CLEISEANO EMANUEL DA SILVA PANIAGUA
(ORGANIZADOR)

Collection:

APPLIED ENVIRONMENTAL AND SANITARY ENGINEERING

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Ano 2022

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Atena Editora
Ponta Grossa – Paraná – Brasil
Telefone: +55 (42) 3323-5493
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PRESENTATION

The e-book:“Collection: Applied environmental and sanitary engineering” consists of nineteen book chapters that address different themes, but which converge to an enormous concern that increasingly threatens the quality and well-being of future generations: use sustainable environment and its different biotic and abiotic factors. In this sense, the organization and presentation of book chapters was carried out in four thematic areas, providing a better organization and sequencing, leading to a better understanding and ease in understanding each chapter in this e-book. Therefore, the e-book was divided into four thematic areas, namely: *i*) evaluation of the quality of water resources intended for human consumption; *ii*) emission of particulate materials from the combustion of fuels by the fleet of motor vehicles and the burning of large green areas in order to meet the interest of the agricultural sector; *iii*) actions to minimize the amount of waste sent to sanitary landfills, controlled or dumps based on the practice of segregating recyclable waste; *iv*) basic sanitation and the increase in the Human Development index, generation of energy and fertilizers from biodigestion processes and the presence of pesticides and pharmaceuticals in foods of animal origin.

The first theme consists of six book chapters dealing with the importance of continuous monitoring of water quality for drinking purposes, with studies being presented that prove the lack of efficiency in removing microorganisms with pathogenic properties. Furthermore, the importance and creation of public policies in order to avoid the eutrophication of aquatic bodies that are increasingly common in urban areas. The second consists of four chapters that evaluated the air quality from the emission of particulate materials from human activities, including the burning of fuels and fires in different biomes and how these have been influencing the increase in the formation of islands of heat in urban centers.

The third theme consists of four book chapters that address the importance of carrying out the construction of residential works (condominiums) in order to encourage residents to develop an environmental awareness in relation to the segregation of waste, especially organic and recyclable ones, and the latter would be intended for people who work and with recycling and who contribute significantly to the reduction in the final disposal of waste. Finally, the fourth theme consists of five chapters that present works that discuss the importance of biodigestion in rural areas, basic sanitation as an important factor in determining the HDI and the importance of monitoring the presence of pesticides and drugs in food of animal origin.

In this perspective, Atena Editora has been working with the aim of stimulating and encouraging researchers from Brazil and other countries to publish their work with a guarantee of quality and excellence in the form of books and book chapters that are available on the Editora’s website and elsewhere. digital platforms with free access.

Cleiseano Emanuel da Silva Paniagua

SUMÁRIO

CAPÍTULO 14

ECONDOMÍNIOS PROJECT: SOLID WASTE MANAGEMENT IN RESIDENTIAL CONDOMINIUMS

Data de aceite: 10/01/2022

Gerson Araujo de Medeiros
São Paulo State University, Campus of Sorocaba

Ana Paula Loro
São Paulo State University, Campus of Sorocaba

ABSTRACT: The National Solid Waste Policy has governed the panorama of solid waste in Brazil. In this Policy, all municipalities must present their Solid Waste Master Plan. As an expressive generator, condominiums play a prominent role in this scenario, as their waste is, as a general rule, originated from domestic activities. The objective of this work was to present the results of the Econdomínios project to establish solid waste management strategies in residential condominiums in the municipality of Sorocaba, state of São Paulo, Brazil. The solid waste characterization, sorting and quantification in a Sorocaba condominium was the methodological base of this work. The results demonstrate the more significant generation of recyclable materials in a residential condominium of a middle social class, pointing to the importance of selective collection in this segment to make the recycling cooperatives in the region economically viable. An improvement in the solid waste management of the evaluated condominiums is necessary, both to reduce the amount of recyclable material in the collection of organic waste and promote a reduction in generation, improving the valuation of garbage collected by cooperative members and seeking management sustainability urban solid waste.
KEYWORDS: Recycling, waste sorting, extension.

RESUMO: O panorama dos resíduos sólidos no Brasil está sendo regido pela Política Nacional de Resíduos Sólidos. Nessa Política, todos os municípios têm que apresentar seu Plano Diretor de Resíduos Sólidos. Os condomínios, como um expressivo gerador, têm um papel de destaque neste cenário, pois seus resíduos gerados são, em regra geral, originados de atividades domésticas. O objetivo do presente trabalho foi apresentar os resultados do projeto Econdomínios, para estabelecer estratégias de gestão dos resíduos sólidos em condomínios residenciais, no município de Sorocaba, estado de São Paulo, Brasil. A metodologia se baseou na caracterização dos resíduos gerados por um condomínio de Sorocaba, incluindo a sua identificação, separação e quantificação. Os resultados demonstram a maior geração de materiais recicláveis em condomínio residencial de uma classe social média, apontando para a importância da coleta seletiva nesse segmento como forma de viabilizar economicamente as cooperativas de reciclagem da região. Um aprimoramento da gestão de resíduos sólidos dos condomínios avaliados se faz necessário, tanto para reduzir a quantidade de material reciclável na coleta de resíduos orgânicos, quanto para promover a redução na geração, melhorando a valoração do lixo recolhido pelos cooperados e buscando a sustentabilidade da

gestão de resíduos sólidos urbanos.
PALAVRAS-CHAVE: Reciclagem, separação de resíduos, extensão.

1 | INTRODUCTION

In the context of generators of municipal solid waste, condominiums have played a prominent role due to the phenomenon of urbanization in Brazil and the growth of this type of settlement in the urban space of cities.

In 2019, Brazil generated 79 million tons of municipal solid waste (MSW), corresponding to a per capita generation of 0.379 kg per year (ABRELPE, 2020). In cities with the highest population concentration, the daily average of solid waste generation exceeded 1.2 kg per inhabitant, an amount that is equivalent to the rates verified in developed countries (ABRELPE, 2020).

The destiny of approximately 63% of the total is the landfill, followed by the discard of 18% in dumps without any treatment, and 5.4% treated in facilities for sorting, composting, and recycling materials (Paes et al. 2020a).

The state of São Paulo highlights in the Brazilian country because of the highest gross domestic product (GDP) (US$ 527 billion) and the second-highest per capita annual income in the country (US$ 12,075.00) (IBGE, 2019). In this state, a total waste generation reached around 23 million t per year (ABRELPE, 2020), where about 50% of generated MSW in just nine of the 645 municipalities, with more than 500,000 inhabitants, including Sorocaba (State of São Paulo, 2017). Sorocaba covers an area of 456 km2, with 671,000 inhabitants and an industrial economy profile.

The environmental impacts of the disposal of MSW in dumps and landfills include soil, surface and underground water, and air pollution, according to investigations of several authors, in municipalities of different Brazilian states, such as São Paulo (Medeiros et al., 2008a; Medeiros et al., 2008b; Beli et al., 2005), Minas Gerais (Medeiros et al., 2009a, Medeiros et al., 2009b), Amazonas (Oliveira & Medeiros, 2020), in addition to other countries, like Angola (Cristóvão et al., 2021). Such researches demonstrate the adverse effects on the environment of the disposal of residues in the soil, which highlights the importance of an MSW management plan in the municipal, state and federal scope (Paes et al., 2020a)

A social actor with growing importance in Brazilian cities is the cooperatives that collect, sorting and send the waste generated in the municipality to recycling companies. The improvement in the performance of these cooperatives is possible through a waste management plan for the different settlements living in the urban environment, such as those in residential condominiums. Such a plan can incorporate a series of guidelines that, if followed, provide an optimized and effective system for the transport, allocation and disposal of discarded waste. In this process, environmental education assumes considerable relevance as an instrument of awareness and information on municipal solid

waste management precepts, such as the hierarchy (reduction, recycling, recovery and reuse).

The main goal of this chapter was to present the results of the ECOndomínios project and substantiated by the diagnosis of recyclable household solid waste in a residential condominium. Based on this diagnosis, we developed guidelines for environmental education.

2 | MATERIAL AND METHODS

The ECO-domains project was created in 2012 to disseminate the principles of sustainable management of domestic solid waste, more specifically in the residential condominium sector, showing considerable growth in Sorocaba and the region. In this way, we outlined extension and environmental education guidelines.

The first step of the work was the characterization of the waste generated by the Encanto condominium in Sorocaba, state of São Paulo, in August 2014. Encanto condominium is a residential located in 1.49 ha, with 150 apartments and around 350 residents.

This stage included the identification, separation and quantification of solid waste generated in the condominium. We provided two containers for residents to deposit solid waste. The first corresponded to the deposit of organic waste (food waste) and the second for the disposal of dry recyclable waste (plastic, glass, paper and metals) and rejects (clothes, ceramics, greased paper, snack packaging). In the awareness and environmental education campaigns with the tenants, we prepared dissemination materials, such as pamphlets, on recycling and solid waste management, becoming one of the main methodological approaches of this study. Meetings with residents, structured the work carried out inside the condominium and presented the material developed for the campaign, characterization and strategies for solid waste management.

3 | RESULTS AND DISCUSSION

The estimation of domestic waste generation in the Encanto condominium reached 1,450 kg.month^{-1}, or 4.1 kg.(inhabitant.month)$^{-1}$. This total was about a third of that observed by Ribeiro et al. (2013) in work carried out in the Lagoa Azul condominium (13 kg.(inhabitant.month)$^{-1}$) in the city of Sorocaba, also part of the ECOndomínios project. This difference may be related to the profile of the Encanto condominium residents, predominantly a student population, unlike the Lagoa Azul condominium, which is family-owned. Costa et al. (2002) carried out a survey of the generation of solid waste in a residential condominium where about 36 people lived in Campina Grande, state of Paraiba, Brazil. In this study, the authors measured a generation of 10.7 kg.(inhabitant.month)$^{-1}$, demonstrating the variability in the

quantity of MSW in the context of condominiums.

The average monthly generation in Sorocaba, in 2014, reached 24.1 kg.(inhabitant.month)$^{-1}$ (Paes et al., 2020a). Therefore, the estimated generation in the Encanto condominium corresponded to approximately 17% of that observed in that municipality. The municipal waste collection of Sorocaba includes garden and commercial establishments, with a different generation profile from that studied in this research. A private sanitary landfill in the municipality of Iperó, 14 km far from the centre of Sorocaba, receives the waste from Sorocaba city. Therefore, a broad solid waste management program is essential in this municipality, involving all sectors of society (Paes et al., 2020).

The results of the MSW analysis surveyed at the Encanto condominium can be seen in Figure 1.

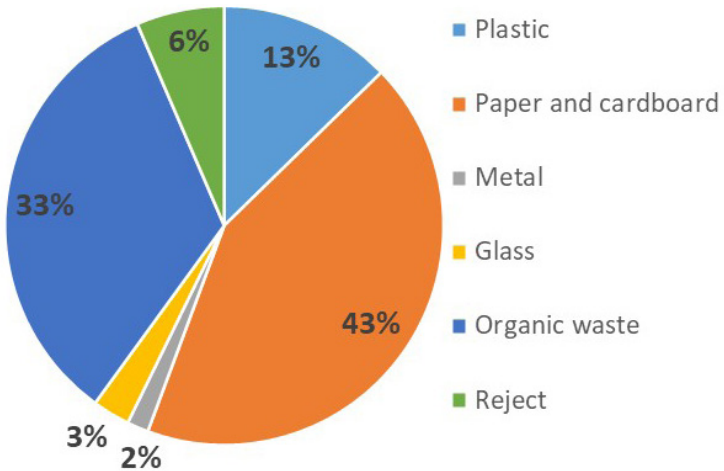

Figure 1. Characterization of solid waste generated in the Encanto condominium in Sorocaba, Brazil.

Paper and cardboard residues predominated, corresponding to 946 kg.month^{-1}, or 2.7 kg.(inhabitant.month)$^{-1}$. This amount represented 65.3% of dry recyclable waste. The predominance of paper and cardboard agrees with the results of Ribeiro et al. (2013) in a residential condominium in Sorocaba, reaching 57% of the amount of dry recyclable solid waste generated.

Organic waste was the second category that stood out regarding generation, reaching 754 kg.(month)$^{-1}$, or 2.1 kg.(month)$^{-1}$ per capita. Next, the generation of plastic highlighted, reaching 280 kg.(month)$^{-1}$, or 0.80 kg.(inhabitant.month)$^{-1}$, corresponding to 19.3% of recyclable waste. Ribeiro et al. (2013) found that the generation of plastic corresponded to 19.2% of dry recyclable waste in the Lagoa Azul condominium. In Costa et al. (2002), plastic was also the second residue in relative importance, representing about 9% of the total generated in the evaluated condominium.

The generation of glass reached 60.8 kg.(month)$^{-1}$, or 0.17 kg.(inhabitant.month)$^{-1}$, representing the fifth category of waste in importance in the amount generated. In the Lagoa Azul condominium, the generation of glass reached 132 kg.(month)$^{-1}$ or 2.20 kg.(inhabitant.month)$^{-1}$, corresponding to 17% of the total dry recyclable waste generated (Ribeiro et al., 2013).

Metals had the lowest generation, reaching 35.1 kg.(month)$^{-1}$ or 0.10 kg.(inhabitant.month)$^{-1}$. In the Lagoa Azul condominium, Ribeiro et al. (2013) observed the generation of 28 kg.(month)$^{-1}$ of metals or 3.5% of the total dry recyclable waste, equivalent to 0.46 kg.(inhabitant.month)$^{-1}$.

The rejects corresponded to other discarded materials (fabric, wood, ceramics) plus paper with characteristics that make its sale unfeasible, such as contamination with grease. This category corresponded to 132 kg.(month)$^{-1}$, or 0.4 kg.(inhabitant.month)$^{-1}$.

In the municipality of Sorocaba predominated, in 2014, the generation of organic waste, corresponding to 48% of the total generated, followed by paper and cardboard (17%), plastic (9.5%), glass (5.4%), and metals (3.5%) (Paes et al., 2020b). This aspect demonstrates the importance of solid waste characterization studies in the different social actors that make up the urban environment to establish decentralized MSW management strategies.

Another important aspect of this study was the recyclable material discarded in the organic waste container, which reached 173 kg.(month)$^{-1}$, corresponding to approximately 20% of organic waste generated in the condominium. In the container of organic waste, animal feces and others were observed, such as light bulbs and batteries (Figure 2).

Figure 2. Waste observed in the recyclable container, such as batteries and light bulbs, in the Encanto condominium, in Sorocaba, Brazil

Consequently, the results of this study pointed out to the importance of selective collection in the condominium sector to make recycling cooperatives economically viable. This action incorporates the principles of sustainability in solid waste management by integrating the social, economic, and environmental aspects involved.

The project generated educational material for disseminating solid waste management

practices in condominiums based on the results of the Encanto condominium. In Figure 3, it is possible to see a pamphlet developed to disseminate paradigms of sustainable solid waste management related to reduction, reuse and recycling. In addition to information on the disposal of waste and its washing, it provides guidance on the disposal of cells, batteries, and light bulbs, which were materials found in the recyclable materials container.

In Figures 4, one can see the posters created to disseminate guidelines related to managing organic (Figure 4A) and dry (Figure 4B) solid waste in Encanto condominium.

Figure 3. Educational material developed to disseminate the paradigms of urban solid waste management in the Encanto condominium in Sorocaba, Brazil

4 | FINAL CONSIDERATIONS

The characterization and quantification of solid waste are essential steps to establish guidelines and extension strategies to achieve sustainable MSW management. Therefore, environmental education emerges as an alternative to support the implementation of these strategies with adults and adolescents in residential condominiums.

Figure 4. Posters developed to disseminate the management of organic (A) and dry (B) waste at Encanto condominium, in Sorocaba, Brazil.

This chapter highlights environmental education guidelines related to solid waste separation guidance, with particular attention to dry recyclable waste, aiming at a greater valuation of waste and promoting the financial sustainability of recycling cooperatives that collect these materials for sale. In this bias, orientation about the third category of separation emerged as necessary: the rejects. This category of waste demands specific management actions.

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REFERENCES

ABRELPE - Associação Brasileira de Empresa de Limpeza Pública e Resíduos Especiais. **Panorama dos resíduos sólidos do Brasil 2020**. São Paulo: ABRELPE, 2020. 52p.

BELI, E.; NALDONI, C.E.P.; OLIVEIRA, A.C.; SALES, M.R.; SIQUEIRA, M.S.M.; MEDEIROS, G. A.; HUSSAR, G.J.; REIS, F.A.G.V. Recuperação da área degradada pelo lixão Areia Branca de Espírito Santo do Pinhal - SP. **Engenharia Ambiental**, v. 2, n.1, p. 135-148, 2005.

COSTA, M.G.D.; SILVA, M.M.P.; LEITE, V.D. Caracterização e destino dos resíduos sólidos na Quadra 11, do Residencial Bonald Filho uma contribuição para a coleta seletiva. In: CONGRESO INTERAMERICANO DE INGENIERIA SANITARIA Y AMBIENTAL, 18., 2002, Cancun. **Anais**... Cancun: AIDIS, 2002, p. 1-4.

CRISTÓVÃO, G.S.F.; MEDEIROS, G.A.; MANCINI, S.D.; PESSELA, J.D. Index for the assessment of municipal solid waste management in Angola: a case study in Kuito, Bié Province. **African Geographical Review**, v.40, p.1-13, 2021. https://doi.org/10.1080/19376812.2021.1974902

MEDEIROS, G. A.; REIS, F.A.G.V.; MENEZES, P.H.B.J. et al. Diagnóstico do aterro do município de Poços de Caldas, no estado de Minas Gerais, Brasil. **Engenharia Ambiental**, v. 6, p. 3-15, 2009a.

MEDEIROS, G. A.; REIS, F.A.G.V.; SOUZA JUNIOR, A. P.; GIRALDI, B.; SILVA, R. B. Diagnóstico ambiental do aterro do município de Andradas, no estado de Minas Gerais. **Engenharia Ambiental**, v. 6, p. 532-543, 2009b.

MEDEIROS, G.A.; REIS, F.A.G.V.; SIMONETTI, F.D. et al. Diagnóstico da qualidade da água e do solo no lixão de Engenheiro Coelho, no Estado de São Paulo. **Engenharia Ambiental**, v. 5, p. 169-186, 2008a.

MEDEIROS, G. A.; REIS, F.A.G.V.; COSTA, F.B. et al. Diagnóstico do lixão do município de Vargem Grande do Sul, no estado de São Paulo. **Engenharia Ambiental**, v. 5, p. 1-16, 2008b.

PAES, M.X.; MEDEIROS, G.A.; MANCINI, S.D.; BORTOLETO, A.P.; OLIVEIRA, J.A.P.; KULAY, L.A., Municipal solid waste management: Integrated analysis of environmental and economic indicators based on life cycle assessment. **Journal of Cleaner Production**, v.254, p. 119848, 2020a. https://doi.org/10.1016/j.jclepro.2019.119848

PAES, M.X.; MEDEIROS, G.A.; MANCINI, S.D.; GASOL, C.; RIERADEVALL-PONS, J.; GABARRELL-DURANY, X. Transition towards eco-efficiency in municipal solid waste management to reduce GHG emissions: the case of Brazil. **Journal of Cleaner Production**, v.263, p. 121370, 2020b. https://doi.org/10.1016/j.jclepro.2020.121370

OLIVEIRA, B.O.S.; MEDEIROS, G.A., "Municipal solid waste management in the Amazon: environmental, social, and economic problems, gaps, and challenges. **WIT Transactions on Ecology and the Environment**, v.245, p. 9-20, 2020. https://doi.org/10.2495/EID200021

RIBEIRO, L.F.C.; BENTO, B.L.; LIMA, N.S.S; et al. Educação ambiental e gestão de resíduos sólidos domésticos em condomínio residencial: projeto ECOndomínios. In: CONGRESSO BRASILEIRO DE ENGENHARIA SANITÁRIA E AMBIENTAL, 27, 2013, Goiania. **Anais**... Rio de Janeiro: ABES, 2013. v. 1. p. 1-7.

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