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ENVIRONMENTAL MANAGEMENT OF CONSTRUCTION AND DEMOLITION WASTE IN COLOMBIA: THE CASE OF THE DISTRICT OF BARRANQUILLA

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ABSTRACT

The generation of construction and demolition waste in Colombia is increasing, so in recent years regulations have been issued to regulate its management. However, it has not been fully consolidated, in part due to regulatory gaps, in part due to the lack of local regulations and, of course, due to behaviors by citizens contrary to the provisions on the matter. Considering the above, this article analyzes the management of construction and demolition waste in Colombia, taking the District of Barranquilla as a case study, examining the degree of implementation of the instruments established in current regulations. Our analysis was based on the collection and processing secondary data on regulations using dynamic data tables. Our conclusions show that little progress was made in Barranquilla, a dynamic common to the rest of the country's cities.

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GESTÃO AMBIENTAL DE RESÍDUOS DE CONSTRUÇÃO E DEMOLIÇÃO NA COLÔMBIA: O CASO DO DISTRITO DE BARRANQUILLA

RESUMO

A geração de resíduos de construção e demolição na Colômbia vem aumentando e, nos últimos anos, foi emitida legislação para regulamentar sua gestão. Embora isso não tenha sido consolidado, em parte por causa de lacunas regulamentares, em parte em decorrência da falta de regulamentos locais e, é claro, à existência de comportamentos dos cidadãos contrários às disposições sobre o assunto. Tendo isso em vista, este artigo analisa a gestão de resíduos de construção e demolição na Colômbia, tendo como estudo de caso o Distrito de Barranquilla, verificando o grau de implementação dos instrumentos indicados na regulamentação vigente. A análise foi baseada em um processo de compilação e processamento de dados secundários de natureza doutrinária e normativa, processados usando tabelas dinâmicas de dados. As conclusões mostram o escasso progresso alcançado, uma dinâmica comum e extensa na maioria das cidades da Colômbia.

Palavras-chave: *Colômbia; Direito; meio ambiente; gestão de resíduos; urbanismo.*

INTRODUCTION

As Colombia becomes more urbanized, development and construction activities have been increasing significantly, which has brought about positive effects, such job creation or expectations for better cities, but at the same time other negative effects, such as the generation of construction and demolition waste (CDW), usually called rubble (*escombros*). The Capital District of Bogotá, for example, produces around 12 million tons of CDW per year, of which just over 300,000 are managed. This situation is not new for Colombian environmental legislation, however, as the then Ministry of the Environment issued Resolution No. 0541 already in December 1994, which regulated the management of debris, soil and subsoil of excavations related to construction and demolition activities (MINISTERIO DEL MEDIO AMBIENTE, 1994). Although this regulation has been in effect for nearly 25 years, it has not been properly implemented and, as a result, compliance has been sporadic.

Currently, there are new regulations in force aimed at establishing tools based on a comprehensive approach to enable CDW management, taking into account waste life cycle, waste components and, of course, waste management activities: collection, transport, storage, use and final disposal. In this regard, we refer to Resolution No. 0472, issued by the Ministry of the Environment and Sustainable Development in February 2017.

In the case of the District of Barranquilla, the city has experienced an unprecedented urban transformation over the last decade, due to the implementation of various public and private projects, while also being a typical case of CDW management.

According to Barranquilla's 2016-2027 Integrated Solid Waste Management Plan-PGIR, the city lacks an integrated waste management system, which is why only 1,900 tons of CDW are collected in average per month of the almost 20,000 tons generated.

On the other hand, the real estate sector has not implemented actions to create a CDW management culture; on the contrary, treatment and management practices are insufficient. In Barranquilla, it is common practice the use of public spaces for the temporary storage of CDW; the improper disposal of waste in prohibited places, such as water bodies and forests; the inadequate and illegal transport of waste, such as in mule carts, wheelbarrows and dump trucks; as well as the scarcity of recovery and reuse activities.

Considering the above, this article aims to analyze the integrated management of CDW in Colombia, taking the Barranquilla district as a case study and examining three aspects in particular: a) the current situation of CDW in Colombia and Barranquilla; b) the level of regulatory development and; c) the level of implementation of management activities by the competent city authorities.

This article aims to answer the question: What has been the level of implementation and performance of CDW environmental management instruments established by current regulations, taking the district of Barranquilla as a case study?

1 INTERNATIONAL AND NATIONAL CONTEXTS REGARDING CDW

As we mentioned above, CDW is generated on a large scale. The European Union generates around 3 billion tons of waste, of which 300 million tons are CDW; the United States generates about 170 million tons; and Hong Kong, a small autonomous territory, 20 million tons per year (JAILLION; POON; CHIAN, 2009). It is worth mentioning a large megalopolis also on the South American continent, São Paulo, in Brazil, where almost 70 million tons are generated annually (FARIAS; GOMÉZ, 2012).

CDW management is not a new issue for countries around the world. Since the 1970s, Japan has implemented efficient CDW treatment as a result of improved regulations requiring the use of recycled concrete aggregates in construction. Following the example of Japan, strict legislation on CDW came into force in the 1980s in countries such as Denmark, Russia, Germany, France, Spain, Belgium, Norway, the Netherlands and China (CHÁVEZ PORRAS *et al*., 2013). As a consequence, countries such as the Netherlands, Belgium and Denmark achieved CDW reuse rates of 90%, 87% and 81%, respectively (CONPES, 2016).

Currently, Ireland, New Zealand, Spain, the United States, Brazil and Mexico have also developed integrated CDW management models and plans (CHÁVEZ PORRAS *et al*., 2013). Studies carried out by Begliardo *et al*. (2013) and Gutierrez *et al*. (2015) confirm that CDW can be reused efficiently.

Among countries of the Americas, Brazil pioneered the adoption of recycling technologies; for example, by installing a CDW plant in Brasília, its capital (CHÁVEZ PORRAS *et al*., 2013). Brasília generates 2.2 million

tons of waste per year and, considering the volume generated and the environmental liabilities involved, the waste is characterized as suited for industrial use, given its environmental, technical and economic feasibility (FARIAS; GOMÉZ, 2012).

2 NATIONAL CONTEXT OF CDW MANAGEMENT

Despite the restrictions imposed worldwide by the COVID-19 pandemic, Colombia's construction sector has expanded. According to the Colombian Construction Chamber (CAMACOL, 2020), 190,000 new housing units were sold, a growth of 4%, driven largely by sales of social housing units, which grew by 17%. However, while the sector's growth continues amid difficulties, CDW management performance remains negative. Besides the case of Bogotá we already mentioned earlier, this trend also occurs in the rest of the country. Illustrating this fact, the company *Aguas de Bogotá S.A.E.S.P.* identified 345 critical points in the 12 locations in which it operates, and there are 395 critical points in which CDW are dumped clandestinely (PARRADO DELGADO, 2016).

In Colombia's second largest city, Medellín, the problem is also complex. According to Martínez, Mejía and Giraldo (2013), 4,600 t/day of CDW are dumped in landfills, but only 2,400 t/day in legalized sanitary landfills. Usually, 12,000 tons of CDW are collected, transported and disposed of each month, 70% of which in legalized collection centers and the remaining 30% through clandestine collection. Medellín has three CDW Collection Centers, which are operated by *Empresas Varias de Medellín* and serve small waste generators (GAITÁN CASTIBLANCO, 2013). Special wastes, clandestinely disposed of by the community on streets, sidewalks, green areas and ravines, are collected and taken to the municipal garbage dump, "*El Trapiche*." Although 205 critical CDW disposal points have been identified, estimates point that there may be up to 500 in total (ECHEVERRI, 2013).

In Cali, Colombia's third largest city, an average of 2,480 m^3 of CDW is generated daily, representing 0.5 cubic meters of waste per person. Of this volume, about 77% come from private construction firms and public works companies, with the remaining 23% generated by household renovations (BURGOS *et al*., 2015). According to Cali's Administrative Department for Environment Management, 40% of the waste generated is not monitored and the remaining 60% is dumped in authorized final disposal

sites (ROBAYO, 2019). CDW generation rate has reached an alarming level and places Cali in second place among Colombian capitals, after Bogotá (BURGOS *et al*., 2015).

Finally, we refer to Colombia's fourth largest city, the District of Barranquilla.

As mentioned above, Barranquilla has undergone in recent years a remarkable transformation as a result of construction activities. According to CAMACOL (2020), 4,619 units were reported to have had their construction started in the first half of 2016, which represents a growth of 35% compared with 2015. Regarding the launching of housing units, 5,473 units were reported in the first half of 2016, that is, an increase of 33% from 2015.

However, the COVID-19 pandemic has affected the sector in that region of the country. In the last quarter of 2020, the construction sector suffered the worst hit compared with other industries, shrinking by 27.7%, with falls in its subsectors ranging from 24.7% to 27.2%. Between January and December 2020, however, 8,443 m^2 were approved for housing construction in the Atlántico Department, of which 5,750 m2 were destined for the VIS segment and 2,692 m2 for the Non-VIS segment (CAMACOL, 2020).

As noted, construction in the city has progressed despite the difficulties faced, which is positive in terms of economic recovery but at the same time perpetuates difficulties in CDW management.

The city's environmental authority at the time (2011-2012), Barranquilla's Administrative Department for the Environment-DAMAB, pointed out at the time the lack of up-to-date statistics on CDW generation and, naturally, especially on CDW management. Thus, for the city, we used data from the *Conpes* document no. 3874, dated November 21, 2016, on the National Policy for Integrated Solid Waste Management, which reported that Barranquilla generated 18,000 tons of CDW in 2011, but provided no data on the management of this waste (COLOMBIA, 2016).

3 NATIONAL LEGISLATION ON CDW

In general, waste management regulation in Colombia began with the first Colombian environmental law, Law No. 23 of 1973, whose main objective is: "[…] to prevent and control environmental pollution and seek the improvement, conservation and restoration of renewable natural

resources, in order to protect the health and well-being of all inhabitants […]" (COLOMBIA, 1973).

This law provides in its article 3 that:

> […] are considered resources susceptible to being polluted the air, the water and the soil [while its article 4 defines pollution as] "the changes made to the environment by substances or forms of energy placed there by human activity or by nature, in quantities, concentrations or levels capable of interfering with people's well-being and health, harming flora and fauna, degrading the quality of the environment or affecting the resources of the Nation or individuals (COLOMBIA, 1973).

Also of interest is article 19 of the law, which granted extraordinary powers to the President of the Republic to establish the Renewable Natural Resources and Environmental Protection Code with the issuance of Decree-Law No. 2,811 of December 1974.

In its art. 34, this Decree provided for the management of waste, garbage, debris and residues. In particular, its paragraph 4 established as one of the Code's goals: "[…] to improve and develop new methods for the treatment, collection, storage and final disposal of solid, liquid or gaseous waste not susceptible to reuse;" and in its art. 37 that: "[…] municipalities must implement adequate services for the collection, transport and final disposal of waste" (COLOMBIA, 1974).

Five years after the issuance of the Natural Resources Code, Law No. 9 of 1979, the Sanitation Code, still in force, was enacted, which establishes in its art. 1 that the Code "[…] establishes the procedures and measures to be adopted for the regulation, legalization and control of the disposal of waste and materials that affect or may affect the health conditions of the Environment" (COLOMBIA, 1979).

The Sanitation Code makes many references to waste management, such as in arts. 8, 9, 12 and 14, among others. However, the most relevant in terms of CDW management is its art. 166, which establishes that: "[…] buildings must be constructed in places that have adequate systems for waste disposal" (COLOMBIA, 1979).

In 1993, Colombia's general environmental law was passed. In paragraph 32 of art. 5, it assigns to the Ministry the responsibility: "[…] to promote the development of industrial reconversion plans linked to the implementation of environmentally correct technologies and to the performance of activities of decontamination, recycling and reuse of residues" (COLOMBIA, 1993).

In turn, paragraph 12 of art. 31 establishes that the Regional

Autonomous Corporations must:

> […] Exercise the functions of environmental assessment, control and monitoring of the uses of water, soil, air and other renewable natural resources, which shall include the disposal, emission or incorporation of liquid, solid and gaseous substances or residues into the water, in any form, the air or the soils (COLOMBIA, 1993).

Finally, art. 66 of the law established duties for the Environmental Authorities of Large Urban Centers:

> […] In addition to the environmental licenses, concessions, permissions and authorizations that they are responsible for granting for the exercise of activities or the execution of works in the territory of which they have jurisdiction, the municipal, district or metropolitan authorities will be responsible for the control of the discharge and emissions of pollutants, for the disposal of solid waste and of toxic and hazardous waste, for the issuance of measures to correct or mitigate environmental damage and for implementing cleaning and decontamination projects (COLOMBIA, 1993).

With Law No. 99 in force, the then Ministry of the Environment issued Resolution No. 0541 of December 1994 to regulate CDW management in Colombia. Currently, this norm, which regulated the loading, unloading, transport, storage and final disposal of rubble, materials, elements, concrete, loose construction and demolition aggregates, and the organic layer, soil and subsoil from excavations, is no longer in effect. However, its most important aspects should be pointed out.

Its art. 2 established general provisions applicable to the loading, unloading, transport, storage and final disposal of CDW[4]:

I. With regard to transport:

a. Transport vehicles must have appropriate containers or bodies to ensure that their cargo are fully contained, avoiding spillage, loss of material or spillage of wet materials;

b. The cargo must be loaded so that its volume is level with the body or container;

c. It is mandatory to cover the transported cargo in order to avoid spillage or emissions;

II. With regard to loading, unloading and storage:

a. The temporary or permanent storage of materials and items in public areas is prohibited;

b. In the case of public works, the following management provisions apply:

b.1. The public space to be used for the temporary storage of materials and elements used in the construction, adaptation, transformation or maintenance of public works must be properly delimited, signalized and its use optimized;

b.2. The loading, unloading or temporary or permanent storage of materials and elements used in public works is prohibited in green areas, wooded areas, nature reserves and similar areas, recreational areas and parks, rivers, streams, canals, water courses,

4 Given its length, the article has not been transcribed in its entirety here, only its most relevant parts.

swamps and, in general, any body of water;

b.3. Public areas destined for pedestrian circulation can only be used for loading, unloading and temporary storage of materials and elements when public works are carried out in these same areas or in underground works;

III. Final dispositions:

a. The final disposal of materials and items in public areas is prohibited;

b. Mixing materials and elements with other liquid or hazardous waste, among other wastes, is prohibited (MINISTERIO DEL MEDIO AMBIENTE, 1994).

Further on, with regard to disposal sites, this resolution obligated municipalities to select specific sites, which would be called sanitary landfills. These landfills should be primarily located in areas with a degraded landscape, such as abandoned mines and quarries, among others, so that disposed of materials contribute to landscape restoration.

According to Pacheco (2017), it is also necessary to refer to Law No. 142 of 1994, which regulates the provision of public sanitation services for households, as it assigns to generators the responsibility for CDW collection, transport and final disposal. Furthermore, this law assigns to sanitation service providers the duty to ensure that CDW are separated from other wastes and disposed of in sanitary landfills.

In 2002, Decree 1713 was issued with the aim of regulating aspects related to the provision of public sanitation services and the integrated management of solid waste arising from Law 142 of 1994, which included debris and was therefore complementary to Resolution 0541. We address below some important aspects of this decree.

Its article 1 defined rubble as "[…] any solid residue left over from construction, renovation or demolition activities, civil works or other related, complementary or similar activities" (COLOMBIA, 2002).

Its art. 44 established the generators' duty to collect, transport and dispose of waste in landfills, all within the framework of the respective Integrated Solid Waste Management Plan-PGIR. The article further established that: "[…] in all cases, the collection, transport and final disposal of rubble must be done separately from other solid waste" (COLOMBIA, 2002).

Its art. 102 stipulated that waste not included in a recovery and reuse program should be properly deposited in landfills whose location had been previously defined by the municipality or district, taking into account the provisions of Resolution 0541. One of the main difficulties is that the vast majority of the country's municipalities and districts do not have sanitary landfills in operation.

In 2008, Law 1259 was enacted, which established the *Comparendo Ambiental* (environmental citation), a type of administrative sanction applicable to those who violate sanitation, cleaning and rubble collection regulations. The *Comparendo Ambiental* was regulated by Decree 3695 of 2009, which, in turn, was revoked by the Sole Decree 1076 of 2015 on the environmental sector. Law 1259 is still in force, but it should be interpreted in accordance with the provisions of section I of Chapter 14 of Decree 1076[5].

In this regard, art. 2.2.5.14.1.1. of Decree 1076 lists a set of 16 infractions that may lead to the imposition of a citation, among which there are some directly related to CDW management:

> 03 Disposing of solid waste or debris in unauthorized public spaces;
> 04 Dumping solid waste or rubble in public spaces or in spaces open to the public;
> 05 Dumping rubble or solid waste in wetlands, swamps, forests, among other ecosystems and water sources;
> 08 Hindering the sweeping and collection of solid waste or rubble;
> 09 Storing materials and waste from construction or demolition works on public roads and/or public areas; among others (MINISTERIO DE AMBIENTE Y DESARROLLO SOSTENIBLE, 2015).

However, environmental and urban planning authorities are not the only ones responsible for aspects related to CDW management, as the issue is also concerns other authorities. This is illustrated by art. 19 of Law 1383 of 2010, the Transport Law:

> Article 102. Debris management. Each municipality shall determine the authorized location or locations for the final disposal of debris generated in its jurisdiction; the handling of these materials must be carried out in a properly isolated manner to prevent spillage on roads and in accordance with environmental regulations in force, under the responsibility of the holder of the license granted by the transit authority, who will be responsible for controlling and monitoring compliance with regulations, without prejudice of responsibility for damage to public goods (COLOMBIA, 2010).

Another regulation that has environmental protection as one of its goals, although not strictly environmental, is the National Police and Coexistence Code, Law 1801 of 2016.

Chapter 11 of Law 1801 deals with waste and debris cleaning and collection. In paragraphs 3, 8, 9, 11 and 13 of its article 100, the law specifies prohibited behaviors in waste collection and transport in the following terms

5 Sole Decree on the Environment and Sustainable Development Sector.

> 3. Dumping solid waste and rubble in public spaces, without agreement or authorization by the competent authority.
> 8. Dumping garbage, tires, waste or rubble in public spaces or on public or private property.
> 9. Promoting or contracting the transport of waste in inappropriate or inadequate means of transport.
> 11. Transporting rubble by inappropriate and inadequate means.
> 13. Disposing of any object, substance, residue, rubble, sludge, fuel and lubricants into sewage, water and rainwater networks that may interfere with or obstruct their normal operation (COLOMBIA, 2016).

Lastly, after 23 years the Ministry of the Environment and Sustainable Development issued Resolution 0472 of 2017, which specifically regulated integrated CDW management in the national territory as a whole. As this is the regulation currently in force, integrated management activities must follow its provisions.

3.1 Local legislation on CDW

According to Pacheco (2020), few cities in Colombia established municipal legislation specifically aimed at regulating the integrated management of CDW. Local provisions have varied between regulating other environmental instruments for CDW management and the regulation of the requirements for the entry into force of the environmental citation. Undoubtedly, this represents a restricted view of the issue.

Paradoxically, the most advanced local regulations have been established by Bogotá, despite the unsatisfactory results achieved. Bogotá initially issued Decree 357 of 1997, with guidelines for the correct management of this type of waste detailed in the *Environmental Management Guide for the Construction Sector*, established by Resolution 6202 of August 23, 2010, which had a second edition established by Resolution 1138 of July 31, 2013 (SECRETARIA DE AMBIENTE DE BOGOTÁ, 2013).

Following Decree 357, Resolution 1115 of 2012 was issued, "[…] which establishes technical-environmental guidelines for the use and treatment of construction and demolition waste in the Capital District" (CASTIBLANCO, 2013), as well as Resolution 00715 of May 30, 2013, "[…] which amends Resolution 1115 of September 26, 2012 and establishes technical and environmental guidelines for the use and treatment of construction and demolition waste in the Capital District " (SECRETARIA DE AMBIENTE DE BOGOTÁ, 2012).

Finally, other two resolutions were issued in 2015: Resolution 0932 of

2015, "[…] which amends and supplements Resolution 1115 of September 26, 2012" (SECRETARIA DE AMBIENTE DE BOGOTÁ, 2015), and Decree 586 of 2015, "[…] which establishes an efficient and sustainable model for the management of construction and demolition waste – CDW in Bogotá D.C." (ALCALDÍA DISTRITAL DE BOGOTÁ, 2015).

As shown above, there are regulations in place to guide CDW management in the Capital District, although this city illustrates the fact that having more regulations does not necessarily mean better management.

In the city of Medellin, Decree 0874 of May 2010 was issued, but its sole purpose is regulating the environmental citation's implementation in the city.

The city of Cali issued Municipal Decree 291 of 2005, which specifically regulated the integral management of rubble.

In Colombian Caribbean districts, local regulations have also been issued on CDW management, taking into account that article 13 of Law 768 of 2002 (Law on Caribbean Districts) established that "[…] The districts of Cartagena, Santa Marta and Barranquilla shall exercise, within the urban perimeter of the district's main center, the same functions assigned to the Regional Autonomous Corporations as applicable to the urban environment" (COLOMBIA, 2002).

Cartagena issued Decree 0195 of February 2006, which prohibits the entry of waste transported in motor vehicles or animal-drawn vehicles into the city of La Boquilla. Subsequently, Decree 0511 of July 2006 and Decree 0889 of October 2006 prohibited the passage of motorized, animal-powered and human-powered vehicles transporting rubble and demolition material through the city's historic center, and assigned to the Local Government No. 1 (*Alcaldía Local No. 1*) the duty of enforcing the regulation. This shows a very narrow view of the issue.

Next, Decree 0938 of October 2006 assigned to local mayors the duty of prohibiting the storage of construction or demolition materials and waste on public roads and spaces and, at the same time, provided for the use of protective barriers in loading and unloading operations to prevent the spillage of CDW (GOMEZ *et al*., 2008).

In Santa Marta, only one decree was issued, Decree 0063 of March 2016, which regulates the proper handling, transport and disposal of rubble, vegetation and unusable waste in the city (ALCALDÍA DISTRITAL DE SANTA MARTA, 2016). The regulation does not comply with current regulations on the matter.

Finally, we will examine in the next section the case of the District of

Barranquilla.

4 CDW MANAGEMENT IN BARRANQUILLA THROUGH INTEGRATED MANAGEMENT ACTIVITIES

The district of Barranquilla also issued local regulations for CDW management in view of the city's increasing urbanization rate (ROLONG, 2012). However, for the most part, these regulations only reproduce national provisions on the matter.

First, Resolution 1011 of June 2016 was issued by the Environment Technical Administrative Department – DAMAB[6], which established "[…] technical-environmental guidelines and protocols for the management, use, transport and final disposal of construction and demolition waste in the District of Barranquilla" (ALCALDÍA DISTRITAL DE BARRANQUILLA, 2016). Despite the issuance of the resolution, CDW management in the city remained largely unchanged.

The legal instrument was not properly disseminated and, therefore, was scarcely implemented. On the other hand, an institutional weakness was clearly recognizable at that time in the urban environmental authority, which had little control over anthropic activities in the city. Finally, the vague and ambiguous regulation established only a few general guidelines and focused on procedural matters, without taking into account basic and relevant aspects, such as: self-regulation mechanisms; command and control measures; the responsibility regime; and, above all, co-responsibility guidelines for the various actors involved. However, what is most surprising is that, although issued to regulate the integrated management of CDW, it did not establish integrated management measures.

The second local regulation was Resolution 1482 of December 19, 2017, which regulated the Registration of Generators and Managers within the Framework of Integrated Management of Waste Generated in Construction and Demolition Activities – CDW in the District of Barranquilla (ALCALDÍA DISTRITAL DE BARRANQUILLA, 2017).

4.1 Implementation of the current regulation for the integrated management of CDW in Barranquilla

According to Resolution 1482, the integrated management of CDW is

6 Since 2017 there is a new public environmental department in the city named Barranquilla Verde. This is the fourth urban environmental authority created in the District of Barranquilla.

composed of a cycle of activities, as shown in Figure 1. We will thus verify the degree of compliance with each of these CDW management stages in the district of Barranquilla.

Figure 1 – CDW cycle or stages.

Source: Castiblanco (2013).

Each of these activities requires an action in response or involves an obligation, in terms of the exercise of environmental duties. Thus, the question is: What has been the response of Barranquilla's environmental authority?

4.1.1 Generation: prevention and reduction

CDW generation is closely linked to urban development activities: urbanization, land subdivision, construction and demolition of buildings and subdivisions. The construction process has at least three stages – demolition, excavation and construction (OROZCO GUTIÉRREZ *et al*., 2014) – which generate this type of waste: in demolition, existing structures are demolished or dismantled; in excavation, soil or existing road structures

are removed; and in construction the building of structures involve handling large volumes of waste (see Figure 2 below).

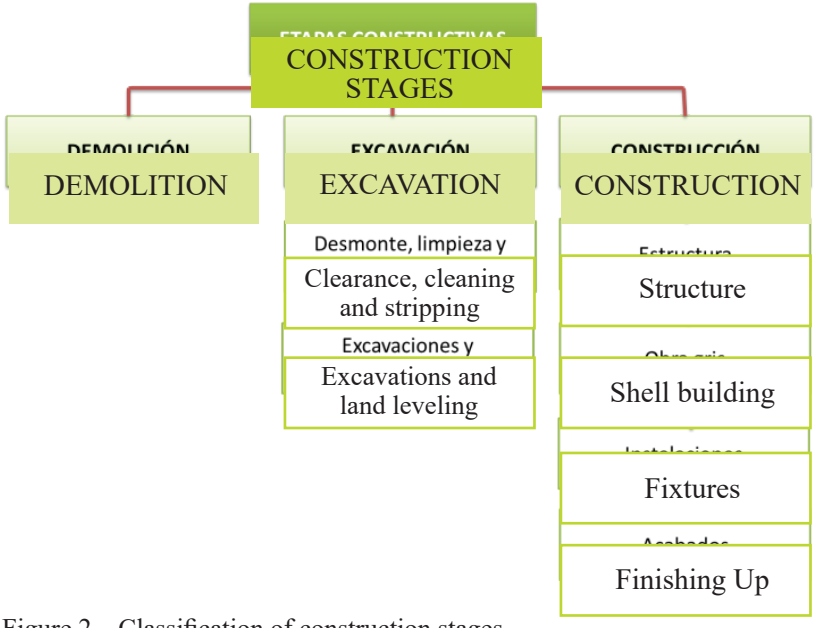

Figure 2 – Classification of construction stages.
Source: The authors.

Article 3 of National Resolution 0472 of 2017 establishes a hierarchy of activities for the integrated management of CDW in Colombia: first, there is prevention and reduction; second, use; and finally disposal. Article 5, in turn, establishes guidelines to prevent and reduce CDW generation, summarized in 4 measures:

1. Plan development activities so they only use what is necessary, avoiding waste of materials;
2. Sort wastes by type at the generation point;
3. Store waste correctly and specifically;
4. When applicable, control rainwater runoff and properly manage rainwater (MINISTERIO DE AMBIENTE Y DESARROLLO SOSTENIBLE, 2017).

On the other hand, Barranquilla's local resolution (1482) does not include as an obligation, or even as a suggestion, any of the measures established by the national regulation.

4.1.2 CDW collection and transport

The second integrated management activity is collection, which consists of the loading or removal of waste generated by construction, renovation or demolition activities when requested by waste generators (MINISTERIO DE AMBIENTE Y DESARROLLO SOSTENIBLE, 2017).

Transport, on the other hand, consists of the removal of waste from the generation site to a storage place or final destination, such as a sanitary landfill or a recycling facility (BURGOS, 2010).

As has been usual in CDW regulations, certain conditions were established for transport vehicles, as well as for the loading and transport of waste. These obligations were provided for in Resolution 0472, which, in its article 6 establishes that:

1. The cargo must be loaded so that its volume is level with the container;
2. The loading and unloading of CDW must prevent any dispersal of particles;
3. The cargo must be covered during transport, preventing contact with rain and wind;
4. Vehicles used for this activity must comply with current regulations on traffic and transport and atmospheric emissions 211 (MINISTERIO DE AMBIENTE Y DESARROLLO SOSTENIBLE, 2017).

On the other hand, Barranquilla's local resolution (1482) does not establish any specific provision in relation to collection and transport activities. Of course, national regulations apply to the District of Barranquilla, although the city's environmental authority have not issued any specific consideration or obligation on the matter.

The issue is even more complex, since environmental authorities have no competence in terms of traffic or transport and the city regulation does not provide for any coordination or collaboration between authorities. It is common to observe a lack of enforcement efforts on the part of environmental authorities in this regard, as their hands are tied by the regulations in force.

4.1.3 Storage

With regard to storage, Resolution 0472 of 2017 establishes that CDW must be stored in collection and transport receptacles, containers and/or tanks for later use or final disposal.

Its article 7 establishes that large waste generators must designate one or more locations for the temporary storage of CDW at the generation site,

in which they must sort CDW by type and, in particular, establishes a set of activities that must be carried out:

> 1.1. Installation of barriers to avoid visual impacts on the vicinity of the storage site;
> 1.2. Perform drainage and sediment control works;
> 1.3. Signalize properly;
> 1.4. Take actions to avoid the dispersal of particles (MINISTERIO DE AMBIENTE Y DESARROLLO SOSTENIBLE, 2017).

Resolution 0472 also establishes additional obligations in relation to storage, including the express prohibition of CDW storage in green areas, wooded areas, forest reserves, recreational areas and parks, rivers, streams, beaches, canals, waterways, heaths, wetlands, mangroves and riparian areas.

An examination of the local resolution (1482) shows that the national regulation is transcribed in article 5, paragraph 8, without any addition.

4.1.4 Reuse

The resolution's definition of reuse includes the reutilization, treatment and recycling of CDW, with the purpose of reincorporating it into the economic cycle (MINISTERIO DE AMBIENTE Y DESARROLLO SOSTENIBLE, 2017).

Article 9 of Resolution 0472 establishes that this activity can take place in fixed or mobile collection facilities, which must have separate areas of operation. Moreover, the resolution also provided for the establishment of "Clean Points" as a recovery option, which are widely used in other parts of the world but have only recently been introduced into Colombian legislation. These are sites that CDW managers designate for the separation and temporary storage of waste.

In order to promote reuse implementation, the national resolution's article 16 establishes a series of obligations for CDW managers, regardless of the method of reuse:

> 1. Register with the regional or urban environmental authority in whose jurisdiction activities are performed;
> 2. Have available the equipment required for performing CDW management activities;
> 3. Issue a certificate for the generator containing the information specified in Annex II of the resolution;
> 4. Inform the competent regional or urban environmental authority, in the first quarter of each year, the quantity and final destination of all waste managed;

5. Managers who operate clean points or recycling plants must prepare and implement a document establishing minimum environmental management measures, as provided for in art. 10 of the resolution; and
6. Managers responsible for the final disposal of CDW must formulate and implement minimum environmental management measures, as provided for in art. 12 of the resolution (MINISTERIO DE AMBIENTE Y DESARROLLO SOSTENIBLE, 2017).

In this regard, local regulations established various provisions to promote reuse. Article 9 of resolution 1482, for example, establishes obligations for Managers of Clean Points and Recycling Plants, but also introduces some requirements not contained in national regulations, which therefore could not be required of managers.

The article establishes that, before meeting the obligations specified in the resolution, individuals or firms seeking authorization to manage Clean Points or Recycling Plants must submit to the environmental authority (Barranquilla Verde) a written request and an Environmental Management Program for evaluation, attaching a land use certificate for the site where the service will be provided, a property ownership certificate (*certificado de tradición*) in case of being an owner and, if not, a copy of the contract and/or authorization to carry out the activity, as well as a description of the separation, storage and reuse techniques to be used, as applicable (ALCALDÍA DE BARRANQUILLA, 2017).

As noted, this obligation is not in accordance with the provisions of Resolution 0472 of 2017, as it does not require prior operation authorization by the environmental authority. As provided for in article 10 of the resolution, the interested party or manager of a clean point or recycling plant must submit to the competent environmental authority a technical document presenting the minimum environmental management measures within 30 calendar days following the start of activities, for monitoring and control purposes.

Therefore, as established by the national regulation, environmental authorities have limits on their actions and cannot exercise prior control of these activities. This is precisely one of the flaws identified in Resolution 0472, since a manager of a clean point or waste management plant can initiate activities without prior pronouncement by the environmental authority.

Furthermore, the article establishes that of the total waste volume/month received by Clean Points and Recycling Plants, a minimum percentage of 30% must be reused and only 70% can be finally disposed

of in landfills situated in locations registered with and authorized by the competent environmental authority. Once all the information presented in the Environmental Management Program has been evaluated, the corresponding authorization to operate the Clean Point or Recycling Plant will be issued, as the case may be. As mentioned above, this is not in accordance with national regulations.

4.1.5 Final disposal

Finally, there is the final disposal, which can be carried out in any operating site technically selected and designed for the final disposal of CDW, including the minimization and control of environmental impacts and the use of engineering solutions for the confinement and isolation of waste.

Article 12 of National Resolution 0472 of 2017 establishes a set of minimum environmental management measures for CDW final disposal sites; managers of these sites must prepare a document containing the following minimum management measures and information:

1. Describe the flow of CDW processes performed;
2. Develop and implement control actions to prevent particle dispersion, drainage work and sediment control;
3. Define measures to guarantee the geotechnical stability of the site;
4. Install barriers to prevent visual impacts on the vicinity of the site;
5. Have available properly calibrated weighing instruments;
6. Install a perimeter fence to guarantee the isolation and security of the site;
7. Install a visible sign containing relevant information on the site.
8. Describe and implement decommissioning and post-closure activities (MINISTERIO DE AMBIENTE Y DESARROLLO SOSTENIBLE, 2017).

Furthermore, the article establishes that the manager must send a copy of the minimum measures document to the competent environmental authority ninety days before the start of activities at the CDW disposal site, for monitoring and control purposes. This document must be accompanied by a copy of permits, licenses and other relevant environmental authorizations, as well as a copy of the certification of conformity with the

corresponding Land Use Plan.

Barranquilla's local resolution (1482) also establishes provisions in this regard. Its article 11 establishes that the individual or firm seeking to operate a CDW final disposal site must submit to the environmental authority (Barranquilla Verde) a written request for authorization for the reception and final disposal of CDW, attaching an Environmental Management Program for evaluation, as well as a land use certificate for the site where the service will be provided or a property ownership certificate (*certificado de tradición*) or, in case of not being an owners, a copy of the contract and/or authorization to carry out the activity and a description of the final disposal techniques to be used (ALCALDÍA DE BARRANQUILLA, 2017).

However, once again this Resolution imposes a series of obligations not provided for in the national regulation.

Article 12 establishes the following obligations for CDW disposal operators:

1. Register with the environmental authority as manager of the CDW disposal site, in accordance with the provisions contained in Annex IV of Resolution 0472;
2. Comply with environmental guidelines for CDW disposal site accreditation;
3. Upon reception of CDW, managers will be jointly responsible for the impacts on the environment resulting from inappropriate handling, use or disposal of CDW;
4. CDW operators must issue a receipt to the vehicles carrying the disposed of CDW;
5. The manager has the obligation to report annually any relevant information to the environmental authority (MINISTERIO DE AMBIENTE Y DESARROLLO SOSTENIBLE, 2017).

FINAL CONSIDERATIONS

The first National Solid Waste Policy established in 1998 included the implementation of plans, programs, projects, strategies and goals to properly perform integrated waste management, but did not addressed in depth CDW management, since it was limited to the provisions of Resolution 0541 of 1994 (GOMEZ *et al*., 2008). A new National Waste Policy (2016) incorporates this issue in a much clearer way, but still insufficiently, how-

ever. Furthermore, this document acknowledges that, with regard to the management of construction and demolition waste, there are no national guidelines for the use of this type of material and no systematic information to develop policies for their management (CONPES, 2016).

In regulatory terms, as recently as 2017 the Ministry of the Environment and Sustainable Development issued Resolution 0472, seeking to establish a true integrated management of CDW and consequently minimizing the environmental impacts generated by the construction sector.

Still, the issuance of Resolution 0472 of 2017 meant an advance in integrated waste management, given the holistic view incorporated into CDW stages, processes and life cycle.

This Resolution generated regulatory improvements in aspects such as the promotion of prevention measures and the reduction in materials or natural resources used in construction activities; the harmonization of guidelines for the temporary storage of CDW in construction sites; the establishment of environmental management guidelines for the separation, use and final disposal of CDW. These improvements are also visible in the district of Barranquilla, according to some construction sector actors and CDW managers, but they are still not fully optimized and efficient.

An evidence of the above is the fact that the Ministry of the Environment and Sustainable Development (MADS) has held technical meetings with different actors of the National Environmental System – SINA (construction industry, environmental authorities, universities, etc.) in order to update national regulations and address the regulatory gaps that their application have brought to light. A final document has been made available by the MADS for comments before dissemination.

With regard to the use of CDW, it is worth noting that goals were defined for large generators regarding the use of CDW, as well as technical and methodological evaluation criteria for the selection of final disposal areas or locations, together with development planning instruments for municipalities. The main issues are still the separation, transport and final disposal of waste.

In the case of the district of Barranquilla, there is still no advance in the definition of locations for separation (clean points), use or final disposal, much less in its harmonization with the planning instruments mentioned above, which represents an urban-environmental problem, since much of the CDW is currently disposed of in important ecosystems such as swamps, mangroves, dry tropical forest, etc.

Regarding regulatory aspects, even after the issuance of Resolution 0472 Barranquilla still does not have established adequate local regulations to strengthen management. The biggest problem in the city is the transport of CDW, because although these regulatory instruments have provided some management guidelines or technical measures, it has not yet been defined how such activities are linked to an integrated management vision and the authorities' roles and powers in their monitoring and control. This encourages informality.

In the case of the Barranquilla district, there is an evident use of inappropriate or illegal vehicles, such as animal-powered vehicles (mule carts), vehicles in disrepair or without technical and environmental conditions to ensure adequate transport.

In general terms, despite the efforts made to reduce CDW generation impacts through mechanisms such as Clean Production Agreements, Laws, Decrees, Resolutions, among others, they are still delivering insignificant results (ALDANA; SERPELL, 2016). Another obvious problem affecting CDW management in Barranquilla is the fact that there is no coordinated Local Public Policy bringing together the various entities involved, which would establish guidelines or strategies for adequate environmental management.

As Pacheco (2020) points out, Barranquilla needs an urgent adjustment to its CDW management model, given its current urban development dynamics. The city is undoubtedly in the process of establishing a strategy to facilitate the coordination between the various actors (public and private) involved in the handling and management of Construction and Demolition Waste (CDW). This strategy should be agreed on by conducting technical discussions in which public policy and regulatory solutions are proposed and a clear and coherent action plan is established.

On the other hand, it is necessary to redouble efforts to carry out environmental education campaigns aimed at citizens, in order to encourage collective behaviors that contribute to the improvement of integrated CDW management at the district level. Addressing bad behavior on the part of citizens is the current priority.

Finally, it is necessary to abandon the typical and traditional view of CDW management in order to clearly incorporate a circular economy view, which today is not clearly observed in the management of this waste.

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