

Urban Solid Residues Management: An Analysis from Sobral-CE/Brazil

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Abstract

Integrated Solid Residues Management can be understood as a way of designing, implementing and managing urban solid residues management systems, considering a broad participation of sectors of society and having sustainable development as a perspective. However, the excessive consumption of post-modern society has contributed to the increase in residues generation, especially in urban centers and, allied to this, the precarious Brazilian scenario regarding the management and logistics of disposal and treatment of residues, ending up trigger great harm in the environmental and socio-economic context. The main objective of this research was to analyze the current context regarding the management of urban solid residues in the city of Sobral-Ce, considering from the adequacy to PNRS, socio-environmental impacts associated with in appropriate residue disposal, as well as measures implemented by the city hall in mitigation of such impacts. The methodology used was descriptive and exploratory research. The results indicate that, despite the existence of public policies (in the initial phase) aimed at the correct disposal of solid residues in the city of Sobral, it was possible to verify during the field research that, in almost all neighborhoods of the city, there is inadequate accumulation of residues. Therefore, it is necessary, even if in the implementation phase, the elaboration of the integrated plans is really effective, as well as measures implemented by the city hall in the mitigation of such impacts.

Keywords: solid residues, socioenvironmental analysis, development

1. Introduction

The excessive consumption of postmodern society has contributed to the increase in residues generation, especially in urban centers. Allied to this problem, the precarious Brazilian scenario, with regard to the management and logistics of waste disposal and treatment, ends up triggering major environmental and socioeconomic problems.

In this context, the environmental impact triggered by the disposal of residues requires society to study and produce administrative and managerial alternatives for urban life, with the scope of not only maintaining, but also expanding the possibilities of proper disposal of residues generated in the urban environment, in addition to offering a better quality of life that is in line with the protection of the environment.

In order to solve problems of this nature, Law n°. 12,305/2010, which addresses the National Solid Residues Policy (PNRS), brings together a set of principles, objectives, instruments, guidelines, goals and actions adopted by the Federal Government, alone or in cooperation with States, Federal District, Municipalities or individuals, with a view to integrated management and environmentally appropriate management of solid residues.

Thus, this law aims, in general, to protect public health and environmental quality, promote an adequate final disposal of waste, adoption of clean technologies and sustainable alternatives, and provide the basis for the implementation of an integrated management of solid waste in different locations.

One of the main objectives of the National Solid Residues Policy (PNRS) is undoubtedly the adequate treatment of tailings aligned with socio-environmental issues. For the final and environmentally appropriate destination of residues, aligned with the list of technologies, the PNRS provides for "reuse, recycling, composting, recovery and energy use or other destinations admitted by the competent bodies of SISNAMA, SNVS and SUASA, including the final disposal" (BRASIL, 2017, p.54).

Following this line of thought, the ESA – Environmental Services Association (2014), according to Zago and Barros (2019), reinforces that composting and bio digestion are the most recommended technologies worldwide

for the recycling of organic residues.

It is considered as a sustainable municipality that seeks to maintain or improve the health of its environmental system, to reduce degradation and anthropogenic impact, in addition to seeking social equity and providing the inhabitants with basic living conditions, as well as building an environment in a healthy and safe way and also political pacts that allow to face present and future challenges (BRAGA, 2004).

From this, an integrated waste management system is seen as adequate to the extent that the resources collected are sufficient to provide quality services to citizens and environmental problems are remedied (DANTAS, 2008).

The main objective of this article is to analyze the current context regarding the management of municipal solid residues in the city of Sobral-CE/Brazil, considering from the adequacy to the PNRS, socio-environmental impacts associated with the improper disposal of residues, as well as measures implemented by the city to mitigate such impacts.

The municipality of Sobral, located in the state of Ceará (Figure 1) has a territorial area of 2,068.474 km², an estimated population of 212,437 people, and a density of 88.67 inhabitants/km², with a human development index of 0.714 and has 75.6% of its households with adequate sewage and only 11.9% of urban households on public roads with adequate urbanization (presence of culvert, sidewalk, paving and curb) (IBGE, 2021). The city is located 235 km from Fortaleza, in the north of the state, being characterized as a landmark of development and growth in the interior of Ceará, a regional capital and the largest university pole of the interior portion. It is known for its broad and modern structure in the sectors of health, education, commerce, industry, services, leisure, culture and art.



Figure 1. Location map of Sobral

Source: Authors (2023)

1.1 Solid Residues: Classification, Environmental Impacts and the National Solid Residues Policy: The Classification of Solid Residues

The word garbage originates from the Latin *lix*, which means ashes and is linked to all kinds of products that no longer have a purpose, that is, material discarded after its use. With Law N° 12,305 of 2010, which establishes the National Solid Residues Policy (PNRS), other technical denominations emerged, replacing the word "garbage" for solid residues and tailings, having a difference in meaning between them. Residues is leftover or remains of the production or consumption process, which has values and can be reused or recycled, while waste is considered unusable, unwanted or worthless (CORTEZ, 2016).

The residues can be characterized according to its physical, solid and semi-solid state, which can come from industrial, domestic, hospital, commercial, agricultural, service and sweeping activities. In addition, there are subclassifications of these solid residues, (1) according to the chemical composition, subdivided into organic and inorganic; (2) in relation to the risks to the environment can be classified as dangerous (flammable, corrosive, reactive, toxic and pathogenic) and non-hazardous and (3) referring to their transformation into inert (material that when in contact with water, do not undergo physical, chemical or biological transformations, remaining unchanged for a long period of time) and non-inert (have biodegradable properties, oxidizing or soluble in water).

Some examples of hazardous materials are: paints (may be flammable), hospital materials (potentially pathogenic), chemical residues (may present toxicities or corrosivity), radioactive materials, fluorescent lamps, batteries (products with various metals in their composition that can be corrosive, reactive and toxic, depending on the environment) (NBR 10.004, 2004).

In an interview granted by the current representative of CGIRS-RMS, the Sobral Treatment Center (CTR) has four units to which the residues will be destined, namely: trench, health service, construction residues and composting. Despite the presence of these destination units, in CTR there is no accurate separation of residues, since it is the responsibility of each municipality to separate and sort residues, except in civil construction and composting units.

In this context, it is essential to know the main solid residues that is generated in Brazil, with a view to promoting projects and actions aimed at establishing an adequate management of solid residues. After all, according to the Ministry of the Environment (MMA), it is estimated that in Brazil 51.4% of the municipal solid residues collected is organic matter and about 32% dry fraction (plastic; paper, cardboard; glass) (PLANARES, 2022).

1.2 Geography and Environmental Issues in the Context of Urban Solid Residues in Brazil

Geography is a science that has as one of its attributes the study of the interaction between society and nature in the conception of space. Pretreatment, nature and society were analyzed in a dissociated way by Geography until the twentieth century and the geographical landscape was understood in a fragmented way and with disconnected elements, the most important being the in-depth knowledge of its constituents: lithosphere, relief and geomorphology, for example (MENDONÇA, 2017). In this perspective, nature, for a long time, was seen simply as an object to be possessed, dominated, subdivided and fragmented (SANTOS, 2008).

Thinking of man and nature as an organic and integrated set became increasingly difficult, given that this separation took place in the intellectual field and in the objective reality constructed by men (RODRIGUES and RODRIGUES, 2014). However, the inordinate changes in nature, arising from the intensification of production relations in the last decades of the twentieth century and in the beginning of the twenty-first, corroborated in Geography the urgency of an integrative vision between society and nature (MENDONÇA, 2017).

The segmented knowledge of the components of nature and society, even if deepened, was no longer so effective in the face of the need to advance in the understanding of environmental problems and in the intervening possibilities with the scope of reversing environmental degradation (MENDONÇA, 2017).

In the period of the 1970s and 1980s, a renewal in Geography began in a kind of revision and redefinition of its object of study. In this process, Milton Santos stood out as great influencers, from his publication "Por uma Geografia Nova", in 1978; Massimo Quaini, in "Marxism and Geography" (1979) and Yves Lacoste, in "Geography Serves First of All to Make War" (1976). The set of these three works, in addition to others, contributed substantially to a Geography concerned with social issues (CAVALCANTE, 2018).

The main milestone in the concern and debate around ecological issues was structured by the United Nations in 1972, through the Stockholm Conference in Sweden. This conference was important for the internationalization process on environmental issues, for the discussion of the causes, consequences and to favor an interlocution between the countries for a joint solution, resulting in the United Nations Environment Program (UNEP).

Subsequently, more events were held in this area, such as RIO+10, held in 2002 in Johannesburg, which proposed

as goals: the promotion of sustainable modalities of production and consumption, reduction of residues production and increased reuse, recycling and the use of materials innocuous to the environment (DIAS, 2018).

All this concern focused on sustainable development and the man-nature relationship has gained more notoriety contemporaneously, since society is quite dependent on natural resources for its evolution and survival. However, the indiscriminate use of natural resources and environmental degradation still represent serious problems of this century. In the midst of these issues, discussing and finding alternatives to solid waste figure as central issues that would promote the much-advocated sustainable development.

Considering the Brazilian context, it is observed that in 2020 the country had 4,145 municipalities that had some initiative of selective collection. However, many of these cities still have timid initiatives. Among the municipalities in the Northeast region, where the State of Ceará is located and, consequently, the city of Sobral, 56.7% of the municipalities have some type of initiative, which represents a percentage below the average of the country (74.4%), as observed in Figure 2 (ABRELPE, 2021).

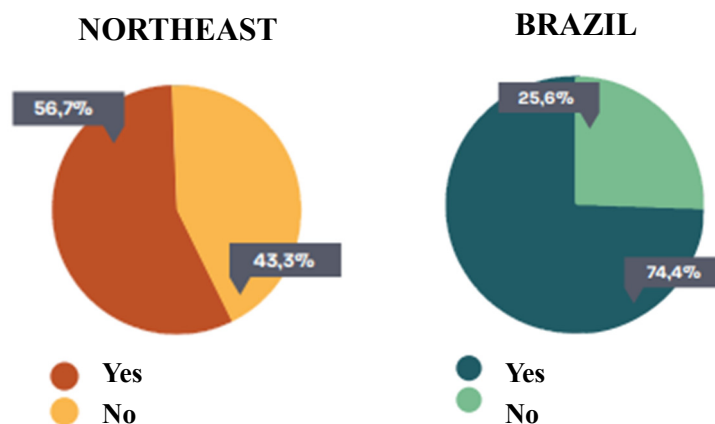


Figure 2. Percentage of municipalities with some selective collection initiative in the Northeast and Brazil
Source: ABRELPE (2021)

This data clearly reflects how far we are still from an ideal scenario in terms of selective collection and proper management of solid residues in Brazil, including considering the regional context of inequality.

1.3 Environmental Impacts from the Generation and Improper Disposal of Solid Residues: Concepts, Problems and Alternatives

Environmental impacts are characterized as any type of change in the physical, chemical or biological properties of the environment, resulting from human practice, whether directly or indirectly. In this context, these impacts on the environment have a deleterious impact on the well-being of the population, which favors damage to health, safety, and socioeconomic activities, as well as greatly affecting the quality of natural resources (CONAMA, 1986).

Sánchez (2013, p.29) considers that environmental impact is the "alteration of environmental quality that results from the modification of natural or social processes caused by human action", that is, the environmental impact can have harmful or beneficial characteristics, as ratified under the perspective of ISO 14.001, which states that environmental impact represents "any modification of the environment, adverse or beneficial, which results, in whole or in part, from the activities or products or services of an organization" (NBR ISO 14.001, 2004, p. 23).

From the negative perspective of environmental impacts, it is notorious that the increasing generation of solid residues in line with improper disposal and treatment, corroborate with numerous problems not only in the environmental context, but also reflects on the socioeconomic and health sphere, given that the consequences of the incorrect destination of these residues have coverage beyond its disposal area.

In this sense, the improper handling of solid residues harms the quality of soil, water and also air, since the various components of this waste, such as heavy metals, volatile compounds and other chemical compounds, are too polluting and, consequently, harmful to the environment.

The formation of slurry from organic components and the presence of heavy metals in solid residues, for example,

can contaminate the soil, nearby rivers and groundwater in the region and, in this way, damages the soil for the handling of agriculture, as well as contaminates water, which causes damage to the health of the surrounding population that is in continuous contact with these substances, favoring the incidence of cancers, congenital anomalies, low weight in newborn children and even abortions (GOUVEIA, 2012).

In addition, with the decomposition of organic residues, there is elimination of methane gas, which contributes to the aggravation of the greenhouse effect, in addition to being flammable. Another problem arising from the improper disposal of solid residues, as in open dumps, is the creation of an environment conducive to the spread of disease vectors, especially for the surrounding population and for workers in this sector, such as residues pickers, who handle the debris in unsanitary conditions and without protective equipment, causing various damages to health (GOUVEIA, 2012).

Therefore, it is essential to propose alternatives that aim to mitigate the numerous problems of improper disposal of solid waste. Therefore, based on the National Solid Residues Policy (PNRS), it is important that municipalities have a residues management plan, which includes the replacement of dumps and the effective implementation of selective garbage collection. The goal would be to create a logistics in which the garbage is, in fact, treated correctly, as well as to create public policies aimed at the class of residues pickers and, in this way, provide a beneficial environmental impact to the population and the environment.

In addition, as presented in article 9 of the PNRS, non-generation is a priority action, followed by reduction. However, these actions are still incipient in the Brazilian context, since there are no indicators that demonstrate the volume of material that is no longer discarded or that has been reduced (PLANARES, 2022). Therefore, it is valid to carry out educational campaigns that guide the population to reduce consumption, as well as to create the habit of reusing objects in order to reduce the amount of residues produced. In addition, it is crucial to implement the action of recycling, through the training of residues pickers and the creation of cooperatives (GOUVEIA, 2012).

Companies, as large producers of residues, should adopt measures that reduce the production of solid residues. Therefore, the adoption of the concept of Cleaner Production is an excellent alternative to reduce the impacts of tailings from the production scale, since this concept is based on the continuous application of an economic, environmental and technological strategy integrated to industrial processes and products, with the scope of making the use of raw materials more efficient, water and energy, through strategies aimed at not generating, minimizing or recycling the residues generated in a production process.

With the Cleaner Production approach, companies are encouraged to innovate. Therefore, it favors sustained and competitive economic development for the company itself and the entire comprehensive region (CNTL, 2003). In addition, an interesting practice of non-generation of residues is linked to the sale and consumption of second-hand materials, that is, a business logistics that occupies space in technical assistance and in the sale of used products, which can be accepted in exchange, or at a discount, for the acquisition of a new product. Therefore, companies have the possibility to use the product that would be discarded to recondition it and put it on the market again (PLANARES, 2022).

1.4 National Solid Residues Policy

According to Law No. 12,305 of 2010, municipal governments are responsible for the management of the solid residues in which it is generated, including preserving public health, the creation of Integrated Solid Residues Management Plans (PMGIRS) and the extinction of open dumps. In addition, this law also provides that municipalities should have prepared the Solid Residues Management Plan - compatible with each regional reality, with the presence of a diagnosis of the waste situation, the goals for reduction and recycling and the establishment of the end of open dumps, in addition to deliberating consortium solutions with other municipalities - by August 2012 (GOMES, 2014).

However, the application of the National Solid Residues Policy still faces challenges in its implementation due to the contradictions and regional disparities of the Brazilian reality, especially socioeconomic. As an example, we highlight a study conducted in eight municipalities in the region of Curimataú-PB, with interviews with mayors and technicians of the Brazilian Institute of the Environment (IBAMA), in order to carry out a survey on the challenges faced in the implementation of the PNRS by the municipalities, in which mayors list as difficulties the paucity of financial incentives by the Federal Government, in addition to technical and specialized support for the execution of the policy. Another challenge listed was the limited environmental awareness of the population as one of the obstacles to implementation.

However, IBAMA technicians and officials from the Public Prosecutor's Office stated that the slowness of the application of the PNRS is due to the lack of activism on the part of the municipal power itself in encouraging

selective collection and the construction of sanitary landfills. In addition, when asked about the population of waste pickers in the region of the dumps, the mayors claimed ignorance, which shows the lack of concern of the public authorities, in some regions of Brazil, with the integration of the community of waste pickers, contrary to the socioeconomic inclusion of law 12,305/10 (MENDES, 2017).

In this context, it is worth mentioning that although many municipal authorities do not engage in this project, the financial resources constitute a very important issue for the application of the PNRS, because according to the National Survey of Basic Sanitation (PNSB), waste management services, such as collection, public cleaning and especially the correct final destination, they greatly burden municipal administrations, and can reach 20% of expenses, without taking into account the organization of cooperatives to support waste pickers (IBGE, 2008).

In addition, according to the ABRELPE survey (2017), Brazil needs to invest R\$ 11.6 billion until the next decade in infrastructure to universalize the proper final disposal of solid residues, in addition to R\$ 15.59 billion per year in order to finance the operation and maintenance of the works to be built.

Therefore, it is undoubtedly true that the PNRS guidelines aim to promote numerous socioeconomic and environmental benefits. However, the practical and effective actions for the consolidation of the PNRS are still time-consuming, as well as costly. Therefore, it is essential that there is a fair financing, considering the reality of each municipality, in order to implement the plans. In addition, it is important that managers understand the importance of environmental public policies aimed at the correct management of solid residues, because with the implementation of the PNRS, each municipality will be performing important prophylactic action of local public health, benefiting its population and reducing environmental degradation (MENDES, 2017).

2. Method

Initially, the bibliographic research was used, of which, according to Fonseca (2002) reveals that it is carried out from the survey of theoretical references already carried out and published through electronic writings. Thus, this research addressed concepts related to the management of urban solid residues with views in the city of Sobral, located in the northwest region of the state of Ceará.

This research other different phases/stages, such as theoretical and documentary research, already mentioned above, as well as field research, which included from on-site visits to the main points of improper disposal of the city - for better analysis and understanding of the problem in the city - as well as interviews with actors (residents near these points of accumulation, waste pickers and public officials responsible for urban public cleaning) that allowed an understanding of the socio-environmental reality focused on the management of urban solid residues in Sobral-CE.

In addition, it also had interviews with the coordinator of the Consortium for Integrated Management of Solid Residues of the Metropolitan Region of Sobral (CGIRS-RMS) and the coordinator of public cleaning of the Sobral City Hall.

3. Results

According to the Regional Plan for Integrated Management of Solid Residues, prepared in 2018 by the Department of the Environment, considering the Northeast Hinterland, the municipality of Sobral stands out for being the largest in territorial extension (36.19%), and in urban population, consubstantiating 46% of the region. Regarding Solid Residues Management, until 2018, Sobral presented as waste disposal environments the presence of four dumps, three ECOENEL points (reuse and recycling of solid residues), two sorting sheds (segregation of dry residues) and one ECOPONTO (reception and temporary storage of defined recyclable materials).

The municipality also has three municipal waste recycling centers: the CMR Sinhá Sabóia (Figure 3), the CMR Expectation and another located in the Dom José neighborhood. These plants have the important function of sorting waste collected by waste pickers, serving as a voluntary delivery point by the population for recycling, as well as receiving bulky materials such as pruning, furniture, construction waste and other types of unusable materials, in addition to welcoming the associations of waste pickers to work on the separation and sale of reusable and recyclable materials (LIMA, 2022).

After the CMR's carry out the necessary actions for the treatment of municipal solid waste, the tailings generated are forwarded to the CTR (Solid Waste Treatment Center).



Figure 3. CMR Sinh  Sab ia of Sobral

Source: Author (2022)

The Solid Residues Treatment Center of the Northern Region, managed by CGIRS-RMS (Consortium for Integrated Management of Solid Waste of the Metropolitan Region of Sobral), began its activities on October 26, 2020. Thus, this project provided the completion of the operations of at least 18 dumps in the metropolitan region and adapted the 18 consortium municipalities (Alc ntaras, Carir , Corea , Forquilha, Frecheirinha, Gra a, Groa ras, Massap , Meruoca, Mora jo, Mucambo, Pacuj , Pires Ferreira, Reritaba, Santana do Acara , Senador S , Sobral and Varjota) to comply with the legal obligations recommended by the National Solid Residues Policy, Federal Law N . 12,305/2010, and State Law N . 16,032/2016 (SECRETARIAT OF CITIES, 2020).

CTR includes a Sanitary Landfill equipped for the disposal of solid residues, with spreading and compaction, waste coverage, division into cells, waterproofing, drainage and treatment systems for fluids, in order to promote the safe disposal of tailings and reduce environmental impacts, as well as offer more protection to the health of the population. In addition, the plant is made up of a Civil Construction Residues Treatment Unit (RCC), a Health Residues Treatment Unit (RSS), as well as a Composting Unit (Figure 4).



Figure 4. Residues treatment center, in Sobral

Source: Secretariat of Cities (2019)

Such actions already contemplate, in part, what was previously defined in the National Solid Waste Policy (PNRS, 2010), especially with regard to the creation of Integrated Solid Waste Management Plans (PMGIRS) and the extinction of open-air dumps

3.1 Socio-Environmental Projects and Actions in the City of Sobral

In order to promote support for waste pickers and improve logistics in the separation of solid residues, cooperatives were created with the support of the Secretariat of Cities, which operate in the Municipal Treatment Centers. These associations are of great importance for the regularization of these professionals, for the income of waste pickers, as well as the strengthening of public management of solid residues. Through the work of the collector, the amount of discarded materials that would occupy space in the Residues Treatment Center decreases, increasing its useful life, in addition to the municipality saving on the collection, transportation and final disposal of these materials (SOBRAL, 2021).

The municipality of Sobral has four associations of waste pickers operating within the Municipal Residues Centers, three of which are located at the headquarters, operating since 2021, and one in the district of Aracatiáçú, which has been in operation since 2015. An example is the Association of Waste Pickers Dom José Tupinambá da Frota, composed of 21 associated waste pickers, who have been accompanied by the technical team of the Secretariat of Conservation and Public Services for three years, with logistical support on how to operationalize, receive waste, segregate and package in the premises of the CMR (SOBRAL, 2021).

According to the interviews conducted with both the representative of CGIRS and the Sobral City Hall (Public Cleaning Coordinator), the situation of the Solid Residues Management of the Municipality, in this context, indicates that most of the municipalities of the consortium are in the process of enclosing these areas and already have a recovery plan for degraded areas. In this sense, 14 cities have already deactivated these sites and are going through the recovery phase.

In addition, the municipalities have an Environmental Education Plan, which seeks to raise the awareness of individuals in reducing the generation of solid residues. To this end, CGIRS representatives used pedagogical strategies, such as courses and lectures on environmental education in universities and schools. According to Reis (2017), such actions are extremely relevant, since the responsibility for the waste generated is shared (between the public sphere, companies and citizens), based on Federal Law No. 12,305, enacted on August 2, 2010, which institutes the National Solid Waste Policy (PNRS).

In addition, the municipality of Sobral seeks to strengthen the environmental policy, through actions of cleaning and revitalization of critical points of the city, where the Department of Conservation and Public Services has a georeferencing database to identify these sites. In this way, in these critical points the city focuses on urban recovery actions, taking into account the characteristics of public health, visual impact, accessibility, and construction of useful space for adults and children.

Depending on the area to be revitalized, they use from image paintings that provide inclusion, such as dictionaries in pounds and hopscotch games painted on sidewalks, in addition to the leveling of sidewalks, rebuilding or construction of walls, paintings that consider the characteristics of the dynamics of the population that uses the area, installation of fixed benches, planting of plant species, etc.

In the surveys carried out in the places with accumulation of waste, the intervention of the City Hall was verified with regard to the revitalization and cleaning of these spaces (Figure 5). An example of these actions occurred in the vicinity of Avenue José Euclides Ferreira. The intervention took place through the removal of solid waste that was accumulated in vacant land in line with the revitalization of the spaces, through paintings that refer to the local culture, promoting appreciation of the area and facilitating access to these areas by the population.



Figure 5. Interventions carried out by the municipality of Sobral/CE

Source: Author (2022)

In addition to these actions by the Department of Conservation and Public Services in places of incorrect disposition, there is also the Scheduled Collection Program, which has servers and trucks intended to collect unusable materials, such as sofas, mattresses, appliances through the request of citizens by telephone contact. From the collection, the materials are forwarded to the CTR. In line with this, there was an intensification of inspections and assessments of individuals who dispose of residues in an inappropriate manner and owners of vacant land who do not ensure proper cleaning of the same.

3.2 Residues Conjuncture in Sobral

Federal Law N°. 12,305, promulgated on August 2, 2010, which establishes the National Solid Residues Policy (PNRS), addresses the principles, objectives, instruments, goals, responsibilities, as well as the guidelines related to the integrated and management of solid waste (PNRS, 2010), composed of 57 articles, with the objective of building an environmentally appropriate integrated solid residues management, to be adopted by the Union, States, Municipalities and private entities.

The Law addresses in its guidelines the problem of integrated solid residues management, which is defined as a set of actions aimed at finding solutions to solid residues, in order to consider the political, economic, environmental, cultural, social and sustainable development dimensions, integrating from socioeconomic to environmental issues. From this law, the responsibility for garbage becomes shared between the municipal public power, companies, citizens and the state and federal governments (REIS, 2017).

The law is based primarily on solid waste management for non-generation, reduction, reuse, recycling, treatment of solid residues and environmentally appropriate final disposal of waste. The PNRS also brought more precise definitions, such as operational and financial sustainability, reverse logistics, sectoral agreement, integration of waste pickers, sustainable patterns of production and consumption, etc.

In addition, the PNRS discusses aspects such as the protection of public health and environmental quality and the environmentally appropriate final disposal. Article 3 of the PNRS defines solid residues as:

XVI – solid waste: material, substance, object or discarded good resulting from human activities in society, whose final destination is proceeded, it is proposed to proceed or is obliged to proceed, in solid or semi-solid states, as well as gases contained in containers and liquids whose particularities make it impracticable to release them into the public sewage network or into water bodies, or require technically or economically unviable solutions in the face of the best available technology (BRAZIL, Law No. 12,305/10, item XVI, article 3).

The law recommends the principles of shared responsibility and reverse logistics, in which waste returns to the initial manufacturing process of the discarded material itself, polluter-pays, which are costs of repairing any

environmental damage. It also defines the instruments, such as the Solid Residues Management Plan, Environmental Education, Selective Collection, socioeconomic inclusion of recyclable waste pickers, etc. Thus, the PNRS has two perspectives, one related to the management of industrial waste and the other to the municipal management of solid residues, with the elaboration of integrated plans, such as the one that is being implemented in the city of Sobral/CE.

The city of Sobral is composed of 37 neighborhoods, according to the City Hall, which are: Alto da Brasília, Alto do Cristo, Parque Alvorada (Campo dos Velhos), Centro, Cohab I, Cohab II, Cohab III, Colina da Boa Vista, Residencial Nova Caiçara, Coração de Jesus, Distrito Industrial, Dom José I (Alto Novo), Dom José II (Sumaré), Dom Expedito (Feitosa), Domingos Olímpio, Dr. José Euclides Ferreira Gomes (New Grounds), Expectation, Jatobá, Jerônimo de Medeiros Prado, Junco, Mucambinho, Novo Recanto, Padre Ibiapina, Padre Palhano, Paraíso das Flores, Parque Santo Antônio, Parque Silvana I, Parque Silvana II, Pedrinhas, Pedro Mendes Carneiro, Recanto I, Recanto II, Renato Parente, Sinhá Sabóia, Tamarindo, Várzea Grande e a Vila União.

During the field research, which was carried out on alternate days of the week during the period of March and April 2022, in order to quantify and record the main places of accumulation of solid waste in the neighborhoods of the municipality and qualitatively analyze their impacts, it was found that almost all the neighborhoods of the city of Sobral presented inadequate accumulation of waste (Figure 6), mainly arranged in abandoned land, in circulation roads and forest areas.



Figure 6. Accumulation of solid waste on public roads

Source: Authors (2022). Legend of the neighborhoods: A - Alto da Brasília, B - Dom José, C - Alto da Brasília, D - Padre Palhano, E - CoHab II, F - Dom José, G - Colinas, H - Sinhá Sabóia, I - Dom José.

Such changes in nature are analyzed, within the scope of geographic science, from an integrated view, and come from the intensification of production relations in recent decades, as pointed out by Mendonça (2017).

Within this context, it was found that the Dom José neighborhood, with a population of 8,316, according to the 2010 demographic census, is the place with the most aggravating situation, given the presence of residues in almost the entire length of the neighborhood's roads, canals and especially in the vacant lots.

In addition, it was observed in these places true disregard for garbage, with regard to the correct disposal and separation of waste. In addition, it was observed the presence of several animals such as dogs, cats, vultures, insects and horses, which are potential vectors of diseases for the local community and surroundings and, mainly, for waste pickers in general, as was witnessed at the time of collection of recyclable materials at these disposal points and other citizens depositing even more residues.

It was found that the discarded materials come mostly from the neighborhood community itself, with characteristics of household waste (organic matter, packaging, paper, plastics, aluminum) and large volumes such as furniture (sofas, refrigerators, tires, etc.). It was also found civil construction waste (bricks, ceramics, concrete) and pruning services exposed in roads, squares and vacant lots, in addition to the presence of waste that has the potential risk of causing damage to the health of waste pickers and public cleaning professionals, such as glass, lamps and sharp objects.

In the most central neighborhoods of the city and with greater circulation of people and vehicles, such as the neighborhoods of Centro, Coração de Jesus, Junco, Campos dos Velhos and Mercado, the inadequate deposit of solid waste was also observed, contributing to the socio-environmental and visual impact of the city.

From this, a preliminary mapping of the city of Sobral was elaborated, demonstrating the main points of accumulation of improperly disposed waste generated by the local community, sectioned by neighborhoods. (Figure 7).

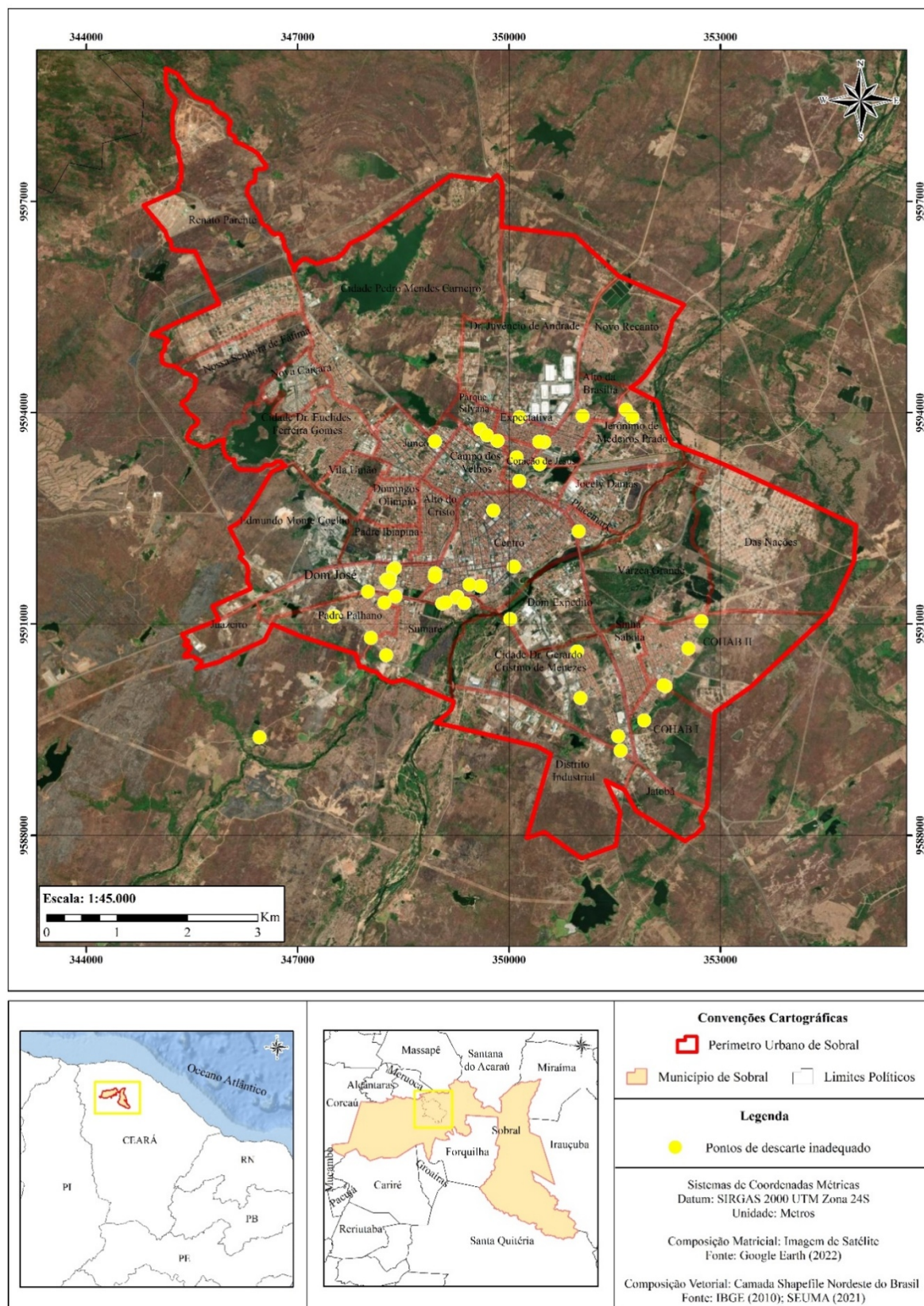


Figure 7. Maps of the main points of inadequate accumulation of solid waste in the city of Sobral/CE
Source: Author (2022)

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Acknowledgments

The implementation of the National Solid Residues Policy still faces challenges due to the contradictions and regional disparities of the Brazilian reality, especially socioeconomic. The city of Sobral, despite offering projects and actions focused on socio-environmental issues, still faces difficulties in complying with the determinations of the PNRS. However, it is necessary to comply with such actions with a view to expanding the collection, treatment of solid residues and the conscious and active role of society in the processes that are related to the separation of waste and the difficulty of eradicating dumps and their replacement by sanitary landfills in the city's neighborhoods.

During the research period, it was possible to observe that most of the city's neighborhoods presented some type of inadequate accumulation of residues, mainly disposed in abandoned land, in circulation routes and forest areas, making more and more the environmental quality in the city compromised due to the evolution and urban development. Therefore, it is necessary, even if in the implementation phase, the elaboration of integrated plans in an effective way, in addition to measures/actions that promote environmental education and facilitate the denunciation, thus contributing to the mitigation of such impacts from the production, accumulation and destination of urban solid residues.

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