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Evolution of Solid Waste Management in the Context of Environmental Management in the Municipality of Aracati – CE

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ABSTRACT

Solid waste management represents one of the greatest environmental challenges, especially in small and medium-sized municipalities, due to limited financial and structural resources. This study aimed to analyze the evolution of environmental management in the municipality of Aracati, Ceará, with an emphasis on solid waste management. To this end, a bibliographic survey was conducted, consulting official documents, municipal and state legislation, as well as publications from government agencies, with data collected between May 2019 and July 2020. The results indicate that, although Aracati has a significant set of laws and initiatives aimed at environmental protection, including the creation of municipal policies and awareness programs, the effectiveness of these actions is still limited. The municipality does not have a Municipal Solid Waste Plan, does not carry out selective collection, does not have a sanitary landfill, and still uses open dumps as the final destination for waste, in violation of the National Solid Waste Policy (PNRS). Despite regulatory advances between 2017 and 2019, there is a gap between legislation and its practical application, highlighting the need for integrated actions and investments to bring local management into line with established environmental standards.

Keywords: sanitary landfill; selective collection; environmental education; public environmental policies.



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RESUMO

A gestão de resíduos sólidos representa um dos maiores desafios ambientais, especialmente em municípios de pequeno e médio porte, devido à limitação de recursos financeiros e estruturais. Este estudo teve como objetivo analisar a evolução da gestão ambiental no município de Aracati – CE, com ênfase no gerenciamento de resíduos sólidos. Para isso, foi realizado um levantamento bibliográfico, consulta a documentos oficiais, legislações municipais e estaduais, bem como publicações de órgãos governamentais, com coleta de dados entre maio de 2019 e julho de 2020. Os resultados indicam que, embora Aracati possua um conjunto significativo de leis e iniciativas voltadas à proteção ambiental, incluindo a criação de políticas municipais e programas de conscientização, a efetividade dessas ações ainda é limitada. O município não dispõe de Plano Municipal de Resíduos Sólidos, não executa coleta seletiva, não possui aterro sanitário e ainda utiliza lixão a céu aberto como destino final dos resíduos, em desacordo com a Política Nacional de Resíduos Sólidos (PNRS). Apesar de avanços normativos ocorridos entre 2017 e 2019, observa-se uma lacuna entre a legislação e sua aplicação prática, evidenciando a necessidade de ações integradas e investimentos para adequar a gestão local aos padrões ambientais estabelecidos.

Palavras-chave: aterro sanitário; coleta seletiva; educação ambiental; políticas públicas ambientais.

Introduction

In the context of solid waste management, in 2010 the National Solid Waste Policy (PNRS) was instituted through Law No. 12,305/2010, which established a deadline of 2014 for Brazilian municipalities to implement environmentally appropriate final disposal of waste. This policy was designed to be comprehensive, covering the national, state, and municipal levels (Law No. 12,305, of August 2, 2010). However, most small and medium-sized municipalities were unable to meet the established goal, mainly due to limited financial resources. Given this scenario, new deadlines were set, extending until 2024, taking into account the number of inhabitants per municipality, with criminal penalties for municipal managers who did not comply with the requirements (Senate Bill No. 425, 2014; Farias 2018).

The proper management of municipal solid waste is a topic of discussion at the national and international levels, since the incorrect disposal of waste poses serious risks to both the environment and the health of the population. In Brazil, the challenges related to municipal solid waste are most evident in small municipalities, which have structural and financial limitations to implement effective solutions. In this context, waste management is one of the main obstacles faced by municipal managers, considering that contemporary society generates increasingly larger volumes of recyclable and non-recyclable materials, whose improper disposal has significant socio-environmental impacts (Bensen et al. 2010; Farias 2018; Nascimento 2021).

The generation of solid waste is directly related to the population's lifestyle and socioeconomic conditions, factors that increase society's access to consumer goods and, consequently, to the disposal of these products (Rodrigues et al. 2016). This context creates a cycle in which individuals quickly acquire products, which become obsolete in a short period and are discarded, resulting in a continuous increase in solid waste production.

In view of this, the present study is justified by the environmental problems faced in the municipality of Aracati, Ceará, resulting from inadequate solid waste management. Thus, the general objective of this research was to conduct a diagnosis of the evolution of environmental management in the municipality of Aracati, Ceará, with a focus on solid waste management. In this context, the study specifically sought to identify the situation of solid waste collection and final disposal; gather information on solid waste policies in the region; and verify the existence of problems related to solid waste in the municipality. It should be noted that, although the research actions are local, the study is of great regional interest, since all federal entities need to adapt to the National Solid Waste Policy (Law No. 12,305, of August 2, 2010).

Materials and Methods

Study characterization

The work originated from observation and experience with the environmental problems faced by the municipality of Aracati-CE, which are associated with apparent poor solid waste management. To diagnose the impacts resulting from this situation, a bibliographic study was conducted. This research is applied in nature, investigating the problem of solid waste in the region in question. In terms of its objectives, it can be classified as descriptive, since it delves into scientific information to describe events related to the topic in the locality studied, through observation and data analysis. According to Marconi and Lakatos (2003), descriptive research aims to detail a particular phenomenon through empirical and theoretical analysis.

Data collection

This work was carried out by collecting data from academic papers, city hall documents, and government agency publications, accessed mainly through research platforms such as *Google Scholar* and the CAPES Journal Portal, in addition to the official website of the Aracati City Hall.

The collection period extended from May 2019 to July 2020. This survey provided essential knowledge about solid waste management in the municipality. The information collected served as a fundamental basis for discussing the topic in the local context, allowing for a comprehensive understanding of the situation in Aracati in this area. The entire analysis was conducted considering the guidelines and standards established by the National Solid Waste Policy (PNRS) - Law No. 12,305/2010.

Results and Discussion

Aracati is a municipality in the state of Ceará, Brazil, founded on April 11, 1747. It is located 150 km from the capital of Ceará, Fortaleza. Its urban center, the seat of the municipality, was listed in 2000 as a national heritage site by the National Institute of Historic and Artistic Heritage. Area: 1,229 km² and Population: 74,975 (IBGE 2010).

The municipality of Aracati is located in the eastern region of the state of Ceará. The first records of the region date back to 1603, when the fort of São Lourenço was built, a settlement built on a vast plain on the right bank of the Jaguaribe River (Figure 1), which was elevated to city status only in 1842 (Aracati City Hall 2000).

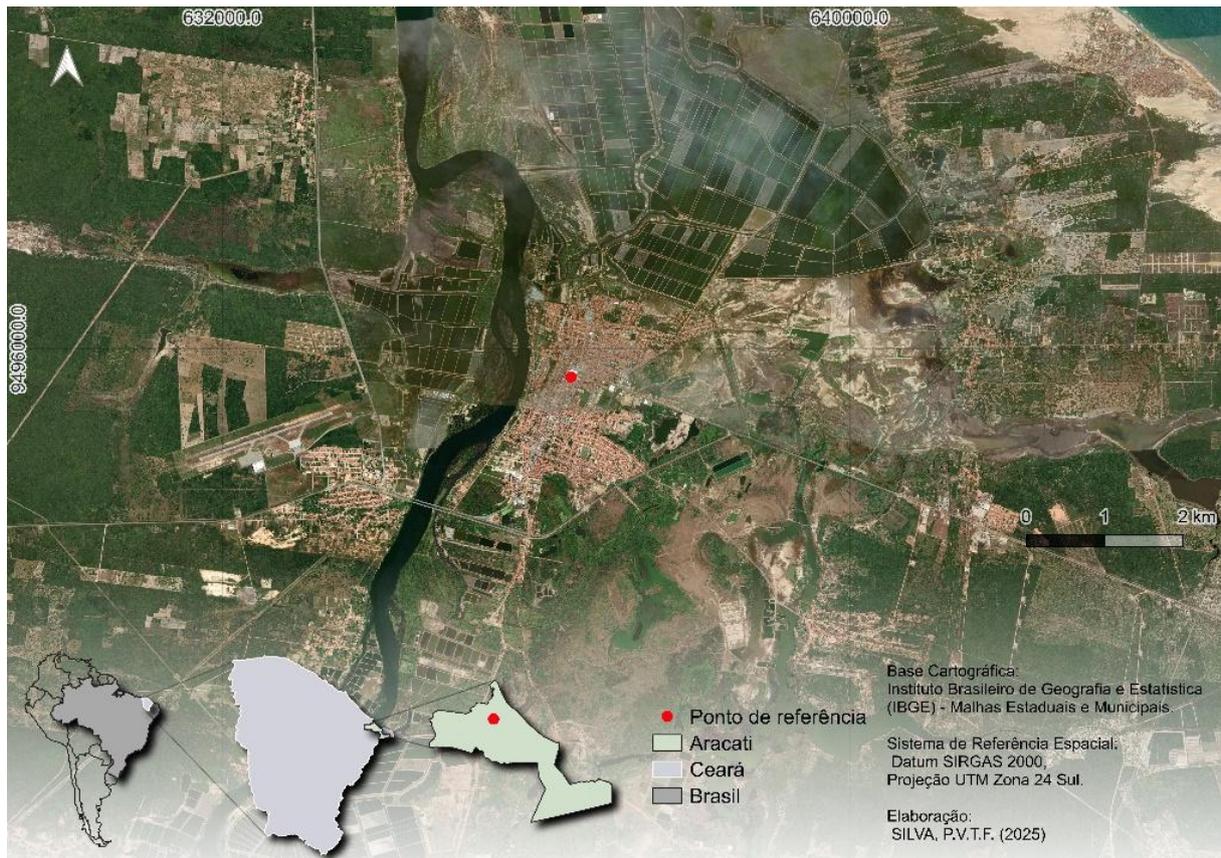


Figure 1. View of the location of the municipality of Aracati-CE. Source: Silva, P.V.T.F. (2025).

According to data provided by the city government, the municipality is an economic hub for services, with more than 3,000 commercial establishments, notable for its production of shrimp farming and fish, and in 2015 it was among the three municipalities that generated the most jobs in Ceará. Its main access routes are the BR 304 highway, connecting the state capital of Ceará to Mossoró, in Rio Grande do Norte, as well as the BR 116 and CE 040 highways, which provide access to the municipalities of Itaiçaba and Fortim, as well as other municipalities on the east coast in the direction of Fortaleza (Dantas 2003).

The importance of the municipality of Aracati to the state of Ceará dates back to the early 18th century, when beef jerky factories set up in the Jaguaribe River estuary boosted the local economy. Aracati remained for a long time a center for beef production and trade, becoming one of the most influential locations in the state's economic, social, and political processes, even competing with the capital of the time in the context of the captaincies. After its golden age, the beef jerky factories went into decline, driven by a severe drought and competition from producers who adopted more technological methods.

This scenario led to cotton cultivation gaining prominence in the regional economy. At the same time, the port of Aracati, once vital to the city, failed to modernize. With the advent of steamships around 1860, its shallow draft became an insurmountable obstacle, leading to its obsolescence. The combination of these factors, the end of the beef jerky cycle, the port's lack of competitiveness, and economic stagnation condemned Aracati to a long period of decline. Currently, the municipality's main economic activities in the industrial sector are the processing of tropical fruits, the production of ceramics, and the extraction of carnauba wax. In the agricultural sector, the main crops are melons, corn, watermelons, beans, coconuts, and cashews.

In 1955, the municipality underwent a territorial division, consisting of seven districts: Aracati (headquarters), Barreiras dos Vianas, Cabreiro, Córrego dos Fernandes, Jirau, Mata Fresca, and Santa Teresa.



Concerns about the environment began in the 1990s in the municipality of Aracati, when one of the first environmental protection laws was created, Law No. 06/97, which established Environment Week (Municipal Law No. 06/97 1997). The following year, Law No. 056/98, which established public cleaning measures and other provisions, classified the disposal of paper, cans, and waste of any kind outside of appropriate containers, such as sidewalks and squares, as well as on public land, whether inhabited or not, as harmful acts. The aforementioned law also prohibited littering public roads due to construction or deforestation and dumping waste of any kind in streams, lakes, and creeks in a manner that causes damage to the environment, subject to penalties (Municipal Law No. 056/98 1998).

The aforementioned law also proposed strategies for its implementation, such as the development of cleaning programs, such as cleaning days in the municipality, as well as information programs on recyclable and biodegradable materials, visiting schools, and promoting educational campaigns on the subject.

A few years later, Law No. 01/2009 was created. One of the principles of this law establishes the city's socio-environmental functions, among which is the pursuit of environmental preservation and conservation, ensuring the protection of existing ecosystems and environmental resources, seeking an ecologically balanced environment, as well as sustainable development, with rational use of natural resources, so that they are available to present and future generations (Complementary Municipal Law No. 01/2009 2009).

Among the objectives listed in Article 5 of the aforementioned law are the preservation of ecosystems and natural resources, as well as the promotion of basic sanitation in its different aspects, reducing urban and environmental risks. The guidelines for promoting this sanitation are described in Article 32, including ensuring selective waste collection and urban cleaning, encouraging the recycling of solid urban waste.

Although there are important laws that guarantee environmental protection, the reality of the municipality of Aracati in 2013 was far from this ideal. At the request of the local District Attorney's Office, the Technical Support Center (NAT) conducted a Technical Inspection Report that found a critical situation in solid waste management. The document attested that the management was totally inadequate: the final destination of both domestic and hospital waste was an open-air dump.

The report also highlighted the absence of selective collection and the inactivity of the association of recyclable material collectors. Another serious problem identified was irregular waste collection, which did not cover all districts of the municipality. These failures clearly demonstrated the lack of a specific and effective Integrated Solid Waste Management Plan, even though the municipality already had a Municipal Basic Sanitation Plan, which, at the time, was in need of revision.

Many of the socio-environmental problems identified in this report continue to this day. In 2021, the final destination of waste was still the landfill, the municipality still did not have selective collection, and the waste pickers' association had been dissolved. It is important to emphasize that the development of Municipal Plans for Integrated Solid Waste Management (PGIRS) is a necessary condition for the Federal District and municipalities to have access to federal funds for urban cleaning and waste management (Silva and Silva 2015).

The financial difficulties and fragile management of most Brazilian municipalities in solving problems related to solid waste have created an opportunity for cities to organize collectively to develop intermunicipal plans for integrated solid waste management (Silva and Silva 2015). The Association of Municipalities of the State of Ceará, represented by its president, Expedito José do Nascimento, made statements to the *Diário do Nordeste* newspaper in 2015, saying that there was not a single small or medium-sized municipality in Ceará that was able to develop its own management plan and build a landfill on its own.

In the context of this problem, Decree No. 7404/2010 states in Article 52 that municipalities that opt for intermunicipal consortium solutions for solid waste management are exempt from preparing a municipal



integrated solid waste management plan, provided that the intermunicipal plan meets the minimum requirements set forth in Article 19 of Law No. 12,305 of 2010 (Secretary of the Environment of Ceará 2012).

Knowing that one of the objectives of this Plan is to eliminate dumps, replacing them with sanitary landfills, one of the actions of the 2018 Multi-Year Plan of Aracati is to install, with the State Government, a Regional Sanitary Landfill in partnership with the municipalities of Fortim, Itaiçaba, Icapuí, and Beberibe, which was amended by Law No. 449 of July 8, 2019, which discusses the Contract for the Constitution of the Intermunicipal Consortium for Integrated Management of Solid Waste Landfills, but specifically the amendment to this contract entered into between the municipalities of Beberibe, Cascavel, Pindoretama, and Aracati (Municipal Law No.º 449/2019 2019). It should be noted that this construction has not yet been implemented as of 2025.

The most recent environmental legislation in the city began on October 18, 2017, with the creation of the Aracati Institute for Quality and the Environment (IQUAMA), through Law No. 006/2017, with the objective of carrying out environmental quality control activities through licensing, inspection, and monitoring of the environment and as a way to encourage compliance with environmental laws. Law No. 344/2017 created the Environmental Quality Certificate-Aracati Green Seal, which can be granted to establishments that adopt measures for the preservation, protection, and recovery of the environment in their activities, as well as develop actions aimed at the sustainable development of the municipality (Municipal Law No.º 344/2017 2017; Municipal Law No. 006/2017 2017).

The same Law, in its Article 4, lists the requirements for obtaining this Seal, among which are compliance with environmental laws at the national, state, and municipal levels; maintaining selective waste collection; and developing programs to encourage environmental preservation.

In 2019, Complementary Law No. 017/2019 established the Municipal Urban and Environmental Control System of Aracati, composed of IQUAMA; the Aracati Environment Secretariat; the Aracati Municipal Environment Council; and the Aracati Infrastructure and Urban Development Secretariat. Article 3 of the aforementioned Law states that its purpose is to combine the efforts, resources, and strategies of the Municipal Government and the different spheres of the Brazilian Federation, private companies and organizations, international bodies, and society in general, for the preservation, conservation, improvement, and recovery of environmental quality conducive to life, aiming to ensure conditions for economic, social, and environmental development for the inhabitants of Aracati, with a focus on the protection and integration of the natural and built environments (Complementary Law No.º 017/2019 2019).

The aforementioned Law, in its Article 4, lists the objectives, of which item I stands out: to reconcile the economic and social development of the municipality with the preservation of the natural and built environment, and item II: to encourage the adoption of attitudes, customs, behaviors, and social and economic practices that protect, preserve, defend, conserve, and restore the environment.

In 2019, a program for the selective collection of electronic and technological waste was also created in the municipality of Aracati, through Law No. 423/2019, consisting of organizing, scheduling, collecting, transporting, and correctly disposing of this waste. Article 2 of the aforementioned law defines electronic waste as material generated from the improper disposal of electronic materials, such as computers and cell phones. In order to dispose of this waste properly, it must be placed in an appropriate environment provided by the Executive Branch (Municipal Law No.º 423/2019 2019).

The objectives of this program are listed in Article 3 of the aforementioned law, among which is raising awareness of the risks to health and the environment when waste is disposed of incorrectly, encouraging the



population to dispose of waste correctly through awareness campaigns to comply with the law as described in Article 6.

In 2019, the environment was a major focus in the municipality of Aracati, with the creation of several environmental protection laws that emphasize care for the natural environment, pollution reduction, and public awareness with incentives for the collection and proper disposal of different types of waste, as can be seen in the laws mentioned above. It is believed that the creation of IQUAMA contributed to these actions and also due to the deadline given to municipalities in Ceará to comply with the PNRS, which is about to expire, other bills were created, which will be discussed below.

In May 2019, Law No. 439/2019 was created, which requires bars, restaurants, snack bars, beach huts, street vendors, and similar establishments authorized by the city to use and supply biodegradable and/or recyclable paper straws individually and hermetically packaged with similar material, with fines for violations. street vendors, and similar establishments authorized by the city to use and provide biodegradable and/or recyclable paper straws individually and hermetically packaged with similar material, with fines for violations of the law (Municipal Law No. 439/2019 2019). This bill was conceived by the Chamber of Deputies amid ongoing discussions about the growth of ocean waste, especially that prohibited by the law, and the damage caused to marine life, considering the initiative relevant to the municipality, given its coastal location and prominence as a tourist destination. This law came into force on January 1, 2020.

In July 2019, Law No. 446/2019 instituted the Municipal Environmental Policy of Aracati, establishing principles and setting objectives and basic standards for environmental protection and improvement of the population's quality of life, based on articles 23, items VI and VII; 30, items I and II; and 225 of the Federal Constitution; Law No. 6938/1981 (Municipal Law No. 446/2019 2019).

This Policy addresses the issue of solid waste in several instances, beginning with the objectives, when in its Article 7, emphasizes in item XXVI the incentive and guarantee of integrated solid waste management, with the implementation and maintenance of selective collection and promotion of recycling with sectoral agreements for reverse logistics, prioritizing the economic and social inclusion of recyclable material collectors. Thus, among the instruments of the aforementioned law, Article 11, item IX establishes the implementation of the Municipal Integrated Solid Waste Management Plan, seeking consistency with the PNRS.

Article 12 of the aforementioned law also establishes the Municipal Solid Waste Plan as a guideline and creates, in its Article 48, the Environmental Sustainability Certification Program for public and private enterprises in the municipality, with the purpose of encouraging more sustainable practices with regard to the waste generated, whether solid, liquid, or gaseous, its treatment and/or reuse, the efficiency of the construction materials used in the enterprise, and water and energy consumption.

It is known that in order to implement bills, financial capital is needed. With this in mind, in July 2019, Law No. 447 created the Municipal Environment Fund, with the purpose, in its Article 3, raising funds for the development of Environmental Education programs, the recovery of degraded environments, and the preservation of areas of ecological interest, including the financing of activities such as Environmental Education and the promotion of scientific research, with a view to raising public awareness of the need to protect, conserve, preserve, and recover the environment (Municipal Law No. 447/2019 2019).

In summary, all the information collected shows that although the municipality has legislation that supports a balanced environment, with actions to encourage sustainable development, it is still not in compliance with the PNRS, given the lack of a Municipal Solid Waste Plan and Urban Solid Waste Management Plan in the municipality, even though these are provided for in the municipal legislation itself (), and it does not have a sanitary landfill, although there have been municipal laws aimed at its construction



since 2018, sending domestic and pharmaceutical waste to the dump and without any practical initiative for recycling, even though this is present in the legislation.

This shows that the municipal reality in Aracati, in relation to solid waste management, is not encouraging and warrants attention, as the PNRS deadlines are ending and the municipality, although it has created laws that seek to comply with the National Solid Waste Policy, still does not meet the specifications of that law, requiring rapid and viable actions to contain the advance of waste and its consequences for the population and the environment.

Conclusions

In view of the above, it was found that concerns about environmental management in the municipality of Aracati are not recent, but have existed since the 1990s, with the creation of the first laws aimed at environmental care. Over the years, municipal legislation has been implemented to promote compliance with state and federal laws, since, according to an inspection requested by the Public Prosecutor's Office of the District of Aracati, the municipality was found to be inadequate in terms of solid waste management issues. To resolve this issue, several laws were created between 2017 and 2019, aiming to promote this compliance, and a Municipal Environmental Policy was also developed.

In general, the municipality has legislation that supports a balanced environment. However, these laws have not been effectively implemented, and the municipality is still not in compliance with the National Solid Waste Policy, as it does not meet its specifications, such as the failure to develop a Municipal Solid Waste Plan and an Urban Solid Waste Management Plan; no selective collection; no practical recycling initiative and no sanitary landfill, still using a dump; also, in all surveys conducted, no specific Solid Waste and Environmental Education policy for rural areas was identified.

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