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Diagnosis of solid waste management and characterization of collected waste and its cycle in Queimadas, PB, Brazil

Diagnóstico do gerenciamento de resíduos sólidos e caracterização dos resíduos coletados e de seu ciclo em Queimadas, PB, Brasil

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Abstract

Brazil has two federal policies that address solid waste management, the National Basic Sanitation and Solid Waste Policies, legal objects aimed at sustainability still neglected by Brazilian society. In this work, we aimed to characterize urban cleaning and solid waste management in Queimadas, PB, and the adequacy of services to what public policies require. The work was divided into the phases of questionnaire application with the residues manager, field visits to capture data and images, assessing the services related to MSW and the most evident impacts due to system failures, and characterization of collected MSW. The main failures identified were the lack of treatment of the collected MSW (about 29 tons/day) and its deposition in the dump area that had been operated for 20 years. On the plus side, waste management of heath services and construction has been done properly. More than 2/3 of MSW, according gravimetric composition, should receive other destination such as reuse and recycling, bringing several environmental benefits. Potentially noteworthy is the participation of Queimadas as a member of Consortium, because national policies in this area highlight the priority for consortium resource allocation. Queimadas MSW management needs services related to the selective collection and environmentally appropriate final disposal of these.

Keywords: Municipal solid waste, MSW management, Gravimetric composition, Waste cycle.

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Resumo

O Brasil possui duas políticas federais que tratam do gerenciamento de resíduos sólidos, as Políticas Nacionais de Saneamento Básico e de Resíduos Sólidos, objetos legais voltados à sustentabilidade ainda negligenciados pela sociedade brasileira. Neste trabalho, objetivamos caracterizar a limpeza urbana e o gerenciamento de resíduos sólidos em Queimadas, PB, e a adequação dos serviços ao exigido pelas políticas públicas. O trabalho foi dividido nas fases de aplicação do questionário com o gestor de resíduos, visitas de campo para captura de dados e imagens, avaliação dos serviços relacionados aos RSU e dos impactos mais evidentes devido a falhas no sistema e caracterização dos RSU coletados. As principais falhas identificadas foram a falta de tratamento dos RSU coletados (cerca de 29 toneladas/dia) e sua deposição na área de lixão, em operação há 20 anos. No lado positivo, os gerenciamentos de resíduos de serviços de saúde e de construção são feitos corretamente. Mais de 2/3 dos RSU, de acordo com a composição gravimétrica, devem receber outro destino, como reutilização e reciclagem, trazendo vários benefícios ambientais. Potencialidade digna de nota é a participação de Queimadas como membro de Consórcio, porque as políticas nacionais nessa área destacam a prioridade para a alocação de recursos para consórcios. A gestão de RSU de Queimadas precisa de serviços relacionados à coleta seletiva e disposição final ambientalmente adequada.

Palavras-chave: Resíduos sólidos urbanos, Gestão de RSU, Composição gravimétrica, Ciclo de resíduos.

1 Introduction

The problem of municipal solid waste (MSW) is admittedly difficult to solve among the actions of environmental sanitation, more precisely basic sanitation, especially in developing countries such as Brazil (Queiroz et al., 2016; Abdel-Shafy and Mansour, 2018; Drudi et al., 2019; Idowu et al., 2019; Khair et al., 2019). In these countries, the environment is directly affected by the irrationality with which humans treat soil, water and air, polluting them and thus causing degradation that triggers various social and economic impacts, threatening sustainability (Wang et al., 2018; Idowu et al., 2019; Lunag Jr et al., 2019).

In Brazil, constitutionally, it is the responsibility of the local government to manage the solid waste produced in their cities (IBGE, 2008). Federal Law No. 12,305 of August 2, 2010, instituted the National Policy on Solid Waste (NPSW) which, as provided in its article 4, principles, objectives, instruments, guidelines, goals and actions directed to the integrated management of solid waste by the Union and federated entities (Brasil, 2010). Not far away, the National Basic Sanitation Policy (NBSP) was instituted by Federal Law No. 11,445 of January 5, 2007, which, among others, "establishes national guidelines for basic sanitation" and defines basic sanitation as "the services, infrastructures and operational facilities for drinking water supply, sanitary sewage, urban cleaning and solid waste management and urban rainwater drainage and management" (Brasil, 2007). The legal basis for urban cleaning and solid waste management is given in two prominent federal policies. Applying these stricter legal provisions would certainly greatly improve the country's infrastructure situation. According to Lima et al. (2019), many opportunities for environmental, social and economic improvements are missed, a fact that goes against the breadth of national policies.

The accelerated population growth and the ever increasing degree of urbanization, seen in present scenarios and, especially, projected in future scenarios, are serious aggravating factors (Cherubini et al., 2009; Chong et al., 2016).

Producing solid waste (SW) is an inevitable activity characterized by the extraction of raw material to produce material goods that, after being used, are almost always discarded without any previous treatment, generating more environmental impacts (Ali et al., 2017; Chen, 2019). This production only increases, given the increasing demand by the people, who still treat the environment as an inexhaustible source of raw material and without limits

of capacity and resistance to waste storage (Wang et al., 2018; Stefania et al., 2019; Zbib and Wøhlk, 2019).

According to the annual survey by the Brazilian Association of Public Cleaning and Waste Companies (ABRELPE), the generation of municipal solid waste (MSW) in Brazil again registered a decrease from 2015 to 2016 (-2%), surpassing the urban population growth rate that was about 0.8% in the period (ABRELPE, 2018). During this period, per capita generation of MSW fell 2.9%, according to such a survey. This is encouraging because it reverses the line of previous years, which is certainly due to advertising campaigns and educational practices that encourage reduction, something proposed as a main tool in several countries (Chong et al., 2016; Malinauskaite et al., 2017; Moreira et al., 2018; Silvennoinen et al., 2019).

There are several related problems, because it is still far from Brazil to have selective collection, treatment and final disposal environmentally appropriate in its municipalities, as required by public policies (IBGE, 2017; ABRELPE, 2018; Gill et al., 2019)

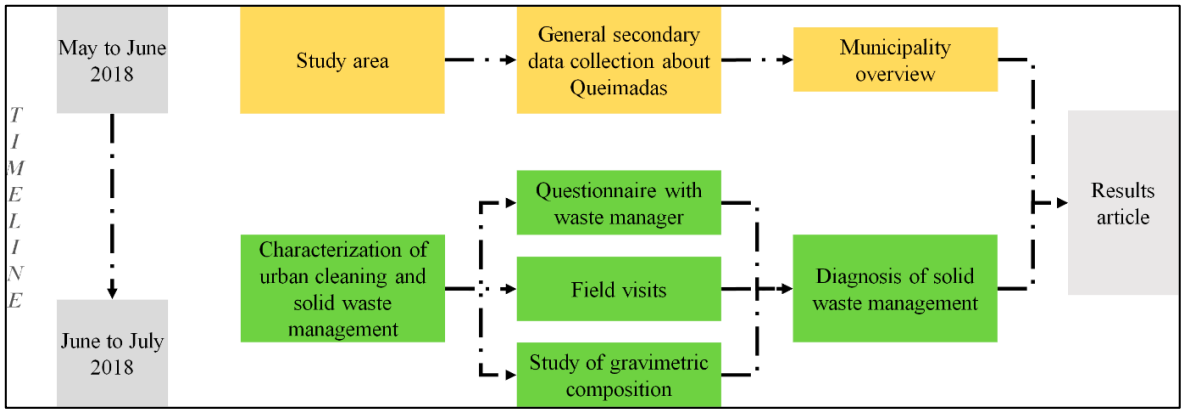
A worrying fact is that, according to IBGE (2018), almost half of Brazilian municipalities do not even have a Municipal Plan for Integrated Solid Waste Management (MPISWM), one of the important planning tools provided for in NPSW. In the Northeast, only 36.3% of the municipalities have these plans. In another analysis, the fact that these plans can be replaced by the Municipal Basic Sanitation Plans (MBSP), an instrument of the NBSP, since urban cleaning and solid waste management represent one of the components of basic sanitation, it does not interfere substantially in solving the problem of lack of planning, as few municipalities rely on this strategic document. These data reflect the lack of government planning in the sector, as MPISWM itself establishes municipal plans as one of the main tools for solid waste management.

Based on the importance previously described for the waste management, the objective of this work was to characterize urban cleaning and solid waste management in the city of Queimadas and the adequacy of services, facilities and infrastructure to the requirements of national solid waste and sanitation policies. Obtaining the necessary information for planning, as there is a lack of accurate information on the subject, as well as the publication of effective one-off actions to solve problems of this area can directly and indirectly help in solving environmental problems in the region.

2 Methodology

This work was developed between May and July 2018, during which period the aspects of integrated solid waste management and their changes were studied. The work flowchart is shown in Figure 1.

Figure 1 – Work flowchart.

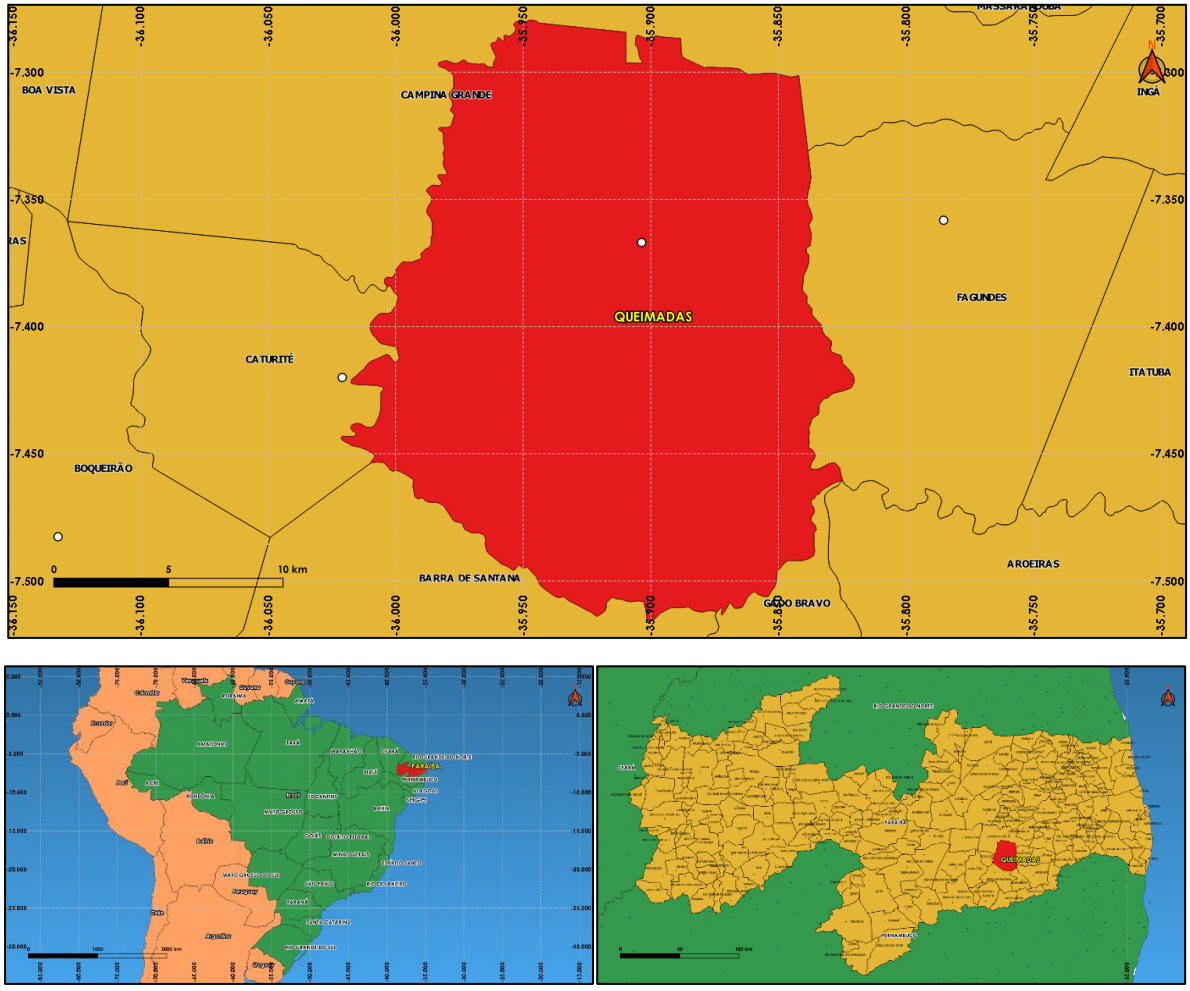


2.1. Study area

The Municipality of Queimadas is located in the Agreste mesoregion and Campina Grande microregion, of Paraíba state, Campina Grande Metropolitan Region. Its area is 409.196 km^2, representing 0.725% of the state, 0.0263% of the Northeast region and 0.0048% of the entire Brazilian territory. This is part of the Paraíba River watershed, the Middle Paraíba sub-basin. With headquarters at the coordinates 07°21'28"S and 35°53'52"W (Figure 2), 146 km from the capital, it has as its neighbors Barra de Santana (22.6 km) and Gado Bravo (39.1 km), South; Campina Grande (18 km) to the north; Aroeiras (40 km) and Fagundes (17.8 km) to the east; Cabaceiras (16 km) to the west. Administratively, this one has its headquarters and a district called “Ligeiro” as divisions of urban denominated areas.

(Continue...)

Figure 2 – Location of Queimadas, Paraíba, Brazil



According to the Brazilian Institute of Geography and Statistics (IBGE), by the Census 2000 and 2010, the municipality of Queimadas had population numbers of respectively 36,032 and 41,054 inhabitants (inhab.), with 22,249 (54.2%) living in the urban area. and 18,805 (45.8%) domiciled in rural areas. For 2018 and 2019, it was estimated, respectively, 43,917 and 43,967 inhabitants. Queimadas has 12,512 families distributed in 12,511 domiciles, of which 12,421 (99.28%) are built of brick, 82 (0.65%) of coated mud, 6 of uncoated mud (0.05%) and 2 of materials used (0.02%) according to Primary Care Information System (SIAB) (2019).

The municipal human development index (HDI-M) of Queimadas is 0.608, occupying the 3,962 position in Brazil, with values of 0.578 for income, 0.796 for health and 0.489 for education (ADHB, 2013).

The economy of the Municipality revolves around the service sectors, responsible for 54.5%, industry, with 36.83%, and agriculture, with 8.67%. Budgetary revenues and expenses are, respectively, R$ 92,727,230 and R$ 83,188,320, showing a surplus of R$ 9,538,910 (11.47%) (IBGE, 2019). Its gross domestic product (GDP), for the last year of 2016, was R$ 439,351,660, being R$ 9,997.76 the GDP per capita.

The Municipality is included in the geographical area of coverage of the Brazilian semiarid. This delimitation has as criteria the rainfall index, the aridity index and the risk of drought. Its climate is characteristically tropical semi-arid, with rainy season in summer. The rainy season begins in November and extends to March, when in the normal rainy season (Beltrão et al., 2005). According to Paraiba State Water Management Executive Agency (AESA) (2019), it has an average annual rainfall of 800 mm.

Queimadas is inserted in the geoenvironmental unit of the Country Depression, with very undulating relief, narrow valleys and dissected slopes, part of which falls in the Planalto da Borborema unit. The altitudes of the unit vary from 300 to 700 meters, and the average altitude in its headquarters is given by 450 m. Regarding soils, according to Beltrão et al. (2005), these are predominantly of medium natural fertility.

The vegetation is composed of deciduous forest and, predominantly, caatinga – biome of the northeast region, being of the Hyperxerophilous type. Regarding the use and vegetation cover, this municipality includes areas such as an anthropism area, covering almost the entire territory, with small stretches of open arboreal caatinga and closed arboreal caatinga. Land use capacity classes in the Burnt territory are characterized by: uncultivated land with severe limitations for permanent crops and reforestation; steep lands more susceptible to erosion, suitable for continuous cultivation and more suitable for sporadic farming; land suitable for permanent crops mainly grazing or reforestation; regular land, which may be cultivated without erosion risk provided that terrace or strip-planting agronomic practices are employed; and uncultivated land with severe limitations for permanent crops and reforestation; land suitable for permanent crops and reforestation (AESA, 2019). Also according to AESA (2019), its territorial domain is divided into "non-arable land", "arable land of restricted aptitude for irrigated agriculture" and "special use arable land".

According to IBGE reports, the fauna has endangered species which are: Northeast duckling (Platyrinchus mystaceus niveigularis) and brown piccolo (Schiffornis turdinus intermedius), such as birds, and giant anteater (Myrmecophaga tridactyla).

Regarding water resources, according to IBGE, as previously mentioned, Queimadas has as its main tributaries the Bodocongó, Paraibinha and Boa Vista rivers and the Curimatã stream, all with intermittent flow regime and the drainage pattern is the dendritic. The surface water potential follows the characteristic of much of the region, is low, having as its main body of accumulation the Campo do Boi weir and the municipality, which has the Boqueirão water mains, is in rationing water supply. Groundwater, according to Beltrão et al. (2005), this has 128 registered tubular wells, 13 public (10%) and 115 private (90%) wells, and only seven have their supply purpose defined, in this case, 6 as "community service" and 1 as "community service". 74 were in operation, 36 paralyzed, 12 not installed and 6 abandoned, with a predominance of 54% for use in desedentation and hydration of animals, 40% for secondary or general use, 4% for primary domestic use and 2% for agriculture, which must be because 26% of the wells evaluated have brackish water and 74% have fresh water.

2.2. Characterization of urban cleaning and solid waste management

A specific questionnaire was prepared and submitted on the theme of urban cleaning and solid waste management, containing objective questions, with openness for comments when necessary, to those responsible for the services to characterize what system operated and identify failures and potentialities.

To assist in this characterization, an in-depth field survey in the areas where the basic units of the system are allocated was made with the capture of images and observation of the most evident management and environmental problems.

With all the information and materials obtained, the diagnosis was systematically elaborated, thus making the solid waste management of the municipality well characterized. The waste cycle in Queimadas was also traced.

2.3. Study of gravimetric composition

The gravimetric composition was studied based on the methodology established by the Brazilian Technical Standard (NBR) 10007 of 2004, of the Brazilian Association of

Technical Standards (ABNT), "Sampling of solid waste", being the method widely referred to as “quartering” (ABNT, 2004).

Were considered as fractions of residues for the study: Putrescible organic matter: food and animal or vegetable waste; Paper; Cardboard; Malleable plastic: plastic bags and films; Rigid plastic: sturdier plastic utensils; Pet: containers or bottles of water, sodas, juices and cleaning products; Glass; Ferrous metals: Identified by a magnet; Aluminum: beverage, food and kitchenware cans; Long life: packaging with layers of paper, metals and plastics; Wood; Rubber; Stryrofoam; Textiles; Soils and the like: public cleaning waste; Others: waste without the possibility of separation or identification.

To determine the percentage index of each fraction of the residues, (1) was used.

$$Fraction_{(\%)} = \frac{Fraction\ mass}{Sum\ of\ the\ masses\ of\ all\ fractions}\ x\ 100\%$$

In equation 1, the mass of the fraction and the sum of the masses of all fractions are given in kg.

3 Results and discussion

3.1. Urban cleaning and solid waste management

Queimadas is in an interesting position to regulate public policies aimed at this area, as it already has the Municipal Plans for Basic Sanitation and Integrated Solid Waste Management. It is also noteworthy that this Municipality is part of the Intermunicipal Consortium for Solid Waste Management of the Eastern Cariri and Region (CIGRESCOR) which already had its Intermunicipal Plan for Integrated Solid Waste Management prepared and approved in 2017. However, even with these strategic management documents, in practice deployment is timely and slow.

Services related to municipal solid waste are divided into two groups of services that suggestively come together under the title: urban cleaning and solid waste management. All activities are performed by employees linked to the Municipal Infrastructure Secretariat.

In urban cleaning or street cleaning, the main services performed are: sweeping; weeding; mowing; tree pruning; cleaning and maintenance of gutters and curbs, squares and fairs and events; corrective supervision and cleaning of vacant lots; and miscellaneous waste removal services. With regard to solid waste management, the actions taken are: conditioning; conventional collection; transport; and final deposition.

3.1.1. Sweeping

The sweeping performed in the Municipality is manual, ie, brooms, shovels to collect and mobile collectors are used to transport the material that was swept and collected to specific points of bulk collection. In periods such as after rainy days, when higher volumes of sediment are accumulated in asphalt pavement, especially on the BR-104 highway within the urban perimeter, mechanized sweeping is done. Every day of the week there are teams from the municipalities doing the sweeping of public places, that is, they have 7 days a week with sweeping, when in normal regime. Free markets and other sporadic events are examples of situations that increase the production of solid waste and require increased services.

It is stated that there is planning, even without defining specific criteria and supervising the execution of services. The staff perform the services the way they all sweep up, collect and transport solid waste.

According to the City Hall, through the monitoring of human resources and remuneration, as well as information from the Paraíba State Court of Auditors (TCE-PB), through the Company Resource Management Monitoring System (SAGRES), the Municipality names the function of the staff responsible for the sweeping service as sweeper. There are 17 sweepers, with 15 staff and 2 exceptionally hired, with the average remuneration above one minimum wage in force (R$ 2,121.58) being informed, resulting in R$ 42,431.69 per month and R$ 551,611.97 per year, considering the 12 months and the 13th salary only, without tax and employer obligations (SAGRES, 2018).

It is worth noting that wages are not the only sweeping costs, as personal protective equipment (PPE) and tools are required to perform the work.

Regarding tools, brooms and shovels are, as one would not expect otherwise, suitable for services, being the only inadequacy found, in some isolated moments, the type of pushcart, when the mobile collector is not used, because they are construction type and have no capacity and form for the transport of MSW. With regard to PPE, it was reported that there were already the use of uniforms, steel toe boots, leather shaving gloves, hat, mask and sunscreen, as well as, in some cases, glasses.

The secretariat responsible for waste management ensures the availability of a complete kit annually for each sweeping employee, containing tools (mobile waste collector, 40 cm broom and shovel), costing R$ 390.05, and EPI (overalls, boots, gloves, hat, glasses, masks and sunscreen), with a cost of R$ 455,43. Therefore, R$ 14,373.16 is spent per year in total.

The sum that informs the annual amount released by the City Hall with sweeping is R$ 565,985.13.

The waste generated at this stage is called public cleaning waste (PCW) and is a fraction of MSW. The per capita production of PCW, according to the Paraíba State Solid Waste Plan (PSSWP) Paraíba (2014), is 0.09 kilograms per inhabitant daily (kg/inhab.day), which, comparing with the population 2018 This is equivalent to 3,952.53 kg/day or 1,442,673.45 kg/year and from 2019 to 3,957.03 kg/day or 1,444,315.95 kg/year.

No proportionality can be given between the amount of PCW generated and the amount spent on sweeping services, because regardless of how large or not these people would be acting for a demand dependent on the number and extensions of the Municipalities. Still, for information purposes we have an average spending of approximately R$ 0.40 per kilogram of PCW.

Sweeping is performed in 100% of public places, considering that it is neglected to perform in those without paving, of course.

3.1.2. Weeding, mowing, pruning and other urban cleaning services

Weeding, mowing and tree pruning services are routinely performed in the Municipality, with priority locations defined upon request by necessity identified by an official of the City Hall or the population itself.

The ownership of these services is the responsibility of the City Hall, bearing the costs of hiring specialized personnel or relocating employees to these services, being the type of manual performance for all.

There are four weeding and four brushcutters, which also have the function of pruning trees. Eight employees have a minimum cost of R$ 9,158.40/month or R$ 119,059.20/year.

It is stated that the same weeding and mowing staff have responsibility for this service, as well as other more diverse functions related to basic sanitation, since the demand is not high due to the following factors: reduced length of the streets that demand the service, low afforestation rate, residents make or hire the services at their expense.

The use of PPE when weeding, mowing and / or pruning exists, but some do not use it or use it insufficiently. The staff uses hoes, machetes and scissors for the above tasks.

Regarding the cleaning of vacant land and the occurrence of waste accumulation by the city, only one case was identified, which allows us to affirm the effectiveness of the inspection.

There are also, in urban cleaning, the cleaning and painting of gutters and curbs and cleaning of “wolf mouths”, performed mainly in the days before the relevant events in the city and in the rainy season, respectively.

The PPE when used by employees of these activities, bring evidence of the preparation of the team, aware of the risk of occupational accidents, acceptance of what was spent in training and supervision of activities.

With few shortcomings identified, it is ensured by the person in charge that there is planning and that the execution of these services is regularly supervised.

3.1.3. Collect

3.1.3.1. MSW Collection

The collection of MSW is an indispensable work and responsibility of the municipal government, but needs, for the proper functioning, the responsible participation of the population, which must be properly packaged and disposed of at a pre-determined place and time by those responsible for the collection. .

MSW collection activities are done in a conventional way, door to door. It is noteworthy that the Municipality hired the specialized company and outsourced the service, giving it the right to collect MSW in its territory, in the places where the service serves.

Regarding the frequency of collection services in the Municipality, it is ensured that the staff of the holder collects MSW from public places 6 (six) days a week, ensuring 100% of the urban population, the district and isolated urban settlements.

Some rural areas that do not receive the collection service as often as the urban area, but still receive, with over 90% of the total population of Queimadas this coverage. In these locations the collection is made two days per week, where the waste are deposited by the population at predetermined points for this purpose (voluntary delivery points (VDP)), bringing several health, environmental and social problems, when deposited after the deadlines, as residents say uncomfortable with this unusual situation. The imbalance is due to the geographical arrangement and lack of understanding of the need.

The municipal management clearly assures that there is planning and supervision of the execution of the services, but there is no documentation to prove such statement.

The way the collection services are performed has the aspect of using a low speed motor vehicle, compacting truck, one being designated as a driver and the others as collectors.

A monthly expense of R$ 122,626.40 is claimed with collection, since the contracted company has trucks of varied body, because, besides the MSW, also works with the collection and transportation of other miscellaneous and bulky materials (SAGRES, 2018).

The packaging of residues characterized as household waste, which may be from commercial establishments, is done correctly. Most and especially those of smaller volumes are placed in plastic bags, while those of larger volumes are placed in reusable plastic or rubber containers. This practice happens often in commercial establishments that deposit the residues produced in it, so that the employee of the collect deposit the contents of the collector's body and return it to the place found. In a few cases storage – a factor that increases the speed and quality of collection services – is done in the cardboard containers themselves, which are also recyclable waste.

It is appropriate to point out that the holder does not have in the wages and fuel the only costs with collection, since personal protective equipment is necessary to perform the work, as well as the maintenance of the priceless vehicle. Paying R$ 122,626.40/month, it is calculated, multiplying by 12 months of activity and contract, a cost of R$ 1,471,516/year.

For PPE, the situation is the same as sweeping: rare cases without the use of uniforms, steel toe boots, leather shaving gloves, hat, mask or sunscreen, as well as for some glasses (something less used in this service), but the information was that they were requiring suitability. The guarantee was one full PPE kit per year for each MSW collection employee.

Estimating costs for collection is simplified and is based on urban and other locations, the number of days collected, the average price per liter of diesel oil and the average consumption and distance of the destination point.

Based on the data presented, the total cost of collecting MSW is R$ 1,471,516.8 per year paid to the contractor.

The waste collected is household solid waste (HSW) and PCW that together comprise MSW. The per capita production of HSW, according to the Paraíba (2014), in Queimadas is 0.58 kg/inhab.day and 0.09 kg/inhab.day for PCW.

As mentioned for the PCW, one cannot also give a proportionality between the amount of HSW and PCW generated and the amount spent on collection services, because regardless of whether or not the service would be happening by a demand dependent on the number and of the extension of the public places of the municipalities.

Data fed into the National Sanitation Information System (SNIS) indicate a cost of R$ 0.17 per kilogram of MSW collected, of which R$ 1,860,082.95 per year is declared in this.

Figure 3 shows the form of collection performed in the city of Queimadas with compactor trucks and workers.

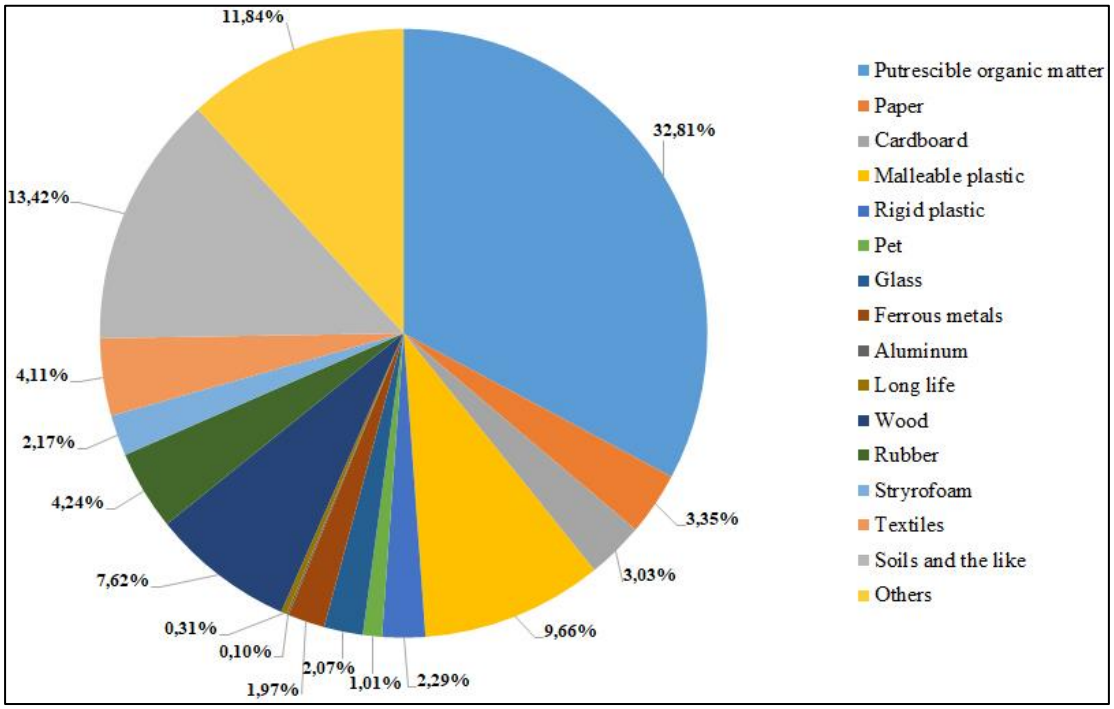
(Continue...)

Figure 3 – Conventional collection in Queimadas

3.1.3.2. Gravity composition of MSW

The characterization of the urban solid waste composition is fundamental for decision making about the implementation of several actions from the collection until the final disposal of the tailings (Palanivel and Sulaiman, 2014). From the knowledge of the percentage of each fraction in the total – gravimetric index – one can define its most appropriate handling and destination for the material. The graph containing the details of the gravimetric composition of Queimadas municipal solid waste is presented in Figure 4.

Figure 4 – Gravimetric composition of Queimadas MSW



Based on the gravimetric composition presented, it is possible to state that the potential for composting or biodigestion (biochemical treatment techniques) is good because it has indexes of putrescible organic matter of about 30% of the total, as well as about 10% of recyclables. On the other hand, it can be seen that the percentage of waste that has the proper disposal of a landfill is too high, about 40% of the total, and this may be due to the form of collection – mixing and compacting – and the lack of some mechanical treatment. Only what cannot be reused, recycled or otherwise treated should be disposed of in landfill (Scharff et al., 2010). According to Miezah et al. (2015), the "paper" fraction may also have the same destination as the putrescible organic matter, as it is also biodegradable, especially when mixed with the former.

3.1.4. Transport

The transportation of waste in the Municipality to the open pit or dump is carried out by the same staff that collects and in the same vehicles used in this, clearly, in other words, the same operators of the previous stage.

From headquarters to the dump, the route is approximately 6,000 m, being partly on asphalt paved road, the federal highway BR-104 (4,452 m), and part on unpaved back road (1,505 m).

On costs, these are included in the contractual cost with the contractor for collection.

3.1.5. Treatment

The most common solid waste treatment in municipalities of this size is mechanical, characterized by separation and, when necessary, processing to give new utility (reuse) or reinsertion in the production chain (recycling).

Thus, in Queimadas, there is not even a solid waste treatment follow-up, since there are only, in some very isolated points, characteristic collectors that, if there is no action of informal collectors destined for recycling, are taken together with the others to the dump. In several other places of the Municipality are some common collectors or containers of type "vat debris" disposed for disposal of waste by the population. Figure 5 shows two locations

where recyclables are stored by people who collect and sort materials on city streets, the only treatment identified but classified as informal.

Figure 5 – Places with separation and storage of recyclable materials – informal activity

There is no selective collection in the city and all waste is placed in collectors of various types found by random points.

3.1.6. Final disposal

Queimadas has as its final destination of waste of its ownership an open pit or dump and this very serious characteristic, then, is one – if not the main – reason that concerns more in environmental terms. According to Mahmood et al. (2016), there is no final destination worse than a dump, but it is still the most used, showing that Queimadas makes a serious and very common mistake yet. The place has been used for 20 years, is the property/ownership of the City Hall.

The general data for the Queimadas dump are synthesized in an area of 6.81 hectares with 1,102 m of perimeter, located at the geographic coordinates 07°19'45.59"S and 35°53'06.57"W, point altitude of 488 m, being flat and without major streams nearby.

The deadline for the termination of this practice has already expired, according to Federal Law 12.305/2010, and has been extended numerous times, but what is commonly understood is that the legal problems have already appeared and will be intensified, perhaps

proportionally to the environmental and socioeconomic, very soon as in those municipalities that have already filed assessments and fines. It is logical, therefore, that such activities do not have environmental licensing.

The fact of high age characterizes that the problem has crossed other municipal administrations, which infers even lack of interest to solve in other times, but can still be environmentally a problem smaller than the younger, because it is almost certain that these were preceded by other dumps that hardly underwent recovery processes of the area, that is, were abandoned.

The dump is 3,712 m radius from the city center, 791 m from the nearest country home and has no surface water accumulation body nearby. The area has free access and a back road as one of its edges. The main problems identified in this are: burning of waste, scattering of less dense waste by neighboring properties, presence of people and animals and vectors and gas releases at diffuse points.

The on-site disposition has no control at all. The waste arrives mixed in the trucks and is placed in non-predefined points, sometimes distant from each other, spreading, blocking the passage and making it difficult to use other points for unloading. It can be predicted that in a very short time, the area will be completely saturated and presenting the impossibility of the deposition of waste be made in it, because more than 90% of the total is already covered.

The most harmful characteristic of the practice of dumps is that, after being used, areas are abandoned without any concern for their remediation, living in them and resisting only more resistant plant species. The Municipal Government states that it will close this activity and work on the recovery of the area, addressing the problems caused by it.

The reported MSW fires, intended to reduce volume, bring problems to the site by the release of pollutant gases into the atmosphere and leaving carbonized waste degrading the soil and water.

Several collectors – 40 (forty), according to reports of some present when visiting – do the daily work of sorting recyclables in the Queimadas dump, storing in large bags and marketing these with middlemen who buy at low cost and resell to recycling industries. One

of the collectors reports several work accidents, having health problems such as backache crises, but says he has no work alternative and wants better conditions.

Residents of neighboring properties complain about the spread of plastic bags, offering risks to animals (cattle, goats and sheep), and the presence of vultures.

Panoramic images of Queimadas dump and recyclable materials separated into large bags are shown in Figure 6.

Figure 6 – Panoramic images an large bags with separate recyclables in Queimadas dump

3.1.7. Other residues

3.1.7.1. Construction wastes

Construction waste (CW), also called construction and demolition waste (CDW) or roughly “shrapnel” and “rubble” are, in short, those formed by the set of materials discarded in construction. This type of waste deserves special attention, even if it does not offer direct risks to public health, as they are voluminous and have the potential to degrade considerable extensions of the environment in which they are disposed. As it is already widespread, these materials have a high potential for reuse and recycling and performing these actions would greatly impact the environment in a positive way (Rosado et al., 2019).

According to the municipal waste management officer, the CW is reused for two purposes: regularization of imperfections in vicinal roads and in the civil construction itself, which, according to Backhan and Faust (2019), is a sustainable practice and therefore indicated. In isolation, some situations of improper disposal of these residues were observed

during technical visits, such as in vacant lots. According to Seror et al. (2014), an illegal disposal is dangerous since there is no control over which materials are being deposited and therefore the risk of pollution is clear.

According to the Municipal Secretariat of Infrastructure, construction waste collection services are charged and also offered by individuals. It is estimated that this type of waste collected in the Municipality is that the City Hall or services contracted by the City Hall collect 9,839 tons/year, private companies or autonomous 4,713 tons/year and itself generated 1,013 tons/year, totaling 15,565 tons/year.

3.1.7.2. Healthcare Waste

Healthcare waste (HW), also known as hospital solid waste, is, in short, those generated in medical-hospital and pharmaceutical activities (Brasil, 2010; Soares et al, 2013; Niyongabo et al., 2019).

According to the folder manager who is responsible for the municipal waste management, there is no more irregular dumping of HW in the dump, nor burning, two highly polluting practices still recurring in some places.

The City Hall annually hires a company that specializes in the collection, treatment and proper disposal of HW. Thus, the Municipality currently has a contract with a company headquartered in the capital João Pessoa, which supplies 200 liters made of high density polyethylene (HDPE) for storage of the material in the municipal health units and collects biweekly. Inside the pails the material is packed in plastic bags. This company is certified and properly performs the heat treatment of the material, which should be the solution according to Ali et al. (2017).

The Queimadas Regional Hospital is the most important health unit installed in the city and, like the others, has the management of HW performed correctly.

3.1.7.3. Industrial Solid Waste

The industrial solid waste group, as its name is quite suggestive, is that formed by waste materials and by-products of activities in industrial enterprises. This group is of an

immeasurable range, because each venture can have a particularity in a waste, even if the material is very similar to another.

The statement, made by the manager of the area of waste in Queimadas, is that there are no industrial projects that generate complex residue or require differentiated treatment, because even if there is an industrial district in the Ligeiro District, they are simple materials, the quantities are small and these have been intended correctly.

Most residue classified in this category is collected and disposed of along with MSW managed by the Municipality, even though the responsibility is of generators when in high volumes, a fact that could be pointed as a failure, but is justified by their reduced volumes.

There is no detailed information, as there are none and/or no Solid Waste Management Plans (SWMP) of the projects.

3.1.7.4. Commercial solid waste

The commercial solid waste group consists of those materials that do not meet the requirements for commercialization. This group can be considered quite large, as each venture has its product range.

The person responsible for solid waste management in the Municipality ensures that Queimadas commercial enterprises generate waste considered domestic, office and counter activities, and typical of their activities.

The disposal of the discarded material is made in higher volume plastic bags, being destined for the conventional municipal collection only those considered domestic and the others being reused. As waste in this category is collected by municipal collection holders, this situation is considered as a failure in the management of MSW.

There is no detailed information, mainly about quantities generated, because the projects do not have or do not make available the SWMP.

3.1.7.5. Special solid waste

Queimadas does not have any reverse logistics policy in place, which would be correct, according to the standards and the PNRS. The problem cited here is quite serious, with the following points for diagnosis being highlighted.

Part of the Municipality has a strongly active agricultural activity and, consequently, there is the use of pesticides and there is no management of their waste and packaging, potentiating vaious environmental and public health problems (Jin et al., 2018);

Batteries have the same fate as MSW, when generators do not take the initiative to take these materials to ENP in neighboring cities such as Campina Grande, continuing the preferred cycle of these materials (Wang et al., 2018; Dehghani-Sanij et al., 2019);

Tires, unless some reuse action is taken in isolation, are mistakenly discarded, a practice extremely against sustainability (Simić et al., 2017; Park et al., 2018);

Lubricating oils and the like are also incorrectly disposed of as MSW (dump) or sewage, another practice that shows nonexistence or no application of management techniques of these materials in the Municipality (Zzeyani et al., 2019);

There are no lamp collection policies for recycling or proper disposal, which indicates heavy metal pollution in the dump (Urniezaite et al., 2010);

Electrical and electronic waste are easily found in the dump, which gives pollution from a range of different materials and even a waste of precious metals (Awasthi and Li, 2019; Duman et al., 2019).

Therefore, the important class of special waste has unmanaged management in the Municipality, traders and generators.

3.1.7.6. Waste from basic sanitation services

Waste from miscellaneous basic sanitation services are those generated in water supply and sewage units. This classification includes sludge from water treatment plants (WTP) and sewage treatment plants (STP) and chemical packaging used in them.

Based on the classification and non-existence of the above mentioned enterprises, it is stated that this type of waste does not exist in Queimadas, since there are no sewage treatment plants in operation and the water treatment plant is not located in its territory.

3.1.7.7. Agroforestry residues

Brasil (2010), in NPSW, defines agroforestry residues as "those generated in agricultural and forestry activities, including those related to inputs used in these activities".

Even with the agricultural activity present in the municipality, the need for waste management directly and indirectly generated in this municipality is unknown and, certainly for this fact, is not realized.

It is only known then that these wastes are worked on the generators themselves at the generation sites, without any technical guidance, just for what is called "popular knowledge".

About this identified fault, it can be pointed out the lack of environmental education actions as aggravating.

3.1.7.8. Mining waste

In PNRS, specifically in Article 13, item I and point k, mining waste is defined as "the waste generated in the activity of mining exploration, extraction or beneficiation" (Brasil, 2010).

The mining activity that exists in this Municipality is simple and discreet and is done with or without technical support and, therefore, with or without environmental or commercial legal licensing for operation, characterized by the extraction of sand in river and stream beds for use in construction. Thus, for cases without SWMP and Degraded Area Recovery Plan (DARP), documents that must provide for the proper management of waste.

Lack of environmental education and supervision by the competent bodies are the factors of responsibility.

3.1.7.9. Waste from transport services

Waste transportation services are, according to Federal Law No. 12,305/2010, are "those originating from ports, airports, customs, road and rail terminals and border crossings" (Brasil, 2010).

Therefore, considering the definition, Queimadas does not have any venture that matches this classification.

(Continue...)

3.2. SWOT analysis

Figure 7 shows a summary of the waste stream in Queimadas and Figure 8 show SWOT analysis of MSW management in this municipality. The figures summarize the entire diagnosis of solid waste management in Queimadas, a management that has several flaws, but is presented as an easy solution.

Figure 7 – Waste management flowchart in Queimadas.

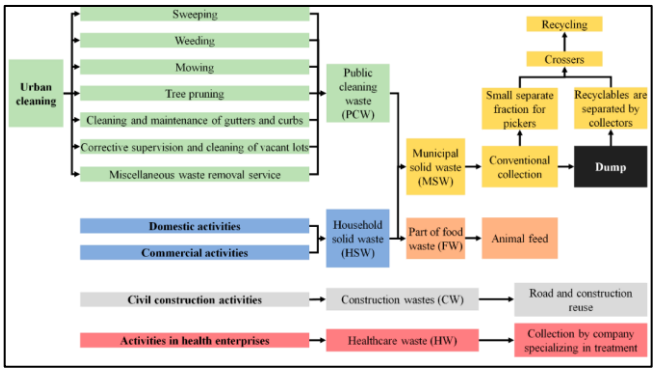


Figure 8 – SWOT analysis of waste management in Queimadas.

	Strengths	Weaknesses
Internal	▪ Regularity of sweeping services ▪ Regularity of conventional waste collection ▪ Adequate number of active employees ▪ Logical integration between waste management activities performed ▪ Collection and reuse of construction waste ▪ Proper collection and treatment of health care waste	▪ Conventional type collection with compacting truck meets the need for waste separation ▪ No selective collection ▪ Environmental education is note worked yet ▪ No waste treatment system ▪ Dump operating for 20 years and receiving all the waste collected ▪ Waste pickers working irregularly
	Opportunities	**Threats**
External	▪ Existence of Municipal Plans for Basic Sanitation and Integrated Solid Waste Management and Intermunicipal Plan for Integrated Solid Waste Management ▪ Participation in the Consortium ▪ Potential for creating Waste Pickers' Associations and / or Cooperative ▪ City manager shows interest in solving problems	▪ Population habits are already cultural and are hardly changed at a satisfactory level. ▪ Municipality already responds legal process on behalf of the dump ▪ Difficult access to resources for solid waste area ▪ Unplanned cities hamper infrastructure improvement actions

4 Conclusions

Urban cleaning and solid waste management, briefly called "solid waste management", is an important instrument for environmental preservation, specifically in basic sanitation, linked to modern public management, which brings with it difficulties that are not overcome and cause social, economic, environmental and, consequently, public health problems.

Quoting conclusively and generally, the main shortcomings are: inadequacy of current MSW management standards; conventional collection does not instruct people on proper packaging and waste sorting, the collection route is effective but not efficient, and inadequate vehicles (as they mix and compact MSW); there are no installed MSW treatment services, i.e. all material is collected, transported and disposed of equally, including the specials; disposal of MSW in dumps is the worst destination that can be given to this type of material, due to the degradation and devaluation of the area and the waste of materials with economic value; and people in subhuman conditions in the dumps picking up recyclable waste in the dump.

Regarding what was identified as positive points in the diagnosis, it is noteworthy that: participation in a public solid waste consortium enhances the adequacy of the integrated system; the existence of plans guides the management; in cleaning activities on public roads, employees carry adequate tools and PPE; health care waste is being collected, treated and / or appropriately disposed of; and construction waste is already being reused as landfill material for construction work itself and for repairs to back roads.

The quality of life of the population of Queimadas will certainly have improvements in intensity proportional to the speed of implementation of the Solid Waste and Basic Sanitation Plans. Therefore, the mobilization for awareness about the need for its effective participation in management should be based on this statement.

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