

Assessment of impacts caused by the inefficiencies of the waste management systems: developing countries situation - State of the art in Colombia

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Abstract

Since the 1970's the international community promotes a certain environmental behavior. Developed countries have knowledge, technology, welfare, willingness and infrastructure for decreasing the environmental impacts while poor and developing countries try hard to follow the evolutions.

Between the obstacles that poor and developing countries confront, we can mention: technology is not always available and is expensive to import it, scientific knowledge is not always available, there is some corruption then regulations are not always abided by, authorities don't have enough knowledge for deciding about the best regulations, environmental protection problems are less important than other social and political problems, and the political priority is to rise up the economy.

All this troubles affect the waste management systems. These problems and inefficiencies cause several environmental and other kinds of impacts

This paper shows the results of a state of the art concerning waste management systems in a developing country: Colombia. The problems and impacts concerning the consumption, the waste collecting and treatment systems are highlighted. Environmental and other impacts, linked to the problems mentioned above are identified. In the same way, we propose some solutions for improving those systems.

Keywords Waste management, Impact Assessment, Poor and developing countries,

1. INTRODUCTION

The international community encourages the practice of sustainable development concept. Besides the social and economic aspects, this concept takes into account the environmental protection wherein resources and waste management are key aspects. Amounts of waste are increasing consequently their impacts. Developed countries have knowledge, technology, welfare and infrastructure for diminishing the environmental impacts while poor and developing countries try to follow the evolutions.

This research tries to elucidate which hindrance prevents optimal waste management in Colombia. Principal impacts caused by this dysfunction are identified. Accordingly, this paper firstly describes briefly how waste management should be. Then the principal results of the state of the art that we have drawn up are presented. Finally we propose some solutions.

2. GENERALITIES OF HOW WASTE MANAGEMENT SHOULD BE

Environmental assessment of different economical activities requires knowledge about **present and future materials flows** (raw materials, products, waste etc). Before going further, it is important to clarify what means to know flows, since through our research, we have noticed that for most actors around the world (authorities, researchers, authors, journalists, etc.), it means predominantly to know flows quantities. It is necessary to know **quantities** but it's not enough for improving their management. Especially, when those flows are waste. It is compulsory to know also their **characteristics** (physical state, density, porosity, toxicity, if they are explosive, pathogen, etc) [1] and to have information about **when and where** (by using Geographical Information Systems) these flows are expected. Optimal waste management requires first of all waste **prevention and minimization**. If that is not possible, then it is necessary to set up **the best waste treatment**.

How to prevent waste?

Waste prevention requires changes on the production and consumption patterns. During production stages, it is necessary to improve or modify processes in order to minimize waste. In the same way, it might necessary to develop an eco-design of the product; i.e. a design that considers the end of life of the product. Minimizing waste would require that consumers prefer products with less packaging and those that were eco-designed. Even more, in some cases consumers should decide only to use necessary objects, as it is suggested by Génèreux [2], Bertolini [3] and Rahnama [4]. Obviously, this kind of decisions and behavior has to be supported and supervised by authorities in order to avoid an economical crash. It would be necessary to move from an economy based on exchange of goods to an economy based on offer of services.

In the same way, it would be crucial that production and consumption locations were closer. This could avoid some transport of materials and their associated but necessary packaging.

How to manage optimally the generated waste?

The choice of the best waste treatments is not only a technical issue. This alternative also depends on the economic, political and social background. This fact makes the difference between poor, developing and developed countries.

Once quantities, characteristics, period and location of waste are determined, it is necessary to classify them. Normally, this classification depends on the national decisions (usually by using regulations). These decisions, generally, are taken by politicians based on some current scientific knowledge. As a result, waste is not always classified and treated as it should be. For example, some times hazardous products are not properly treated, simply because they are not classified in the "official" list of hazardous products. In the same way, it is possible to find

some problems on the classification. Wagner [7] mentions the case of mining waste. It was predetermined by the American Congress as not to be legally hazardous, primarily because of economic reasons.

Once waste is classified their management must start. Waste must be separated and/or collected, transported, stocked (in waste transfer stations) and finally treated. By using information above mentioned, the best waste treatment must be chosen. Waste can be **treated for obtaining energy or materials otherwise it can be eliminated**. The energy can be obtained directly by incineration or indirectly by elaborating fuels (by using mechanical, chemical or thermal process). Depending on waste characteristics, materials can be obtained by using material sciences, recycling, reusing, composting, methanization, etc [8]. Elimination can be done by doing incineration, biochemical process, or by disposing waste in land disposal units (landfills, surface impoundments, waste piles, land treatment units, injection wells, salt dome formations, underground mines or underground caves) [9].

The waste treatment choice is affected by the accessibility to the technology and to the knowledge, the regulation background, and the political decisions. For instance, if authorities have the idea that recycling is the best treatment, as it was suggested by scientists for longtime, they will choose it as treatment. Nevertheless, some new researches have found that in some cases this is not the best environmental option [10]. Let's analyze the case of municipal waste, if it is generated in regions with low population density (which is the case for a big part of the Colombian territory), it will be necessary to drive trucks long distances for collecting waste, then to burn fuel and to contaminate with gas emissions. This contamination can be higher than that caused directly by incineration or simply by disposing waste in specialized landfills. **Then, before deciding, it would be necessary to set up a serious research adapted to the local conditions**. All this means, that knowledge must be available, that politicians should promote this kind of research; and also that it should be necessary that economical conditions allow all these. Unfortunately, if locally other priorities exist, maybe the best environmental treatment will not be chosen.

In addition to all this conditions, **a long lasting and sustainable waste management will require a good communication and education system**. Every citizen (politicians, economists, workers etc.) must be informed and become aware of the importance for the society to optimally manage waste. In this way different actors can change their behavior because they are supposed to be convinced of the resulting advantages. Developed countries citizens are constantly informed, by radio, television, journals, advertisings etc. about environmental impacts, about how they should separate waste. In the same way, industrial workers follow several trainings concerning environmental issues, even if they do not belong to environmental service or department. Unfortunately, this is not the Colombian case.

3. STATE OF THE ART AND IDENTIFICACION OF THE PRINCIPAL IMPACTS CAUSED BY THE INEFFICIENCIES OF THE WASTE MANAGEMENT SYSTEMS IN COLOMBIA

Colombia is a country with several contrasts. These contrasts must be taken into account for developing an optimal waste management. Colombia is one of the countries with most natural resources in the world. Colombia has two coasts. One part of the Amazons forest belongs to Colombia. On the Pacific coast there is a rain forest (one of the rainiest place in the world, it is amongst the forest with more biodiversity on earth). The total length of rivers is about 17000 kilometers. Geographical accidents make that this country has several weathers and temperatures (between 0 and 35°C depending on the altitude). Since Colombia lies in the equatorial zone, there are not seasons. The biodiversity of Colombia is amazing. With an area of 1.14 million km² (less than 1 % of the world's land surface), it hosts around 20 percent of the world's bird species. The diversity is greatest in the Andes, which cover a fourth of the country; the rest of the country is almost flat. Colombia has the world's largest open-pit coal mine ("El Cerrejón"). There are also mines of emeralds (95% of world's production) and gold. Colombia is the second largest producer and exporter of flowers on the world. The country is one of the principal coffee and textile producers and exporters. Colombian population is about 45 millions and among them 80 % lives on the mountains (almost 25% in Bogota).

In 1993, Congress approved the "Law 99" which authorized the creation of the Ministry of Environmental (currently the Ministry of Environment, Housing, and Territorial Development) and the National Environmental System (SINA); but because of social and political problems Colombian natural resources are not always well kept and managed. Authorities try to maintain the social and political equilibrium and to rise up the economy. National industry produces usually without taking care of the environment (this is not one of their priorities and taking care of the environment is not always compulsory, it is more like a willingness process). In addition, multinational companies in Colombia does not always respect environment, as they would have done in developed countries (In 2005, the country received more foreign inversions than other Latin-American countries [11]).

In spite of this entire situation, this year Colombia was ninth (amongst 149 countries) in a ranking of excellence in environmental performance (last year the country was ranked seventeenth). For classifying countries, US universities, Yale and Columbia, took into account the Environmental Performance Index. This index measures 25 indicators in six different areas: environmental health, air pollution, water, productive natural resources, biodiversity and habitat, and climate change. As we can observe, they

did not take into account waste management. Maybe this indicator would not grade Colombia in the top ten [12].

Concerning **Colombian production and consumption pattern**, some products are produced nationally (some cleaner production is applied but eco-design concept is almost unknown); some other products like electrical and electronic device, automobiles, and cars are imported (Colombia have not controlled their “environmental quality” and this is important especially when more new materials are being developed). Consumed products are not easily disassembled when they become waste, because the appropriate treatments do not exist, they have been simply disposed in landfills. For instance, according to mobile phone companies, most Colombians change their mobile phone every 18 months and this has been a serious problem. For this reason, last year, the environmental minister asked programs that avoid disposing mobile phones into landfills. Henceforth national mobile phones operators have the obligation to take back used mobile phones and give them an appropriate waste management.

Regarding waste generation and management, The IDEAM (Colombian Institute of de Hydrology, Meteorology and Environmental Studies) estimated, in 2001, that about 8 million tons of solid waste was generated (about 0.71 kg/person/day) [13]. The waste management programs have been somewhat a low priority in Colombia. However, since 2000, waste management systems are being established and improved at regional level. Regulations concerning hazardous one are not widely enforced except in large cities such as Bogotá, Medellín and Cali. Disposal in open pits and on the rivers is still common in many municipalities [13]. In Cundinamarca, department where Bogota is located, only until 2005 this open pits were totally closed [16]. Construction and Demolition waste (CDW) very frequently are dumped into open pits (this behavior is very common because people think erroneously that CDW is always inert).

According to a study done by the Program for Researching Solid Waste, 500 thousand tons of hazardous waste are generated on a yearly basis (Bogotá produce about 73,000 tons) [13] [14]. This waste comes principally from the petroleum, coal, chemical, pharmacologic, metallurgic and textile industries [14] [15]. In practice, hazardous and nonhazardous waste are often mixed together and treated as municipal wastes (less than 15% of hazardous waste is treated properly) [14]. This fact represents a risk for the environment and then for public health. Since disposals are largely unregulated, animals presents in landfills, could spread diseases. Leachate (containing high concentrations of toxics, methane leaks, particulate emissions, and other pollutants) could contaminate ground water. In the same way noise and smells could disturb neighbors. Visual impact can also affect neighbors as well.

Fortunately, in 2002, the Ministries of Environment and Economic Development developed guidelines for the integrated management of wastes within the framework of the Quality of Urban Life Program. It was fixed as one of the goals: 30% of recycling or reusing of waste materials.

(Currently 65% of waste is disposed in landfills) [13]. Nevertheless, it is worth to say that for 60 years, Colombia has been recycling paper, metals and glass. This work has been done by homeless or poor people as a way to earn just the necessary money to survive. Unfortunately, they do all this without any security measure and this will certainly have health consequences.

Recently, all municipalities were asked by the ministry of environment to have a plan for integrated solid waste management (with an initial assessment, future projections, and a viable financing plan). At a national level, like most developing countries, it was found a major portion of organic waste (60%), 13%. Plastics, 11% paper, the rest was glass, metal, textiles, leather and others.

In Bogota, where 5 million tones of municipal solid waste are produced dairy, it has been decided, in 2007, to separate waste at the sources to avoid them to be disposed in landfills. In other regions separation and collection of waste have been started. Nevertheless, it is possible to find still some conceptual mistakes in the systems. For example, in the Santander’s region, people are asked to separate municipal waste in three groups: “inert, recyclable and organic waste”. In the “inert waste container” people is supposed to put: “medicaments”, “chewing gum”, “toilet paper”, “razors”, “hair”, “syringes” etc, but not bricks, ceramics, chinaware etc. They may be wanted to say “non recyclable waste”. In addition to this, not all citizens help with the system since they are not aware about the importance of their behavior.

Some regions have been trying to put into practice composting for treating yard trimmings, food scraps, shrubs, stumps etc. Some of these projects have had success but others had some problems. People thought this kind treatments was easy to do and then sites were not well designed. Temperature, biological process and aeration were not well controlled. In addition, waste was not always well separated. Consequently good quality compost was not obtained, some times ground water was contaminated with leachate and smells has disturbed neighbors.

Concerning waste combustion it is done in kilns in cement factories but only for selected “clean” waste as pneumatics. Incineration has been used for medical and some other hazardous waste. But there are only 3 available units [13] where only 1000 tones are treated on a yearly basis [14]. Unfortunately atmospheric emissions are not always controlled. Then it is possible that these incineration units sent some hazardous substances to the atmosphere, such as: HCl, HF, SO_x, NO_x, Dioxins and furans, heavy metals such as Cd, Cr, Hg, Pb [8] (which are not even identified in official documents, at the RAS 2000, which are guidelines for waste and water management).

Municipal waste is collected and transported by truck to the landfills. Concerning **transport of hazardous waste** is usually done without any security measure. There is almost any information, in the trucks, about associated risks. Transboundary movement of hazardous wastes is

theoretically not possible since the country signed the Basel Convention. Nevertheless, it would be necessary to assess if this is abided by.

Relating to **waste storage**, between the point where waste is generated and the elimination points there are any legal or controlled storages places. These places were already suggested in the RAS 2000; then they are supposed to be constructed very soon. The RAS document has specified their conditions.

Environmental education and communication are not largely spread. Environmental education is not compulsory at school, but voluntary. There is almost any information done by radio, or television. Some information is given by journals. In fact, Colombia has already problems in the education area. Theoretically, education is free and compulsory for the elementary school (five years). In 2001, elementary students totaled 89.5 percent. Illiteracy is declining. In 2000, it was estimated to be around 8 %. But in many rural areas, teachers are poorly qualified, and only five years of primary school are offered. For different reasons (some children need to work for surviving, some of them don't like to study, some teenagers become parents before finishing their studies, etc), only 17% of students finish their high school and only 10% finish the university.

4. DISCUSSION AND CONCLUSIONS

The state of the art that we have done highlight that Colombian waste management systems presents problems at different levels. There are difficulties developing and implementing them. One major problem is the lack of updated knowledge about the risk associated with waste and about the best waste treatments. For this reason some regions do not separate waste as it should be, some other regions have problems with composting, hazardous waste is still transported without almost any safety measure etc.

Different reasons originate this situation:

- It is difficult to plan waste management systems since studies and available data inform about waste already generated but they don't give any information about future waste. The purpose of most researches was to estimate the figures for a certain year or period but not to develop a method as a tool for future uses;
- It is difficult to propose adapted and actualized waste management since available waste description is principally quantitative but not qualitative;
- Waste treatments are chosen by politicians and not necessarily by waste specialist.
- Currently, scientific waste management knowledge is not available in every region then local authorities take decisions with the poor information and knowledge that they have;
- Sometimes authorities and national researchers use results coming directly from researches done for developing countries and they don't adapt then to the Colombian reality;

- There is almost any economic incentive for avoiding landfill disposals. Prices for disposing waste are not legally fixed, and then most of the times it is less expensive to dispose waste than to obtain energy or materials from it. It should exist, like in France, the concept of "**ultimate waste**" (the waste that, for economical or technical reasons, is impossible to treat and that have to be disposed). Only this kind of waste can be eliminated in landfill, incineration or other elimination treatment. In addition, if a not "ultimate waste" arrives to a landfill the price that has to be paid is more expensive than to return the object to the economic cycle.
- There is not a national official list containing waste classification and characterization (principally for hazardous waste). Waste managers are constrained to find information outside of the country in databases like these done by the CEPIS (at Latin-American level), by the REACH program (in Europe) or by the EPA (in USA). By using this information managers could transport hazardous waste using labels like this asked for the international standard NFPA 704.
- There is no Geographical Information Systems containing information about waste generation (quantity, periodicity, characteristics location etc) and about treatment plants. They have to be implemented.
- There is any control about the environmental quality of the national and imported products. It is compulsory to develop for national products research which allows obtaining, at the end of the product life, a better kind of waste (easy to reuse or recycle, with fewer risks for landfills etc). In the same way, it would be necessary to establish a protocol to avoid not eco-designed products.
- Not all Colombian citizens are aware about the importance to protect the environment. It is necessary to improve this situation. Some introduction has to be given at school. In the university, every student should complete this environmental education since every economic activity impact the environment.
- There is not deep environmental impact assessment of waste associated to every economical activity in Colombia. An assessment of the impacts with quantification would allow establishing priorities in waste management.
- Regulations for every kind of waste exist. Nonetheless, noncompliance is a severe problem. It is suggested that the current regulations be evaluated with for simplifying their definitions and requirements. At the same time, it would be necessary to improve monitoring and enforcement.
- The implementation of standards, such as ISO 14001, in the industry is only starting.
- CDW represents a big problem since their amounts are rising up. In addition, their treatments are not easy to set up. Currently material sciences have done new materials which are not easy to recycle. In addition buildings are

not constructed for being “separated”, eco-design is almost not applied in this economic sector CDW [5] [6].

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