



A Multi-Level Perspective of the Construction and Demolition Waste Management in the City of Guayaquil, Ecuador. A Close Look to Actor's Response to the Legislation and the Reasons Behind their Behavior.

Author

Walter Garcia Cedeño

waltero79@hotmail.com

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Supervised by:

Barry Ness, PhD

Barry.ness@lucsus.lu.se

Lund University Centre for Sustainability Studies, LUCSUS

Geocentrum 1, Sölvegatan 10

P.O. Box 170, SE-221 00 LUND, Sweden

Phone: +46 (0)46 222 48 09

Fax: +46 (0)46 222 04 75

Abstract

Construction and Demolition Waste (C&DW) represents an important fraction of the total amount of waste generated. Though the construction sector is an important component in the economy, it creates impacts on the environment due to the amount of waste generated and the consumption of natural resources. This is why some developed nations, especially those with a shortage of aggregates and landfill space, have implemented environmental regulations that raise the price for discarding recyclable materials in landfills. Such regulations initiated in developing nations however have contributed to problems regarding improper management of waste while low, or even non-existent, recycling levels still persists. This research focuses in the city of Guayaquil in Ecuador, and aims to survey the legislation in place with regard to CDW policies at different levels (i.e. state, regional, local) and the effects of this policies at the action level (e.g. construction sector, landfill operators, waste transport companies). The analysis focuses significantly on the identification of *disconnects* between and within the different levels. In order to accomplish this, all the legislation regarding waste management was reviewed. Additionally, authorities at the different levels and actors at the action level were interviewed to find out how they are addressing the problem of C&DW. As a result, important disconnects were found between the different levels, especially at the local level, where some important aspects that appears at the top level legislation are not taken into account by municipal authorities. Furthermore the majority of the disconnects take place between the local (Municipality) and the action level (construction sector, landfill, waste transport companies) were deficient control mechanisms which cause an inaccurate management of the C&DW. There are serious voids at local level, such as control issues and the exclusion of important aspects that are ruled out by the current ordinances dealing with C&DW. This is why the communication between state, regional, local and action level should be strengthened. Likewise, an integral plan is necessary to progressively improve C&DW management, as there are several areas that need to be faced first in order to reach the ultimate goal; that is the reduction of resource consumption and the amount of waste generated.

Keywords: Construction and Demolition Waste, Sanitary Landfill, Construction Sector, Action Level

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Abbreviations

C&DW – Construction and Demolition Waste

IE – Industrial Ecology

1. Introduction

Construction activities have a twofold impact on the environment: the activities generate excessive use of natural resources in order to produce building materials, and the environmental impacts associated with the waste generated during the construction and demolition processes. This thesis focused on how government authorities manage Construction and Demolition Waste (C&DW) in the city of Guayaquil, Ecuador, and how the primary stakeholders react to the governmental measures regarding C&DW. Guayaquil is the biggest city in the country and where, in the last years, the construction activity has been escalating as a result of the revitalization and new housing projects. This is why this research has been set up to gain a better understanding of the reasons behind the behavior of actors in the landscape, and locate where the gaps between the different actors are during the implementation and enforcement of C&DW legislation. Subsequently it is possible to address the question of how to reconnect these gaps, in order to improve the way in which C&DW is managed in the city of Guayaquil.

1.1 Objectives and Research Questions

The objective of this research is to increase awareness and potentially attract the attention of government authorities and the society, on how the waste generated at the construction sites in Guayaquil is currently being handled; pointing essential issues that need to be fixed in order to progressively improve C&DW management in the city. Moreover, in order to accomplish this, it is important to identify and analyze the main stakeholders, the motivations for their behavior, and at which level the legislation is not being recognized or enforced.

The specific research questions that will be explored in this study are:

- How do the actors in the construction sector in Guayaquil handle their waste, and are they acting in accordance with current legislation?
- At which spatial levels is the legislation being carried (or not carried) out by construction companies, waste collection companies, and landfill operators?
- What measures should be established to ensure that C&DW management legislation is carried out and enforced amongst sectoral actors?

1.2 Thesis structure

The remainder of this document will explore the limitations and the methodological and theoretical basis of this thesis. Section two will provide the definitions and relevance of the C&DW management and the geographical background for this study. Section three will present the main stakeholders and the levels in which they are situated. Section four will analyze the hierarchical structure of the C&DW system in Guayaquil and analyze the main stakeholders acting in the landscape. Section five will discuss the behavior of the actors regarding the established regulations, and analyze at which levels the legislation is not recognized. Section six will provide potential solutions for fixing these disconnects between the different levels with the goal of improving the way C&DW is currently been managed in the city of Guayaquil. Section seven will describe the relation between the case of Guayaquil and the Industrial Ecology paradigm. Finally sections eight and nine will present conclusions and recommendations, respectively.

1.3 Methodological basis

The choice for qualitative research is rooted in the fact that there is not any statistical or official quantitative data regarding waste in Ecuador, and according to Bryman (2004, p. 266) “this type of research tends to be concerned with words rather than numbers.” In addition, this study is about actors and their behaviors regarding C&DW legislation; that is why it makes more sense to adopt the ontological position known as constructionist as it recognize the fact that “social properties are outcomes of the interactions between individuals, rather than phenomena out there and separate from those involved in its construction.” Following this theory, the way the C&DW is being managed in Guayaquil is a consequence of the interactions between the different stakeholders.

Furthermore, under this constructionist approach “the social phenomena and their meanings are continually being accomplished by social actors” and that the social phenomena is not only produced by social interaction but is in constant revision (Bryman 2004, p. 17). Consequently the researcher is also included, as his own versions of the social world are also constructions. This is important to be aware of, as the presented material is only one version of the social reality (ibid). However, not only the researcher falls into this as his respondents will also be giving their own version, influenced by their context and realities, as Mikkelsen (2005 p. 137) explains it; the sets of answers given are in all cases human constructions, so they are all inventions of human mind and hence subject of human error. This will be kept in mind when gathering the data and

interviewing the different stakeholders, as they will only provide their own version of the current events influenced by their particular context and situation. The same can be applicable to the author during the analysis of the information as he will also be giving his own point of view.

Moreover, according to Yin (1994, p. 6) there are three conditions in choosing a particular research strategy: the type of research question, the control the researcher has over actual behavioral events, and the degree of focus on contemporary as opposed to historical events. In this research the main research question: *How do the actors in the construction sector handle their waste? And are they acting in accordance with current legislation?* will, according to Yin, lead to the use of case studies as “these types of questions deal with operational links needing to be traced over time, rather than mere frequencies or incidence” (ibid) Furthermore, this study is focused in the particular case of C&DW management in the city of Guayaquil, which is a contemporary event and where the researcher does not have any control over behavioral events (ibid). These conditions, in addition to the type of research question, are the reasons why the author will choose a case study instead of other types of research strategies.

In addition due to the lack of information and official records regarding waste management, the main method to gather data was face-to-face semi-structured interviews made with individuals involved in the building sector, C&DW management, and civil servants. According to Bryman (2008, p.196) in these types of interviews, the researcher can vary the sequence of the question, and have more space to ask further questions depending on how interviewees reply, which is very convenient in this case, as the author’s intention was to obtain as much information as possible from the actors handling waste issues, without having the restriction imposed by other formats.

Furthermore, the interviews were made to people working at the decision-making level going down the chain through local authorities until reaching the actors at the action level¹ where the legislation should be implemented (fig I). In most cases the interviews were made to people working at executive levels in the companies; as they are the ones in power to apply or not the current legislation or promote the implementation of new strategies for managing their C&DW (see Appendix A). However, it is important to highlight that the people involved in the construction sector were very reluctant to talk about how they handle their waste, as some of them are breaking the regulations expressed in the legislation. This is why observation and the author’s experience in the construction sector was an important asset for collecting the data. A literature review was also performed. The literature used was comprised of publications on the city of Guayaquil, statistics about the construction activity, and legal documents on waste

¹ The Action Level refers to the landscape. According to Hagerstrand it is where the effects and portential side-effects [i.e. of legislation] can be observed (Hägerstrand T., 2001 p. 37).

management. In addition, scientific articles related to C&DW management, strategies for reducing C&DW volumes, research methods and industrial ecology literature were also used.

1.4 Scope and Limitations

Due to time and length limitations, this research will focus on the environmental impacts as a consequence of inappropriate management of the C&DW during the construction process or at the end of a building life. However some actors involved in the production of building materials were also included during the interviews solely with the purpose of finding out how the construction sector and its intensification have affected their production. Additionally, the geographical focus will be limited to the city of Guayaquil because is the largest city in Ecuador and it is where the construction activity is currently the most intense, despite the present economic crisis. Some other limitations are the lack of available data concerning waste volumes including C&DW, and the mistrust of some companies in providing information regarding their production and management of waste. Moreover, this research will not consider the pros and cons of the implementation of strategies for the reduction of C&DW, or expand on the existing strategies (i.e. deconstruction, recycled aggregates, selective demolition, etc) and their applicability to this case study.

1.5 Theoretical Basis

1.5.1 Industrial Ecology and links to C&DW management.

The concept of Industrial Ecology (IE) is based on the notion that society will become more sustainable if we embrace the principles originated in nature (Bohne, 2005 p. 10). One of these principles is that the waste that is been produced by one individual, becomes a valuable resource to another (Bohne, 2005 p. 10, Frosch and Gallopoulos, 1989 p. 144). Consequently the concept of waste, as we know, does not exist in the natural system (Bohne, 2005 p. 10).

Furthermore, according to Frosch and Gallopoulos (1989), which paper popularized the idea of IE, propose this concept as a shift from the traditional industrial model. Under this (traditional) model resources are taken to produce new products which not only produce waste during the production process, but the products themselves become waste at the end of their lives (Korhonen, 2001 p. 58, Erkman and Ramaswamy, 2003 p. 4). The new approach by Frosch established an analogy to a biological ecosystem, whereby plants synthesize nutrients that feed herbivores, which in turn feed a chain of carnivores whose wastes and bodies eventually feed further generations of plants. (Frosch and Gallopoulos, 1989 p. 144). However, despite their

acknowledgement of the imperfections in the analogy, “much could be gained if industrial system were to mimic the best features of the biological analogy” (Frosch in Erkman and Ramaswamy, 2003 p. 4).

In addition, according to Korhonen (2001) IE metaphor is commonly understood as roundput, as the ecosystem is a master of recycling, and cascading of energy. This is why, in theory, a successful application of this analogy to an industrial system might reduce the use of raw materials and energy inputs. Consequently, with the implementation of a roundput approach, the amount of waste and environmental burden of the industrial activities will also be reduced (Korhonen, 2001 p. 58) This roundput idea where the waste is never discarded but used as an input in industrial processes, can be related to the development of new strategies for improving the way the C&DW is being handled. One example is the Closed Cycle Construction concept which according to Mulder et al. (2007 p. 1408) transforms the old building into a source of new building materials to keep feeding the activities of the construction sector. Under this approach, the combustible fraction of the C&DW is used to fuel a thermal process in which the minerals content in the recovered building materials is separated in order to produce new materials like concrete and masonry (ibid). Consequently nothing is wasted and all the elements existing in the edifications are reused again. Some other strategies, such as deconstruction and selective demolition which recover some materials that are found in the buildings at the end of their life before placing them in the landfills (Thormark, 2003 p. 7) and the production of Recycled Aggregates from demolished concrete (Akash, et al, 2006 p. 74), can be linked to the idea of closing the material loops present in the Industrial Ecology (Erkman, and Ramaswamy, 2003 p. 8).

Here (under the IE paradigm) the C&DW is not perceived as waste anymore and placed directly into the landfills, but it rather becomes an important source of material (replacing the exclusive use of virgin materials) in order to generate new products. This is how the construction sector becomes a system where its own waste provides the necessary input to keep fueling their processes. However, as Erkman & Ramaswamy (2003) point out, it is important to improve how the system works, as until this closed loop system keeps using fossil fuels as the main source of energy, it will keep contributing to the generation of waste from combustion processes.

1.5.2 Scale and Hierarchies

Another basis of this thesis is with scale and hierarchies. Gibson (2000, p. 218) defines scales as the spatial, temporal, quantitative or analytical dimensions used to measure and study any phenomenon. The use of scale becomes important in analyzing interactions at different levels, as complex problems comprise multiple spatial and temporal dimensions (ibid). One feature that

can be linked to scales and is useful for structuring problem areas is the use of hierarchies. According to Gibson this hierarchical system can be use for clustering different phenomena along a particular defined scale. Moreover, Hägerstrand's (2001) approach of nested spatial domains, is used to represent the interactions between different stakeholders situated at different levels. Levels on the other hand according to Gibson (2000, p. 219) refers to locations along the scale. This multi-level tool (nested spatial domains) is use to situate top decision making at macro level communicating with actors at the micro level where the decisions are implemented (Hägerstrand, 2001 p. 37). With this approach "the rule-makers in the higher domains are responsible for the regulations of selected sets of conditions and actions in the lower ones, down to the level of actions in the landscape" (Hägerstrand, 2001 p. 39). Simply this means one group makes the rules that the other group has to follow. For instance a simplified order would be the state at the top level, then the province, the local government and finally the action level (Hägerstrand, 2001 p. 38).

The problems emerge when the spatial scale where the levels are starts to grow, which also widens the cognitive and geographical distance between those who formulate the management goals and those who needs to act according to them (Hägerstrand, 2001 p. 36). According to Hägerstrand the major problem is the difference between the abstract nature of the macro-level discourse and the micro-level concrete reality (Hägerstrand, in Buttimer, 2001 p. 45). This gap between these two levels happens because of the bird's eye view of the world of those writing and making the decisions, which sometimes do not consider the reality of those who need to comply (Hägerstrand, 2001 p. 36).

2. Background

2.1 Definitions: What is the Construction and Demolition Waste?

C&DW is the debris generated as a result of the demolition and the construction process. C&DW streams represent a relevant environmental problem due to the amount of waste generated and scale resource consumption (Miliūtė and Staniškis 2006 p. 42). Furthermore according to Kourmpanis et al. (2008) the C&DW can be defined from considering its origins, and can cover a wide range of materials, for instance:

- Waste arising from total or partial demolition of buildings. The most common materials are soil, gravel, concrete, ceramics, coatings, bricks, etc.
- Waste arising from construction of buildings and/or civil infrastructure. They can be concrete, wood, plastic, bricks, tiles, etc.

- Waste arising from excavation and land leveling. They comprise soil, rocks, clay, and vegetation
- Waste produced from roads construction and maintenance. This includes asphalt, sand, gravel, and metals.

According to Aguilar (1997) the materials found in the C&DW that can be of use are classified as:

- *Reusable materials:* These are materials recovered in good shape, for instance high quality wood or structural steel, and manufactured pieces like bricks, concrete blocks, and tiles (roof, floor). Also excavation material or demolished concrete, free of impurities that can be used directly as sub-base material in the construction of roads.
- *Recyclable materials:* These materials (metal, glasses, plastics, etc) can be reincorporated into the recycling market, as long as they are free from impurities, and can be used to produce the same or similar products that created the waste.
- *Materials used for the generation of secondary products:* Besides the glass, plastic, and metals which can also be used for this purpose; they are mainly materials of stone, ceramics, concretes the ones that can be used for manufacturing secondary products.

In order to recover C&DW, it is important to know some of the strategies that are available. One strategy is deconstruction, which is an alternative to standard demolition in which all the C&DW is sent directly to the landfill. In contrast, the deconstruction approach sorts the different materials in the C&DW, separating the hazardous materials from those that can be reused or recycled (Thormark, 2003 p. 6-7); the remainder then is sent to the landfill. Another alternative is the production of recycled aggregates. They are obtained from demolished concrete, precast elements and testing cubes. In order to obtain recycled aggregates we need to triturate the demolished concrete, in order to obtain aggregates that can be use in the production of new concrete (Rao et al, 2006 p. 74). Even though these strategies are important contributions for a reduction in the consumption of raw materials by the construction sector; there are also some negative effects due to the additional use of energy needed to transform some of the C&DW into new products. However, this approach can also be argued for, due to the reduced production of new products and the consequent lessening of energy use (Aguilar, 1997 p. 1).

2.2 Why is important to deal with C&DW?

The construction sector is an important job generator and is essential in the economical development of nations. In spite of the benefits to social and economic development, however, the sector poses serious impacts on the environment. This sector uses a large amount of virgin materials and energy during the construction processes. In addition, there is waste generated during the construction process and following the end of a buildings life.

Some countries in Europe, where it is more common to have a strategic approach to environmental matters, there are sometimes shortages of raw materials needed in building products, especially of aggregates. This is part of the reasons why these countries lead in matters concerning C&DW regulations. Subsequently, implementing the three Rs (i.e. reduce, reuse and recycle) in their waste management policies is common (Aguilar, A. 1997 p. 1). However, the scenario in Latin America and the Caribbean is different. In these countries a total of 424,000 tons of waste are generated every day, from which roughly two-thirds or 275,000 tons, ends up in open air dumps and rivers (Monge, 2009 p. 1). This is why the author chose to study the case of Guayaquil, a big city in the Latin American context. This case will allow people at decision levels in these countries to have a better understanding of the reasons behind the deficiencies in the management of C&DW.

2.3 Guayaquil, Ecuador

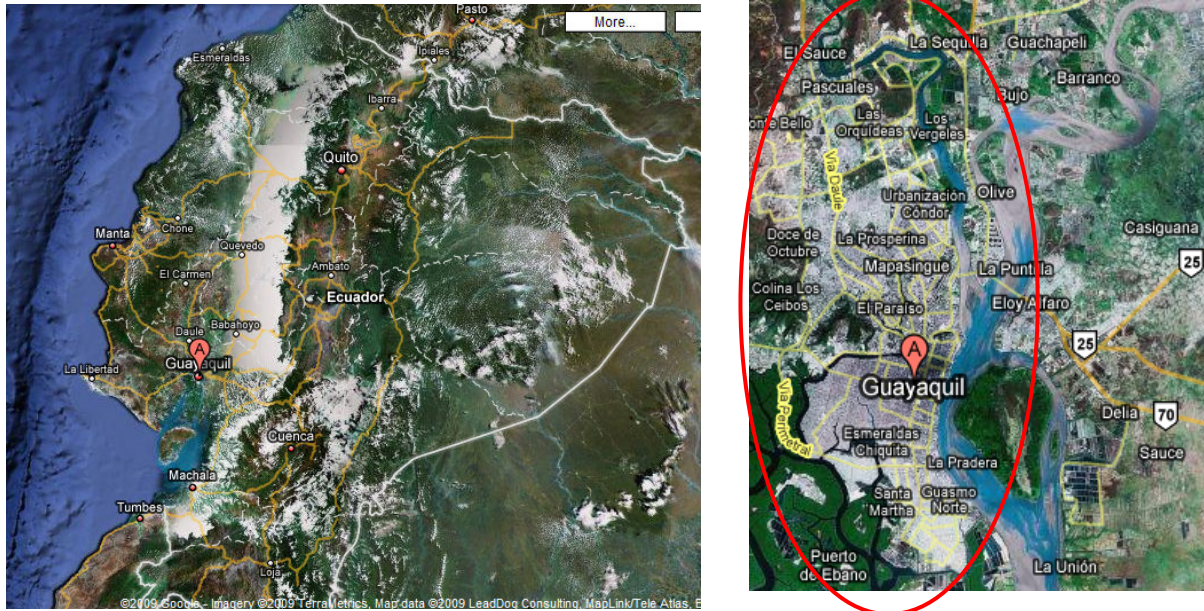


Fig. 1: [left] Ecuador and the location of Guayaquil, [right] The urban area of Guayaquil, and the Guayas River.
Source: Googlemaps (<http://maps.google.com>)

The city of Guayaquil is located in the coast region of Ecuador (Fig I). Santiago de Guayaquil (the official name of the city) is the capital of the Guayas Province (Municipality of Guayaquil, 2009). The city has a population of 2,040,000 inhabitants (INEC, 2001) and 172.8 km² of urbanized land (Municipality of Guayaquil and UN, 2002 p. 13). Furthermore, Guayaquil is the economical center and the largest city in Ecuador (UN-Habitat, 2009). Due to these positions, Guayaquil attracts people from other provinces, which move into the city looking for ways to improve their financial situation. This is how the city has a total floating population of 3,329,000 persons or roughly 1.3 million more people than stated in official figures (Municipality of Guayaquil, 2009).

The rapid urban growth has put tremendous pressure on the city's infrastructure. The increasing tendency of human migration to cities influences the urban growth and the necessity of generating space for newcomers. This is reflected in the construction sector's activities, which have been growing in past years (The Universe journal, 2008). As can be observed in the Fig. II, there is a clear increase in the amount of construction in recent years. There is a considerable increment in only six years (between 2000 and 2006) where the amount of permits has almost tripled. Consequently, this intensification creates environmental consequences. One of the most important is the waste amounts generated by the building sector.

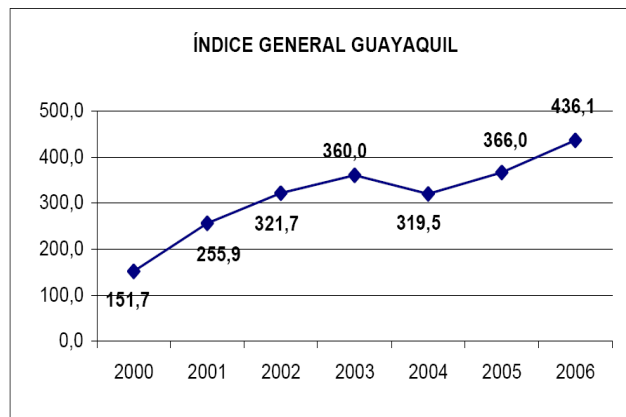


Fig. II: Evolution of the construction activity in the city of Guayaquil between the years 2000 and 2006. The figure shows the number of permits (Y axis), along the different years (X axis)
Source: INEC, 2009 [National Institute of Statistics and Census]

3. The Main Stakeholders

One important process is the identification of the important stakeholders dealing with C&DW at different levels; for instance decision makers at governmental levels establishing the rules, going

through all the levels until actors reacting to these management operations are reached. At the *State Level* the Central Government's main legal instrument is the Ecuadorian Constitution, which includes both waste management issues and environmental protection aspects in its main text. There is also the Ministry of Environment, which deals more specifically with issues of solid waste using for this The Unified Text where rules and responsibilities for local authorities are placed.

Is important to note despite that the Regional Level (Guayas Provincial Government) does not play any relevant role regarding C&DW or other types of waste. It is included in the system analysis presented in the following sections because this might be part of the problems regarding C&DW management. Furthermore, the *Local Government level* is represented by the Municipality of Guayaquil. This Municipality implemented in 2006 an ordinance for dealing with the waste produced by the construction sector- *the rubble management ordinance for the city of Guayaquil*. This is the main instrument regulating the activities of the construction sector. Next in the hierarchy is the *Action level* in which one of its stakeholders, the Sanitary Landfill "Las Iguanas", receives all the non-hazardous waste of Guayaquil. This is the only place authorized by the municipality for depositing waste. Subsequently, in charge of collection for all of the waste produced in the city and taking the waste to the sanitary landfill is the Waste Collection Company "Vachagnon", this consortium is in charge of the collection for all of the waste produced in the city. Contracted by the Municipality of Guayaquil, they transport all the waste that is placed in the Sanitary Landfill "Las Iguanas", with the exception of the C&DW fraction. This last should be transported directly by the waste generators.

Also at the actor level are the construction companies; there are several construction companies working in the city, one of these companies is the Inmobiliare International Corporation. This large company designs and develops housing projects for the inhabitants of Guayaquil; as result they contribute a considerable amount to the C&DW of Guayaquil. In addition two private builders (freelance contractors) were also included during the interviews to find out if there was a difference in the way big and small size companies handle the C&DW. The C&DW Transport Companies are another group that need to be considered, as they are the ones who handle and transport C&DW to the Sanitary Landfill. This group is comprised of companies that transport C&DW generated at the building sites to the different authorized and unauthorized locations for its final placing.

In the city of Guayaquil recycling activities are very infrequent. There are not plants handling C&DW and there is only recycling of materials like plastic, glass, paper and metals but is done in an informal way. In the city, people look through the garbage recovering materials which then sell to companies like REIPA (a local recycling company). Finally there are the Building Materials Companies, in this case the company ALFADOMUS was chosen as it is one of the

most important companies in the country producing building materials and one of the major suppliers for the revitalization projects being executed in the city of Guayaquil.

Table I: Main Stakeholders and their roles regarding C&DW Management in the city of Guayaquil. The table summarizes the main responsibilities of the different stakeholders concerning C&DW.

STAKEHOLDER	RESPONSIBILITY	OBSERVATIONS
Central Government	Provides general policies for the proper management of resources and sustainable development.	Main Legal Instrument is the Ecuadorian Constitution. At this level regulations are very general.
Ministry of Environment	Establish the general legislation concerning solid waste management in the entire country.	Main Legal Instrument is the Unified Text. Here the legislation starts to be more specific and set more specific responsibilities regarding waste management.
Government of the Guayas Province	They are not involved in the management of waste.	
Municipality of Guayaquil	Establish the legislation for the management of the C&DW in the city. Their different departments have to implement and enforce the ordinances.	Main Legal Instrument is the Rubble Management Ordinance for the city of Guayaquil.
Construction Companies	The construction companies need to fulfill all the requirements regarding C&DW established by the Municipal Ordinances.	Three companies interviewed (one big size and two small size)
Waste Collection Company "Vachagnon"	They are in charge of the collection of the non-hazardous waste in the entire city.	They do not handle C&DW or hazardous waste.
C&DW Collection Company	They are hired directly by builders and developers. They collect the C&DW and transport it to Sanitary Landfill.	One company was interviewed. They were the most difficult group to access.
Sanitary Landfill "Las Iguanas"	Is the only authorized place by the Municipality, in which the C&DW and non-hazardous waste can be place.	
Building Material Company	Provides the construction sector with building materials.	Two companies were selected, Alfadomus and San Luis Quarry
Recycling Company	There are not recycling plants handling C&DW in Guayaquil. However, for other materials (i.e. plastic, glass, and paper) there are some companies buying from informal collectors this type of materials.	One company was interviewed. REIPA

4. Analysis and Discussion: The Hierarchical Structure of the Construction and Demolition Waste System in Guayaquil

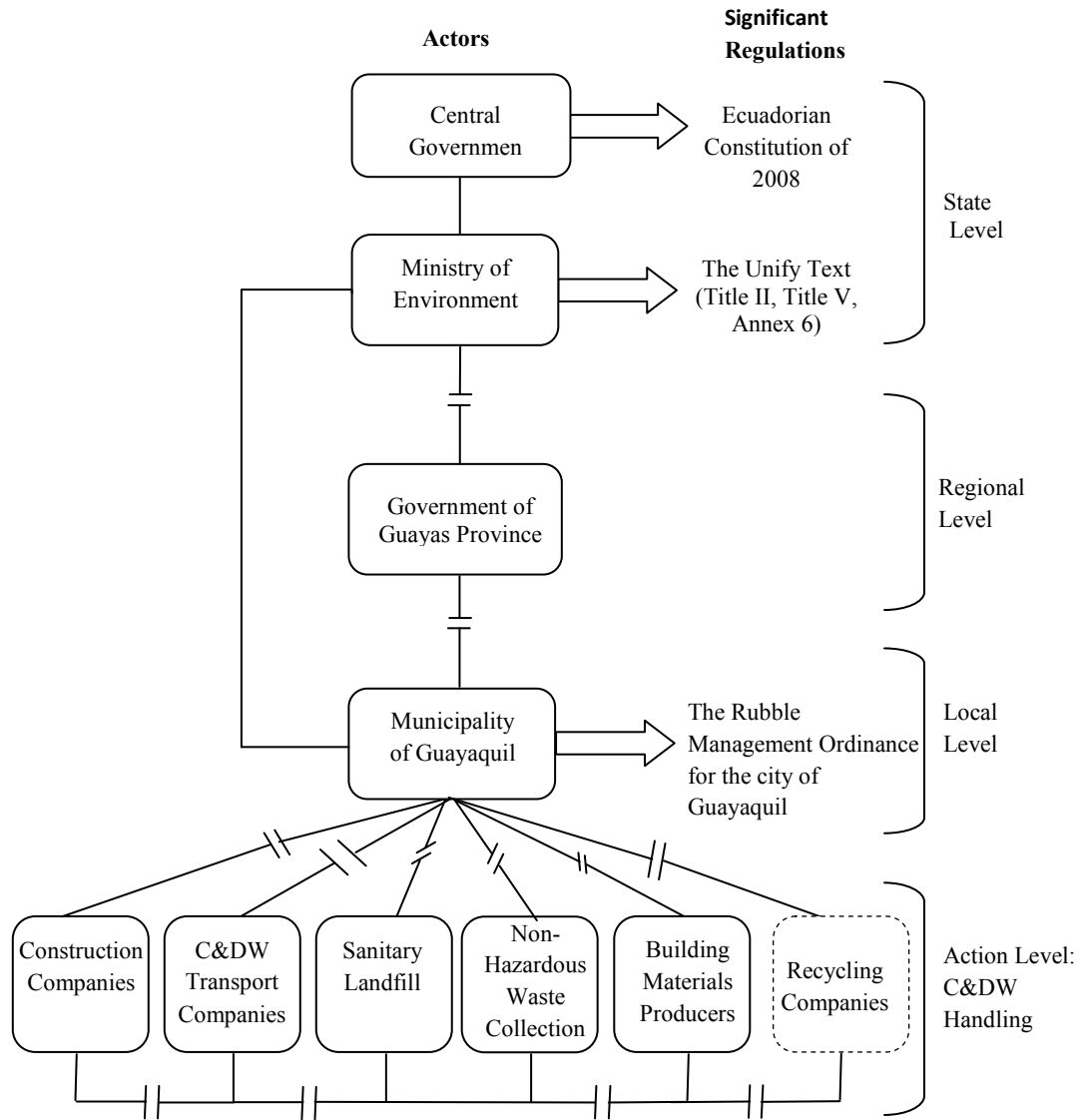


Figure III: The Hierarchical Structure of the Construction and Demolition Waste System in Guayaquil. The figure shows the main actors at different levels, and its legal instruments influencing how the C&DW is managed in the Landscape. Also is possible to observe the disconnects, represented by the broken lines, between the different levels and within actors.

The figure III shows the main actors at the different levels of the system. At the top are the Central Government and the Ministry of the Environment; despite being on the same level (*State Level*) they have different legal instruments, where the Ecuadorian Constitution is the main

legislation and prevails over any other. Below is the Government of the Guayas Province, which is bypassed by the Ministry of Environment who gives the entire responsibility for the solid waste management to the Municipalities (this is stated in the Unified Text and will be further discussed in the next sections). This issue is represented by the lateral lines and also with the broken lines, which represent the disconnects between the *State* and the *Regional Level*. Next is the *Local Level* where the Municipality of Guayaquil through the Rubble Management Ordinance for the city of Guayaquil regulates the activities of people handling C&DW in the *Action Level*, and where the majority of the disconnects occur. Here it is possible to observe disconnects between the local authorities (*Local Level*) and actors in the *Action Level*.

4.1 Action Level Interactions

4.1.1 The Construction Company

To understand how the legislation influences the behavior of the construction companies, interview results provided insights. One of the interviews was made to the planning director at the Inmobiliare International Corporation; in this company the C&DW has two destinations: the stony fraction is used as base material for leveling the land, and the rest is sent away by the contracted waste trucks (Personal communication, Interviewee 10). In order to reduce the cost of using too much wood, they usually employ metal formworks that can be reused several times during the construction of the houses, instead of dumping them after a short while like the wood formworks. According to the interviewee, one strategy aimed to reduce the debris volumes, implemented by the company was the modular design. Here the designed house was proportionate considering the exact numbers of concrete blocks needed to build the walls. This approach aimed to reduce the amount of wasted material during the construction process (ibid).

The problems, however, started when the concrete block supplier failed in delivering the complete set of materials needed in the modular design. This was usually the pieces called “trabas” which are the concrete blocks whose size is half of a standard one, used at the end of the walls. So they kept breaking the blocks in half to replace the missing elements when the delivery was incomplete. This eventually made them abandon the idea of modular design (Personal communication, Interviewee 10). Furthermore the C&DW is sent away in the trucks hired for this task. Nevertheless, when the interviewee was asked about the measures taken in order to ensure that the transported materials reach the Sanitary Landfill “Las Iguanas” his response was they do not have anything to do with this. The decision of where the C&DW ends up depends on the driver’s decision. They (Construction Company) do not specify to the truck driver where the waste should be placed or ask if their trucks are authorized by the local authorities for providing the service of waste transport. This clearly contravenes the Municipal ordinance regarding the

management of rubble in the city of Guayaquil. It is important to highlight that during the interview the builder mentioned that he did not know about *The Rubble Management Ordinance for the city of Guayaquil*. The fact that he does not accept the responsibility of how the waste is handled after leaving the construction site confirms this.

Moreover, at present there is no training of the construction workers regarding strategies to reduce the C&DW, even though the Construction Company is interested and considers this an important subject that needs to be raised. In addition to this, they are also willing to include recycled material into their constructions if they become available (Personal communication, Interviewee 10). Regarding the controls performed by the Municipality, the interviewee mentioned that they submitted all the necessary documentation including how the waste was going to be managed. They had to do this in order to obtain the building permits by the Municipality of Guayaquil. However, after this stage was completed no inspection of their construction sites was made. The local authorities did not check that what was stated in this document regarding the waste and other environmental measures were actually implemented (personal communication, Interviewee 10).

4.1.2 Waste Collection Company (Vachagnon)

The Vachagnon Consortium is the only collection service provider for the city of Guayaquil. Their trucks transport all types of waste to the Sanitary Landfill Las Iguanas, except for hazardous waste and the C&DW which has to be transported directly by private trucks (Personal communication, Interviewee 5). According to the administrator of the Sanitary Landfill, they only receive non-hazardous waste, however when talking with the chief of operations at Vachagnon, he mentioned that in some cases they also collect and transport bio-chemical waste to the Sanitary Landfill “Las Iguanas”. This happens, because even though there is a company called GADERE collecting and incinerating this type of (hazardous) waste, they do not cover all the hospitals and laboratories that exist in the city (Personal communication, Interviewee 5). Moreover, the Vachagnon company only collects the waste and dumps it inside the landfill facility, but does not perform any type of sorting of the waste; or has additional compartments inside the trucks to transport sorted waste. Also they do not provide any kind of storage spaces where people can place their sorted domestic waste or any type of waste including C&DW in the construction sites.

4.1.3 Recycling Company

In the city of Guayaquil the recycling activity is rather small. There are few companies that collect waste elements and then sell them as raw materials. Unfortunately this only happens with some articles but not for construction or demolition materials. Among the companies dedicated to this activity (recovery of recyclable materials) is REIPA, and is one of the most important due

to the volume of waste they handle. The recyclable materials are collected by people dedicated to this activity (informal workers who make a living out of this), who gather the materials from the garbage containers situated in the streets.

4.1.4 Sanitary Landfill “Las Iguanas”

Until 1993 the city did not have a place where to technically handle the solid waste. The majority of the waste, 63,7%, was deposited in the municipal dump of “San Eduardo”. The remaining fraction was burned [9.5%] or illegally placed on empty lots and estuaries [4.4%] (Municipality of Guayaquil and UN, 2002 p. 42). In 1994 the Municipality of Guayaquil created the Sanitary Landfill “Las Iguanas” as a response to the sanitary, social, and environmental problems due to the operations of the municipal dump “San Eduardo”. The ILM consortium is in charge of administration, and is under the supervision of the local authorities who control the fulfillments of the requirements established in the contract with the administrator (Personal communication, Interviewee 6). Moreover, in the year 2000, 94% of all the solid waste was placed in the Sanitary landfill. However the percentage that is recycled is still very low, 1.3%; the rest is then burned in open sky (Municipality of Guayaquil and UN, 2002 p. 12). Although the situation has been improving in the city of Guayaquil there is still a large amount of waste that goes directly to the landfill without any type of recovery.

It is regarded as a “Sanitary Landfill” because according to the chief of land filling, it is a place where multiples measures are taken in order to prevent environmental, social, and economical problems. This measure is incorporated into the planning and selection of the place and the surveillance and control during the operations, and closure of the plant (Personal communication, Interviewee 6). The Sanitary Landfill takes care of the domestic and inert waste, placing them in separate sections. For the first group special equipment is placed for taking care of gases and liquids generated by the organic waste. But all of this is then omitted for the inert fraction (Personal communication, Interviewee 6). The Sanitary Landfill has already in place 8,000,000 tons of waste since it started to function in 1994, filling sections A and C of the landfill. So far the Section D which is still being filled has 2,300,000 tons of domestic waste in place, and the Section B-B’ which takes in the inert fraction (including C&DW) has 1,100,000 tons so far. Moreover, approximately 2,750 tons of waste enters the Landfill every day. Here (Sanitary landfill) arrives the domestic waste collected by the Vachagnon Consortium, the private company which provides the service of waste collection in the city of Guayaquil. The other types of waste like the Construction and Demolition should be delivered by particular trucks contracted by builders or other generators (ibid).

Furthermore, the Vachagnon Consortium does not collect rubble; only in special cases where it is hired by the Municipality to clean clandestine dumps (Personal communication, Interviewee 6).

As in some cases rivers, mangroves, forests or other unauthorized sites are used by builders to get rid of their construction waste (Personal communication, Interviewee 2). The particular trucks contracted by the builders arriving to the Sanitary landfill should be only the authorized by the Municipality of Guayaquil, according to *The Rubble Management Ordinance for the city of Guayaquil* (Municipality of Guayaquil, 2006 p. 5). At the landfill the trucks have to pay a fee of USD 4,00 per metric ton in order to place their C&DW in the landfill (Personal communication, Interviewee 6). It is also important to mention that the C&DW that arrives to the Sanitary Landfill is directly placed in the landfill without any type of material recovery for reusing or recycling (Personal communication, Interviewee 6). The same happens to other materials like plastics, glass, cardboard, paper and metals. Furthermore, the Sanitary Landfill is expected to reach its limit in 2016. For this reason the Municipality of Guayaquil is preparing a project to expand the landfill, allowing it to function until the year 2030 (Personal communication, Interviewee 6).

4.1.5 C&DW Transporters

This company works with several of the most important construction companies in the city. They provide the service of supplying construction materials (i.e. aggregates), and the transport of C&DW to the landfill. Although it was extremely difficult to gain access to the most important information due to reluctance of the interviewees to discuss the topic of waste management, some information was obtained. Most of the times they (C&DW transporters) have been handling the C&DW in an inappropriate manner, placing it in unauthorized sites, according to the interviewee. Lately the municipal controls have been increasing and this has forced them to change their practices (Personal communication, Interviewee 14). The capacities of their trucks are 9 m³ and they charge US\$ 25-\$28 for sending the waste to the Sanitary Landfill if the construction site is located in the North of the city. If it is in the South the price is increased to US\$40,00 (ibid). Additionally at the Landfill the builder needs to pay a fee (US\$ 4 per metric tone). This may be one of the reasons why builders try to lower their costs sending their C&DW to other places than the Sanitary landfill.

4.1.6 Building Materials Company

4.1.6.1 Alfadomus

This company produces building materials made with clay. Their products are comprised of bricks, cobblestones, blocks, roof and floor tiles, etc. The only raw material they use is clay and currently the percentage of waste produced during the production process is 2%. This percentage consists of cooked clay which cannot be reinserted in the process and is placed inside the extraction sites to fill them up (Personal communication, Interviewee 7). In the interview with the executive from Alfadomus, it is stated that it is more expensive to re-introduce the wasted

material into the process again rather than adding more clay (virgin material). This is because in order to reuse the waste formed by cooked clay they will have to triturate this until is pulverized in order to be able to use it again (ibid).

This is a clear signal that something is wrong here; in this case the price of the clay is so low that it will never be necessary to reduce its consumption. It is important to note that the prices of raw materials have only been affected by increasing distances between the extraction sites and the production plants. The transport of the material gets more expensive, while the price of the raw material has been more or less the same along the years (Personal communication, Interviewee 7). Also the preferred material for the revitalization projects executed by the Municipality of Guayaquil is the cobblestone. This is why Alfadomus reports an increase in the production volumes in the last years (Personal communication, Interviewee 7). The use of this type of material (especially clay cobblestone) is part of the new image of the city. This is why is the most common choice for all types of projects, especially in recreational areas and main streets of the city.

4.1.6.2 San Luis quarry

The San Luis quarry is one of the most important suppliers of aggregates in the city. It produces lutite² [which is the stony fraction used in most of the concretes] and gravel (Personal Communication, Interviewee 13). This quarry produces 1200 tons/month (14,400 tons/year). The price of the material is US\$ 6,12/ton and in the past years this price had an increase of 3%. According to the interviewee, currently 2,6% of waste material is generated during the production processes. This material is placed in canals existing in the site, so there is no transportation of waste needed. For hazardous and special waste they have hired a collection company to handle these substances (ibid). Lately the demand for aggregates has been increasing. This quarry used to generate 800 tons/month, at the moment the production reaches 1200 tons/month of material. And in the last years its production has an increase of 30% more every year. According to the San Luis quarry technician this is due to the construction of new roads by the government (ibid).

5. Identifying the main disconnects

² Lutite is a general name used for consolidated rocks composed of silt and/or clay and of the associated materials which, when mixed with water, form mud; e.g., shale, mudstone, and calcilutite (Hacettepe University Department of Mining Engineering)

5.1 State Level

Starting at the top level of the hierarchy in the Ecuadorian Constitution, in article 395 and 396 Chapter II, the State adopts a sustainable development model and the precautionary principle (Constitutional Assembly, 2009 p. 151). These two articles influence the policies and regulation at the ministerial levels. In the case of articles 395 and 396 of the Constitution, which are very general, their connection to the action level can only be perceived through more specific regulations. Furthermore, art. 415 establish that decentralized governments will develop programs for the rational use of water, and for the reduction, recycling and appropriate treatments for solid and liquid waste (Constitutional Assembly, 2009 p. 156). This article has been also considered in the ministerial legislation. Consequently the Ministry of the Environment produced the main legal instrument, the Unified Text [Texto Unificado], regarding waste management of solid and other types of waste.

Although the Ecuadorian constitution mentions aspects regarding waste management is in the Unified Text where distribution of responsibilities starts to be more direct and consequently where disconnects starts to emerge. For instance, in the Unified Text it was found that the art. 4.1.19 states that the waste collection entity should implement systems for the selective collection of solid waste in urban areas. This will ease the recycling process or other ways of placing value into solid waste (Ministry of Environment of Ecuador 2009, Annex 6 p. 8). However, the waste collection service in Guayaquil, provided by Vachagnon Consortium, is not implementing any type of project that allows the sorting of waste in the city. According to the interviewee, the chief of operations at Vachagnon, the possibility of sorting the waste or facilitate the separation of the solid waste is not part of their plans at the moment (Personal Communication, Interviewee 5).

The reason for the lack of motivation of the waste collection entity (Vachagnon) could be the insufficient pressure by the governmental authorities to improve their collection methods. However, it can be argued that this should be a collective effort from regional and local authorities, as they are the ones who should take the first steps. This can be providing the city with proper infrastructure that allows the citizens to place their waste in separate deposits. Then the waste collection service can take the already sorted waste, and transport it to the recycling plants where it can be processed.

Moreover, in art. 397.3 of the Ecuadorian Constitution, is declared that the state will regulate the production, importation, distribution, use, and final placing of toxic and hazardous materials (Constitutional Assembly, 2009 p. 152). This commitment is reflected in the art. 4.1.22 of the Annex 6 in the Unified text. This article expresses that industries that produce, possess, or handle hazardous waste, are obligated to sort (at the source) the solid waste, separating the regular from

the hazardous solid waste. This will prevent contamination in the final location of the waste (Ministry of Environment of Ecuador 2009, Annex 6 p. 8). Additionally art. 4.2.18 of the same document (Annex 6) prohibits mixing non-hazardous with hazardous solid waste (Ministry of Environment of Ecuador 2009, Annex 6 p. 8). This is relevant for the C&DW because there is a potential there to promote the sorting of other types of materials. If the industries are expected to sort their waste and separate hazardous from non-hazardous waste it is possible to recover other types of materials that can be recycled and use in the generation of new products like building materials.

Moreover, despite a number of businesses handling hazardous and special waste that sort their waste, the problem is that there is not an official company³ in place who is responsible for the collection of this type of waste in the entire city. This is why during the interview with the chief of operations at Vachagnon, he said that they collect all types of waste, including the ones originated at the hospitals. These is why even if laboratories and hospital sort their bio-chemical waste, and place them in separate deposits, after it is collected by Vachagnon everything is mixed again inside the trucks.

This contradicts the declaration of the Sanitary Landfill administrator, who said during the interview that they only receive non-hazardous waste and that he does not know what happens to the other fraction of the solid waste, like the hazardous one (Personal Communication, Interviewee 6). Probably this is the official version but in reality they (Sanitary Landfill) are receiving hazardous waste in their facilities, which is a very serious matter as they are not prepared to receive this kind of substance, and the environmental consequences can be very serious. It is important to mention this because if authorities do not fix this problem first (separation of non-hazardous from hazardous waste) it will be very unlikely that they will start to work in matters of C&DW.

Moreover, art. 4.9.1 and 4.13b refers to a reduction of the volumes of solid waste before reaching the landfill, if the materials cannot be reused or recycled (Ministry of Environment of Ecuador 2009, Annex 6 p. 16, 24). Nevertheless, there is very little recovery of building materials, and this only happens with certain types of materials. The builders mainly recover wood, bamboo, and nails, [mainly used for formworks and in the case of bamboo for scaffolding] which can be used at least a couple of times more in other constructions, reducing some of their costs (Interviewee 10, 11, 12). However, eventually they [recovered materials] get damaged and end up in the same place as the rest of the C&DW.

³ Official collection company refers to companies like Vachagnon, in charge of the collection of non-hazardous waste, where there is a contract between the Municipality of Guayaquil and the Consortium. In contrast for the case of hazardous waste are the companies who have to hire directly the service of companies specialized in handling this type of [hazardous] waste.

Additionally, regarding other aspects of waste management there are articles like art. 32, that could be beneficial for all types of waste including C&DW, for instance setting up policies for the creation of a culture regarding solid waste management, through education and awareness of the population (Ministry of Environment of Ecuador 2009, Title II). Even though the article concerns solid waste (where the C&DW is a fraction) no information campaigns that educate the population on matters concerning waste management have been implemented by the authorities. Nevertheless, there is one project being implemented by the Municipality regarding the recycling of certain products like glass, paper and plastic. This pilot project consists on placing special storage bins along the Malecon Simon Bolivar and in the Malecon del Salado which are the two main waterfronts in the city, visited by hundreds of people every day. In the Malecon del Salado there is a stock place where the visitors can observe how the sorting of the material is done and learn how the waste should be placed in the corresponding containers (Chacon S., 2006 p. 1) This way the Municipality of Guayaquil is trying to introduce the idea of recycling to the population. This can be regarded as an important step for the development of a society aware of their role in the conservation of environmental resources. However, it is important to note that educating the population should start with basic issues, for instance, with respect to the waste collection hours. There are people who take out their garbage at any time of the day, attracting animals that break the bags and scatter the waste in public spaces. In addition there are also individuals who throw their garbage into the rivers and mangrove forests without any consideration for the environment. This is why information campaigns should tackle all the aspects and potential problems generated due to the incorrect management of waste.

Another aspect covered in art. 32.c of the Unified Text is the organization of informal recyclers, aiming to include them in the production sector; legalizing their organizations and favoring mechanisms which guarantee their sustainability (Ministry of Environment of Ecuador 2009, Title II). However, the recycling activity in Guayaquil remains an informal activity. The people involved in this activity recover the materials from the garbage. These persons do not have any benefit of a formal worker and their incomes depend in the amount of recyclable materials that they can found in the streets. As it was mentioned in previous sections there are companies buying these materials from them; however the prices they pay are low, for instance, for a kilogram of cardboard they only get US\$ 0,06 (Personal communication, Interviewee 8). After purchasing this recovered materials the companies sort the waste, pack it and re-sell it to other companies which use this as an input in their production processes (Personal communication, Interviewee 8). Furthermore is important to highlight that this activity of recovering wasted products and selling them to companies like REIPA, is an important livelihood for low income families in the city of Guayaquil.

Another types of disconnects occur because some of the aspects taken into account by the Unified Text are not transferred to the Regional or Local authorities. For instance the main ordinance dealing with C&DW in Guayaquil is *The Rubble Management Ordinance*, which excludes some aspects expressed in the Unified Text. Although these aspects are expressed in general terms in the Unified Text, they need to become operational at the local level and incorporated in the strategic plans implemented by the Municipality. Examples of this can be observed when going through the Unified Text and then contrasted with the Municipal Ordinance. For instance the Unified Text in the art. 33b mentions the creation of incentives and economical and financial instruments for an efficient management of waste (Ministry of Environment of Ecuador 2009, Title II). However there are no economical incentives in place at the action level and it seems that the only incentive is not to be sanctioned by the Municipal authorities.

Furthermore, the promotion of the use and value of the solid waste, regarding them as economic goods, is also mentioned in art. 33b of the Unified Text (Ministry of Environment of Ecuador 2009, Title II). However, nothing is happening at any level regarding this. In order to put value into the recovery of solid waste, the authorities should promote the creation of a market for these materials that enable the waste generators to reduce their costs or even profit from the recovery of C&DW. In addition, another incentive could be the tax exoneration for those reducing their C&DW volumes that enters the landfill through the use of recycled or recovered building materials. Consequently although these aspects are expressed in the Unified Text none of them are present in the Municipal regulations or strategic plans. If the Municipality wants to promote the use of recovered or recycled materials it should improve not only the enforcement of their current regulations, but to introduce new aspects into them. The idea of promoting solid waste as economic goods or the possibility of incorporating recovered materials in new projects should start in public projects. For instance, all the revitalization and massive housing projects that the city is experimenting these days could be an excellent place to start.

5.2 Regional Level

At this level we can find another important disconnect, because the State Level through the Ministry of Environment's Unified Text, transfers directly the responsibility for the solid waste management to the Municipality of Guayaquil, bypassing the Regional Government. According to the Title IV, Book VI, article 4.4.1 of The Unified Text, *the solid waste management in all the country is responsibility of the municipalities according to the Municipal Regime Law and the Health Code* (Ministry of Environment of Ecuador 2009, Annex 6 p. 5). This can be an important aspect regarding the enforcement of the current legislation, as the regional authorities

are partially left out of the waste management issue, whilst the municipal authorities have problems to cope with in the situation in Guayaquil.

5.3 Local Government and Action Level

Following in the hierarchical order are the Municipalities which are in closer contact with the actors in the action level. The Municipalities are forced to deal with waste management issues by the state level, as observed in art. 4.4.1, Book VI, of The Unified Text (Ministry of Environment of Ecuador 2009, Annex 6 p. 5) already discussed above. As a response to this request, the Municipality of Guayaquil implemented the Municipal Rubble Management Ordinance for the city of Guayaquil. It is at this stage where the majority of disconnects emerge between the Local Government Level and the Action Level.

To begin with, art. 5, Title III, establish that those who generate the rubble (owners, contractor, and technical responsible) are liable for the collection, transportation, and deposit of the waste in the sanitary landfill⁴ (Municipality of Guayaquil, 2006 p. 4). However in practice according to the interviews with the builders, they do not have anything to do with the way the C&DW is handled after it leaves the construction site. They hire private trucks to transport the C&DW and it is the drivers who decide where to put the material (Personal Communication, Interviewee 10, 11, 12). It is important to note that the places where the waste transport trucks choose for dumping their rubbish are usually unauthorized sites, like rivers, mangrove forest, and private land. However, probably the main reason for throwing the C&DW in unauthorized places is that the Sanitary Landfill “Las Iguanas” (the only place authorized by the Municipality for depositing waste) is, in the majority of the cases, extremely far from the construction sites. So in order to obey the ordinance the trucks will have to cover large distances which consequently will increase the prices they charge for transporting the C&DW out of the construction sites.

According to some builders, because there is hardly any control by the Municipality, they (builders) do not feel the necessity to insist that truck drivers place the C&DW in the Sanitary Landfill, as they in addition to spending more money making the trucks cover the distance between the construction site and the landfill, will have to pay a fee at the Sanitary Landfill (Personal Communication, Interviewee 10). This lack of control, according to the Director of the Environmental Department of the Municipality of Guayaquil, comes from a personnel and transport shortage that impede them to cover the entire city. As the interviewee expressed, their

⁴ The sanitary landfill is a technique for the deposit of the solid waste inside the ground without harm to the environment and to the public health and safety. This technique use engineering principles to confine and reduce the waste to the minimum volume possible. Additionally a layer of earth is placed over the waste at least at the end of every working day (Ministry of Environment of Ecuador 2009, Annex 6 p. 5).

operations are only reactionary, which means that they only act after the waste has been placed in the unauthorized sites (Personal Communication, Interviewee 2).

In some cases they capture the trucks while they are throwing the waste in illegal places. However, after the owners of the trucks pay the fine, they go back to work again (Personal Communication, Interviewee 2). This is what happened to the interviewee providing the service of C&DW transport. One year ago one of his drivers was arrested for placing C&DW in an illegal site; consequently they arrested the driver but left the truck. The owner of the truck had to pay a fine and after three days the driver was released and went back to work (Personal Communication, Interviewee 14). It is important to note that according to the interviewee (C&DW transport company) the municipal controls have been increasing lately, and this is why nowadays they only place the C&DW in the Sanitary Landfill or at construction sites, previously established by the builders (Personal Communication, Interviewee 14). This is why despite his trucks still being unauthorized by the Municipality to perform these kind of jobs (according to the municipal ordinance all trucks must be authorized) they have shifted their practices discarding job offers where the builder does not want to send the generated waste to the sanitary landfill “Las Iguanas” (Personal Communication, Interviewee 14).

The increasing control is probably one way of changing the behavior of people who transport the C&DW; however more control is needed in order to force the builders to hire these companies (the ones committed with proper management of C&DW). According to the interviewee, once he offers to place the waste only in the Sanitary Landfill sometimes the builders do not call him again, because they found a cheaper option where they dump the waste in a closer, but also illegal place (Personal Communication, Interviewee 14). Even though the Municipal ordinance establishes sanctions for incorrect handling of the waste; the main issue is the lack of control by the local authorities, and the builders’ unawareness of this ordinance, for instance the three interviewed builders did not know the existence of this ordinance and that it establishes shared responsibility in the case of incorrect management of the C&DW.

In addition it is important to highlight that all the interviewed builders thought that sending the C&DW in the trucks is the only responsibility they have over the waste, and that how the waste is handled after leaving the construction site had nothing to do with them. However, the ordinance clearly establishes in the art. 10.7, that the generator or owners of rubble who give the material to a third party for its collection, transport and final placing in the sanitary landfill will share the responsibility if any harm is produced from the result of incorrect management of the waste (Municipality of Guayaquil, 2006 p. 9). Furthermore, it is important to note that they were all surprised that the construction can even be stopped in case of relapse as is stated in art. 12.3 of the same ordinance (Municipality of Guayaquil, 2006 p. 10).

However none of the interviewed builders have experienced any kind of reprisal, even though they have always employed unauthorized trucks and have never sent the C&DW to the sanitary landfill (Personal Communication, Interviewee 10, 11, 12). This kind of behavior can be due to a lack of environmental awareness, economic reasons trying to reduce their costs, and of course the lack of control by local authorities. Due to this latter aspect there is no reason for them to change their actions. Moreover, among the responsibilities of the Municipality is to demand the execution of an environmental assessment in order to grant the builders with the construction permit. However, despite the builders submission of this study; the document usually stays filed in the Municipal archives. According to the interviewee no audit is performed after the construction permit is granted to confirm that what was mentioned in the document is actually implemented during the construction process (Personal Communication, Interviewee 10).

Demand of an environmental audit is part of the responsibilities of the local authorities according to the same ordinance. Additionally they (local authorities) have the responsibility to check that the waste enters to the Sanitary Landfill facilities. Also they are obligated to verify that the volumes of waste (quantities that are also included in the environmental assessment document submitted by the builders) are the same as the ones registered by the scale system at the Sanitary Landfill facilities. According to the Municipal Ordinance the DACMSE (The Cantonal Cleaning Direction, Markets and Especial Services) will issue a form that will be filled by the generator, and verified during the inspections to the construction sites (Art. 9c, Municipality of Guayaquil, 2006 p. 8). However, in practice this procedure is not taking place, and is one of the reasons why the builders are not sending their waste to the sanitary landfill.

Regarding the collection and transport of C&DW Art. 5.8a points out that the generator will employ only authorized vehicles which fulfill the requirements by the municipality, for the transportation and placing of the rubble in the sanitary landfill (Municipality of Guayaquil, 2006 p. 5). Yet again the interviewed builders did not employ authorized trucks during the transportation of the waste out of the construction sites (Personal Communication, Interviewee 10, 11, 12). According to the interviewees they do not ask the drivers if their vehicles are authorized or not by the Municipality (Personal Communication, Interviewee 10, 11, 12). This represents a problem because only authorized vehicles are subject of inspections by the Municipality in order to guarantee the proper management of the C&DW.

5.4 Within the Action Level

Some important disconnects happen between the actors at the action level, for instance between the builders and the C&DW transporters. The first group does not demand that the C&DW should be placed in the sanitary landfill, for all the reasons mention above. Another disconnect is between the C&DW transporters and the sanitary landfill. They usually prefer to place the waste

in illegal (but closer) locations contravening the current ordinance. Moreover there are no relations between C&DW transporters and the non-hazardous waste collection entity (Vachagnon). The only indirect relation between them is that Vachagnon is usually hired by the Municipality of Guayaquil to clean the C&DW that has been dumped by the C&DW transporters in unauthorized places.

6. Improving the C&DW management in the city of Guayaquil

6.1 From general legislations to specific ordinances

At the Local Level the main legal instrument is the Rubble Management Ordinance for the city of Guayaquil. However, it is important to mention that at this level some important features of the Unified Text (legal instrument at the state level) are not taken into account. In this level is where the more general policies need to be introduced in particular ordinances and strategic plans in order to keep improving the C&DW management in the city. The Rubble Ordinance only addresses operational duties that people handling C&DW need to fulfill. However it does not incorporate the ideas present in the Unified Text, regarding selective collection of waste, incentives, education and awareness of the community, etc.

6.2 Integral Action Plan

The best approach would be the creation of an integral action plan for managing the C&DW, where a set of goals and objectives are placed in a specific timeframe. Because we cannot shift from a system where we have clandestine dumps for the C&DW and a Sanitary Landfill where we can find hazardous waste, to a system where the waste is being recovered for recycling right away. First we need to fix the operational problems, increasing the control of the authorities and trying to implement different strategies in order to be sure that the waste is ending where it is supposed to end. Then we can start to think of providing the city with the proper infrastructure for sorting their waste and C&DW recycling plants.

6.3 Providing proper infrastructure

The main instrument at the State Level is the Unified Text; it has clear parameters in order to handle the waste in a proper manner, and not only that, but it also introduces the idea of reuse and recycling of the solid waste. Nevertheless the text states that the selective collection should be a responsibility of the cleaning service entity. However, the collection entity cannot start to sort out the waste if there is no infrastructure in place that supports this task. It should be the governmental authorities who provide the city with the proper infrastructure [recycling plants, separated storage bins (i.e. one for plastic, glass, metal, etc)] in order to facilitate the task of the

waste collection entity and consequently the recovery of reusable materials. Secondly it should be clear how the recovered material is going to be used as well as where and how is going to be processed. The industrial sector should be involved, and control mechanisms placed in order to supervise their operations. Otherwise we will be creating an additional problem in the city due to incorrect management of the recovered waste.

6.4 Other waste streams

It is important to note that in order to improve how the C&DW is managed, the way the other types of waste is handled needs to be developed as well. The Municipality can provide (in phases of course) the necessary equipment so the community can sort their waste. These places (first phases of the project) can be use as live learning facilities for the rest of the community where people can learn how to sort their waste, which then can be collected by the cleaning company Vachagnon or directly by recycling companies that will start to flourish due to the increasing potential and creation of market. Moreover, as the landfill is transformed as the only alternative for placing the C&DW then the builders will start to try to reuse some of the materials that they used to discard. There are potential ideas that can emerge during this transformation process, for instance the material produced at the C&DW recycling plant, if owned by the government, can be used in housing projects for low income families. Here the builders can send their materials without any extra cost but the previous sorting of the materials, avoiding to pay the fee at the Sanitary landfill.

Furthermore, is important to mention that art. 397.3 of the Ecuadorian Constitution, art. 4.1.22 and 4.2.18 of the Unified Text, they all demand the separation of the hazardous and the non-hazardous waste. This needs to be enforced because it does not make sense to start to work in improving the way C&DW is managed when hazardous waste is still entering the Sanitary Landfill facilities. One solution could be to contract the services of companies that provide the service of collection and elimination of hazardous materials by the Municipality, like they did with Vachagnon (non-hazardous waste collection entity). If the authorities do not want to do this but want the industries to directly contract their services, then appropriate control measures should be implemented in order to ensure that these hazardous substances do not end in the landfill, as is happening at present.

6.5 Supporting the reduction of C&DW

Another disconnect is related to art. 4.9.1 and 4.13b, regarding the reduction of the volumes of solid waste before reaching the landfill in case the materials cannot be reused or recycled (Ministry of Environment of Ecuador 2009, Annex 6 p. 16, 24). However, in order to this provision to succeed, an incentive for the builders should be in place for them to want to reduce their volumes of waste and not sending everything to the landfill; as sorting the materials in order

to recover some of the materials will imply extra costs due to additional wages to the workers. The prices of some building materials are still very cheap, especially in the case of aggregates, so there is no reason for them to try to recover this, and also there is not a market where they can sell the recovered material, they (builders) will only recover materials that can be used in their own constructions. This is why a group of measures should be taken if a successful action plan is to be implemented. For instance the creation of a network between constructions companies so they can be in contact and trade their recovered materials. As in all construction sites there are always some remainder of material that sometimes is dumped, and which can be transferred to other builders for a lower price than the normal. This can go hand by hand with the improved control by the authorities making the sanitary landfill the only option for placing the C&DW. In addition an increase in the fee paid at the Landfill and the possibility of placing additional taxes in some of the building materials should be carefully studied because is important not to harm the construction sector which is a great source of employment. This is why the plan should be implemented progressively and continuously revised solving first the most urgent problems like the improper handling of the C&DW.

6.6 Carrots and not only sticks

In addition art. 33b of the Unified Text encourages the creations of incentives and economical and financial instruments for an efficient management of waste (Ministry of Environment of Ecuador 2009, Title II). This step is very important; to include some type of incentive for those who improved their methods and reduce their waste volumes. For instance tax exonerations for companies sorting their waste or for those who use recovered or recycled building materials in their constructions. They could even introduce a reduction on the fees paid to the Municipality in order to obtain the construction permits if the project will reduce the C&DW using recovered materials from other construction sites, etc. The idea is to offer a reason other than being sanction to reduce their (builders) waste.

6.7 Education and awareness

Moreover, as the art. 32 of the Unified Text mentions is important to set policies for the creation of a culture regarding solid waste management, through education and awareness of the population (Ministry of Environment of Ecuador 2009, Title II) This will promote better waste management among the community as their role is essential if the authorities want to implement a successful plan to reduce the volumes not only of C&DW but all types of waste. However, the information campaigns should start with basics issues, as was already mentioned in this document as there are still some problems that need to be solved first like the incorrect management of waste. In some part of the city, especially popular sections, people throw their waste directly into rivers, or take out the garbage outside of the collection schedules so dogs and other animals rip the bags and all the waste ends in the public spaces. First the basic problems

need to be tackled so the city can move on to other issues like sorting and reducing waste volumes.

6.8 Including all the stakeholders

For example the exclusion of the Regional Level authorities regarding waste issues, as the entire responsibility for the waste management is transferred directly to the Local Authorities (Municipality of Guayaquil) according to the art. 4.4.1 of the Unified Text (Ministry of Environment of Ecuador 2009, Annex 6 p. 5). Regional authorities can assist the Municipality during the control and inspections operations, as they (municipal authorities) mentioned there is a shortage of personal and economical resources in order to guard the entire city of Guayaquil.

In addition, it is important that the Municipality includes the C&DW transporters in the decisions and formulation of new action plans, asking them what can be done to facilitate their activities. They need to be asked them where they think is convenient to have strategic points to leave the C&DW instead of taking it to the Sanitary Landfill which is too far. The information from the waste transporters can be very helpful as they know where the potential clandestine dumps are located and can suggest a discharge place close to these locations, avoiding future contamination.

6.9 Enforcement of the current legislation

Nevertheless is important to fix disconnects between the local government [Municipality] and the action level [construction sector, landfill administration, C&DW transporters]. As we already observed during the identification of the disconnects, one of the main problems is the lack of control by local authorities regarding C&DW, which has as its main consequence people throwing their waste in clandestine dumps. One way to improve this situation is to increase the control by the local authorities over the C&DW that comes out of the construction sites. The authorities have already a study of environmental impact stating the amount of waste that is going to be generated in each of the construction sites, which is a requirement in order to be granted with the construction permit. Consequently they only need to check these quantities and control that the C&DW ends in the Sanitary Landfill “Las Iguanas”. One way of doing this is that after the C&DW leaves the construction site the driver then needs to present to the municipal inspectors a stamped (or signed) card by the Sanitary Landfill administrators, this way the authorities can be sure that the C&DW is been placed in the landfill and not in a clandestine dump. This is just a simple suggestion but this idea can be improved in order to make it more practical, with the ultimate aim still being to increase the control over what is going out of the construction sites and what is going in the sanitary landfill.

Another way to improve the C&DW management is to demand the execution of the environmental audit. Even though part of the requirements in order to obtain the construction

permit is that the builders should contract an authorized environmental auditor to supervise their operations, this is currently not been enforced by the local authorities. This environmental audit is an important tool which can be used by the Municipality to verify that what was stated in the environmental study submitted by the construction companies, is actually been implemented, enabling a better control of the sector. Furthermore according to the article 5 of the Municipal Ordinance, the rubble generators (owners, contractor, and technical responsible) are liable for the collection, transportation, and deposit of the rubble in the sanitary landfill (Municipality of Guayaquil, 2006 p. 4). Consequently according to this article all of them need to be sanctioned because what is happening at the moment is that only the C&DW transport companies are been punished. From the interviews with builders and C&DW Transport Company, the builders have never been punished for dumping their waste in unauthorized places. However the interviewed C&DW transport company was. If the punishment targets also the technically responsible and owners of the buildings more professionals involved in the construction activity might change their current practices as they do not want to be sanctioned or affect their reputation, and will start to send their waste to the sanitary landfill. In addition this will solve the disconnect between constructor and C&DW transporters as if the sanctions start to affect builders they will start to demand that the drivers to dump the waste exclusively in the landfill.

Moreover, according to the Municipal Ordinance the C&DW generator should employ only authorized vehicles for the transportation of C&DW to the sanitary landfill (Municipality of Guayaquil, 2006 p. 5). But this is not happening; all the builders interviewed did not employ any authorized vehicles. Consequently it is important to regulate the activity of all the informal C&DW transport companies. This will facilitate the supervision of their activities and ease the control by the pertinent authorities.

6.10 Introduction of non-state agents

In addition is important to introduce new agents into the system (see figure IV). Non-state actors, like NGOs, or environmental groups, can work as a link between the rule-making levels and actors in the landscape. In Ecuador there is a top-down system and this could be a factor in why the legislation is being disobeyed, as the necessities of the construction sector and other actors dealing with C&DW are not taking into consideration. The non-state agents can (impartially) provide an external view of what needs to be improved. In addition they (NGOs) can work with the community in educational campaigns introducing concepts and strategies for the reduction of waste volumes.

6.11 Transnational Networks

The use of city to city cooperation between cities in developed and developing countries is not a new idea. According to de Villiers (2009) there can be different type of linkages between North-

North, North-South or South-South. Nevertheless, this can be an important tool in order to improve the C&DW management in the city of Guayaquil where cities with more experience in waste management can share their knowledge with the government authorities in Ecuador. Municipalities (one in the North and one in the South) can work together where the city in the North can offer advice and build capacity among the local authorities in Guayaquil. However, cooperation can also take place at the State level and not only at the local level.

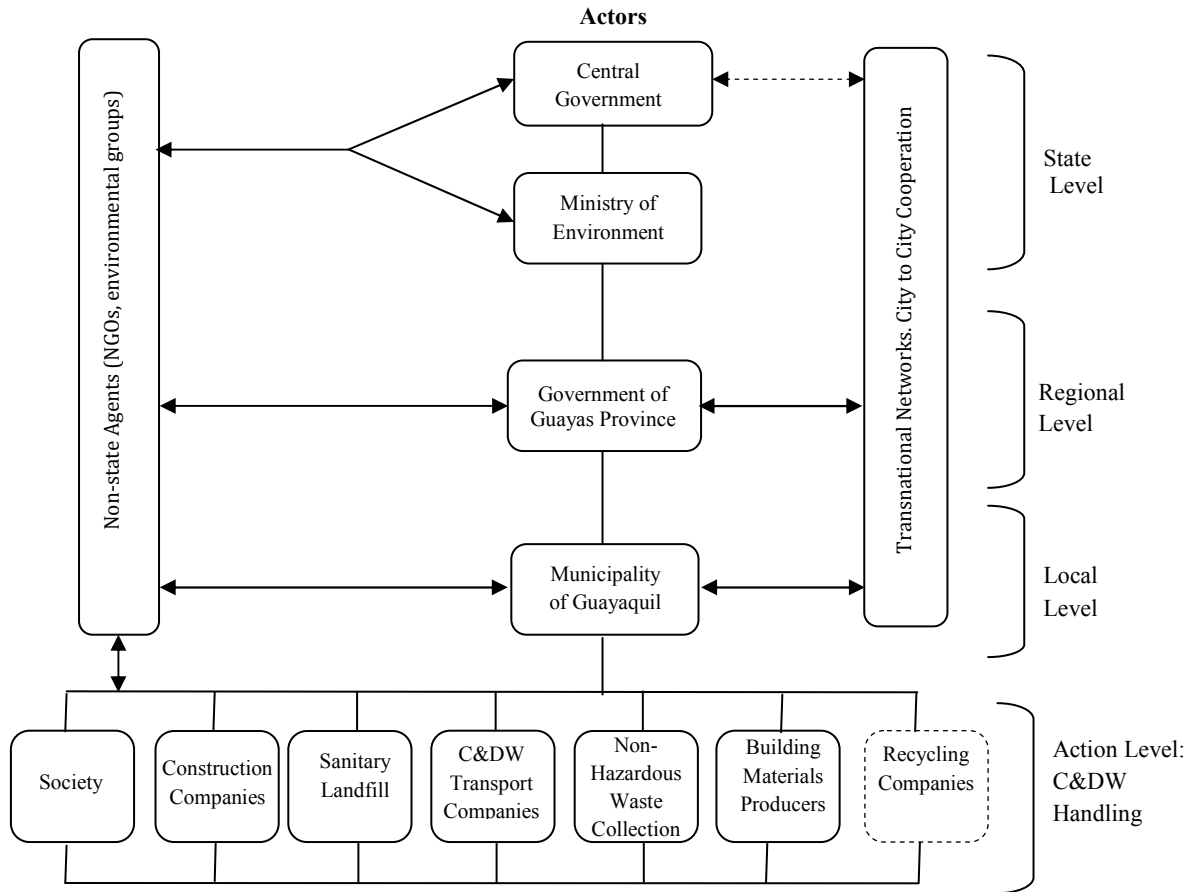


Figure IV: Improved C&DW System in the city of Guayaquil.

The figure IV shows the different levels and their actors connected with each other. In addition new agents have been introduced in the systems, NGOs and environmental groups (non-state agents) who will work as a link between the rule-making levels and the actors in the landscape. This will change the current top-down system that is predominating in Ecuador. Also transnational networks have been added to the system; this cooperation between cities (North-South) will facilitate the capacity building and continuous improvements of the strategies reducing the incorrect management and volumes of C&DW.

7. C&DW and IE

The case of Guayaquil can be used to introduce concepts of IE into the current system. In the city the entire amount of C&DW is being discarded. In the best case it's placed into the landfill, but what is worst and more common is it being dumped into rivers, forest, or other illegal places. So nothing is being recovered and fed back into the system. For this reason, even though it can be argued than is impossible to mimic the perfection of an ecosystem, the ideas behind the concept of IE are something worthy to aim for. Even though the system is not entirely closed or if some energy is coming from non-renewable resources like fossil fuels, (which is not the case of Guayaquil whose main source of energy is the hydroelectric power) still the contributions from reducing the amount of waste been placed in the landfill and being recovered for reuse or recycling purpose will decrease the consumption of natural resources for the generation new products. In Guayaquil is important to (after solving some of the basic problems mentioned previously in this document) implement some of the available strategies like selective demolition, or deconstruction. And these apply the roundput metaphor concept, as they will reduce the extraction of virgin materials in order to produce new products; using instead the recovered C&DW to provide the necessary materials to the same construction sector that originated the waste.

However to accomplish this, communication between the different actors should be reinforced, not only between the different levels of the system but within the same level. The construction companies should create a network that allows builders from different companies to trade remainder or/and recovered materials between them. In addition communication between governmental authorities is also important in order to succeed, as the implementation of strategic plans might require economic and logistic support in order to succeed. This is why in order to implement strategies to improve how the C&DW is managed in the city, first the system should be re-connected and all its parts should be considered; if not any attempt to close the cycle will be futile.

8. Conclusions

The main intention of this thesis has been to contribute to the C&DW management in the city of Guayaquil, analyzing the reasons why the legislation is failing to fulfill its purpose. As the main problem here is not the lack of legislation in place, but their enforcement. However, this should be complemented with an integral strategic plan at regional and local level, considering the most important aspects present in the legislation at the top levels. Despite there are some voids left in practice (for instance what is happening with the clandestine dumps) the city has experienced a great shift from having an open sky dump and public spaces full with waste, to a sanitary landfill and a more efficient waste collection service. Nevertheless, very little has been done to promote the recovery and recycling of the materials placed in the sanitary landfill. It is important then to fix the basic problems and enforce the existing legislation eradicating illegal practices concerning the C&DW, so then we can take the next step and start to reduce the volumes of C&DW and solid waste in general that is land filled, thus reducing the use of virgin materials to feed the industrial sector. However this will take time and a significant investment by the government in order to provide the city with the necessary infrastructure, and will require the education and training of all the stakeholders and the population in general.

Furthermore, there are several potential strategies that can be easily implemented by local authorities to improve the way C&DW is handled; like the ones presented in the last sections of this document. Others will need the cooperation from the state level; however, the decision to do these changes is the most important factor. The Municipality of Guayaquil have shown interest in improving how the waste in general is been managed, however there is still a long road to cover. Fortunately the Mayor of the city was re-elected and four more years will ensure the continuity of the already started plans, as one of the major problems in the country is the continuity of long term plans. However, there are other aspects that need to complement these plans, and also new plans that need to be introduced.

9. Recommendations

The main recommendations that can be draw from the analysis and discussion section are:

- Include all the different stakeholders and give them specific tasks and responsibilities, avoiding the exclusion of important stakeholders like the Regional Government, which is currently excluded from the system.
- Is important that non-state actors (i.e. NGOs, environmental groups) come into play and assist the rule-making levels working as a link between this levels and the landscape. They (NGOs) can also carry out educational campaigns to introduce reduce-reuse-recycle concepts in the community.
- Creation of transnational networks between more experienced cities regarding C&DW management and the city of Guayaquil. This will facilitate the creation of better strategies to tackle waste issues.
- Government should provide the necessary infrastructure first. Is essential to create a C&DW recycling plant (and for other types of solid waste). Then they can demand (as mentioned in the Unified Text) the selective collection of waste by the cleaning entity.
- The promotion of information campaigns to educate the society about how to manage their waste and discuss the importance of doing so. These campaigns can start covering basic issues like taking their garbage out during the collection schedule, and then evolving into ways to reduce their waste volumes recovering and reusing some of the materials instead of throwing them. Also once the recycling infrastructure is in place, the community should be informed on how to sort their waste.
- Establish incentive mechanisms for those contributing to improve the C&DW management. For instance tax exonerations for those building materials manufacturers including in their production recovered materials from C&DW. Also discounts in the Municipal fees, in order to obtain the construction permit, for projects where there is a reduction of the generated C&DW placed into the landfills, or using a percentage of recovered or recycled materials in their projects.
- Is important that the pertinent authorities generate an integral strategic plan with a long term perspective, tackling first basic problems and then evolving into more complex tasks. For instance the shift from a sanitary landfill to a recycling plant. Nowadays this [landfill] is the only alternative for the C&DW and this is not working right as there are a lot of problems like the clandestine dumps and the fact that the hazardous waste is been

mixed with the non-hazardous. However, once these problems are solved, then we can move into better and more integral solutions. For this reason is important to have a strategic plan stating all the necessary steps in order to accomplish it, and the time each task should last.

- Review the current municipal ordinances dealing with C&DW to include other aspects that are mentioned in the Unified Text (Ministerial Level) but which are omitted in the Municipal legislation. Is at this level where the general rules established at the top levels should be included, not only in the ordinances but in the strategic plans as well.
- Reinforce the Municipal controls on the construction sector. There are alternative strategies that can be implemented in order to ensure that the C&DW is placed in the Sanitary Landfill. However the state should support and finance the expansion of the departments in charge of performing the inspections to the construction sites and patrolling the city looking for lawbreakers.
- Local authorities should demand the environmental audit and use the report to check that what was stated by the construction companies' environmental assessment has been carried out.
- Sanctions should also target the generator of the C&DW (owner, developer and constructor) and not only to the drivers or owners of the trucks transporting the C&DW in case of placing it in illegal places. This will contribute to generating a change in how the C&DW is currently managed at the construction sites and regarded by the builders.
- In addition to this the sanctions should be strengthened because after paying the fine the C&DW transporters go back to old practices, however this also has to do with the fact that the sanctions are only targeting them [C&DW transporters] and not the generators as it was mention above.
- Create strategic points for placing the C&DW inside the city [i.e. North, Center, South, etc] to reduce the distance between the sanitary landfill and the construction sites, this way the builder will have an alternative place for their waste that does not increase their cost significantly.
- Local authorities should contract the services of entities specialized in handling hazardous waste to avoid further contamination of the sanitary landfill. If not they need to increase the control over the industries handling this types of waste to stop them hiding it inside the regular waste collected by Vachagnon.

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Appendix A: List of Interviewees and basic information.

	Name and Surname	Organization	Type of Organization	Position	Interview Date
Interviewee 1	Maria Auxiliadora Jacome, Eng.	Ministry of Environment	State Institution		22-01-2009
Interviewee 2	Camilo Ruiz, Eng.	Municipality of Guayaquil. Environmental Department.	Municipality	Director	29-01-2009
Interviewee 3	Glubis Muñoz Ruiz	Municipality of Guayaquil. Environmental Department	Municipality	Chief of the Natural Capital Department	29-01-2009
Interviewee 4	Fernando Ayala, Eng.	National Institute for Statistics and Census.			26-01-2009
Interviewee 5	Juan Carlos Garcia, Ec.	Vachagnon Consortium	Waste Collection and transport Company	Chief of Operations	30-01-2009
Interviewee 6	Andres Intriago, Eng.	Sanitary Landfill "Las Iguanas"		Chief of Landfill	24-02-2009
Interviewee 7	Jorge Borja	ALFADOMUS	Building Materials Company	Director	11-03-2009
Interviewee 8	Hernan Solorzano	REIPA	Recycling Company	Technician	16-03-2009
Interviewee 9	Edgar Pinzón, Eng.	GADERE S.A. Environmental Management of Waste	Hazardous Waste Collection Company	Director	16-03-2009
Interviewee 10	Pablo Cattan	Inmobiliare International	Design and Construction	Planning Director	17-03-2009

		Coorporation	Company		
Interviewee 11	Gustavo Lucin, Arq.	Private contractor	Design and Construction	Contractor	03-03-2009
Interviewee 12	Luis Rivera	Private contractor	Design and Construction	Contractor	19-03-2009
Interviewee 13	Anonymous worker ⁵	San Luis Quarry	Aggregates production	Production Technician	29-03-2009
Interviewee 14	Agustin Ponce	Private company	Construction and Demolition Transport Company	Owner	03-04-2009

⁵This person requested to remain anonymous.

Appendix B: Questions for Interviews

**This is a sample of the questions, the rest of the interviews are in the CD. The interviews were conducted in Spanish and translated to English by the author.*

	Questions	Responses
Interviewee 1	Which are the laws dealing with the solid waste management in Ecuador?	There is one document named Unify Text where you can find norms for waste management.
	How the Construction and Demolition is handled?	All the waste generated at the construction sites is handled the same way as regular waste. This means that is sent to the landfills.
	Is there any kind of statistical information concerning Construction and Demolition Waste?	No that I am aware of.
	Is there a recycling project been implemented in Ecuador?	No at the moment.
	Is there a project for implementing a recycling project in the near future?	No
	Is there a recycling plant in the country?	There are some at the private level, but for specific materials like plastic, glass, paper, and metal.
	Does the Ministry have written some legislation concerning the recover, reuse, or recycling of solid waste?	Yes, there are in the Unify Text [Texto Unificado]
	Which is the final destiny of the waste?	All the waste is place in the landfills or in some cases in clandestine dumps.
	Is the waste been sorted in order to separate toxic from non toxic waste, before put it in the landfills?	No at all.
	Is the solid waste been sorted for recovery or recycling of some of its components?	No.
	Who performs the sorting of the waste that is sent to private recycling companies and for which reasons?	There are persons whose way of living is to go and look into the waste recovering plastics, metals, cardboards in order to sell them to the recycling plants.
	Are there any legislation requiring the separation of hazardous from non-hazardous waste?	Yes, they exist in the Unify Text.