

Solid Waste, A Critical Review: The Case of The Department of Sucre, Colombia

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Abstract : Solid waste, commonly known as garbage, are those materials discarded after having completed their work or function. Their origin depends on the human beings' activities and are divided into two large groups: Hazardous and nonhazardous. General issues about solid waste are exposed in this article to have a clear idea of the solid waste diversity and how to take advantage from them or discard them. Furthermore, management of solid waste in Colombia is reported, particularly, in the department of Sucre, where deficiencies in integral management were found. The department of Sucre has high contamination from solid waste due to lack of attention given by the competent regional and national authorities.

Key Words : Solid waste, Integral management, Reuse, Recycling.

Introduction

Human beings always generate waste to meet their needs and as a result of their activity. In their beginnings men had a nomadic life. They lived in small groups, where their main organic waste decomposed simply and naturally. Nonetheless, with emergence of agriculture and permanent settlements, population increased and with it, solid waste generation¹. With towns' settlement and development of their activities, men sought to make efficient use of resources with re-use and recycling. There are archeological evidences from 3000 BC of recycled metal objects².

The city of Rome, with almost one million inhabitants by 600 BC, had the "Cloaca Maxima" as part of a large drainage and sanitation system, very important for hygiene of streets and buildings of the city, which had waste collected from the Tiber River³. In the middle ages, the first garbage collection systems began in many European cities, where people with carts used to walk on streets and clean them in certain times, to improve the city's hygienic conditions⁴.

Inappropriate evacuation of "garbage" in the Middle Ages and Renaissance generated many vectors of diseases that significantly affected inhabitants' public health in these periods and, it was only until nineteenth

century when they became aware of the importance of proper waste management on human health and began to develop more appropriate practices for waste disposal⁵. In the nineteenth century with the industrial revolution and the increase in production of goods and services, a systematic collection and disposal of waste began in developed countries such as Germany, the United States and England, where they had people specialized in carrying out these functions⁶.

World population was estimated at about 5,700 million people for the twentieth century with a waste production of nearly 1,300 million tons per year, and it is estimated that by 2025 production will increase to 2,200 million tons⁷. Currently there are around 7.5 billion people⁸ that generate an average of 0.8 kg waste per day⁹ that must be collected, transported and treated in proper manner to avoid pollution of soil, air, and water, and harm to people's health.

General issues on Solid Waste

Rejected solid materials are called solid waste. These useless or unwanted solid compounds are generated due to human activities, and currently world volume is approximately 2.2 trillion kilos per year. Unfortunately, half of these wastes are dumped in the oceans around the world¹⁰. In general, solid waste can be classified and named differently, such as household organic waste, hospital waste, institutional waste, agricultural waste, electronic waste, forest waste, chemical waste, construction waste, green waste, marine debris, biomedical waste, mining waste and radioactive waste¹¹.

To reduce environmental and human health effects associated with dumping of solid waste on the environment, it is necessary to properly manage these by reducing consumption of goods and adopting alternatives for prevention, reuse, recycling and recovery¹². Municipal solid waste typically has 46% organic material, 17% paper, 10% plastics, 5% glass and 4% metal, while the remaining 18% is from another type of material⁷. Globally, the most generic form of final disposal is in landfills, nonetheless, they cause direct impacts on environment and risks of soil and groundwater pollution in the long term. Furthermore, in landfill facilities, reusable materials are not recovered, and recycling is not carried out¹³.

For organic solid waste treatment, most common techniques are Anaerobic Digestion (AD) and Mechanical Biological Treatment (MBT). AD is a microbiological process in which organic matter decomposes in the absence of oxygen¹⁴; and MBT is part of a family of mechanical and biological processes for separation and transformation of waste into other products¹⁵.

Recovery of waste material as paper, serves as a raw material for remanufacture. It is as important for the paper industry as the pulp's virgin fiber. In the post-consumption stage, paper is recovered from homes, offices and all kinds of locations; however, this type of waste paper is often the most contaminated and difficult to collect¹⁶. Waste paper can also be used for generation of fuel, through extraction of monofibers and nanofibers of cellulose, polyhydroxyalkanoate (PHA), carboxymethylcellulose and polymer composite matrix¹⁷.

Plastic waste is usually contaminated or mixed with organic and inorganic material. In addition, they have a homogeneous composition due to variety of forms and use of plastic, mainly in bags, packaging and expanded plastic¹⁸. Plastic reuse is preferable for recycling or treatment before its final disposal in landfills, since it uses less energy and resources. Some plastics end their life cycle after a sole use and are discarded, though. The most common method for plastic recycling is mechanical treatment, including washing and grinding for its reincorporation into the commercial chain. Nevertheless, depending on the plastic nature, these processes may vary slightly¹⁹.

In the case of metals, with their recovery, up to 95% of the energy expended in production of primary metal, can be saved. It is more important in places with little or no mining exploitation. In metals such as steel, iron nickel, and others, up to 84% of common air pollutants and 99% of CO₂ emissions can be reduced²⁰. However, wastewater treatment and disposal are an environmental concern in almost every country around the world. This wastewater is full of biodegradable organic matter, organic chemicals, toxic substances and pathogenic microorganisms²¹. Inadequate management can lead to air and soil pollution, and contamination of surface and groundwater supplies, and therefore it has a multidimensional impact on human health and environmental well-being. Sewage systems are the wastewater recipients. In Colombia, Out of 1122 municipalities, just 541 have sanitation systems²².

Solid Waste in Colombia

Solid waste management in Colombia is regulated since 1993 with Law 99 through which the public sector, responsible for management and conservation of the environment and renewable of natural resources, is reordered, giving function to autonomous regional environmental corporations to evaluate, control and environmentally monitor liquid, solid and gaseous waste to waters in any form. Subsequently, in December 2013, the National Government issued Decree 2981, which updated regulations for management of solid waste as a function of the cleaning service in the country and, by means of which, municipalities are mandated to implement the Plans of Integral Management of Solid Waste²³.

In 2016, according to the Superintendence of Residential Public Services, 11 million tons of solid waste were produced in Colombia, out of which, 97.6% was adequately disposed of and the remaining 2.4% (about 268,328 tons) was burned, buried or disposed in water bodies or in other inappropriate places.

State of the Solid Waste in the department of Sucre, Colombia

Sacre is a department located on the north of Colombia, in the Caribbean region. It is administratively divided into 5 sub-regions: *La Mojana*, *Montes de María*, *Morrosquillo*, *Sabanás* and *San Jorge*. Figure 1 shows location and sub-regional division of the Sucre department.



Source: https://es.wikipedia.org/wiki/Subregiones_de_Sucre

Figure 1. Department of Sucre, Colombia

The cleaning service in the municipalities of the Sucre department, as well as in municipalities throughout the country, is the responsibility of municipal governments as established in Decree 1713 from 2012. In 2016, solid waste generation in the department of Sucre was 138,610 tons, and out of which, nearly 7,232 tons do not report any information on final disposition²². In Sincelejo, capital of Sucre department, waste generation per inhabitant is estimated at 0.51 Kg / person-day for a total of 119.0 tons / day⁷.

Poor solid waste disposal causes considerable damage to the environment²⁴. A direct impact is the contamination of water sources, both surface and underground. In the department of Sucre, domestic and

industrial wastewater from Sincelejo, Corozal and Morroa municipalities are discharged into the Gran de Corozal stream. On the other hand, Los Palmitos Municipality pours them over in the Caracolí stream, the Sampues Municipality over the Canoas Stream and the Ovejas Municipality over Mancomojan Stream. All these streams cross the recharge zone of the Morroa aquifer, the only source of drinking water supply for more than 500,000 inhabitants of rural and urban areas in the municipalities of Sincelejo; Sampues, Ovejas, Los Palmitos, Morroa, Corozal and San Juan de Betulia²⁵.

Table 1 shows major features of the cleaning service and final disposal of solid waste in the different sub-regions of the Sucre department.

Table 1. Main characteristics of the service and final disposal of solid waste in the sub-regions of the department of Sucre, Colombia.

Sub-Region	Municipality	Solid Waste Kg/month	Cleaning Service		Final Disposal		Reference
			Urban	Rural	Urban	Rural	
La Mojana	Guaranda	-	Sewer: No Collection in: Animal traction cart	Does not exist	Open Air	Water Sources, Open Air, Burning	[26]
	Majagual		Sewer: YES, Collection in: Collection truck	Does not exist	Landfill	Water Sources, Open Air, Burning	[27]
	Sucre		Sewer: NO Collection in: TRACTOR	Does not exist	Landfill	Water Sources, Open Air, Burning	[28]
Montes de María	Chalán		Sewer: YES, Collection in: Collection truck	Does not exist	Landfill	Water Sources, Open Air, Burning	[29]
	Colosó		Sewer: 86% coverage Collection in: Collection truck	Does not exist	Landfill; Open Air	Water Sources, Open Air, Burning	[30]
	Morroa		Sewer: YES, Collection in: Collection truck	Sewer: YES, Collection in: Collection truck	Landfill; Open Air	Landfill; Open Air	[31]
	Ovejas		Sewer: 90% coverage Collection in: Collection truck	Does not exist	Landfill	Water Sources, Open Air, Burning	[32]
	Sincelejo		Sewer: YES,		Landfill		[33]

			Collection in: Collection truck				
Morrosquillo	Coveñas		Sewer: YES, Collection in: Collection truck	Sewer: 60% coverage Collection in: Collection truck	Landfill	Landfill; Open Air	[34]
	San Antonio Palmito		Sewer: YES, Collection in: Collection truck	Does not exist	Landfill	Water Sources, Open Air, Burning	[35]
	San Onofre		Sewer: NO Collection in: Animal traction cart	Does not exist	Open Air	Water Sources, Open Air, Burning	[36]
	Santiago de Tolú	562.500	Sewer: 95% coverage Collection in: Collection truck	Does not exist	Landfill; Open Air	Water Sources, Open Air, Burning	[37]
	Tolú viejo		Sewer: 77% coverage Collection in: Collection truck	Does not exist	Landfill; Open Air	Water Sources, Open Air, Burning	[38]
Sabanas	Buenavista	130.000	Sewer: 97% coverage Collection in: Collection truck	Does not exist	Landfill; Open Air	Water Sources, Open Air, Burning	[39]
	Corozal	1.125.000	Sewer: 96% coverage Collection in: Collection truck	Does not exist	Landfill; Open Air	Water Sources, Open Air, Burning	[40]
	El Roble		Sewer: 93% coverage Collection in: Collection truck	Does not exist	Landfill; Open Air	Water Sources, Open Air, Burning	[41]
	Galeras		Sewer: 86% coverage Collection in: Collection	Does not exist	Landfill; Open Air	Water Sources, Open Air, Burning	[42]

		truck					
	Los Palmitos	Sewer: 90% coverage Collection in: Collection truck	Sewer: 30% coverage Collection in: Collection truck	Landfill; Open Air	Landfill; Open Air	[43]	
	Sampués	Sewer: YES, Collection in: Collection truck	Does not exist	Landfill	Water Sources, Open Air, Burning	[44]	
	San Juan de Betulia	Sewer: NO Collection in: Animal traction cart	Does not exist	Open Air	Water Sources, Open Air, Burning	[45]	
	San Pedro	Sewer: YES, Collection in: Collection truck	Does not exist	Landfill	Water Sources, Open Air, Burning	[46]	
	San Luis Sincé	380.000	Sewer: YES, Collection in: Collection truck	Does not exist	Landfill	Water Sources, Open Air, Burning	[47]
San Jorge	Caimito	Sewer: YES, Collection in: Collection truck	Does not exist	Landfill	Water Sources, Open Air, Burning	[48]	
	La Unión	Sewer: YES, Collection in: Collection truck	Does not exist	Landfill	Water Sources, Open Air, Burning	[49]	
	San Benito Abad	7200	Sewer: YES, Collection in: Collection truck	Does not exist	Open Air	Water Sources, Open Air, Burning	[50]
	San Marcos	Sewer: 70% coverage Collection in: Collection truck	Does not exist	Landfill; Open Air	Water Sources, Open Air, Burning	[51]	

According to the data recorded in Table 1, the department of Sucre has a fundamental problem with the integral management of solid waste. The 26 municipalities that make up the department of Sucre, including its capital city (Sincelejo) have problems in terms of sewerage coverage and cleaning system. It is evident that due to lack of infrastructure in the sewerage network system, solid waste is disposed in water sources that flow into the rivers near the region, creating sources of pollution. The same happens with the municipalities cleaning systems, since the municipalities do not currently have a program of collection and final disposition of efficient and reliable rubbish.

Conclusions

Inadequate management of solid waste produces multiple negative impacts on people's health and environment. It is important to know the amount of waste produced, the amount collected, and the final disposition assigned to it. It is also important to know costs generated by these activities and what to do to achieve reuse and recycle of the generated waste. Recycling is founded on the fact that waste must be treated as a resource to, then, reduce demand for natural resources and the amount of material requiring a final disposal.

It is necessary for the competent authorities to be aware of the fundamental problem of not collecting and properly disposing of solid waste, since in the future it will be uncontrollable.

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