeen years, closing in 2009 (Cavalcante, 2014). Four years later, the expansion project of the CTL Leste landfill restructured the area, unifying it with the Sítio São Joao landfill.

As is possible to see in Figure 13, the landfill is located just on the boundaries of the municipality. There is only one residential area near the landfill, in the northeast part, in which the monthly income varies from 203 to 643 BRL. The main area around the plot has no data available and the census sectors appear in grey colour. The southern part, which is not inside the city limits, appears in white.



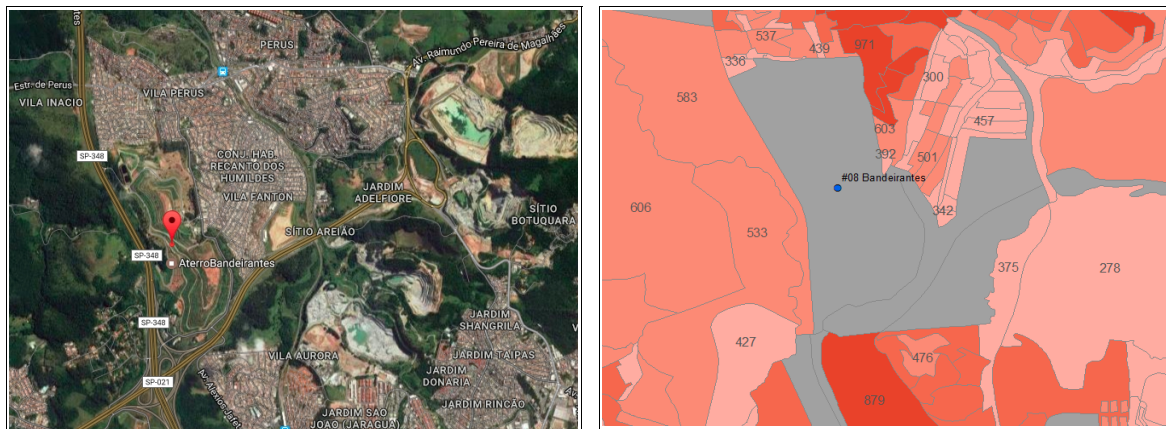
**Figure 13.** Income (in BRL) of census sectors around Sitio São Joao landfill

*Source: author's elaboration*

#### **4.5.3 Bandeirantes landfill**

After three decades as the main recipient of the city's solid waste, Bandeirantes became known as the largest landfill in the world: 37,5 million tons of solid waste received, 7000 tons daily (Leite, 2005). Now closed, Bandeirantes landfills started to operate in 1979 and by the end of its life, occupied an area 140 hectares, equivalent to 14 football stadiums, and a maximum height of (depth) of 110 meters. This huge landfill site is located in a small district called Perus, far from the hubs of jobs and commerce, but a strategic point of mobility for the neighbouring regions (Rizzi, 2011). According to Cavalcante (2014), when the area for the implementation of the landfill was chosen, its surrounding were not occupied by residential settlements or other urban facilities. After the opening, an intense occupation occurred. Today, the landfill is still administered by LOGA utility company and generates electric energy through the combustion of methane gas emanating from the decomposition of accumulated waste. It is a CDM Project - Clean Development Mechanism, an instrument for

the operationalization of the so-called Kyoto Treaty (Rizzi, 2011). In 2012, Bandeirantes landfill generated 4000 m<sup>3</sup> of gas (São Paulo, 2014).



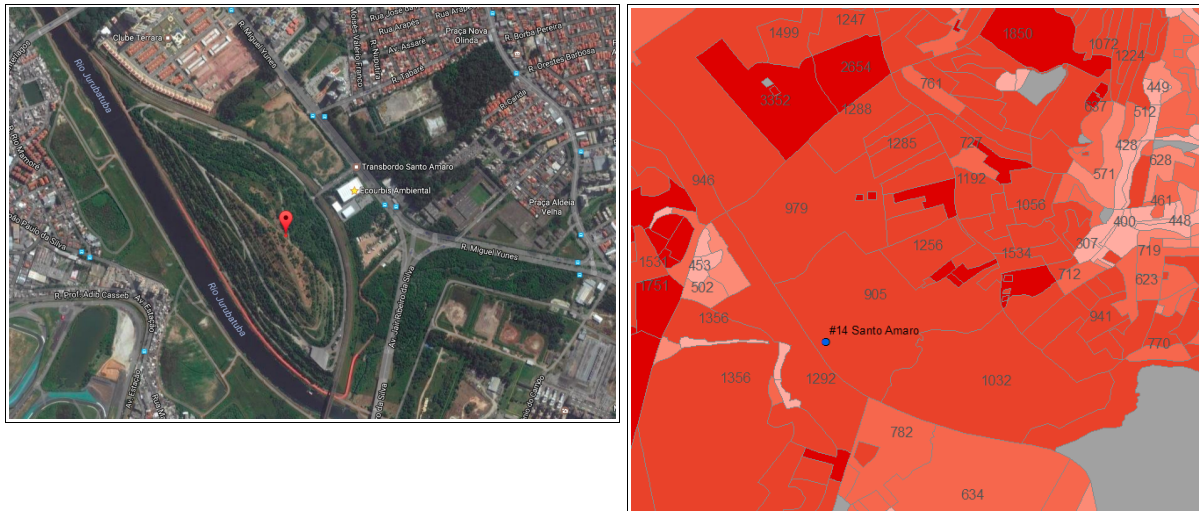
**Figure 14.** Aerial photograph and income (in BRL) of census sectors around Bandeirantes landfill

*Source: Google Earth and author's elaboration*

In Figure 14, it is possible to visualize how the surrounding area of the landfill is occupied today. To the west, there is a green area and some residential spots, but the east and south side are completely occupied by residential settlements, with income varying from 300 to 951 BRL.

#### **4.5.4 Santo Amaro landfill**

The landfill of Santo Amaro exemplifies a landfill built more than 40 years ago that today is surrounded by urban occupations in a very urbanized central area. The landfill started to operate in 1976 when, according to Cavalcante (2014), there was no urban densification nearby. Santo Amaro landfill was initially inaugurated as a controlled landfill, but it went through a recovery process when it was transformed into a sanitary landfill. Installed in an area of 300.000 m<sup>2</sup>, the landfill received more than 16.000.000 tons of solid waste during its almost 20 years of operation. Santo Amaro landfill was closed in 1995, but still has maintenance services. A waste transshipment station ("Transbordo Santo Amaro") currently operates in the area (Leo, 2006).



**Figure 15.** Aerial photograph and income (in BRL) of census sectors around Santo Amaro landfill

*Source: Google Earth and author's elaboration*

Figure 15 demonstrates the landfill surrounded by residential areas and then the income distribution of the vicinity, dominated by census sectors of high income levels. It is also possible to observe and indicator of the lack of environmental awareness of the time: the landfill was built on the banks of the river Jurubatuba.

#### **4.5.5 Jardim Damasceno landfill**

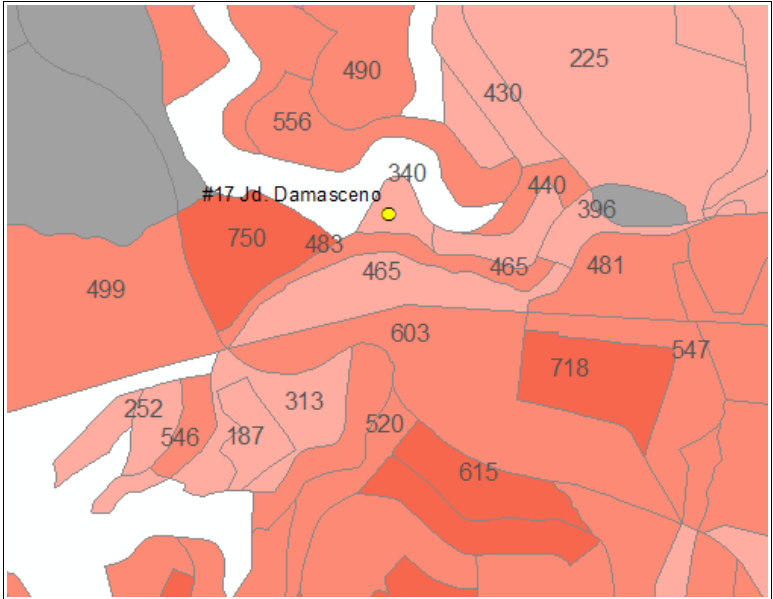
The landfill Jardim Damasceno was one of the first controlled landfills of São Paulo and operated during for only 10 months, between February 1975 and November of the same year. After the closure of the landfill, the area was abandoned and clandestinely occupied. Today, the area is densely occupied by a favela (Leite, 2005). In previous studies of the landfill area, it was reported cases of children amusing themselves by setting fire at the points of gas escape, which evidences the geotechnical instability reported (Stuermer et al., 2011; Silva, 2001).

Figure 16 shows the landfill site completely occupied by residential settlements. Since is not possible to visually identify the landfill area, a figure from Silva (2001) was used to obtain the exact location. Figure 17 shows the economic status distribution of the region surrounding the landfill.



**Figure 16.** Aerial photograph and approximate location of waste disposal area of Jardim Damasceno landfill

*Source: Google Earth and Silva (2001)*



**Figure 17.** Income (in BRL) of census sectors around Jardim Damasceno landfill

*Source: author's elaboration*



## 5 Discussion

### 5.1 Landfills of the city of São Paulo

The placement of landfills can be justified by several reasons and is a complex process that includes elements from both the physical environment and socioeconomic system. The significant number of landfills scattered throughout the city of São Paulo allowed a spatial analysis of their locations and the establishment of a case of environmental injustice. The environmental justice concept used in this thesis has focus in the community impact, i.e. whether a population already vulnerable in other dimensions (economic and social) are being exposed to additional environmental risks due to proximity to waste facilities. This thesis does not aim to answer the chicken-egg controversy, which came first, the landfill or the low income population. A single case study cannot prove or rule out intentional discrimination, without more accurate studies about the decision making at the time of opening of the landfills, additional time series data or a suitability analysis study. An understanding of the location of the landfills is, nevertheless, essential for the discussion of the solid waste management planning process, policy making and regulatory practices.

Table 1 'Chronology of the landfills of São Paulo, by year of opening' (section 4.1.1) presents the 18 landfills of São Paulo listed in order of the date opened. The first controlled landfill of the city started to operate in 1974 and in the next three years, eight more landfills were inaugurated. The CDR Perdreira landfill, presented in section 4.5.1, illustrates a very common kind of landfill of this time. According to Silva (2001), several controlled landfills were installed in old sand mining or quarrying ditches, a practice that was already common with open dumps. Just like the CDR Pedreira landfill, these open dumps were later operated as landfills. It also means that, in general, controlled landfills were inaugurated without prior and proper planning and operated for short periods of time, sometimes only for months. For example, Jardim Damasceno landfill (section 4.5.5.) operated for less than a year. The other landfills described in the previous sections demonstrate the little or none environmental awareness at the time of their construction, for example, the landfill of Santo Amaro (section 4.5.4) that is located exactly on the banks of the river Jurubatuba, which is worrying considering that the leachate liquids may still be contaminating people and the environment. Silva (2001) affirms that at this time, there was no concern about protecting groundwater and none of the landfill areas were effectively waterproofed.

Table 1 also showed that, in general, both the controlled and sanitary landfills in São Paulo have always been public landfills. However, after the change in the waste management regime (for the concession model), the consequent the lack of investment and exhaustion of

existing landfills, the city's solid waste began to be destined to private landfills, including one outside the city's borders. The absence of plans for the construction of new public landfills has implications for environmental justice, once the privatization of waste sites ends up undergoing to a profit logic. The waste municipal authority (AMLURB) still has the responsibility to control this issue and there is an urgent need to review the financing of the concession contracts, thus allowing greater investment and discussion of the implementation of a new public landfill in the city. It is hoped, therefore, that the concept of environmental justice be considered by the municipality in the planning of future public landfills.

Today, the city of São Paulo (SP, Brazil) has 18 landfills, of which 3 are active landfills, although one is located outside the borders of the municipality (Caieiras). Of the 15 closed landfills, eight are controlled landfills and seven are sanitary landfills, but two (Santo Amaro and Vila Albertina) started to operate as controlled landfills and were transformed later into sanitary landfills. The overlapping of the urban expansion map with the exact location of the landfills, shown in Map 1 (section 4.2), were essential to establish at what period of the urban expansion the landfills were installed. From this map derived the analysis presented in Table 2 'Landfills of São Paulo and period of urban expansion' (also section 4.2), in which it is possible to see if each landfill was placed in a region that was already urbanized or not. The results are interesting. Most of the landfills are installed in areas already urbanized. In turn, the most recent sanitary landfills installed in areas not yet urbanized. This may be a result of the lack of environmental awareness present decades ago, but it also means that, in the past, the landfills were installed in areas where they already had residents. In total, of the 13 landfills covered by the map, seven were installed in non-urbanized areas and eight in areas already urbanized. The most recent landfills are installed in areas not urbanized.

This result alone is not sufficient to establish a case of environmental injustice. Rather, it serves as a basis in the discussion regarding the social and economic conditions of the populations living around these landfills and the reasons why they choose to (or are forced to) live there.

## **5.2 Residents of landfill surrounding**

### **5.2.1 Socio-economic status**

As explained in the Methodology section, a GIS map relating the placement of the landfills of the city of São Paulo and the income per capital distribution was produced (Map 2, section 4.3). The results demonstrate that São Paulo followed a core-periphery model of city

development, as described by Ramires (2015) and Ripoli (2015). Adopting the environmental justice concept and based on the available data and the analysis carried out, it is possible to affirm that there is a case of environmental injustice in the waste management of the city of São Paulo (SP, Brazil). Map 2 shows that the inhabitants living near to the landfill and consequently the ones more susceptible to potential environmental impacts, are also the most economically vulnerable. The association between socio-economic status and differential exposure to waste is then demonstrated, so answering so the first research question. Regardless the period of urban occupation, inhabitants living near to landfills are also the most economically deprived.

Although it is possible to state that the majority of landfills in São Paulo are located near to economically deprived populations, some points need to be better discussed. The scope of this thesis is the city of São Paulo (SP, Brazil) and the data obtained refers exclusively to the city. However, since several landfills are located in the extremes borders, where, in some cases, it was not possible to accurately assess the population living around the landfill. For example, regarding the CTL Leste landfill (section 4.4), although the southern part contains a residential area, it is out of the geographic limits of the city of São Paulo, there is no available data and the area appears blank on the map. It happens again on the maps of Sitio São Joao and CDR Pedreira landfills.

Another point to be clarified refers to inclusion of the Waste Treatment Centre of Caieiras, one of the three active landfills of São Paulo that is actually located outside the city's borders. CTR Caieiras landfill could not be studied in detail because the scope of the thesis is the city of São Paulo, and the data obtained referred only to the city. However, this landfill is the final destination of almost half of the city's solid waste (São Paulo, 2014). Caieiras landfill began to operate in 2002, serving only the municipalities of Caieiras and Cajamar. After the closure of the Bandeirantes landfill and requested changes to the project, it was re-designed to also receive the solid waste from the city of São Paulo and perform treatment and disposal of industrial and health service waste (Cavalcante, 2014). It appeared as a temporary substitute for the so closed Bandeirantes landfill, while *"awaiting the definition of the area for the installation of a new municipal landfill"* (São Paulo, 2014, p. 75). However, since then no indications or information that indicates the planning of a new landfill were found on LOGA utility company website nor on the municipality website. It is questionable that almost half of the solid waste of the city is forwarded out of its borders.

### **5.2.2. Social context**

Besides the already proven link of location of landfills and economic status, this thesis also aims to analyse the role that the presence of the landfill has on the social conditions of the surrounding inhabitants. In order to do these, a more detailed study about the profile of the population, their social conditions and motivations to live there is required. This was the main justification for the realization of the field visit. The data collected through interviews and observations aim to provide material for this type of discussion.

The profile of the inhabitants of the community 'Terceira Divisão', captured through the interviews, provides important insights about the social conditions of the inhabitants of the surrounding of CTL Leste landfill. As showed in Table 3 (section 4.4.1), the majority of interviewees are women and since most of the interviews were conducted at the doors of homes, this may reflect the community dynamics in which women are more likely to stay at home (while their husbands are working, for example). The results regarding the occupation help to elucidate this. Thirty-two percent of the respondents are unemployed and 19% are housewives. The other occupations are often considered precarious and subject to many stigmas, such as workers of the waste sector (waste picker and garbage collector) and cleaner. The results related to race also reveal an important characteristic of the landfill's surrounding inhabitants. The vast majority of respondents are self-declared black or pardo (mixed race) and less than one-fifth (19%) are white. Of course, the relationship between poverty and race is complex, and therefore, the results of this study alone cannot characterizes a case of environmental racism. However, it is true that a population already suffering from other social injustice may also being affected by the impacts caused by living in proximity to the landfill. Finally, the results regarding age demonstrate that the sampling was representative, thus making the answers to the other questions more reliable.

The lack of dialogue and respect for residents from the side the municipality and landfill utility company was a surprising point that emerged during the interviews. There was a certain tone of revolt in the interviewees' responses. The residents are suffering bad living conditions and there is no initiative to commence a dialogue or negotiation of any kind in order to make housing conditions better. In fact, the population feels abandoned by the government. Data from the content analysis of the interviews confirms this (Table 4, section 4.4.2). Regarding the perception about the landfill's role on their quality of life, a common answer from respondents was that the 'government should find a new place for us to live'.

Finally, it was interesting to note that when asked about the problems in the region, the main answers from respondents were about their social conditions and not about problems related

to proximity to the landfill. Almost all respondents talked about the lack of public services in the region. The content analysis of the interviews showed a list of public services that the population claims are not available in the community: unpaved streets, lack of public lighting that makes the circulation of people at night problematic, considerable distance to municipal bus stops and need for long walks for daily locomotion, precariousness and/or absence of basic services in the region, such as kindergartens, schools and health posts. It was possible to confirm through the observations some of the points raised, such as the precarious housing and unpaved street (Figure 9 and 10, section 4.4.2), lack of public lighting and bus stops. The emphasis on social problems is an indication that the precarious social conditions of the surrounding residents is not necessarily directly connected with the presence of the landfill itself. This issue will be further discussed and elaborated in next sections.

### **5.3 Environmental conditions of landfill surrounding**

Sanitary landfills are the most modern method for final waste disposal on the soil, once they are ruled by engineering principles and specific technical standards e.g. treatment for soil permeability, successive land coverages, gas capture and drainage systems (Cavalcante, 2014; Leo, 2006). However, landfilling can still cause social and environmental impacts, such as release of gases, generation of noise, production of vectors of diseases, degradation of soil and landscape, degradation of fauna, potential soil contamination and underground waters by leachate (Stuermer et al., 2011), contaminating neighbouring areas and exposing the population to risks.

In the broad context, it is possible to assume that the environmental conditions surrounding the majority of landfills in the city of São Paulo are degraded. The city has eight controlled landfills and, as stated before, this kind of landfills presents some improvements in terms of the sanitary conditions in comparison to open dumps, however, the areas are not waterproofed. It means that more than half of the city's landfills did not have soil lining to reduce soil permeability. This is an important aspect because environmental and health impacts are more likely to happen in controlled landfills without measures to reduce soil permeability (Leo, 2006), where leachate percolation and consequent water contamination is possible. It is important to note that only 6 landfills in São Paulo have some kind of geotechnical and environmental monitoring activities. Further, a point to be considered is the proximity of landfills to residential areas. It is worrying that there are people living too near to waste disposal areas. In the Bandeirantes landfill (section 4.5.3), for example, Figure 14 shows the extreme closeness of the residential settlements to the landfill area.

In order to confirm the existence of additional environmental risks caused by living in proximity to a landfill, an overview of the environmental conditions of the community 'Terceira Divisão', located in the vicinity of CTL Leste landfill, is presented. This thesis does not aimed to carry out an environmental diagnosis and no analysis techniques or assessment guides were applied for this purpose. The understanding of the environmental conditions of the community was made through the analysis of the content of the interviews and observations made in the field, with theoretical support of related literature. One of the questions in the semi-structured interviews referred to the impacts that the landfill had on the health of the inhabitants of the community. The content analysis presented in Table 4 (section 4.4.2) shows that the residents have the perception that the landfill is responsible for aggravating cases of respiratory diseases due to air pollution. It has also been reported that children become sick more often, because they play in and have direct contact with purportedly contaminated soil and water. Cases of allergies were also cited. The observations made in the field confirm that children play, many barefoot, on the unpaved, muddy floor, as can be seen in Figure 11 (section 4.4.2). However, it is acknowledged that this results only reflects respondent perceptions and it was not possible to affirm that in fact the air, soil and water are contaminated.

The pictures presented in Section 4.4.32, Figure 10, demonstrate an indicator of an impact reported by many residents: the occurrence of floods. It was observed in the field visit that the main street and the subsidiary ones of the community are not asphalted and are thus made of clay. Besides being a factor that directly affects the quality of life of the residents, the occurrence of flash floods during rainy season was reported by many respondents. In the pictures, it was possible to observe water puddles on a bumpy floor. At some points, there is accumulation of household waste and some respondents even claimed that some houses release their untreated waste onto the street. Residents attribute some health-related impacts to the environment on the street, for example, the proliferation of vectors (mosquitoes, rats and cockroaches). Respondents also say the frequent flooding is worrisome because they do not know the origin of the water or where it had passed previously. A widespread fear from the residents of having contact with contaminated water from the landfill was noted. However, it is not possible to confirm this situation. Further, gas explosions and the presence of vultures were also reported, but this information could also not be confirmed.

An impact that could be confirmed and observed directly in the field visit was the odour produced by the landfill. In fact, the bad smell was felt throughout all the field visit. Bad odour was cited as an impact by all sixteen respondents, who also claimed that on hotter days the

smell gets even stronger, bordering on unbearable. This is considered a very degrading situation to which the inhabitants of the surrounding are subjected daily. Another impact to which the residents are subjected daily is the noise coming from garbage trucks. The community is located next to a main road on which all the trucks that are going and returning to the landfill have to pass. It has been reported that several garbage trucks pass all day on the road, including early morning and late evening. During the field visit, several trucks were observed passing by.

Concluding, the data collected through the interviews and field visit is enough to confirm some of the environmental conditions to which the surrounding inhabitants of CTL Leste landfill are subjected. Some of these conditions could be observed directly, others refer to testimonies and impressions from the residents. In general, it is possible to affirm that the residents of the 'Terceira Divisão' community live under degrading environmental conditions. This result further confirms a situation of environmental injustice, in which a population already socio-economically vulnerable (as proven in the previous sections) are being exposed to additional environmental risks due to proximity of a waste facility.

### ***5.3.1 Reasons to live near to landfills***

The results show that the populations living in the areas surrounding landfills are the poorer ones and, in general, are subjected to precarious social conditions. With this in mind, why do these people submit themselves to living in places where they are also subject to environmental risks? This sub-section seeks to answer this question, based on the data collected during the field visit and interviews with the residents of the 'Terceira Divisão' community.

In the content analysis table, a specific row was created to summarise the main answers regarding the reasons the interviewees provided for why they live in that place (Table 4, section 4.4.2). Economic motivation was quoted several times, meaning that residents are living there simply because they can afford the very cheap rent or the low land value. Some respondents declared that in the past the area was unoccupied and they invaded to live there, thus getting rid of paying rent. Such residents are therefore living illegally. Another motivation that emerged was family closeness, i.e. moving to live with or close to family members or spouses.

A testimonial from one resident symbolizes the main motivation to live near to landfill sites. Alzemir, an unemployed woman of 38 years said (translated from Portuguese):

*“I do not like to live here and I do not think it's a good place for my family. But the rent is cheap and it is very difficult to get another place nowadays. So we were staying here, if one day we find a better place and we could afford it, we move”*

This statement captures the main and most important reason why residents live under such conditions: there is no other option. The last question of the interviews further clarifies this statement. Almost 90% of the respondents would like to live somewhere else if the option presents itself. It is possible to conclude that the economic conditions of the residents affects not only their social conditions, but also their own (non) choice of where to live and the consequent environmental risks they end up enduring.

## **6 Conclusion**

The thesis aimed to relate the location of landfills and social and economic conditions of residents in order to establish possible cases of environmental injustice in waste management. Environmental conflicts are perceived as consequence of economic growth and social inequality, as framed in the background section. The concept of Environmental Justice adopted sees social and power inequality as the root of environmental degradation, directly affecting in a disproportionate way social, economic and environmental conditions. It can be seen in the urban expansion of the city of São Paulo (SP, Brazil), where a process of social segregation of space created specialized places to meet the needs of capital, promoting territorial inequalities and resulting in peripheries occupied by inhabitants with low purchasing power.

As the population of the city grew and consequently increased the volume of waste generated, new solutions for waste management have to be implemented, such as the construction of landfills far away from the urban centres. The first landfills of São Paulo were inaugurated without prior and proper planning, with little or no environmental awareness. Of the 18 landfills studied in this thesis, more than half did not have measures to reduce soil permeability and only six have some kind of geotechnical and environmental monitoring activities. Considering that landfilling can still cause social and environmental impacts and the closeness of several residential settlements to landfill sites, it is assumed that some closed landfills may be contaminating neighbouring areas and exposing the population to environmental risks. The data collected through the interviews and field visit to one



community in the surrounding of the CTL Leste landfill confirmed some of the environmental conditions to which the inhabitants are subjected.

The relation between economic status, urban expansion and landfill locations was analysed through the production of two maps, which showed that the residents currently living around the landfills are the most economically deprived, although many sites were not urbanized at the time of landfill implementation. This is the answer to the first research question. The field visit was essential to illustrate the social conditions of the residents and provided material about the role that the landfill has regarding these conditions. It is fair to say that the presence of the landfill itself is not the main cause of the precarious socioeconomic conditions of the surrounding inhabitants. Instead, the city dynamics makes populations that are already socioeconomically vulnerable accept to live in the vicinity of landfills sites, which, by consequence, affects not only their social conditions, but also their own (non) choice about where to live. The latter answers the second research question. Thus, a economic and socially vulnerable population also end up being victims of the environmental risks caused by living near a landfill. This thesis has sought to configure a case of environmental injustice, in which an already more vulnerable population are being exposed to additional environmental risks. It was visually demonstrated this relation in Sao Paulo, what filling an existing gap in the literaure.

Demonstrating cases of environmental injustice can help municipalities to avoid systematic biases in policy making and change regulatory practices. In Brazil, landfilling is the main waste final disposal and environmental justice is less stressed or even discussed behind the sustainability achievements in the national framework or in the municipal waste management plans. Further, an environmental justice approach is rarely considered and the location of landfills and the conditions of surrounding populations are barely discussed. Including the concept of environmental justice in the solid waste management planning process can promote more efficient government measures and better protect deprived populations, in order to guarantee that the presence of a landfill does not further expose an already vulnerable population to one more type of risk, the environmental risk.

More accurate studies about the decision making of the time of installation of the landfills, additional time series data or suitability analysis studies may help to prove cases of environmental injustice. Environmental diagnoses can also prove the social and environmental vulnerabilities of surrounding populations. Questioning the large share of Brazilian solid waste that is disposed in landfills is also needed, so seeking other solutions for the final disposal adapted to the Brazilian reality. Further, re-thinking our consumer society and the patterns of urban expansion are also essential. Sustainability science could help to

link different disciplines and balance social and environmental demands, as well as help to equate the complex factors related through interdisciplinary studies. Use sustainability science to analyze cases of environmental justice can provoke a shift from a simple 'blaming' to a applicable and transforming 'framing' of a more just future.

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