


Solid waste management in rural areas: A narrative review

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ABSTRACT

In Brazil, the deficit in access to basic sanitation services, of which waste management is a part, is also concentrated in rural areas, which is worrisome, given the importance of the services for the promotion of human health and environmental quality. Thus, the objective of the present study was to conduct a narrative review of the literature on solid waste management (SRM) in rural areas. To this end, the review was carried out in a non-systematic manner, from January to July 2023, using the following databases: Scopus, Web of Science, Science Direct and Google Scholar. The results are discussed in two sections: 1) concepts and situational overview; and 2) empirical studies. From the literature analyzed, it was found that MRS in rural areas represents a concern in several countries, however, there are additional challenges for economically developing countries. Specifically in Brazil, historically, there has been an inefficiency and even non-existence of the service, which leads the communities themselves to establish forms of management, which are often inadequate. Thus, the information collected in this study can contribute to a broad understanding of the situation of the MRS in Brazilian rural areas, in addition to the identification of the different aspects that have been worked on in the literature, in which emphasis was placed on the situational diagnosis of waste management.

Keywords: Basic sanitation, Rural sanitation, Environment, Rural communities.

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INTRODUCTION

In Brazil, the public services of urban cleaning and solid waste management, components of public basic sanitation services, are defined by the legal frameworks of the sector, Law No. 11,445/2007 and Law No. 12,305/2010, as: activities and the provision and maintenance of infrastructures and operational facilities for collection, manual and mechanized sweeping, cleanliness and urban conservation, transport, transshipment, treatment and environmentally appropriate final disposal of household solid waste and urban cleaning waste (BRASIL, 2007, 2010). When disposed of inappropriately, in the absence or presence of a public service, solid waste can cause potential harmful effects to the environment, such as pollution of surface and groundwater, soil pollution, and air pollution, in addition to potential impacts on human health (BARROS, 2012).

In Brazil, there is a coverage rate of the collection service that can be considered high, although not yet universalized: 92.1%¹ of the waste generated in the municipalities is collected. However, there are still low rates of selective collection, and 53.9% of the waste collected still has inadequate final disposal (controlled landfill or dump)⁴ (Brasil, 2019). On the other hand, when looking specifically at the deficit in access to the service, it is concentrated in peripheral and rural areas (Brasil, 2014).

Approximately 29.9 million Brazilian inhabitants live in rural areas (IBGE, 2010). In these areas, the rate of adequate service for the solid waste management service is only 23.6% (Brasil, 2019). One of the factors that led to this situation is the historical trajectory of the basic sanitation sector, since there was a supremacy of public policies aimed at urban areas to the detriment of rural ones (Porto; Sales; Rezende, 2019). Thus, in these areas there is little or no action by the government, which leads to the use of alternative solutions by the population, which are often precarious (Roland et al., 2019).

When it comes to the provision of basic sanitation services in rural areas, it is important to take into account that these areas are made up of heterogeneous sociogeographic spaces, with regard to social, productive, technical, biological, spatial and cognitive aspects, where there is a diversity of actors and ruralities, which can influence the adoption of sanitary solutions (Brandenburg, 2022; Brandenburg; Ferreira; Santos, 2004; Roland et al., 2019). In addition, specific characteristics and aspects related to rural areas that influence the adoption of adequate sanitary solutions and the provision of sanitation services are pointed out, including demographic, economic, regional and environmental, social and cultural aspects (Andrade et al., 2017; Roland et al., 2019).

Thus, taking into account that the provision of adequate basic sanitation services contributes to the improvement of the environmental and life quality of the population, and to the prevention of diseases (Lisboa; Heller; Silveira, 2013), and that, specifically in rural areas, basic sanitation can also

⁴ Data for the year 2018.



contribute to solidary and sustainable rural development and to the achievement of food and nutritional security for the populations of these areas (Brasil, 2019), it is relevant to know how solid waste has been managed in rural areas, based on the literature. Thus, the objective of the present study was to conduct a narrative review of the literature on solid waste management in rural areas.

METHODOLOGY

To meet the objective of the present research, a narrative review of the literature was used. The narrative review is characterized by having the potential to describe and discuss the development of a theme, from a theoretical or contextual point of view, and its strengths are the possibility of verifying what has been previously published, and the help in identifying omissions or bibliographic gaps (Grant; Booth, 2009; Rother, 2007). The review was carried out in a non-systematic way, from January to July 2023, and for this, the searches were based on the objective of the research. The following databases were used: *Scopus*, *Web of Science*, *Science Direct* and Google Scholar. The keywords were: "solid waste management in rural areas" or "rural solid waste management" or "solid waste in rural areas", also searching for these keywords in English and Spanish. In addition, the survey was carried out without limitation of date, country or area of knowledge. Theses, dissertations and abstracts published in annals were excluded.

Thus, taking into account the themes related to the objective of the research, the results were divided into two sections: in the first, conceptualizations about waste management are presented, as well as the panorama of services in rural areas of Brazil; and in the second, empirical studies are addressed about each stage encompassed in the management of rural solid waste.

CONCEPTS AND SITUATIONAL OVERVIEW OF SOLID WASTE MANAGEMENT IN RURAL AREAS

First, it is necessary to present important concepts: solid waste, solid waste handling and management. Solid waste is defined by Law No. 12,305/2010, the National Solid Waste Policy (PNRS), as: (Brasil, 2010)

"material, substance, object or discarded good resulting from human activities in society, whose final destination is carried out, is proposed to be carried out or is obliged to be carried out, in solid or semi-solid states, as well as gases contained in containers and liquids whose particularities make it unfeasible to discharge them into the public sewer system or into bodies of water, or require solutions that are technically or economically unfeasible in the face of the best available technology."

Solid waste management, on the other hand, refers to the stages of collection, transportation and disposal (Pan; Ying; Huang, 2017). The PNRS defines solid waste management as the stages

of collection, transportation, transshipment, treatment and environmentally appropriate final disposal of solid waste and environmentally appropriate final disposal of tailings. This is different from management, which comprises the set of actions aimed at finding solutions for solid waste, in order to consider the political, economic, environmental, cultural and social dimensions, with social control and under the premise of sustainable development. The concept of tailings is highlighted, which is "solid waste that, after exhausting all possibilities of treatment and recovery by available and economically viable technological processes, presents no other possibility than environmentally appropriate final disposal" (Brasil, 2010). It is essential here to conceptualize each stage of solid waste management (Chart 1).

Table 1 - Definitions of generation and steps used in solid waste management/management

Stage	Definition
Generation	The act of generating solid waste and its inherent characteristics, what waste is generated, in what volume and in which places.
Packaging and storage	Packaging means the act or effect of packaging solid waste; and storage refers to the situation in which waste is stored while waiting to be collected.
Collection	Activity of gathering solid waste previously packaged, aiming at its transportation.
Transport	Conduction of solid waste, after collection, to the treatment or final disposal units.
Transshipment	This is a step related to the transfer of solid waste from trucks or other collection vehicles to larger trucks, in order to reduce system costs and increase collection efficiency.
Treatment	Stage related to the treatment of solid waste, which involves techniques such as pyrolysis, biological conversion of solid waste into energy, plasma, among others.
Environmentally appropriate final disposal of solid waste	Waste disposal that includes reuse, recycling, composting, energy recovery and use or other destinations admitted by the competent bodies of the National Environmental System (SISNAMA), the National Health Surveillance System (SNVS) and the Unified System for Agricultural Health Care (SUASA), including final disposal, observing specific operational standards to avoid damage or risks to public health and safety and to minimize the adverse environmental impacts.
Environmentally appropriate final disposal of tailings	Orderly disposal of tailings in landfills, observing specific operational standards in order to avoid damage or risks to public health and safety and to minimize adverse environmental impacts.

Source: Authors (2024), from Barros (2012), Brasil (2010) and (Brasil, 2022)

Regarding the classification of solid waste, the PNSR classifies it according to its origin and hazardousness. As for the origin, they are classified as: urban solid waste, encompassing household waste - considered to originate from domestic activities in urban activity - and urban cleaning waste; waste from commercial establishments and service providers; waste from public basic sanitation services; industrial waste; waste from health services; construction waste; agrosilvopastoral residues; waste from transport services; and mining waste. Thus, it can be seen that the PNSR mistakenly disregards waste from rural areas in the official classification of household waste, a gap also pointed out by Rocha et al. (2012) e Simonato et al. (2019)



Regarding the panorama of solid waste management observed in the literature, this represents a concern worldwide, however, there are additional challenges for economically developing countries. In these countries, because of having experienced a population increase and economic development, the generation of solid waste has increased, and a scenario of inadequate disposal is still very common, especially in the form of open disposal (dumps). There is also a more critical scenario in rural areas, which is worrisome, given that almost half of the world's population still lives in these areas. In the rural areas of developing countries, there are common challenges: large gaps in the rate of solid waste collection, resulting in high rates of burning and disposal in the open air; costs considered high and the poor conditions of rural roads as obstacles to the implementation of adequate service; organic portion as the most representative among the composition of the residues, being commonly used for animal feed; and the most sparse and remote rural areas are the most neglected in relation to service delivery (Bundhoo, 2018; Mihai; Taherzadeh, 2017; Taghipour et al., 2016; Vinti; Vaccari, 2022; Wang et al., 2018)

Specifically in Brazil, historically, there has been an inefficiency and even non-existence of solid waste management services in rural areas, which leads the communities themselves to establish forms of management, which are often inadequate. Factors attributed to this issue are: long distances and isolation of communities; lack of political will and public investment, in addition to the historical trajectory of the sanitation sector, since there was a supremacy of public policies aimed at urban areas to the detriment of rural ones (Postage; Sales; Rezende, 2019; Simonato et al., 2019).

The situational analysis of rural sanitation contained in the PNSR portrays the great deficit of solid waste management services in Brazilian rural areas, as shown in table 1. The following concepts used in the program regarding the situation of solid waste are highlighted: 1) adequate assistance regarding the management of solid waste in rural areas, which is represented by the population that has direct or indirect collection and environmentally appropriate final disposal; 2) precarious care refers to the population that has direct or indirect collection with an environmentally inappropriate final destination; 3) without care refers to all situations that do not fit into the definitions of care and that constitute practices considered inadequate. These last two categories make up what is considered the deficit in access to solid waste management. (Brasil, 2019)

Table 1 - Attendance and deficit in solid waste management in rural areas in Brazil

Rural area - Classification, according to census tract groups	Proper service		Deficit			
	(Hab)	%	Poor service		No Attendance	
			(Hab)	%	(Hab)	%
Agglomerations close to the urban ⁵	4.420.617	44,8	4.368.568	44,3	1.080.451	10,9
Isolated denser agglomerations ⁶	607.474	47,2	605.057	47	75.006	5,8
Isolated less dense agglomerations ⁷	1.200.787	26,4	1.136.145	25	2.209.303	48,6
No agglomerations, with households relatively close to agglomerations or isolated ⁸	3.135.668	13,1	2.203.631	9,2	18.684.695	77,8
Total	9.364.545	23,6	8.313.400	20,9	22.049.455	55,5

Source: from the 2010 Demographic Census (IBGE, 2011), Information System for the Surveillance of the Quality of Water for Human Consumption (SISAGUA) (Brazil, 2007), PNSB (IBGE, 2008) Brazil (2019)

EMPIRICAL STUDIES ON RURAL SOLID WASTE MANAGEMENT

Several studies have addressed the management of rural solid waste. Regarding the generation aspects, they are influenced by several factors. The increase in the use of natural resources, the advancement of technology, and the changes in the needs established by the modern population are cultural factors that have increased the generation of solid waste both in urban and rural areas, and for the latter has directly implied the increase in the generation of inorganic waste, such as plastic and glass. Despite this, the rate of solid waste generation in rural areas is lower than in urban areas, and the composition of the waste generated varies not only in comparison to the urban area, but also among the rural areas themselves, given the variety of social, economic and cultural

⁵ Referring to census codes 1b, 2 and 4. It is assumed that the sanitary solutions adopted in the households located in these areas are directly influenced by the solutions practiced in the nearby urban centers. They are defined as follows: Sectors of codes 1b and 2 - characterized by population agglomerations in the urban peripheries, being considered urban in the original IBGE database and reclassified as rural, despite maintaining the original characteristics; Code 4 sectors - characterized by agglomerations that are located at most one kilometer away from urban areas.

⁶ Referring to census code 3. Characterized by agglomerations, in principle, considered urban by the local authorities, but far from more dense agglomerations, such as the district headquarters. They may have, in general terms, greater economies of scale and the possibility of collective actions organized in structured management models for the provision of sanitation services.

⁷ Referring to codes 5, 6 and 7: Consisting of population agglomerations distant from each other and also from other denser areas and by population agglomerations arranged around a rural enterprise, with this entrepreneur being its sole owner. In these areas, sanitation actions, despite agglomerations, are still greatly influenced by individual practices that coexist with collective practices, for which management tends to be less organized and more incipient.

⁸ Referring to code 8: Characterized by the IBGE as a rural area without agglomerations, it has the largest population contingent among all segments of rural sectors considered by the IBGE in the 2010 Demographic Census. From this perspective, the most appropriate solutions for these areas could be those capable of serving a household unit. However, fieldwork revealed the existence of small agglomerations in code 8 sectors, in some of which collective solutions represent the adopted practices. It is assumed, therefore, that individual actions will be predominant in this context, and that collective practices should advance based on the identified health framework



characteristics of each one. In some cases, rural consumption patterns are similar to those of small municipalities, and similarities can be observed in the characteristics of the waste generated in these areas (Fao et al., 2018; Rocha et al., 2012; Silva et al., 2017) (Lima; Paulo, 2018; Taghipour et al., 2016)

Bernards and Günther, (2014), in a study conducted in communities located in two sustainable use conservation units in the state of Amazonas, Brazil, estimated a per capita solid waste generation rate of 0.5 kg/person/day, representing an estimated total of 437 tons generated per year; as for the gravimetric composition, i.e., the composition in percentage by type of component of the solid waste generated (Barros, 2012), 90% of the waste was of organic origin and 10% inorganic. In the study, carried out in Sítio Boca da Mata, in the rural area of Jardim, CE, it was found that most of the interviewees claimed that most of the waste generated was inorganic, with little reuse rate. Santos and Cordeiro(2021)

It is also interesting to observe aspects related to the generation of solid waste in ruralities linked to agribusiness. The results of Mazza et al. (2014), based on a study conducted in rural properties in municipalities in the interior of Rio Grande do Sul, They emphasized that a large part of the waste generated comes from the agricultural sector (82%) - pesticide packaging, lubricating oils, among others - in contrast to 18% of household waste. In a study carried out in the rural area of Ceres, GO, in 86 rural properties, which had an area of up to 6 bushels, it was observed the generation of packaging of pesticides, fertilizers, veterinary pharmaceutical products and organic fertilizers. It is noteworthy that most of the interviewees (61.5%) reported that pesticide containers were incinerated or thrown into ditches, even though there was a receiving station in the municipality. As for fertilizer packaging, the vast majority was used to bag manure, sawdust and grain. Finally, regarding the destination of the packaging of veterinary pharmaceutical products, the vast majority of farms dispose of them in ditches, or burn them. Souza Et al. (2019)

Brazil has a large deficit regarding garbage collection in rural areas, with most of the population having to seek means of waste disposal, which are often inadequate and precarious (Lima; Paul, 2018). In the studies conducted by, in rural communities located in the municipalities of Mossoró and Baraúna, RN; and in, in the Estrela da Ilha settlement, Ilha Solteira, SP; In all of them, there was no public solid waste collection service. Soon the organic fraction was used mainly for animal feed and composting, and the inorganic fraction was sometimes burned, sometimes buried, sometimes irregularly arranged in open areas, in some cases, the recyclable fraction was reused. In this sense, he states that when this type of destination given to organic products is used, they do not present themselves as an environmental problem. In Bernades and Gunther (2014) it was highlighted that the burning was carried out by women, for the most part, which emphasizes the issue of gender



and sanitation. Bernardes and Günther (2014); Fidelis- Man , Lunardi and Lunardi , (2020) Simonato Et al.(2019) Rocha et al. (2012)

Regarding the conditions of packaging and storage for waste disposal, in the study it was observed that in 67% and 49.5% of the cases, respectively, the storage sites were close to the properties, or close to running water or forests. In both studies, there were respondents who stated that there was the presence of animals such as rats, birds and insects such as flies and cockroaches in the storage sites. As for the predominant forms of packaging in Rocha et al (2012), they were through feed/fertilizer bags and deposited in a shed or other specific place with a roof and in Santos and Cordeiro (2021) in plastic bags in backyards, mainly, followed by drums. Ceretta ; Silva and Rocha (2013), carried out in the rural area of the municipality of São João, PR, and de Rocha et al. (2012), in the rural area of the municipality of Artboard PR

Regarding the characteristics of public collection when present, in the study by Ceretta, Silva and Rocha (2013), it was observed that in relation to the distance from the property and the collection point, the distances ranged from 100 m to 1 km. According to the authors mentioned above, the proximity of the collection point motivates the participation of the families, because, due to the working hours on the properties, time is limited. Therefore, longer distances make participation unfeasible, due to the effort and time expended. In addition, it was found that in the areas farthest from the urban area and difficult to access, there was no public collection. In the areas where there was collection, despite this, there was still the presence of burning, burial on the property, deposition in a black pit and in the open air (inorganic fraction of the garbage). The organic fraction, on the other hand, was buried in the backyard or used in animal feed. Similar situations were observed in Lima and Paulo (2018), Mazza et al (2014), and Rocha et al (2012). In Santos and Cordeiro (2021), collection in the studied community was present, however, due to the low frequency of collection (once a week), residents adopted complementary inadequate practices (burning, burial, and disposal in the open).

Finally, we move on to general perceptions regarding waste in rural areas. In Bernardes and Gunther (2014) it was reported that most of the population interviewed in the study was concerned about the inadequate disposal of inorganic solid waste, and it was also indicated by the interviewees that they would be engaged to participate, if it existed, in a solid waste program. In the study by Ceretta, Silva and Rocha (2013), the presence of the school was highlighted as a way of adding knowledge and information to the community regarding the theme of waste. In Mazza et al (2014) it was pointed out as difficulties for the correct disposal of waste: lack of appropriate place; lack of adequate garbage bins; lack of awareness; lack of billing; and lack of information. It should also be noted that in Santos and Cordeiro (2021) the respondents considered dumps (62%) to be appropriate destinations, followed by controlled landfills and sanitary landfills (17 and 16%, respectively), which



demonstrated for the author the lack of environmental education, also, when asked about their knowledge of the PNRS, it was noticed that the vast majority stated that they did not know it.

FINAL CONSIDERATIONS

From the literature analyzed, it was found that solid waste management in rural areas represents a concern in several countries, however, there are additional challenges for economically developing countries. Specifically in Brazil, there are still low rates of waste collection, and even the absence of the service in some areas, which leads the communities themselves to establish forms of management, which are often inadequate. In addition, it was possible to raise different studies about the generation and each stage of solid waste management: packaging, storage, collection, final disposal - in which it was possible to observe aspects related to generation rates and types of waste generated; packaging and storage conditions for waste disposal; and usual practices, such as burning and using the organic fraction of waste for animal feed and composting.

Thus, the information collected here can contribute to a broad understanding of the situation of solid waste management in Brazilian rural areas, in addition to the identification of the different aspects that have been worked on in the literature, in which emphasis was placed on the situational diagnosis of rural waste management. As a suggestion for future work, there are studies that investigate the other basic sanitation services in these areas – water supply, sewage and rainwater management – as well as the formulation and implementation of related public policies, in view of the large existing rural sanitary deficit.

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