Capítulo 87

Sustainability indicators in municipal waste management in the municipality of Salvaterra (Ilha do Marajó-Pará)

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ABSTRACT
The municipality of Salvaterra is located on Marajó Island and is one of the Brazilian municipalities where the final disposal of solid waste still occurs incorrectly. In this sense, the present work aimed to analyze the current scenario of solid waste management in the municipality of Salvaterra/PA through the system of sustainability indicators PEIR (Pressure-State-Impact-Response). The results show thatthe waste generated in the municipality is disposed of in a dump located near the city and that the health service waste, produced in hospitals, is burned in the open air in this same dump. There is no type of solid waste management, waterproofing of soil or treatment of gases generated by the decomposition of the city's waste, which further aggravates the situation because the water resources and soil can be contaminated by slurry, the population is vulnerable to the contagion of vector-borne diseases and the burning of health service waste contributes to air pollution and can also cause respiratory diseases. Thus, it is noted that the system of sustainability indicators PEIR proved to be an effective tool to perform the first data collection and municipal diagnosis on the reality of waste in Salvaterra, thus being a starting point that can support actions, stimulate and direct new studies and complement the construction of the municipal waste management plan.

Keywords: Salvaterra, Methodology of PEIR indicators, Municipal Solid Waste.

1 INTRODUCTION

The National Solid Waste Policy (PNRS), Law No. 12,305/10, establishes principles, objectives, guidelines, targets and actions, in order to regulate the management of solid waste and its management by public and private entities. However, Mesquita Junior (2007) states that the situation of solid waste management in Brazil is worrisome, especially with regard to the issue of final disposal. In this sense, the search for solutions for the final disposal of waste has been an important challenge, especially with regard to the prevention of soil, air and water pollution (Oliveira & Galvão Junior, 2016).

The municipality of Salvaterra, located on Marajó Island, is one of the Brazilian municipalities in which the final disposal of solid waste still occurs, mostly inappropriately, through dumping in the dump and/or burning the waste. Considering the importance of adequate waste management, the municipality of Salvaterra instituted, through Law No. 1,189 of July 1, 2016, the municipal solid waste policy that defines goals, principles and guidelines and provides other measures. However, the municipality did not yet have any type of Solid Waste Management Plan (PGRS).

Therefore, the elaboration of a PGRS is essential, because from it it is possible to manage solid waste more effectively, from collection to final destination. One of the main stages of the elaboration of PGRS is the diagnosis, according to Soler (2018) the realization of diagnoses can occur through Models of Sustainability Indicators, these are used to measure the sustainability of enterprises, economic sectors and political units. Being one of these models the Pressure-State-Response Model (PER).

The PER Model is the most used authorising framework in the analysis of statistics and indicators in the environmental area and sustainable development. It is based on a conceptual framework that addresses environmental problems according to a causal relationship. The indicators developed by the model seek to answer three basic questions: what is happening to the environment (State); why this occurs (Pressure) and what society is doing about (Response) (Carvalho & Barcellos, 2010).

The EPA approach expanded by the United Nations Environment Programme (UNEP) aims to understand how human action is impacting the environment. Because of its intimate connection over the four dimensions, it is noticeable the effect that one dimension influences the other, that is, there is a cause-and-effect relationship (Tayra & Ribeiro, 2005; Brito & Candide, 2015).

Thus, through the PEIR model it is possible to simplify the study of solid waste, having techniques and methodologies that facilitate decision-making – from society, public managers and social organizations – highlighting citizens' rights and duties, as well as shared responsibility for the environment. With this, the present work aimed to analyze the current scenario of solid waste management in the municipality of Salvaterra/PA, through the system of sustainability indicators Pressure-State-Impact-Response (PEIR).

2 METHODOLOGY

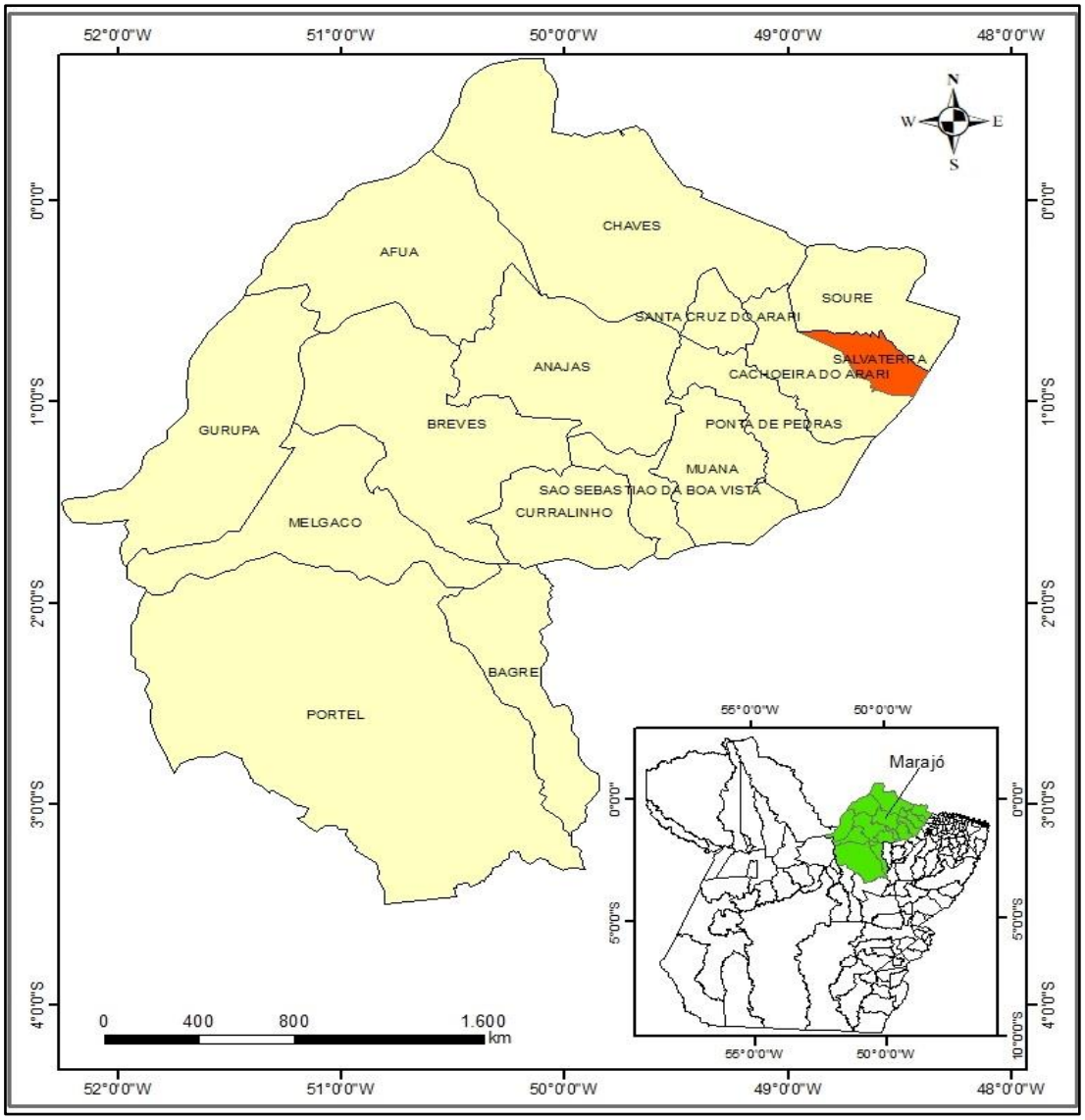
2.1 RESEARCH CHARACTERIZATION

This is an exploratory descriptive research that, according to Gil (2008), aims to describe and explain the characteristics of a given population or phenomenon. The research is also characterized as documentary and experimental, since it was developed through consultation in technical documents and governmental information bases to obtain data capable of influencing the object of study that were subsequently systematized and analyzed to meet the proposed objectives (GIL, 2008).

2.2 AREA OF STUDY

The research was carried out in the municipality of Salvaterra, located on marajó island, Pará, with Geographic Coordinates 48°30'44"W and 0°45'32"S (Figure 1). The municipality has 918.563 km² of territorial extension and, according to recent estimates of the Brazilian Institute of Geography and Statistics, has an estimated population of 24,392 inhabitants, resulting in a population density of 26.55 inhabitants/km² (IBGE, 2021).

Figure 1: Location map of the municipality of Salvaterra.



Source: Authors.

2.3 METHODOLOGICAL PROCEDURES

2.3.1 Data collection

General and specific data on solid waste were collected, such as: main economic activities; number of neighborhoods and villages located in the rural area; existing policies and legislation; estimated quantity of waste generation per day/month; frequency of collection; type of vehicles used for collection and quantitative; final provision, etc. Data collection occurred from the consultation on ibge and municipality

websites (prefeituradesalvaterra.pa.gov.br), interviews in the city hall and municipal departments (Environment, Works and Health) and questionnaire applied to the population. A prior analysis of the collected data was performed, using Excel as a tool to better understand the current scenario of waste in the municipality. Next, the sampling was calculus to know the number of questionnaires to be applied to the population.

2.3.2 Sampling

To perform the sample calculation, the Survey Monkey platform was used, which can be accessed by website or application. It is a reliable tool for the development of online research and sample calculation, which has been used in several studies of a national and international nature (Faleiros et al. 2016; Arceo et al. 2021).

In the sampling calculation performed by Survey Monkey, three variables are considered: population size, margin of error and confidence level. The sample size corresponds to the number of responses received or that need to be received from a survey. The sample represents, in this case, the target population, to whom and how many were applied the questionnaires. The margin of error is inversely proportional to the confidence level, that is, the lower the margin of error the higher the confidence level, the safer and more reliable the search.

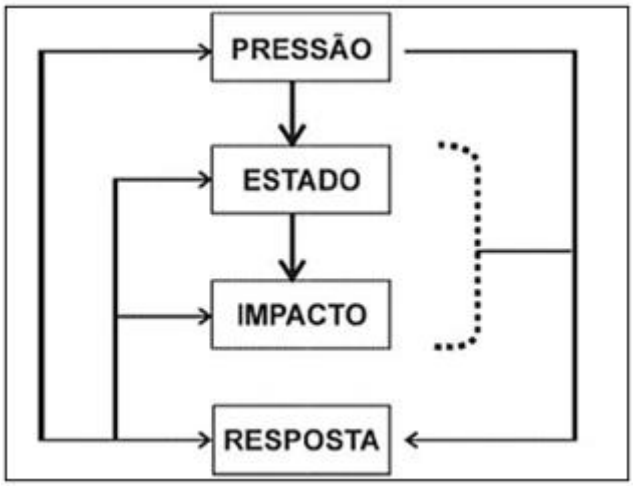
Therefore, for a population of approximately 24,000 inhabitants, with a margin of error of 5% and a confidence level of 90%, the sample size is 270. The sample represents the number of questionnaires applied to the population of the municipality of Salvaterra, namely pressure indicators, the first component of the IRP methodology.

2.3.3 PEIR Methodology

There are numerous methodologies of indicators for data collection and analysis, one of which is the Pressure-State-Response (PER) model. According to the Classification of the OECD (OECD - Organization for Economic Cooperation and Development), environmental indicators can be organized through the PER model, which is based on the concept of causality: "Human activities put pressure on the environment and change its quality and quantity of natural resources (state). Society responds to these changes through environmental, economic and sectoral policies" (OECD, 1998).

However, considering the need to assess the impacts exposed to the environment, the research will be carried out from an adaptation of the OECD model, adding the impact dimension as carried out by the United Nations Environment Program (UNEP). Information was collected to explain the pressures (P) evidenced over the years in the municipality and the state (E) that the environment is located due to the generation and inadequate final disposal of waste, in addition to identifying the impact (I) that environmental degradation has on society and the responses (R) mentioned by municipal managers (Figure 2).

Figure 2: Cycle of the P-E-I-R methodology.



Source: Pan American Health Organization - PAHO.

The pressures, state, impacts and responses were collected through the consultation in a database, such as: Brazilian Institute of Geography and Statistics (IBGE) and the Brazilian Association of Urban Cleaning Companies (ABRELPE). The application of questionnaires and interviews were also tools used in data collection.

2.3.4 Identification of pressure and status indicators

In order to identify the pressure indicators, in addition to the application of the PEIR questionnaire for the environmental technique of the Municipal Environment Secretariat -SEMMA, responsible for issues related to solid waste, another pressure questionnaire was applied in order to identify the perception and understand the population scenario (Chart 1).

Table 1: Description of pressure and status indicators

Dimensions	Indicators		Description
PRESSURE	Direct	Volume of waste per capita	Volume of waste (m³)/ Population (Hab)
		Waste collection directly to the dump	Total waste destined for the dump(m³)/ Total waste collected (m³)
		Waste health services intended without treatment	Total RSS collected(m³)/ Total untreated RSS (m³)
	Indirect	Waste collection in the Urban Zone	Occurrence (yes or no) and weekly frequency (daily, 3 to 4 times, less than 3 times or without collection)
		Waste collection in the Rural Area	
		Increase in waste generators	Occurrence (yes or no)
		Existence of waste pickers on the streets	
		Burning waste in the open	
		Performance of the city in waste management	
		Wall insulation	
		Presence of animals and vectors in the area	
		Insufficient waste collection points	
		Presence of waste pickers in the area	
		Villas in the disposition unit	
		Place of final disposal near aquifers	
STATE	--	Absence of gas drainage at the disposal site	Occurrence (yes or no)

		Lack of use of gases at the place of disposal	
		Collection deficit in rural areas	
		Collection deficit in urban space	
		Transmission of diseases by vectors	
		Accumulation of waste on wasteland	
		Lack of use of organic waste	
		Lack of selective collection	
		High rates of open waste burning	
		Absence of administrative facilities at the place of disposal	
		Lack of soil waterproofing base	
		Absence of slurry drainage	
		Lack of slurry treatment	
		Absence of environmental monitoring	
		No coverage of solid waste	

Source: Authors.

The monthly estimate of the residues was performed from the collection of the primary data. Considering the frequency of collection and the amount of waste collected per day of collection, the following calculation was made:

$$Total\ (mês) = \frac{Q*N}{7} * 30 \quad (1)$$

Where: Q= quantitative of waste collected per day of collection; N= number of collections that occur per week.

Thus, it was possible to estimate the amount of waste collected monthly in urban space and rural areas separately.

2.3.5 Analysis of the positive and negative impacts of solid waste management and response from the government and society

Based on the understanding of the P-E-I-R chain and comparing with the guidelines and criteria established by the PNRS, the negative and positive points of waste management of the municipality were observed, as well as its possible causes, taking note of the impact indicators (Chart 2).

Table 2: Description of impact indicators.

Dimension	Indicators	Description
IMPACT	Diseases involving the population living near the place of disposal	Occurrence (yes or no)
	Pollution of water resources	
	Soil pollution	
	Air pollution	
	Odor generation	
	Visual pollution	
	Flooding of public roads	

Source: Authors.

After performing the impact analysis, the management was asked about the measures taken by it to mitigate or solve the problems encountered, or what actions it intends to perform to do so. Thus, it was possible to know the reality of the last indicators of the PEIR chain, the answers (Chart 3).

Table 3: Description of answer indicators.

Dimension	Indicators	Description
ANSWERS	Waste pickers' associations or cooperatives	Occurrence (yes or no)
	Solid waste treatment	
	Participation of the population in waste management	
	Improvement measures for the final disposal of waste	
	Partnerships with other municipalities for the treatment of RS	
	PGRS, PGIRS or PMGRS	
	Selective collection incentive program	
	Programs to combat the irregular disposal of SR	
	Reverse logistics programs	
	Landfill installation project	
	Measures to combat the burning of open-air waste	
	Social control instruments for the management of RS	

Source: Authors.

3 RESULTS AND DISCUSSION

3.1 GENERAL SCENARIO OF WASTE MANAGEMENT IN THE MUNICIPALITY OF SALVATERRA

3.1.1 Collection and Transport of waste

When conducting data consultation in digital information systems and directly in the municipal departments, there was a lack of consistent and articulated information. Thus, although not an indicator proposed in this study, this fact demonstrates fragility in the monitoring of public policies, and of the management of municipal solid waste itself. Regarding this, the study by Reis, Mattos and Silva (2018), demonstrates that the low quality and low availability of updated data regarding the waste management of the municipalities, in general, were limitations found in their research. Moreover, the complexity of the theme did not allow all questions to be fully contemplated in the study (Kings; Mattos & Silva, 2018).

To better understand waste management, the territorial division in the municipality was identified, classified in urban and rural areas. The rural area consists of 16 villages, while the urban space has 10 neighborhoods. In relation to the scenario and waste management, the Secretariat of Works, Transport and Urbanism - SOTUR is responsible for the collection and transport of municipal solid waste throughout the municipality. On the other hand, the waste of health service is the responsibility of the generator, as established in Art. 20 of the PNRS (Brazil, 2010). Thus, it was possible to know the logistics of the waste from its collection to the final destination.

In all, there are 20 vehicles that are used for waste collection and urban cleaning services (Table 1). The municipality has a compactor truck, known as "Papa Lixo", with a maximum capacity of 19 m³, the main responsible for the collection of waste. The vehicle performs two daily collections in the urban space (morning and afternoon), traveling along the main roads.

Table 1: Vehicles used for urban collection and cleaning services.

Type of vehicle	Quantity	Ability
Trucada	01	13 m³
Toquinho	01	9 m³
Wagon	17	1 m³
Pope trash	01	19 m³

Source: Authors.

To complement the collection service, 17 wagons with a capacity of 1 m³ pmainly make the roads that are difficult to access for the garbage pope. The collectionof debris and pruning of trees occurs through two buckets destined for this service, a troupe (truck) and a toquinho (stump) with a capacity of 13m³ and 9m³, respectively. Buckets are similar and the main difference between them is the amount of axes and their capacity.

3.1.2 Estimation of waste production in the municipality

Regarding the quantity of waste collected, the municipality of Salvaterra did not have effective data, so through primary information collected from the works department, it was estimated the monthly quantity produced in the municipality, both in urban and rural areas. Thus, the monthly quantity collected was estimated at 771.30 m³ in the urban space, 81.60 m³ in the rural area, totaling 852.90 m³ of waste collected in the municipality (table 2).

Table 2: Estimation of waste collected in the municipality.

Amount of waste collected in the municipality (m³)				
Space	Day	Week	Month	Monthly total
Urban	25,71	179,97	771,30	852,90
Rural	2,72	19,00	81,60	

Source: Authors.

It is noted that the quantity of rural space is clearly lower than that collected in urban space and this is directly linked to two main factors, population index and collection coverage, especially the latter. For, when it comes to waste collection in the rural villages of Salvaterra, only the five largest (Condeixa, Joanes, Foz do Rio, Jubim and Caldeirão) receive the service and the collection is only carried out on the main avenue, Highway PA 154. Therefore, it is not possible to have an exact value of waste produced in the municipality, since in some villages it is not possible to esthetism them.

3.1.3 Health Service Waste Management

As for Health Service Waste (RSS), those from analysis laboratories, medical, dental and veterinary clinics, waste produced in hospitals and outpatient clinics are classified as RSS (Barbosa, 2012). In relation to sss in the municipality of Salvaterra, it was found that the management is done separately. The Municipal Hospital Almir Gabriel - HMAG together with the Health Department carry out this management, both of the hospital, as well as of the UBS and health posts of the urban and rural space.

In relation to private clinics, despite performing the proper segregation and packaging, its destination is the same, the municipal dump, since there is no alternative destination in the municipality. Thus, like HMAG, the other generators of this class of waste do not yet have a Health Service Waste Management Plan - PGRSS.

In the HMAG hospital, the internal collection of waste is performed daily and regularly, in specific containers for each type of residue. Externally this collection occurs twice a week, on Mondays and Fridays. Approximately 1 ton of waste is collected monthly. Transportation is carried out by means of a rental car, truck type, lined with sturdy canvas. In relation to the disposal of these residues, they are burned in the open air in the city dump (Figure 3). Regarding the legal documentation, the hospital declared to have an environmental license (which does not authorize this type of destination, since it goes against the PNRS) with the State Department of Environment and Sustainability - SEMAS, but did not specify it.

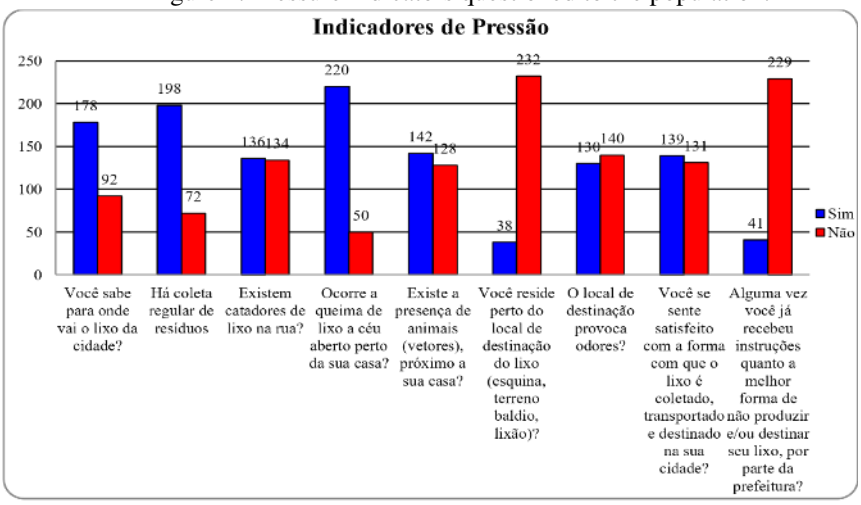
Figure 3: Burning RSS in the open.

Source: Autores.

3.2 P-RESSION INDICATORS

The pressure indicators, applied through a questionnaire to the population, and their respective results are shown in Figure 4.

Figure 4: Pressure indicators questioned to the population.



Source: Authors.

3.2.1 Knowledge of the population about the final destination of waste

Regarding the questionnaire applied in the community to identify pressure indicators (Figure 4), it was found that 65.92% of the interviewees stated that they knew the destination of the residues. Of this percentage, 62.22% people answered that the destination is the city dump (Figure 5), 1.48% people said that the garbage would go to landfill, 1.85% claimed that garbage is burned and 0.37% reported that in the village of Jubim garbage is dumped on a plot next to the local cemetery. The remaining 34.08% said they did not know the disposal of waste.

Figure 5: Place of final disposal of waste in the municipality of Salvaterra.

Source: Authors.

The Sanitation Framework, sanctioned in July 2020, established that, by December 31, 2020, municipalities should carry out the environmentally appropriate final disposal of tailings (Brasil, 2020). But, Soares (2017) states that the dumpsare still u sados as the final destination ofthe waste generated in brazilian municipalities. According to the Brazilian Association of Urban Cleaning Companies (ABRELPE, 2019) there are still about 3000 dumps in the country, in addition, there is also inadequate deposit of waste in open air vents, in areas close to the urban area and in landfills that do not meet current legislation.

About household waste collection, 73.30% of the participants reported having regular collection, while 26.70% indicated that they did not have this service. According to ABRELPE (2021), the amount of materials arranged for collection with urban cleaning services reached a total of 76.1 million tons collected in 2020, which implies a collection coverage of 92.2% in the country. However, in the North and Northeast regions they have just over 80% of the collection coverage, which means that around 20% of the waste generated is not achieved by regular collection services in the municipalities located in these regions (ABRELPE, 2020).

3.2.2 Frequency of waste collection

Regarding the frequency at which the waste collection service is provided, 42.20% people stated that it occurs daily, 8.90% people said that the collection occurs 3 to 4 times a week, 22.20% people reported that the service occurs less than 3 times a week and 26.70% do not receive the collection service.

The rural population reported that it receives collection 3 to 4 times a week and, in some cases, less than 3 times. When asked about the collection of waste in rural areas, SOTUR stated that the collections are performed 2 times a week (on Tuesdays and Fridays),quanto to the decision criteria to determine the frequency of collection, SOTUR reported that it was defined from the demand for collected waste.

For residents of urban space, SOTUR states that the collection takes place daily (Monday to Friday). On the other hand, part of the population of the urban space stated that the collection occurs 3 to 4 times, others that occurs less than 3 times or even, that the collection is nonexistent, this reality corresponds to residents of more remote neighborhoods, where the collection coverage does not reach all streets daily.

3.2.3 Presence of waste pickers on the streets

Regarding the indicator "presence of waste pickers in the streets" where they sought to verify if it occurs the collection of recyclable materials in the municipality, 50.37% of the people stated that there is presence of them and 49.63% stated that they do not or that they do not know. Waste pickers can be grouped into two groups: waste pickers who work to separate materials, collecting all waste and are able to perform this function, besides being engaged to a cooperative, or the waste picker who develops his activity as the only source of profit, not separating the materials and collecting only those that have a profit purpose (Moreira , 2016). In Salvaterra it is possible to observe in the streets, waste pickers who collect only aluminum cans, also occur, waste pickers who are part of cooperatives and collect a greater variety of waste, such as paper, cardboard, pet bottle and others.

3.2.4 Burning waste in the open

Regarding the burning of waste in the open, 81.48% stated that there is burning near their residence and 18.52% denied this statement. However, when asked about the disposal of their waste, 58.90% of the people stated that they pack in plastic bags to leave at the nearest collection points, 25.92% answered that they pack in plastic bags indoors. However, 4.07% reported that their destination is burning and 11.11% said they were in another location, but did not specify this location.

Improper burning of solid waste causes a phenomenon known as "smokescreen". This curtain is composed of a series of polluting and harmful compounds for the health of the human population, among which we can highlight carbon monoxide (CO) and methane (CH4) (Brandão Júnior et al., 2018). Burning waste in the open is an inadequate incineration process. Waste incineration is a type of final disposal possibly adequate, however, when done in a correct way causes the emission of particles and other air pollutants, produced directly by burning garbage outdoors or by incinerating waste without the use of adequate control equipment (Gouveia, 2012).

3.2.5 Presence of vectors and odors

Regarding the presence of vectors in the vicinity of the residences, 52.59% of the people confirmed this statement, while 47.41% of the people reported that there was no presence of these. Of this amount that stated that there were vectors, 14.07% of the interviewees reported living in the vicinity of the final destination. And when asked about the release of odors by the dump, 48.15% said yes, while 51.85% said there was no release of odors.

The disposal of waste in dumps generates odors from the biological, chemical and physical reactions of the anaerobic decomposition of organic waste, and also favors the appearance of vectors such as cockroaches, flies, rats and mosquitoes. These vectors directly influence the health of human beings, since they can contribute to the transmission of numerous pathogens that cause diseases such as Dengue, Zika, Cholera, filarioses, among others (Bezerra et al. , 2019).

3.2.6 Disposal of organic waste

Regarding organic waste, it was questioned what its destination was and 11.85% of the individuals perform composting, 47.41% put in their plants, 7.41% of people intended for common waste, 24.07% perform open burning, 4.07% provide as food to animals and the remaining 5.19% said they give another destination, without specifying it. The decomposition of the existing organic matter in the waste mass produces slurry, a dark-colored liquid that can contaminate soil and surface or groundwater through surface runoff and leaching (Oliveira, Miranda & Soares, 2019).

One of the forms of proper disposal of organic waste is composting, through it it is possible to reduce the amount of organic waste and reduce the fires that pollute the air and cause negative impacts to the neighborhood, in addition, the composting system has as product a stable material, rich in hyumic substances and mineral nutrients, capable ofenriching the earth and increasing the distribution of nutrients to plants (Silva, 2019).

3.2.7 Degree of population satisfaction

In order to know the degree of population satisfaction about how public management is performing solid waste management, the following question "do you feel satisfied with the way the waste is collected, transported and destined in your city?". Of 270 individuals, 51.48% said they were satisfied, while 48.52% answered the opposite, which represents a balance between the statements. Of the people interviewed who said they were dissatisfied with the management, 52.67% are from the rural area and 47.33% live in the urban space, this reveals that the problems related to management, such as the absence of total coverage of collection and inadequate disposal of waste, are a scenario that is seen both in rural and urban areas.

It is important to point out in this indicator that 34.08% (92 answers) of the people who answered the first question of the questionnaire said they did not know the destination of the garbage. And of this

total 33.70% of the individuals, living in the rural area, the maximum level of education is incomplete high school and indicated that they were satisfied with the management of the waste.

In this case, the answer to this question may have been misguided and/or influenced by the lack of knowledge about how solid waste management happens in the municipality of Salvaterra, the environmental impacts and health risks that inadequate management or lack of management can cause to the population. Since, to indicate satisfaction or dissatisfaction, we asked to consider the three factors linked to waste management, collection, transportation and final destination. And that 26.70% of the population does not receive the collection services, and the final disposal of the waste is inadequate.

3.2.8 Transfer of instructions on waste management by the city to the population

When asked about the transmission of information by public management, about the appropriate way of managing waste at home, 84.81% of the interviewees stated that the city does not pass on these instructions and only 15.19% of the people declared toreceive this information. Regarding the classification of the performance of the city in the way ofcollecting and treating waste, 4.81% said it was very good, 12.96% voted good, 52.97% in regular, 18.15% in bad and 11.11% in very bad.

As complementary and comparative to the pressure indicators listed in the questionnaire for the population, pressure indicators comprised the questionnaire of PEIR indicators directed to the environmental technique of SEMMA, responsible for issues related to solid waste (Chart 4).

Table 4: PEIR indicators, part 01, pressures.

QUESTIONNAIRE 01 - PEIR INDICATORS (part 01)		
PRESSURE INDICATORS - DIRECT	**Yes**	**No**
1. Is there a waste disposal system directly to the dump?	X	
2. Is it likely that health service waste (SSC) is destined without treatment?	X	
PRESSURE INDICATORS - INDIRECT	**Yes**	**No**
3. Is there regular waste collection in all neighborhoods/villages?	X	
4. Are there SS waste pickers on the street?	X	
5. Does open waste burn?	X	
6. Does the rs disposal site have some kind of wall insulation, or other type of fence?	X	
7. Is there the presence of animals (vectors) in the waste disposal area?	X	
8. Do houses occur near the place of final disposal of waste?	X	

Source: Authors.

In summary, it was confirmed the destination of waste to the dump, as well as the occurrence of disposal of RSS without treatment, the burning of waste in the open, the presence of vector animals and residences near the place of final disposal of garbage as unfavorable factors, already confirmed in the previous questionnaire aimed at the population.

Likewise, Moreira et al. (20177) studying the disposal of solid waste in wastelands in the city of Aurora-CE, found through interviews with social actors that the main environmental problem in the city is the open-air leak and the absence of selective collection. As well as, Silva & Cândido (2012) researching the management of solid waste in the city of Campina Grande - PB, through the Pressure-State-Impact-

Response indicator system, found worrying results regarding the presence of animals in the final disposal unit. By being pointed out as unfavorable, these indicators can generate pressures, changing the quality of the environment and compromising the quality of public health.

3.3 ESTADO INDICATORS

When analyzing the answers obtained for the state indicators, through the questionnaire applied to the environmental technique responsible for questions related to solid waste in the municipality of Salvaterra, it was found that the result was 100% unfavorable, that is, there is no type of treatment, monitoring or coverage of waste deposited in the dump, as expected (Chart 5).

Moreira (2016), in his study conducted analyzing the scenario of solid waste through the PEIR chain in the municipality of Aurora-CE, with an estimated population of 24,567 inhabitants, presented similar characteristics to the municipality of Salvaterra in the indicator "state". Where 90% of the indicators studied were unfavorable, differing only in the solid waste coverage indicator, which in turn was favorable according to the author.

Table 5: PEIR indicators, part 02, state.

QUESTIONNAIRE 01 - PEIR INDICATORS (part 02)		
STATUS INDICATORS	**Yes**	**No**
9. Is there a gas drainage system in the final disposal location of RS?		X
10. Is there any gas use system in the rs disposal locality?		X
11. Are there administrative facilities in the locality?		X
12. Is soil waterproofing base at the site of waste disposal?		X
13. Does slurry drainage occur at the waste disposal site?		X
14. Is there slurry treatment in the same area of the unit?		X
15. Does environmental monitoring occur?		X
16. What is the frequency of solid waste coverage?	It does not occur	

Source: Authors.

3.4 IMPACT INDICATORS

It can be inferred that the results of the impacts are directly related to the state of the environment presented in Chart 5, it can be seen that, except for the indicator of flooding of public roads, all the other ones were unfavorable in relation to the municipality of Salvaterra, since it is not an current factor (Chart 6), which demonstrates a negative reflection on the environment and public health.

Table 6: PEIR indicators, part 03, impact.

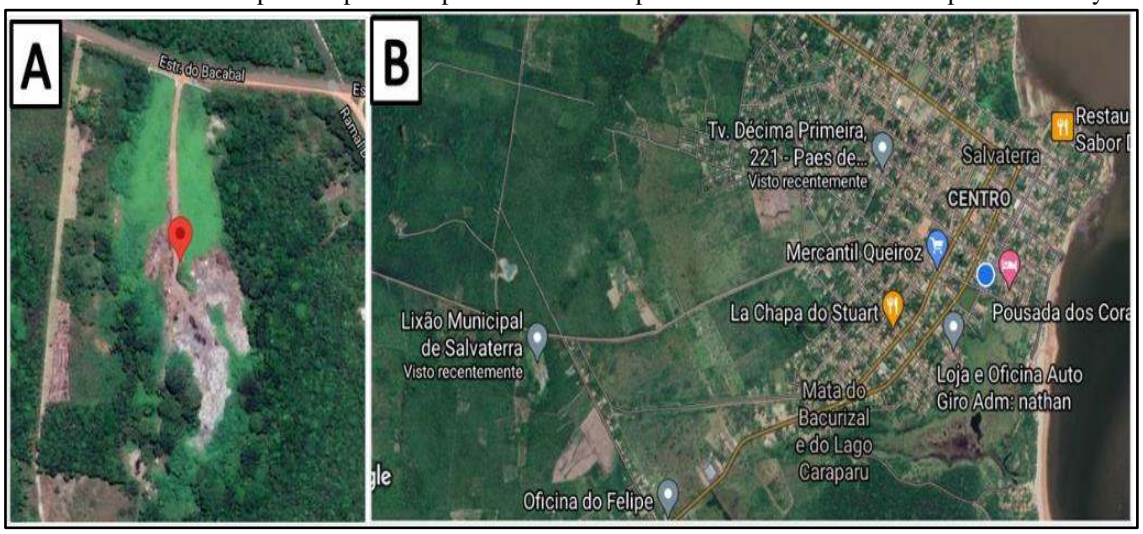
QUESTIONNAIRE 01 - PEIR INDICATORS (part 03)		
IMPACT INDICATORS	**Yes**	**No**
17. Do there are diseases involving populations around the dump?	X	
18. Is there pollution of water resources due to the presence of waste?	X	
19. Does soil pollution occur due to the presence of waste?	X	
20. Does air pollution occur due to the presence of waste?	X	
21. Is there flooding of public roads due to the presence of waste?		X

Source: Authors.

When not properly managed, solid waste contributes to thetransmission of diseases, since vectors find a suitable place for reproduction and feeding. With the presence of people residing in the vicinity of the Salvaterra dump, the occurrence of diseases becomes a worrying factor. According to Silva (2010) the risks to exposure of diseases transmitted by mosquitoes, rats, flies, cockroaches, contaminated feces of domestic animals and even by the consumption of animals (cattle and pigs) that feed or have contact with the garbage exposed in the disposal area, are more alarming s. Moreover, n the interface with environmental issues, waste contaminates air, surface and groundwater and, consequently, soil (Marques et al, 2021).

Also according to Marques et al. (2021) with the use of dumps for final d isposition d and waste, contamination or alteration of the quality of water bodies may occur, which may lead to the compromiseof thewater supply system. This is because, and in contact with water, the volume of slurry increases by contaminating river courses and groundwater. Its high pollution content stems from the fact that its production is not derived only from organic materials, since during its exposure in the flow rate it can adhere to toxic products such as batteries, batteries and fluorescent lamps (Lopes, 2006). The dump is located about 3.0 km from the center of age, near a water body, the latter being an even more worrying factor (Figure 6).

Figure 6 : Salvaterra municipal dump. A - Top view of the dump. B - Distance from the dump from the city center.



Source: Google Maps.

An alternative to avoid water contamination would be soil waterproofing which, in addition to avoiding pollution of water resources, would preserve the quality ofthe water. However, in the municipality of Salvaterra, waste is deposited directly in the soil, without the use of waterproofing bases (structures found in landfills used to prevent soil contamination). Thus, it has been that the correctmanagement of waste generated in the municipality of Salvaterra is essential to place barriers dand waterproofing of soil and protection networks to contain the slurry produced by garbage (Portella & Ribeiro, 2014).

On air quality, Silva (2010) reports in his research in Cuité - PB that landfills are evaluated as the most appropriate facilities for garbage storage, mas, require a gas drainage system, for collection and use of biogas (methane, carbon dioxide and water), when it refers to air quality. Moreira (2016) emphasizes, in his work carried out in Aurora - CE, the importance of biogas as an alternative of renewable energy, producing electricity, steam and fuel.

Thus, the use of the gases produced becomes a source of profit from an adequate solid waste management, making the impacts to the environment less frequent. In Salvaterra, being the dump the final disposal of solid waste, there is neither a type of drainage or use of gases, causing air pollution and providing the triggering of respiratory diseases.

3.5 RESPONSE INDICATORS

Given the scenario drawn by the pressures exerted on the environment and public health, due to the current management of solid waste in the municipality of Salvaterra, the responses of the public authorities and society must be known. Such responses represent the actions that exist today in the municipality capable of influencing (positively or negatively) the pressures identified. Thus, Table 07 presents the results obtained.

Table 7: PEIR indicators, part 04, answers.

QUESTIONNAIRE 01 - PEIR INDICATORS (part 04)		
RESPONSE INDICATORS	**Yes**	**No**
22. Is there an association or cooperative of waste pickers in the city?	X	
23. Is there a treatment of municipal solid waste?		X
24. Is there a participation of the population in the management of solid waste?		X
25. Is there any improvement in relation to the final destination of solid waste?	X	
26. Is there a partnership with other municipalities in the treatment of RS?		X

Source: Autores.

Of the five indicators studied, only two had a positive response. The municipality has a cooperative, which is in accordance with the National Solid Waste Policy. On the other hand, solid waste does not receive treatment, as well as there is no participation of the population in waste management or partnership with other municipalities to carry out waste treatment. It is noted that the process of extinction of dumps is, in fact, an important obstacle for the municipality, as well as in other municipalities of Pará. Reis et al. (2019)reports that in the municipality of Bragança/PA the extinction of the municipal dump was still under discussion, without a developed project, and attributes the reality found, among others, to the lack of a state legislation that corroborates with the PNRS.

Currently, there is no program in the municipality to clarify and encourage the population regarding the separation of solid waste for selective collection. However, withSEMMA, the preparation of the program is in the planning phase. Thesolid waste generated does not receive any kind of treatment and its

destination is the municipal open-air dump, but, there is selective collection initiative by cooperatives, as well as waste sorting initiatives.

The Municipal Department of Environment of Salvaterra is aware of the programs established for waste management according to the PNRS, however understands reverse logistics as the "return of packaging" and states that the municipality does not yet apply this strategy. One of the biggest challenges for the application of selective collection in the municipality is the fact that it is still in the organization phase and that in Salvaterra there is no PGRS being applied, although previous studies and data collection actions were initiated by SEMMA to perform the technical report. Another point is the absence of a landfill project, where according to SEMMA, the main obstacles are the lack of funds and financial structure.

As for the lack of financial support Lopes (2019), he found in his research that in small municipalities one of the main difficulties is low collection, causing the lack of resources for investments. The study also points out that the absence of specialized labor for the realization of waste management and management projects is another difficulty present in small municipalities. This reality does not apply in Salvaterra, since the municipality has a skilled body of work at SEMMA.

As an instrument of social control, the Environment Secretariat began to promote environmental education through its social networks, as a starting point. It is important to consider that there are already inspection and monitoring actions, through complaints and visits by semma environmental technicians to combat the irregular disposal of solid waste in the municipality. In 2031 the city expects the population to be informed about the factors related to municipal solid waste and about selective collection, inaddition,the lmeja that the municipality is usingrecyclable materials and eliminating only what can no longer be used, that is, the tailings.

It should be considered that the deadline given by the city for the population to be educated environmentally is below the reality, considering that this process accompanies the extinction of the municipal dump, which must occur legally (Sanitation Framework, 2020) by the year 2022. In addition, Santos et al. (2021) mentions that environmental education should be a continuous process in order to optimize the environmental management of solid waste in a shared way.

One ofthe most recent improvement s initiative for environmental issues of the municipality, occurred on December 3, 2021, in the City Hall, and consisted of a public hearing for the presentation, discussion and receipt of criticisms / suggestions of the Municipal Plan of Basic Sanitation of Salvaterra, which includes, among others, the scenario of solid waste. At this meeting, they met with semma members, funasa representatives, representatives of the waste pickers' cooperative, religious representatives, politicians and the general population. After the hearing, the plan would undergo amendments (if necessary) to be submitted for approval by law.

4 CONCLUSION

From the research carried out and the analysis of the collected data, it was concluded that the municipality of Salvaterra does not have any Solid Waste Management Plan being implemented and, consequently, has a great lack of data about the management of RS. Thus, the performance of the gravimetric composition of the residues is essential for the elaboration of waste management plans.

In addition to the lack of data, the waste collection currently performed in Salvaterra does not cover the municipality completely, lacking the coverage of this service mainly in rural areas. Moreover, applying and stimulating selective collection are important steps that should be advocated by managers, as well as alternatives for the use of organic waste and reduction in the generation of solid waste from sustainable measures.

Another major factor evidenced in the research was the practice of open fires, this activity needs to be mitigated and if possible extinct, since it causes not only air pollution, but the gases released and particulate matter are propelling for the triggering of diseases, especially respiratory diseases.

In general and conclusively, the complete analysis of the IRP chain, despite presenting many unfavorable results to the environment and health, was essential to perform the first data collection and municipal diagnosis on the reality of waste in Salvaterra. Thus, a starting point that can support actions, stimulate and direct new studies and complement the construction of the municipal waste management plan.

REFERENCES

ABRELPE (2020). Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais. *Panorama dos Resíduos Sólidos no Brasil 2020*. https://abrelpe.org.br/panorama-2020/.

Barbosa, E. A. (2012). Resíduos sólidos: aspectos conceituais e classificação. In: Batista, R. C.; Barbosa, E. M; Barbosa, M. F. N. (Org.). Gestão dos Recursos Naturais. Rio de Janeiro: *Ciência Moderna*. p. 169-210.

Bezerra, A. M. S., Silva, A. N. B., Andrade, A. W. N., Honorato, N. R. M., Silva, A. P. F. (2019). Estudo de Impacto Ambiental do lixão municipal de Currais Novos, estado do Reio Grande do Norte – Brasil. *Anais do 10º Fórum Internacional de Resíduos Sólidos*, João Pessoa, PB, Brasil.

Brandão Júnior, E. L. B., Bernardo, G. P., Bernardo, L. P., do Nascimento, S. I. B., Lima, B. F. R., da Silva, K. V. C. C., & Cavalcante, G. M. E. (2018). Queima Inadequada de Resíduos Sólidos Domésticos, Principais Gases Tóxicos e Manifestações Clínicas: Uma Revisão de Literatura. ID on line. *Revista de psicologia*, 12(42), 602-612.

Brasil (2010). Lei n.º 12.305/2010 – Institui a Política Nacional de Resíduos Sólidos; altera a Lei n.º 9.605, de 12 de fevereiro de 1998; e dá outras providências. Brasília, DF.

Brasil (2020). Lei nº 14.026/2020 – Atualiza o marco legal do saneamento básico. Brasília, DF.

Brito, A. L. C. & Cândido, G. A. (2015). Contribuições do sistema de indicador de sustentabilidade Pressão-Estado-Impacto-Resposta (P-E-I-R) na análise situacional da vulnerabilidade socioambiental das terras indígenas. *Espacios*, 36 (6), p.116.

Faleiros, F. Kappier, C., Pontes, F. A. R., Silva, S. S. D. C. Goes, F. D. S. N. D. & Cucick, C. D. (2016). Uso de questionário online e divulgação virtual como estratégia de coleta de dados em estudos científicos. *Textro & Contexto-Enfermagem*, 20.

IBGE (2021). Instituto Brasileiro de Geografia e Estatística. *Cidades*. https://cidades.ibge.gov.br/brasil/pa/salvaterra/panorama.

Gil, A. C. (2008). *Métodos e Técnicas de Pesquisa Social*. 6 ed. São Paulo.

Gouveia, N. (2012). Resíduos sólidos urbanos: impactos socioambientais e perspectiva de manejo sustentável com inclusão social. *Ciência & Saúde Coletiva*. Rio de Janeiro 17 (6), p.1502-1510.

Lopes, L. (2006). *Gestão e Gerenciamento Integrados dos Resíduos Sólidos Urbanos: Alternativas para pequenos municípios*. Dissertação de Mestrado. Faculdade de Filosofia, Letras e Ciências Humanas, Dept. de Geografia, Universidade de São Paulo, São Paulo.

Lopes, M.G.(2019). *Propostas de gestão de resíduos sólidos urbanos para municípios considerados como "pequeno porte": sistematização de diretrizes e procedimentos relacionados à educação ambiental*. Trabalho de Conclusão de Curso. Curso de Engenharia Ambiental e Sanitária, Centro Universitário UNIFACVEST. Lages.

Marques, R.F.P.V., Silva, A.M., Rodrigues, L.S., Mendes, L.F., & Oliveira, A.S. (2021). Impactos da disposição de resíduos sólidos urbanos no solo em municípios de Minas Gerais–Brasil. *Revista Brasileira de Geografia Física*, 14(3), 1382-1392.

Mesquita Júnior, J. M. (2007). *Gestão integrada de resíduos sólidos*. Coordenação de Karin Segala. Rio de Janeiro: IBAM.

Moreira, R. S. (2016). *Contribuições do sistema de indicador de sustentabilidade Pressão-Estado-Impacto-Resposta (P-E-I-R) na análise situacional do gerenciamento dos resíduos sólidos urbanos em Aurora – CE.* Monografia. Licenciatura em Ciências Biológicas. Universidade Federal de Campina Grande (UFCG/CFP). Cajazeiras.

Moreira, R.S., Barros, J. D. S, Silva, J. L. A., Araújo, J. T. & Pordeus, A. V. (2017). Sustentabilidade Socioambiental no gerenciamento de resíduos sólidos urbanos: estudo de caso com aplicação do modelo Pressão-Estado-Impacto-Resposta. *Revista Espacios*. 38 (58), p.5.

OECD - Organisation for Economic Co-operation and Development. (1998*). Towards sustainable development: environmental indicators*. Paris.

Oliveira, F. A., Miranda, R. A. & Soares, L. A. (2019). Impactos ambientais em áreas de disposição de resíduos sólidos em Santa Helena de Goiás. *Revista Gesrão & Sustentabilidade Ambiental*, 8 (1), p. 688-706.

Oliveira, T. B.& Galvão Junior, A. C. (2016). Planejamento municipal na gestão dos resíduos sólidos urbanos e na organização da coleta seletiva. *Eng Sanit Ambient*, 21 (1), p. 55-64.

Portella, M. O. & Ribeiro, J. C. J. (2014). Aterros sanitários: aspectos gerais e destino final dos resíduos. *Revista Direito Ambiental e Sociedade*, 4 (1), p. 115-134.

Reis, P.T.B.; Mattos, U.A.O. & Silva, E.R. (2018). Gestão municipal de resíduos sólidos urbanos à luz da Política Nacional de Resíduos: estudo de caso no município de Japeri, RJ, Brasil. *Sistemas & Gestão*, 13 (3), p. 321-333.

Reis, R. L., Peixoto, F. S., Miranda, C. D. S., Rosa, P. C. M., & Silva, C. H. (2019). Impactos socioambientais causados pela dinâmica do lixão do município de Bragança-PA, Brasil. *Anais do 2º Congresso Sul-Americano de Resíduos Sólidos e Sustentabilidade*. Foz do Iguaçu, PR, Brasil.

Santos, E. F., Lara, D. M., & Prestes, M. M. B. (2021). Gestão compartilhada dos resíduos sólidos como instrumento para a educação ambiental na escola. *Revista Brasileira de Meio Ambiente e Sustentabilidade*, 1(2), 167-189.

Salvaterra. (2016). Lei nº 1.189/2016 – Institui a Política Municipal de Resíduos Sólidos; e define metas, princípios e diretrizes e dá outras providências. Salvaterra – PA.

Silva, K. K. B. (2019). *Implementação de projeto integrado de compostagem e educação ambiental em uma escola na cidade de Natal-RN*. Trabalho de Conclusão de Curso. Curso de Engenharia Civil, Centro de Tecnologia, Departamento de Engenharia Civil, Universidade Federal do Rio Grande do Norte, Natal.

Silva, M. E. & Cândido, G. A. (2012). A análise de indicadores de sustentabilidade na problemática de resíduos sólidos em Campina Grande – PB. *Reuna*, 17 (1), p. 91- 110.

Silva, S. S. F. (2010). *Diagnóstico situacional dos resíduos sólidos urbanos no Município de Cuité-PB, através da aplicação do Sistema de Indicador de Sustentabilidade Pressão-Estado-Impacto-Resposta (P-E-I-R).* Dissertação de Mestrado. Universidade Federal de Campina Grande. Campina Grande.

Soares, A. M. (2017). *Avaliação do gerenciamento de resíduos sólidos através do sistema de indicadores de sustentabilidade Pressão-Estado-Impacto-Resposta (PEIR).* Trabalho de Conclusão de Curso. Curso

de Licenciatura em Ciências Biológicas, CFP/UFCG, Universidade Federal de Campina Grande, Cajazeiras.

Soler, J. A.P., Delgado, F. M., Sanjuán, A. M. B., & García, M. N (2018). Modelos para evaluar la sostenibilidad de las organizacione. Estudios Gerenciales, 34 (146), 63-73.

Tayra, F. & Ribeiro, H. (2006). Modelos de Indicadores de Sustentabilidade: principais experiências. *Saúde e Sociedade*, 15 (1), p. 8495.