

## MAPPING AND IDENTIFICATION OF IRREGULAR SOLID WASTE DISPOSAL SITES IN THE URBAN AREA OF CHAPADINHA, MARANHÃO

### MAPEAMENTO E IDENTIFICAÇÃO DE PONTOS DE DESCARTE IRREGULAR DE RESÍDUOS SÓLIDOS NA ÁREA URBANA DE CHAPADINHA - MA

### MAPEO E IDENTIFICACIÓN DE PUNTOS DE DISPOSICIÓN IRREGULAR DE RESIDUOS SÓLIDOS EN EL ÁREA URBANA DE CHAPADINHA – MA



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#### ABSTRACT

This study aimed to map and identify sites of irregular solid waste disposal in the urban area of Chapadinha (Maranhão, Brazil), characterizing their spatial distribution and associated socio-environmental risks. A descriptive and exploratory approach was adopted, involving on-site observations, photographic records, georeferencing, and informal conversations with residents. Eleven critical points were identified, predominantly composed of household waste, plastics, organic material, and construction debris, typically deposited over exposed soil and vegetation. Investigation of the municipal open dump revealed inadequate waste management practices, including open burning, worker exposure without Personal Protective Equipment, and uncontrolled leachate formation. The findings demonstrate significant public health impacts, such as vectors proliferation, environmental contamination, and greenhouse gas emissions. The study offers evidence to support environmental management policies and environmental education initiatives in the municipality.

**Keywords:** Solid Waste. Disposal. Environment. Public Health. Maranhão.

#### RESUMO

Este estudo teve como objetivo mapear e identificar pontos de descarte irregular de resíduos sólidos na área urbana de Chapadinha (MA), caracterizando sua distribuição espacial e os riscos socioambientais associados. A pesquisa adotou abordagem descritiva e exploratória, com observações in loco, registro fotográfico, georreferenciamento e conversas informais com moradores. Foram identificados 11 pontos críticos, com predominância de resíduos domésticos, plásticos, orgânicos e restos de construção civil, geralmente depositados sobre

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solo exposto e vegetação. A investigação no lixão municipal revelou manejo inadequado, incluindo queima a céu aberto, exposição de trabalhadores sem Equipamentos de Proteção Individual e formação de chorume sem contenção. Os resultados evidenciam impactos sobre a saúde pública, como atração de vetores, contaminação ambiental e emissão de gases de efeito estufa. O estudo fornece subsídios para políticas de gestão ambiental e ações de educação ambiental no município.

**Palavras-chave:** Resíduos Sólidos. Descarte. Meio Ambiente. Saúde Pública. Maranhão.

## **RESUMEN**

Este estudio tuvo como objetivo mapear e identificar puntos de disposición irregular de residuos sólidos en el área urbana de Chapadinha (MA), caracterizando su distribución espacial y los riesgos socioambientales asociados. La investigación adoptó un enfoque descriptivo y exploratorio, con observaciones in situ, registros fotográficos, georreferenciación y conversaciones informales con los residentes. Se identificaron once puntos críticos, que contenían predominantemente residuos domésticos, plásticos, residuos orgánicos y escombros de construcción, generalmente depositados sobre suelo y vegetación expuestos. La investigación en el vertedero municipal reveló una gestión inadecuada, incluyendo la quema a cielo abierto, la exposición de trabajadores sin equipo de protección individual (EPI) y la formación de lixiviados sin contención. Los resultados destacan los impactos en la salud pública, como la atracción de vectores, la contaminación ambiental y la emisión de gases de efecto invernadero. El estudio respalda las políticas de gestión ambiental y las acciones de educación ambiental en el municipio.

**Palabras clave:** Resíduos Sólidos. Disposición. Medio Ambiente. Salud Pública. Maranhão.

## 1 INTRODUCTION

Social, economic, political, cultural, technological, and educational transformations have reconfigured the modes of interaction and communication processes, requiring continuous adjustments in personal and professional activities (Toebe, 2016). In the educational field, these changes have a direct impact on the organization of formal education, which also needs to adapt to new rhythms, demands and forms of knowledge circulation.

We live in a context marked by the acceleration of time, the fluidity of relationships and the need for constant adaptation, characteristics of liquid modernity (Bauman, 2001). In this scenario, time management becomes a daily challenge, as the fast pace does not necessarily correspond to the meaning or predictability of actions, producing a feeling of emptiness and discontinuity (Skliar, 2014). Contemporary society, guided by agility and efficiency, demands fast, accessible practices with often reduced social interaction, reinforcing the centrality of digital technologies in this process of rearrangement of human and professional relations (Bauman, 2001).

The COVID-19 pandemic in 2020 intensified this scenario of uncertainties and transformations. The social distancing measures adopted globally to contain the spread of the virus have required abrupt adaptations in the world of work, in daily life, and especially in the university environment (Monteiro, 2020). The impact of the pandemic was broad and deep, affecting economic, social, and emotional dimensions of the population, with worsening inequalities and interruption of essential activities, including education.

In the educational sphere, higher education institutions needed to quickly restructure their practices to ensure the continuity of academic activities. The adoption of Emergency Remote Learning (ERE) has become the main strategy to mitigate the gaps generated by the suspension of face-to-face classes, imposing significant challenges on university networks across the country (Arruda, 2020). The regulation of this model, through CNE/CP Opinion No. 5, of April 28, 2020 (Brasil, 2020), guided the pedagogical reorganization during the isolation period, emphasizing the need to understand its impacts on student learning and training.

In this context of social transformations and reconfigurations in urban daily life, environmental issues, such as the inadequate disposal of solid waste, become even more critical. The identification and mapping of irregular disposal points are essential to subsidize public policies, guide environmental management actions and promote improvements in the quality of life of the population.

Thus, the objective of this study was to map and identify the points of inadequate disposal of solid waste in the urban area of Chapadinha, Maranhão, aiming to characterize

the current situation and provide subsidies for environmental management strategies in the municipality.

## 2 METHODS

The research was developed based on descriptive and exploratory procedures, adopting a qualitative and quantitative approach. Initially, a literature review was carried out in scientific articles, books and institutional documents related to solid waste disposal, urban environmental management and socio-environmental impacts.

### 2.1 AREA OF STUDY AND OBSERVATION SCRIPT:

The collection of empirical data took place at different points in the urban area of Chapadinha (MA), selected for presenting a history or evidence of irregular waste disposal.

The observation route included:

- ✓ area of the cemetery in the Boa Vista neighborhood;
- ✓ surroundings of the Parque Universitário condominium;
- ✓ region near the water tank in the Mutirão neighborhood;
- ✓ dirt road located at the back of the Esplanade neighborhood;
- ✓ Gustavo Barbosa Avenue (Downtown);
- ✓ internal roads in the Vila Isamara, Liberdade and Vila Brasil neighborhoods.

These locations were chosen to allow the identification of the spatial distribution, the composition of the waste and the disposal methods adopted by the population, as well as to assess the associated socio-environmental risks.

### 2.2 FIELD PROCEDURES:

On-site visits were carried out, during which images were recorded using a cell phone with a high-resolution camera. The direct observation was complemented by informal conversations with residents of the investigated areas, in order to understand the local dynamics of disposal, community perception and the periodicity of waste disposal.

### 2.3 OBSERVATION IN THE MUNICIPAL DUMP:

In addition to the scattered points of irregular disposal, a technical visit was made to the municipal open-air dump, the final destination of the waste collected by the Municipal Department of Infrastructure and Public Cleaning. The area is surrounded by vegetation and presented two relevant conditions:

1. Reduction in the area occupied by the dump: It was found that the space previously used was significantly larger. The reduction in area occurred through the process of deep scraping of the soil with heavy machinery, removing vegetation and waste simultaneously. This procedure left extensive portions of soil exposed, with signs of erosion and absence of any environmental mitigation or recovery action.
2. Working conditions and waste management: It was observed the presence of workers manually separating PET bottles, which would later be sent to São Luís for recycling. The remaining waste, including non-recycled, organic, and mixed plastics, remained on site for open incineration. None of the workers used Personal Protective Equipment (PPE), such as respiratory masks, gloves, overalls or closed shoes, being exposed to physical, chemical and biological risks.

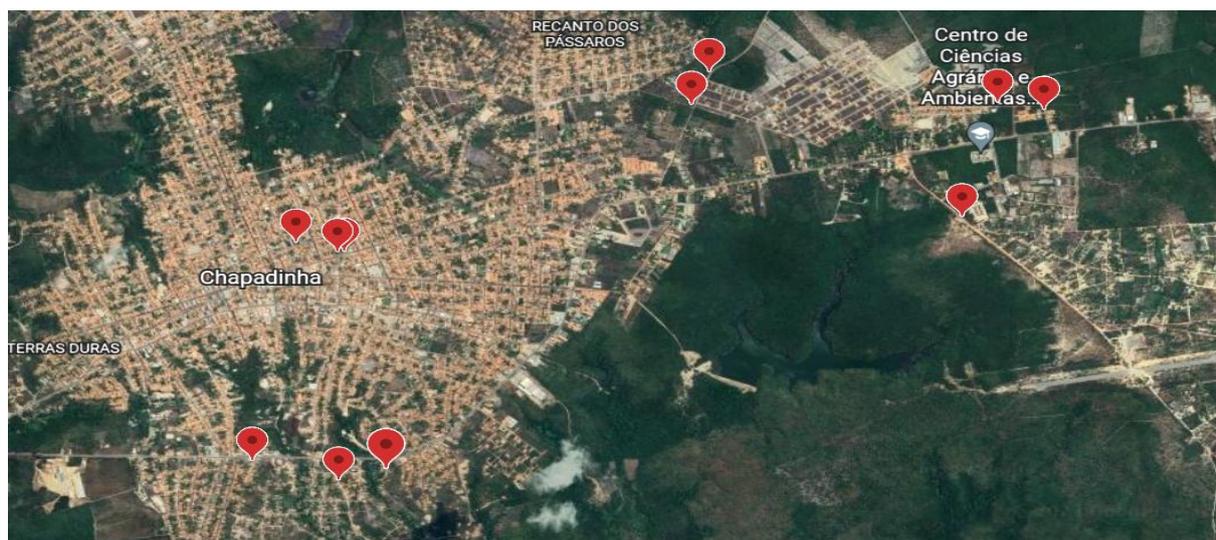
### 3 DEVELOPMENT

Through on-site visits, 11 points of irregular disposal of solid waste were recorded in the urban perimeter of the municipality of Chapadinha - MA and, with the collection of the coordinates of the locations, it was possible to generate a map with their spatial distribution (Figure 1).

We can highlight that solid waste in the study period was collected in this municipality only in urban areas, in addition, public garbage cans are insufficient in the main streets of the city (some were destroyed by vandals) and in more remote areas they are non-existent. Also in this scenario, we can highlight the lack of awareness on the part of residents, who in many situations deposit their waste inappropriately, especially in vacant lots.

**Figure 1**

*Places of irregular disposal of solid waste in the urban perimeter of Chapadinha - MA*



Source: Google Earth, 2022.

Due to this habit of a significant part of the population, this environment becomes an attractive source for several groups of animals which can vector a wide range of diseases, especially to the residents of the vicinity, making it not only an environmental problem but also involving several issues for public health programs.

In the sites investigated in the urban area of Chapadinha (Figure 2), there was a predominance of domestic waste, with a strong presence of plastics and organic materials, accompanied by civil construction and textile waste. The frequent disposal of these materials directly on vegetation and exposed soil highlights a vulnerable environmental scenario, in which natural processes of decomposition and interaction with the physical environment can amplify relevant health risks.

**Figure 2**

*Garbage distribution in different locations in the municipality of Chapadinha – MA*



Locations checked: a. In front of the cemetery in the UFMA area; b. In front of the University Condominium in the University Park; c. Next to the Water Tank in the Mutirão; d. 3 Different Garbage Points on the Dirt Road at the Bottom of the Esplanade Neighborhood; e. Garbage piled up on a public road at Av. Gustavo Barbosa; f. Garbage Accumulated in the Back of a Residence in the Liberdade Neighborhood Where Collection Does Not Occur. Source: Francisca Lima (2022)

The report of the Municipal Plan for Basic Sanitation of Chapadinha (PMSB, 2015) already pointed out that the municipality generated, at the time, approximately one thousand tons of waste per month, a number that did not include waste produced in rural areas, still devoid of systematic collection. From the observations made in this study, it was found that, in different urban areas and in the municipal dump, the reduction of the volume of waste usually occurs through the practice of direct burning. This procedure releases large amounts of greenhouse gases, especially carbon dioxide and methane, the latter up to twenty-eight times more potent than CO<sub>2</sub> in its global warming potential.

The scientific literature shows that the increase of these gases in the atmosphere is associated with multiple impacts on human health, such as increased extreme temperatures, intensification of severe weather events, and worsening of respiratory diseases. The WHO estimates that between 7 and 8 million people die annually as a result of air pollution (WHO, 2021), with children, the elderly, and people with previous clinical conditions being the most vulnerable groups. Climate change also has repercussions on the ecological balance, influencing vector population dynamics and expanding the distribution of diseases such as dengue, malaria and leishmaniasis, which find favorable conditions for proliferation in scenarios of intense heat and irregular rainfall.

Another critical element related to waste management is leachate, a highly concentrated liquid that is formed from the decomposition of the organic fraction. The absence of adequate containment and waterproofing systems allows its infiltration into the soil, increasing the risk of contamination of surface layers and groundwater. According to Costa (2021), leachate can carry heavy metals, toxic compounds, protozoa, and parasite eggs, posing a significant threat to human health. Exposure can occur both by consuming water from contaminated aquifers and by eating food grown in affected soils.

Thus, the observed results indicate that the interaction between solid waste, soil, water and atmosphere constitutes a central axis for the understanding of environmental and sanitary impacts in the municipality. The characterization of these processes is essential to support actions aimed at minimizing risks, promoting healthier urban environments, and strengthening preventive strategies based on scientific evidence.

#### **4 FINAL CONSIDERATIONS**

The mapping and identification of irregular solid waste disposal points in the urban area of Chapadinha showed a multifaceted scenario, in which environmental, social and public health factors are intertwined. The analysis of the visited sites revealed that the inadequate disposal of waste predominantly of domestic origin, but also composed of civil construction materials and textiles, occurs recurrently on exposed soil and vegetation, favoring environmental degradation processes and increasing the potential for health risks.

The observations carried out demonstrate that the current management of waste, both at the points distributed throughout the city and at the municipal dump, favors the release of greenhouse gases, the formation of leachate and human exposure to vectors and harmful substances. Such elements, widely documented in the scientific literature, contribute to the worsening of air pollution, soil and groundwater contamination, and increased vulnerability of the most sensitive populations, such as children, the elderly, and people with preexisting clinical conditions.

The results of this study reinforce the understanding that solid waste management is an essential component of environmental health and should be treated as a strategic axis for the promotion of quality of life in urban environments. The detailed characterization of the points of irregular disposal allows subsidizing more effective actions of planning, inspection, environmental education and territorial planning, in addition to guiding public policies aimed at mitigating the socio-environmental impacts identified.

Although this work does not propose to exhaust the theme, its evidence contributes to a broader reading of the problem and points to the need for intersectoral approaches, based

on sustainable practices and continuous monitoring processes. The strengthening of adequate waste management strategies, combined with community participation and integration between educational institutions, civil society and public management, is a promising path for the construction of a more environmentally balanced and socially healthier city.

In summary, the findings presented reaffirm that the efficient management of solid waste is a contemporary challenge of great complexity, whose overcoming requires technical knowledge, environmental sensitivity and collective commitment. The present study seeks to contribute to this process by offering a detailed and grounded diagnosis, capable of supporting decisions and fostering transformative actions in the municipality of Chapadinha.

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