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Artigo Original

Educação ambiental aplicada ao gerenciamento de resíduos sólidos em Frederico Westphalen, RS

Environmental education applied to solid waste management in Frederico Westphalen, RS

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Resumo

A gestão de resíduos sólidos urbanos (RSU) constitui uma questão altamente desafiadora a ser enfrentada para se avançar nas políticas urbanas sustentáveis. Para que um sistema de gestão de resíduos seja sustentável, espera-se que o mesmo seja ambientalmente eficiente, economicamente viável e socialmente aceito pela população diretamente afetada. Porém, no que se refere às áreas rurais, a gestão e o tratamento de resíduos estão sendo esquecidos e, consequentemente, grandes quantidades de resíduos estão sendo descartados de forma inadequada, levando a sérios problemas ambientais. Nesse contexto, este trabalho teve como objetivo avaliar a situação real dos resíduos sólidos na comunidade da linha São José localizada na zona rural do município de Frederico Westphalen-RS, buscando-se propor soluções para o gerenciamento de resíduos, juntamente com o desenvolvimento da sensibilização ambiental dos moradores. O procedimento metodológico utilizado compreende um levantamento de dados para obter informações através de um questionário. Foram instaladas coletoras de resíduos secos no centro da comunidade e realizadas campanhas de educação ambiental. O maior agravo encontrado foi a queima de resíduos secos, sendo que a coletora implantada na comunidade trouxe resultados positivos para esse problema. As demais campanhas realizadas demonstraram grande importância para a gestão de resíduos e uma melhora na qualidade de vida dos moradores da comunidade.

Palavras-chave: Destinação final; Meio ambiente; Gestão ambiental; Sensibilização ambiental; Gestão de resíduos

Abstract

Urban Solid Waste (USW) management is a highly challenging issue to be addressed in advancing sustainable urban policies. For a waste management system to be sustainable, it should be environmentally efficient, economically viable and socially accepted by the directly affected population. However, with regard to rural areas, waste management and treatment are being forgotten and consequently large amounts of waste are being inappropriately discarded, leading to serious environmental problems. In this context, this study aimed to evaluate the real situation of solid waste in the Linha São José community, located in the rural area of Frederico Westphalen city (RS, Brazil), proposing solutions for waste management and seeking the environmental awareness of the inhabitants. The methodological procedure used includes a data survey through questionnaire, in order to obtain information. Dry waste collectors were installed in the community center and environmental education campaigns were performed. The biggest issue found was the burning of dry waste which was handled by the collector implanted in the community, showing positive results for the problem. The other campaigns performed showed great importance for the waste management and an improvement in the quality of life of the community's inhabitants.

Keywords: Final destination; Environment; Environmental management; Environmental awareness; Waste Management

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1 Introduction

Urban Solid Waste (USW) management is a highly challenging issue to be addressed in order to advance sustainable urban policies (PERI et al., 2018), being one of the most relevant factors for public sanitation including population health, aesthetics and environmental protection of the cities. USW management encompasses all necessary activities and actions to manage waste from collection to final disposal (AL-KHATIB et al., 2007). For a waste management system to be sustainable, it should be environmentally efficient, economically viable and socially accepted by the population directly affected by the system itself (MORRISSEY; BROWNE, 2002; TOPALOGLU, 2018). However, with regard to rural areas, waste management and treatment are being forgotten and consequently large amounts of waste are being inappropriately discarded, leading to serious environmental problems.

In Brazil, data referring to the generation of domestic solid waste present an annual total of 78.4 million tonnes, of which the amount collected was 71.6 million tonnes, registering a collect index of 91.2% (ABRELPE, 2017). The rural population is estimated at 30 million people, generating 39,000 tonnes of domestic solid waste per day, of which only 33% are collected (BRAZIL, 2011). With the lack of investment in the rural area, especially with regard to the sustainable management of solid waste, these areas may present many negative environmental impacts (ROVERSI, 2013).

The participation of the population is also a key aspect for the success of environmental policies and waste management. Among the responsibilities of the small generator are the actions of separating dry and wet waste, as well as their correct storage. Therefore, it is necessary to stimulate environmental awareness of the population with environmental awareness campaigns in cities, communities and schools, motivating them to effectively participate in programs and actions. Thus, it will be possible to strengthen a partnership between society and public authorities aiming at sustainable development (SILVA, 2014).

Solid waste is still a problem for society, especially those that have dangerous elements in their composition, such as fluorescent lamps, batteries and general electronics, which have heavy metals in their composition. Fluorescent lamps, when broken or buried, contaminate the environment, demanding some care with handling and destination (VALDUGA, 2015).

In this context, this study aimed to evaluate the real situation of solid waste in the Linha São José community, located in the rural area of Frederico Westphalen city (RS, Brazil). After this evaluation, we sought to propose solutions for waste management, with regard to the separation and proper destination of solid waste.

2 Methodology

2.1 Study area

The study area is located in the Linha São José in Frederico Westphalen city (Rio Grande do Sul, Brazil). The city has a population of 30,832 inhabitants, according to estimates made in 2017 (IBGE, 2017) and, concerning to its geographical position, it appears as an academic center, covering five university centers. Frederico Westphalen has an extension program known as Recicla Frederico, which develops several actions to assist the municipality in solid waste management such as recycling, adequate destination and reverse logistic (Recicla Frederico, 2016), as addressed by the National Policy on Solid Waste (Law 12.305/2010).

2.2 Data Collection and Analysis

The methodological procedure used includes a data survey through questionnaire, in order to obtain information. The questionnaire was composed by 17 closed questions applied to the residents of the Linha São José, aiming to cover all education levels and to identify possible issues in relation to waste, for subsequent correct destination. Data were collected from 50 residences, covering a study population of approximately 155 people, with an average of three people per residence, contemplating the whole population of the community. The figures were made using the software *Microsoft Excel 2013*.

Five dry waste collectors were installed in the community center, which covers school, church, cemetery, gymnasium, soccer fields and basic health unit, because they are places with larger crowds of people. After the placement of the collectors, the collected wastes were quantified. Then, campaigns were performed: the first one covered waste collection near the community center, and environmental awareness signs were placed on the margins of traffic routes, so that people from outside the community may be aware of the inadequate disposal of waste. In addition, other campaign was performed through reverse logistic, aiming the collection of agrochemical packaging.

3 Results and Discussion

It is important to observe that 41% of the population is adult (35 to 59 years old), 24% is senior (60 years or more), 22% is young (19 to 34 years old), 7% is adolescent (13 to 18) and children (0 to 12) represent 6% of the population, as can be seen in Figure 1. The gender of the population was identified as 53% female and 47% male.

With regard to schooling, 1% only completed primary education, 14% only completed high school, 9% completed higher education, 57% presents incomplete primary education, 4% presents incomplete high school, 14% presents incomplete higher education and 1% is illiterate, as shown in Figure 2. These aspects analyzed are of great importance in order to choose the best environmental awareness method to be used, aiming to successfully bring knowledge to all the residents.

As the population is mostly adult with little education (incomplete elementary education), it was observed the difficult access to the Internet and social networks as means of communication. Thus, the best way to reach the maximum target audience was through informal

Figure 1 — Age group of the population

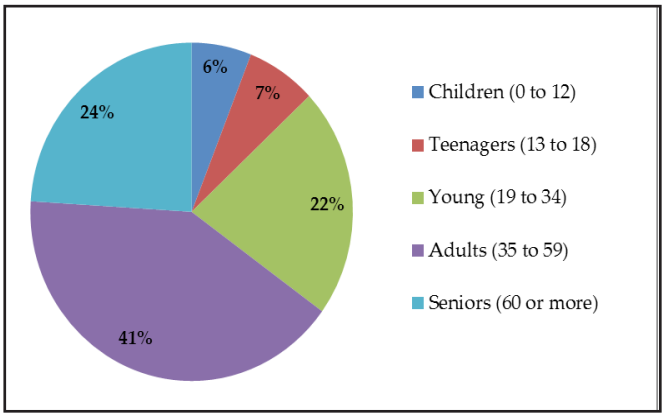
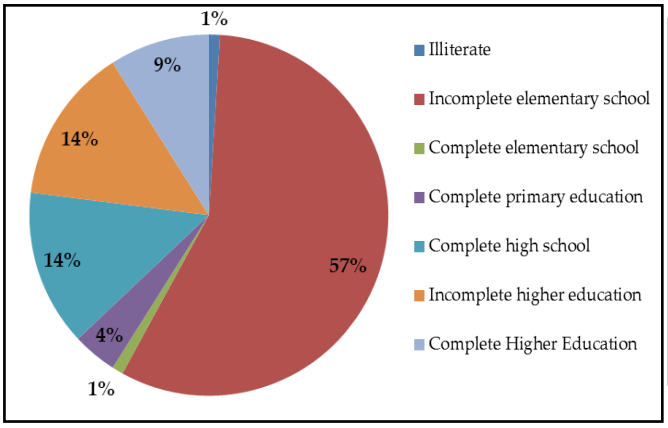


Figure 2 — Scholarity of the population



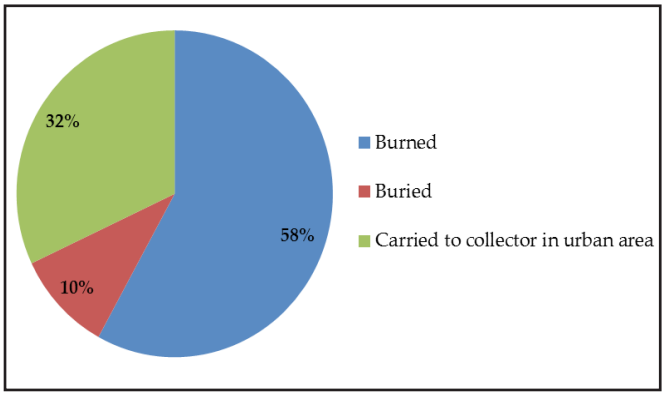
conversation, clarifying doubts and providing guidance, in order to encompass environmental awareness.

Considering the knowledge of the population on specific issues such as selective collection, solid waste and the difference between waste, 80% of the population claimed to have knowledge about selective collection, 74% said they know what solid waste is, and 66% knew the difference between waste and tailings. These data are very important to know the study population and what measures should be taken to achieve the expected results.

3.1 Diagnosis of the Current Situation of Solid waste Generated in the Community

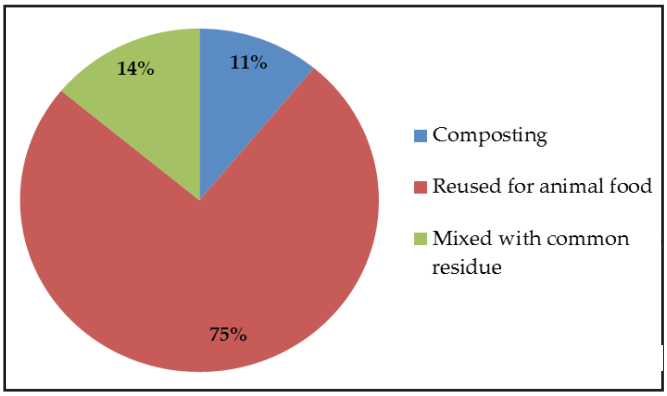
With the study performed, it was observed that 86% of the population separates the waste and 14% does not present this habit. Regarding the final destination of dry waste, 58% of the population burns their waste, 32% takes the waste to some collector in the city, and 10% buries them, as shown in Figure 3. From these results, we can observe the severity of the problem, since most of the population burns their waste open-air, causing numerous environmental impacts (such as soil contamination, air and water pollution) and problems that may affect the population's health. Therefore, the solution adopted was the installation of waste collectors in the community center, aiming the proper waste disposal by the community.

Figure 3 — Data on the destination of dry waste from the residences



Regarding organic waste, 75% of the inhabitants use them as animal feed, 14% mix them with the dry waste of the residence and 11% compost the waste (Figure 4).

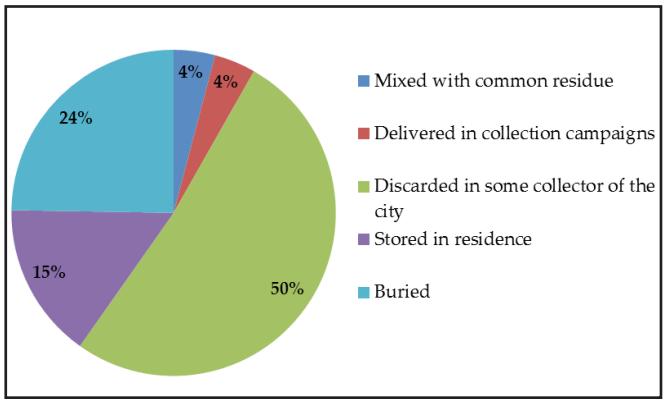
Figure 4 — Data on the destination of organic waste from the residences



It was identified that organic waste is not a serious problem in the community, since most of the residents performs the correct separation, reusing it as a complement to animal feed. With respect to wastes mixed with common waste it was oriented to give them an adequate destination, through composting and soil application, thus obtaining an efficient fertilizer, which makes the food planted by the inhabitants healthier, without chemical additives.

Success was achieved considering this issue, since the results indicated that there was no mixing of the organic fraction after the dialogue with the community, evidencing the community's awareness. On glass and burned/disused lamps, all residents claimed to give the glass the same destination as for the lamps, 50% claimed to discard them in some collector in the city, 24% buried them, 18% have this waste stored in their home, waiting for the correct destination, 4% mix them with common waste and 4% take the waste in collection campaigns (Figure 5).

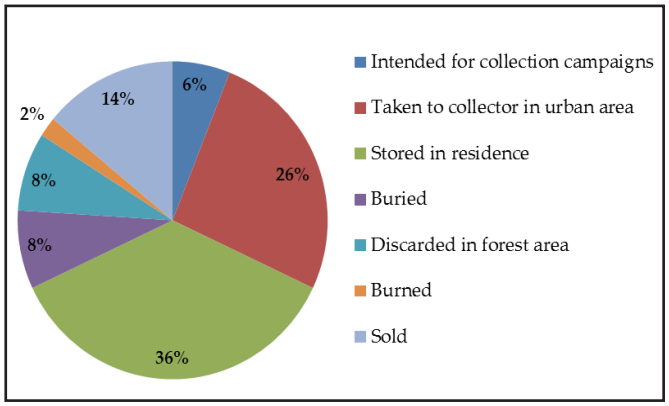
Figure 5 — Destination of glasses and lamps



According to the research performed, 50% of the people who bury their waste of glassware and light bulbs had knowledge about taking these residue to a collector in the urban area, since it was possible to perceive the concern in making the correct disposal. We sought to understand the reason for not having more community participation in the special waste collection campaigns of the city and, according to the residents, the greatest difficulty found by them is the prioritization of other tasks on the days of collection.

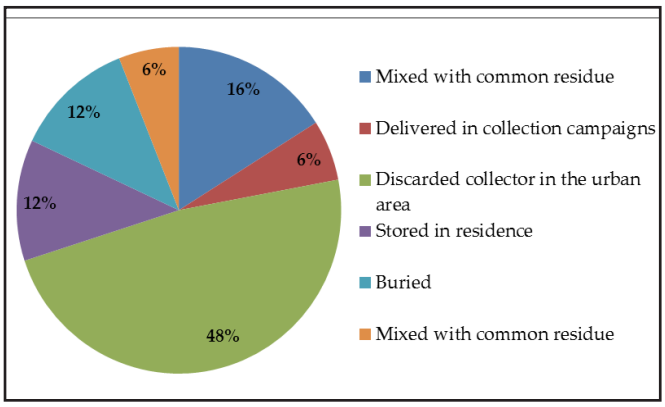
Considering the electrical and electronic waste, it was identified that 36% of the community stores this waste to send it to the correct destination, 26% take it to a collector in the city, 14% sell it for scrapyard, 8% bury it, 8% discard it in the forest area, 6% take it to collection campaigns and 2% burn it, as shown in Figure 6.

Figure 6 — Destination of electronic and electrical waste



On the unused batteries, a percentage of 48% of residents take them to a collector in the city, 16% mix them with common waste, 12% buried them, 12% store the batteries in their residences, 6% take them to collection campaigns and 6% store them in their residences and mix them later with common waste. These results are presented in Figure 7.

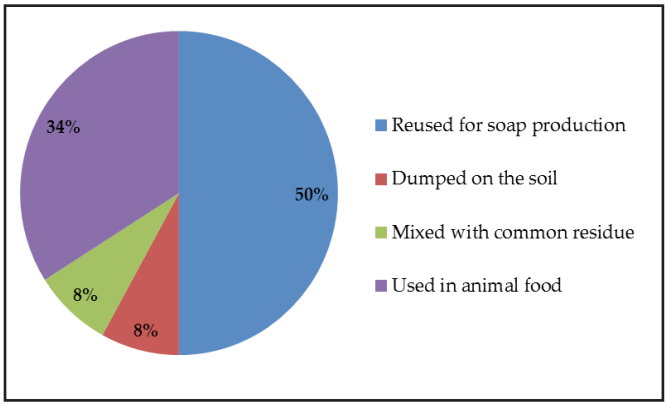
Figure 7 — Destination of batteries by community residents



Hazardous waste requires a special treatment, since they have harmful components in their composition, such as heavy metals (FURTADO, 2004; AFONSO et al., 2003; SOUZA et al., 2001). A serious issue was observed in the community, since 52% of the inhabitants claim to make incorrect destination of this waste.

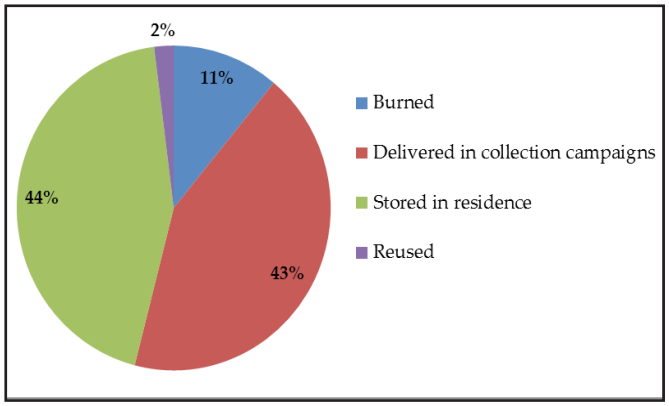
With regard to cooking oil waste, most of the inhabitants claim to reuse it: 50% have been using oil waste for making homemade soap, 34% have been using it in animal feed (along with organic waste), 8% mix it with the common waste and 8% discard it in the soil (Figure 8). Cooking oil is not considered a waste that has great impact on the community, as most reuse it. However, it is important to highlight the contamination potential of these improperly disposed wastes (in the soil or mixed with common waste), especially in surface water sources.

Figure 8 — Destination of reused cooking oil



As the study area was in the rural area, it is important to consider the agrochemicals packaging, since the generation of this type of waste is common in these areas. It was observed that 76% of the interviewees use agrochemicals. When analyzing the destination of the packages, it was identified that 44% of them are stored awaiting the correct destination, 43% are taken to collection campaigns, 11% are burned and 2% of the containers are reused as flower pots or as diesel storage containers, as shown in Figure 9.

Figure 9 — Destination of agrochemical packaging



To the inhabitants who use agrochemicals, it was questioned about the triple washing of the packages, that is, washing the agrochemical packaging after the emptying, three consecutive times. In this case, 97% said they know this practice and do it, and 3% said they know it, but do not make use.

It was also investigated the interest of the community residents in campaigns of environmental awareness and waste collection within the community, observing that they show interest in these practices. It was identified that they are interested in participating in projects such as special waste collection (55%), waste recycling courses such as home composting, homemade soap and handicrafts (31.5%), as well as lectures and seminars on environmental issues (13.5%).

The community has collection services and solid waste transportation once a week, which are offered by the City Hall. The waste is taken to CIGRES (Consórcio Intermunicipal de Gestão de Resíduos Sólidos), an intermunicipal consortium on waste management located in the Municipality of Seberi (RS, Brazil). However, the waste collection occurs only in the central area of the community, making it difficult for residents to give the correct destination to their waste. This is due to the lack of a specific location for the storage of the waste. In order to solve this problem, collectors were installed in the community center.

3.2 Collectors Sizing

The collectors sizing is very important since the waste that is collected must be stored in order to meet the population's total waste volume during the seven days, considering that it will be collected once a week, and storage space is needed to avoid problems such as open-air waste, insect proliferation and agglomeration of animals. Thus, calculations were made to obtain the amount of waste being generated and the volume needed for its storage.

Domestic waste generation was calculated for the collector dimensions based on the Manual de Gerenciamento Integrado de Resíduos Sólidos (Manual of Integrated Management of Solid Waste), which can be calculated by the average amount of waste per inhabitant/day. The value can vary from 0.35 to 1 kilogram (kg) per inhabitant/day, but for the Brazilian population it is estimated from 0.60 to 0.8 kg per inhabitant/day (Manual de Gerenciamento Integrado de Resíduos Sólidos, 2001). For the south region, a generation of 0.76 kg per inhabitant/day is estimated (ABRELPE, 2017).

For the calculation of the waste generation, the population considered was 155 inhabitants, and the waste generation of 0,76 kg per inhabitant /day, thus:

Waste generation per day

Waste generation per inhabitant/day = inhabitant · per capita generation

Waste generation/day = 155 inhabitants • 0,76 kg/inhab/day

Daily generation = 117.8 kg

Weekly generation

Weekly generation = 117.8 Kg/day • 7 days

Weekly generation = 824.6 kg/week

The organic waste represents, on average, 52% of the total waste generated by the population (ABRELPE, 2014). Therefore, from the total of 824.6 kg generated weekly, 52% of the organic fraction will be excluded, since the collectors will be implanted to receive only dry waste. Thus, the collector must hold 395.8 kg of dry waste per week.

For the calculation of the total volume, it is necessary to know the gravimetric density of each material. As the volume of each type of waste generated per week is unknown, the volume that had already been deposited in the community center was used during the first three weeks. Thus, the percentage calculations were made for each waste deposited in the collector, obtaining a weekly percentage of each type of waste, making possible to obtain the waste average, as shown in Tables 1 and 2.

According to Silva and Santos (2009) the waste density is 179.5 kg/m^3 (kilogram per cubic meter) for plastic, 338 kg/m^3 for paper and paperboard, 53 kg/m^3 for metal, 119 kg/m^3 for fabrics, 50 kg/m^3 for glass and 240 kg/m^3 for waste. Considering a total required amount of 395.8 kg of waste per week, the calculations were performed to identify the amount that this value is equivalent for each material, obtaining the following values: 207.4 kg of plastic (requiring a volume of 1.17 m^3 for its storage), 49.87 kg of paper (occupying 0.14 m^3), 45.91 kg of metal (occupying 0.87 m^3), 32.57 kg of fabric (occupying 0.27 m^3), 10.96 kg of glass (occupying 0.22 m^3) and 49.07 kg of waste (occupying 0.2 m^3). Finally, it was possible to identify that the volume requirement for the collectors is about 2.87 m^3, thus attending to the waste volume deposited weekly.

In order to choose the model and material to be used for making the collectors, it was taken into account that the waste could not be exposed to the open-air, subjected to soil contamination and proliferation of animals and insects. Therefore, the collectors were made with top and bottom sealing. Initially, two collectors were installed in the community center, however, through the quantification of the waste in the first two weeks of study, the acceptance and use of the collectors by the community

Table 1 — Percentage of waste in the collector in the first three weeks

1st Week		2nd Week		3rd Week	
Percentage	**Waste**	**Percentage**	**Waste**	**Percentage**	**Waste**
50 %	Plastic	52 %	Plastic	55 %	Plastic
10 %	Paper	10 %	Paper	18 %	Paper
10,60 %	Metal	12,40 %	Metal	11,80 %	Metal
24 %	Fabric	0 %	Fabric	1 %	Fabric
1,40 %	Glass	5,60 %	Glass	1,20 %	Glass
4 %	Waste	20 %	Waste	13 %	Waste

Table 2 — Average percentages

Percentage	Waste
52,40 %	Plastic
12,60 %	Paper
11,60 %	Metal
8,23 %	Fabric
2,77 %	Glass
12,40 %	Waste

Figure 10 — Collectors installed in the Linha São José

were observed, being necessary to make more collectors, which were later installed together with the others, as shown in Figure 10.

The volume of the collectors was calculated based on the required quantity, considering the weekly volume to be served (2.87 m^3). For that reason, the volume of each collector was calculated, which is 0.23 m^3, thus requiring 13 containers, as shown in the following calculations:

Diameter of the container base = 59,5 cm → radius = 29,75 cm → 0,297 m
Container height = 84,6 cm → 0,846 m
Container volume = Container base area · height
Container base area = $\pi \cdot 0{,}2975^2$
Container base area = 0,2975 m^2
Container volume = 0,278 $m^2 \cdot$ 0,846 m
Container volume = 0,23 m^3

The wastes were weighed weekly in April and May 2018, with separation of plastics, papers, fabrics, styrofoam, glass, metals and tailings. The results obtained by weighing dry waste in the collectors can be observed in Tables 3 and 4.

Through the weighing it was observed that in the first week of April there was not much participation by part of the community, perhaps because it was something new. However, from the following weeks, it was observed a gradual increase in the quantification of waste and in the participation of community residents.

3.3 Waste Collection on the Main Road to Community Access

During the development of the study, residents reported that many people of the municipality would be depositing their waste along the main road to community access. Thus, a day of waste collection was performed in the place, the wastes were stored in plastic bags and later separated and quantified, according to their source material. The way found to work on environmental awareness, in this case, was the implantation of environmental awareness signs in this place, as shown in Figure 11.

Figure 11 — Sign fixed for environmental awareness

Table 3 — Waste weighing in the collector in April 2018

Types of Waste	April (1st week) (Kg)	April (2nd week) (Kg)	April (3rd week) (Kg)	April (4th week) (Kg)
Plastic	6,5	11,2	16,6	15,3
Paper	1,2	2,1	5,3	5,8
Metal	1,4	2,7	3,3	2,4
Fabrics	3,2	0	0,2	0
Styrofoam	0	0	0,3	0,5
Glass	0,2	1,2	0,5	0
Waste	0,5	4,3	3,8	4,8

Table 4 — Waste weighing in the collector in May 2018

Types of Waste	May (1st week) (Kg)	May (2nd week) (Kg)	May (3rd week) (Kg)	May (4th week) (Kg)
Plastic	16,9	17,3	19,3	21,8
Paper	6,3	5,2	4,7	5,1
Metal	2,3	1,6	1,8	2,1
Fabrics	0	4,0	0	0
Styrofoam	0	0	0,4	0
Glass	1,2	2,6	0	1,8
Waste	5,1	4,2	4,6	5,3

By weighing the waste collected on the road, it was concluded that most of them were plastics, glass and metals. After this collection, environmental awareness signs were fixed in this place, and it was observed that there was no effective and immediate result in the inhabitants' awareness, since in the same week plastic bags, cans, styrofoam trays and other wastes appeared. However, after the first week of implementation of the environmental awareness signs there was a gradual decrease in the amount of waste generated.

3.4 Reverse logistics of Agrochemical Packaging

In the campaign for the collection of agrochemicals, 50 packages were collected, 13 of which were of 20L (liters), 8 of 5L and 29 of 1L (Figure 12). The packages collected were sent to a company specialized in this area.

Figure 12 — Agrochemical packaging collected in the campaign

3.5 Collection of Special Waste

Special waste such as glass and electronics were collected on an abandoned property where the owners requested a disposal for this waste. They were collected and delivered to the intermunicipal consortium for solid waste management, located in the municipality of Seberi - RS (Brazil). The collected wastes were quantified, obtaining 45.3 kg of glasses, 8.5 kg of junkyard, 3.3 kg of electronics and 0.6 kg of plastics.

3.6 Environmental Education

The Environmental Education of the study population was approached in three different moments. In the first moment a questionnaire was applied, clarifying the residents' doubts about the types of waste that would be collected, as well as some important information about the respiratory diseases that can occur with the burning of the waste and the impacts of the inadequate disposition of waste in their residences (such as contamination of the environment, visual pollution and vectors attraction). In the second moment the environmental awareness signs were placed along the main access road to the community. Finally, the third moment was evidenced by dialogue with the community, where a larger audience was reached. There was also an opportunity to talk about the decomposition time of some waste, such as the glass (that takes around 4,000 years to decompose), the PET bottle and the aluminum (that take more than 100 years), the plastic bag (30 to 40 years), among others (RICCHINI, 2015). This moment was attended by an audience of all ages and genders.

4 Final Considerations

The population chosen for study accomplishment was predominantly adult and had incomplete elementary schooling, so the development of this study was through dialogue, in an informal language, thus reaching the target audience. It is important that, along with the waste management work, there was awareness of the population for the success of the research.

In the design and implementation of dimensioned waste collectors it was estimated that there would be a need for 13 collectors, however, due to some factors such as the non-participation of the whole community, or a per capita generation of waste lower than the expected in urban areas, only 5 containers were implanted, which are sufficient to meet the demand imposed by the community.

The work had great value to the residents of the Linha São José community, located in the city of Frederico Westphalen - RS, as it enabled the clarification of residents' doubts regarding the correct separation of waste, and other information related to environmental education, sensitizing them and making the community as an example to the others, now having a place for dry waste collection. Through the installation of signs on the main access road to the community, it was possible to keep the road clean and organized, allowing people to move around and have access to the community, visualizing the concern with the environment and the destination of waste, and sensitizing those who travel along this route.

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