Economic valuation of hazardous waste management and its impact on the sustainable development of the Cuitzeo region, Michoacán

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Economic valuation of hazardous waste management and its impact on the sustainable development of the Cuitzeo region, Michoacán

Valoración económica de la gestión de residuos peligrosos y su impacto en el desarrollo sostenible de la región de Cuitzeo, Michoacán

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Economic valuation of hazardous waste management and its impact on the sustainable development of the Cuitzeo region, Michoacán

El Book ofrecerá contribuciones seleccionadas de investigadores que contribuyan a la actividad de difusión científica de la Universidad Michoacana de San Nicolás de Hidalgo para su área de investigación en la función de la Universidad ante los retos de la Sociedad del Conocimiento. Además de tener una evaluación total, en las manos de los directores de la Universidad Michoacana de San Nicolás de Hidalgo se colabora con calidad y puntualidad en sus capítulos, cada contribución individual fue arbitrada a estándares internacionales (RESEARCH GATE, MENDELEY, GOOGLE SCHOLAR y REDIB), el Book propone así a la comunidad académica, los informes recientes sobre los nuevos progresos en las áreas más interesantes y prometedoras de investigación en la función de la Universidad ante los retos de la Sociedad del Conocimiento.

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Introduction

By nature, human beings seek to optimize their productive or consumption processes, without this necessarily being in accordance with the availability of natural resources, a situation that has implied the need to control such activity and direct it under parameters of sustainable use that makes feasible a development with economic, environmental, social, technological, political and legal perspectives (Jiménez, 1996).

The technological changes reflected in the production and productivity of the 19th century gave the guideline to consider its effects as a problem that had to be dealt with under the magnifying glass of value and not price; the environmental economy deals with it by studying the behaviour and impacts of a whole from a particular behaviour, that is, the imbalance that the human being causes in his environment and how the intergenerational assignment of responsibilities for environmental care is necessary (the contributions of Hotelling, 1931; Solow, 1974; Weiss, 1989; Field, 1995 and Yu Chang, 2005 stand out). One of these imbalances is the generation of hazardous waste that inevitably arises from human production or consumption and its impact is the result of the economic activity of one person on the welfare of another, hence the importance of economically valuing hazardous waste to know the willingness to pay for changing or redirecting its environmental and social impacts.

The purpose of the research is to analyze various studies on economic valuation of waste in order to highlight the suitability of which economic valuation method is more appropriate to know the willingness to pay for an environmentally sound management of hazardous waste generated, this in consideration of the legal framework that establishes technical and operational obligations to be observed in order to reduce risks, damage and dangers to health and environment. The Cuitzeo region, made up of thirteen municipalities, concentrates the largest number of generators of hazardous waste, which motivates the study of the way in which they are handled and the willingness to pay so that they do not cause adverse effects to health and the environment. This is because there is evidence that the improper management of hazardous waste can cause health effects such as cancer, asthma, neurological problems, chronic intoxication, hemorrhages, etc., as well as soil contamination, water, greenhouse gases, damage to flora and fauna, among others. This undermines the social welfare of those who come into contact with waste and is therefore reflected in the sustainable development of the region, understood under the parameters of the 1987 Brundtland Report.

In this order of ideas, the first part deals with the problem of the generation and management of hazardous waste in Mexico, starting from the descriptions of the environment, society and waste, in order to contextualize the main national experiences of environmental impact related to the inadequate management of hazardous waste, analyzing the official estimates of waste generation and describing the generating sources. The second part emphasizes the Cuitzeo Region as the spatial horizon for the generation of hazardous waste, addressing from the terminology of the region's construction to the various theoretical approaches that have sought to define it. This in order to address the social, economic and environmental dynamics of the region under study and highlight the importance of the spatiality of the region the paradigm of the new economic geography. The third part refers to the economic valuation of hazardous waste management in the Cuitzeo Region and seeks to analyze the problem from the point of view of the optimal environmental economy, highlighting the importance of economically valuing externalities for social welfare, highlighting the main methods of economic valuation in the area of waste. The fourth part refers to the problem of hazardous waste in the context of development from regional experiences to the paradigm of sustainability, highlighting the areas of opportunity that arise from environmentally sound waste management in the region studied.

The foregoing is not outside the scope of legal regulation in the area of waste, which is why the fifth and sixth chapters refer to the role of the legal framework in the area of waste, emphasizing the environmental responsibility that proper waste management entails. Once the general panorama, waste generation estimates and the legal framework have been dealt with, chapters seven and eight infer on the contingent valuation method to know the willingness to pay for an environmentally adequate waste management, starting from its antecedents, biases, delimitations, the hypothetical market, the sample, the elaboration of the data collection instrument, the pilot application and the final application of the instrument to proceed to its descriptive, inferential and partially predictive analysis. Finally, some proposals are made, some conclusions and recommendations are addressed and some future lines of research are considered that can be addressed from the methodological perspective used.

Chapter I The problem of the generation and handling of hazardous waste in Mexico

1.1. Environment, society and waste Teorías del comercio internacional

The relationship between environment, society and waste is intrinsic, and the size of the problems depends on the contexts in which it develops. Certainly, the environment includes society, and this is the main cause of waste generation. However, although there are natural processes that support the load capacities internally, the production and consumption factors can alter the relationship, causing adverse effects towards the society itself and therefore towards the environment.

In this sense, it is convenient to know in the first place the dissertation of the Spanish construct "medio ambiente." This term has been defined from different approaches; the word has been associated with other Spanish terms such as "medio ambiente" or "medioambiente." The reason is due to a semantic error in the sense that "medio ambiente" was translated from the English expression "environment" (meaning both Spanish words "medio" or "ambiente"), and in the Spanish translation of the 1972 Stockholm Declaration, the conjunction "or" was omitted, finally being written as "medio ambiente." However, the continuous use of the expression led to settle as "medioambiente", which was later defined in the Dictionary of the Royal Spanish Academy (2005) as the "Set of circumstances or conditions outside a living being that influence its development and activities" (DRAE, 2005).

It has been said that in the environment there is the interaction of elements that propitiate their own existence. The General Law of Ecological Equilibrium and Environmental Protection (Spanish acronym: LGEEPA) has defined it as "a set of natural and artificial elements or induced by man that make possible the existence and development of human beings and other living organisms that interact in a specific space and time "(LGEEPA, article 3, section I). Gutiérrez (2000: 60), argues that "it is a set of natural or man-induced elements that interact in a given space and time." Arana (2005) indicates that it constitutes all the systems of living organisms that form an ecosystem made up of the physical elements and living beings that act reciprocally.

On the other hand, Quintana (2000) has defined the environment as the set of physical circumstances surrounding living beings, and by extension, the set of cultural, economic, and social circumstances that surround people. Moreno (1991) indicates that environment is the balanced set of natural components that make up a certain area at a certain moment, which represents the physical substrate of the activity of every living being and is susceptible to modification by human action.

The previous definitions agree that there is the possibility of modification by the human being. However, the first three and the last incorporate the human being as a parallel element to the rest of the living beings. On the contrary, the fourth definition of Quintana (2000) does not exclude it, but it includes it and circumstantially mentions cultural, economic and social aspects around living beings. That is why the environment must be defined as the set of elements that interact in a given space and time, adapting constantly. This definition goes beyond just considering a whole in something; it seeks to interpret a coexistence among natural elements, including the human being. In this context, Brañes (2000) indicates that the environment must be the set of environmental systems that has to do with all possible life forms. In other words, the environment involves the human being as part of its elements, as well as other elements such as water, air, soil, flora and fauna, etc. All of them interact in a specific place and time, but the difference between different kinds of environment is the internal adaptation of each element.

Brañes (1987) states that the environment should not be confused with nature because the latter is considered as the set of elements that interact with each other and within which the human being does not intervene, or its intervention would not stop or alter the regeneration cycles. It is necessary not to forget that the human being has existed and formed an intrinsic part of nature. Then, it can not be said that it does not belong to nature by the mere fact of seeking its modification. The same happens with other species or factors that alter the nature cycles, such as volcanoes, floods, tornadoes, hurricanes or the competition between displaced species.

Certainly, the anthropogenic activity has accelerated the deterioration of natural elements, which has put at risk the human existence itself. That is why both the human being and the rest of the natural elements hold a significant role in that interaction of the environment. Carmona (2016) argues that this process of interaction contains diverse elements both from the perspective of society and nature.

There are the social subjects that carry out actions and the reasons that induce them to perform such actions, the subjects on which those actions have positive or negative effects, and the manner in which such effects impact the rest of the society. From the perspective of nature, the elements are: the affectation that human actions cause, the natural elements particularly affected, the ecological elements or functions affected by the eventual transmission of the effects generated by such actions, and the reorganization of nature to deal with the affectations caused by the first element. It is important to note that nature itself, when reorganized by the alteration, may also affect the society in a different way.

However, it should be considered that nature has exceeded human activity to some extent, adapting to changes with greater agility than human beings themselves, modifying its cycles in a way that seeks to eliminate such aggressive actions of man. That is why, a lower capacity of resistance of man against natural changes is observed. Such changes are first induced by man but then adjusted by the rest of the natural elements. Therefore, it is worthwhile to question the following: Will we be able to adapt to natural changes? Are the natural elements or our ability to adapt to them exhausted?

This represents a vicious circle rather than an interdependence because in the humanity-nature relationship, if there is an action, there will be a reaction that will at the same time provoke another or other parallel reactions and actions that derive from the first approach. Gallopín (1986) argues that nature will cause effects that impact the social system due to human actions that have previously affected the natural system. Therefore, the relationship between nature and humanity does not constitute a unique and absolute relationship, both words are implicit and related (Reboratti, 2000). Although it can be observed that the human being is not indispensable or necessary for nature, nature is essential for the human being.

The human being, as such, must belong to a social group to secure its survival. That social group is commonly called "society"; the term comes from Latin *sociĕtas*, and constitutes a set of people, peoples or nations living under common rules. It is also defined as a natural or agreed group of people, organized to cooperate in the attainment of certain ends (Dictionary of the Royal Spanish Academy, consulted in http://dle.rae.es/, July 2016).

This organization takes place in a specific space, made up of natural elements that promote living conditions. It is observed in this definition, that the term of society is limited to the figure of the person, which etymologically derives from the Latin*personae* or "*personare* that in the Greek and Roman theater indicated the mask that an individual used to play a role. With the passing of time the word *personae* came to refer to a role and not to a mask (Quisbert, 2010).

To improve their quality of life, people seek to streamline their production and consumption processes, thereby generating different types of waste, commonly called "externalities." However, unlike the rest of other species that are also part of the environment, the generated quantities exceed the load capacity of the environment to support such waste. In this regard, Del Val, A. (2011) states that there is no waste in the biosphere production method, due to the constant recycling that makes life possible.

However, it has been constantly argued that, thanks to the industrial society focused on the production of objects, there has been an exaggerated generation of waste due to the need to prioritize market requirements, breaking natural cycles that alter the entire system.

Such exaggerated generation of waste is the consequence of the inefficient use of natural resources in human activities. Not considering the limits of natural elements, these have been devastated to such a degree that the effects have transcended to the society itself. Particularly hazardous waste (Spanish acronym: RP), due to its dangerous characteristics, has been aligned to technological advances that need to efficient production mechanisms and therefore seek to use hazardous substances that sooner or later will result in the generation of RP (Del Val, A., 2011).

Waste has been considered as sub products that have been subject to strategies aimed at making them less visible and annoying. In this respect, as Immanuel Kant indicated in his essay on the beautiful and sublime (1764), the idea of waste is associated with garbage, rubbish, stain, dirt, guilt, smell and sin, whereas cleanliness is associated with beauty and virtue, *"beauty does not smell"*. Continuing in this position reflects a deficit of knowledge that favors the carrying out, as up to now, of partial strategies that do not address the problem of the generation of waste, particularly RP, leaving aside the possible energy use of this type of materials.

Therefore, it is not strange that society itself refuses to properly handle the RP through the installation of treatment plants and final disposal. It seems that it is preferable to bear the risk of mixing RP with solid urban waste (Spanish acronym: RSU) or to see them in landfills in the open air or on the roadsides, rather than having adequate sites for their handling, which in the short and long term can give beneficial results to the society itself.

As indicated by Díaz (1996), the technological processes are not perfect; RP incinerators can emit toxic substances and the confinements of RP can leak from the confined material. This reflects uncertainty, so nobody wants to have them nearby, hence the phrase "Not in my back yard." However, having an adequate handling of the RP has constituted and still constitutes one of the main challenges of the society, which shows a a two-way problem: the technological aspect and the health aspect. The former, says Díaz (1996), is aimed at implementing measures to remedy environmental damage, and the latter is focused on defining the risk associated with contamination by waste.

In addition, RP research should be encouraged to serve as a basis to project programs, public policies and legal reforms with solid, theoretical and scientific bases that allow promoting the minimization of RP in all social sectors. This is important to encourage the principle of prevention and to leave aside the corrective figure of the environmental legal system in Mexico. This system has sought to impose responsibilities that aim to correct actions, impose sanctions and measures that decelerate and hinder the objective of protecting the environment and allow the evasion of justice.

Certainly, the generation of waste is inevitable, but its environmental impact can and should be minimized with preventive actions; this does not imply that the responsibility in the management of RP is left aside. This responsibility has until now been erroneously directed under the amending sense and not with the purpose of responding to any action before another.

It is to be appreciated that the relationship environment-society and RP have a common factor: they all constitute a process; they are the cause and consequence of a relationship that is implicitly recognized and accepted. The environment implicitly carries society, which in turn adds danger to its waste. Such waste is received by the environment, which in turn will react back to society. In other words, the relationship between these elements is cyclical, constant and necessary. The controversial issue is not the degree of relationship but the type of relationship that is established. That is why, in order to seek control and minimization actions, it is necessary to know the willingness to act towards the promotion of an environmentally adequate handling of the PR based on estimates of the generation and handling of RP.

1.2. The situation of hazardous waste in Mexico from experiences of environmental impact

The problem of inadequate waste handling is global and is increasing as handling methods contribute, more than other factors, to causing adverse effects on health and on the environment. Today, it represents a problem that must be addressed from different edges: environmental, economic, legal, social, cultural, political and technological. Currently, the control, management and handling of waste has evolved in such a way that, to date, there are proposals at the international, national, state and municipal levels. However, many of them focus on RSU or Special Handling Waste (Spanish acronym: RME), without considering RP in the same way. Likewise, the existing literature that addresses the problem of waste handling, elaborates on the RSU without there being relevant precedents that make it known if the RP handling is carried out under socially acceptable parameters of health, environmental, economic and technological efficiency.

The handling of waste is understood as the whole set of activities carried out to minimize and value waste (LGPGIR, 2003). Therefore, to determine whether or not it is carried out under environmental parameters, it is necessary to know if the RP generator complies with the provisions of the law, how much is it Willing to Pay (Spanish acronym: DAP) for such handling to be correct, and how it is perceived by the society surrounding the PR generators. All this has the purpose of determining the possibility of impact on the environment and society and its actual impact on the sustainable development of a given region. This is because the literature suggests that PR handling can affect development when it is incorrect. That would cause adverse effects to the environment and society damaging or putting at risk natural elements such as water, soil, air, flora, fauna or diminishing the quality of life of those who are in contact with RP (Díaz, 2004).

The generation of RP in all social sectors is inevitable. However, their handling method makes the difference in limiting or not the possibilities of sustainable development. It is true that industrial production provides goods, services and jobs to the economy, but it is also an important source of pollution. The RP generated represent potential threats to health and to the environment when not handled correctly. The concerns range from the toxic effects on fetuses and children to the health implications of low-level exposures to multiple pollutants and the degradation of habitats and ecosystems (Muñoz, 1995). These concerns do not stop at national borders, because some pollutants can be transported over long distances and the waste is shipped for recycling and on-site disposal across political borders (CEC.ORG, 2010).

The globalized tendency that supposes productive processes of consumption, causes externalities that lead to distortions in the use of the resources. They arise as an effect of a planning decision and as the generation of waste that, independently of its type, represents risks and damages to the society and the environment (Delacámara, 2008). RP reduce social welfare by causing chronic diseases such as cancer, pulmonary insufficiencies, malformations, intoxication, poisoning, neurological problems, vascular disorders and anemia. Either by the inadequate use of arsenic generally employed in agriculture or by the improper handling of other residues such as those from hydrocarbons, they can cause damages such as affectations by infiltration of toxic substances to the soils, contamination by leachates or loss of natural components of the soil, erosion, etc. (Anglés, 2009).

The World Health Organization (OMS, 2002), states that RP are an economic burden, causing damage to health and the environment. In Mexico, there is no methodological scheme to determine the potential of affectation and to evaluate the risks to health and the environment associated to the problems derived from the inadequate handling of RP(Cortinas, 2005). The few studies conducted, in particular in Michoacan, focus on the analysis of chemical accidents as environmental contingencies. By the year 2000, a total of 72 spills, 14 explosion situations and 14 contingencies due to fire were reported (COFEPRIS, 2001). In addition, there are few studies that address an in-depth analysis of risk and harm, and few analyzes of intoxication by pesticides, arsenic, radon and lead have been found.

An example of the above is that the few studies evaluating the environmental effects carried out in Mexico have focused mainly on specific problems or accidents, such as the case of RP discharge to wastewater or to open air (Cromatos de Mexico S.A., a company dedicated to produce chromium compounds; Alco Pacifico de Mexico SA de CV, a company that imports batteries to use lead without returning them to their country of origin, leaving more than 12,000 m3 of RP and 18,000 m3 of contaminated soil). Currently, joint actions are being conducted in Guanajuato among universities to properly handle and dispose of more than 13,000 tons of alumina waste and 300,000 tons of chromium waste. The purpose is to treat them and reduce their dangerousness (SEMARNAT, 2000).

On the other hand, in the literature, there are very few studies that address the problem of generation and handling of RP from its economic assessment. It has been observed that from 1995 to 2014, 13% of the studies conducted a comparative review to determine the suitability and reliability of methods of economic assessment in the matter of waste. 57% of the studies address the problem of economic assessment of the management, generation and handling of RSU, 7% consider the problem of the RME, and only 23% analyze the feasibility of economically assessing the handling of RP. To complement the information, the studies of Cho and Heo (2015), Ferreira and Marques (2015), Gaglias *et al.* (2015), Damigos and Kaliampakos (2016) can be consulted.

The above reflects the need to analyze the handling of RP from the point of view of economic valuation, adding that the vast majority of the studies reviewed show the need to address the problem from the point of view of society. That is, the society's Willingness to Accept (Spanish acronym: DAA) some sort of compensation is analyzed. Such compensation is accepted by the society and not by the generator who, according to parameters provided in the current regulations, is directly responsible for ensuring an environmentally sound handling of the waste. This demonstrates the urgent need for analysis and research of RP under the schemes of economic valuation. This in turn will allow to establish a statistical analysis model that is able to work as a tool for analyzing the problem and to offer economically viable, environmentally appropriate, technologically feasible and socially accepted solutions to the problem under study.

All this is associated to the accelerated growth of the population. The patterns of production and consumption have caused a series of problems on a world scale due to both the lack of environmental control in industrial processes as well as inadequate or insufficient facilities for safe RP handling.

It is known that every process generates waste with physiochemical and / or biological features that make it dangerous. This causes damage to ecosystems and human health, thus impacting the environment. The amount of RP generated depends properly on the activity that is developed, which at the same time promotes a greater or lesser negative impact to the environment. (Cortinas and Mosler, 2000).

RP represents a complexity in its handling, it is not enough for generators to establish internal minimization and valuation measures; It is also necessary to consider the phases of its handling, which involve service providers of collection, transportation, storage and final disposal. The latter covers actions of recycling, reuse, treatment and incineration or controlled confinement. All these actions represent costs in infrastructure, training, adherence to legal provisions and marketing expenses (Cortinas, 2006).

At present, the issue of RP constitutes different aspects, some positive and some other negative. Some are positive in the sense that it has an impact on the creation of integral waste handling services; it creates job sources, and it contributes to the correct disposition of RP from different generating sources. Every company, institution or commercial activity requires another company to provide this service and make sure that their waste will have a correct disposition (PNPGIR, 2008). The negative aspect is even more complex. The generation of RP and especially its incorrect handling have a negative impact on health and on the environment, which causes alterations in the ecosystems and therefore affects the water, soil, air, natural landscape, health, etc. That is why ensuring environmentally sound handling must be a primary activity of those who generate such waste in order to reduce its negative impact.

Mexico has extensive experiences of loss, deterioration, and negative effects on natural elements and on the integrity of people. Some examples are the oil spills from well IXTOC I, in June 1979, or the most recent in Campeche in 2012 due to the collision of the oil platform Usumacinta against the well Kab-101. Another example is the pollution and deaths caused by the release of hazardous materials and waste into the environment, such as those caused by the explosions of the agrochemicals company ANAVERSA, in the state of Veracruz. Other examples are: the stranding of boats Leeward, in Quintana Roo and Rubin in Parque Arrecifal Veracruzano; the release of hazardous pollutants by companies such as Pyosa in Monterrey, Nuevo Leon, Peñoles in Torreon, Coahuila, Metals and Derivatives in Tijuana, Baja California, Cromatos de Mexico, in the State of Mexico, Fundidora Asarco in Ciudad Juarez, Chihuahua, PEMEX in Nanchital, Veracruz among others; the improper handling of RP in the Municipality of Cadereyta, Nuevo Leon, as well as those documented in the State of Mexico (Neri, 1980). There is evidence that RP is deposited in the desert in Ciudad Juarez. In 1995 the discovery of clandestine RP confinements of RP located in a desert area known as El Sauzel, where the company Polymers of Mexico was located, was highlighted in the state news. The Texas Natural Resource Conservation Commission (TNRCC) argued that, during 1995, 32 counties on the border cleaned a total of 1,247 illegal garbage sites with RP from maquiladoras. Another evidence is the spills of RP, like the one happening in Ciudad Juarez in 1995 by the PEMEX company on the Ecological Route. There are also cases of abandonment of RP by foreign companies that leave their externalities in Mexico. A very particular case happened in Colonia Chilpancingo, in Tijuana, in 1994. There, a smelter called Metals and Derivatives, which recycled car batteries, abandoned more than 8,500 tons of RP (arsenic, cadmium, antimony and lead) that had been mixed with storm water and had reached adjacent communities putting alarming concentrations of these pollutants in the blood of people and provoking cases of anencephaly (babies born without brains) (Reed and Villamar, 2000).

Another case took place in Ciudad Juarez by a company called Candados Presto. Their excessive use of cyanide, chromium, nickel and sodium hydroxide, caused poisoning, hemorrhages, rashes and intense headaches to the surrounding inhabitants due to the fact that their RP mixed with sources of drinking and irrigation water.

In the case of Michoacan, as indicated by Israde, et al., (2008), there are no precise figures of cases of damage or impairment to health. It has only been observed that in the open dumps and landfills RP is mixed with RSU, mainly in Morelia, Zinapecuaro, Charo and Tarimbaro, which leads us to believe that there are infiltrations to the surrounding aquifers. In addition, the shedding of dead cattle from the swine industry in the dumps of Huandacareo and Chucandiro is continuous. This leads to assume possible damage to health by pathogenic organisms.

Silva (2006) argues that in Zamora, Michoacan, there have been cases of poisoning by agricultural pesticides: about 177 cases according to records of the Federal Commission for the Protection of Health Risks (Spanish acronym: COFEPRIS). However, the rest of the events have been considered as accidents or environmental chemical contingencies. That is why it is not unusual to find studies that are limited to the chemical analysis of dangerous substances such as radon, arsenic, lead, fluoride and pesticides and are not focused on the negative effects on health.

To establish environmentally appropriate PR handling actions, it is necessary to start from a diagnosis that provides the appropriate estimates to have a starting point and then look for alternative solutions through instruments that offer accurate figures.

1.3. Generation and handling of hazardous waste in Mexico, Michoacan and in the Cuitzeo region

In Mexico, the process of industrialization has advanced and diversified quickly in the last fifty years. As a consequence, there has been a growing and varied production of RP (Garfias and Barojas, 1995). RP management efforts have been contrasted with a lack of reliable information about the amount of waste generated in the country.

RP generation has been estimated between 350 and 400 million tons per year worldwide. 90% belongs to industrialized countries, which have shown greater capacity to respond in case of risks. Countries such as Mexico, Brazil and South Korea can generate close to five million tons of RP per year (Rodríguez and Ibardien, 1999).

In Mexico, the figures for waste in the year 1991 exceeded forty-five thousand tons per day, where it was estimated that almost one third corresponded to RP, that is, 14.5 thousand tons per day. This represented five million tons that have to be properly disposed every year. This problem is greater in some regions of the country due to the particular composition of industries. For example, approximately 78% of the total industrial waste in the northern border area is considered dangerous (SEMARNAT-INE, 2009).

In Mexico, for the period between 2004 and June 2015, it was estimated that 97,348 generators created 2, 223,866 tons of RP. In the case of Michoacan during the same period, a generation of 11,673.30 tons of RP was estimated to come from 4,852 generators that have an Environmental Registration Number (Spanish acronym: NRA) with the Ministry of Environment and Natural Resources (Spanish acronym: SEMARNAT).

This registry is higher than that reported by the states of Baja California Sur, Sinaloa, Durango, Colima, Nayarit, Zacatecas, Morelos, Tlaxcala, Chiapas, Guerrero, Oaxaca, Quintana Roo and Yucatan (see table 1).

The National Inventory of RP Generation (Spanish acronym: INGRP) of SEMARNAT identified 35 records as small generators, 24 as micro generators and one as a large generator for the same period of time. These generators were not located in any specific region. It is not known whether those 60 records belonged to the Cuitzeo, Lerma, Bajio, Oriente, Tepalcatepec, Purepecha, Patzcuaro, Tierra Caliente, Costa or Infiernillo regions. This shows the lack of knowledge on RP handling in Mexico, particularly in Michoacan. In addition, there is a legal void which encourages these circumstances by providing that only large generators must report their RP handling through the Annual Operation Certificate (Spanish acronym: COA) to SEMARNAT. They represent only 2% in Michoacan and only 7% of the total number of RP generators nationwide (INGRP, 2015).

This is worrying since 36% of the considered small generators nationwide and 32% at the state level are not obliged to submit annual reports, which represents the possibility that the most important generations of RP are not being reported. A generator is considered small if it generates between 400 kilos and 10 tons of RP per year. This situation allows the generators to play with the waste generation ranges as long as they do not exceed this amount. They are then free to report and abide by the legal provisions when the limits are exceeded. This situation is never evident and therefore there is no real control of the generation of RP for both small and micro generators (INGRP, 2015).

It can be assumed that the 3,808.76 tons reported by the small generators do not represent the actual generation of RP, in the sense that on average they would generate a little more than 2 tons per year per record. This does not match the quantities generated and received by providers of collection, transport, storage and final disposal of waste.

This premise is of course an assumption, and part of the research aims at contrasting reality with the facts expressed by those who control the generation of RP in the entity, specifically in the Cuitzeo region, which houses the majority of registered generators.

If RP is associated with the term danger, it must be linked to the capacity to produce damage. It must contain some of the six characteristics of danger identified with the acronym CRETIB, which means: corrosiveness, reactivity, explosiveness, toxicity, inflammability and infectious biologics (NOM-052-SEMARNAT-2005). The risk depends on the degree of damage they could cause by exposure or dispersion (Jimenez, 1996).

A broad legal framework has been created to establish an adequate management parameter of RP. It imposes obligations and provides for rights to address the generation and PR handling conducts. RP has been officially regulated in Mexico since 1988 through the publication of the General Law of Ecological Equilibrium and Environmental Protection (Spanish acronym: LGEEPA).

However, waste and mainly RSU, had already begun to be regulated by 1971. In addition, environmental protection is preceded by the Political Constitution of Mexico (Spanish acronym: CPEUM) of 1917, which in its article 27, third paragraph referred to *"regulate the use of natural elements susceptible to appropriation, to make an equitable distribution of public wealth and to take care of its conservation. With this purpose, the necessary measures will be dictated to (...) avoid the destruction of the natural elements ... "*

This indicates that the legal regulation of the environment in Mexico is not recent. However, the basic prerogative of any regulation is the constitutional guarantee marked in Article 4 that referred to a suitable environment for development and welfare as stated in the principles of the Stockholm Declaration. This prerogative was reformed in 2012 to indicate that everyone has the right to a healthy environment for development and well-being (DOF, 2012)

In addition to the CPEUM, the legal framework on waste is made up of the LGEEPA, the General Law for the Prevention and Integral Waste Management (Spanish acronym: LGPGIR), the Federal Law on Metrology and Standardization (Spanish acronym: LFMN) and the Federal Law of Environmental Liability (Spanish acronym: LFRA).

These four regulations together with thirty other Official Mexican Standards (Spanish acronym: NOM) take place at the federal level. At the state level, Michoacan has the Constitution of the State of Michoacan (Spanish acronym: CPEM), the Environmental Law for the Sustainable Development of the State of Michoacan, the Law for the Prevention and Integral Waste Management in Michoacan (Spanish acronym: LPGIRM), as well as regulations and various organic laws of the municipal public administration.

This legal basis is the answer to the need of harm prevention for the human being, the environment and the country's own development. By reducing risks, public spending is also reduced to address situations of intoxication, soil contamination, water, atmosphere, etc. This is because the improper packaging of waste or hazardous substances represents a risk that may cause the hazardous properties of these substances or residues to affect the environment and can be accidentally ingested if a container is taken by mistake.

This implies inadequate management of RP. In the case of Michoacan, specifically in the Cuitzeo region as shown in Figure 1, the common form of handling is inappropriate. It poses a risk to the health of those who handle them and those around them. The environment is then damaged both in their goods and services (pollution of soil, water, land and ecosystems) resulting in an economic cost for both the generator and society.

Figure 1 Common RP handling in Michoacan that shows absence of adequate packaging, labeling and provisional storage, according to the corresponding Law to avoid possible damage to health and environment

Table 1 Estimated generation per federal state of PR 2004-2015

			Micro		Small		Large	
	Enterprises	Generation	Enterprises	Generation	Enterprises	Generation	Enterprises	Generation
Total national	97,348	2,223,865	55,925	12,858	34,563	98,649	6,860	2,112,358
Baja California	6,074	33,507.27	3417	367.31	2330	5,990.50	327	27,149.46
Baja California Sur	1,522	1,769.60	988	76.98	512	981.68	22	710.94
Sinaloa	2,662	9,135.03	1390	193.27	1165	3,292.98	107	5,648.79
Sonora	2,160	19,727.22	1016	151.60	973	3,690.43	171	15,885.19
Chihuahua	4,504	348,147.95	1894	221.61	1814	5,738.30	796	342,188.04
Coahuila	1,808	89,886.11	775	105.75	816	2,286.14	217	87,494.23
Durango	1,729	5,304.28	753	102.18	916	1,761.50	60	3,440.60
Nuevo Leon	3,272	140,019.13	1213	157.52	1326	5,113.02	733	134,748.59
Tamaulipas	2,262	158,573.73	821	113.48	1024	3,183.84	417	155,276.41
Aguascalientes	1,502	51,996.92	685	107.14	643	1,649.37	174	50,240.42
Colima	1,494	4,919.12	924	79.51	522	1,118.73	48	3,720.89
Guanajuato	3,181	68,318.46	1725	223.38	1228	3,586.52	228	64,508.56
Jalisco	9,451	70,344.12	5838	515.21	3287	7,107.82	326	62,721.09
Michoacan	4,852	11,673.30	3202	293.76	1559	3,808.83	91	7,570.71
Nayarit	840	2,216.81	455	39.32	370	736.50	15	1,440.99
Queretaro	2,544	29,520.25	1503	145.30	895	2,934.82	146	26,440.13
San Luis Potosi	2,155	22,558.60	635	118.04	1386	2,954.30	134	19,486.27
Zacatecas	991	8,041.08	616	50.21	322	837.89	53	7,152.98
State of Mexico	5,398	46,090.11	3451	407.24	1675	3,964.90	272	41,717.97
Hidalgo	2,154	25,334.04	1479	221.49	536	1,626.09	139	23,486.46
Morelos	1,913	5,504.10	1484	117.84	383	992.12	46	4,394.14
Puebla	2,904	31,003.02	1829	229.80	943	2,433.33	132	28,339.90
Tlaxcala	656	2,494.37	458	60.13	172	388.95	26	2,045.29
ZMVN	15,191	617,228.51	9369	7,481.44	4550	17,082.96	1272	592,664.10
Chiapas	2,831	2,564.36	2257	214.14	537	1,350.63	37	999.59
Guerrero	1,917	3,562.10	1385	163.50	504	981.33	28	2,417.27
Oaxaca	1,594	2,870.48	1069	116.56	476	1,328.13	49	1,425.78
Veracruz	3,993	45,313.65	2361	365.11	1373	4,444.96	259	40,503.57
Campeche	1,010	213,652.77	313	49.93	445	1,590.66	252	212,012.18
Quintana Roo	1,022	7,180.17	576	82.44	382	1,190.10	64	5,907.64
Tabasco	1,758	140,430.38	795	136.54	793	2,684.55	170	137,609.28
Yucatan	2,004	4,977.84	1249	150.07	706	1,817.33	49	3,010.44

If the RP handling is inadequate or is not in accordance with the LGPGIR, it represents a cost that can economically affect the generator's patrimony, in addition to the public cost of carrying out remedial actions on the affected soil, water and social welfare. Such is the case of the investment of more than $ 647,652,365.00 in the 1960s to remedy a site contaminated with hexavalent chromium from the company Cromatos de Mexico in Tultitlan, State of Mexico (Cortinas, 1997).

In the case of RP, the infrastructure and capacity to handle them must also be considered. They include: the financial costs of having to manage permits, contracting service providers for collection, transport, storage and final disposal of waste; the preparation of a specific area with the conditions set out in the regulation (Article 82) of the LGPGIR; the development and execution of a management plan, a tally of entry and exit of hazardous waste from the warehouse; costs of legal advice in case of administrative procedures; compliance with corrective measures; payment of fines and pending procedures. Since there are differences among states, and therefore their strengths and weaknesses in the integral waste management are different, the effects of change in flows and profits must be considered to determine the degree of value (Daly, 2002), (see table 2).

Table 2 Main financial costs of RP handling in Michoacan, 2015

Service providers		Conditioning of temporary storage*		Administrative and legal management			
RP	Cost			Preventive		Remedial	
Oil employed	$120.00	Covered area	$5,000.00	Training	$5,000.00	Fines*	$100,000.00
Filters employed	$450.00	Signs	$1,000.00	Tally of hazardous waste	$1,000.00	Office management	$5,000.00
Tow	$650.00	Containers	$2,000.00	Handling plan	$5,000.00	Legal advisory	$15,000.00
Antifreeze	$200.00	Paint	$1,000.00	COA	$1,000.00	Warehouse conditioning	$10,000.00
Cardboard and plastic	$350.00	Retaining walls and gutters	$2,000.00	NRA	$500.00		
Total	**$1,770.00**		**$11,000.00**		**$12,500.00**		**$130,000.00**

* Estimated costs for a monthly service, according to data provided by the service company Ambiental Michoacana, located at: Periférico de la República 2560, col. Hermanos López Rayón, Morelia, Michoacan. ** The costs for fines are estimated considering fines imposed by PROFEPA ranging from 20 to 50 thousand days of minimum wage for each irregularity, applicable in Mexico City. Source: Author's own design, 2016.

RP handling must be studied from different angles: the environmental angle, starting from the effects and impacts on the environment; the social angle, when it harms the welfare of those exposed to RP handling; the economic angle, based on the costs that an efficient handling represents; the legal side, which constitutes the enforcement parameter in RP handling; and the technological angle, which covers the infrastructure to ensure environmentally sound handling. For this, it is necessary to start from a specific space and time.

This research covers the Cuitzeo Region, which concentrates the largest number of RP generators in Michoacan and therefore the highest amount of RP generated (see table 3).

Table 3 Number of hazardous waste generators in Michoacan, 2015

Region	Generators		
	Large	Small	Micro
Cuitzeo Region	**38**	**637**	**1598**
Lerma-Chapala Region	2	70	189
Bajio Region	6	70	159
Oriente Region	3	58	172
Tepalcatepec Region	3	53	122
Purepecha Region	11	438	505
Patzcuaro-Zirahuen Region	0	43	88
Tierra Caliente Region	3	12	87
Sierra-Costa Region	22	143	198
Infiernillo Region	2	11	56
Without established location	1	24	35
	91	**1559**	**3202**

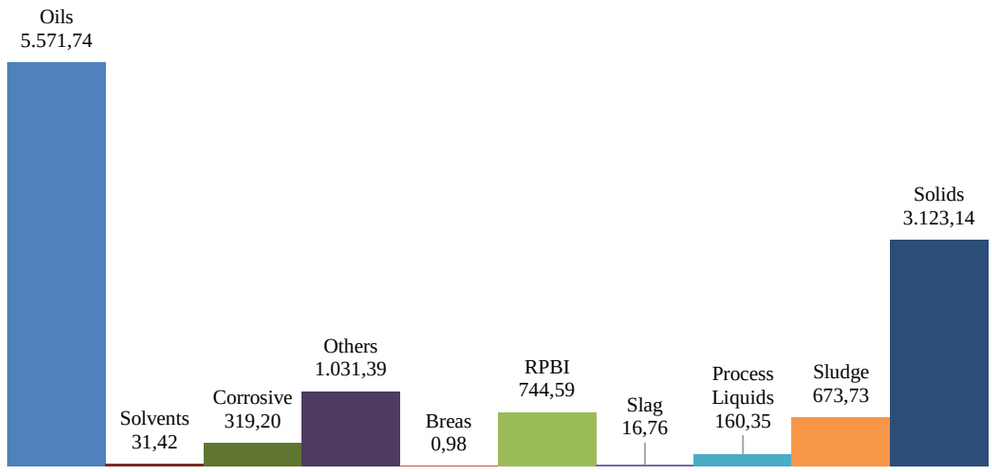
Source: Author's own design based on data from INGRP-SEMARNAT, (2016)

The service sector is one of the main sources of RP generators. The health industry belongs to this sector, which includes clinics, hospitals, medical centers, veterinarians, etc. However, the PR with the highest rank of generation are those listed as used oils (dielectrics, lubricants, hydraulic, soluble, metals tempering, among others) with a generation of 5,571.74; followed by solids (fabrics, skins, automotive maintenance, asbestos, heavy metals, filter cakes, others) with a generation of 3,123.14 tons. For more details see Grafic 1.

This is a reflection of the need to contrast the reports with the real generation, deepening a research that provides scientific basis on the economic valuation of RP handling in the studied region. It is necessary to suggest improvement mechanisms based on the valuation and minimization of RP, since its inadequate handling can negatively affect the sustainable development of the Cuitzeo region.

This can constitute a risk to public health with possible direct or indirect damages to natural resources such as soil, water and air. It can also diminish the quality of life and economically affect social welfare (SEMARNAT- DGGIMAR, 2016).

Graphic 1 Generation of hazardous waste by type in Michoacan, 2015



Source: Author's own design based on data from SEMRNAT-DGGIMAR, (2016)

Cuitzeo Region is made up of 13 municipalities, representing 6.7% of Michoacan's territory. It has an area of 3,940.44 km2 with 1, 061,011.00 inhabitants (see table 4). It is undoubtedly the most populated region, and its density is 254 inhabitants per km2: more than three times the state average. Morelia, the state capital, is located in this region (INEGI, 2010). It is conformed by the territory of the endorheic basin, area in which the water does not have fluvial exit towards the ocean of the Cuitzeo lagoon (García, 2009). Its main streams are the Rio Grande and the Rio Chiquito that run south from the Guayangareo Valley and the Sierra de San Andres, between Morelia, Villa Madero and Acuitzio. Other important tributaries are the Querendaro river and the streams of Zinapecuaro. The presence of hot springs and the great diversity of religious monuments and helmets of old haciendas is prominent. The Morelia-Querendaro-Alvaro Obregon valley has irrigated infrastructure surfaces in more than 15 thousand hectares.

A large part of these are underexploited due to the heavy contamination of the Rio Grande by the wastewater of the city of Morelia. 30 years ago, it was an important dairy basin with almost 15 thousand heads in stable. As for the primary sector, pig-raising, breeding of dairy cattle, poultry for meat and eggs, more than 20 horticultural products, grains and fodder, honey and wax are developed (García, 2009).

Table 4 Total population by gender and by municipality. 2014

Municipalities	Men	Women	Total
Acuitzio del Canje	5,475.00	5,948.00	11,423.00
Alvaro Obregon	10,549.00	11,414.00	21,963.00
Charo	11,949.00	10,815.00	22,764.00
Chucandiro	2,292.00	2,758.00	5,050.00
Copandaro	4,440.00	4,950.00	9,390.00
Cuitzeo	13,750.00	15,509.00	29,259.00
Huandacareo	5,566.00	6,356.00	11,922.00
Indaparapeo	8,295.00	8,837.00	17,132.00
Morelia	363,379.00	399,052.00	762,431.00
Querendaro	6,829.00	7,240.00	14,069.00
Santa Ana Maya	5,955.00	7,057.00	13,013.00
Tarimbaro	45,564.00	49,015.00	94,579.00
Zinapecuaro	22,969.00	25,047.00	48,016.00
Totals	507,012.00	553,999.00	1,061,011.00

Source: Author’s own design based on data consulted in 2016 from INEGI, 2014

In the city of Morelia there is manufacturing industrial activity (furniture), chemistry, resins, oil and flour, as well as manufacture of paints. It concentrates educational and professional services, public administration and trade, so it concentrates the largest number of RP generators. As a whole, the region hosts a fifth of the total state population. More than 11% of the total population live in Morelia alone (INEGI, 2010). According to the premise that guides the present investigation, it is convenient to stand out that Morelia is a city specialized in services (although it also has some industry). A lot of movement towards the western highway and directly to the port of Lazaro Cardenas is noticeable. One of the features of the region is Lake Cuitzeo. It is considered to be the second largest lake in the country with an average surface area of 420 km2. The lake, together with other bodies of water, represents 8% of the surface of the region. (CONABIO, 2005).

In spite of this, there are threats against the lake such as the discharges of domestic and industrial wastewater, the increase in the levels of silt due to the deforestation of the basin, the construction of a highway that has provoked and will continue causing serious environmental effects (Gómez-Tagle, 2014 through http://www.cambiodemichoacan.com.mx/nota-226085), etc. These facts are aggravated by the absence of legal regulations that protect water resources from pollutants derived from RP (SEMARNAT, 2009).

The most recurrent phenomena are: the harmful plague of flies and insects; floods that affect agricultural activity; the use of insecticides and agricultural fungicides that contaminate soil and environment; inadequate RP handling as well as RSU; frequent forest fires; floods caused by the overflow of rivers in some colonies of the state capital; the location of industries in areas of high population density. In addition, the degradation of the soil in the region goes from moderate to light to extreme, depending on its cause. Moderate degradation is caused by overgrazing, reforestation and agricultural activities of a greater degree; light degradation is due to deforestation, vegetation removal, overgrazing, agricultural activities and overexploitation of vegetation for domestic use; and he extreme level is mainly caused by urbanization and industrial activities (PREDUR, 2009-2030).

Rural service activities, trade, construction, among others, are susceptible to generating RP. Therefore, there is a need to know, based on each economic activity, the ranges, types and volumes of RP generated. It is also important to determine if the way they are handled adheres to the legal provisions in the matter.

This will make it possible to economically assess RP handling in order to determine if it adheres to the legal provisions and to what extent it affects the environment in terms of soil contamination and health by exposure. It is important to assess the DAP of those who generate it as well as the social perception of RP handling by the surrounding inhabitants.

These are direct and indirect actors whose quality of life can be altered by the inappropriate handling of RP. All this affects the central axes of sustainable development that represent part of the environmental, economic and social problem. This issue must be addressed to guarantee the well-being of both present and future generations from a dynamic point of view.

The Cuitzeo Region generates 47% of the RP reported in the state, that is, 4,861.90 tons, while the rest of the regions have reported 6,811.39 tons of RP. These figures include all micro, small and large generators whose activity focuses on the provision of RP generating services (with 1773 generators). These are divided as follows: 269 of mercantile services, 43 of food, 25 of construction, 16 of metallurgical, 14 of plastic articles, 14 of the chemical sector, one of automotive, two of electronic equipment, eight of RP handling service, seven of energy generation, five of petroleum and petrochemical, five of textiles, four of metallic articles, five of cement and lime, four of freezing and ice products, three of wood and its products, two of cellulose and paper, two of articles and products of different materials, one of exploitation of stone benches, one of communications, one of paints and inks and one of dressing garments.

This indicates that the health sector (clinics, hospitals, medical centers, veterinarians, etc.) is a source of RP generation. However, the RP with the highest generation rank is that listed as used and solid oils. (SEMARNAT, 2016).

The Cuitzeo Region has 2273 registered RP generators. This number represents 42% of the state's large generators, 51% of the small generators and 41% of micro-generators (see table 5).

Table 5 Number of generators per municipality of the Cuitzeo region, 2015

Cuitzeo Region			
	Generators		
Municipality	**Large**	**Small**	**Micro**
Acuitzio Del Canje	0	0	4
Alvaro Obregon	2	4	19
Charo	0	2	9
Chucandiro	0	0	2
Copandaro	1	2	3
Cuitzeo	1	2	7
Huandacareo	0	0	8
Indaparapeo	1	0	8
Morelia	33	601	1463
Querendaro	0	1	6
Santa Ana Maya	0	0	12
Tarimbaro	0	12	24
Zinapecuaro	0	13	33
Total	**38**	**637**	**1598**

Source: Author's own design considering date from INGRP-SEMARNAT, (2016)

The foregoing is relevant in the sense that each record generates RP, which represents an economic cost that is sometimes not quantified. This will thus be reflected in the sustainable development of the region, so the present investigation seeks to demonstrate this relationship. According to the estimates of the SEMARNAT (2016), the Cuitzeo Region generates 40% of the RP reported in the state, that is, 4,861.90 tons. The rest of the regions have reported 6,811.39 tons of RP. This is true for micro, small and large generators, whose activity is essential to know the types and volumes of RP they generate and, based on this, to know the possible risk and damage (see table 6).

Table 6 Sectors and numbers of hazardous waste generators in the Cuitzeo region, 2015

Activity	**Number of generators**	**Activity**	**Number of generators**
Food	42	Energy generation	7
Automotive	12	Wood and its products	3
Plastic items	16	Metallurgical	22
Metal Items	6	Oil and Petrochemical	6
Cellulose and Paper	2	Paint and Ink	1
Cement and Lime	5	Textile	6
Communications	1	Chemical	14
Freezing and Ice Products	4	Private Mercantile Services	271
Construction	25	RP Handling Services	8
Electronic Equipment	8	RP Public Health Services	1812
Exploitation of Banks of Materials	2	**Total**	**2273**

Source: Author's own design based on data from the National Inventory of Hazardous Waste Generation, SEMARNAT, (2016)

RP handling is based on a legal complex that allows to occur in an incorrect way, that is, with serious environmental, economic and social repercussions. This is usually done either consciously or unconsciously by the generators. Michoacan and especially the region under study is not exempt from this possibility. Because there are legal, economic, technological and social voids between each phase of RP handling, compliance with the regulations is never guaranteed. The fundamental premise of such regulations is to guarantee an adequate environment for the development and well-being of Mexicans, without compromising the natural resources of future generations.

As a result of the existence of a series of legal loopholes in the control of RP at the national level, the government of the state of Michoacan has focused on monitoring RSU and RME handling arguing to have better proficiency in the subject. However, this does not exempt the state from establishing control, evaluation and improvement mechanisms in terms of RP (Cortinas, 2006).

The actions carried out to control RP generation and handling are reduced at the municipal level. They essentially focus on RP derived from health centers (biological-infectious), which is generally controlled in subordination to the health centers established in the state capital (INGRP, 2016). In addition, it is important to highlight that the environmental cost derived from an inadequate RP handling is irreparable.

It damages the state ecosystem to such an extent that it is impossible to regenerate. Such is the case of contaminated soils that are usually damaged by the automotive service activity (generation of used oil, tow, contaminated filters, antifreeze, etc.).

This environmental damage usually brings about an economic cost for those who generate it, for the government and for society itself. The generator is forced to pay fines, administrative procedures, advisory, the authorization of areas to temporarily store their waste, etc.

In turn, it constitutes a cost to the public administration for having to enforce the law through the Federal Attorney for Environmental Protection (Spanish acronym: PROFEPA). Therefore, these costs have an impact on social welfare as they alter natural services and resources and the prices for the services that a RP generator provides rise. This is usually reflected in the costs of products or services (Anglés, 2009).

1.3.1 Description of the generating sources and generated estimation of hazardous waste in Michoacan and the Cuitzeo Region

The main economic industries generating RP in Michoacan are as follows: food; articles and products of different materials; plastic and metal articles and products; automotive; cellulose and paper; cement and lime; communications; freezing, ice and its products; building; electronic equipment and articles; exploitation of material banks; explorations and mining operations; electric power generation; wood and its products; maritime; metallurgical; miner; oil and petrochemical; paint and ink; clothing and dressing garments; chemistry; RP generation services; RP handling services; provision of RP generation services; textile and glass (see table 7) (SEMARNAT, 2016).

Table 7 Estimated generation of hazardous waste by sector in Michoacan. 2016

Sector	Estimated generation	Sector	Estimated generation
Food	429.63	Wood and its products	79.45
Articles and products of different materials	0.51	Maritime	6.06
Plastic items	21.41	Metallurgical	1,900.35
Metal items	144.79	Mining	16.10
Automotive	3.97	Oil and petrochemical	96.07
Cellulose and paper	339.93	Paint and inks	588.01
Cement and Lime	112.26	Clothing and dressing garments	1.16
Communications	0.60	Chemical	371.89
Freezing and Ice Products	21.61	RP generation services	1,782.64
Construction	175.50	RP handling services	40.27
Equipment and electronic items	1.30	Provision of services for RP generation	5,269.95
Exploitation of material banks	2.89	Textile	49.81
Explorations and mining operations	122.54	Glass	0.40
Generation of electric power	94.20	**Total**	**11,673.30**

Source: Author's own design based on data from the General Directorate of Integral Management of Materials and Risky Activities of SEMARNAT, (2015)

Regarding the RP generation services sector, there is no greater description by SEMARNAT. According to the activities included in this sector, it can only be deduced that the industries mainly belong to medical care activities.

In the case of the Cuitzeo region, the main generating sector of RP is referred to as the provision of RP generation services, having 1773 records as RP generators. It includes medical care services like: health centers, clinics, hospitals, pharmacies, drugstores, X-ray laboratories, biology laboratories, dentists, veterinarians, distribution and production of drugs, fertility clinics, weight control, cardiology, blood banks, dental care, alternative medicine, rehabilitation, rental, sale and rental of medical equipment and devices.

In addition to this, some service industries are included, such as: maintenance and automotive repair of vehicles and motorcycles, service and administration of airports and heliports, car washed and service, funeral services and cemeteries, tattoos and piercings, tires, car-repair garages, alignment and rolling, photographic studios, purchase and sale of scrap and recyclable materials, storage and distribution of snacks, drinks and sweets (SEMARNAT, 2016).

As for the commercial services generating RP, with 269 records, it includes: service or departmental stores (hypermarkets, mega markets, shopping centers, etc.), sale of tires and cameras, gas stations, warehouses, auto parts and automotive additives as well as the commercialization of industrial gas. The food industry with 43 records includes businesses such as: storage and distribution of beer; production and distribution of flours, oils and fats, snacks, soft drinks, carbonated drinks, water, food, dairy, spices, breeding and grain of birds, production of agricultural and livestock machinery, restaurants, bakeries and industrial patisseries (SEMARNAT, 2016).

The sector of articles and production of different materials shows two records and refers to the production and distribution of brooms. The sector of plastic items and products shows 14 records and refers to the production of stretch films, bags, pieces of plastic and polypropylene. The metal items sector shows four records and includes the production and assembly of machinery and equipment for industrial use. The automotive sector, with only one record, refers to the production of auto parts. The pulp and paper sector, with two records, refers to the production of paper.

The cement and lime sector shows five records and refers to the production of ready-mix cement. The communications sector comprises one printed news agency. The sector of freezing an ice products, with four records, includes the manufacture of ice products and freezing of products. The construction sector covers 25 construction and civil work records and roads. The electronic equipment and items sector comprises two records on electronic equipment and accessories (Ibidem).

The sector of exploitation of materials includes one record of extraction of stone materials. The power generation sector includes seven records focused on the generation and distribution of power. The wood sector, with one record, refers to the manufacture of wood products. The metallurgy sector comprises 16 records and includes the production of metal structures, molding of iron and steel parts, secondary iron and steel lamination, production of accumulators and batteries, metal refining (Ibidem).

The petroleum and petrochemical sector shows five records and focuses on gas stations, asphalt production and mixtures for paving. The paint and ink industry includes one record on the production of paint, coatings and waterproofing. The clothing sector shows one record, it includes the making of dressing garments. The chemistry sector, with 14 records, covers the production of perfumes, cosmetics and the like, photographic development, the production of turpentine and tar, as well as matches, soaps, detergents, synthetic resins, plasticizers, pharmaceutical production, marketing and storage of chemical products, gas and petroleum products. The RP handling sector, with 8 records, considers on-site treatment of RP, wastewater, RP handling, cleaning of gas stations and dispensaries. Finally, the textile sector comprises five records related to the manufacture of shells, threads, synthetic raffia fabrics and the manufacture of polypropylene bags (SEMARNAT, 2016).

The above-mentioned sectors show the diversity of economic industries in the Cuitzeo region. They are randomly incorporated into sectors by the RP control authorities (SEMARNAT). This shows the need to reclassify the sectors in order to come to more feasible alternatives in the handling of generated RP. It is evident that the industries belonging to the health sector represent a majority. However, due to the diversity of the different industries, the RP that is mostly generated in the region are not from the health sector but belong to the group of solids and oils. It should be remembered that the LGPGIR, in article 31, lists all wastes considered hazardous.

These include: used lubricating oils, used organic solvents, catalytic converters of automotive vehicles, batteries of automotive vehicles containing lead, mercury or nickel-cadmium-based electric batteries, fluorescent and mercury vapor lamps, fittings containing mercury, cadmium or lead, drugs, pesticides and their containers with remnants , persistent organic compounds such as polychlorinated biphenyls, oil-based drilling mud from the extraction of fossil fuels and sludge from wastewater treatment plants when they are considered hazardous, and biological-infectious waste.

This is in contrast to the provisions of the Official Mexican Standard NOM-052-SEMARNAT-2005 *"Which establishes the characteristics, identification procedure, classification and lists of RP"*. It allows waste generators to identify if their waste is hazardous, taking into account the following: the specific source, the non-specific source, the RP resulting from the disposal of non-specified or obsolete chemical products (Acute Toxics), the RP resulting from the disposal of out-of-specification or obsolete chemicals (Chronic Toxics), waste that is subject to Particular Handling Conditions, and waste that is regulated by specific Mexican official norms (polychlorinated biphenyls, mining residue, soils contaminated with hydrocarbons, sludge and Bio-solids). Additionally, only if the generated waste is not included in the above criteria, the following classification will apply: a CRIT analysis of the waste together with the determination of any explosive and Biological-Infectious characteristics; scientific knowledge or empirical evidence about the materials and processes used in the generation of the waste; if the generator knows that its waste has some of the dangerous features established in the standard; if the generator knows that the waste contains a toxic constituent that makes it dangerous; if the generator declares under protest that its waste is not dangerous.

The materials classified under the first five criteria are considered RP and it is not necessary to perform a CRIT analysis to demonstrate whether or not it is dangerous (NOM-052-SEMARNAT-2005). In accordance with the LGPGIR, the above criteria allow to define RP as that which shows any of the characteristics of CRETIB, as well as containers, molds, packaging and soils that have been contaminated by the effect of transferring such waste from one place to another. Molds and packages not used on one same hazardous material or waste or for the same purpose are still considered RP. An exception of this are those that have been subject to treatment for reuse, recycling or final disposal (LGPGIR, 2003). Considering that the RP generated in the region have one or more of said CRETIB features, it is pertinent to point out that the installed capacity for its handling is greater in the northern states, which also show greater generation. On the other hand, the center also shows considerably more installed capacity then the southern states (see table 8).

Table 8 Installed Capacity for the collection, transport and handling of hazardous waste, 2016

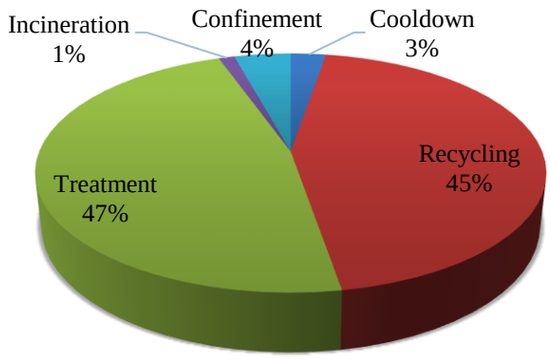
Collection and transport (1993-2013) (cumulative capacity of the period in tons / trip)		(Accumulated tons)		**Collection and transport (1993-2013)** (cumulative capacity of the period in tons / trip)		**Handling (2000-2013)** (accumulated tons)	
State	**Inst.**	**Capacity**	**Cumulative**	**State**	**Inst.**	**Capacity**	**Cumulative**
Aguascalientes	11	241	15 000	Morelos	11	51	307
Baja California	67	2 353	195 177	Nayarit	2	15	651
Baja California Sur	5	292	639	Nuevo León	216	78 444	4 364 237
Campeche	15	23 927	75	Oaxaca	3	334	2 868
Chiapas	6	60	2 834	Puebla	36	1 000	159 984
Chihuahua	35	6 902	43 722	Querétaro	18	2 264	219 790
Coahuila	39	10 944	1 144 164	Quintana Roo	3	20	17 282
Colima	9	395	26 480	San Luis Potosí	32	2 970	170 167
Distrito Federal	67	6 576	563 418	Sinaloa	12	308	1 908
Durango	21	1 712	2 256	Sonora	26	808	133 143
Estado de México	195	16 337	1 589 792	Tabasco	66	15 438	2 368 743
Guanajuato	39	3 267	178 786	Tamaulipas	98	56 196	1 052 330
Guerrero	4	45	47 000	Tlaxcala	3	11	91 105
Hidalgo	21	21 125	259 146	Veracruz	125	161 587	708 515
Jalisco	78	10 785	115 520	Yucatán	7	524	6
Michoacán	9	187	139 012	Zacatecas	1	4	435

Notes: 1) The information represents the management of authorizations for companies to provide handling service. The companies specify the capacity they have in their facilities. Therefore, the values expressed do not represent the volume of waste actually transported and processed. The values may be lower because the plants do not operate at full capacity. 2) The data are updated to May 2013.

Source: Undersecretariat of Management for Environmental Protection, General Directorate of Integral Management of Materials and Risky Activities. Mexico, (2013). Consulted in May 2016.

According to the PNPGIR (2008), the industrial RP recycling and processing capacity in Mexico represents more than 85% of the total handling capacity in the country, as shown in Graphic 2. The incineration process shows the lowest percentage.

Graphic 2 Distribution of the main hazardous waste disposal actions in Mexico



Source: Undersecretariat of Management for Environmental Protection, General Directorate of Integral Management of Materials and Risky Activities. Mexico, (2013).

Regarding the final disposal of RP, currently only two controlled confinements located in the states of Coahuila and Nuevo Leon operate for this type of waste. However, 6 projects were authorized for this type of infrastructure in the period from 2003 to 2006. One of these is already operating, another one is under construction in the state of Hidalgo, and the rest are in pre-operational stages (SEMARNAT, 2013).

Michoacan does not have any plant that provides an environmentally and technologically adequate or viable disposition of its generated RP. The only handling option is the transfer through service providers who collect and transport them to the above-mentioned plants. This represents an additional direct financial cost and an indirect environmental cost (SEMARNAT, 2015).

All this reflects the main obstacles facing Michoacan, particularly the Cuitzeo region in term of RP handling. It is convenient to understand the social, economic, political and environmental dynamics of the heteronomous space called region

Chapter II The Cuitzeo Region as a spatial landmark for the generation of hazardous waste

2.1. Origin of the term region and its theoretical approach

The origin of the term region is associated with a centralist political management structure, the region, used at the time of the Roman Empire, to name the areas that had a local administration and that were under the central power resided in Rome (Da Costa, 1998). Academically, the concept dates back to the 18th century, when it was systematized, after the geographers considered that the political areas were not adequate for the analysis of physical and environmental variables (López and Ramírez, 2012). Then, they took back from Geology the concept of natural region, which reached a wide prestige among the academic community in the middle of the XIX century. It allowed to analyze a special unit through the interdependence of the physical factors of the space that made it up, highlighting its homogeneous nature as an essential characteristic (Da Costa, 1998). Vidal de la Blache and Hettner were the most important representatives who gave weight to the natural and cultural aspects within the description of a region (Grigg, in Chorley and Haggett, 1969).

At the end of the 19th century, man and the concept of a humanized landscape were incorporated into the natural region, and the concept of geographical region emerged (Ávila, 1993). This new identity based on the social and natural perspective (Wallerstein, 1996) allowed to generate the national identity of the states that emerged with modernity (Capel, 1981). "The region then emerges as a category that is used in different ways, leading, to a great extent, to consolidate the material and ideological transformations that capitalism required for its implementation" (Agnew, et al., 1997: 25).

Silks (1968: 379) states that a region *"is an energy reserve whose origin is found in nature, but its development depends on man. It is man who modifies the earth according to his purposes; it is he who gives rise to individuality and who establishes the various features. It is he who replaces the incoherent effect of local circumstances with a systematic set of forces ".*

The "*region*" construct depends on a spatial and temporal dimension. It is influenced by factors of various kinds, such as economic, social, cultural, environmental, political-legal, technological, etc. It results in a concept with different connotations, depending on the approach of analysis. The region has been considered as a way to identify certain portions of a terrestrial surface defined by preconceived criteria and objectives, which may come from the natural or social sciences (Palacios, 1993). Under a different vision, it has been defined as a *"geographic space larger than a locality, but smaller than a national state, with a boundary determined by the effective scope of some system whose parts interact more with each other than with the external system"* (Young, 1992: 30). It should be noted that the region has been understood as an effect of the social construction of space (Jalowiecki, 1998), evidently a geographical perception. On the other hand, and in this same social sense, it has been defined as a portion organized by a system and that is part of a larger group (Dollfus, 1976).

Then, the region constitutes a space and a social activity. Said space is formed by geographic, environmental conditions and by human interactions, hence the fact of highlighting the historical-cultural conception of the region whose meanings change by circumstances of time and place. So, it has been argued that *"the region is a changing reality, because it changes the society settled there over time*" (Ortega, 1993: 10).

On the other hand, the term has been used as a methodological means because it allows to guide investigations that have the study of a clearly determined territory as unit of analysis. It is defined a priori to determine the variables that are going to be used; otherwise it could end up explaining a phenomenon different from the one that was intended. Social, cultural, economic, political, historical and anthropological elements that are typical of a time and a space affect these variables (Moreno and Florescano, 1973).

The functionality of a region, once its homogeneity has been determined by geographical aspects, results from the social interaction that delimits its action based on an important population center, on which economic, political and social activities revolve.

An example of this is the region studied, which, when concentrating the majority of RP generators, means that these in turn determine the economic activities that are part of the development of the entity. This causes certain economic, environmental and social impacts and can have not only statewide but nationwide consequences. Thus, Coraggio (1974) considers the region as that homogeneous territorial area delimited by the prevalence and the singularity of a similarity.

Theoretically, three generic types of region have been considered based on a space: the homogeneous, the polarized and the planning regions. The first of these is determined by groups of contiguous units with similar characteristics. In these cases, the problem of choosing the variations with their demographic characteristics, social welfare, economic, etc., arises. When the criterion for regionalization is physical, natural regions are found as in the case of the region we are dealing with. The polarized region known as nodal is conceived as a continuous heterogeneous area, located in a geographical space whose different parts are interdependent by their relations or complementation and their interaction around a center of gravity. This interaction is supported by socio-economic aspects that are reflected in flows between economic means. Finally, the planning region is a continuous space delimited with the purpose of applying a plan or regional development program in it. The regions subject to planning can be classified as administrative, homogeneous or polarized, or they can also be delimited taking into account the three concepts already mentioned (Boudville, 1996).

There is another type of region, one delimited by administrative and historical approaches, which includes a space subject to a political-administrative jurisdiction. It is generally the product of the historical development of a country and does not follow an economic criterion (idem). This is relevant because the subject that concerns us brings with it the importance of environmental responsibility in the handling of RP among the Federation, the states and municipalities. Unikel (1981), points to the localities under a classification that he denominates: Rural, Mixed Rural, Mixed Urban and Urban. Rural are those with less than 5,000 inhabitants, Mixed Rural are those whose number of inhabitants goes from 5,000 to 10,000, Mixed Urban go from more than 10,000 to 15,000 and Urban are all those that exceed 15,000 inhabitants. The National Institute of Statistics and Geography (Spanish acronym: INEGI), establishes a division between rural and urban, where the rural localities are those with a population of less than 2,500 inhabitants, and urban localities are those over 2,500. In order to regionalize the national territory based on rural and urban communities, the original criterion must be taken into account. If Unikel's concepts are considered, the regionalization will obviously result in a different map than that of the INEGI.

Rionda (2006) argues that a region should not be confused with a space, which is susceptible to be occupied because it represents a real dimension. Although a space represents a certain social and territorial tangibility, it is not a synonymous of region. A region must be understood as a parameter based on the needs of society in a given territory. That is, the region as a concept allows us to understand, identify, single out, and classify a certain social feature that influences the society either positively or negatively. This influence allows carrying out actions to meet the specific needs of the region.

However, the term region must be replaced by *bioregion* (Moncayo, 2008), because it speaks of a territory whose limits are geographic and ecological. It allows maintaining the integrity of the elements that are in it, supports ecological processes, such as the generation of waste, and satisfies the requirements of the territory. This is done through the inclusion of communities in the handling, use and understanding of resources. This definition provides key elements to thoroughly comprehend the region as something more than a single space or territory. These elements are intangible, because they follow the continuous and reciprocal participation that arises in the region in relation to the scope and limits of the rest of the elements. In the Cuitzeo Region, this definition would be appropriate based on the recognition of the limits and scope that the constant coordination of the elements of the region can offer for common purposes. Therefore, it is necessary to highlight the key elements of the Cuitzeo region and its main regional dynamics.

2.2. The Cuitzeo region from a theoretical connotation to its main social, economic and environmental dynamics

The concept of region allows us to identify that the analyzed region has different social features that integrate it to this regional dynamism. For instance, the concentration of the greatest number of RP generators in the entity is in the most populated region, and it is the one that groups productive, service, commercial, manufacturing, professional and educational sectors.

These characteristics influence the need to economically value the handling of RP and the way it affects the sustainable development of the analyzed region. This happens under the consideration that the region is a structured functional unit, interrelated and with higher order units. Such units allow a conformation of elements that complement one another and are reciprocally related, always having a social connotation from the determination of the social space itself (Sánchez, 1996).

With the purpose of delimiting the determined space of the region, the regionalization of Michoacán of 2004 is considered by the state government under the scheme of being constituted as an integrating mechanism of infrastructures, spaces, social and political agents, markets and public policies. Thus, the socioeconomic regions become the structuring axis of development strategies and a link to the growth dynamics of the rest of the country (SEPLADE, 2004).

2.2.1 Social dynamics of the Cuitzeo Region

The Cuitzeo region is one of the regions that has experienced the greatest growth, which is explained by the fact that the state capital has been constituted as a strong pole of population attraction. From 1960 to 2000, its population almost tripled and its participation in the state increased from 16% to 21.5% during that period. In particular, the highest growth rates in relation to the state average were observed from 1970 to 1990; and to a lesser extent, during the last decade (Regional strategy of the government of Michoacán, 2005).

During the last 40 years, it has represented the highest growth rates, especially due to migratory movements. Within it, it is clear that the metropolitan area formed by Morelia and Tarímbaro has by far the highest rates and a great impact on the entire region.

During the last two decades, there has been a general tendency in most municipalities to reduce their degree of marginalization. In fact, the region has only two municipalities: Chucándiro and Copándaro, which are characterized by their high percentage of the economically active population (Spanish acronym: PEA). Over the last two decades, these towns have not managed to reduce their high marginalization levels (PREDUR, 2009-2030).

2.2.2 Economic dynamics of the Cuitzeo Region

The distribution at the municipal level of the PEA is an ideal indicator of the dynamics of the economy in the region. It is observed that the region presents a high percentage of workers in the service sector (63%); a quarter of the PEA is engaged in manufacturing activities, while only 9% is engaged in agriculture.

The highest percentage of PEA employed in the service sector is located in Morelia. On the other hand, Cuitzeo, Indaparapeo and Charo are the municipalities that have the most workers engaged in the industrial sector, while Chucándiro, Copándaro, which are very small municipalities, concentrate the highest percentages of agricultural PEA (see table 9).

Morelia produces 16% of all the state's manufacturing production. The Morelia-Charo industrial corridor stands out, where food, oil, soft drinks and others are produced. There is located the paper mill called CRISOBA Industrial (north of Morelia) which, although economically important, in terms of watershed it uses and pollutes the equivalent of half of what the city consumes and produces. However, the region has an important area of irrigation areas, which are located right on the banks of the rivers. Likewise, some areas are noticed for perennial crops whose importance is that they are highly productive (PREDUR, 2009-2030).

2.2.3 Environmental dynamics of the Cuitzeo Region

The region has Lake Cuitzeo, which is considered the second largest in the country, with an average surface area of 420 km2. The lake represents 8% of the surface of the region. It contributes to regulate th e climate of the basin, which means the livelihood of thousands of families of fishermen, and provides irrigation to some areas, but it is severely threatened by domestic and industrial wastewater.

Without treatment, the Morelia-Salamanca highway, which crosses the lake, has increased the levels of sediment due to the deforestation of the basin and the overexploitation of groundwater in the vicinity of the lake. (www.conabio.gob.mx/institucion/conabio_espanol/doctos/lagos.html. Consulted on April 14, 1014).

River pollution, severe erosion and overexploitation of aquifers directly impact the possibilities of sustainable development of cities and primary activities (Regional strategy of the government of Michoacán, 2005).

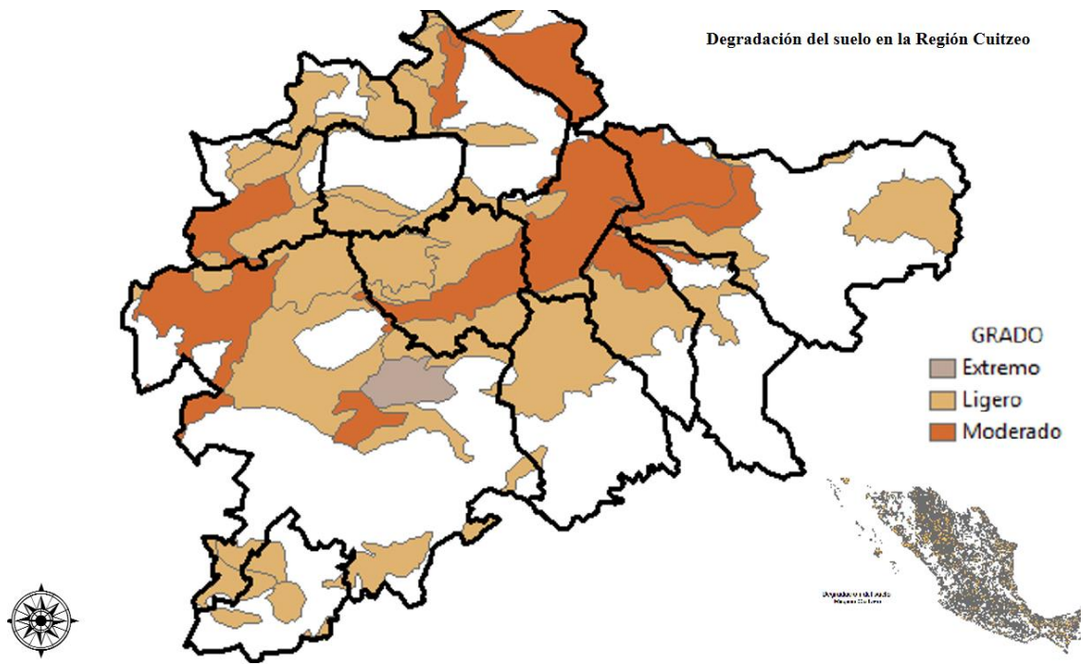
The natural heritage of this region is still important; 35% of the surface is still conserved as natural soil, and 8% is water. In addition, three-quarters of the natural soil is forests (See Figures 2, 3 and 4).

Table 9 Population occupied by sector and percentages, 2000

Municipio	P. occupied	Primary	%	Secondary	%	Tertiary	%	N/E*
Acuitzio	2,811	1,074	38	692	25	947	34	98
Álvaro Obregón	4, 614	1, 829	40	1,087	24	1,619	35	79
Copándaro	1,812	999	55	228	13	549	30	36
Cuitzeo	7,026	1,656	24	2,885	41	2,206	31	279
Charo	5,967	1,702	29	2,360	40	1,719	29	186
Chucándiro	1,381	894	65	211	15	248	18	28
Huandacareo	3,177	718	23	1,005	32	1,414	45	40
Indaparapeo	3,981	1,144	29	1,653	42	1,021	26	163
Morelia	230,201	8,041	3	53,742	23	162,010	70	6,408
Quréndaro	3,557	1,344	38	826	23	1,301	37	86
Santa Ana Maya	3,341	1,066	32	1,056	32	1,123	34	96
Tarímbaro	9,897	3,190	32	2,610	26	3,765	38	332
Zinapécuaro	12,600	3,644	29	3,595	29	5,130	41	231

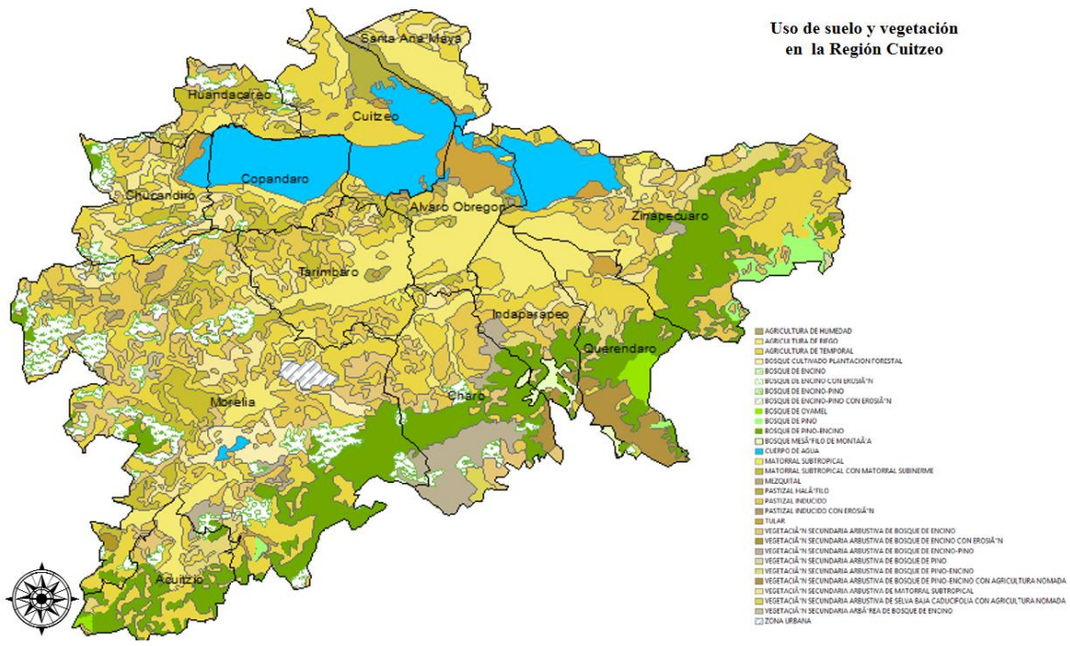
Source: XII General Population and Housing Census 2000, Michoacán, INEGI, (2016)

Figure 2 Land degradation in the Cuitzeo Region, 2015



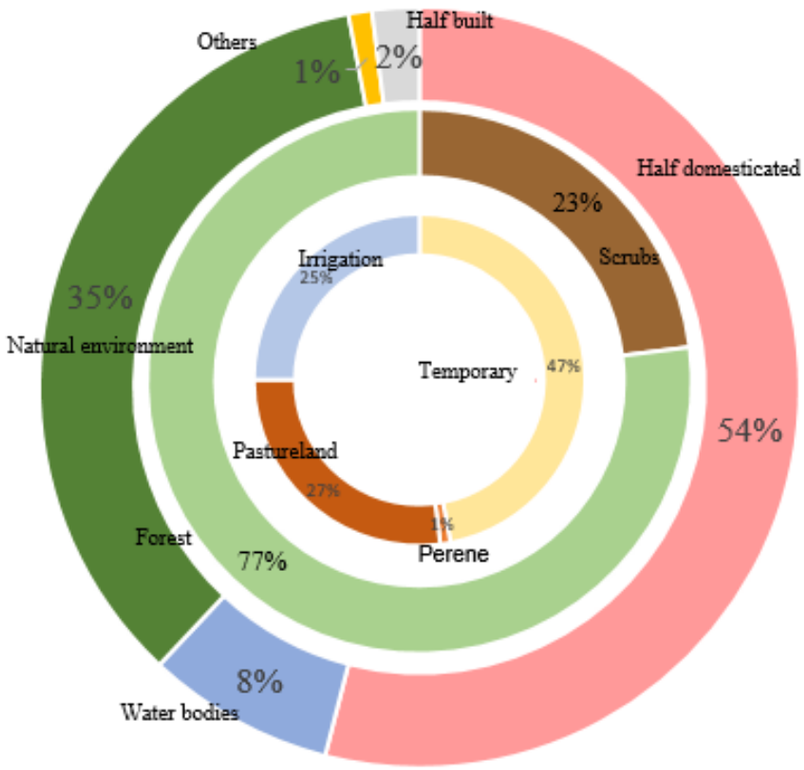
Source: Author's own design based on data from SEMARNAT, Geometrics Directorate, through CONABIO in: /www.conabio.gob.mx/informacion/gis/,(2016)

Figure 3 Use of soil and vegetation in the Cuitzeo region, 2015



Source: Author's own design based on data from INEGI through CONABIO in: www.conabio.gob.mx/informacion/gis,(2016)

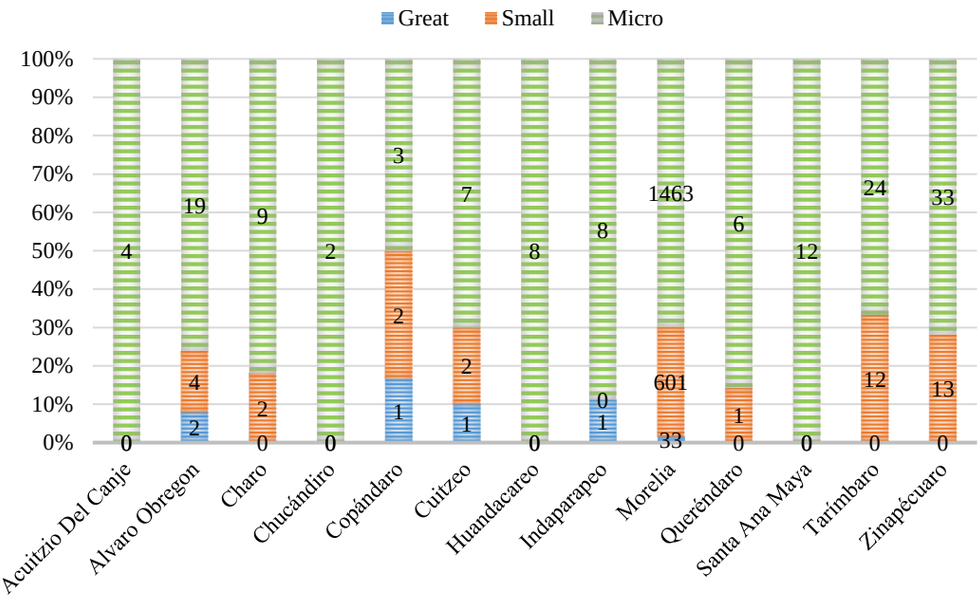
Figure 4 Land expansion, natural heritage and soil type of the Cuitzeo region, 2015



Source: Author's own design based on data from the Regional strategy of the government of Michoacán, 2005, (2016).

However, considering the population dynamics of the region, as well as the economic activities carried out, it is estimated that the generation of RP obeys the consumption and /or production requirements. Therefore, the region has the highest concentration of RP generators. In this context, the distribution of generators according to their category is more stressed in Morelia, Tarímbaro, Zinapécuaro, Álvaro Obregón, Cuitzeo and Indaparapeo, (see Graphic 3).

Graphic 3 Distribution by generator category in each municipality of the Cuitzeo region. 2015



Source: Author's own design based on data from INGRP-SEMARNAT, (2016)

Based on the above, the main affectations observed by the inadequate handling of RP is water pollution. Due to the concentration of waste thrown to the water bodies (in the case of Morelia), nearby crops are affected. When water is used for irrigation, they seriously damage crops (as in the case of Charo, Indaparapeo, Tarímbaro and Queréndaro). In addition to this, the affectation to the soils is tangible. It is due to the salinization caused by the erosion of the valley's cultivation areas, contamination of subterranean aquifers, contamination of agricultural products, etc. (Chávez, 1997 in García and Carrillo, 2006).

The problem is exacerbated because the contamination by waste does not rule out the presence of dangerous components. Therefore, its proper handling is necessary, especially because of the agricultural influence existing in the region. This is supplied with sewage water from the Rio Grande de Morelia, the most important in the area, which develops other sanitary problems.

This fact, which initially constituted a dynamic and innovative factor in agricultural development, nowadays fosters a harmful situation in the region. In addition, a factor to be considered is the fertility of the soils of Vertisol type (soils of mild and warm climates, especially in zones with a marked dry season and another rainy one, characterized by their massive structure and their high content of clay) and Andasol type (soils of volcanic origin, consisting mainly of ash with a high content of aluminum silicate, which gives lightness and unctuousness to the soil and are located in the regions of Mil Cumbres). This highlights the need to address the problem. (SARH, 1987: 57-62 en García y Carrillo, 2006).

Some studies suggest that high concentrations of boron, cadmium, bicarbonates, fats, oils, sodium and fecal coliform were detected in the black waters of the Morelia-Querendaro District. These are highly toxic components for crops (wheat, corn, sorghum, alfalfa, oats, chili, tomato and carrot) and vegetables. Calcium, magnesium, manganese, iron, copper and aluminum have been found in the tissues of plants, which represents negative implications for the health of the population (Martínez, 1991, Restrepo et al., 1991).

The above reflects that 88% of large generators, 95% of small and 91% of micro generators are concentrated in Morelia. It is pertinent to describe the economic, social, political, cultural, legal and environmental characteristics of each one of the municipalities that make up the studied region in order to be more precise about the RP generation conditions and to determine if its handling is environmentally appropriate according to the INGRP-SEMARNAT (2016). Tables 10 and 11 show the physical and geographical characteristics of the Cuitzeo region. Tables 12, 13, 14 and 15 show the characteristics of the economic and public finances, the population, household conformation, society, government, environment and RP generation.

Table 10 Physical-geographical characterization of the Cuitzeo Region, 2015

Municipality	Acuitzio	Álvaro Obregón	Charo	Chucandiro	Copándaro	Cuitzeo	Huandacareo	Indaparapeo	Morelia	Quréndaro	Santa Ana Maya	Tarímbaro	Zinapécuaro
Terminology	"land of snakes",	in memory of General Álvaro Obregón	"Land of the Child King".	"groves",	"cupanda" which means avocado and "rhu" meaning place.	"place of jars"	"Place of preaching"	"place of games";	It comes from General Morelos	"land of crags"	"fertile land"	"land of willows"	"Place of healing"
Area	176.29 km²	159.44 km²	323.15 kms²	191.87 kms²	173.27 km²	255.17 km²	95.65 Km²	176.85 Km²	1196.95 km²	233.82 Km²	103.64 Km²	256.94 km²	597.40 Km²
Orography	Acuitzio, Cerro Viejo, La Huizata and El Melón ranges	La Purísima, Quirio and Tzentzénguaro knolls; Policarpo, Las Reservas, La Tuna, La Peña and El Grande de los Remedios hills.	Mil Cumbres range and Las Encinilla, Borregas, Potrerillo, Ipallos hills	Hills: La Leona, Las Ventas, Guaguatua, Las Dos Cejas, El Varal, Los Zapotes and El Sauz	Hills: Largo, Caracol, Churcha, Tierras Azules and Cerro Prieto.	Manuna and Melon hills.	Hills: Manuma, Campanas, Coronilla, Encina and Amoles	Hills: El Águila, los Tinguaraque and Del Aire	Punhuato, San Andrés, Cuto and Uruétaro hills and El Zapote, Santa María de los Altos knolls.	Otzumatlan or Mil Cumbres range; Blanco, Peña Rajada and Calvario hills; Querendaro valley.	Cuitzeo basin	Tecolote, De Oro, Tlacuache and La Calle hills	San Andres range; Pedrillo, Comalera, Cruz, Clavelina, Piojo, Monterrey, Mozo, Doncellas, Cuesta del Conejo and San Andrés hills.

Source: Author's own design based on data from the municipal records of Acuitzio, Álvaro Obregón, Charo, Chucándiro, Copándaro, Cuitzeo, Huandácareo, Indaparapeo, Morelia, Queréndaro, Santa Ana Maya, Tarímbaro y Zinapécuaro. Planning Coordination for Development, Government of Michoacan, 2014, Population of the Municipalities of Mexico 1950-1990, National Population Council (Spanish acronym: CONAPO), XII General Population and Housing Census 2000, Michoacan, INEGI and XIII General Census of Population and Housing 2010, Michoacan, INEGI. United Nations Development Programme (UNDP). UNDP and RP generator estimates from SEMARNAT (2015)

Table 11 Physical-geographical characterization of the Cuitzeo Region, 2015

Municipality	Acuitzio	Álvaro Obregón	Charo	Chucandiro	Copándaro	Cuitzeo	Huandacareo	Indaparapeo	Morelia	Querendaro	Santa Ana Maya	Tarímbaro	Zinapécuaro
HYDROGRAPHY	water springs: Ojo de Agua Chiquito, Ojo de Agua Grande, La Palmita and La Alameda	river: Rio Grande in Morelia and part of Cuitzeo Lake	streams that flow into Rio Grande in Morelia and Purungueo river.	Chucandiro River, Arenas and Presa de Undameo streams, and several springs of cold and thermal water.	Cuitzeo Lake, Ocuares and Del Padre dams, and several springs of thermal water such as San Agustin del Maíz.	Cuitzeo Lake; rainy season streams: La Barranquilla Grande and El Tren; several springs of thermal water such as San Agustín del Maíz.	El Colorado and Blanco streams; part of Lake Cuitzeo and San Cristobal dam.	San Lucas Pío, Los Naranjos and Cañada del Moral seasonal streams; Jagüey Grande and Jagüey Chico water deposits; several springs of thermal water such as Agua Caliente.	Lerma-Santiago, Río Grande, Río Chiquito rivers; De La Zarza and La Pitaya streams. Cointzio, Umécuaro, Laja Caliente and La Mintzita dams. Several springs of thermal water that are used as bathing facilities, such as Cointzio, El Ejido, El Edén and Las Garzas.	Queréndaro and Otzumatlán rivers; Cuitzeo Lake; El Peral, Pocitos and Las Pilas streams. Besides, Morelia - Queréndaro irrigation district	Cuitzeo Lake	San Marcos river, several streams, several springs of cold water, several dams and part of Cuitzeo Lake	Zinapécuaro, Las Lajas, Ojo de Agua de Bucio and Bocaneo rivers; several springs of cold and thermal water
CLIMATE	mild	Mild	mild	mild with rains	mild with rains	mild with rains	mild with rains	mild with rains	Mild with average humidity	mild with rains	mild with rains	mild with rains	mild with rains

Source: Author's own design based on data from the municipal records of Acuitzio, Álvaro Obregón, Charo, Chucándiro, Copándaro, Cuitzeo, Huandácareo, Indaparapeo, Morelia, Queréndaro, Santa Ana Maya, Tarímbaro y Zinapécuaro. Planning Coordination for Development, Government of Michoacan, 2014, Population of the Municipalities of Mexico 1950-1990, National Population Council (Spanish acronym: CONAPO), XII General Population and Housing Census 2000, Michoacan, INEGI and XIII General Census of Population and Housing 2010, Michoacan, INEGI. United Nations Development Programme (UNDP). UNDP and RP generator estimates from SEMARNAT (2015).

Table 12 Economic and public finance characterization of the Cuitzeo Region, 2015

Municipio	Acuitzio	Álvaro Obregón	Copandaro	Charo	Cuitzeo	Chucándiro	Huandacareo	Indaparapeo	Morelia	Querendaro	Santa Ana Maya	Tarimbaro	Zinapecuaro
Economy													
Primary activities													
Total sown area (hectares), 2011	3659	11413	1496	5572	2381	1222	1847	7843	17559	6659	4105	9238	12921
Total harvested are (hectares), 2011	3124	11257	1335	5560	2373	743	1622	7818	16818	6443	4100	9111	11463
Secondary activities													
volume of sales of electric power (Megawatts/hour), 2011	5407	14346	6035	13554	20663	2849	9404	8411	938686	6758	13818	67525	27179
Worth of sales of electric power (Thousands of Pesos), 2011	7488	19123	6474	17208	27346	3891	13209	10778	1489186	10003	16751	92044	41529
Public investment in electrification works, 2009	183	0	0	0	0	27	0	75	9629	0	418	32	36
Electric power users, 2011	3448	7010	3168	6240	9863	2536	5477	5111	285300	4928	5492	32817	18455
Tertiary activities													
Flea markets, food markets, general groceries 2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Automobiles sold to the public, 2010	0	0	0	0	0	0	0	0	6550	0	0	0	0
Trucks sold to the public, 2010	0	0	0	0	0	0	0	0	4527	0	0	0	0
Airports, 2010	0	1	0	0	0	0	0	0	0	0	0	0	0
Post offices, 2010	2	6	2	10	10	4	4	1	77	4	3	2	18
Registered automobiles, 2014	3148	8717	871	3069	3117	599	2133	2490	332381	6389	1969	8832	23302
Registered motor vehicles in 2014	7406	18814	2415	5736	7116	1792	3858	5760	487477	13911	4017	14893	48041
Pick-up and cargo trucks, 2014	4211	10032	1522	2621	3935	1182	1681	3241	151192	7475	2036	5978	24619
Buses, 2014	47	65	22	46	64	11	44	29	3904	47	12	83	120
Branches of commercial banking, 2010	0	0	0	0	1	0	2	0	102	0	1	0	3
Branches of investment banking, 2010	0	1	0	0	0	0	0	1	3	0	1	0	0
Registered lodging rooms, 2010	0	37	0	0	0	0	75	0	4513	20	0	0	229
Lodging facilities, 2010	0	2	0	0	0	0	4	0	124	1	0	0	11
Tourists Hosted, 2010	0	N/A	0	0	0	0	N/A	0	816071	N/A	0	0	N/A
Public investment exercised, 2010	8655	26812	10891	120466	39185	16099	17249	14661	1985806	8472	11417	45460	27606
Public investment applied on economic development, 2010	2047	14621	5132	6208	26288	9472	4666	3515	196546	5357	3674	21815	4752
Public investment applied on urbanization and environment (Thousands of Pesos), 2010	0	0	0	98857	0	0	0	0	76389	0	0	0	0
Public finances													
Gross revenue of the municipalities, 2013	38341	50492	29645	53971	66448	22288	37614	44437	1881910	51090	44885	154972	136885
Gross expenditures of the municipalities, 2013	38341	50492	29645	53971	66448	22288	37614	44437	1881910	51090	44885	154972	136885

Source: Author's own design based on data from INEGI (2015)

Table 13 Population, families and household conformation in the Cuitzeo region, 2015

Municipio	Acuitzio	Álvaro Obregón	Copandaro	Charo	Cuitzeo	Chucandiro	Huandacareo	Indaparapeo	Morelia	Querendaro	Santa Ana Maya	Tarímbaro	Zinapecuaro
Population													
Total population, 2014	11,423.00	21,963.00	9,390.00	22,764.00	29,259.00	5,050.00	11,922.00	17,132.00	762,431.00	14,069.00	13,013.00	94,579.0	48,016.00
Population (men), 2014	5,475.00	10,549.00	4,440.00	11,949.00	13,750.00	2,292.00	5,566.00	8,295.00	363,379.00	6,829.00	5,955.00	45,564.0	22,969.00
Population (women), 2014	5,948.00	11,414.00	4,951.00	10,815.00	15,509.00	2,758.00	6,356.00	8,837.00	399,052.00	7,240.00	7,057.00	49,015.0	25,047.00
Birth and fertility													
Births, 2013	294.00	469.00	207.00	496.00	681.00	92.00	217.00	441.00	15,057.00	263.00	272.00	1,814.00	1,014.00
Mortality													
Overall deaths, 2013	70.00	115.00	57.00	113.00	162.00	45.00	89.00	83.00	3,701.00	83.00	82.00	326.00	295.00
Homes													
Homes, 2010	2,678.00	4,971.00	2,198.00	4,635.00	6,674.00	1,458.00	3,182.00	3,791.00	184,601.00	3,278.00	3,126.00	19,291.0	11,608.00
Average size	4.10	4.18	4.07	4.20	4.22	3.54	3.63	4.33	3.84	4.13	4.03	3.77	4.01
Housing and urbanization													
Inhabited homes, 2010	2,680.00	5,018.00	2,198.00	4,648.00	6,690.00	1,458.00	3,196.00	3,799.00	190,434.00	3,279.00	3,129.00	21,209.0	11,613.00
Average number of home occupants, 2010	4.10	4.18	4.07	4.20	4.22	3.54	3.63	4.33	3.84	4.13	4.03	3.77	4.01
Floored homes, 2010	1,891.00	4,674.00	2,001.00	4,050.00	5,955.00	1,376.00	3,006.00	3,093.00	175,737.00	2,898.00	2,772.00	18,420.0	10,649.00
Homes that have water from the public pipelines	2,375.00	4,883.00	2,009.00	4,196.00	6,138.00	1,283.00	3,148.00	3,515.00	173,404.00	2,995.00	3,018.00	18,786.0	10,660.00
Homes with drainage, 2010	2,244.00	4,551.00	2,070.00	4,328.00	6,198.00	1,159.00	3,130.00	3,520.00	178,221.00	2,947.00	2,834.00	18,543.0	10,738.00
Homes with electric power, 2010	2,563.00	4,910.00	2,178.00	4,521.00	6,544.00	1,447.00	3,158.00	3,706.00	183,340.00	3,209.00	3,067.00	19,130.0	11,391.00
Homes with a refrigerator, 2010	1,904.00	4,127.00	1,803.00	3,884.00	5,230.00	1,215.00	2,820.00	2,833.00	168,838.00	2,644.00	2,521.00	16,994.0	9,658.00
Homes with a television, 2010	2,386.00	4,750.00	2,098.00	4,239.00	6,298.00	1,373.00	3,012.00	3,546.00	179,221.00	3,042.00	2,952.00	18,663.0	10,991.00
Homes with a washing machine, 2010	1,496.00	3,042.00	1,116.00	2,767.00	3,149.00	742.00	2,077.00	1,917.00	140,109.00	2,195.00	1,910.00	12,835.0	7,838.00
Homes with a computer, 2010	245.00	451.00	159.00	453.00	601.00	71.00	493.00	274.00	76,866.00	354.00	333.00	4,852.00	1,341.00
Capacity of water treatment plants, 2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,380.00	0.00	0.00	0.00	0.00
Annual vol. of drinking water (Millions of m^3), 2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.00	0.00	0.00	0.00	0.00
Installed electrical power outlets, 2011	3,448.00	7,010.00	3,168.00	6,240.00	9,863.00	2,536.00	5,477.00	5,111.00	285,300.00	4,928.00	5,492.00	32,817.0	18,455.00

Source: Author's own design based on data from INEGI (2015)

Table 14 Society and government in the Cuitzeo region, 2015

Municipality	Acuitzio	Álvaro Obregón	Copandaro	Charo	Cuitzeo	Chucandiro	Huandacareo	Indaparapeo	Morelia	Querendaro	Santa Ana Maya	Tarímbaro	Zinapecuaro
Education													
Population with elementary education	5140	9370	4194	9771	13544	2731	5237	7997	197505	6299	5527	25396	20552
Population with secondary education	9599	18099	7821	18992	24766	4682	10367	14295	637427	11904	11269	62842	41247
Population with higher education	340	418	157	522	956	74	557	303	119424	402	315	6133	1636
Population with a postgraduate degree	18	22	9	19	43	2	34	23	12256	32	11	459	69
Alphabetization rate	98.20	97.67	98.76	97.25	97.77	98.18	98.84	97.00	99.13	98.25	98.55	98.43	98.099
Health													
Entitled population, 2010	6647	9610	6062	12665	13143	3657	6251	7103	442856	6686	6423	46048	22591
IMSS-entitled population	724	1954	369	2623	2723	197	1222	1197	268944	1363	555	24711	4845
ISSSTE-entitled population	271	602	482	548	1040	76	472	333	70551	647	280	4632	1728
Non-entitled population	4325	11124	2879	8683	14982	1482	5269	9269	267281	6833	6168	26581	23908
Families holding *popular* social security, 2010	2429	3994	2106	2986	4296	1406	2243	2674	69302	2406	2463	8383	6879
Right holders of public institutions	536	1319	296	596	2238	10	1742	502	718699	1344	160	9266	6042
Medical units, 2011	4	11	4	9	11	5	8	5	46	5	7	13	15
Employment and labor relations													
Workers affiliated to the IMSS, 2011	80	270	13	172	460	3	257	57	158649	46	46	2452	774
Workers affiliated to the ISSSTE	115	163	147	143	394	27	129	107	34129	197	146	1091	543
Human and social development													
Families that benefit from the Oportunidades Human Development Program, 2010	1209	1875	910	1796	2584	710	668	1550	18834	1160	1099	3407	4257
Public investment applied on social development (Thousands of Pesos), 2010	6607	12190	5759	15401	12897	6627	12583	11146	1712871	3115	7743	23646	22854

Source: Author's own design based on data from INEGI (2015)

Table 15 Environment and waste in the Cuitzeo region, 2015

Municipality	Acuitzio	Álvaro Obregón	Charo	Chucandiro	Copandaro	Cuitzeo	Huandacareo	Indaparapeo	Morelia	Querendaro	Santa Ana Maya	Tarímbaro	Zinapecuaro
Storage capacity of the dams (Km^3), 2011	0	0	1	0	1	1	0	0	88	24	5	1	7
Annual volume of water used for dams (Km^3), 2011	0	0	1	0	1	1	0	0	60	24	5	1	7
Planted trees, 2011	0	0	0	48400	0	0	0	0	55000	0	0	0	16500
Reforested area (Hectares), 2011	0	0	0	44	0	0	0	0	44	0	0	0	147
Pasture area (Km^2), 2005	3.72	8.2	9.92	51.78	15.75	27.69	19.81	16.51	169.63	1.14	3.26	42.19	78.94
Area of other types of vegetation (Km^2)	0	23.6	0	0	12.79	0	0	0	0	6.83	0.24	0	7.35
Agricultural area (Km^2), 2005	82	96.27	28.05	66.83	68.93	62.08	25.93	78.03	393.05	61.95	69.89	152.9	191.82
Forest area (Km^2), 2005	63.96	0	0.69	75.64	6.14	19.84	8.87	45.6	293.98	116.89	0	0	167.21
Rain forest area (Km^2), 2005	0	0	0	8.43	0	0	0	0	0	0	0	0	0
Xerophilous scrub area (Km^2), 2005	0	0	0	0	0	0	0	0	0	0	0	0	0
Secondary vegetation area (Km^2)	25.72	18.17	25.69	118.28	14.33	67.29	37.79	35.53	261.71	44.63	20.79	59.4	79.85
Area without vegetation (Km^2)	0	2.88	0	0	0	0	0	0	0	0	0	0	0
Urban area (Km^2), 2010	6.245	3.609	1.84	3.402	5.554	1.343	4.2656	6.0277	117.844	4.9046	3.68	7.6289	13.832
Micro generators	4	19	9	2	3	7	8	8	1463	6	12	24	33
Estimated generation by micro generators (tons)	0.3669	1.743	0.825	0.1834	0.275	0.642	0.7339	0.7339	134.21	0.550	1.1008	2.201	3.0127
Small generators	0	4	2	0	2	2	0	0	601	1	0	12	13
Estimated generation by small generators (tons)	0	9.772	4.886	0	4.886	4.886	0	0	1468.24	2.443	0	29.31	31.75
Large generators	0	2	0	0	1	1	0	1	33	0	0	0	0
Estimated generation by large generators (tons)	0	166.26	0	0	83.13	83.13	0	83.13	2743.44	0	0	0	0

Source: Author's own design based on data from INEGI (2015); SEMARNAT-INGRP, (2016)

The socioeconomic and environmental characteristics of the region under study are useful to contextualize the conditions in which this region is found, and whose influence is decisive in the handling of RP. It is essential to highlight the importance of spatiality, which merits analysis under the magnifying glass of the new economic geography. Then, the approach of the problem must be centered in the environmental economy. This has contributed with different methods of economic valuation that seek to stress the value of natural elements over price allocation.

Among said methods, the MVC provides the necessary elements to economically value the handling of the RP in the region under study. This allows for the assessment of the DAP or the DAA, considering the existence of a hypothetical market that supposes environmental improvements (Múnera and Correa, 2009).

Therefore, it is necessary to consider that the region, rather than a space or territory, must be viewed from environmental, social, economic and institutional approaches to define its dependence and spatial heterogeneity (Esqueda, 2015). The Cuitzeo region gathers these elements that tend to identify, single out, and classify certain particular processes following this dynamic, such as the handling of RP. In this sense, it is convenient to analyze the spatiality of the region in consideration of the theoretical contributions of the region and how it can be linked to its overall development.

2.3. Spatial territory of the Cuitzeo region from the generation of hazardous waste

The economic, social, environmental and institutional dynamics that unfold in the Cuitzeo region are the result of the inner fusion mechanisms that are continuously developed. Méndez and Yuzhou (2007), in Esqueda (2015), sustain that the relationships within the region are not the cause and effect of its space and economy. They go further considering factors that make the space where such relationships occur unique. The conformed space then influences the decisions and existence of other agents. In terms of RP, this is feasible since there is a clear focus on the development of RP concentration in the municipalities with the largest population. Such is the case of Morelia, where its own peculiarities promote the installation of new RP generators that seek to offer a service or product. Oslender (2002) indicates that a space is a complex network of power and knowledge relationships expressed in physical landscapes of domination and resistance. Considering the problem under study, it is clear that RP generators represent domination, and the society and the environment would represent the resistance.

Due to these circumstances, the spatial effects of dependence, heterogeneity and spatial self-correlation must be addressed. Dependence, says Esqueda (2015), is the existence of a functional relationship between what happens at a point in space and what happens in the rest of the space, thus enabling the origin of the diversity of spatial interaction phenomena. Spatial heterogeneity, says Anselin (1988) in Esqueda (2015), is an unstable behavior in space that can create spatial patterns of development in the form of spatial regimes. Self-correlation is the process of sharing data to induce the singularity of the space. It is the awareness of sharing values according to local similarities (Gallo 2003, in Esqueda, 2015).

These effects of spatiality are reflected in the particularities of the region analyzed; it is dependent, heterogeneous and correlational. It is dependent because the dynamics that develop in it affect the groups that comprise it. For instance, considering the generation and handling of RP, it can be seen that there is a functional relationship in the behavior of the concentration of generators in the municipalities with the highest population; then, there is a dependency between internal actors.

It is heterogeneous because despite being dependent, there is a diversity of groups or generators that determine their RP according to the industry they belong to. Lastly, it is self-correlated because when information on regional dynamics is shared, conditions of agglomeration or concentration are fostered. This is the case of RP generators who obey the economic and social dynamics to establish themselves as providers of services or products.

These arguments allow to view the spatiality of the Cuitzeo region as as transcendental. In addition to the concentration of the generators and the greater generation of RP, it presents other geographical and social characteristics that differentiate it from the rest of the regions. Such is the case of the concentration of tertiary and primary activities, education, employment, housing, medical attention, etc.

Therefore, the region is seen from an integrating and unique viewpoint, with its own characteristics and with delimited scopes in consideration of social, environmental, economic and institutional dynamics. Such characteristics should not be generalized to any other type of region. Therefore, it is important to consider the region as a parametric concept that depends on quantitative and qualitative factors and that meets the particular needs of a society.

Among those needs, fostering conditions for improvement in RP handling stands out. RP represent risks, dangers and damages for the entire environment, of which society is an essential part. Therefore, the handling of RP must be visualized starting from the conditions of the region -in this case, the Cuitzeo region-, to later assess the problem and finally provide an alternative solution.

One of the ways to address the problem, is by means of the economic valuation methods provided by the Environmental Economy, such as the MVC. This method seeks to assess the DAP or the DAA. All this will be essential to determine the parameters of sustainability on which the analyzed region is conducted. It will then be necessary to address the principles of environmental economics, the new economic geography, the conceptions of development and the regulations on RP. The latter offers the control schemes for the generation and handling of waste, under the principles of assessment and minimization.

For this, it is convenient to reference the sites where the RP generators are located in the Cuitzeo region, highlighting the importance of geo-referencing and its benefits when applied to scientific research.

2.4. The importance of geo-referencing of hazardous waste generators in the Cuitzeo Region

The purpose of geo-referencing is to be a tool that provides a location map of strategic sectors that are investigated, as in the case of RP generators. Knowing their location makes it possible to determine, investigate, explore and discern all the social, economic, environmental, political and cultural, contexts that surround them and that can affect, either positively or negatively, the behavior of the sectors analyzed. Hein (2005) indicates that geo-referencing as an analytical tool allows describing the behavior of variables in a specific space and in a specific social context. This facilitates the orientation of all scientific research.

The main contributions of the geo-referencing of RP generators in the Cuitzeo region allow to confirm that most of the generators are concentrated in the Municipality of Morelia as well as in Álvaro Obregón, Tarímbaro and Zinapecuaro (See Figure 5).

Another outstanding contribution is that the large RP generators are concentrated in the Municipality of Morelia, mainly in the Industrial City zone. The small generators are located in the peripheral area of the City of Morelia, and the micro generators are located in the lower-class neighborhoods of Morelia.

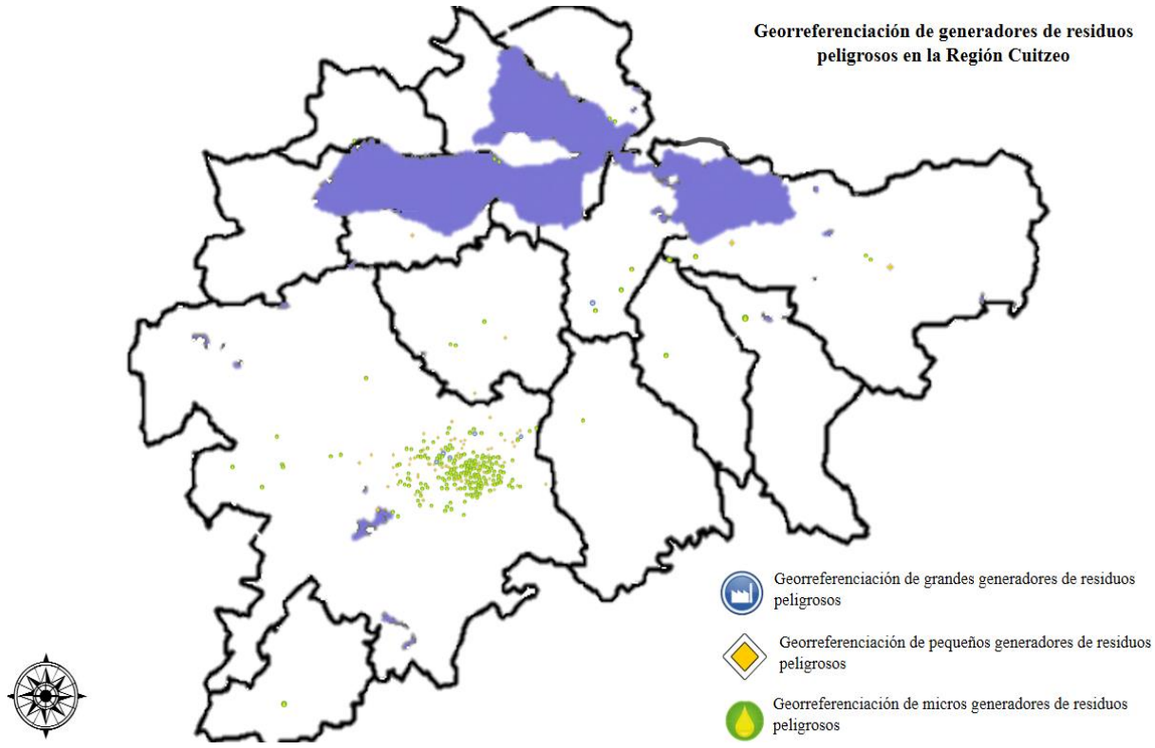
It is important to note that RP generators are concentrated in areas far from bodies of water. There are few, mainly micro generators, which are located close to a body of water. In addition, they are located in soil already affected by the urban sprawl, and few of them are concentrated in soil with moderate and light degradation.

The purpose of geo-referencing RP generators in the Cuitzeo region was to open future lines of research that allow analyzing the problem under different edges and based on a specific location. As it has been widely argued, the fact of considering a specific region goes beyond knowing its social, economic, political and environmental dynamics in a given time and space.

The purpose is to provide proposals and alternative solutions based on a given problem to approach the long-awaited sustainable regional development that offers the parameters of quality of life and social welfare.

This reflects the importance of considering the space with all its environmental, social, economic, political and cultural dynamics. One way to visualize space under this perspective is through the new economic geography.

Figure 5 Geo-referencing of the location of the generators to whom the survey was applied, 2015



Source: Author's own design based on data from SEMARNAT and the application of the survey, (2016)

2.5. The new economic geography and the management of hazardous waste as a study focus of the Cuitzeo Region

Moncayo (2008) states that the foundation of the new economic geography are the already analyzed proposals of Von Thunen, Cristaller, Losh, Marshall, Isard and Myrdal and Kaldor although it was originally proposed by Paul Krugman (1999). The latter considered contributions from the central place, the hierarchical organization of the urban centers, the economy of the agglomeration, the regional science and the cumulative circular causation to postulate a theory that would focus on spatial concentration. (Moncayo, 2008).

This new perspective indicates that development constitutes a circular effect. Thus, there are centripetal forces that foster conglomerations sustained in contamination within a certain space and time (Moncayo, 2008).

In terms of RP, this proposal responds to spatial and temporal adjustments that originate from the handling of RP. Whether correct or incorrect, the concentration of social activities in a space (attracted by centripetal forces based on social, economic, institutional or environmental conditions) fosters conglomeration in such spaces.

This creates externalities that will cause the action of centrifugal forces which will release such fostered conditions and collaborate to solve the problem of congestion and pollution.

This new economic geography seeks to explain the formation of a great variety of forms of conglomeration or concentration in geographical spaces. It highlights the importance of spatial awareness.

If this is considered for the generation and handling of RP, it can be said, as Daly (1993) considers, that the emission rate of the waste must be equal to the natural assimilation capacities. That is, the generation of waste must not exceed the load capacity of the spaces (Moncayo, 2008). This is fairly idealistic.

However, social habits diminish the load capacities of the environments because market dynamics encourage consumerism. Therefore, Brown and Flavin (1999), in Moncayo (2008), point out that an ethical pattern based on the principles of satisfaction and respect is very much needed.

The foregoing allows focusing the concern on the endogenous characteristics and on the way they promote sustainable development. Therefore, the concept of region should be substituted by the bioregion. For Moncayo (2008) the former is a territory geographically limited by the human communities and ecological systems, sufficiently broad to maintain the integrity of the communities, sustain ecological processes, satisfy the requirements of the territory and involve the communities in the handling, use and understanding of the biological elements. In other words, a bioregion is a space that brings together different social, economic, environmental and institutional dynamics to attain the coordination, participation and understanding of its own scope and limits.

This definition of bioregion was observed by Boisier (2001: 113) as an eco-region, arguing that *"...it is not the region itself that is sustainable, but the way it is intervened.*" Regarding this argument, it is clear that what Boisier refers to is the set of interactions that unfold in the region. When they are guided by a moral and ethical sense and their scope and limits are known, conditions for sustainable development can surely be fostered.

But in order to promote sustainable development conditions, it is necessary to determine what these conditions are originated from. This allows for an analysis of the environment based on value and not price attributes. Here, the interaction and load capacities that can reduce the quality of life and affect social welfare are essential. All this eventually will turn into sustainable development. Consequently, the next chapter aims to contextualize the management of RP in the parameters of the Environmental Economy (Spanish acronym: EA) viewed as a science that seeks to highlight the the value of the environment above market, commonly price-driven, standards.

Chapter III The economic assessment of hazardous waste handling in the Cuitzeo Region

3.1 The problem of waste generation, from the perspective of environmental economics

The economic assessment is one of the central issues of environmental economics (EE) due to the importance assessing the environment. Therefore, it is pertinent to start with the basic elements of the EE and to know how it is inserted in the economic thought to boost the value of the environment. This highlights the need to properly handle waste since it can constitute a market failure.

These contributions allow us to contextualize the problem from those theoretical thoughts observing that the generation of waste constitutes a possible environmental imbalance. Waste is associated with population dynamics, and its handling should be incorporated into the rest of the dynamics, such as economic, institutional and social.

EE is the name of the interpretation of a school of the neoclassical economic thought, which has incorporated the environment as an object of study. For this reason, the EE addresses the same basic assumptions of the analysis of scarcity and the value of goods according to their existence that neoclassical theory recognizes.

The incorporation of the environment into the market begins with the internalization of externalities through the setting of a price that categorizes it as a property, which is addressed by EE through the economic valuation of the environment (Yu Chang, 2005).

In the 18th century, evidence of the recognition of nature over and for man is recovered, as indicated by Vivien (2000). The formulators of natural history Linnaeus and Humboldt in 1758, as well as the physiocrats (first school of economic thought of the 18th century, which rejected the idea of mercantilism for the accumulation of money because they considered that the only source of wealth was nature), recognized that, although man dominates over the natural order, belongs to it. This vision positions the human being as part of the chain of living beings subjected as all to the laws of nature.

Due to the technological changes reflected in the production and productivity of the 19th century, the discussion of environmental issues did not gain priority, it was until the 1960s-1970s, when environmental problems were visible as oil spill pollution that it required attention to the problem (Yu Chang, 2005).

This problem of the relationship between human activity of production and consumption and environmental rationality is addressed by EE, which is situated between macroeconomics and microeconomics under the fact of studying the behavior of a whole when analyzing a particular behavior. Therefore, it seeks to focus on understanding the reason for whatever social behaviors that may cause environmental impacts. In addition, in order to achieve an environmental balance, it studies economic policies and institutions to harmonize human needs with ecosystem requirements (Field, 1995).

Normally, the EE addresses the problem of externalities and the intergenerational assignment of responsibilities for environmental care, for which authors such as Pigou (1962, 1974), Coase (1960), Mishan (1967) and Slow (1974) delve into analysis.

Coase stands out for being the one who initiated the controversy by pointing out that the conclusions derived from Pigou's treatment lead economists to three possible options whose results do not seem desirable. These three options are: a) that the company that contaminates responds for the damages caused, b) that the company pays a tax based on the damages caused, and c) that the factory is separated from residential districts (Aguilera and Alcántara, 1994).

Aguilera and Alcántara (1994) argue that the three options are far from the proposals of Pigou (1962) who, when referring to the correction of externalities, suggested the intervention of the State as a restrictive agent or promoter of investments when the externalities are addressed, or stop being addressed. The expression "Pogouvian taxes” comes from the above. However, little has been studied and referenced Pigou's proposal to reach solutions based on "voluntary agreements" (Pigou, 1974: 168-169).

Coase stands out for its Social Cost Theorem, where it recognizes the need for regulation by the State under a coercive scheme. He argues that the distribution of property rights does not influence the final product obtained and that this will be always the same, that is, that the economic optimum is unique with the condition that the transaction costs are zero (Coase, 1960).

Mishan (1967), on the other hand, shows that even in the situation of null transaction costs, each distribution of property rights corresponds to an optimum. In other words, different legal frameworks (laws that prohibit pollution or laws that allow it) influence economic activities differently. In other words, with different right distributions, people will show that the DAP differs from the DAA (the compensatory variation is not equal to the equivalent variation) since there are income effects. There will be as many optima as institutional frameworks. This premise is associated with research because it is precisely in the institutional dynamics (legislation in terms of RP) that obligations and duties arise to properly handle RP. This prevents certain technical and operational obligations that every generator must comply with otherwise, their decision will be reflected in their economic activities.

Another problem addressed by EE is the intergenerational responsibility of natural resources and services since it is necessary to insert them into legal systems to safeguard the interests of future generations. That is to deal with environmental problems in a certain time and space in order to guarantee the same conditions for later generations. These and other aspects are mainly addressed by Brown (1989) and Hotelling (1931). However, it is convenient to adhere to the principles of environmental responsibility in the handling of RP that are stated in the present investigation and which guarantee the exception of the approaches of sustainability

Hotelling (1931) considered the price of the natural resource in its exhaustible sense, questioning its profitability to be extracted or to be conserved. On the other hand, he considered that the discounted present value of scarcity income should be the same in each period, otherwise there would be incentives to move the extraction from one period to another. Alier (2000) states that the intergenerational allocation of exhaustible resources provides an argument against the methodological individualism of economic theory. This is because many of the relevant economic agents have not yet been born and can not therefore express their preferences. This context supports the foundations of assessing in one way or another the natural resources and the negative effects that can be fostered in them by anthropocentric activity, such as the generation of RP.

3.2 The importance of economically assessing externalities

One of the central themes of environmental economics is the problem of assessment (Aguilera and Alcántara, 1994). This has constituted a new model of economy based on value and not on price. In this model, the environment becomes a process that implies recognizing that the economy is a social science based on human behavior and requires the interpretation and reinterpretation of such behavior in each historical moment. Hence, assessment involves more than just a technical-bureaucratic process of allocation of costs and prices. It becomes a process of recognition of human behavior that, in this case, integrates nature and culture as productive forces (Leff 1993).

Neoclassical economics has reduced the field of economics to the universe of appropriate and valued objects that are considered to be productive. This reveals a paradigm problem for those goods that have use value but that are not recognized within a given market. Such is the case of environmental goods or the handling of RP, which are not tangible market-wise but are essential not to put the environment and society at risk.

Hence the supposed need to establish direct and indirect monetary valuation criteria for these goods, outside the real market. However, what is originally presented as a simple problem of design and choice of appropriate assessment techniques, allowing objective decisions to be made within the framework of economic management, becomes a matter not exempt from subjective approaches of considerable magnitude (Fischer, 1970).

The debate on the assessment of the environment is presented in two areas: the cost-benefit analysis (CBA) and the process of reviewing the national accounts, which includes the valuation of natural capital correlated with GDP and / or the Gross National Product (GNP) as indicators of social welfare.

The CBA method, closely linked from its birth to the analysis of investment projects, has been used frequently, especially in the USA, in the study of certain actions on the environment. In fact, although environmental costs and benefits are not the only ones that present an inclusion problem (due to the difficulty of translation into monetary terms when dealing with elements external to the market) in the analysis of projects, the CBA method requires translation into monetary terms of the aforementioned benefits and costs using economic valuation techniques that empirically present biases of consideration (Eberle and Hayden, 1991).

However, the CBA constitutes the conceptual basis of a method that has served as a guide to environmental policies despite several objections such as those raised by Pearce (1975). He states that the generation of waste and its inadequate handling sooner or later will exceed the environmental capacity of the site where they are deposited which will lead to stop all economic activity and ultimately life. However, this does not limit the application of the method as such to know and assess the externalities, being that the main limitation for Pearce is the validity but not its validation (Aguilera, 1992).

In this sense, assuming that value constitutes a variable dimension, not determined objectively but depending on social interests, cultural perceptions, historical moments, levels of knowledge among other factors (Buenaño, 2013), what is important to assess in terms of of RP is the social behavior. In other words, it is the way in which the generator adopts, adapts and complies with the provisions of law to minimize the RP that it generates and therefore the risks, dangers or damages that can cause on the environment and society.

In addition, the perception of damage from the society surrounding those generators can minimize the risk or damage with their social participation. An adequate handling of the RP can be reached through the institutional intervention of the authorities in charge of the monitoring and compliance. However, to understand the scope of value, it is necessary to address the elements of economic assessment of the environment.

Under the guidelines that govern the process of globalization of the economy, sustainable development constitutes an ideological utopia of ecologists and environmentalists under the scheme of radical change of global economic models.

This requires the inclusion of environmental goods and services in the world market in the search for the sustainability of the stock of natural resources (Marchín and Casas, 2006). In this sense, all relevant environmental issues, such as water pollution, waste handling, air pollution in urban areas, deforestation and biodiversity loss, should be included in the economic valuation of the environment (Tolmos, 2002).

To value the environment economically implies the attempt to assign quantitative values to the goods and services provided by environmental resources, independently of the existence of market prices for them. The assessment indicates that the environment is not free, the challenge is to acknowledge that it has value. Valuation translates the environmental impact into values that can be compared and integrated with economic and financial criteria (cost-benefit) to make sound decisions, leaving less space for subjective judgments.

The assignment of economic values to possible environmental impacts (also known as externalities) generated on the natural and social environment is based on an anthropocentric approach. In other words, it is based on market preferences and trends, therefore, it is a dynamic science (Almansa, 2001).

For Azqueta (1996), economic valuation means having an indicator of the importance of the environment in social welfare. This indicator should allow to compare it with other components of it. According to Pearce and Turner (1993), the essence of the economic valuation of the environment is to find the DAP for obtaining the environmental benefits or for avoiding the measured environmental costs where the market reveals this information.

In terms of RP, what is sought to assess is the handling of RP according to the socioeconomic conditions of the generator, the types and volumes of RP generation and compliance with the technical and operational regulatory obligations that guarantee an environmentally sound handling of the RP. This is done through the DAP for an adequate management of the RP generated.

The recent development of methods of economic valuation, in the framework of the new discipline called EE, allows the monetarization of environmental benefits (or costs) and its inclusion in the analytical context of the CBA, which is usually given then the name of Generalized CBA. None of the tools generated by the EE is exempt from methodological difficulties, not to mention the ethical criticisms they receive from other alternative approaches (Almansa, 2001). Without underestimating these problems, its use may be of interest for certain objectives, such as the case study analyzed here.

The understanding that the environment has value per se, which means that it does not need someone to grant it. Nature, life, earth have value by themselves by the mere fact of existing. It can be believed that things have value as long as they have for man. It is the human being who gives value to nature, natural resources and the environment in general (Azqueta, 1996).

The environment has value because it fulfills a series of functions that affect the welfare of the people: the users. People are positively affected by enjoying a healthy environment; if the environment were altered, they would be adversely affected. Increasingly, there are cases in which environmentally friendly or harmful activity originates in a particular social group (a region, for example) while the negative consequences are suffered by others (Azqueta, 1996).

In recent decades, environmental assessment methodologies have been frequently applied, especially in those aspects that were previously considered intangible and that can currently be measured. So, it is convenient to know what needs to be measured in order to apply the corresponding methodology: whether goods, services or environmental impacts (Machín and Casas, 2006).

Tangible goods are used by the human being as inputs in the production or in the final consumption and are worn and transformed in the process. The feature of services is that they are not worn nor transformed in the process, but they indirectly generate profit to the consumer. Their environmental impacts, also known as externalities, are the result or the effect of one person's economic activity on the welfare of another. In the present research, this line is addressed because RP are considered as externalities (Machín and Casas, 2006).

The difference of these resources lies in the benefits they provide. This benefit is used as an element of value and, according to Boyle and Bishop (1987), different types of value can be distinguished. First: those whose use implies consumption, such as fishing or hunting. Second: those whose use does not imply consumption, such as the satisfaction obtained when observing a sunset on the shores of a lake. Third: those that provide services through indirect use.

Another perspective is to distinguish use values and non-use values. The use value is the most elementary of all. For example, a person visits a natural park to contemplate the fauna and flora, to walk or to do sport; as a user, any alteration in its quality affects his/her level of well-being. In relation to non-use values traditionally identified in the economic literature, two of them stand out: option value and existence value. Regarding the first, Weisbrod (1964) argued that an individual who was not sure about a possible visit to a natural park could be willing to pay a certain sum of money for a right of option to visit in the future. For this individual, the disappearance of said natural park supposes an evident loss of well-being while the conservation of it increases it.

Krutilla (1967) defined the option value as the willingness to pay for the opportunity to choose between alternative and competitive uses of an environmental good. The option value is derived from the individual uncertainty that the person experiences with respect to whether said good will be available in the future or not.

The basic idea is that, given this uncertainty of supply and given the fact that most people do not like risk or uncertainty, individuals would be willing to pay more than the expected consumer surplus (Spanish acronym: ECE) to ensure that they can make use of the environmental good later on.

The total DAP is called Option Price, and it includes the expected consumer surplus plus the option value. The latter is the additional payment made to ensure the future availability of the environmental good (Pearce and Turner, 1993).

On the other hand, the value of existence is a value that is granted to an environmental good and that is not related to any use, neither current nor future, of the good. In fact, there is a group of people who are affected in their well-being with respect to what happens to a certain environmental good even when they are not users of it. They simply value their mere existence positively. At first glance, this may seem a very strange category for an economic value, since value would surely derive from its use (Machín and Casas, 2006).

The inclusion of externalities or values for which there is no established market into a broader framework that is compatible with traditional market values has been a constant in the EE. The commonly accepted framework is the Theory of Total Economic Value developed by Pearce (1993) and Pearce and Turner (1990). This theory has the benefit of adapting the economy to the quantification of natural and environmental resources.

The theory of externalities has been widely studied since Coase (1960). Its quantification, based generally on experimental results obtained by statistical methods, was applied to the environment first outside of Spain (Constanza 1991, Hartwick 1977, Tietemberg 1988, Daly 1989, Johansson 1990, Hausman 1993, Pearce and Turner 1990, Pearce 1993, Cummings and Harrison 1995, to mention some relevant examples among many others cited in Martínez, 2004). In the 1990s, numerous applications were developed from Naredo (1993). Noteworthy are the works of Azqueta (1996) and those of Riera (1994).

To economically value the handling of RP (considered as externalities), it will be necessary to start from the DAP, and then build a hypothetical market with the MVC through individual responses to hypothetical circumstances raised in an artificially structured market (Eberle and Hayden, 1991). The survey replaces the non-existent market associated to the good in question. It tries to simulate a hypothetical market in which the respondent manifests his DAP for obtaining a benefit, for avoiding environmental damage, or his willingness to receive the corresponding compensation for losing the benefit or withstanding the damage.

In terms of RP, the hypothetical market will be shaped by the proper handling of RP through actions of recovery and minimization of waste. They will be promoted by the generator (in compliance with the law on waste) and its DAP to achieve environmentally adequate handling, avoiding harm to society and the environment as well as fines and economic sanctions. Thus, it will shape the offer: the need to achieve the proper handling of RP through the offer of a service (administrative and operational management) and the demand: the fact of complying with the legal provisions on RP. In addition, studies suggest that the hypothetical market for RP may be presented to the society that is located near the RP generators.

The satisfaction of needs represents a level of well-being. When such needs are met through access to a specific commodity, the DAP of the person to enjoy it can be an adequate indicator of the increase in well-being experienced by consumption. In this case, these goods and services have an instrumental use value for their holders, and they are duly screened taking into account the deviations caused by public intervention and market imperfections. Their market prices constitute a good starting point to assess changes in well-being a consumer behavior. All this is true in the absence of external effects: externalities (Delacámara, 2008).

Externalities cause distortions in the use of resources because society does not pay the price of the good in question. In this way, the problem lies in estimating the price that should prevail in the face of the malfunctioning of the market price mechanism. In most transactions, the price is the same for those who provide a good and for those who consume it, but this symmetry cannot be maintained if externalities appear.

Delacámara (2008) argues that recognizing an externality should be based on the link between the environmental impact in question and the decline in the well-being of a person or a group. For this, the perception of damage or impairment must be given either directly or indirectly. It is given indirectly by damaging some natural element such as the soil that has the capacity to assimilate RP and that in the short term will not cause adverse effects. In this case, its scope is underestimated and therefore the damage is not perceived. The direct affectation lies in the damage that immediately affects the society such as poisonings, burns, wounds, etc.

As for the RP, this relationship with externalities can cause direct and indirect effects that would reduce social welfare. In terms of health, chronic diseases such as cancer, pulmonary insufficiencies or malformations can be shown in the long run. In terms of damage to natural components like the soil, long-term effects such as infiltration of toxic substances, contamination by leachate, loss of natural components of the soil, erosion and others can be caused. (INE, 2009).

A determining factor for the existence of externalities is free trade, which has led to worldwide destruction in an asymmetric manner. The international economy is controlled by companies in the Northern Hemisphere, which increasingly exploit the resources of the Third World for their international activities. The South is the one that carries a disproportionately large share of the environmental burden of the globalized economy (Giddens and Hutton, 2001).

It is therefore not surprising that members of the World Bank (WB) such as Lawrence, who was responsible for the 1992 World Development Report, were dedicated to the economics of the environment. In 1991, he suggested transferring highly polluting industries to Third World countries in the sense that they had low wages that made possible lower economic costs for repairing damages.

He also considered that since the poor are poor, they cannot worry about environmental problems (http://databank.bancomundial.org/data/reports.aspx?source=Indicadores, consulted in July 2015; IMF, 1991).

The theoretical perspectives with the support of international organizations such as ECLAC and GTZ (Gesellschaft Für Technische Zusammenarbeit, in English: Association of German Technical Cooperation. They have considered that the cost of handling RP is defined as that which allows acquiring, operating and maintaining the profitability conditions of a company (GTZ, 1998). However, none of these two views of the terminology of costs specify their scope and limitations in the environmental, economic and social spheres. It is only assumed that costs depend on a damage or activity and that at a certain time they have to be covered, favoring the corrective and not the preventive fact. From an environmental perspective, the cost will be understood as that which is linked to the current or potential deterioration of natural assets due to economic activities. They can be seen from the perspective of two different concepts: a) costs incurred and b) costs borne (Sánchez, 2011).

The existence of externalities implies, in fact, a rupture of that social equilibrium: someone wins at the cost of someone being affected. A negative externality (or external cost) occurs when an individual's action results in welfare losses not compensated for another. This loss of well-being has two essential characteristics. First, it is a unilateral effect because who suffers it could not decide whether or not to suffer it, nor the kind of loss of well-being the person is willing to assume. Second, it is a loss of well-being without any kind of compensation. If the loss were compensated, the externality would not exist from an economic point of view. The economic externality will have disappeared even if the environmental externality does not. Negative externalities are associated with the provision of goods (electric and thermal energy, transport services, drinking water supply and sanitation services, among others). The society will be choosing from a combination of goods (the possibility of moving by private car to work, for example) and evils (the congestion derived from the fact that others decided the same thing) in exchange for a constant adaptation to the damages that this represents (Pearce, et al., 1996).

From an economic perspective, a cost implies monetary outlays that arise due to the way in which RP are handled even complying with the norms of underutilization of raw materials. Example of such monetary expenditures in the management of RP are the sanitation of contaminated sites, the regulation of waste generating industries and the assurance of medical treatment to address the adverse effects produced by environmental exposure. Non-monetary costs include the depletion of non-renewable resources, the consumptive use of land and the degradation of ecosystems (CCA, 2004).

Pollution as the deterioration of environmental quality is in itself a market failure result that restricts optimal allocation of resources. An example of market failures that give rise to pollution is the existence of incomplete markets. They promote externalities such as RP whose handling is usually considered a public problem. When it comes to RP, the problem is aggravated depending on the possible damages, risks or dangers that it implies and that must be considered in each of its phases. This is added to the fact that the market does not pressure RP generators to pay the costs of producing and disposing of them (Ibarrarán et al., 2003).

The generation of RP is a problem that seeks to overcome the NIMBY (not in my back yard) syndrome (Ortiz et al., 1987), which is present in all human activity. In 2004, industrial facilities in North America generated more than five million tons of toxic chemicals as waste and contaminants related to production. In the period 1998-2004, total releases of carcinogens and substances that alter development or reproduction declined 26% in Canada and the US, compared to a 15% reduction in total chemical substances recorded. Industrial waste and pollution represent potential threats to human health and the environment if they are not handled correctly. The concerns range from the toxic effects on fetuses and children to the health implications of low-level exposures to multiple pollutants and the degradation of habitats and ecosystems. These concerns do not stop at the borders. Some pollutants can be transported long distances, and the waste is shipped for recycling and for on-site disposal across political borders (CEC.ORG, 2010).

In this context, international agreements have been implemented to promote the proper handling of RP in order to reduce the risk or proximity of damage and possible material or moral damage or impairment. Such agreements represent both the society and the environment. RP are usually associated with danger. At the same time, they have the capacity to produce damage according to the CRETIB characteristics. The risk depends on the degree of damage they could cause by exposure or dispersion (Jiménez, 1996).

The main international agreements that stand out in this matter are the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989). This agreement was created with the purpose of reducing RP traffic from one country to another (particularly from industrialized countries to developing countries) as well as to ensure their environmentally adequate final disposal. The Stockholm Convention on Persistent Organic Pollutants (2001) has the purpose of protecting human health and other organisms from biota through the reduction and possible elimination of production, utilization, importation and exportation of POP products (such as chlorinated pesticides and polychlorinated biphenyls).

The Rotterdam Convention (1980) creates legally binding obligations for the application of the Prior Informed Consent procedure and systems for the exchange of information on dangerous or severely restricted chemical products and pesticides. The Strategic Approach for the Management of Chemical Substances at the International Level (2006) seeks to link the actions developed within the framework of the multiple international agreements that pertain to the management of substances and RP. It creates synergies and ensures effectiveness in the achievement of the goal agreed at the World Summit on Sustainable Development in Johannesburg in 2002.

Said goal is to ensure that by 2020 the substances are produced and used in ways that significantly reduce the adverse effects on the environment and health (SEMARNAT, 2005).

The Kyoto Protocol (1998), meanwhile, aims to reduce by 5.2% greenhouse gas emissions in the world. The North American Agreement on Environmental Cooperation (1994), signed by Mexico, Canada and the United States, has the purpose of facilitating regional cooperation in this matter and promoting social participation in the determination and evaluation of public policies for the sustainable development of the three countries, especially the handling of cross-border RP.

The Northern Border Program (1986) is committed to design programs that promote both the sustainable development at the border between Mexican cities and their "sister cities" in the United States and the history of bilateral cooperation in environmental matters. Annex III on cooperation on waste was incorporated to it in 1986. The Border Program (2012) incorporates actions related to the management of RP. It allows the exchange of information, knowledge and experiences not only between the states on both sides of the US-Mexico border, but also within the states of the rest of Mexico. The Rio Conference on Environment and Development (Agenda 21) refers to the environmentally sound management of hazardous waste and solid waste respectively. It also establishes that waste handling must contemplate the minimization of its own generation as well as its recycling, collection, treatment and final disposal; it must be done as close to its source of origin as possible based on common but differentiated responsibility. The Johannesburg Summit on Sustainable Development (2002) includes the development of actions on sustainable consumption and production that involve urban planning and waste management among others (SEMARNAT, 2005).

Despite the international legal framework for controlling the generation and management of RP, there are still behaviors that put economic needs before the risks and dangers involved in improperly handling RP. In turn, this situation implies environmental and economic costs with social repercussions (Antúnez, 2011).

Given this irrational fact of the XXI century, the concern remains in the handling of RP. Despite the actions taken internationally, the risk, danger and damage of these components prevail and propitiate externalities that may cause adverse effects to the natural resources and services such as soil contamination. Also, some effects on health can be observed, such as various types of cancer, chronic intoxication, neurological problems, vascular disorders and anemia. This is caused by the incorrect handling of arsenic, an element commonly used in agriculture, the paint and paper industry, pesticide manufacturing, metallurgic and the pharmaceutical industry. Some other cases are eye irritation, asthma, pulmonary edema, burns, anemia, chronic poisoning, coma and death. These are caused by the poor handling of hydrocarbons as a component of gasoline, solvents, textiles, liquids for dry cleaning, inks, latex, pharmaceuticals, explosives, fungicides, chemicals just to cite some examples (Anglés, 2009).

Payment for management services, administration, collection, transportation, storage and final disposal of RP is added to this. It is reflected in the final costs of a particular product or service to society, which also absorbs this economic cost for the handling of RP and is affected by environmental changes (CANACINTRA, 2011).

Thus, the concept of the externality with social welfare is observed when the RP are handled improperly (outside the parameters provided by the LGPGIR) and cause a perception of loss of well-being, as some environmental damage or imbalances are caused.

3.3 Waste handling and its importance in social welfare

It has been said that social welfare can be affected by negative externalities. However, social welfare can be positively affected if an optimum in the handling of RP is achieved in accordance with the legal considerations provided by the LGPGIR, both in technical and operational matters.

Trapero (2009: 302) sustains that social welfare is *"the set of factors that participate in the quality of life of people and that make their existence possess the elements that promote peace and human satisfaction."* This concept of life quality includes the quality of the environment, the quality of action and the subjective enjoyment of life (Veenhoven, 1998, in Trapero, 2009). Thus, life quality is based on the satisfaction of basic needs and includes objective and subjective aspects that go beyond economic approaches.

Welfare has been analyzed from the classical postulates. Marshall said that welfare is *"the satisfaction that the producers and consumers of an economy obtain with the exchange of goods and services"* (Quoted in Bautista, 2011). However, this quote only addresses the economic side of it. Another approach is that of Pigou. He proposed the intervention of the State through taxes and subsidies in favor of the environment, thus correcting market failures caused by externalities. Pigou's welfare economy considered not only the correction of externalities but also the State’s actions providing security and opportunities to achieve equality in education, health and housing (Bautista, 2011).

Also, the Coase Theory motivated the exchange between private agents to solve the cost of externalities in market decisions. Daly's proposals considered consumption process costs as indicators of progress and well-being.

It is said that three aspects influence social well-being: the economy, profits and social indicators (Trapero, 2009). Each approach, with its multiple criticisms, provides elements that take up the subjective scope of welfare. For instance, economic growth is said to be the main social goal while economic achievement is the main individual goal.

However, given a certain extent of development, higher economic levels will no longer represent the same satisfaction, so other types of values are retaken such as the quality of the environment. Certainly, not all elements of well-being can be measured in terms of money nor generalized.

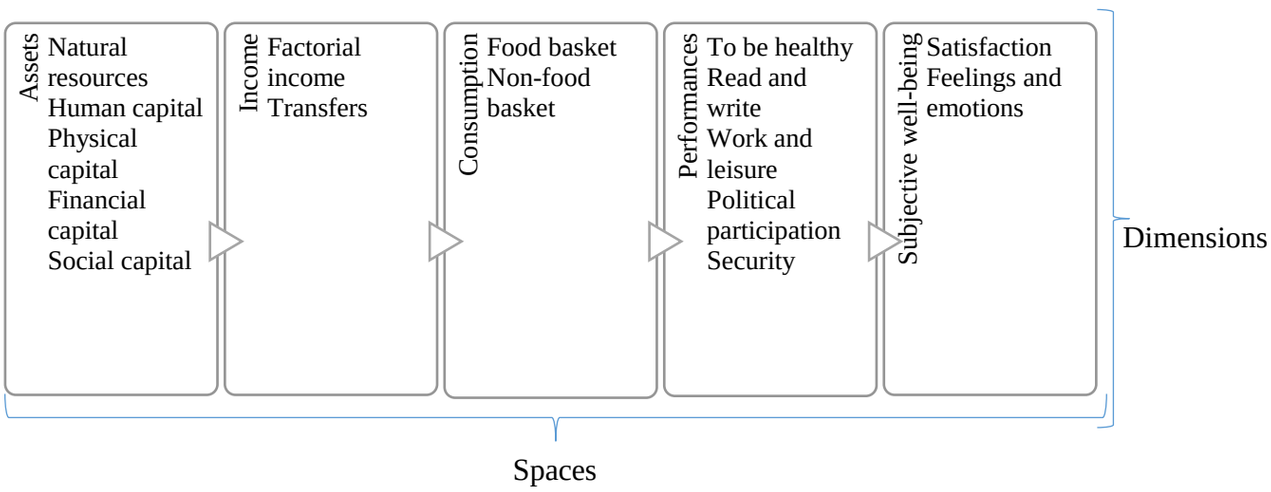
The role of profits in social welfare has limitations as well. It is not possible to generalize the results given to society. It may provide a measure from the individual point of view, where profit parameters can be obtained according to the satisfaction gained from consuming or using an element. However, such profit is still a function of the perception of an individual recipient and not of the rest of the social group (Abarca and Díaz, 2005). There are proposals that measure social welfare based on individual profit such as Bergson (1938), Arrow (1950), Samuelson (1947) among others.

On the other hand, it has been proposed to measure social welfare through social indicators, based on the dominant ideas from the 1970s that rethink the limits of growth. Such ideas mainly came from the Rome Club in 1972 (non-governmental organization concerned with improving the future in an interdisciplinary and holistic way) and the Manifesto of Survival (1972). In response to this, some proposals of social indicators arose, most importantly the ideas of Groos (1976), Bauer (1967), Bell (1969), OECD (1971), UN (1975).

According to Trapero (2009), they first argued that health, work, leisure, financial and personal security are social indicators that constitute a statistic of direct normative interest that facilitates the understanding and balance of conditions and different features of a social sector. In other words, social welfare must be made up of a multidimensionality of aspects that describe the living conditions of people, and in this, time and space must be considered.

As indicated by De la Torre (2009: 26), social welfare is *"the set of states and actions open to people. Each achievable transformation for individuals is a facet of well-being"*. This indicates that the multidimensionality of well-being refers to fundamental needs in consideration of spaces and multiple dimensions. Thus, the spaces will focus on assets, income, consumption, functioning and subjective well-being while the dimensions will focus on the groups that make up each space (see figure 6).

Figure 6 Multidimensionality of social welfare, 2009



Source: Author's own design based on De la Torre, 2009, (2016)

Added to this, life quality must be considered in relation to the capacities and conditions of people as well as their social interactions.

In this order of ideas, social well-being can be altered by inadequate handling of RP. It affects the space and dimension of the environment (active), health (functioning) and the subjective well-being of those who generate the RP as well as those directly or indirectly affected. Therefore, it is important to recognize the impact on the environment and the importance of providing solutions.

One way to achieve this is to correctly establish information gathering processes so that there are parameters to establish future actions based on reliable information. As Bautista (2011: 17) says: *"The actions carried out in the present affect negatively and decisively the possibilities of progress and well-being of the generations to come"*. This is important because it is not possible to consider the needs of future generations if the present needs, conditions and means to promote the current social welfare are not taken into account.

3.4 Main methods of economic valuation in the field of hazardous waste

It is known that the inadequate handling of RP, considered as externalities, can cause chronic diseases such as cancer, pulmonary insufficiencies, malformations, chronic intoxication, neurological problems, vascular disorders, anemia, eye irritation, asthma, pulmonary edema, burns and even death. Example of the above is the exposure to RP containing arsenic. This is an element usually used in agriculture, the paint and paper industry, pesticides, metallurgy, among others, or by contact with hydrocarbons, solvents, inks or other products that derive in RP (Anglés, 2009).

In terms of damage to natural components like the soil, water, landscapes, protected areas, flora, fauna long-term effects such as infiltration of toxic substances, contamination by leachate, loss of natural components of the soil, erosion and others can be caused. (INE, 2009; Cristeche and Penna, 2007).

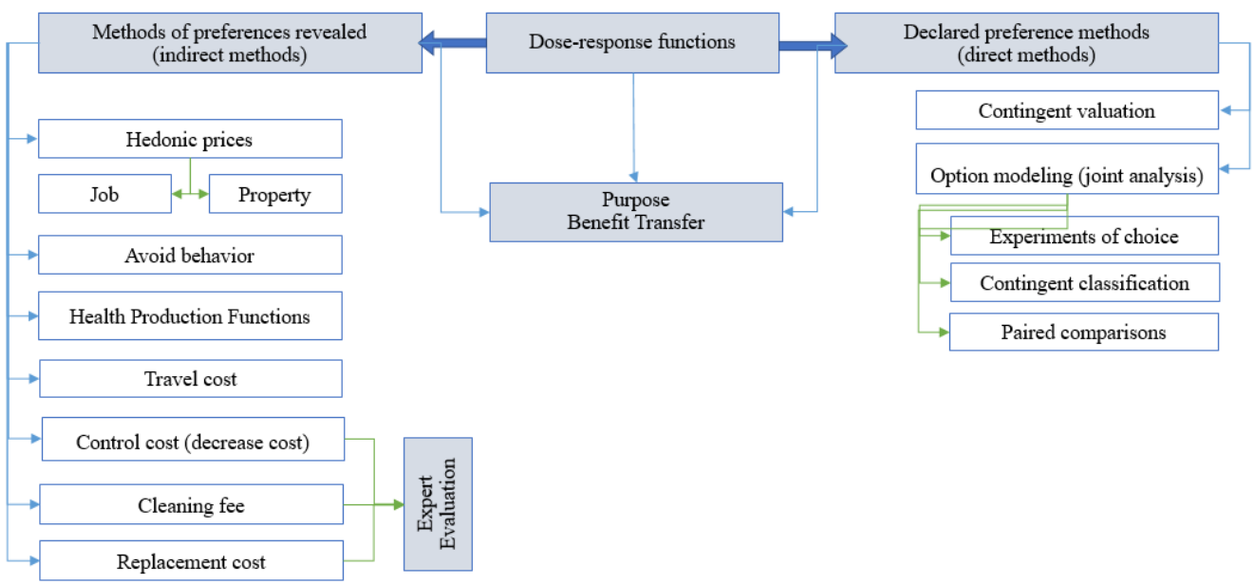
This represents monetary and non-monetary expenditures such as fines, sanitation of contaminated sites, regulation of generating industries, assurance of medical treatment to address the adverse effects produced by environmental exposure, and the like. Non-monetary costs include the depletion of non-renewable resources, the consumptive use of land and the degradation of ecosystems that in turn cause social damage in the short, medium and long term (CCA, 2004, Campa et al, 2013).

The scientific literature shows contributions that look for VE externalities. Some authors that stand out are: Hanemann, 1994; Carson and Mitchell, 1989; Carson et al., 1993; among others. They have argued that the most commonly used methodology is the MVC. It tends to discover values based on the explicit recognition of a prior right over the environmental asset under valuation.

It seeks to discover the DAP or the compensation required by a person due to the variation in the conditions of an environmental asset. To achieve this, it is suggested to carry out surveys, which will allow knowing the value by asking directly about the monetary amount that a respondent would be willing to receive or disburse in a hypothetical situation (Hanley et al., 1998).

Regarding waste, it has been observed that previous studies suggest its handling based on VE methods such as MVC, MPH, MCB, DCM, RCM, among others (see figure 7). These methods have been supported by econometric models both descriptive and inferential. Some of them are: correlations, comparisons, simple regressions, logistic regressions such as LOGIT, TOBIT, PROBIT and Ordinary Least Squares (OLS).

Figure 7 Methods and techniques of economic valuation



Source: Eshet y Shechter, 2006

To know the main variables used in the analysis of the problem of waste handling, a total of thirty VEMR studies carried out from 2000 to 2014 have been reviewed. It was observed that 13% of the studies made a comparative review to determine suitability and reliability of VE methods on waste; 57% of them addressed the issue of VE in the management, generation and handling of RSU; 7% considered the problem of RME and 23% analyzed the viability of VE in the handling of RP. There are more recent studies that can be consulted to strengthen the arguments of the present article, such as the case of Cho and Heo (2015), Ferreira and Marques (2015), Gaglias *et al.* (2015), and Kaliampakos (2016). They reflect on the limited literature of VEMR, the limited research in this area and highlight the feasibility of applying these methods to waste handling. They tend to analyze the RSU and not the RP from a social approach. However, the approach that is intended to underline focuses on the RP generator.

13% of the studies reviewed sought to know the suitability and reliability of the VE methods in the matter of waste. For this, they made a comparative review of 34 studies elaborated between 1990 and 2005 in Europe and the USA. These studies addressed problems of externalities in landfills, in incinerators and general soil and air pollution. They examined different scenarios such as urban, rural areas with or without energy recovery, and others. Their main observations were that the MCB are mostly employed because they seek to know the incidence in social welfare. For this, they suggested social impact, income, demographic considerations and mitigation policies to be key variables (Tzipi, *et al*., 2006).

On the other hand, Múnera and Correa applied the MVC on waste in 2009. They sustain that the valuation context and a clear definition of property rights on the object of valuation should be taken into account in the design of the survey. They see this as essential to know the social perspective of what proper waste handling should be, Guiliano and Raga (2014) conducted a study on the use of the MVC in the evaluation of a landfill mining project of RSU. The study evaluated the monetary benefits perceived by the community from the restoration of a site considered as landfill of RSU that converted it into a recreational park. Its main results were that the population near the landfill proposed a DAP to build the park. The result was obtained through a correlation between the following variables: distance from the landfill, age, income, sex and educational level.

Within 57% of the reviewed studies that address the problem of the VE of the RSU, it is observed that about 82% use the MVC to know the environmental and social impact of the RSU. For example, Afroz and Masud conducted a study to suggest improvements in the handling of RSU, applying the MVC in Kuala Lumpur, Malaysia in 2011. Their study was based on knowing the DAP of households to improve the collection system of RSU in Kuala, by determining how the DAP of households change when recycling and separation of RSU are made mandatory. Their method was to directly survey people, and the results obtained showed that people are not DAP when recycling and separation are mandatory. This showed that people are unaware of the benefits that this would represent for them. Reason why, they suggest encouraging environmental awareness.

On the other hand, Ibarrarán et al. (2003) proposed a model that explains VE through the DAP on additional amounts for a public good: environmental quality. The main variables used were income, wealth, schooling, number of children, credibility in the government, personal environmental ethics, among others. They found out that the logarithm of income positively influences the DAP and is significant at a confidence level of 95%. This result shows that the income is decisive when making the decision of DAP. On the other hand, age turned out to be a significant variable at a confidence level of 95%, showing an inverse relationship with respect to DAP. Trust in the government negatively influenced the WTP with a confidence level of 95%. It was observed that when the government subsidizes a project, people usually expect the government to carry it out, so the DAP is lower.

Likewise, Agüero et al. (2005), conducted a study of the MVC in Argentina through the application of 779 surveys aimed at evaluating the management system of the RSU in 13 neighborhoods. 38% of users said they did not know the difference between RSU and RP. 13% of the citizens rated the quality of the sweeping and cleaning as excellent. The collection and transportation at homes was rated as very good by 37% of the interviewees. 98% of the users did not know the characteristics of the RSU treatment and final disposal. A surplus of the individual consumer of $5.31 per month was obtained from the application of the MVC and through a LOGIT adjustment. 34.02% of the interviewees expressed the need to incorporate improvements to the service, of which only 27.9% answered affirmatively to be DAP.

The use of the MVC in the evaluation of the MSW management systems was discussed as a tool for its evaluation and integral improvement.

Gándara (2007) presented an application of the MVC with the purpose of estimating in monetary terms the value of the environmental impacts and damages to health associated with the incineration and the dumping of RSU in the Metropolitan Area of Barcelona. The proposed valuation scenario consisted of a technological renovation associated with less deterioration of the environment with a lower risk of damage to health. The value of externalities for the incineration of waste was estimated between 108 and 126 million euros; the value of externalities for the dumping of waste was between 83 and 94 million euros. Variables such as age, gender, income, social welfare, risk, diseases associated with inadequate MSW management and environmental impact were highlighted.

Ajata (2008) conducted a study of the MVC to analyze the socio-economic factors of the DAP for urban cleaning service among the residents of Huanuni, Bolivia. The LOGIT statistician was applied, and the main observations were that the population is DAP according to their income: no more than 4.5 Bolivians. The most important variables were environmental education, lack of monitoring of public policies on waste and little investment in environmental protection.

Cerda et al. (2010), used the MVC in Chile through a double dichotomous format. They assumed a linear function and a logistic distribution to determine the WTP for an improvement in air quality via the creation of a certification body for dry lumber. The DAP obtained would be enough to cover the costs of the certifying body, opening the possibility of applying a municipal charge for that concept. In addition, the people who would use the lumber were DAP less than those who would not use it. The core variables included the government function, socioeconomic conditions, climate, population and environmental goods.

Alcalá et al. (2012), sought to implement a recycling system with support from the VE applying the MVC and choosing the population Texcoco, Mexico as a case study. A simple random sampling was applied obtaining a total sample of 402 households to survey. The results showed that more than 90% of the households were aware of the garbage problem, 70% know little about recycling and almost 100% agree that it is necessary to implement a recycling system. The DAP per household was estimated applying the MVC and through a binomial LOGIT adjustment. The estimated amount of the DAP was $ 27.18 pesos per week, with total benefits of $ 1, 295,915.00 pesos per week. The observed variables were the socioeconomic conditions (income, education, housing, health services, employment, etc.), the obligatory nature of norms, the governmental function, fines or sanctions, municipal services, the knowledge in the separation of RSU and its composition.

Saidón (2012) analyzed which factors significantly affected VE in the handling of RSU in the district of Quilmes, Argentina. Two econometric models were used based on the PROBIT and ordered PROBIT methods. The MVC used showed that the level of formal education and trust in the government have a significant impact on the population's DAP. In the same way, gender differences were noticed in terms of the magnitude of the effort that the population of Quilmes would be willing to make. The main variables used were socioeconomic.

Geipel and Sauad (2014) affirmed that the RSU are generated as a result of consumer activities, generation of services and industrial activities that, due to their characteristics, generate waste similar to household waste. Their inadequate management impacts the environment and directly or indirectly affects the society. Therefore, they can be classified as negative externalities. The study was conducted with information from the municipality of El Bordo (Province of Salta, Argentina) where there was no RSU treatment. Their final disposal was in open dumps, river banks and ditches. This was a source of air, water and soil contamination that involved a risk to the health of the population. The MVC was applied through a comparative analysis of current and expected waste management. The VE of the current system was estimated at $294,780 pesos, which reveals the global surplus of the urban hygiene service. The additional benefit that the users of the municipality would obtain with the implementation of a new management service would be $176,868 pesos per year. The overall economic profit obtained was $471,648 pesos with the implementation of an adequate management system. It was concluded that the current urban hygiene service has lower financial costs. However, it generates negative external effects that induce costs to the population, reduce its economic viability and affect its efficiency. The variables considered were mainly socioeconomic: environmental quality and municipal taxes.

Other studies on MSW have sought to know the characterization of disposal sites and management forms; they represent 41% of the total of the reviewed analyzes in this matter. Among them are those made by Fuentes and Serrano, 2006; Escobar, 2007; Osorio and Correa, 2009; Alcalá et al., 2012 and Canchari and Ortiz, 2007. They suggest that the VE in the matter of waste can be used to know the management of the RSU, the use of the sites of final disposal and to identify the determinants of the imposition of fines for their improper handling. PROBIT regressions identified the determinants for non-compliant firms to be fined or not, and TOBIT regressions analyzed the determinants of the amount of a fine imposed. Based on these results and through surveys, the authors assumed that the political will of the regulators and the bargaining power of the companies during the process of imposing fines were key elements to explain the variation in the amounts of fines imposed.

Fierro et al. (2010) carried out a research to characterize the RSU in situ of three supermarkets. They noted that cardboard with 10,239 kg / week and organic waste with 6,728 kg / week are the ones that are generated in greater quantity. They found a difference in the composition of organic waste. Meat bait was generated in greater quantity in one of the supermarkets while vegetables and fruits were in the other two. Organic waste among the three supermarkets accounted for approximately 23% of the total waste generated. Once the characterization was completed, it was compared with the previous diagnosis made through a survey applied to the managers of each supermarket. This evidenced a deep ignorance regarding the type and amount of waste generated daily.

In the year 2003, Buenrostro and Israde proposed a study to characterize and quantify the RSU, locate the final deposit sites and quantify the residues that were confined in municipal dumps of eight municipalities near Lake Cuitzeo, Michoacán. As a result, they obtained that none of the municipalities studied had RSU handling resource.

The lack of information on their generation and the location of the municipal dumps was enormous. They demonstrated the existence of a general ignorance among the population. Also, they found a lack of records that were attributed to the lack of technical advice to implement follow-up processes in the management of the RSU. This has repercussions in deficiencies to properly manage and plan the systems of public sanitation in those municipalities. They also observed that the sites where they had the RSU did not comply with the current regulations, which exacerbated the environmental and social risks.

Ochoa (2010) studied the handling of RSU in the municipality of El Alto, Bolivia using the MVC. He considered the economic, social, environmental characteristics and the recycling of the RSU to estimate the factors that affected the participation of households through a PROBIT model. They observed that variables such as knowledge of the benefits of recycling and age had a greater effect on the household's decision to participate or not in the recycling of some RSU.

De la Parra et al. (2010) showed in their analysis that the cleaning service in Tijuana, Mexico represents an important aspect for citizens. This is either to maintain a good image of the city, avoid health problems related to the problem of RSU or care of the atmosphere of the city.

The studies on the suitability and reliability of the VEMR as well as those focused on the problem of the RSU offer different variables that can be considered when proposing the data matrix of the ideal method for VE handling of RP.

Variables that stand out in this study are socioeconomic, those of knowledge in the types and volumes of waste, knowledge of the legal provisions that regulate them, trust and government efficiency and environmental education. It is also observed that the statistical methods of analysis tend to be inferential predictions; they have used logarithms that predict the behavior of the variables, as in the case of LOGIT or PROBIT.

On the other hand, 7% of the studies that have analyzed the problem of the RME have been focused on construction waste or demolition waste; they represent environmental, social and economic problems (Marzo and Shumaa, 2014).

They argue that there is no coherent legal framework for the generation and disposal of this kind of waste, which causes social damage, contributes to the increase in energy consumption and depletes finite resources.

To arrive at these arguments, they first quantified the costs of the impacts caused by waste without adequate disposal, then they quantified the total avoided emissions and energy savings and finally estimated the total costs saved by recycling waste. The evaluation methodology allowed them to propose the regulations that restrict waste disposal and the development of incentives to encourage the recycling of waste.

The results showed that recycling promotes the reduction of energy use and therefore global warming. When waste is disposed, space is saved in landfills, and the impact of waste disposal on the environment and health is mitigated.

These studies address the problem of RME and tend to consider variables such as legal provisions, social participation and environmental education. So is the case of the studies that considered RSU.

Regarding RP, the analyzed studies only represent 23% of the total of those reviewed for this article. About 29% of these studies consider the MVC to analyze the RP problem. Also, 29% of the studies generally use VE methods to address said problem. It's important to note that income is not a strong and significant variable. 14% of these studies address the problem with the MPH and the remaining 28% perform descriptive VE studies in RP matters.

The studies that applied the MVC at the same time used another type of method, such as the case of P. Anex (1995). Here, the DCM and the MVC were used in order to obtain a demand curve and an estimate of the consumer surplus to properly handle RP in King Washington County, USA. in 1993. Elimination of RP turns out to be more optimal with the use of the MCD. This is because a displacement cost estimate was obtained in a demand curve, where the surplus of the consumer was $ 95,396. This reflects a lower cost than the more than $1.6 million-dollar cost represented by the RP disposal at that time.

Almansa and Calatrava (2000) sought to assess the RP generated by the Aljibe basin restoration projects in Almería using the MCR and the MVC. The results obtained showed that the use of the MVC assigned a higher social return to the project of 5.23% of the internal rate of return, compared to the value obtained with the classic methodology of 2.25%.

In the USA, Deatona and P. Hoehn (2004) and Lladó and García (2004) made use of the VEMR. The former applied the MPH to prove that the residential areas close to final RP disposal sites have a lower cost. The latter focused on determining the differences among the generation of Infectious Biological RP (Spanish acronym: RPBI) in a general hospital through an economic evaluation of programs and a training intervention.

For this, they performed an observational, longitudinal and retrospective study observing a reduction of 21,869 Kg or 0.5 Kg. of RPBI /bed / day in the year of the intervention. This was done by the Student's t-test which showed a value of 3.14 and a <0.004 p-value. In the training, they found a difference in the proportions from 0.2% in the year 2000 to 28% in the year 2001.

In his analysis of VE of the provision of RP, Alberini (2007) highlighted that the generator should be responsible for assuming all the costs of its handling. This should be from transfer to disposal; the responsibility is not a function of the income of the generator. He suggested that RP handling depends on the generator's willingness to stick to environmental conditions that reduce risks. Buenrostro et al. (2007) determined that the production of RP is independent of the level of income, and its composition depends on another set of variables such as climate, migration and marketing.

Castillo et al. (2013) used the VE to perform an evaluation of the determinants of RP disposition in the USA. The purpose of their study was to refer to companies located in the state of Baja California during the 2008-2010 period. The analysis was carried out by means of the estimation of two econometric specifications.

The first consists of a truncated data model in the spirit of TOBIT. The second one raises a probabilistic model. The results of the first model indicated that the size, location and origin of the company influence the amount of waste that is sent. Specifically, shipments show an increase when companies are large, located in Mexico and of foreign origin.

After the second model, it was established that a depreciation of the peso results in an increase in the probability of shipment. This is very likely due to an improvement in the productive environment of the border area. In another RP study, the importance of VE is highlighted given that its treatment and disposal represent high costs that can be avoided or reduced. This study was conducted in Portugal. It concluded that not only do they require political but also legal, technological, production and consumption changes in order to minimize generation and handle them properly (Coutoa et al., 2013).

These studies show the consistency of two variables: the need to know the legal provisions and environmental education. They prove feasible to be analyzed with parametric statistical models such as the student's t-test and non-parametric prediction models such as the LOGIT and PROBIT logarithms. These models are very similar to those highlighted in the studies of RSU and RME. This allows to propose a data matrix of the MVC for it is the method that presents greater suitability to address the RP problem. These variables can be grouped into four categories: condition, knowledge, compliance and disposition (see table 16).

The foregoing indicates the importance of economically assessing the environment through the elements that can modify it. First of all, the social factor can be mentioned since it is focused on those who must adequately handle the waste and RP they generate.

Hence the importance of analyzing the institutional indicators translated into laws, which reflect the limits of conduct, legal responsibility and legal consequences like economic sanctions. It is also important to theoretically address the precept of development. It constitutes a paradigm that has sought the incorporation of various factors through time, such as economic, technological, environmental, social and human.

Table 16 Matrix of data on the main variables considered for the contingent assessment of hazardous waste handling

Variables				
Condition variable	**Knowledge variable**	**Compliance variable**	**Compliance variable**	**Knowledge and willingness variable**
Socioeconomic characteristics of the generator	**RP generation characteristics**	**Technical characteristics of RP handling**	**Operational characteristics of RP handling**	**Characteristics of the DAP for RP handling**
Age Gender Studies Income Dependants Housing Services Medical assistance Occupation	Types Volume CRETIB characteristics Health damage Environmental damage	Economic classification NRA Category COA Handling plan Binnacle Manifests Environmental insurance Service providers	Exclusive storage area Gutters Retention pit Retaining walls Signs alluding to dangerousness Extinguisher Packing Labeling Identification Service providers Handling phases	Knowledge of the legal provisions in the matter Fines/ PROFEPA Preventive administrative management Corrective administrative management Legal management Preventive operational actions Corrective operational actions Final disposition of RP

Source: Author's own design, (2014)

The theoretical perception of development emerges from the social needs of justifying and planning the actions of production and consumption in relation to the limits of environmental resources and services to conceive it. It is necessary to take into account the spatiality provided by the context in which the analyzed phenomenon occurs. As it could be observed, the Cuitzeo Region has the conditions to be considered as a scheme of analysis to observe the ways to handle RP and its generation. This is important to establish patterns according to social, economic, environmental and institutional dynamics.

In these conditions, RP handling cannot be economically assessed if the historical contributions of development theories are not indicated. It is important to highlight the value of the environment instead of the price, analyze the scope of social behavior and redirect it under the social, economic, environmental and institutional dynamics. For this reason, the next chapter deals with the theoretical contributions of the main theories of development. The analysis goes from the classical, neoclassical to post classical postulates that consider the spatiality, heterogeneity and dependence of the regions.

Chapter IV Hazardous waste in the context of development

4.1 Development in its sustainable connotation and the generation of hazardous waste from a regional experience

The historical perception of development has been influenced by parallel situations that society perceives, be they of economic, political, social, environmental, technological or legal nature. In terms of RP, development goes hand in hand with the way in which they are handled, avoiding their impacts on the environment and society and achieving valuation and minimization actions as much as possible. But it was not always visualized in that way.

The development construct has encompassed various philosophical currents that seek to respond to concerns and changes in a given time. Considered as a paradigm, it should be noted that this word comes from the Greek (παράδειγμα) meaning model or rule and that, by the formation of the word, it is composed of the prefix "para", which means together, and by the word "deigma" which is translated as example or model (DRAE, consulted in http://dle.rae.es/, in February 2016). Therefore, it can be said that development, seen as a paradigm, is visualized as an ideal model to follow and to improve living conditions. The current model to be followed, encompasses various economic, environmental, social, human, political, legal, cultural spheres.

The above was considered in terms of the economy. It is not strange that it will be called the frontier economy, according to which nature has an infinite supply of resources and an infinite place to receive waste processed and consumed by society (Boulding, 1966).

Throughout history some classical and neoclassical postulates stand out. These have focused their attention on economic growth and distribution, respectively. These are the theories of Adam Smith, David Ricardo, Carlos Marx, as regards the former, and Marshall, Walras, Pireto, Pigou, regarding the latter (Jurado, 2005). Therefore, it is not unusual to find theories arguing that development is based on economic growth and that it consists of a *"continuous process whose essential mechanism consists of the repeated application of profits in new investments, and it results in continuous expansion of the productive units. These units can be, of course, a whole society "*(Solari et al., 1976: 91). Sunkel and Paz argued about this perspective by listing current development characteristics or approaches, underlining the identity of concepts (Sunkel and Paz, 1970).

The Theories of Development begin by proposing the bases of growth under two models: the dual and the linear models. They highlight the coexistence of a modern or capitalist sector and a traditional or agricultural sector that achieve a balanced growth beneficial to both sectors (Lewis, 1957). Regarding the linear model, the contribution of Rostow (1960) is stressed by visualizing economic growth as a sequence of stages that traditionally go from the start, to the takeoff, the maturity and to mass consumption. In this last stage, the main sectors of the economy would move towards the production of durable consumer goods, and a large part of the population would achieve a high standard of living. The essence of the Rostow model lies in two issues: first is the definition of development as the simple effect of natural processes of conventional policies *"that tend to raise the levels of savings, investment and productivity and product per inhabitant"* (García, 1978: 218), without profound changes in the economic structure and without the need to alter the relations of domination and dependence in which underdevelopment is reinforced; second is the explanation of underdevelopment as a problem of historical stages through which all countries necessarily go, making emphasis on economic development in the form of urban / industrial growth, led by large companies (Vázquez, 1993).

This leadership follows the functional logic of the Industrial Revolution, referring to a European vision that visualized the positioning of the industry in relatively small populations and spaces full of natural resources (Gudynas, 2004). This made the industrial sector the engine of growth that ordered the space in which it naturally develops, the "urban" arena was the natural setting and hence the urban-industrial couple (Boisier, 1999).

This dichotomy left aside the limitations of an environment that degrades and tends to gradually deteriorate until it disappears. The environment was seen as the means of providing the resources that humans would take advantage of to achieve their well-being (Gódinez, 1995).

The first century of the Industrial Revolution promoted the existence of a center and a periphery, where highly industrialized countries favored the propagation of modern techniques, initially it was England and then the U.S., causing the center to always favor, creating inequalities of all kinds (Gurrieri, 1982). The above highlights the Theory of Dependence that represented a vision on development and its conceptualization in the importance of the environment. This theory postulated structuralism and dependence as basic ideas, and it criticized the classical and neoclassical conceptions of price allocation and the ways in which the market operates. The concept of dependence starts from recognizing that certain regions develop at the expense of others, that is, a center and a periphery (Prebisch, 1981 in Furtado, 1987).

Certainly, industrialization provoked the emergence of theoretical tendencies focused on explaining its effects in countries that reflected differences. This is why the neoclassical theory, the Keynesian theory and that of development poles stand out. Several economists from metropolitan nations focused their attention on problems of development and growth, such as Lewis in 1955; Schumpeter in 1958; Kaldor in 1961; Adelman in 1964; Bénard, Kalecki, Leontief and Tinbergen in 1965; Bangs in 1968 and Currie in 1966.

They proposed to define development in all its variants. They identified it with the growth of the value of economic production, which also facilitated its measurement. This tendency to define development was based on the perceptions of growth leaving aside the environmental, ethical and social focus. Years later, this approach would result in a new complex paradigm that currently reflects deficiencies and that never considered the environmentally correct handling of RP despite the observation of Lewis Mumford. He stated in 1975 that the transition to coal as an energy source, iron as the dominant material and power, profit and efficiency as social objectives would lead the way towards the deterioration of nature. Furthermore, Jevons warned in 1865 that the end of Industrial evolution would occur as a result of the depletion of carbon deposits in England (Sotolongo and Delgado, 2006).

Some other perceptions originated in the Economic Commission for Latin America (ECLAC). They view development as a discourse derived from the creation of a domain of thought and action with a particular historical and geographical origin, a space in the political and academic sphere, actors that contribute to its construction, dissemination and consolidation, and above all, a great influence on the culture and daily life of the people (Bunge, 1985). This at the same time has a temporality; it can be objectified, questioned, rethought, not legitimized, and even canceled. This proposal is the one that allows the dynamism of development, which must address problems given in a given time and space without standardizing definitions that remain despite their inapplicability (Múnera, 2001; Órnelas, 2008).

ECLAC's proposal on development is based on an inward growth model aimed at achieving a productive transformation with equity (Rionda, 2005). This justified the need for a change that prevailed by the end of World War II against the obsession with development by the Latin American governments and their desperate adoption of industrialization policies, improvement of the infrastructure through hydraulic supports, road systems and production subsidies, as well as third party protectionism and distributive plans for health and education. However, despite the conceptual diversity that was visualized, development continues to be associated with growth according to the aim of society of giving everyone what they deserve, according to their needs and capabilities. This is a democratic aim in the sense that nobody would enjoy privileges and that all would have the same opportunities for participation, realization, choice and decision (Briseño, 2006).

Another perspective of development is that which refers to the existing potential, a defined accomplishment, conclusion, or energy given. It is the contrast of a certain matter against its future fulfillment, being this a norm to follow.

There is the language of Aristotle, the Aristotelian ontology, which supports all Western thought, and which refers to the principle of any action that tends toward its own aim. This is how the development of the Third World countries is discussed, establishing that there is a state of definable maturity that must be achieved (Castoriadis, 1980: 212). This goal of reaching a maturity is pursued by the so-called underdeveloped countries. They have been considered to be at a certain stage, and various authors have elaborated about this, such as Hegen, Rosenstein-Rodan, Nurkse, Hisrchman, Nelson, Lewis, Leibenstein, Clelland, (Hidalgo, 1998).

Sunkel and Paz (1971) affirm that underdevelopment is part of the global historical process of development, which goes hand in hand with those who have development. According to them, overcoming underdevelopment requires the participation of excluded or marginalized groups; the greater degree of social participation, the greater national autonomy there is. The so-called "Theory of Development Poles" emerged, and was initially developed by François Perroux, in response to the need to offer, at least theoretically, the possibility of initiating an orderly and balanced growth in post-war France (Sunkel and Paz, 1971).

Antunez (2011) says that the concept of development has been changed in the course of history by the events that promote it. This was the case of the Industrial Revolution, economic crises, industrialization processes and globalization among other events, which have allowed to reinforce this concept. Its scope will depend on the vision that is analyzed. Today it must consider environmental, economic, social, cultural, political, technological and legal approaches. The latter states that all human behavior must be regulated in order to respect and enforce rights and obligations as well as to achieve social harmony that in turn promotes and facilitates other social activities that are fundamental to human existence such as the economy. Nevertheless, it is not the only one because various factors influence the social doing such as the biological ones that make the existence of social relations possible. In this context, the main efforts for Mexico to achieve development have been limited to the concepts of modernization, dependence, global systems and globalization (Hidalgo, 2000; Órnelas, 2013).

The deterioration of the environment, in particular the polluting emissions both to the air and to the ground, deepened with the transition from primitive industry that used coal as the only energy and caused large amounts of polluting gases to technical industry that seeks to incorporate chemical substances. Such substances are highly toxic to ecosystems and end up becoming RP without real control parameters (Díaz, 2004). In addition to this, the excessive use of chemicals in daily life makes it even more difficult to minimize waste and protect natural elements. Therefore, several social movements emerged as a response to the devastation of natural resources and proposed to make structural changes that reconcile nature with development to achieve continuous sustainability (Gligo, 2001).

The so-called ecological violence - devastation that man exerts on renewable, non-renewable resources, on animal and plant species, as well as on soil, subsoil, air and bodies of water - was unleashed since 1845. It has been enormous and poorly avoided or controlled ever since. They were more than 150 years of irrational and merciless depredation of the land in favor of a continuous but unsustainable growth model that was gradually attacking humanity itself (Alfie, 1994).

Part of all human needs do not adhere to social, political, economic and environmental conditions. For that reason, it is a wide concept that requires the conjugation of economic, political, cultural, environmental social and even legal spheres. This perspective has been associated with the political sphere although it differs in its objective. The legal framework does not only seek to implement public policies but to regulate, monitor and guarantee the rule of law conformed by obligations and rights that guarantee stability in society (García, 2000).

The common good would be achieved if development is viewed as a normative concept, full of value judgments that highlight human potential, attending to the basic conditions such as food, employment and equity (Seers, 1970). In this sense, development should go beyond economic considerations; it would have to address issues of respect for equality. This would translate into a state of law where the order of prerogatives and obligations prevails to achieve social coexistence. This is the guideline to achieve human development that can be described as "the process of expanding people's options. Beyond those needs, people also value benefits that are less material. These include, for example, the freedom of movement and expression and the absence of oppression, violence or exploitation. People also want to have a sense of purpose in life, as well as a sense of empowerment. As members of families and communities, people value social cohesion and the right to affirm their own traditions and culture" (P.N.U.D, 1996: 55-56).

Thus, the term development transcends from the economic sphere to spheres that involve humanitarian aspects. In the seventies a crisis of capitalism came throughout the American economy. This was the crisis of Fordism, which was based on a chain production mode with specialized machinery, high salaries and numerous employees, initiated by Henry Ford in the twentieth century.

It was evidenced by the collapse of the steel industry and automotive, and two proposals arose: The Human Development Theory of Amartya Sen and the Human Development Index (HDI) of the United Nations Development Program (UNDP). On the other hand, the contributions of environmental movements allowed progress towards the construction of a holistic and multidisciplinary vision of sustainable development (Gutiérrez, 2008).

Development is focused on and sustained by the satisfaction of fundamental human needs, the generation of increasing levels of self-dependence and the organic articulation of different entities: human beings with nature and technology, global processes with local behaviors, personal with social matters, planning with autonomy and Civil Society with the State (Neef, et al., 1986).

This point of view promotes the linking of natural elements with the existence of society in the sense that human beings need the natural resources and services to survive. Thus, the idea of observing development under the magnifying glass of sustainability arises. The transition from development to sustainable development begins to manifest itself in the late fifties and early sixties, when ecological awareness is aroused.

This happened especially at the level of analysis and isolated approaches that showed the exponential tendency to the degradation and extinction of natural resources. However, it is until the seventies when the processes of environmental degradation and depredation of the land became so evident and their costs began to manifest in all areas. Now humanity has to reflect and look for alternative forms of growth and economic development on one hand to avoid the continuous processes of environmental deterioration, and on the other hand, create mechanisms that contribute to the recovery and sanitation of the environment. This can be achieved through the emergence of clubs in favor of the environment, such as the Club Sierra and Friends of the Earth (Godínez, 1995; ECLAC, 1990).

Criticism of the development model had its origins in civil society and scientific reflection, progressively reaching the sphere of institutions (Carson, 1962, Goldsmith, 1974, Shumacher, 1973, Meadows, Rander and Behrens, 1993). By recognizing that economic development required an environmental dimension, the idea began to spread, and the Club of Rome (1972) was created. It questioned the central thesis of development theories about the unlimited possibilities of growth in developed countries. The Cocoyoc Declaration (1974) and the Dag Hammarskjöld report (1975) analyzed the unsustainable nature of population growth, the consumption of non-renewable natural resources and the increasing expansion of pollution (Sachs and Freire, 2007: 289).

The main question is about the conditions of underdevelopment and poverty existing despite the technological advances in production, where the differences between rich (capitalist) and poor (underdeveloped) countries stand out. On the other hand, the environmental costs of economic growth models, such as those followed since 1789, had entailed a serious environmental deterioration and ecological erosion. It was impossible to continue with such growth processes, so the real abundance of natural capital started to be in question.

This was why the internationalization of the effects was sought by proposing that pollution problems be solved by incorporating the principle of natural conservation into the physical economic process (ECLAC, 1993).

According to Ayres and Kneese (1970), the environment has a double function: first as part of the productive process by providing inputs, and second as a waste deposit of said process. The problem in this perception is the affectation that is made to a common good such as the environment. Not having a declared property, it is defenseless against any means of contamination (Ramírez, 2010).

From 4 to 12 June, 1971, the meeting of the Group of Experts on Development and the Environment was held in Founex, Switzerland. Here, a document on the state of the human and natural environment of the planet was prepared. This work became one of the bases for the United Nations Conference on the Human Environment that was held in Stockholm in 1972, and it resulted in a Declaration and a Plan of Action for the Human Environment that contains 109 detailed recommendations (Godínez, 1995). ECLAC organized a series of World Conferences in 1972 to address this problem. It referred to the fact that the low level of development of nations is a predominant factor for environmental deterioration.

These nations will seek to reduce their poverty levels through intensive and extensive exploitation of natural resources. Therefore, the environmental problem must be incorporated in the national development policies as something transcendental and of vital importance. In this year of 1972 there was a boom in the topic, and environmental conferences and postulates were given in large numbers, such as the Bariloche Foundation in Argentina and the group of Globalists in the US. They sought to raise awareness and alert the humanity on environmental issues (Foladori and Pierri, 2005).

In 1987 the World Commission on Environment and Development (Spanish acronym: CMMAD), coordinated by Gro Harlem Brundtland, issued a report entitled Our Common Future. It was favorably received by the United Nations General Assembly and become a basic point of reference for all the debates and proposals that were formulated towards the end of the decade of 1980. The essential approaches state that ecology ceased to be a national or regional task and became a global problem. There is a need to exchange opinions between advanced and less advanced countries in order to approach environmental dangers. There is a need to thoroughly review the environment-development correlation and the theories of development that have been held by the different regimes for decades. There is a raising urgency for new sustainable development methods (Fernández, 2000). Said report will later be known as the Brundtland Report, which proposes a new style of development (sustainable development) that redirects the activity of the industrialized nations with the rest of the nations, acting at the global level to reach particular cases. Finally, this report calls for ceasing forms of development as well as technical and economic processes that affect future generations and cause serious damage to poor countries, making the ecological costs evident (Foreign Trade, 1992).

In the last decade of the twentieth century, a renewed interest in the relation between development and environment and the concern for the deterioration of the land and its resources is evident. This has been reflected in the different activities, forums and assemblies that have been held since the beginning of said decade until the present. The Commission for Development and Environment of Latin America and the Caribbean (Spanish acronym: CDMALC), carried out by the Inter-American Development Bank (Spanish acronym: BID), represents a Latin American and Caribbean expression of said interest and concern for ecological considerations since the beginning of the decade. In this same sense, some of the governments of this region have held several ministerial meetings on the environment in Latin America and the Caribbean. The Action Plan for the Environment has been one of the main achievements of such ministerial meetings (Órnelas, 2013).

Another form of global concern about the environment was expressed in the two United Nations Programs: The Environment Program and the Development Program. Also, several ecological groups expressed it, such as the National Wildlife Federation (NWF), the largest environmental group in the US and one of the largest in the world, the Council for the Defense of Natural Resources (NRDC) and the World Wildlife Fund (WWF) among others (Antúnez, 2011).

This way, the concept of sustainable development was coined by the World Commission on the Environment and development called the Brundtland Commission (1987), defining it as one that: “meets the needs of the present generation without compromising the capacity of future generations to meet their own needs” (Jardon, 1995: 100).

On the other hand, the meeting of the United Nations Commission for Environment and Development (UNCED), known as the Rio de Janeiro Summit, incorporates the right to development of June 1992: the right of future generations in principle 3 establishing: "The right to development must be exercised in such a way as to respond equitably to the development and environmental needs of present and future generations.” Also, in principle No. 4 the right to sustainable development is postulated as a goal to be achieved by stating: "In order to achieve sustainable development, the protection of the environment must be an integral part of the development process and can not be considered in isolation" (García and Bauer, 1996: 92).

Based on the above, Foladori and Tommasino (2000) indicate that defining sustainable development as the satisfaction of needs of the present societies without putting at risk future generations implies that it is necessary to rationally and efficiently assign resources towards alternative uses. This, then, must be done without degrading the biophysical basis (biological studies using principles and methods of physics) on whichthe whole economic circuit stands. This has the purpose of guaranteeing a right to act equitably in society.

In Mexico, that right translates into a constitutional guarantee and recently into a human right to guarantee a healthy environment for development and well-being. For this reason, environmental regulations are necessary to establish social limits in the use of natural resources and services. In terms of RP, the control of the generation and its handling must be translated into legal systems that give weight and support to the actions of society, particularly the RP generators. They have technical and operational obligations to guarantee the correct handling of the RP they generate, in order to avoid harm to society and the environment. In addition, the participation of the individuals surrounding the generators is necessary because they are social agents capable of deciding on the efficiency and equity of development (Antúnez, 2011).

At the end of the decade of 1990, and therefore with it the twentieth century, organized ecological movements were observed to have important degrees of consolidation. They exposed topics in international forums, such as climate changes, the depletion of the ozone layer, ocean pollution, forest destruction, the deterioration in biodiversity, acid rain, changes in water quality, the irrational generation of RP and many others. They also adopted approaches that revolved around the compatibility of economic development with the environment, productive transformation with equity, as well as the reorientation of growth models. An example of this are the topics discussed between Mexico and the USA on the movements of PR, which make evident the complexity of this neighborhood and the need to strengthen the cross-border cooperation associated with it (Meixueiro, 2008).

Therefore, the trend is to consider the environmental limits of the planet. Its full acceptance was reached in 1992 at UNCED, the Earth Summit in Rio de Janeiro, with the participation of 179 governments that generally assumed the principles of sustainable development. They formulated strategies to direct the necessary changes that allowed the growth of societies and economies in healthy and lasting environments (Cárdenas, 2004). The concept of sustainability raised in the Rio Declaration of 1992 included three basic types of objectives to fulfill: "ecological, which represent the physical state of the ecosystems and are essential for long-term survival; economic, which should promote a productive economy based on and supported by knowledge and technical-scientific development to provide sufficient income and guarantee continuity in the sustainable handling of resources; and social, in the sense that the benefits and costs must be equitably distributed among different groups" (Cárdenas, 2004: 8).

Finally, it is clear that the new developments and ecological approaches are being influenced by the current trend of globalization that involves economic, technological, social and cultural aspects. This makes possible the constant and growing communication among countries that transfer their goods, capital, societies or cultures. Generally, those countries are the developed ones which have that capacity of risk. Faced with this situation, globalization goes hand in hand with financial crises, both having a common adjective: unpredictability. It is reflected in the development approach that is adopted, which has always sought to account for the environmental factor (Rodríguez, 2008).

For this reason, it is not strange to find the privatization of natural assets and the sale of rights to pollute (the polluter pays). This constitutes the internationalization of production costs (neoliberal approach), which allows polluting companies to incorporate pollution costs as production costs that are generally absorbed by society in general. The approach proposes that the solution consists in internalizing the costs, that is that the polluter will absorb the costs of such contamination and that these repair costs are considered in the pricing process (Godínez, 1995).

In the case of RP handling, this approach will allow the generator to assume the costs of handling of its RP responsibly. It then will be guaranteed to incorporate them into the prices of the products or services it develops. It will also avoid the increase in environmental liabilities that seriously harm society. In the region under study, this approach would be effectively applied due to the socioeconomic and concentration conditions of RP generators.

The Coase Theorem can be added to this, which argues that the intervention of the state is necessary to solve the problem of pollution by waste. It will exercise its function through the imposition of taxes or subsidies that oblige the generators to cover externalities and internalize them. However, pollution should not be considered as a situation that can be corrected through a payment or a tax, but rather as something that should be prevented and not corrected (Jiménez, 1989 in Ramírez, 2010).

On the other hand, there are tendencies to increase environmental protection via economic growth and the creation of jobs in the branches of the new environmental industry. Such is the case of Ecoplan or the Special Program for Work and Environment, both arising in Germany. Here, the exports of technologies and ecological products are promoted among developing countries. This way, it contributes to improve the level of occupation and economic growth in the industry dedicated to such technologies and to improve the ecology of the recipient countries. The purpose is to achieve future environmental protection that can serve to stabilize the political and economic structures causing environmental deterioration while generating jobs and correcting environmental effects (Neo-Keynesian approach) (Godínez, 1995).

Another approach is to put aside the industrial model that has been carried out to incorporate a new social system based on an economic mechanism of ecological nature. This would be a new growth vision where natural and economic elements coexist and stabilize each other. This radical approach considers the compatibility between economic systems and their environmental surrounding, giving rise to postulates such as "Ecodevelopment" and "Economy of subsistence in developed countries" (Godínez, 1995).

Finally, the structuralist approach is based on the studies carried out by Martin Janicke between 1982 and 1988. It considers that private consumption of energy (as one of the most relevant factors in the assessment of environmental wear) has grown faster than the GDP, establishing a direct relationship between GDP growth and increased environmental pollution. This approach is logical in relation to the corrective actions used to improve environmental conditions. Thus, I consider that it is not essentially proactive, but it serves as a basis to highlight the importance of controlling the pollution that affects all social spheres. The radical approach would be the result of the feasibility and effectiveness of the previous approaches. It would show optimal results when applying the neoliberal approach together with the Neo-Keynesian approach in the Cuitzeo region.

It is important to point out that no implementation of any approach is easy and that its feasibility depends on the particular and specific circumstances of the country or region where it is intended to be implemented. Therefore, State intervention is necessary, not as a despotic and authoritarian entity as it was in the past, but as a regulatory entity that promotes social coexistence through the observation of legal provisions. It must adapt to society’s real needs and conditions by establishing mechanisms for application, evaluation and improvement in the field of RP due to the damages, dangers and risks involved in improper handling. This obviously should be generalized in legal provisions as it has so far, but it must be mainly focused on state and municipal regulations in order to take effect in an environmentally appropriate, technologically viable, socially acceptable and economically feasible way. Faced with this equitable distribution, the right of future generations to sustainable development as a goal is tacitly incorporated (Cortinas, 2010, García, 1996).

Therefore, it is justifiable to see that development is governed by four elemental pillars the economic, the social, the institutional and the environmental. The purpose is to describe in a synthesized way the components of each pillar, which, taken as a whole, allow us to analyze the degree or level of sustainable development (see table 17). This perception of development synthesizes in a table the indicators considered to encompass sustainability int the Cuitzeo region. They will serve as a basis for comparing the level of development that prevails and eventually determine the impact caused by the handling of RP (Schuschny and Soto, 2009).

Waste represents an immense loss of resources and energy, so it can be considered as an indicator of the efficiency in the use of materials in a society (Waste generation and management. www.eea.europa.eu/publications/92-9157-202-0/3.7.pdf., consulted on November 24, 2014). The sustainable management of waste not only involves the traditional intervention of the municipal authorities of clean services, but also the authorities of the different orders of government responsible for economic and social development, protection of the environment and health, education, scientific and technological development, energy, and others.

In addition, all sectors of society should be involved, considering that each of them is a generator of waste and should be responsible for the prevention of its generation as well as its minimization, valuation and environmentally appropriate handling. They must also assume the costs that this implies and the consequences of the damages that they cause.

Considerations on the sustainability of waste are based on a comprehensive vision of its handling and on the need to change the paradigm of sustainable waste management for the paradigm of the life cycle of materials.

This should lead the Mexican society to focus its attention on the sustainable use of resources -materials, energy and others- that are transformed into goods and services for consumption. This way, resources would not be wasted but recovered and reintroduced into productive chains as satisfiers of needs just like in nature, where biological processes do not generate waste (www.ceja.org.mx, consulted in July 2015).

Based on the sustainable development approaches, the solution to conceptual conflicts is the practice of alternatives that involve a series of aspects such as: productive processes, the conditions of natural elements based on their existential limits, the technological conditions that eliminate or seek to reduce waste, the cultural conditions that make the population aware, the political circumstances to promote actions of access to resources, participative management and the equitable distribution of the goods and services generated. (Ramírez, 2010).

It must not be forgotten that RP handling is associated with sustainability and development parameters because they are a consequence of the production and consumption processes. They are considered as externalities that cause health and environmental effects. If such relationship is analyzed from the regional perspective, theories that are linked to the problem of RP handling stand out; these theories compose regional development (ECLAC / GTZ, 2008).

If the problem is analyzed from the regional development point of view, Von Thünen's location theory stands out. It is based on the location of the agrarian activities and tries to provide explanations from the supply, demand and price that are used in a certain region. Thüner argues that distance is the main element of development because it determines the type and use of the land, which promotes the creation of ordered zones of land use around a central place. This may justify the fact that the majority of RP generators are concentrated in the Cuitzeo region because it is the state that offers the best conditions of supply, demand and price.

When the state capital is located in it, it fosters this possibility. Said offer, demand and price have an impact on the handling of RP because in order for it to take place correctly, it will have to reflect the costs involved in its collection, transfer and final disposal.

This same principle would apply to Weber's localization theory, which presents a solution through the minimum cost. It tries to develop a set of localization principles that could be applied to any social and political system. In terms of RP, it would be applicable in a region that is strategically located to make RP handling feasible. The Cuitzeo region would be ideal once provided with infrastructure for the proper handling of RP, which it would supply all regions of the state (Mihotek, w/o date).

In addition, it is worth mentioning Christaller's Theory of the Central Place (1933) on the hierarchy of larger places that offer more specialized goods and services and promote the relationship between municipalities. For the subject under study, the main place is Morelia, which by concentrating the greatest number of RP generators, it fosters a certain influence in waste handling with the rest of the municipalities in the region (García and Carrillo, 2006).

This does not constitute a development pole. It would certainly be thought that way; however, the only pole of development existing in the state is located on the coast and is currently called the fourth development pole. Although the Cuitzeo region is not a development pole in the terms of Perroux, it does institute Pottier's so-called linear development, which states that development takes place along transport routes and their trajectories are linear.

It stimulates scale economies, decreases the cost of transport and sets in motion a cumulative process that concentrates wealth and industrial activity in the immediate areas of the integration routes. Industrial corridors and tourist and cultural routes are a clear example of this theory. This is relevant for the region studied because the concentration of companies and industries that generate RP, mainly in Morelia, Zinapecuaro, Alvaro Obregón and Tarímbaro, attracts other lower-level companies that also generate RP by offering consumer goods or services.

The foregoing brings up the proposal of Hermansen (1969), who argues that the agglomerations of human activities are characterized by: relative location, size and functional composition, the service network for product movements, people and information that connect these agglomerations and the distribution that allows integration. The development of a region has three processes: cultural development (supposes a high distribution of knowledge, values, norms, beliefs, attitudes, etc.), social development (it includes the economic distribution, the satisfaction of needs and sociological processes sociological such as social mobility), and political-administrative processes (referring to the change of power relationships and the direction of a region as part of a process).

Evidently, this perception is linked to research because industrialization favors the generation of RP being oriented to the economic satisfactions of those who generate them, without considering their environmental, economic and social repercussions.

Mexico lacks technologically feasible and socially acceptable conditions to correctly handle RP because it favors economic needs and dependency on other countries that harm and make it impossible to properly handle this type of waste, leaving the externalities for manufacturing in Mexican land. In the case of the Cuitzeo region, the situation is associated with the fact that it is the state capital that fosters the cultural, social, political and administrative dynamism that can facilitate RP handling (Márquez, 2004). Said dynamism must adhere to the concentration of private and public investments to create active agglomerations that transmit development among all regions, that is, a network in the handling of intraregional RP (Myrdal, 1957).

These theoretical visions evidently had an economic and social focus. However, they isolated other components of development such as environmental, political, administrative, cultural and legal aspects.

This is how economic aspects have been considered based on the fact that local entrepreneurs use their capacity to organize: endogenous productive factors with adequate levels of efficiency; environmental aspects, which must always consider the sustainability dimension of any environmental transformation option; sociocultural factors, in which values and institutions serve as the basis for the local development process; and political-administrative principles, in which territorial policies should try to create an innovative territorial environment favorable to the promotion of local economic development (Carrasco, 2004).

This promotion of development should start from the interpretation of society on its main problems (Bassols, 1993). In terms of RP, it should not be forgotten that the generation of waste depends to a large extent on the service, process and social consumption.

Also, the greater number of people, the greater possibilities of increasing RP and, therefore, greater environmental problems exist. Such problems can be the transfer of waste from the city to surrounding places, water currents, vacant lots, ravines, etc., affecting not only places where the RP arrive and impact, but also the surrounding spaces (García and Carrillo, 2006).

All these premises center the analysis of space, considered not as territory but as a perception. It is measured in terms of all the dynamics that develop in it, so proposals arise seeking an exchange of the regime of accumulation for the regime of regulation, highlighting the welfare and working state.

As indicated by Esqueda (2015), development must have four dimensions: the social, the economic, the environmental and the institutional, as long as the spatial dimension is considered intrinsic to the object of study.

These dimensions can be seen in the synthetic indicator of sustainable development analyzed by Schuschny and Soto (2009); Ortiz and Infante (2008) and the INEGI, (2009). All this has the purpose of locating the problem analyzed within these parameters and to observe if the situation in the Cuitzeo region is near or far from sustainable development (See Table 17).

Table 17 Synthetic indicator of sustainable development

Synthetic indicator of sustainable development					
Social					
Poverty	**Demographic Dynamics**	**Education**	**Health**	**Human Settlements**	
Unemployment rate Wages	Population growth rate Migration Fertility Population density	Literacy Illiteracy Percentage of GDP allocated to education	Sanitation Life expectancy Access to water Mortality rate Access to health through clinics	Urban population growth rate Fuel consumption Human losses due to natural disasters	
Economic					
Distribution	**Consuming patterns**	**Technology transfer**			
GDP per capita NDP Economic activities	Energy consumption Industrial participation Expenditures on environmental protection as a proportion of GDP	Importation of capital goods Share of environmentally clean capital goods in the importation of capital goods			
Environmental					
Water	**Land**	**Waste**	**Deforestation**	**Biological Diversity**	**Atmosphere**
Freshwater resources Protection of oceans, type of seas and coastal areas	Changes in land use Rainfall Desertification Use of pesticides and fertilizers Use of energy in agriculture	Solid urban waste Special handling waste Hazardous waste	Forest surface	Endangered Species Protected surfaces	Emissions of greenhouse gases Concentration of pollutants in urban areas
Institutional					
Public policy	**Scientific action**	**Legal instruments and mechanisms**			
Sustainable development strategies	Research in science and development	Federal legislation State legislation Municipal legislation International agreements Access to information			

Source: Author's own design based on data from Schuschny y Soto, 2009; Ortiz e Infante, 2008; Indicators of sustainable development, INEGI, 2009; (2016)

4.2 Waste handling as an indicator of sustainable development based on a multifunctional challenge

According to the synthetic indicator of sustainable development, there are four types of development sectors with their respective indicators: the social sector, whose indicators are poverty, demographic dynamics, education, health and human settlements; the economic sector, whose indicators are distribution, consumption patterns and technology transfer; the environmental sector, which has as indicators water, land, waste, deforestation, biological diversity and atmosphere; and the institutional sector, whose indicators are public policy, scientific action and legal instruments and mechanisms.

Economically incorrect RP handling influences the DAP either by the performance of the management or by the adequate disposition of said RP. The economic factor is present in the monthly income of the generating company, in the portion of such income allocated to RP handling and in all the generator's actions or omissions that imply sanctions from the authorities. Generators will eventually have to pay for the execution of corrective measures imposed, payments destined to the accomplishment of steps or procedures, legal advice, fines, storage of RP, as well as their storage and environmentally adequate disposal.

Institutionally, it is noticeable that there are limitations that complicate an environmentally sound management of the RP in the analyzed region. The legal parameters have qualifications that release the generator from the responsibility to adequately inform on their RP handling, forcing only the large generators to annually inform on such handling. However, there are no clear institutional control schemes that allow to accurately know which RP are generated, how they are handled and how they are disposed.

This may eventually cause damages and environmental imbalances, including affectations to society as part of the environment.

It is environmentally alarming not knowing specifically which RP are generated by municipality, what are the environmental conditions where they are generated and how measures to reduce risks and damages are carried out, especially knowing that the Cuitzeo region still conserves 35% of natural soil with 26% of it being forest.

It also conserves about 8% of water bodies such as Lake Cuitzeo. This lake has an area of 420 km2, and its main environmental functions are the regulation of the basin's climate, the economic support of fishermen and the irrigation of nearby areas. However, it has significant effects today, not only because of domestic wastewater discharges but also because of the discharges of serious pollutants from industries and agricultural activities. In this case, waste is discharged with heavy metals such as cadmium, mercury, radon and fluoride, and it represents a latent risk for the society of the entire region and a contaminating factor of the natural elements.

In the social stage, the inadequate handling of RP causes a negative impact on social welfare and on the life quality of people who are located close to the RP generators in the Cuitzeo region.

4.3 Main impacts of hazardous waste handling on the sustainable development of the Cuitzeo region

It has been argued that sustainable development is a parametric perception of the coexistence of different factors that make equilibrium and social harmony possible. For this reason, if the RP handling is incorrect and causes alteration to this balance, it would stop any possibility of development. Under this sustainability scheme, the mainly observed impacts that would limit a sustainable development in the studied region are:

a) Environmental Impact

1. Land and water pollution. The contamination of these elements is evident in the collected annexes within the photographic file. In addition, 21% of the responses from the surrounding people indicate that RP contamination is an environmental problem, and 42% of them state that RP spill is one of the main causes of water and land contamination. This situation is worrying because there is still 35% of natural land (26% of forest) and 8% of water in the Cuitzeo region.
2. In addition, the people surrounding the generators of RP show a clear knowledge of the effects that can be caused by the inappropriate RP handling in soil, water, flora, fauna and health. 29% of them stated that RP handling affects their well-being.
3. It is noteworthy that society perceives that pollution, spills, fires, damage to the landscape and respiratory airways are some of the affectations associated with the RP handling in the Cuitzeo Region.

b) Economic Impact

1. Costs for management by generators Payments for the management of NRA, categorization, COA, management plans (preparation and payment of fees), RP logbook and environmental insurance.
2. Costs for the environmentally adequate disposition of RP by generators. Hiring of service providers for collection, transport, storage and final disposal (incineration, treatment, recycling, co-processing, reuse or controlled confinement) of RP. The conditioning of the RP temporary warehouse (roof, restricted, separated from common areas, with signs about the danger, with fire extinguisher, with retaining walls, gutters, retention pits, containers for each RP perfectly labeled and separated, anti-slip floors, etc.).
3. Fines and economic sanctions for generators.
4. Payment of advice and environmental litigation by generators.
5. Remediation costs of sites contaminated with RP by the institutions.
6. Costs that people near generators would pay and amounts for which they would like to be compensated.

c) Social Impact

1. The improper RP handling is seen to affect the welfare of the people surrounding the RP generators at a 29% level.
2. The society perceives that the improper handling of RP can cause spills, fires and contamination of water, soil, flora and fauna, health, as well damage to the landscape.
3. It is observed that the education factor is associated with the correct handling of RP. It is also perceived that there are RP that must be handled adequately, both by generators and by society. It is therefore necessary to encourage Environmental Education on RP in order to raise awareness of the basis for achieving environmentally sound handling of all types of waste, especially hazardous waste.
4. It is noteworthy that there is a DAP for RR handling not only by generators, but also by the surrounding society.
5. There is a lack of knowledge of the technical and operational obligations that every generator must fulfill to guarantee an environmentally sound handling of the RP.
6. It is a priority to look for human settlement regularization patterns. People's demands for goods can lead to the increase of RP generators, which provide a service to these sectors, but do not properly handle their RP.
7. It is necessary to create a list of the main economic industries and their RP in the Cuitzeo region. This would serve as a basis for determining the operation of future economic industries that seek their establishment in the region. For this, it is important to give voice to the business and industrial organizations of the State (CANACO, CANACINTRA, CMIC, etc.).

d) Institutional Impact

1. Restrictive legislation on RP. It is evident that the current regulatory framework limits the control schemes for the generation and handling of RP. This is because it only requires large generators (which represent only 2% at the regional level) to report annually on their RP handling systems. Therefore, it is necessary to reform the LGPGIR, its Regulations and the LFRA in order to encourage all generators to report on how they handle RP.
2. There is an impact at the institutional level as the costs of repairs of RP-contaminated sites in the Cuitzeo region are covered.
3. There is a significant lack of information on the damages caused by the incorrect handling of RP in the Cuitzeo region. This is true both for the environment and for society. The few existing studies seek to contextualize the behavior of substances such as cadmium, lead, arsenic, radon or fluorine, without a research that delves into the damages that these elements can cause.
4. There is no research on RP in the Cuitzeo region under economic valuation schemes. Even less, there is no research focusing on generators, who are in the first instance responsible for guaranteeing an environmentally sound management of their RP.
5. There are no conditions to apply environmental responsibility regulations on the improper handling of RP in the region analyzed.

In addition to the above, the direct opinion of the people who are located near the RP generators should be taken into account. This social perception offers an overview of the existing knowledge on RP handling. It also shows to what extent is RP handling considered correct, how much it is perceived to have an impact on social welfare, what is society willing to do to improve that perception and determine if the community would be DAA.

4.4 Social perception of hazardous waste handling by generators located in the Cuitzeo Region

In order to know the perception of the people surrounding the generators, a personal survey was applied to know the DAP or the DAA of handling of RP. A sample of 384 people was selected to apply the survey, taking into account that the Cuitzeo region concentrates about 1,004, 723 people.

The survey consisted of 31 items. Eight of them aimed at knowing the socioeconomic conditions of the respondents; 17 were designed to know the characteristics of degeneration perception of RP and six of them to know the handling characteristics of RP and DAP or to be compensated (DAA). It can be seen that 54% of the respondents were female, while 46% were male. The age of the respondents ranged from 15 years to 82.

The first part of the survey shows that the predominant educational level is higher education (36%) - a condition that is similar to RP generators - 35% have higher secondary education, 9% have incomplete education, 3% have no education and 1% have a basic level. The occupation variable highlights that 50% are employees, 27% are owners or entrepreneurs, 10% are professionals, 9% have no occupation and 4% have a different occupation. Regarding housing, 39% own housing, 37% leased, 9% lent, 9% shared and 6% other, having all services such as water, drainage, electricity and telephone. Medical care is provided at a 48% by the IMSS, 22% by the popular service, 19% privately, 10% do not have any and 1% by the ISSSTE.

The second part of the survey aimed at knowing the perception of RP generation and environmental problems. Here, 63% of respondents are concerned about the scarcity of water, 21% contamination by RP, 9% are concerned about the felling trees and 7% noise. 43% consider garbage as the main cause of water and soil contamination; 42% believe that it is the RP spill, 9% the urbanization and 6% the fertilizers. 70% of respondents do know what RP are, while 30% do not know. In the same percentage they know that RP can contaminate the soil, while in 85% they know that they can contaminate the water and 15% do not know it. 58% know that RP can damage the flora and fauna, while 42% do not know it; 75% know that RP can damage health, while 25% do not.

Regarding the item asking if they knew if there were RP generators around them, 84% said that they do know and 16% did not. In addition, 63% do not know what RP are generated, while 37% do know what RP are generated around them. 67% of the respondents have stated that the generator's handling of RP is good enough, while 33% believe that it is bad. 29% of the respondents consider that nearby generators' handling of RP affects their well-being. They perceive that the identified generators are located less than 50 meters from them (40% indicate this perception), while 27% indicate that they are more than 50 meters, but less than 100 meters. 14% indicate that they are further than 100 meters but closer than 150 meters; 10% say they are further than 150 meters away and 9% decided not to respond.

On the other hand, they were questioned about the economic type of industry that they perceive generates RP and is close to them. They stated that 57% belonged to the health sector while 27% stated the automotive sector, 9% did not respond, 2% indicates that the generating activity of RP belongs to the plastic, metal or wood sector. In the same percentage they consider that it refers to the food or ice manufacturing sector, 1% believe it is cement or construction, 1% considers that it is referring to chemistry, petroleum or metallurgy and 1% refers to others. Regarding the benefit that these different industries represent for the respondent, 57% indicate that it does represent a benefit while 43% indicate that it does not.

The last part of this section focused on asking them if they knew of any damage or contingency caused by the improper handling of RP. They argued that pollution, spills, fires, damage to the landscape and damage to the respiratory tract were the problems associated with it.

The third part of the survey focused on the perception of how the RP handle the neighboring generators, the DAP and or the DAA, as well as the actions that they could take to improve RP handling. It was observed that 92% do not know if the generator has a temporary warehouse for the RP while 8% do know; 71% do not know how RP are stored while 27% do know. For this, 20% believe that they are stored in plastic or metal containers, 10% other types of packaging, 8% in buckets, 4% in soft drink containers, 2% in cardboard boxes and 56% do not know.

Regarding what they are willing to be done to improve the handling conditions of RP, 36% would request the RP generator to comply with the regulations, 30% would be informed, 20% would report, 11% would ignore the problem and 3% would seek to be compensated for the affectations.

Regarding the DAP, 94% would pay up to $ 200 pesos and 6% more than $ 200 but less than $ 400 pesos. However, 43% would like to be compensated (DAA) for less than $ 200 pesos, 29% more than $ 1,000 pesos, 10% more than $ 400 but less than $ 600 pesos, 7% DAA for more than $ 800 but less than $ 1,000 pesos and 5% DAA for more than $ 600 but less than $ 800 pesos.

These results show that there is a low perception of the affectations that may imply an inadequate RP handling in the Cuitzeo Region. However, it is noteworthy that about 29% of the respondents argue that such incorrect handling would affect their well-being and 33% consider that it is bad or inappropriate.

It was then necessary predict the welfare of the people who perceive the generation of RP based on their knowledge of the types, volumes and impacts to the environment and society, the compliance with the technical and operational provisions, the legislation and the DAP for the handling and management of the RP by the generators. For that, an RL LOGIT was carried out to determine the significance between these variables. It was observed that as other variables of the generator (II, III, IV, V1, DAP by management and DAP by RP) are incorporated, the prediction model scores improve. So, the perception of well-being based on RP handling would increase incorporating all the variables of the generator as independent (II, III, IV, V1, DAP by management and DAP by RP) and the answers where respondents considered that RP handling of nearby generators affect the welfare as dependent variables.

It is appreciated that there is a Chi-square of 16,877 with a significance of .000, a value that is <a 0.05, which indicates that the prediction is improved with all the variables included. A Negelkerke R-squared score of .137 is observed, indicating that the proposed model explains the variance of the dependent variable at a 3.7% level. In addition, the model provides an overall forecast percentage of 69.6%.

Finally, as it can be observed in the variable box of the equation, the consideration that RP handling affects the welfare of the people (this can be seen in the annex referring to the RL LOGIT between generators and nearby people) increases, according to the Exp (B) value, if knowledge of types, volumes, impacts, the legislation and the DAP for the generator's handling and management of RP increase as well.

This shows that the better the RP handling is, he better the perception of the people surrounding the RP generators will be. In this context, it is worth pointing out the possible impacts that an incorrect handling of RP would cause on the sustainable development of the Cuitzeo region. This is with the purpose of proposing actions to improve said RP handling. (For more details on the variables, see table 18).

Table 18 Data Matrix of the Contingent Valuation Method

Cat.	Grouped variable	Dimension	Indicators (Items)	Type of variable	Measurement level
Condition variables	Socioeconomic characteristics of the generator	It covers economic and social aspects of the RP generator defined as any individual or entity that generates RP within the ranges established in the LGPGIR, in its micro, small and large categories. Within the economic aspects, emphasis is placed on the type of industry, the employees who are in charge of the respondent, income at the core (company) and personal (surveyed) level, as well as the amount that is used to manage RP. The social aspect includes gender, age, education, occupation, economic dependents, housing and health.	How old are you?	Categorical	Nominal
			Indicate the type of industry of the establishment	Categorical	Nominal
			Gender	Categorical-dichotomous	Nominal
			What is your education level?	Categorical-multiple	Ordinal
			What is your occupation?	Categorical-multiple	Nominal
			How many employees are you in charge of?	Categorical-multiple	Ordinal
			What is the company's estimated monthly income?	Categorical-multiple	Ordinal
			How much of the company's monthly income is allocated for the handling of hazardous waste?	Categorical-multiple	Ordinal
			What is your monthly income range in pesos?	Categorical-multiple	Ordinal
			How many economic dependents do you have?	Categorical-multiple	Ordinal
			What type of home do you have?	Categorical-multiple	Nominal
			What type of health care service do you have?	Categorical-multiple	Nominal
Knowledge variables	RP generation characteristics	The variable covers aspects related to the degree of knowledge of the characteristics of the generated RP as well as the impacts that can be caused by them when handled improperly, both on the environment and on people's health.	Do you know what waste is?	Categorical-dichotomous	Scale
			Do you know what hazardous waste is?	Categorical-dichotomous	Scale
			Do you know the difference between hazardous and non-hazardous waste?	Categorical-dichotomous	Scale
			Do you generate hazardous waste?	Categorical-dichotomous	Scale
			Do you know the generation volume of your hazardous waste?	Categorical-dichotomous	Scale
			Do you know the hazardous characteristic of some of your waste?	Categorical-dichotomous	Scale
			Do you know if your generated hazardous waste is corrosive?	Categorical-dichotomous	Scale

			Do you know if your generated hazardous waste is reactive?	Categorical-dichotomous	Scale
			Do you know if your generated hazardous waste is explosive?	Categorical-dichotomous	Scale
			Do you know if your generated hazardous waste is toxic?	Categorical-dichotomous	Scale
			Do you know if your generated hazardous waste is flammable?	Categorical-dichotomous	Scale
			Do you know if your generated hazardous waste is biologically infectious?	Categorical-dichotomous	Scale
			Do you know that hazardous waste can contaminate the soil?	Categorical-dichotomous	Scale
			Do you know that hazardous waste can contaminate water?	Categorical-dichotomous	Scale
			Do you know that hazardous waste can damage the surrounding flora and fauna?	Categorical-dichotomous	Scale
			Do you know that hazardous waste can damage your health?	Categorical-dichotomous	Scale
			Do you know that used oil can cause poisoning if it is not handled properly?	Categorical-dichotomous	Scale
			Do you know that some plastics, textiles, paints, filters, contaminated cardboard among others items considered as hazardous waste can cause cancer if not handled properly?	Categorical-dichotomous	Scale
			Do you know that pathological and non-anatomical waste can transmit contagious diseases if not handled properly?	Categorical-dichotomous	Scale
Compliance variables	Technical characteristics of RP handling	This variable considers aspects of normative observance in the handling of the RP generated. It is based on the requirements that every generator must comply with, such as the registry, the logbook, handling plan, the COA, environmental insurance and the contracting of service providers of RP handling duly authorized by SEMMARNAT and SCT.	Do you have an Environmental Registration Number (Spanish acronym: NRA)?	Categorical-dichotomous	Scale
			Do you know your category as a hazardous waste generator ?	Categorical-dichotomous	Scale
			Do you have a hazardous waste handling plan?	Categorical-dichotomous	Scale
			Do you have a hazardous waste input-output logbook from the warehouse?	Categorical-dichotomous	Scale
			Do you have hazardous waste delivery-receipt manifests?	Categorical-dichotomous	Scale
			Do you present the Annual Operation Certificate (Spanish acronym: COA) annually? *	Categorical-dichotomous	Scale
			Do you have Environmental Insurance for the handling of your hazardous waste? *	Categorical-dichotomous	Scale
			Are the providers of collection, transport, storage and final disposal service for your hazardous waste authorized by SEMARNAT?	Categorical-dichotomous	Scale
			Are the providers of collection, transport, storage and final disposal service for your hazardous waste authorized by SCT?	Categorical-dichotomous	Scale
Compliance variables	Operational characteristics of RP handling	This variable covers aspects of the operational compliance of the RP handling. It is based on the current regulations focused on knowing the way in which the RP are stored and under what conditions they are disposed.	Do you have a hazardous waste warehouse?	Categorical-dichotomous	Scale
			Do you store your hazardous waste for less than six months? **	Categorical-dichotomous	Scale
			Is your warehouse roofed?	Categorical-dichotomous	Scale
			Do you have an extinguisher in your hazardous waste warehouse?	Categorical-dichotomous	Scale
			Is all waste labeled with the corresponding name?	Categorical-dichotomous	Scale
			Is all waste identified with the danger characteristic?	Categorical-dichotomous	Scale
			Do you store your hazardous waste in separate containers?	Categorical-dichotomous	Scale
			Does your warehouse have signs alluding to the danger of the waste stored?	Categorical-dichotomous	Scale

			Does your hazardous waste warehouse have gutters?	Categorical-dichotomous	Scale
			Does your hazardous waste warehouse have retaining walls?	Categorical-dichotomous	Scale
			Does your hazardous waste warehouse have a retention pit?	Categorical-dichotomous	Scale
			Do you dispose your hazardous waste through a provider of collection, transport, storage, recycling, treatment, confinement services?	Categorical-dichotomous	Scale
			Do you know the next phase of your hazardous waste handling?	Categorical-dichotomous	Scale
			Is your hazardous waste warehouse not located near common areas?	Categorical-dichotomous	Scale
			How long do you store your RPBI?	Categorical-dichotomous	Scale
Knowledge and willingness variables	Characteristics of the DAP for RP handling	This variable considers three phases. The first one is focused on determining the degree of knowledge about the existence of regulations in terms of RP; the second is focused on knowing if the generator has been instructed in an administrative process by PROFEPA and knowing what the fine has been; the third is based on determining the DAP and the MHP (Amount that has been paid) for the management of the RP. The latter includes technical procedures (procedures such as NRA, COA, handling plan, etc.) and operative management (conditioning of the temporary RP warehouse).	Do you know that there is legislation on hazardous waste?	Categorical-dichotomous	Scale
			Do you know that the Law establishes technical and operational obligations as a generator of hazardous waste?	Categorical-dichotomous	Scale
			Have you been sanctioned by PROFEPA?	Categorical-dichotomous	Scale
			Have you paid for any action to prevent or correct measures imposed by PROFEPA?	Categorical-dichotomous	Scale
			Have you paid for legal attention to administrative procedures?	Categorical-dichotomous	Scale
			Have you paid for the conditioning of the hazardous waste warehouse?	Categorical-dichotomous	Scale
			Do you pay for the disposal of your hazardous waste?	Categorical-dichotomous	Scale
			Are you willing to pay for the management of administrative procedures in terms of hazardous waste?	Categorical-dichotomous	Scale
			How much is DAP for the Environmental Registration Number?	Numerical	Scale
			How much is DAP for the categorization as a generator?	Numerical	Scale
			How much is DAP for the waste handling plan?	Numerical	Scale
			How much is DAP for the waste logbook?	Numerical	Scale
			How much is DAP for the COA?	Numerical	Scale
			How much is DAP for preventive and corrective legal advice?	Numerical	Scale
			How much is DAP for the construction of the concrete roofed area with retention pits, retaining walls, gutters, non-slip floor, natural ventilation and artificial lighting?	Numerical	Scale
			How much is DAP for the containers for each type of waste with its indicative sign?	Numerical	Scale
			How much is DAP for the signs alluding to danger?	Numerical	Scale
			How much is DAP for the extinguisher?	Numerical	Scale
			How much is DAP for the disposal of your generated RP?	Numerical	Scale

* Only applies to large generators of hazardous waste. Source: Author's own design based on Castro (2010)

Based on the fact that the inadequate handling of RP in the Cuitzeo region can halt the possibilities of sustainable development, it is necessary to consider that RP generation cannot be stopped but can only be reduced and improved. This is why there is an opportunity to transform dangers, damages as well as environmental and social impact into energy strategies that promote development.

4.5 The environmentally adequate handling of hazardous waste in the Cuitzeo Region as an energy- related, development-promoting area of opportunity

The Cuitzeo region generates about 4,861.90 tons of RP of the 11,673.30 tons of RP that are generated in the entire state of Michoacan from 2,273 different industries. However, it is noteworthy that this region also concentrates 1,061, 011.00 people, which makes it the region with the highest population and economic density. This situation deserves special interest because the RP generated by the population mass are handled as RSU disposed by the municipalities.

This situation represents an area opportunity for the municipality in terms of energy. At the same time, it is an environmental risk that would bring about environmental responsibilities for these municipalities. The RP constitute an opportunity area for environment and energy because of its treatment with Plasma technology. This method is currently used in Australia and Japan to treat RP coming not only from the economic sector but also from the social sector. Basically, the treatment lies in exposing the RP to temperatures ranging from 5,000 to 10,000 degrees centigrade through gasification by plasma, thus producing clean energy.

The current theory on Plasma technology suggests that 673 kilowatt-hours of net energy can be obtained with a ton of RP through an improved plasma fused system. This method can be applied not only to RP but also to RSU and RME (Moratorio et al., 2012).

It is evident that not only by submitting RP to high temperatures can energy be generated. Alvarado et al. (2016) suggest that a way to make use of waste is through the incorporation of Solid Oxide Fuel Cells (SOFC) from biogas. Since RSU disposition is generally mixed with RP, it increases the generation of gases. These become greenhouse gases when not directed correctly. Biogas is also one of the most important energy resources that not only comes from the mixture of gases in the inadequate provision of RP and RSU, but can also come from agriculture, livestock and all rural activity.

Some of the main gases that can be obtained from both RP and RSU are methane (CH_4) and carbon dioxide (CO_2). RP generally come from business or industrial sectors. For this reason, it has been estimated that they would contribute between 50% and 70% of CH_4 and between 30% and 50% of CO_2. On the other hand, the disposal of RSU would contribute from 45% to 65% of CH_4 and from 34% to 55% of CO_2 (Campos, 2001 in Alvarado et al., 2016). This indicates that if both gases are used properly, they can generate enough energy to easily supply more than 40 thousand homes (Ibidem).

Given this fact, what was pointed out by Buenrostro and Israde (2003) must be kept in mind. They indicate that the Cuitzeo Basin has the highest concentration of industries. At a lower scale, the agricultural sector also has high levels of pollution. This situation is magnified by the wrong disposal of residues and by the scarce economic and human resources available in the municipalities. In 2008 alone, more than 150 clandestine sites for the disposal of RSU were counted. However, it is known that there are multiple places such as sewers, ravines, rivers, bodies of water, drainage, abandoned land or solitary places in which a less amount of RSU is disposed. Nonetheless, it represents an environmental and social problem.

In addition to this, more than 2000 RP generators are concentrated in the Cuitzeo region. This increases the challenge of using, minimizing and recovering waste not only by the municipality, the state or the federation, but mainly by those who generate it. There is a broad legal framework for RP in particular that provides for technical obligations, administrative procedures and operational obligations such as special storage.

Chapter V Legal regulation of hazardous waste handling

The contributions on the concept of region, the elements of the environmental economy in relation to the methods of economic valuation, the new economic geography and the paradigm of development in its sustainable and regional connotation merit the analysis of its normative framework. This is because the legislation in matter of waste establishes the parameters of its integral handling through the establishments of technical and operational obligations. The effectiveness prompted by RP generators is sought to be measured with the support of the scientific method. Also, it is intended to know how waste handling is perceived by the people surrounding the generators. According to the analysis of the theoretical contributions of development, a key element has been incorporated in its definition: it seeks to "*meet the needs of present generations without compromising the ability of future generations to meet their own needs. This is achieved by incorporating the right to development, which must be exercised in a way that responds equitably to the development and environmental needs of present and future generations. In order to achieve sustainable development, the protection of the environment should be an integral part of the development process and cannot be considered in an isolated form*" (Brundtland Report, 1987, United Nations Commission on Environment and Development, 1992).

This parameter of equity is reflected in the Mexican regulatory framework on waste in Article 4 of the CPEUM. It seeks to preserve *the right to a healthy environment for development and well-being* through a Constitutional Guarantee and a Human Right. This double bind requires a legal analysis because any General or Private Law, any Regulation or NOM are subject to this constitutional principle and waste regulation is not the exception. Therefore, the regulatory framework provides the basis for comprehensive waste handling as well as the technical and operational obligations for the generators to guarantee that right and not be sanctioned by the authority and by the citizen advocacies.

This section will outline the regulation of RP handling in Mexico from its first regulations to existing and applicable regulations. It also addresses a compendium of the main risks in RP handling, contingencies of improper handling of RP and types and volumes of RP in Mexico, in Michoacan and in the Cuitzeo region. It concludes with a section that addresses environmental responsibility in RP handling.

5.1 The role of regulation on hazardous waste

It has been observed that the development scheme implies a right and an obligation following the consolidation of the Brundtland Report (1987). The report points out the responsibility of satisfying the needs of present generations without compromising the capacity of future generations through the incorporation of the right to development exercised in an equitable manner and integrating environmental protection at all times. This is a reflection of a constant struggle to optimize production and consumption processes under environmentally friendly schemes.

To guarantee this link between equity of development, environmental protection and the satisfaction of present and future needs, a legal system is unfolded. This system establishes the bases and limits of proceeding in order to guarantee the rule of law that promotes social equity. The normative framework, then, is an essential element that guarantees the fulfillment of these international prerogatives. Therefore, several countries have incorporated in their legislation the premises that are derived from said international agreements. Mexico is not the exception and has implemented in its highest normative -the CPEUM- the right to a healthy environment for development and well-being. This right was included for the first time in the CPEUM's article 4 in 1999, and it notes that: "*Everyone has right to an adequate environment for their development and well-being.*" However, a decree was published in the DOF on February 8, 2012 to amend the fifth paragraph and a sixth paragraph was added to article 4 of the CPEUM, stating that: *"... Everyone has the right to a healthy environment for their development and well-being,*" and that *"The State will guarantee the respect for that right. Damage and environmental deterioration will generate liability for those who causes it under the terms provided by law ... Everyone has the right to access, disposal and cleaning of water for personal and domestic consumption in a sufficient, healthy, acceptable and affordable way. The State will guarantee this right and the law will define the bases, supports and modalities for the equitable and sustainable access and use of water resources, establishing the participation of the Federation, the states and municipalities, as well as the participation of citizens for the achievement of such goals."* (CPEUM, artícle 4).

Although there is no express definition of a healthy environment, it can be interpreted as the one that maintains the balance among natural elements. Said elements include the human being, who will also be the possessor of the right to be guaranteed said balance and, otherwise, it may request the repair of any damage (Human Rights Indicators on the Right to the Environment in Mexico, 2012).

This prerogative has been increasingly established in the rest of the environmental laws in Mexico, and has sought more than to just guarantee its basic premise: *"Gradually regulate human activities that generate impacts on the environment in a sectoral manner, such as the management of RP, EMR and RSU, air pollution, environmental impact assessment, etc. Regarding the access of people to the right to a healthy environment for their development and well-being, Mexican law has gradually recognized that for the enjoyment of this right, it is necessary to have the appropriate conditions and a legal framework that recognizes all individual and collective services as wells as the tangible and intangible value that the environmental environment provides to human beings and that affects their quality of life protecting both present and future generations."* Regarding RP, the current regulations incorporate the old constitutional premise referred to the right to an adequate environment for development and well-being, thus the LGPGIR is sustained (Article 1).

This has so far been considered as the framework waste law in Mexico, which defines waste handling as the primary tool to promote the minimization and assessment of waste. It constitutes a diffuse right because it entails a collective way of guaranteeing affectations of public goods or shared rights. It is intergenerational because not only does the right to present generations belong to it, but it also considers future generations. It is dispersed because it is complemented with a set of laws, not only in a single one, and it is transversal because it involves diverse disciplines and is in constant evolution (Consulted in http://ceja.org.mx/ in May 2016).

Thus, the LGPGIR is currently the central axis of wast regulation in Mexico. It defines competencies and responsibilities as well as handling schemes for the three types of waste (RSU, RME and RP), consisting of various principles. The first one is the principle of reality: each federative entity and municipality go through circumstances and have different vulnerabilities. Second, the principle of gradualism: in order for the application of the law to be effective, it is necessary to create the conditions that allow its applicability.

Finally, the principle of flexibility: differentiated measures that distribute their transaction costs according to the volume of waste coming from the generators and their location conditions (Cortinas, 2006). However, this was not always the case, the regulation of waste in Mexico has been a process full of historical demands and international commitments.

Some sources argue that the control of waste began in Mexico in the pre-Cortesian era. On July 15, 1891, the First Sanitary Code prepared by the Higher Health Council was issued. The first studies related to waste were carried out during the second decade of this century, when solid waste shattering studies were developed to be used for agricultural fertilization and sanitation studies in several neighborhoods of Mexico City. However, waste regulation as such became known until 1964, when the Directorate of Sanitary Engineering became part of the Construction and Sanitary Engineering Commission of the Ministry of Health and Assistance (Spanish acronym: CCISSSA).

It had the purpose of serving waste collection and disposal programs at the national level (only the RSU was considered). The first work of great magnitude for the control of waste was made in the decade of 1960, when the first sanitary landfill of the country was designed and operated under the direction of professionals and technicians of CCISSSA in the city of Aguascalientes (INECC 2016 through http://www2.inecc.gob.mx/, consulted in May, 2016).

The regulation was carried out through health institutions that only considered RSU. It was not until 1988 when the regulation of RP started to consider not only to the health problem but also the environmental impact problem. It was through the LGEEPA publication and its RP Regulation Handbook (currently repealed), that the regulation of the RP began. With all this, guidelines were established to track waste from cradle to grave and determine the size of the environmental markets required for an environmentally sound handling (Jiménez, 1996).

5.2 From the first legal regulations on waste in Mexico to its incorporation into state and municipal regulatory frameworks

Nemi Dib (1995:120) states that *"The most useful way to face the complications of RP is not to generate them"*. This premise has many implications. Perhaps the most important one is the provisional nature of any strategy aimed at solving problems, considering that the instruments on which they are based will be useless when there is no more waste. The reason for this temporary rating is based on the inconveniences and the little usefulness of the solution models. They favor dealing with consequences over dealing with causes and do not offer in-depth solutions. Therefore, prevention has been sought before correction in Mexico. The Federal Law to Prevent and Control Environmental Pollution (Spanish acronym: LFPCCA), published on March 23, 1971, refers to waste through the prevention and control of soil contamination. Based on Article 5, the states and municipalities were auxiliary authorities of the Federation (PNPGIR, 2008).

Subsequently, on January 11, 1982, the Federal Environmental Protection Law (Spanish acronym: LFPA) was published. It repealed the LFPCCA and, like it, treated the issue of waste through the protection of soils. It also considered the states and municipalities as auxiliaries to the federal authorities (Jiménez, 1996).

As a reference to the current legal regime on waste, it was modified in 1985 when the constitutional article 115 was reformed, granting municipalities the power to provide public services. In addition to this, in 1987 the LFPA was repealed and the LGEEPA was enacted. The latter was amended in 1996, clearly defining the competences and functions of the different levels of government regarding waste. It is worth mentioning that, at the end of 1999, the collection, transfer, treatment and final disposal of waste was added without distinguishing between the different types that are generated. It is also important to specify that the aforementioned article establishes that municipalities will observe the provisions of federal and state laws in the performance of the functions or the rendering of services under their charge without prejudice to their constitutional competence. There is a regulation in the Constitution regarding the control and handling of waste although the practice focuses on the service of RSU cleaning (Jiménez, 1996, PNPGIR, 2008).

Article 73, section XXIX G, empowers Congress to issue laws on environmental protection and preservation of ecological balance to establish the concurrence between federal, state and municipal governments in the field of their respective competencies. Such competencies are those conferred by the Constitution itself, based on which the LGEEPA was enacted in 1988. The latter was established as the basis for the regulation of RP even though the Constitution only grants power on waste management to municipalities (PNPGIR, 2008).

This was based on the consideration that article 124 of the CPEUM establishes an excessively orthodox vision. It is based on dual federalism where there is a restrictive distribution of competences among government levels, and it states that only the Constitution can distribute competencies among federal and local governments in a federal system.

Fortunately, constitutional law, not only in Mexico but in other countries and regions, considers federalism as a cooperative character where a restrictive distribution of competences coexists with flexible formulas to adjust the exercise of power in a given moment and social scheme. This is stated under the commitment of respect for the principle of legality and legal security that must exist in every modern State.

Federalism, then, is understood as a permanent process of attributions that always recognize how specific competency balances are altered or adjusted according to the variants presented by reality (Azuela and Cancino, 2007).

Therefore, the LGPGIR is based on an interpretation of cooperative federalism. It has been embodied in legal provisions in force such as the General Health Law, the Education Law, the LGEEPA, the General Law of Wildlife and the General Law of Human Settlements. Its scope is given in terms of the three fundamental conducts of waste regulation: generation, handling (includes a wide variety of activities ranging from storage, collection, to its reuse, recycling, transport and treatment), and final disposal (Cortinas, 2006).

Another aspect of this is referred to in Article 25 of the CPEUM. It is the basis for achieving sustainable development to the extent that it is subject to companies in the social and private sectors of the economy, to the modalities dictated by the public interest and to the general benefit and conservation of the productive resources and the environment. The provisions of Article 27 make it possible to proceed with the expropriation of private properties whose pollution conditions constitute a impermissible risk. Said provisions have a particular relevance on the declarations tending to prevent risks to health and the environment from the contamination of sites with waste. (PNPGIR, 2008).

Mexico's legal system in terms of RP is supported by several laws at the federal level such as the Law of Planning, published on January 5, 1983. In its Article 3, it establishes that national development planning is the rational and systematic management of actions aimed at transforming the country's reality. These actions are based on the exercise of the Federal Government in matters of regulation and promotion of environmental protection and rational use of natural resources according to the Constitution (Jiménez, 1996).

On the other hand, the LGEEPA, issued on January 28, 1988, defined the concurrence on waste among the three levels of government -federal, state and municipal. A circumstantial fact is that the LGEEPA considers waste as a potential contaminant, reason why it applies the *"polluter pays"* principle to the generator. In its article 134, it establishes that it is up to the State and the society to prevent soil contamination. Waste should be controlled as it is the main source of soil contamination. It is necessary to prevent and reduce the generation of solid municipal and industrial waste, incorporate techniques and procedures for reuse and recycling, and regulate their efficient handling and final disposal (LGPGIR, 2003).

On the other hand, the LGPGIR, published in the DOF on October 8, 2003 and effective from 2004, aims to guarantee the right of everyone to a healthy environment and promote sustainable development through the prevention of generation, the assessment and the comprehensive management of RP, of RSU and of special handling. It also aimed at preventing the contamination of sites and carrying out its remediation.

This Law establishes that the generation and environmentally sound handling of waste is the responsibility of all social sectors although in a differentiated manner. All of them must take part in the development of the actions envisaged in it to achieve the goals pursued. These goals are to prevent generation, assess waste and achieve its comprehensive handling in an environmentally effective, technologically feasible, economically viable and socially acceptable manner. In this way, the burden that currently lays primarily on the municipal authorities will be shared. The municipalities will only have the administration of collection services for waste generated at the household level (LGPGIR, 2003).

Most of the legal provisions have been issued by the Federal Government. Currently, the Federation has power in matters of RP, the states do in terms of special handling, and municipalities do in RSU and, exceptionally, in hazardous waste coming from micro-generator households. The latter is possible as long as an agreement has been signed with the federal authorities (LGPGIR, 2003).

The Regulation of the LGPGIR was published in the DOF on November 30, 2006. It repeals the Regulations of the LGEEPA on RP published on November 25, 1988. This new disposition aims at regulating the LGPGIR, and it rules throughout the national territory. The areas where the Nation exercises its jurisdiction and its application corresponds to the Federal Government through the SEMARNAT (PNPGIR, 2008).

The LGPGIR Regulation made possible the execution of the waste law. Then, the perception of an adequate or inadequate handling is feasible.

On the other hand, the LFMN, published on July 1, 1992, describes the characteristics and / or specifications that products, processes and services must meet when they may represent a risk to: the safety of people; human, animal or vegetable health; general and labor environment; and the preservation of natural resources. This regulation also describes the specifications and / or procedures of product packaging that may constitute a risk to the safety of people or damage their health and the environment (PNPGIR, 2008).

The Official Mexican Standards related to the classification, handling, final disposal of waste, confinements and remediation of contaminated sites are among others: NOM-053-SEMARNAT-1993 - determines the procedure to carry out the extraction test to determine the constituents that make an RP due to its toxicity to the environment.

NOM-052-SEMARNAT-1993 and NOM-054-SEMARNAT-1993 -- establish the procedure to determine the incompatibility between two or more residues considered as hazardous by the Official Mexican Standard. NOM-133-SEMARNAT-2000 -- provided for environmental protection - polychlorinated biphenyls (PCBs): handling specifications. NOM-098-SEMARNAT-2002 - specified for environmental protection-waste incineration: operation specifications and pollutant emission limits. NOM-087-SEMARNAT-SSA1-2002 - Provided for environmental protection - environmental health, hazardous biological-infectious waste: classification and management specifications. NOM-083-SEMARNAT-2003 - establishes the environmental protection specifications for site selection, design, construction, operation, monitoring, closure and complementary works of a final disposal site for RSU and special handling. NOM-052-SEMARNAT-2005 - establishes the characteristics, identification procedure, classification and lists of RP. NOM-056-SEMARNAT-1993 - establishes the requirements for the design and construction of the complementary works of a controlled RP confinement. NOM-057-SEMARNAT-1993 - establishes the requirements that must be observed in the design, construction and operation of cells of a controlled RP confinement. NOM-058-SEMARNAT-1993 - establishes the requirements for the operation of a controlled RP confinement. NOM-055-SEMARNAT-2003 - indicates the requirements that must be met by the sites that will be assigned as controlled RP confinements and were previously stabilized. NOM-141-SEMARNAT-2003 - establishes the procedure to characterize the tailings, as well as the specifications and criteria for the characterization and preparation of the site, project, construction, operation and post-operation of tailings dams. NOM-145-SEMARNAT-2003 - considers the confinement of waste in cavities constructed by dissolution in geologically stable salt domes. NOM-138-SEMARNAT/SSA-2003 - establishes the maximum permissible limits of hydrocarbons in soils and the specifications for their characterization and remediation. NOM-147-SEMARNAT/SSA1-2004 - establishes criteria to determine the remediation concentrations of soils contaminated by arsenic, barium, beryllium, cadmium, hexavalent chromium, mercury, nickel, silver, lead, selenium, thallium and / or vanadium.

In addition to the laws, regulations and NOMs, there are other legal bodies that concurrently regulate RP. These legal systems are translated into laws as well as state and municipal regulations.

The LGPGIR only establishes bases, principles and general provisions to guide the elaboration of local ordinances. Therefore, the legal regime that supports the environmentally adequate and comprehensive management of waste is complemented by the legal regulations (laws, regulations and technical standards) of the 33 states and 2,439 municipalities (regulations, municipal laws and others).

This is all based on the basic diagnoses of the situation of the corresponding waste. It is important to note that Mexico City was the first entity to issue a local Solid Waste Law. It was published on April 22, 2003 before the LGPGIR itself, but it was based largely on the object and orientation of its provisions. This was complemented by the publication of the Program for the Comprehensive Management of Solid Waste for Mexico City 2004-2008 (Ávalos, 2011).

As occurred when the LGEEPA was published, some states have paid particular attention to the preparation and publication of their waste laws based on the General Law between 2004 and 2007 -- for example, Coahuila, Durango, Guanajuato, Morelos, Querétaro, Quintana Roo and Veracruz. Even some of them have published the corresponding regulations -- for example, Guanajuato and Querétaro -- while others reformed their environmental laws to incorporate the consideration to the new legislative vision of waste. Others have not yet updated their legislation on the matter. Paradoxically, some municipalities in the country have issued their regulations related to waste management after the implementation of the LGPGIR. This has been done without necessarily exhibiting the preventive orientation and based only on the reduction, reuse and waste recycling provisions of the General Law.

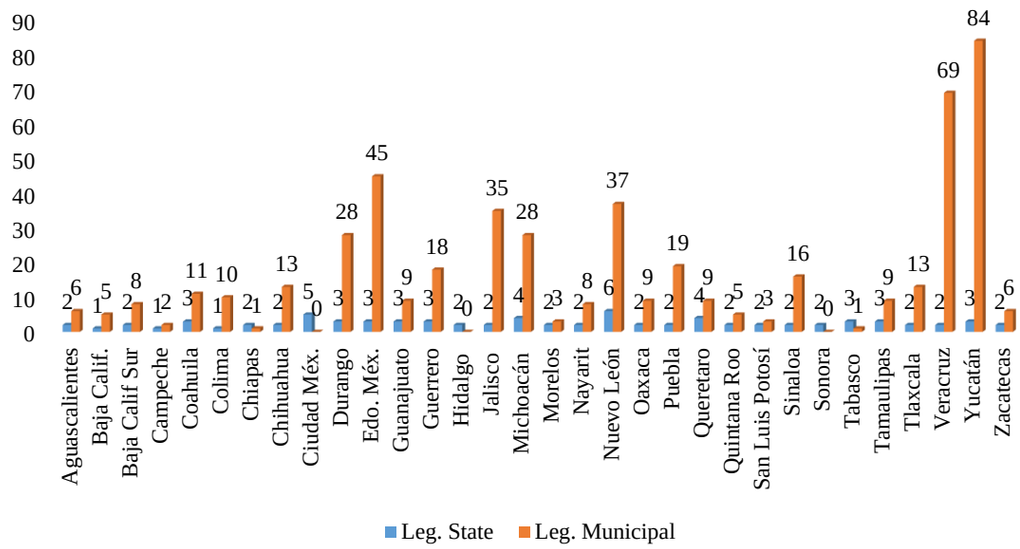
Commonly, waste management local regulations framed in the LGPGIR do not make reference to the domestic RP under municipal responsibility that provide cleaning services. Neither do they mention RP generated by the micro-generator establishments that can be controlled by the state or municipal authorities by agreement with the Federal Government (Ávalos, 2011).

As indicated in the following graph, Mexico has legal provisions that intend to regulate this worrisome situation. These provisions plan for the authorities to offer a cleaning service or merely supervise administrative procedures for generators. They forget in a certain way the establishment and regulation of prevention, minimization and waste assessment mechanisms, in particular of the hazardous ones, as shown in Graphic 4.

In 2006 and 2007, SEMARNAT published two manuals. One covered the Bases for Legislation of the Prevention and Comprehensive Management of Urban Solid Waste and Special Management. The second covered the Regulation of Hazardous Waste in Mexico. This had the purpose of supporting local initiatives to develop the state and municipal legal systems that allow the application of the LGPGIR at the local level (SEMARNAT-INE, 2009).

This would also expose the existing legal bodies in order for generators to comply with their obligations and prevent risks and damages both to society and the environment arising from inadequate RP handling.

Graphic 4 State and municipal legislation by state



Source: Author's own design based on PNPGIR, SEMARNAT 2008 (2014)

5.3 Scope and limitations of the technical and operational obligations of the generators of hazardous waste in Mexico

The Mexican legal framework for RP seeks to regulate and control generation and handling under parameters of health, economic, environmental and social efficiency; it seeks to establish principles of shared but differentiated responsibility, assessment, minimization and prevention.

Therefore, it establishes certain obligations to reduce risks and hazards such as having a temporary waste storage facility that is located far from common areas and that has retention pits, retaining walls, gutters, extinguisher, signs alluding to danger, anti-slip floors, ventilation and appropriate lighting.

Some other obligations are: to separate and label each RP with its name and characteristics CRETIB; to have an NRA, categorization as a generator (micro, small or large), COA, register log of the RP, waste handling plan, manifests of delivery-reception of the RP and environmental insurance; to hire service providers of collection, transport, storage and final disposal of their RP duly authorized by SEMARNAT and SCT; to know the next handling phase of the RP delivered to said service providers (recycling, reuse, co-processing, incineration or controlled confinement); not to store their RP for more than six months (except in the case of RPBI, whose storage must be less than fifteen days) (LGPGIR, 2003, RLGPGIR, 2006 and NOM-087-SEMARNAT-SSA1-2002). For more details, see table 19.

Table 19 Main obligations for generators of hazardous waste, 2015

Obligations	Large generator	Small generators	Micro generators
Environmental Registration Number (Spanish acronym: NRA)	*	*	*
Categorization	*	*	*
Annual Operating Card (Spanish acronym: COA)	*		
RP Logbook	*	*	*
RP Handling Plan[1]	*	*	*
Environmental insurance	*		
Delivery-Receipt Manifests of generated RP	*	*	*
Contract with RP service providers duly authorized by SEMARNAT and SCT[2]	*	*	*
Provisional RP warehouse [3]	*	*	*

[1] Only large generators mus submit their RP handling plan to SEMARNAT for registration. Small and micro-generators can adhere to an existing one.
[2] The contract does not necessarily have to be written; it must only be guaranteed that the service providers have the current authorizations. The generator must request a simple copy from the provider.
[3] The warehouse must meet the conditions indicated in the LGPGIR Regulation. These include: roofing, location separated from common areas, restricted location, signs alluding to the danger of protected RP, ventilation and lighting, anti-skid floor, fire extinguisher, retention pits, retaining walls, gutters, the RP must be packed separately with their sign and CRETIB characteristics.

Source: Author's own design based on the LGPGIR en its regulation, (2016)

In order to determine these obligations, the LGPGIR has a classification of waste that has acquired a double function. On the one hand, it seeks to determine the context and scope of regulatory application by classifying the different types of waste and the generators that are subject to it. On the other hand, it serves as a management tool for several procedures such as: the construction of comparable inventories throughout the country; the determination of market sizes for handling services; the definition of safe, environmentally appropriate, economically viable and socially acceptable forms of handling; and the evaluation of risks that may derive from its handling. In spite of this last positive function of the Law (the current observation), it is pertinent to indicate that its effectiveness depends on the willingness of the generator to report its real waste generation and demonstrate its correct handling.

For the purposes pursued by the aforementioned Law, three types of waste are distinguished: *special handling (RME), urban solid (RSU) and hazardous (RP)*. They define their application context and the individuals who are subject to their differentiated regulatory provisions. (Article 5, sections XXXII, XXXV and XXXIV, respectively).

These three types of waste address the Mexican reality. The notion that waste is a contaminant was introduced for the first time in the country in 1988 with the publication of the LGEEPA and that it must be regulated and controlled from the environmental perspective to prevent risks to health and the environment. For this reason, provisions were incorporated where some criteria and measures were established to prevent and control pollution caused by the handling of all types of waste (LGPGIR, 2003).

Regarding municipal solid waste, this law calls it RSU but keeps the usual criteria to determine its origin and the types of the conforming materials that are commonly referred to in the generation statistics. SME includes waste denoted under the category of industrial waste in the LGEEPA. It also includes all those residues generated in large volumes by social groups and by the industrial and service sectors. These are usually not collected together with household waste for cleaning services but separately and through agreements and differentiated payments (LGPGIR, 2003).

As for the RP relevant to the investigation, the aforementioned Law establishes that *are those that have some characteristic of danger, specifically: corrosive, reactive, explosive, toxic, flammable and biological infectious*. This does not mean that the rest of waste is not hazardous because all waste, regardless of the type, represents a hazard to the environment and health. The difference is that the damage index is higher for those considered hazardous precisely because of their components and the volume that can be generated in factories or service institutions. Said legislation also indicates that RP containers are also considered hazardous, so they must be handled in the same way in the terms established therein (LGPGIR, 2003).

An RP is not necessarily a risk if it is handled safely and adequately to prevent possible harm. The fact that a certain waste is hazardous does not necessarily mean that it causes damage to the environment or health. In order for this to happen, it must be capable of diffusing into the environment, altering air quality, soils, water, and having contact with aquatic or terrestrial organisms and humans (CINVESTAV, 2005).

So, for a certain waste to negatively affect human beings or the environment, it must be handled incorrectly, that is, not observing minimum security conditions. Thus, it is necessary to know what is understood as comprehensive waste handling and what are the phases of such handling so that it can be environmentally adequate (Jiménez, 1996).

5.3.1 Comprehensive waste handling

The rigidity and complexity of the legal provisions that originally ruled RP in Mexico and other countries, established to regulate and control RP (mainly those generated in the manufacturing or processing industry, where the chemical industry stands out), have proven to be impossible to apply to all generators. Such is the case of small establishments that generate RP in very variable quantities, hence the classification of RP generators (Cortinas, 2010).

The same experience has been experienced in other countries, such as the USA, which had to implement more flexible regulations such as the Universal Waste Regulation. Here, RP that consumers return for recycling to producers, importers, and traders is called "universal waste" during transport and collection and are exempt from complying with the legal provisions for RP (Cortinas, 2006).

The Mexican legislation through the LGPGIR, Article 5, fraction VII decided to define comprehensive waste handling. It indicated that different parties are involved since waste originates until it is available, whether hazardous or not. Such parties are: the people who make a product that ultimately becomes waste, those who market it, those who use it and those who provide a waste disposal service that will carry out an exploitation activity (recycling, treatment or co-processing) or a final disposal activity (incineration or confinement).

This legal definition should emphasize the activities of the generators since they are responsible for the waste to be channeled to the people who carry out the following stages of comprehensive handling. In other words, comprehensive waste handling must be carried out individually by a producer, distributor or a provider of a service to streamline their processes and avoid the generation of waste. They must rely on the activity of third parties and on the environmental, technological, economic and social perspective (LGPGIR, 2003). If the regulations are observed in this way, confusion can be avoided when interpreting the definition of comprehensive waste handling.

This definition implies that all activities will be carried out by the waste generator, which in legal terms means a limited but differentiated responsibility. In order to specify the different activities mentioned above, the origin of the RP must be considered since it depends on the consumer's own activity. A product has as destiny to become waste and the impact it causes to society and the environment will depend on how it is handled and how much of it is generated. For this reason, it is convenient to specify the types of RP generators.

5.3.2 Universe of hazardous waste generators

According to the LGPGIR, there are home generators, micro generators, small and large generators, with different responsibilities in the handling of RP.

a) Home-based generators and micro-generating shops

The term home-based is used for other purposes in the areas of urban services. However, in the case of this legislation the term applies to waste generators of consumption materials and products (including their containers and packaging), both with hazardous and non-hazardous components. These are homes, establishments of different nature or public areas with residues of similar characteristics. Mexico’s population size, which reaches almost one hundred and twenty million inhabitants, can be used as a reference to have an idea of the universe size of generating sources in this category (Cortinas, 2006).

According to the reference legislation, industrial, commercial or service establishments, which generate up to 400 kilograms of RP per year, are considered as RP micro-generators. For this reason, they are subject to different types of particular obligations in the text of the Law (LGPGIR, 2003).

The differentiation made between micro and home-based generators is that their waste composition tends to be different in both cases even if a similar amount is generated. For instance, when waste of different products containing hazardous materials in its composition is disposed from homes, different and inconsistent amounts of RP are generated as a result of the infrequent and / or variable consumption. On the other hand, RP of certain particular types are usually generated more constantly.in establishments (for example, mechanical workshops, printing houses, dry cleaners or beauty shops). The universe of industrial, commercial and service micro-generators of RP can reach hundreds of thousands. That is why the Law considers the possibility that state authorities deal with their control (Cortinas, 2006).

b) Small and large generators

Small and large refer to sources generating all types of waste (urban solid, special handling and hazardous) in quantities from 400 kilograms to less than 10 tons per year and from 10 tons per year or more, respectively (LGPGIR, 2003). The differentiation between small and large generators has implications in terms of the obligations they must assume and in terms of the authorities that will be responsible for their control. This type of differentiation aims at distributing the administrative transaction costs of these generating sources proportionally to the volume of waste they produce (taking into account the environmental implications) (Cortinas, 2006). Experience has shown that large generators contribute to generate around 80 to 90% of waste and do not constitute more than 10% of the total generators. Thus, in an "intelligent and cost-effective management system", attention must first be focused on controlling the largest waste generators. This will prevent or reduce greater risks derived from their generation and handling (Cortinas, 2006).

Regarding RP generators, around 10 to 15% of waste from the transformation industry in Mexico is hazardous. This industry is 95% made up of small and micro enterprises, and there are more than 200,000 economic units in this sector (CANACINTRA, 2010).

The differentiation of the generators, *"...allows assigning different types of responsibilities in terms of compliance with the regulatory provisions of environmental performance and environmental management contained in the Law, based on the principles of reality and flexibility. Likewise, this distinction seeks for the transaction or administrative costs derived from compliance with the Law, both for the generators and for the competent authorities, to be proportional to the administrative and financial burden implied by their control, as well as to the risks that involves waste handling according to their volumes***"** (Cortinas, 2005: 3).

In industrial terms, Mexico is in constant development and there are very few companies or industries that can be considered large waste generators (PEMEX, CEMEX, CFE, service providers of collection, transportation and disposal of RP, among others). These make up only 8%, while the remaining 92% are small and micro generators. From the above, it is important to know the following: what are the main RP generated in the studied region; what social sectors generate them; what risks, damages or dangers implies their handling; what type of responsibility derives from said waste handling, what environmental costs they represent, what direct and indirect economic costs are generated and how these circumstances impact on sustainable development of the entity based on economic, social, legal, political, technological and environmental perspectives. Currently, the use of hazardous substances has become widespread and is steadily increasing not only in the industry but also in various social sectors. This has resulted in significant social and environmental risks. From the over one hundred thousand chemicals that are found in world trade, approximately 8,000 have some of the identified hazardous characteristics (Lester, 1997).

The management and environmentally appropriate handling of waste is aimed at preventing or reducing risks. Hazardous waste represents a risk that must be assessed, prevented and controlled. It may contain substances, pathogenic organisms and organic matter that can give rise, among other problems, to environmental pollution as well as to human exposure and aquatic and terrestrial biota (related living organisms in a given space).

The risks in waste handling can arise from the place in which it is generated, where it is collected, during the collection and transport and in the facilities in which it will be subjected to treatment or final disposal. Therefore, it is necessary to identify and characterize the particular risks in each phase in order to propose measures to prevent or reduce them.

5.3.3 Classification of hazardous waste based on risk considerations

The types of waste that are considered hazardous, according to their corrosive nature, are those that are very acidic or very alkaline (pH <2.0 or pH> 12.5). In other words, it is the property of substances capable of yielding hydroxide ions (compounds known as OH) when they are in aqueous solution (Quiminer.com, 2014). They can react dangerously with other residues, cause the migration of toxic pollutants, or they are able to corrode the steel in certain conditions and in a certain time. This can drive them to escape from their containers and release other waste (SEMARNAT, 2000).

Based on the provisions of NOM-052-SEMARNAT-2005, waste is corrosive if it meets the following criteria: it is in a liquid state or in an aqueous solution; has a pH lower than or equal to 2, greater than or equal to 12.5; it is in liquid or in aqueous solution and is capable of corroding carbon steel (SAE 1020) at a temperature of 55 ° C and at a speed of 6.35 millimeters per year or more.

Reactive waste is normally unstable and can react violently without explosion. It can form an explosive mixture with water, generate toxic gases, vapors and fumes. These may contain cyanide or sulfur and generate toxic gases, or they can cause explosions in situations of standard temperature and/ or pressure or if they are heated under confinement conditions or subjected to considerable forces (NOM-052-SEMARNAT-2005).

According to NOM-052-SEMARNAT-2005, a waste is reactive if it meets the following criteria: it is under normal conditions (25 ° C and 1 atm); it is combined or polymerized (of a plasticizing nature) violently without detonation; it reacts violently forming gases, vapors or fumes under normal conditions (25 ° C and 1 atm) when it comes into contact with water in a (waste-water) ratio of 5: 1, 5: 3, 5: 5; it reacts violently forming gases, vapors or fumes under normal conditions when placed in contact with solutions of acid pH (1.0 N HCl) and basic (1.0 N NaOH), in a residue/solution (RR / S) ratio of 5: 1, 5: 3, 5: 5; it is constituted by cyanides or sulfides that can generate toxic gases, vapors or fumes in quantities of 250 mg of HCN / kg of residue or 500 mg of H2S / kg of residue when exposed to pH conditions between 2.0 and 12.5; it is capable of producing free radicals.

Explosive residues are those that have an explosive constant equal to or greater than that of dinitrobenzene, or that are capable of producing a detonating or explosive reaction or decomposition at 25ºC and at a pressure of 1.03 kg / cm2.

According to NOM-052-SEMARNAT-2005, waste is considered explosive if it has an explosive constant equal to or greater than that of dinitrobenzene (reactive chemical substance that presents a serious explosion hazard) or if it is capable of producing a detonating or explosive reaction or decomposition at a pressure of 25ºC and 1.03 kg / cm2.

Toxic residues are those that contain substances capable of causing death or causing harmful effects on the health of the population, flora or fauna. They vary in characteristics and severity according to the forms and intensities of exposure. According to NOM-052-SEMARNAT-2005, waste is toxic when subjected to the extraction test for toxicity according to NOM-053-SEMARNAT-1993, and the leachate of the representative sample contains any of the constituents listed in Tables 5, 6 and 7 of NOM-052-SEMARNAT-2005 at concentration levels greater than the limits indicated in said tables.

Flammable residues are those that can cause a fire in different conditions such as friction, absorption of moisture, spontaneous chemical changes, and that can burn so vigorously and persistently enough to represent a risk. According to NOM-052-SEMARNAT-2005, waste is flammable if it meets the following criteria: it contains more than 24% alcohol by volume in aqueous solution; it is liquid and has a flash point below 60 ° C; it is not liquid but is capable of causing fire by friction, absorption of moisture or spontaneous chemical changes (at 25 ° C and at 1.03 kg / cm2); it is a flammable compressed gas or agents that stimulates combustion.

According to NOM-052-SEMARNAT-2005, waste is considered to have infectious biological characteristics when it contains bacteria, viruses or other microorganisms with infectious capacity, or when it contains toxins produced by microorganisms that cause harmful effects to living beings.

To better visualize the hazard characteristics, see table 20. It reflects some of the substances that present corrosive, reactive, explosive, flammable and / or toxic characteristics and that are part of products commonly used in industrial, particular, academic, service and even governmental activity.

Table 20 Main waste with some dangerous characteristic, 2015

Corrosive	Reactive	Explosive	Toxic	Flammable
Strong acids Strong bases Phenol Bromine Hydrazine Acetyl Chloride Bencensulfonyl chloride	Nitrates Alkali metals Methyl isocyanate Acetylene chloride Metal hydrides Mercury Fulminate Tetranitromethane Zinc Zn3P2 Phosphide Trinitrobenzene Acetyl Chloride	Peroxides Chlorates Perchlorates Picric acid Trinitrotoluene Trinitrobenzene Potassium permanganate Nitroglycerine	Cyanides, Arsenic and salts, Lead, Polyphenols, Pesticides, Aniliba Nitrobenzene, Dinitrophenol, Chloropropionitrile, Aminopyridine Aldrin, Aluminum Fosfuro, Ammonium Calcium cyanide Manganese, Mercury Fulminate, etc.	Aliphatic hydrocarbons Aromatic hydrocarbons Alcohols Ethers Aldehydes Ketones Phosphorus Thallium Sulfate Thallium Selenite Diepoxybutane

Source: Author's own design based on NOM-052SEMARNAT-2005 and INE-SEMARNAT, (2015)

The following components: sulfuric acid, bleach, alkalis and phenol can be easily found in cleaning products such as disinfectants, some detergents, unclogs, among others. Chlorine is used in bleaches while ketone and benzene are used mainly in nail polish removers. Perchlorethylene is used in dry cleaners, and naphthalene is used in carpet cleaning. Ethylene glycol is used in antifreeze for cars. Cyanide is used in mining for the benefit of metals. Lead is in the composition of automobile accumulators and paint manufacturing.

The anilines are used in the dyeing of textiles. Pesticides are used at home, in agriculture, wood treatment and other uses (Anglés, 2009). Once in the environment, toxic pollutants can be ingested and retained in high concentrations by living organisms, causing serious disorders or even death. If they are found in low concentrations, they cause sub-lethal effects such as reducing the life span of certain species or increasing susceptibility to diseases. They may also cause mutagenic (alterations or genetic changes) and teratogenic effects (congenital defects after conception) (SEMARNAT, 2005).

The presence of foreign chemical compounds in natural cycles can also interfere with the mobility of other compounds that are important for biological processes. Organisms have a variable resistance to pollutants according to the degree of adaptation to the toxic. For example, some species of animals are capable of coupling and reducing or canceling the toxicity of some heavy metals by incorporating them into proteins. However, other compounds such as organochlorines can give rise to metabolites (when they are absorbed, they already have toxic action; others can be substrates of transformation reactions, become reactive metabolites and consequently reach greater toxicity) of greater toxicity than the compound that generates them (Carrizales et al., 1999¸ Ruíz, et al, 2001).

In Mexico, there are few experiences of systematic studies on the effect of RP on the environment, their residence time in ecosystems, their flows and final destination and their possible impacts on ecosystems and human health. Studies on the effects on health in populations exposed to environmental toxics are minimal. The most relevant are studies on lead (air pollution and glazed ceramics), arsenic (natural pollution), pesticides (occupational exposure) and fluorine (natural contamination and occupational exposure) (INE, 2007).

Biological processes do not generate waste. There is a multitude of organisms in nature that are responsible for degrading them to reintroduce the materials that make up corpses or plant and animal remains into the life cycle. However, technological advances have contributed to the introduction into the market of products composed of non-degradable or slow degradation materials.

Thus, their final disposal exerts excessive pressures on nature and creates environmental liabilities in the form of waste burials that compete with the productive uses of the lands in which they are located. This explains the need to reduce the quantity to a minimum and to limit the types of waste destined for final disposal (Rojas, 2003).

The decomposition of organic waste produces biogases such as methane, which causes climate change worldwide with consequent risks for humanity and ecosystems. This leads to the interest in controlling the generation of methane to take advantage of it as an energy source and to negotiate the sale of "carbon credits."

This is stated within the Clean Development Mechanism (CDM) framework, established in the Agreement on Change Climate and the Kyoto Protocol. Here, organic waste is valued, and income can be obtained from it instead of generating environmental risks. Subsequently, emphasis is placed on transcendent international aspects of RP handling. (SEMARNAT, INE, 2009).

The burial of organic waste carries the risk of leachate generation. These are liquids that are formed by the reaction, dragging or filtering of waste materials. They contain substances, in dissolved form or in suspension, that can infiltrate into the soil or drain off from the sites where waste is deposited. This can eventually lead to contamination of soil and water bodies, cause their deterioration and represent a potential risk to human health and other living organisms.

For this reason, there is an increasing interest in limiting the amount of wet organic waste disposed in the final disposal sites, in selecting the location of these sites to prevent the infiltration of leachates into the subsoil and in adopting engineering measures to control them. This could be avoided if only dry residues were buried (Cortinas, 2006).

One of the most severe and most worrying consequences that bad practices can generate in RP handling is the affectation of superficial and underground water resources. In the first case, pollution occurs when rainwater infiltrates through waste deposited in ravines, river beds, hillsides and cracks. It then circulates with its polluting load towards the water bodies located on the slope. In the case of underground water resources, pollution occurs through a similar process. During and after the episodes of rainfall, water that has percolated by the waste and that contains a high polluting load can migrate to the and affect its quality (SEMARNAT, 2001).

There can intervene factors that in some cases come to mitigate this affectation, such as the presence of free aquifers with very deep piezometric levels (Consisting in a variable of the state of water). They present a powerful unsaturated zone, in which a large part of the pollutant load can be retained and the presence of aquifers either confined or semi-confined.

Here, the material that stores and transmits the water is covered by practically impermeable or very little permeable horizons, reason why contaminated fluids do not reach the aquifer. In other cases, the aquifer is very shallow or consists of fractured or volcanic materials, which increases its vulnerability to contamination. This last case, which is frequent in the national territory, implies the contamination of water resources, the affectation of the trophic chains or biological community and the deterioration of natural resources and life quality (PMMIRIPM, 1996-2000).

Of the various chemical compounds found in groundwater, the organic are the ones that represent the greatest risk due to their effects on the environment and on human health. Industrial solvents and aromatic hydrocarbons derived from petroleum are the most common within this group of compounds. Many of the pollution problems occur due to leaks, spills and disposition of immiscible organic liquids in the water surface. They do not mix and are inscribed in non-aqueous liquid phases or hydrocarbon spills (Bastían, 2009).

These immiscible or mixed fluids can be classified into two categories: those whose density is greater than that of water, which include the perchlorethylene and trichlorethylene solvents, substances such as creosote, certain polychlorinated organic compounds and some pesticides; and others that are lighter than water, which includes compounds such as benzene, toluene, ethylbenzene and xylene (Cortinas, 2005; Bastían, 2009).

The compounds whose density is greater than that of water are commonly used in dry cleaners, wood preservation, electronics and electrical industry, machining, printing workshops, automotive production and repair, asphalt and aviation. These substances are transformed in a descending way, and even when they have a low solubility, the concentrations detected in several regions exceed the quality standards of drinking water. Sites contaminated with substances whose density is greater than that of water can also represent a significant source of long-term pollution.

Some of the organic pollutants that have been detected in groundwater represent a severe health risk. Substances such as perchlorethylene and trichlorethylene cause depression of the central nervous system or affect the functioning of the liver and kidney, while carbon tetrachloride, chloroform and benzene are carcinogenic agents (Anglés, 2009).

Decomposing organic waste contains nutrients that attract a multitude of insects, rats, birds of prey and other fauna that serve as reservoirs of microbes that are eventually transmitted to humans. Social practices tend to mix RSU with RP, increasing the risk in waste handling whether for health or the environment (Cortinas, 2006). Also, some activities use hazardous substances that generate RP and cause negative health effects (see table 21).

Table 21 Main hazardous materials, their uses and harmful effects on health, 2009

Hazardous material	Main uses	Effects on health
Arsenic	Agriculture, paint and paper industry, pesticides, metallurgy and medicines.	Various types of cancer, chronic intoxication, neurological problems, vascular disorders and anemia.
Asbestos	Production of cement, plastics, fabrics, water tanks and roofing sheets.	Asbestosis (pulmonary fibrosis) and cancer of the Mesothelioma type, mainly pleural.
Benzene	Production of fungicides, manufacture of fireworks, ammunition and synthetic rubber.	Multiple affectations, such as liver, kidneys, the immune system, the thyroid and the central nervous system, as well as cancer.
Cadmium	Antioxidant, production of plastics, paint dyes and enamels.	Chronic intoxication, pulmonary edema, renal failure, stone formation and pulmonary emphysema.
PCBs	Insulating materials in capacitors and transformers, plasticizers, adhesives, plastics and paints.	Irritation of the eyes, gastrointestinal and menstrual disorders, decrease in female fertility.
Chlorine	Manufacture of bleaches, solvents, pesticides and plastics	Acute intoxication, pulmonary edema and pneumonia.
Hydrocarbons	Gasoline, solvents, textile industry, liquids for dry cleaning, inks, latex, pharmaceuticals, explosives, fungicides, chemicals.	Irritation of the eyes, asthma, pulmonary edema, burns, anemia, chronic poisoning, menstrual disturbances, coma and death.
Mercury	Smelting of metals and fungicides.	Intoxication, neurological alterations and death by poisoning.
Pesticides	Pest control	Damage to the central nervous system, cancer, anemia, sterility, mutagenic.
Beryllium	Manufacture of nuclear reactors, aeronautics industry, electronic alloys	Alterations in the respiratory system, lung cancer and bones.

Source: Hazardous Substances, Risk and Health in Mexico, Normative Framework (Anglés, 2009)

Biological waste generated at homes, commercial or service establishments and mainly in health centers demand a very meticulous handling, different from the rest of the RP in some way. Infection prevention must be emphasized in the handling.

In the case of waste generated in medical areas, it is necessary for its packaging and disposal to be in accordance with NOM-087-ECOL-SSA-1-2002. Thus, blood, crops, strains of infectious agents, non-anatomical and sharp items should be packed in airtight containers or red bags, and the pathological waste should be packaged in yellow containers or bags.

In the case of waste generated in other establishments, including homes, it is necessary that they be handled in accordance with the provisions of the LGPGIR regarding RSU in its sanitary category (LGPGIR, 2003).

5.4 Strengths and weaknesses of legislation on hazardous waste in Mexico

Like all legal regulations regarding waste some strengths and weaknesses that limit its application stand out. As a strength, the legal framework of RP defines the competences of the three levels of government but only to manage in the matter of waste. This implies that the generator may be sanctioned by municipal, state and federal authorities. Therefore, it is important to clearly define their concurrent participation within the law and its regulations, thus achieving the long-awaited goal of handling waste in an environmental manner from "cradle to grave". Another notable strength is the classification of waste and existence of regulatory systems applicable to each one of them such as handling plans. However, Mexican legal system does not yet have the issuance of regulations regarding the guidelines for the formulation of handling plans (Jiménez, 1996, Cortinas, 2005).

On the other hand, it classifies the generators of waste by volume and type of waste, as well as the specification of the responsibilities and obligations of each one. However, the weakness lies in the fact that it does not adequately inform more than 35% of RP generators considered as small and do not present COA despite the volume they can generate (Ávalos, 2011). As a strength, the figure of shared but differentiated responsibility of all those involved in waste generation stands out. The need to implement mechanisms for assessment and minimization is essential. However, this criterion is left to the free will of the generator to determine what action does or does not represent minimization and assessment (PNPGIR, 2008). The foregoing is explicit in Table 22, which contrasts these strengths and weaknesses.

Table 22 Legal strengths and weaknesses of waste handling in Mexico, 2015

Legal strengths and weaknesses of hazardous waste handling in Mexico	
Strengths	**Weaknesses**
Concurrent faculty: competence of the three levels of government to know about waste.	The generator of hazardous waste can be sanctioned by federal, state and municipal authorities.
Classification of solid urban, special handling and hazardous waste in consideration of special standards.	No special rule containing a specific classification has been published so far.
Formulation and implementation of handling plans according to special standards parameters.	No special rule containing said parameters has been published so far.
Classification of generators: micro, small and large, according to generation ranges of hazardous waste.	The established ranges do not make a significant difference for small and large generators, so the flexibility of the law regarding the fulfillment of obligations for these types of generators is feasible.
Promotes the assessment and minimization of waste	Although the terms of assessment and minimization of waste are promoted, the mechanisms to reach such parameters are not addressed in the law and complementary regulations. This means that the objective of laws on waste is not met.
It promotes the shared but differentiated responsibility of all the sectors that participate in waste handling, such as authorities, service providers, generators and society.	The parameter is not met due to the absence, confusion and lack of legal certainty in the legislation that specifies the obligations for each of the parties involved.

Source: Author's own design based on LGPGIR (2016)

The main strength of the Mexican legal framework in matters of RP constitutes the limitations imposed on human behavior in the handling of waste under the scheme of environmental responsibilities which bind all those that cause environmental damage. It is convenient to analyze this fact because the existence of a damage or an affectation that is identified and recognized is necessary for this figure of environmental responsibility to emerge. Thus, the intention to cause an injury is not enough, the consequence for it is necessary. According to the weaknesses of environmental responsibility, the damage can be non-existent if there is prior authorization from the environmental authority. This fact violates the human right and guarantee principle marked in article 4 of the CPEUM.

Chapter VI Environmental responsibility in the handling of hazardous waste and its importance in the Cuitzeo region

6.1 The environment as a protected legal asset

The notion of environment did not begin as a legal concept. According to Jordano, *et al.*, it was first approached by biology, sociology and geography. *"The definition that serves as a starting point, but not necessarily as a point of destination, is the one provided by non-legal sciences"* (Jordano, *et al.*, 1995: 101). However, we must not forget that it is a complex system with multiple factors. So, as Cabanillas (1996) points out, it is not easy to accurately establish the legal meaning of environment.

To speak of the environment as a legal protected asset means to elevate it and include it in the legal norm. This norm is coercible, heteronomous, general and external, emanating from a legislative process that seeks applicability on a specific purpose. In this case, the goal is the protection of the environment, then, it is not possible to speak of environment in legal terms by only considering its composition. It is necessary to consider it from the existing relationship between its elements and how this relationship influences the rest of its components.

Some proposals such those made by Gonzalez (2000) and Arce and Gargollo (1994) indicate that the environment must be a legal asset, likely to be appropriated or used. For this purpose, it must remain within a legal order. It is true that neither appropriation nor use define ownership or possession. They define a use and enjoyment of that asset, for example, the air: we are not owners or holders of that natural element; we use it and enjoy it without property or possession parameters, but this does not imply that it ceases to be regulated. In the end, laws must limit human behavior in relation to the rest of the natural elements, not the environment as a good that benefits human beings.

Rodriguez (1988) indicates that the environment as a legal asset represents a high-level interest of abstraction and generality. It is formed by the combination of traditional legal assets (water, air, soil, flora and fauna) whose interaction produce its existence as a new asset. This new entity has, therefore, a character of synthesis of said traditional assets. To speak of the environment as a legal asset entails the inclusion of its protection in a legal framework that establishes scope and limitations for human behavior.

It is through the law that the protection of the environment is consolidated because law recognizes the integration of the elements that make it up. It is through its incorporation into the legal order that its protection is sought.

For the protection of the environment, it must be borne in mind that the entire legal system and all the principles of law must apply. For this, Carmona (2016) and Gonzáles (2000) say that three circumstances must be met:

1. Recognition in a legal system; generally, this is found at the constitutional level. In the case of Mexico, it is also recognized in the LGEEPA.
2. It must be a collective legal asset that is related to the way of harnessing and enjoying its ownership.
3. Weighting on the complex nature of the environment for it to be taken as the object of a right and a duty.

Certainly, when speaking of a legal asset, reference is made to tacit recognition in a legal body in addition to encompassing all its elements in one single concept for it to become the object of a right and a duty. In terms of law, an asset can be tangible and intangible. However, the legal doctrine states that everything that can be subject to appropriation is considered an asset. Therefore, those assets that can not be appropriated will not be useful from the legal point of view even when they are useful to humans. Rojinas (1963) states that there are many assets in nature that can not be appropriated, such as the air, the sea, the stars, among others.

The intangible assets indicated by Rojinas can not be appropriated, but they can be used and enjoyed. This entails them to be legally regulated, either indirectly by regulating human behavior against contamination or directly by making use of them. This is the case of carbon bonuses, which entail a tacit and intangible use.

In this respect, Jescheck (1993) points out that legal assets are not apprehensible objects of the real world but ideal values of the social order on which the security, well-being and dignity of collective existence rest. Their aim are the interests of humans (Jescheck, 1993).

One way to safeguard the environment as a legal asset is the efficiency of the judicial process. Carmona (2016) states that the environment, as a protected legal asset, is a complex concept that safeguards a collective interest. The problem does not lie in the definition or the ownership but in the long way ahead in terms of procedural matters.

Then, the environment, as a legal asset, has two connotations: the first refers to the individual ownership of the asset, and the second refers to a collective asset. This means that if a damage to said environment is caused, repairs can be requested by each affected entity or as a whole through several legal means, such as Civil, Criminal, Administrative and Constitutional.

Jurists such as Carmona (2016), Jordano (1995), Moreno (1991) and González (2000) assert that the environment as a legal asset entails ownership from its recognition in the law. Its scope will depend on the applicability of said law and the action exercised by its owner. In Mexico, this represents a great challenge in environmental matters because the Mexican legal system has not established key definitions that would allow guiding the action of all judges and all factors subject to legal process, such as environmental balance, repairs and compensation. In addition, infrastructure does not allow specialization in the matter, and the personnel who apply the environmental law are presumed to lack technical-scientific knowledge to proceed based on environmental protection.

In terms of responsibility, the environment is a legal asset protected by its owner and by its character as a collective asset. If a direct damage is caused to it, its repair can be demanded in the traditional way, and all those who are entitled to a healthy environment can exercise such right.

This branch of law is known as environmental law, which has been defined by multiple authors. On the stands out is Brañes (2000: 28 and 29), defining it as *"The set of legal norms that regulate human behaviors that can influence in a relevant way the interaction processes that take place between the systems of living organisms and their environmental systems, by generating effects from which a significant modification of the conditions of existence of said organisms is expected".* According to the definition, environmental law does not refer to the rest of the universe that would configure the shape or surrounding environment of human beings or living beings. On the other hand, environmental law does not comprise all the rights of the elements that make up environmental systems. It does not refer to all possible human behaviors with respect to those elements, but only those that may influence the processes of interaction that occur between the environmental systems that they configure and the corresponding systems of living organisms.

The object of Environmental Law is to regulate human behaviors and phenomena to perpetuate life and ensure the continuity of natural processes (Brañes 1987). For this reason, environmental law is the result of the prevailing relationship between man and nature. It is the limit of this relationship that makes it necessary to control social excesses.

Larenz (1978) points out that this nature-human relationship is fundamental to environmental law because it starts from the recognition of human dignity, which is a consequence of his existence. Thus, every human being must be respected by others as a person, should not be harmed in their existence (life, body, health) nor in its own space, and each individual is correspondingly bound to respect any other.

The man-nature relationship implies a recognition of natural elements and of people. In this type of relationship, nature can acquire different fact conceptions of fact. Carmona (2016) states that nature can be an owned asset, an object to be exploited, an object to be enjoyed or an object of protection. This is due to the need for protection services for human purposes.

Carmona (2016) argues that there are standards within the legal system that should not be considered part of environmental law because they were not designed to be applied to the solution of environmental problems. Such is the case of the liability regime, which has its origin in the Theory of Obligations and comes from civil law principles. It is true that environmental law is associated with other types of law such as civil or criminal law.

However, this does not imply that the responsibility of environmental law be ignored because the objective of every law is the establishment of limitations in behavior, specially those laws that may arise from diffuse or collective interests.

In this regard, Millán (1975) points out that environmental protection has been specified as a set of measures of all kinds for the preservation of environmental assets or, as the case may be, as the restoration of an ecological order being disrupted through aggressions against it. Likewise, Brañes (1987) and Valencia (1983) indicate that occupying environmental elements helps defining the legal regime whose application field is limited to addressing environmental effects. For this, it uses civil, criminal, procedural and administrative norms that foster causal environmental relevance together with private property, non-contractual liability, as well as criminal and administrative liability.

In this regard, it is convenient to consider that nature is an asset that can be repaired, protected or preserved. These concepts go beyond just protection, because they refer to past events (repair) and future events (protect serve or preserve). Now, to every fact corresponds a legal consequence, i.e., a limitation to behavior reflected in several juridical norms (Carmona, 2016). For this reason, the foundation for a balance between nature and human behavior lies not only in what is allowed or not in a legal norm, but in all kinds of norms influencing social behavior. By this I mean behavioral norms such as ethics and morals. Although they are not written laws, they should induce the doing, not doing or stop doing of any action that promotes imbalances in nature.

Castán (1982) states that other elements are present in environmental law: the subjective, the objective and the causal. The subjective belongs to the right holder and the obligated subject; the objective is the right to claim any alteration to nature; and the causal is the link between cause and effect. These elements translate into the figure of liability that certainly falls on the Theory of Obligations. According to the civil doctrine, subjective civil liability is divided in two parts: contractual [1] and non-contractual. The non-contractual subjective liability does not result from an agreement of wills. This kind of liability presumes the harm of one person's interests caused by another, which are protected by the law. In other words, it arises from the injury inflicted by an individual to the legal field of another one. Such injury is understood to be directed to the legal norm that protects the affected person. The consequence of the injury will be, then, the obligation to compensate the damages caused. (López y Ferro: 2008).

De Pina (1993: 443) in his Legal Dictionary says that *"Subjective Responsibility is that which falls on a certain person as a consequence of an act of his own that has caused damage to another."*
The type of liability that would take care of the alterations to the environment falls in this category and must be considered within the non-contractual liabilities. This is because law, to be exercised, requires the presence of the subject(s) whose unlawful action or omission causes damage, the illegality of the action, the fault, the compensable damages, the cause-effect relationship and the subject(s) entitled to compensation (Carmona, 2016; Santos, 1984).

This premise is interesting and debatable in the sense that it assumes the existence of subjects of fact and law. However, what would happen if there were no recognized subjects of law, or if they decided not to seek compensation for not having perceived the affectations? Also, how could a fair parameter of compensation be established? What would happen if the causal link were not materially verified? What would happen if there were no fault? These and other questions have been left in a legal vacuum that maintains the existence of recognized environmental damages but avoids acting in a timely manner for not having legal tools.

6.2 The need for environmental responsibility

Starting from the conception that the environment has limits, social movements arise encouraging its protection and assigning responsibilities. Said social movements were inspired by the obvious devastation that human expansion caused in the environment. The dimension of water air and soil pollution, tree felling, loss of species, excessive and uncontrolled generation of waste, among other problems began to be seen more carefully.

[1] Contractual civil liability is caused by an unlawful act, which consists of not fulfilling a pre-established obligation in an agreement of wills.

This allowed to redirect production and consumption, leaving aside the so-called "economy without borders". This type of economy did not consider the limits of nature, assuming that natural elements were infinite and could assimilate all kinds of waste.

The economy without borders was highlighted by Boulding in 1966, perhaps influenced by the proposals of environmental groups such as Club Sierra and Friends of the Earth, proposing to rethink the meaning of the economy that included a biophysical sense (Boulding, 1966).

This and other proposals originated from the fact that there were thoughts in economic history centered on the allocation of scarce resources (neoclassical thought) or distribution (Marxist thought) that set aside the value of natural elements. For example, in the Marxist theory, the determinant of value was human work and not the agent of such work, so natural elements such as water, air and forests did not imply human work. Without human work, such elements would not have any value, and having no value, they were not assigned a price either.

However, the incorporation and acceptance of environmental value took shape in the seventies with a leading neoclassical economy arguing that property systems condition the use of resources and, therefore, are the basic cause of environmental problems. Also, the creation of the Club of Rome in 1972, the Cocoyoc Declaration in 1974, and the report of Dag Hammarskjöld in 1975 tended to analyze the unsustainable nature of population growth, the irrational use of natural elements and its consequences such as pollution based on the irrational waste generation.

Certainly, the unsustainable nature of growth arose from the functional logic of the Industrial Revolution (initiated in the United Kingdom and spread throughout Europe and the US). It sought industrialization at all costs, reproducing modern techniques that devastated the surroundings where they settled. In that sense, several interpretations of the prevailing changes arose. Such was the case of the classical (theories of Adam Smith, David Ricardo, Carlos Marx) and neoclassical postulates (Marshall, Walras, Pireto, Pigou's theories and others) that focused respectively on economic growth and distribution.

That is why growth and progress were associated with development although each concept has its own scope and limitations. For the present essay, it is convenient to focus on the latter, since it brings together a series of perspectives that comprehensively visualize the social process in a given time and space. In other words, it is a social perception with its own space and time characteristics that links economic, environmental, cultural, legal, technological, historical and political approaches. In this regard, Carrillo (2001) indicates that development is a process through and during which a society's life quality is improved. This means that it involves all aspects that affect life quality (social, cultural, environmental and political, among others). It is not just the simple growth of a particular economic variable, no matter how important it may be.

Also, Ochoa (2006: 9) indicates that development *"has been assumed as the result of a technical process of defining means to reach an unquestionable end. In this process, population constitutes one more variable that behaves according to canons generally associated with biometric statistics and, in cases of greater complexity, through the definition and identification of action spaces associated with organization forms in terms of particular or sectoral interests"*.

In this regard, development has been considered as a social process, based on a specific time and space, that seeks to improve living conditions respecting natural limits. The issue of development within the framework of the RA is relevant because this is the commitment of respect and value to the environment from which development can be sustained. It sets the limitations to human behavior under an ethical and moral sense that will motivate the improvement of life quality in a sustainable scheme.

Thus, it is necessary to visualize sustainability in development. This has been defined by Moreno and Chaparro (2008) as the way of interpreting a social context based on economic, ecological and social aspects, considering the environment's assimilation capacity before it is unable to sustain and nurture human activity. Therefore, sustainable development is the process that changes according to the exploitation of resources, the direction of economic investments, the orientation of technological development and institutional changes to meet future and present needs (World Commsision on Environment and Development, our Common Future, 1987)

For the World Bank (WB), sustainable development is integrated by five concepts: financial capital (based on planning, macroeconomics and prudent fiscal management); physical capital (consisting of assets in infrastructure, buildings, machinery, roads, energy and ports); human capital (made up of good health and education to maintain the labor market); social capital (consisting of the skills and abilities of people, institutions, as well as norms that shape the quality and quantity of social interactions); and natural capital (which considers the natural resources and services that sustain life) (World Bank in Moreno and Chaparro, 2008).

The Economic Commission for Latin America and the Caribbean (ECLAC) considers sustainable development as a form of progress in which changes that affect humanity improve the human condition (ECLAC, 2001). Moreno and Chaparro (2008) comment that sustainable development should be oriented not only to preserve and maintain the ecological basis and inhabitability of development, but also to increase the social and ecological capacity to cope with change. It must also be capable of preserving and expanding the options available to confront a world in permanent transformation.

These definitions of sustainable development are only some conceptions that seek to provide key elements to interpret it. They do not neglect its dynamic and changing nature as a specific space and time that seeks to maintain, promote and improve life quality through constant adaptation.

For the purposes of this research, sustainable development is defined according to Schuschny and Soto (2009); Ortiz and Infante (2008); and INEGI, (2009). They argue that it has four components: social (whose indicators are poverty, demographic dynamics, education, health and human settlements), economic (with indicators of distribution, consumption patterns and technology transfer), environmental (indicators of water, soil, waste, deforestation, biological diversity and atmosphere), and institutional (whose indicators are: public policies, scientific actions and legal instruments and mechanisms).

The link between sustainable development and RA lies in the social aspect. There is a transmission of ethical and moral principles that transcend other spheres and favor conduct. This way, the environment suffers no harm that may cause social, economic, environmental and social effects. Social effects may entail direct or indirect damage to the people nearby; economic effects may translate into reparation, remediation or compensation sanctions; environmental effects may result in the loss of or damage to natural elements and will eventually produce other effects that sooner or later will be felt by society; and institutional effects can cause legal vacuums or deficiency.

In addition, all this must be taken into consideration in a specific space. For this reason, it is necessary to limit sustainable development to the regional approach. Boisier (2007) says that it is a localized process of sustained social change that ultimately aims at permanent progress of the region, of the regional community as a whole and of each individual resident therein.

This development of individuals within a region and of the region itself will be achieved through the decentralization of an effective and equitable regional policy. For Delgadillo and Torres (2002), regional development is an inherent concept in the transformation of regions. It is a process and an end in the tasks of administration and promotion of the growth and welfare of the country.

It is evident that both contributions visualize regional development as a process of change or transformation of a given territory. So, I infer that this concept must go beyond the limits of space and transformation because it brings together the needs, requirements and proposals of a group of people who share more than one territory; they share customs, beliefs, natural elements, legal norms, as well as economic, political, technological and social contexts.

Therefore, only then can the regional aspect of sustainable development be addressed. For the case that we are concerned, the focus will be on Michoacan. It has a regionalization of ten socioeconomic regions that seek to become a structuring axis of development strategies and to link to the growth dynamics of the country (SEPLADE, 2004).

The reason for environmental protection has been contextualized; now it is convenient to associate this figure of environmental protection with that of RA. It should have the spirit of commitment to the environment with respect to any action of use, exploitation or affectation and not as we have seen so far, i.e., based on a scheme of repair and/or compensation for damage.

For this, it is necessary to differentiate the concept of responsibility from obligation and from duty. Obligation, according to Borja (1953: 240), is *"a legal relationship in which a subject called debtor is legally bound to another subject called creditor to perform a conduct that may consist of a giving, a doing or a doing not"*. On the other hand, "*duty is the action or omission that is presented as a requirement by the obligation"*. That is why duty and obligation are closely related, and it is not possible to conceive them separately (Borja, 1953; Hierro, 2000).

On the contrary, the term responsibility derives from the Latin verb *respondeo,* which means *to respond*; in turn, the suffix *abilis* indicates the condition of being *capable*. Therefore, being responsible means having the ability to respond. Responsibility, then, is the ability to respond as a habit (Scarinci, 2004). As per the Dictionary of the Royal Spanish Academy, responsibility is the existing capacity in every active subject of law to recognize and accept the consequences of a freely performed action. In addition, the concept associates it with a moral quality, debt, position and obligation (DRAE in Díaz, 2015). This perspective is consistent with the holistic nature of the responsibility that should not only be based on the scope of a legal norm, but on the limitations of the rest of the norms such as ethical and moral. This will allow the acceptance and fulfillment of said legal precept as well as the commitment to control the social procedure.

Speaking of responsibility means going beyond duty and obligation. It is a habit, a commitment that goes beyond the legal spirit. Thus, it must address ethical and moral issues that can not be addressed in a written rule but can influence regulated social behavior. Therefore, the difference between responsibility, duty and obligation is that the first is a capacity or quality, the second is an action and the third is a link.

Preziosa (2005) sustains that the concept of responsibility is characterized by three elements: it is a quality of the link between rational subjects, of a social nature and is in the search for an achievable common goal. On the other hand, Scarinci (2004) highlights other elements by indicating that responsibility includes all: the recognition of the authorship of the facts, the anticipation of the consequences and the accurate choice of the acts from which the best consequences derive. In addition, he argues that when talking about authorship, the ability to increase something is alluded. Those who recognize their own acts are in a position to correct, expand or complement them.

Therefore, responsibility can be defined as a commitment based on morals and ethics in accordance with a legal norm to limit, lead or re-direct a behavior with possible consequences towards the natural environment. Thus, to speak of RA is to speak about prevention, direction, control and acceptance of the behaviors that seek to reach a certain goal in relationship with other elements. However, the RA has been seen as a figure of reparation and compensation, these being only some consequences that derive from the RA and are not part of the actual content of the RA.

This scheme has been adopted in the Mexican legal framework of RA. It has adhered to subjective non-contractual liability in terms of civil law and not as an independent figure seeking to prevent more than correct an illegal situation.

Non-contractual liability is based on the subjective criterion that refers to fault or negligence (Carmona, 2016). However, I believe that this proposal leaves aside the objective criteria of risk and / or danger [2] that should not be excluded from liability due to its own condition. In this regard, Alpa (1985) indicates that damage to the environment is mostly a product of factual situations of risk instead of negligent acts from the subject. This shows a weakness line of non-contractual liability dealing with the environment since the legal system only addresses the subjective aspect of such liability (fault or negligence).

On the other hand, Londoño (1999) sustains that the RA is evolving and that we are witnessing the presence of a new type of RA consisting essentially of five principles:

1) **The precautionary principle**: its origin comes from the Rio Declaration (1992) and requires a rethinking of the activity of the State and society in the face of environmental problems. The State may incur liability for omission.

[2] *Risk* is understood as the contingency approach of a damage, and *danger* means *"all those elements of the physical environment harmful to man and caused by forces alien to him* (Burton, 1978: 10).

2) **The principle of legal security**: It compels the need to develop the concept of environmental insurance as a quick and easy instrument of repair. Also, alternative funds and compensation mechanisms are important. This is due to the potential environmental damage that is increasingly greater depending on human activities.
3) **The principle of full reparation of damage and protection of victims:** it promotes an adjustment in the liability scope by considering the obligation of reparation for lawful acts. It is estimated that not only are there unjustly caused damages, but also unjustly suffered. The vision of the RA must go from harm (traditional vision) to the victim's view of harm. It means humanizing the law by extending the scope and considering nature as a victim that requires representation, leaving aside the search for harms to indemnify.
4) **Breaking the axiom of guilt:** it suggests changing the paradigm of *"there is no liability without guilt"* to the paradigm of *"there is no liability without harm.*" This is done through a solidarity participation of citizens.
5) **Reversal in the focus of proof:** it refers to legal actions established to determine which party in the trial must offer the evidence based on facts.

These principles, indicated by Londoño (1999), reveal two important aspects. The first one is to give voice and vote to nature through representation. Such representation would be in the hands of the State through the Executive power; as the Head of State, it must exercise the position of representative to nature. The second proposal on the change of paradigm of liability without harm -- proposed under the premise that someone should have caused any existing harm- is transcendent because it seeks restore damages instead of imposing blames. In my opinion, the second principle -- legal security -- tends to be corrective by focusing on reparation and compensation and not on prevention. Thus, the arguments of Londoño (1999) fall back into the vice of trying to remedy what is caused and not in preventing or avoiding damage. So, it would be convenient to question whether it will be possible to change the paradigm of the RA based on guilt or damage by the RA based on ethical and moral commitment.

Unfortunately, this is not the case. That is why the RA is under the protection of the common (civil) legislation based on resolving conflicts where there is an affecting agent and an affected one, not considering the collective and diffuse characteristics of the damage caused. Can't an environmental damage be sensed by other beings that are not directly linked? Is it necessary to directly feel the environmental damage in order to ask for a solution to the conflict? Then, what about the environmental damage caused by pollution in water tables? What about the damages caused by unduly authorized changes of land use that promote the loss and displacement of species? In terms of RP, what happens with the infiltration of used oil (toxic and flammable) in water bodies for common use?

It is assumed in all these cases raised that there is no directly affected subject. Then, how and who seeks reparation or compensation for the damage? These and many other questions have served as a basis to argue that the RA should not only be linked to civil legislation. This type of legislation only seeks to resolve conflicts between individuals, but the RA must be related to other types of regulations, such as criminal and administrative. The constitutional option should not be disregarded since environmental damage can be claimed through the figure of indirect protection. This can be done through a collective interest based on the diffuse right enshrined in Article 4 of the Political Constitution of the United States of Mexico (Spanish acronym: CPEUM) for a healthy environment aimed at development and well-being.

This shows a great openness in the delivery of justice. It not only deals with the impact on tangible and tangible assets, but it also seeks to compensate damages by addressing indirect effects based on non-tangible rights through a combination of regulations. However, this seems to be an illusion because, so far, the RA has resulted in remediation and compensation actions limited to civil, criminal and administrative law where the existence of the damage is necessary to act. Also, there is a legal obligation to consolidate specialized courts in environmental matters; this is according to what is stated in the transitory articles of the LFRA. They indicate that said courts must be created within a period no longer than two years from the publication of this Law (2013). Unfortunately they have not been created to date and, even worse, an agreement was issued in July 2015 stating that, *"until the installation of courts specialized in environmental matters is ordered in each of the Judicial Circuits, the Mixed, specialized and semi-specialized District Courts of the Mexican Republic, which are aware of administrative trials because of their competence originally assigned, will continue to deal with the environmental issues referred to in the LFRA*" (DOF, agreement of July 3d., 2015).

The foregoing makes it clear that the specialization of the legal system in Mexico, although significant advances have been made, will be postponed, and the RA will continue to be resolved under the scheme of the civil regime through non-contractual liability.

Regarding the scope of the RA, some authors like Carmona (2016) indicate that the RA is met through formal or material infractions. The former refers to those imposed by the exercise of activities without a license, without verification records, without authorizations, without registration, for not passing regulatory controls, for preventing or obstructing inspections, for not having emergency plans or environmental impact assessments, among others.

The latter refer to the excess of activities such as overcoming levels of emissions, the use of hazardous substances or materials, prohibited technological processes or management systems.

This proposal argues that human behavior is directed to breach environmental procedures (formal infractions) or exceed permissions (material infractions). However, it leaves aside non-intentional omissions that produce damage by not fulfilling, partially or totally, the environmental obligations. For example, in the matter of RP, they cause a damage to health (intoxication) and the environment (contamination of bodies of water by the spill of used oil) due to lack of awareness and storing RP for more than six months. This is an omission conduct that causes a loss without intention to harm. Then, how will the action of RA be claimed?

Carmona (2016) states that damages can be continuous, social or future. He should consider that damages also entail side effects and impact the environment, negatively affecting important aspects for social life such as culture, tourism, economy, politics and some other. In addition, there are moral wounds that consist of psychological affectations arising from the damages, altering the physical and mental health of people.

An interesting historical contribution is addressed in the seventies by the*Organisation for Economic Co-operation and Development* (*OECD*) about environmental protection from the sixties. The protection was based on the allocation of pollution prevention fees and control measures to promote the rational use of scarce environmental resources.

These fees had to be reflected in the cost of the goods and services that caused pollution, both in their production and consumption. It was suggested for such measures not to come together with subsidies that would only cause distortions in international trade and investment.

This contribution from the OECD is the main antecedent of theRA, which seeks to protect the environment through the principle of prevention. Basurto (2015) says that few countries consider the RAsuch as Brazil, Argentina, Canada, USA, Netherlands, Italy, Spain, France and Japan. These countries have included this type of liability in addition to having environmental legislation. In contrast, Londoño (1999) states that Germany is the pioneer in the objective type RA, which connects damages, impacts and causal link.

He also defines a list of 96 facilities that generate environmental impact. He defines the environmental impact in relation to materials, vibrations, noise, pressures, gases, vapors and heat, but he does not include the risks or damages arising from those substances that were not recognized as dangerous at the time of the damage.

The list that considers the German legislation would be the answer to the proposal of Carmona (2016: 710), who argued the need to have a catalog of potentially harmful activities for the environment. It would be based on the "*Class Action*" model.

This model puts together a type of *"process that allows to judge in a concentrated way the situation of a large number of people affected in a similar way by the conduct or omission of the opposite, without adopting the character of a party in the litigation.*" In other words, it is a representative process that is currently applied in the United States (USA), and it can serve as a guide to the Mexican legal framework in terms of RAand be placed in the highest levels of legal innovation.

One of the precedents that the RA has framed around the world is the "polluter pays" principle. González (2000) and Carmona (1998) indicate that this principle was introduced for the first time as an environmental regulator in Japan in 1970. However, the written, agreed and ratified document that serves as a basis for demonstrating the existence of such a principle is the OECD document of 1972. In June of that year, it stated the agreed to Principle 22 of the Stockholm Declaration, which literally states:

> *"States must cooperate to continue to develop international law with regard to liability and compensation to victims of pollution and other environmental damage that activities carried out within the jurisdiction or under the control of such States cause in areas located outside their jurisdiction."*

In 1975, the principle is adopted in the European Community (EC) through the Treaty of Mastrich. It constitutes the first program of environmental action of the community indicating that *"the costs caused by the prevention and the suppression of disturbances from damages will be imposed, as a matter of principle, on the source of contamination*" (Article 174 of the Constitutive Treaty of the European Community, Title XIX, Environment, *Official Gazette n ° C 325 of 12/24/2002*).

There are other documents that accept this principle such as the recommendations of the OECD in 1974 and 1989; the ASEAN Treaty (Association of Southeast Asian Nations) in 1985 about the conservation of nature; the Agreement on APELS of 1991; among other documents. However, this research will be based on those emanating from the above-mentioned Stockholm Conference and the one established at the United Nations Conference on Environment and Development in June, 1992 in Rio de Janeiro, Brazil. In Principle 16 this document foresees as follows:

> *"National authorities should seek to promote the internalization of environmental costs and the use of economic instruments, taking into account the criterion that the polluter should, in principle, bear the costs of pollution, taking due account of the public interest and without distorting international trade or investments."*

If both principles are carefully observed, certain similarities and large differences can be seen. As a similarity, both principles are precautionary and establish the existence of an entity (the States in the 1972 principle and the national authorities in the 1992 principle) with a duty to cooperate in the development of international law or to seek the internalization of environmental costs. Another similarity is that both principles indicate a charge either as compensation or as a cost.

However, their differences are more prominent; the first one is an external general principle that seems to have the purpose of resolving, within the framework of international law, everything regarding RA. The principle covers contamination or other types of damage as long as they are caused outside of the jurisdiction of the agreeing States. This indicates that through an international court, compensation for damages or contamination can be requested. The controversial side of it would be to know who or what would make up that court, how the fact and its causal link would be demonstrated and what criteria would be adopted to establish compensation.

The 1992 principle, after twenty years of the previous one, turns out to be a particular internal principle because it seeks to achieve the internalization of environmental costs through a duty of the national authorities (and not through an international court, as would be thought in the 1972 Principle). It also seeks to use economic instruments always in accordance with the public interest, both internally and externally (externally by not altering international trade or investments).

These prerogatives come from the authorities for those who have public and international interests. Just as in the previous principle, its scope is not appreciated, and it is unknown how such interests will be demonstrated.

When mentioning the precept to cover a compensation or a cost, it is thought that they constitute the guideline to pay for contaminating and not so a means to avoid damages to the environment and society. As opposed to this, Valenzuela (1991) explains that the principle seeks to establish a cost of pollution for one who has a benefit from the environment, either by preventing pollution, reducing it, compensating or repairing its effects. So, it would have two functions: a precaution function and a corrective one (Valenzuela, 1991).

In this regard, the previous argument supposes a tacit acceptance of having to carry out certain actions for the damages that are caused or expected to be caused. Thus, there is an intentional and previously paid behavior; in other words, people pay for polluting. In addition, the precautionary function should be preventive. The aim should not be for damages to be compensated; it should be sought for damages or affectations not to be carried out at all.

Regarding "the polluter pays" principle, Bugge (1996) points out that it can have several meanings. It can be an economic principle, a legal principle of international balance or a principle of cost allocation among states. Porter and Van Der Linde (1999) point out that it is a principle of cost allocation because it can be used as an instrument of public policy, as a definition of legislation, as a limitation of the demands of polluters and as pollution control.

Muñoz (2004) indicates that the cost of pollution should be borne by that who benefits from it, either by taking the necessary measures to prevent or reduce it or by minimizing or repairing its effects in full. Sánchez and Friera (1994) argue that liability entails a coercive burden that has the preventive effect of inhibiting potential offenders for fear of harmful consequences. Salassa Boix (2014) indicates that the principle has several dimensions: the prevention and control principle that is based on persuasion and dissuasion; the reparation and compensation principle; and the punishment principle. Therefore, the principle should tend to be preventive as indicated by Salassa Boix (2014) and Sánchez and Friera (1994). In order for it to be achieved, it must be based on ethical and moral principles of those who cause harm when obtaining a benefit, of the authorities in charge of environmental justice and of all citizens who directly or indirectly receive the affectations.

It is convenient to make a brief pause to comment on the difference between a preventive principle and a precautionary one. These are basic structural elements in environmental law, particularly those that support sustainability and the RA. All kinds of law, whether environmental or not, should be based on preventive protection and aim at preventing damage or impairment. Kiss (1983) has stated that *"the golden rule of environmental law is to prevent,"* that is, to anticipate the production of damages in an effective and correct way. So, *"there is no better reparation of a harm than its own avoidance.*" Riesco (2006) states that prevention is the duty of anticipating damage, adopting all necessary measures to avoid its happening. In this regard, Moreno and Chaparro (2008) point out that it is about anticipating the occurrence of environmental damage or negative impacts through good practices. These good practices must abide by the standards of science and research (Cafferatta, 2004).

It is not convenient to act reactively before the prevailing changes., There must be a need and obligation to know and apply alternatives that allow for a better quality of life through the use of science. For the author of this essay, that means prevention; it does not mean to stop doing activities but to know how to do them.

In the same sense, according to Moreno and Chaparro (2008), the precautionary principle is the action taken in the presence of damage that abides by a discretionary environmental authority. The precautionary principle allows the creation, interpretation and application of environmental law through prudence, vigilance and tolerance of anthropogenic activities (Mirra, 2002). The principle of precaution is not part of the anticipation of a future environmental damage, nor does it adopt actions that allow its cancellation. Its precedent is the uncertainty of the possible consequences (Artigas, 2001). Thus, the action based on the precautionary principle restricts without a scientific assessment of the consequences (positive or negative) in consideration of a mere presumption. The tangible existence of a damage is not required; the possibility of its existence is enough, that is, the risk reigns in this principle. The Mexican legal system tends to be precautionary since the content of the norms i presumptuous. However, the presumption is not enough to proceed, and a harm is required. Then, what kind of legal system do we have, precautionary, preventive or corrective? Obviously, this a corrective system that seeks the imposition of sanctions rather than prevention and remediation.

6.3 The inclusion of environmental responsibility in the Mexican legal framework

In terms of RA, the Mexican legal system has tried "*to embrace the commitments adopted within the United Nations Conference on Environment and Development of 1992 to encourage the progress of the peoples that protect the environment, while ensuring economic and social development "*(Decree of issuance of the LFRA: 3).

This is based on the consideration that Mexico has extensive experiences of loss, deterioration, and negative effects on natural elements and on the integrity of people. The environmental damage due to inadequate provision of RP stands out. It is caused by companies that handle hazardous substances and that cause severe environmental effects due to their heavy metal components. This set the tone for legislation on RA and the publication of the LFRA. Nevertheless, it is not a law directed to environmental protection but to the imposition of faults in consideration to damages. Therefore, from now on, I can say that the LFRA should be modified to the degree of being considered a Federal Law of reparation and compensation of environmental damage.

The point is that this LFRA is very similar to Spain's Law 26/2007 on Environmental Liability. Basurto (2015) argues that it is a faithful copy of it, reason why it turns out to be inapplicable in Mexico. Being a law that is not elaborated in the scope of Mexican conditions, it will hardly have favorable results. Londoño (1999) says that a new vision of a biometric and holistic nature is needed, based on an ethic life and holistic principles. According to Fritjof Capra (1939), the welfare and flowering of life on earth have their own value. The richness and diversity of life forms contribute to the materialism of these values. Human beings have no right to reduce wealth and diversity except to satisfy their vital needs. The flowering of human life and cultures is compatible with a decrease in human population; human intrusion is excessive, and the situation worsens. A political change is needed with economic, technological and ideological structures that appraise life quality. Londoño (1999) states that these tendencies are a complement to the incipient struggle for a real guarantee of human rights, and therefore, they should constitute the principle that promotes all environmental law.

The argument of Londoño, based on the principles of Capra, points out the importance of valuing life quality with due respect for the environment, seeking to land such respect in a human right. This is still an anthropocentric view that visualizes human stability as a cause and consequence. However, the problem can not be analyzed leaving aside those human activities that have certainly influenced a constant alteration. The point is that, under the magnifying glass of the RA, such alteration should not be considered negative. On the contrary, it should be seen as positive under preventative and precautionary schemes.

A parallel precedent of the current LFRA is first Federal Law on environmental matters of 1971, which was subsequently repealed by theFederal Law of Protection to the Environment of 1982. The Decree by which the third paragraph of article 27 was reformed was published in 1987, and fraction XXIX -G was added to article 73 of the CPEUM.

This had the purpose of establishing the preservation and restoration of an ecological balance. It would empower Congress to issue laws that correlate Federal, State and Municipal governments, within their respective competences, in terms of environmental protection, preservation and restoration of the ecological balance. In 1988 the LGEEPA was published; in 1992 the National Institute of Ecology (INE) and the Federal Office of Environmental Protection (PROFEPA) were created.

The LGEEPA is observed to contains the RA in six different ways. The first one, according to Carmona (1988), is an environmental policy immersed in the concept of sustainable development that, from the legal point of view, determines a future projection value based on a present damage. The second is an economic instrument, subject of environmental insurance, with regulatory and administrative mechanisms of a fiscal, financial or market nature (credits, bonds, insurance, funds, trusts, financing, projects, research, etc.), through which environmental benefits and costs are adopted. The third comes as a regime adopted by environmental service providers.

The fourth comes in terms of RP, based on article 115 of the CPEUM, establishing an objective liability to the Municipality in relation to the numerals 152 and 152 bis of the LGEEPA. This foresees a liability, positive or negative, to whom generates, manages and controls RP. The fifth is a liability associated with other liabilities such as civil, criminal and administrative. For me, it should also be constitutional because, as of the constitutional reforms of 2011, the constitutional protection has now the form of adhesive protection and can be promoted under individual and collective legitimate interests. This would proceed when the existence of possible damage is estimated. For example, in terms of RP, it would proceed by the authorization of a project that turns out to be harmful to the environment and society (controlled confinement of RP or an authorization for an industry to handle highly dangerous substances that will eventually become RP).

In such case, the right way would be the indirect protection to try and revert the authorization in accordance with human rights and the constitutional guarantee framed in article 4 of the CPEUM. Finally, the sixth principle of RA that contains the LGEEPA is a self-regulatory instrument based essentially on the figure of Environmental Audit.

In this regard, it would be ambitious to think that the LGEEPA has these RA principles, especially when it has already been argued that the RA must be based on other factors that are not properly regulated such as ethics and morals. So, the principles observed by Carmona can be classified into six categories, but all of them are still principles that seek correction and not prevention under a scheme of solidarity RA.

In 2010, the initiative to issue the LFRA was presented; the respective Commissions took turns to approve the bill in April 2013, publishing the decree on June 7, 2013. Diaz (2015) states that said law provides for a liability that arises from damages to the environment, i.e., the obligation to repair damage and environmental compensation. He states that it is independent from other forms of liability, but there is a link between liabilities (environmental, patrimonial, administrative and criminal), and it establishes economic sanctions.and other actions to prevent damage from increasing. In other words, it is a law reactive to a fact raised and not a preventive law that regulates presumptuous behavior.

As of this Decree of 2013, the RA must be reformed to incorporate several environmental laws such as the LGEEPA, the General Law for the Prevention and Integral Management of Residues (Spanish acronym: LGPGIR), the General Law of Sustainable Forestry Development (Spanish acronym: LGDFS) , General Wildlife Law (Spanish acronym: LGVS), among others. The above gave rise to the implementation of the environmental justice system and the protection of the constitutional prerogatives in the matter. However, some serious weaknesses of the RA figure still prevail. These have benefited the option of polluting and damaging the environment in exchange for environmental compensation actions that protect the interests of certain social associations. Such entities, under the figure of a legal person, make use of mitigating factors that cause legal inequalities and go beyond the meaning of law.

Basurto (2015) says that the LFRA addresses the joint liability, which occurs when the causer of damage uses another person to carry out an affectation. Ponce (2012) argues that the LFRA has had several achievements such as the environmental liability fund, the judicial procedure and the requirement of compensation for damage. However, the LFRA has more weaknesses than strengths. First, it is a law that does not seek environmental protection but the existence of damage; it excludes social sectors, discriminates law enforcement and allows the execution of damages through authorizations. Therefore, it is convenient to analyze in detail some of its articles to be able to link them to RP handling.

The LFRA states, in its article 1º, *that it regulates the environmental liability arising from damages caused to the environment, as well as their reparation and compensation; It is also regulated by Article 4 of the Constitutional Law on Public Order and Social Interest.* However, if the explanatory memorandum and the publication process of the Law are analyzed, it will be appreciated that the provision of Article 4 of the CPEUM was entered at the last moment. The same article 1 rightly recognizes the difference between damage caused to the environment and that suffered by the owners of natural elements. In addition, it recognizes the economic, social and environmental values as part of sustainable national development. Finally, the article mentions that the RA, subject to judicial process, is independent from other liabilities. However, the RA is so far implicit in civil liability without being otherwise promoted. As of RP, it is focused exclusively on the damage that may be caused and not on the procedures to avoid or minimize them.

Article 2 addresses the definitions for the LFRA, but it does not define environmental compensation in this precept. Some of the main definitions include: activities considered highly risky, the equivalence criterion and damage to the environment (loss, change, deterioration, impairment, adverse and measurable alteration or modification of habitats, ecosystems, elements and natural resources, as well as their chemical, physical or biological conditions, the interaction relationships among these, and the environmental services they provide). The LFRA limits this definition to what is indicated in article 6. Here, it states that when there are authorizations by SEMARNAT or the permitted limits are exceeded, the damage, causal chain or base state will not be considered environmental damage. It is remarkable that in this article a damage will not be considered as such when an authorization has been obtained.

This fact is obviously illogical because having or not having authorizations or exceeding or not the limits established in the regulations, a halt in damaging or attempting damage is not guaranteed. In the case of RP handling, this peculiarity would allow for widely spread damages without any type of liability. It would only suffice to have authorization for the handling or generation of RP for that precept not to be applicable. However, this legal precept can be debated by means of a constitutional protection not only against the person responsible for the damage, but also against the authority itself as a direct accomplice.

The responsibility of the subject causing the damage must prevail even when there is authorization. In this regard, Basurto (2015) indicates that joint environmental liability would be applied. Article 8 talks about financial guarantees aimed at integrating a National System of Environmental Risk Insurance. Nonetheless, four years after the LFRA was published, there is still no such system, so it would be worthwhile to question: What will be the insured amounts for the environmental risk insurance?, what criteria would be used to determine the amounts in terms of RP?, will the RP generator be required to have another type of risk insurance in addition to the one demanded by the LGPGIR?

Article 10 states that *any natural or legal person who by its action or omission directly or indirectly causes damage to the environment, will be liable and will be obliged to repair the damage, or if not possible, to environmental compensation.* However, only the damage, not the risk, is considered here, and the LFRA itself establishes mitigating factors for legal persons. Article 11 indicates that liability for damage caused to the environment will be subjective and will arise from illegal acts or omissions. Nevertheless, the RA should be objective and derive not only from illicit acts but also from intentional licit acts or faults as it is the case for RP (article 12). Does causing harm with "authorization" exempt liability?

Article 13 indicates the terms in which the reparation of the damage proceeds. It consists of *the restitution of the Base State of the habitat ... through restoration, reestablishment, treatment, recovery or remediation.* Is restitution, restoration, reestablishment, treatment, recovery or remediation the same concept? Of course not; it is impossible to restore thinking that it means leaving things as they were before.

The dynamic nature of the environment makes it impossible to achieve it. On the other hand, the precept seems irreverent indicating that *the owners or holders of the facilities in which damage to the environment has been caused must allow their reparation in accordance with this Law. Failure to comply with said obligation will result in the imposition of enforcement means and the corresponding criminal liability.* This constitutes a contradiction to the power to penalize owners or possessors of the facilities where environmental damage was caused because repairs are not allowed, while the purpose of the Law is to seek alternative solutions. In addition to this, a restitution in general terms is impossible.

Article 14 addresses the cases of origin for environmental compensation. It will proceed when it is impossible to repair or when the damage comes from illicit activities. For this, SEMARNAT must grant a post-injury authorization based on a previous assessment of damages. This precept has been very controversial; Basurto (2015), Díaz (2015) and Carmona (2016) sustain that the existence of this prerogative is unfortunate because it legalizes an illegal activity.

Environmental compensation must not depend on a illicit activity and much less be conditioned to the discretion of SEMARNAT. This agency has been disappointing in relation to environmental protection in Mexico. As an example of this, it is enough to just mention the irregularities, inconsistencies and illegalities shown in the authorizations for land use change in avocado plantations in Michoacan. It should also be noted that the LFRA does not establish who will determine the criteria for environmental compensation; in Michoacan there is only one environmental expert.

Article 17 defines environmental compensation as *consisting of investments or actions that the person in charge makes to generate an environmental improvement, replacing the total or partial reparation of damages caused to the environment and equivalent to the adverse effects caused by the damage.* However, experience says that this term is fraudulent because through long judicial processes and economic interests, compensation will be sought instead of remediation, causing a benefit for those who cause long-term damages.

Article 19 establishes the amounts of economic sanctions that will apply aside from reparation or environmental compensation. However, it is well known that fines are left to the discretion of the authorities who are aware of the process and have, or at least should have, the commitment to be environmental experts to determine the amount of environmental damage. On the other hand, there are mitigating measures to reduce fines. This is indicated in article 20, saying that they can be reduced to its third part if certain assumptions are met. Such assumptions include: not having a previous sentence for the company and managerial employees, having an internal environmental management and training body (minimum three years prior), having a financial guarantee (insurance) and preferably an environmental certificate (clean industry, for example). If at least three of these assumptions are met, the fine is reduced. This leads to think that companies will seek such mitigating factors to evade liability. This becomes very simple in the case of RP since PROFEPA hardly sanctions the generators or service providers of RP handling. It sanctions them according to irregularities of the LGPGIR, its regulations and the complementary Official Mexican Standards (Spanish acronym: NOM). In addition, article 26 of the LFRA indicates that there will be no joint RA when the internal environmental management and training body, the financial guarantee and the environmental certificate are accredited. This suggests that the Law itself indirectly provides tools to evade the RA despite the effects it causes, which affect diffuse or collective interests that are rarely supported by the law.

Article 24 refers to the liability of legal persons, whose directors and employees exercising a harmful action or omission will be jointly liable. It also indicates that people who use a third party to cause damage will be jointly liable, except in the case of the delivery of RP confinement services from companies authorized by SEMARNAT. Two things are worthwhile to point out in this regard. First, the precept indicates the intention to cause damage, leaving aside the damages caused carelessly or without intention, which limits the scope of the article. Secondly, it breaks the barrier of joint but differentiated liability in terms of RP because it frees the generator from RA when hiring an RP confinement service provider. However, the LGPGIR states in its article 42 that the *"liability for handling and final disposal of hazardous waste corresponds to whoever generates them. In the case of RP handling and final disposal service companies hired and authorized by the Ministry, and if waste is delivered to said companies, it will be the company's liability for the operations, aside from the generator's liability.*"

Article 28 establishes the recognition of the right and legitimate interest to exercise the action of RA, but it establishes limitations that deviate from the intent of the law. It states that *"the right and legitimate interest to take action and bring the RA to justice is recognized such as reparation and compensation for the damage caused to the environment, payment of the Economic Penalty, as well as the benefits referred to in this Title to: I. Individuals living in the community adjacent to the damage caused to the environment."* But, what about the communities that feel the affectation and are not close? Fraction II sets *"Mexican private non-profit legal persons, whose corporate purpose is the protection of the environment in general, or of any of its elements, when acting on behalf of any inhabitant of the communities included in section I.*" This will limit moral persons defending the environment because they can not act on their own. They must necessarily act under the representation of a member of the community adjacent to the damage. Then, what happens with the collective protection trial in the exercise of the RA? In addition, the legal constitution of said company must be verified three years in advance in order to act in representation.

Fractions III and IV acknowledge *"the interest to the Federation through the Attorney General Office or institutions that exercise environmental protection functions of the federal entities and the Federal District within their territorial circumscription, jointly with the Attorney General office."* In this regard, how is it possible that the PROFEPA or the Environmental Protection Agency (Spanish acronym: PROAM) exercise the action of RA against those authorities that establish the guidelines to proceed? They are organisms independent from the SEMARNAT and the Ministry of Environment, Natural Resources and Climate Change (Spanish acronym: SEMARNACC).

Article 29 talks about the prescription of the action, stating that "it prescribes after twelve years from the day on which the damage to the environment and its effects occur." This lapse of time turns out to be quite restrictive considering other environmental legislations that include a prescription of more than twenty years. As for RP, what would happen in the case of environmental damage caused by RP confinement service providers? What prescription should be considered, the LFRA considering twelve years or the LGPGIR indicating twenty years?

Article 32, in consideration of the Federal Code of Civil Procedures (Spanish acronym: CFPC), refers to precautionary measures that will consist of the assurance of documents/elements related to the damage caused as well as the taking of samples. The questions that would apply in this case are: will the district judges have the ability to safeguard the confiscated items? How will the precautionary measures be ruled if there is no actor in the process? The latter goes hand in hand with the CFPC statement. It indicates, in its article 610, that it will have to be done at the request of a party. Then, who will cover the sampling costs? It is clear that the legislator omitted to establish these conditions in an LFRA whose supplementary regulations would be the Codes and not the other way around.

Article 38 refers to the terms that the parties will have to pronounce for in a sentence, considering terms up to thirty days. An extension will be possible for a complementary thirty days. These terms - for the matter that is being sentenced (environmental) - violate the principle of expedited justice when a great damage can be caused in just minutes. An RP example of this would be the spill of a liter of used oil (Poisonous and flammable RP), which can contaminate more than 1,000 liters of water in just a few seconds.

Article 46 on the comprising of the Environmental Liability Fund states, among other things that, "the Ministry will issue the operation rules and base of the fund ...” However, they have not yet been established, and anyway, the purpose of the fund is not to prevent and invest in avoiding environmental damage (relying on scientific research) but rather to remedy.

Article 48 refers to the right to an "adequate" environment for development and well-being. Article 4 of the CPEUM was modified on December 8, 2012 highlighting the right to a "healthy" environment for development and well-being, but this was not considered in the LFRA. In addition, this Article 48 indicates that the morals and the rights of third parties must not be affected in the alternative mechanisms of solution, nor should environmental laws and international treaties be contradicted. Then, is environmental damage placed before morality? How can the rights of third parties not be affected if they do not have a voice and a vote? Are international treaties in which Mexico plays a role more important than environmental damages caused domestically? In relation to the rights of third parties, Article 49 of the LFRA indicates that when an agreement is established as a solution measure and may affect third parties, the judge will seek their consent.

The obvious question is: how can an agreement be given preference over the affectation to third parties who are not given a voice and a vote? In accordance with the above, Article 51 indicates that *"forgiveness"* may be granted or there may be a *"legal disinterest"* of the victim; both cases shall be regulated in terms of the CFPC. The purpose of this is to achieve restorative justice through the participation of the victim and the accused. Thus, if there is no one who exercises the action by RA because the only one affected is the environment, it is worth asking: will this be a case of legal disinterest? Does granting forgiveness restore or compensate for environmental damage? Is it the aim of justice to be restorative instead of protective to the environment?

Article 56 establishes a contradiction or an admission to the right to exercise the action of RA. Contrary to what is stated in article 28 of the law, said article states that "According to the provisions of the fourth paragraph of article 4o. of the CPEUM, any person from the community possibly affected by environmental crime will be considered victim of crimes against the environment when constituted as a complainant before the Public Ministry. Thus, it is no longer just about the community adjacent to the place or site of the damage. It is now about everyone who has the individual guarantee and human right to a healthy environment for development and well-being.

In general terms, the LFRA does not obey social expectations and needs because it leaves society defenseless. It transgresses its rights, not only heritage rights, but also physical, natural and cultural, and it maintains the levels of inefficiency that Brañes observed in 2004 regarding Mexican environmental legislation. Gonzalez argues that Mexico's erroneous approach to environmental legislation is due to *"a scarce presence of the idea of sustainable development in environmental legislation; an insufficient or erroneous consideration of the scientific and social data involved in the environmental problem; a lack of the necessary mechanisms for the application of environmental legislation or the inadequacy of existing mechanisms; and the structural heterogeneity of the legislation*” (González, 2000: 99). Therefore, it is not possible to legislate environmental matters if their strengths, scope, projections, limitations and weaknesses are unknown.

According to Basurto (2015: 26), *"legal fiction surpasses reality"* because the LFRA is seen as an instrument to destroy investment projects, not as a figure of protection to natural resources. In this regard Carmona (2016) indicates that it is necessary to systematize environmental legislation and the liability forms (environmental, civil, criminal and administrative). Also, procedural legitimation is necessary for affected social groups. A general analysis of the LFRA reveals the urgent need to equalize liabilities and rights for persons (whether legal or natural). It is not feasible to discard or deny the exercise of the RA actions to people who do not live in communities adjacent to the areas where environmental damage occurs.

The environment is owned by all and we all have a diffuse interest in its protection. Regarding the operation of the LFRA, it is not possible so far because its Regulation has not been issued, there are no specialized courts on environmental matters and there are no rules and bases to operate the Environmental Responsibility Fund. In addition, it is a reactive law that seeks to establish sanction measures (civil, criminal and administrative) instead of environmental protection.

6.4 Environmental responsibility in the handling of hazardous waste

The issue of RP is quite varied, and it has certain gaps that make environmental care and protection impossible just like the rest of the environmental issues in Mexico (water, forestry, soil, wildlife, protected natural areas and others). Individual guarantees and human rights are infringed, and natural elements are placed at constant and continuous risk.

Mexico has the LGPGIR; it is general and not federal because it considers the concurrence of the three orders of government in waste handling. It was issued in 2003, and its Regulations were published in 2006. They provide for "ideal" waste handling parameters, whether RSU, special handling waste (RME) or RP. RP are "*those that have some of the characteristics of corrosiveness, reactivity, explosiveness, toxicity, flammability, or that contain infectious agents that make them hazardous. It also includes containers, recipients, packaging and soils that have been contaminated when transferred to a different site*" (LGPGIR, article 5, section XXXII).

On the other hand, integral management of waste refers to *"the activities of source reduction, separation, reuse, recycling, co-processing, biological, chemical, physical or thermal treatment, collection, storage, transportation and final disposal of waste that are individually carried out or combined in an appropriate way as to adapt to the conditions and needs of each place, fulfilling objectives of valuation, as well as sanitary, environmental, technological, economic and social efficiency*" (LGPGIR, article 5, section XVII).

The LGPGIR and the Regulations of this Law establish certain responsibilities in the management of RP, whether for the generators, for the service providers, for the authorities, for producers, exporters, importers, distributors and consumers. The LGPGIR establishes, in its article 1, the need to apply the principles of valuation, shared responsibility and integral management of waste under criteria of environmental, technological, economic and social efficiency.

These must be considered in the design of instruments, programs and environmental policy plans for waste management. For this, it is necessary to define the responsibilities of producers, importers, exporters, merchants, consumers and authorities of the different levels of government, as well as of service providers for an integral waste handling.

The LGPGIR defines the concept of shared responsibility as the *"principle by which it is recognized that special handling and solid urban types of waste are generated by the performance of activities that meet the needs of society through value chains of production, processing, packaging, distribution and consumption of products. Consequently, their integral handling is a social co-responsibility that requires the joint, coordinated and differentiated participation of producers, distributors, consumers, by-products users, and of the three orders of government under a scheme of market feasibility as well as environmental, technological, economic and social efficiency*" (article 5, section XXXIV). In this regard, where does it leave RP?

It is convenient to analyze the problem for each of the figures considered by the LGPGIR.

a) Environmental responsibility of generators in the handling of hazardous waste

Perhaps the answer is what is indicated in article 42, which states: "The responsibility for the handling and final disposal of hazardous waste belongs to whoever generates it. *In the case of RP handling and final disposal service companies hired and authorized by the Ministry, and if waste is delivered to said companies, it will be the company's liability for the operations, aside from the generator's liability. The generators of hazardous waste that transfer such waste to companies or managers that provide handling services must assure the Secretariat that they have the respective authorizations in force; otherwise, they will be liable for the damages caused by their handling*" (Article 42).

The above contrasts with the provisions of the LFRA as it indicates, in its article 24, that joint liability will not apply when it comes to hiring service providers of RP confinement. then the chain of responsibility provided by the LGPGIR gets broken.

Among the responsibilities indicated by the LGPGIR for generators, they emphasize that their handling plans must establish schemes in which the principle of shared responsibility of the different sectors involved is applied. In addition, said plans must be presented for registration with SEMARNAT (only large generators). Also, the subjects that are obliged to prepare handling plans may implement them by endorsing the legal instruments they deem necessary and appropriate to set their responsibilities (20 and 33 of the LGPGIR, as well as Article 24 of the LGPGIR Regulation).

Within the responsibilities included in the LGPGIR Regulation (RLGPGIR), the five-year preservation of the RP delivery-receipt manifests and the RP registration logs (articles 71, 75) stand out. In addition to the above, those responsible, whether generators or handlers, have the responsibility to record the collection of samples, their transport and delivery in the laboratory for testing or analysis purposes (Article 2 of the RLGPGIR).

Article 137 of the RLGPGIR indicates that the person responsible for the contamination or environmental damage will carry out the remediation programs, as well as the characterization and environmental risk studies.

These prerogatives show that RP generators are responsible for the damages caused by their generated waste, regardless of whether a service provider is hired for collection, transport, storage or final disposal. The RA's requirement to properly handle RP is implicit in each obligation and duty established by the LGPGIR and its Regulations, independently of other types of liabilities such as criminal liability. In this regard, the Federal Criminal Code (Spanish acronym: CPF) provides a section on crimes against the environment and against environmental management.

It indicates that "a penalty of one to nine years in prison and a three hundred to three thousand day fine will be imposed on a person who unlawfully, or without applying prevention or safety measures, carries out production, storage, traffic, import, export, transport, abandonment, disposal, discharge or any other activity with substances considered hazardous due to their corrosive, reactive, explosive, toxic, flammable, radioactive or other analogous characteristics, whether by order or authorization, causing damage to natural resources, flora, fauna, ecosystems, water quality, soil, subsoil or the environment...

When behaviors are carried out in urban areas with used oils or substances that deplete the ozone layer in quantities not exceeding 200 liters, or with residues considered hazardous due to their biological-infectious characteristics, up to half of the penalty provided for in this article will be applied, except in the case of repeated behaviors with amounts less than those indicated. (Article 414 of the CPF).

It also states that *"a penalty of one to four years in prison and a fine of three hundred to three thousand days shall be imposed on anyone transporting or consenting, authorizing or ordering the transport of any waste considered dangerous due to their corrosive, reactive, explosive, toxic, flammable, biological-infectious or radioactive characteristics, to a destination for which there is no authorization to receive, store, dispose of or abandon it, or assents false data in the registers, logs or any other document used for the purpose of simulating compliance with the obligations derived from the federal environmental regulations, or destroy, alter or hide information, records, reports or any other document that is required to be kept or filed in accordance with federal environmental regulations*"(article 420 Quater of the CPF).

The above shows that improper RP handling brings about an economic penalty in criminal matters (in addition to those that arise from administrative liability) ranging from $24,012.00 to $ 240,120.00 pesos (300-3000 days), considering the Effective Minimum Wage (Spanish acronym: SMV) of 2017, which is $ 80.04.

It also causes a deprivation of freedom that ranges from one to nine and from one to four years in prison. No bail proceeds in this case for being considered serious crimes. However, incorrect RP handling is rarely punishable by criminal law and is generally limited to the action of PROFEPA under the line of environmental liability. PROFEPA establishes a legal procedure according to the provisions of Federal Law of Administrative Procedure (LFPA), which begins by the act of Inspection (visit of verification and compliance at the generators' establishments). Then, the inspected subject is held back in case of irregularities or breaches to provide the requested information within the term of ten days and offer the proofs of either preventive or corrective compliance. once the offender has been heard and the evidence has been offered and admitted, the proceeding resolution shall be issued within the following ten days (LFPA, 1994).

According to the INEGI (2014), there were 116 complaints in Michoacán in 2013 regarding ecological order and environmental impact, of which 46 were concluded. In addition, there are records of 118 inspection visits and 32 verification visits. Unfortunately, these records do not make reference to RP verification and inspection. So, it is assumed that the PROFEPA Delegation in Michoacan is fulfilling its role by monitoring compliance with all the CPEUM, the LGEEPA, the LGPGIR and its Regulations as well as the LFRA.

This remains separate from the obligations and duties of any RP generator. Such duties consist of the following: having an Environmental Registration Number (NRA); having a category as a generator (micro, small or large); an RP handling plan; RP registry log; RP delivery-reception manifests; Annual Operation Certificate (COA); environmental insurance (the COA and the insurance only apply for large generators); temporary RP warehouse of RP which must be roofed, restricted, with signs alluding to the dangerousness of the RP that it protects, retaining walls, retention pits, gutters, non-skid floors, fire extinguisher, suitable containers to protect each RP with the name of the RP and its characteristics of danger: corrosive, reactive, explosive, toxic, flammable and biological (CRETIB); service providers contracts for RP handling, among others.

b) Environmental responsibility of service providers in the handling of hazardous waste

Just like generators, RP handling service providers will have responsibility for the operations they carry out with the RP once the RP are transferred to them without inhibiting the generators' responsibility. An RP handling service provider can perform activities of collection, transportation, storage, recycling, reuse, co-processing, incineration, treatment and controlled confinement of RP.

According to article 59 of the LGPGIR: those responsible for hazardous waste treatment processes, where the release of a toxic, persistent and bio-accumulative substance into the environment is carried out, will be obliged to prevent, reduce or control said release.

In the case of the provision of confinement services, the responsibility of the service provider extends for a term of 20 years after the closing of its operations. The way of estimating the amount, collection and application of the guarantees will be established in the RLGPGIR.

Article 79 of the RLGPGIR indicates that *the responsibility for the handling of hazardous waste, by the companies authorized to provide handling services, will start from the moment in which they are delivered by the generator, for which, they should review that such waste is properly identified, classified, labeled or marked and packaged. The responsibility will end when the hazardous waste is delivered to the recipient of the next stage of handling and the latter signs the corresponding receipt manifest.*

In the case of companies authorized by the Ministry to reuse, recycle, co-process, treat and incinerate hazardous waste, their responsibility ends when their respective processes end and the hazardous waste is transformed into products, or when they lose the characteristics of dangerousness in accordance with the corresponding Mexican official standard (article 80 of the RLGPGIR).

The above is separate from the obligations and duties imposed by the regulations in terms of RP. They basically consist of having authorizations by the SEMARNAT (regarding collection, storage, recycling, reuse, co-processing, incineration, treatment and controlled confinement) and by the Ministry of Communications and Transportation (Spanish acronym: SCT) for the case of RP transportation. In addition, they must have environmental insurance, present the COA, give delivery-receipt manifests and keep records of each RP that they collect, transport, store, process, recycle, reuse, co-process, incinerate and confine. They must also have trained personnel and technology suitable for the proper handling of RP.

In addition, the provisions of the CPF are applicable in criminal matters to the RP handling service providers.

c) Environmental responsibility of importers and exporters in the handling of hazardous waste

For these cases, the responsibility contained in the LGPGIR indicates that *companies that import or export hazardous waste will be responsible for the damage they cause to health, the environment or property as a result of its movement between the generating source and the final recipient, regardless of the sanctions and penalties that may apply (article 91 of the LGPGIR).*

In addition, the RP entering the country illegally, *must be returned to the country of origin within a period not exceeding sixty days. The costs incurred during the process of returning to the country of origin will be covered by the company responsible for the operation that intervened in the import of the waste* (Article 92 of the LGPGIR).

The above does not exempt from criminal liability those who cause environmental damage due to RP import or export and remain subject to the provisions of the CPF.

d) Environmental responsibility of authorities in charge of the control and management of hazardous waste

The LGPGIR, in article 23, provides for RP handling in municipalities. For this, RP must be generated in households in amounts equal to or less than those generated by micro generators. Also, consumer products containing hazardous materials must be discarded in housing units, offices, institutions, agencies and entities. In this regard it should be noted that this provision derives from article 115 section III, paragraph c) of the CPEUM. It indicates that the Municipalities will be responsible for the functions and public services of cleaning, collection, transfer, treatment and final disposal of waste. This allows us to think that the Municipality has a double environmental legal function. The first is to handle RP and to provide the service of final disposal of waste. Then, the Municipality has a wide and complex RA in relation to RP.

On the other hand, article 75 of the LGPGIR provides that SEMARNAT and the competent local authorities will be responsible for carrying out actions to identify, inventory, register and categorize the sites contaminated with hazardous waste. This is with the purpose of determining if its remediation proceeds in accordance with the criteria established in the RLGPGIR.

Finally, article 31 of the RLGPGIR states that responsibilities should be specified in the systems of environmental handling, and the actions of handling residues should be described. In this regard, it is appropriate to indicate that, so far (ten years after the publication of the RLGPGIR), there is no environmental handling system that addresses waste issues.

e) General considerations of environmental responsibility in the handling of hazardous waste

The LGPGIR indicates that any natural or legal person who, directly or indirectly, contaminates a site or causes harm to the environment as a result of the generation, handling, release, discharge, infiltration or incorporation of hazardous materials or waste into the environment, will be responsible and obliged to repair and, where appropriate, provide corresponding compensation and remediation in accordance with the provisions of the LFRA (articles 68, 69 and 77). This provision indicates that not only reparation and compensation, but also remediation actions will be carried out.

This means taking the necessary measures in the contaminated sites to eliminate or reduce the contaminants to a safe level for health and the environment, or to prevent their dispersion in the environment without modifying them (article 5 of the LGPGIR).

Parallel to this, article 70 of the LGPGIR provides joint liability for the owners or holders of privately-owned properties and holders of concession areas whose soils are contaminated. Here, the great difference with the LFRA's provisions, which even indicate criminal responsibility, is that owners have the right of reply against the contamination source.

For these reasons, it is convenient to know the perspective of RP generators regarding their DAP and/or DAA in order to achieve an environmentally appropriate handling of their waste. Thus, it is important to know the approach of the main studies carried out to economically value waste handling. This can be done once the legal framework and environmental responsibility that implies inadequate RP handling has already been deeply analyzed.

Chapter VII Feasibility of the Contingent Valuation Method for hazardous waste in the Cuitzeo región

7.1 Methods for Economic Valuation of Externalities

The Valuation of Externalities Method (VEM) arise with the discipline called EA to allow the monetarization of environmental benefits (or costs) and its inclusion in the ACB context (Almansa and Calatrava, 2001).

None of the tools generated by the EA is exempt from methodological difficulties, not to mention the ethical criticisms they receive from other alternative approaches. Without underestimating these problems, its use may be of interest for certain objectives, such as the case study analyzed here. The value amount of goods that the human being uses, often disregards the social factor in the market, where a price is assigned. For that reason, various methods of economic valuation seek to know and highlight the value instead of the price.

As for externalities, they are known as indirect valuation methods that address issues such as the willingness to pay (to avoid damage or enjoy an improvement) or the compensation required (for giving up an improvement or supporting a damage).

These methodologies use the preferences revealed by consumers as a mechanism to access the value of an environmental service. They are based on the relations established in the production functions (of goods and services or of profit) between the goods and environmental services object of valuation as well as other goods and services or productive inputs that circulate in the market (Delacámara, 2008).

Regarding the subject under investigation, the methods of declared preferences are those in which individuals express their own preferences directly in a hypothetical but credible scenario. These methods intend to assess the value of environmental services when it is not possible to determine the relation between the valuation of a certain environmental good or service and the behavior of its related goods or services in real markets (as it happens with the methods of revealed preferences).

These methodologies are indicated in the context of estimating externalities when it comes to discovering values based on the explicit recognition of a prior right over the environmental asset being valued.

The most representative is the Contingent Valuation Method (CVM) (Hanemann, 1994, Carson and Mitchell, 1993); it tries to discover the willingness to pay or compensation required of a person through the variation in the conditions of an environmental asset. A contingent valuation survey would normally lead to that value by asking directly about the monetary amount that a respondent faced with a hypothetical situation would be willing or able to pay (Hanley et al., 1998, Davis, 1963, Boyle and Bishop, 1987, Viscusi, 1993).

7.2 Background of the Contingent Valuation Method

It arises from the neoclassical economy that perceives the environment as abundant, whose alterations are due to the absence of clear rules to explain social processes. It sustains that if true value can be assigned to environmental goods and services, the latter can be managed just like any scarce economic resource (Yu Chan, 2005).

To account for this problem, the EA tries to create the conditions for commercial exchange to be established where it does not occur. This is called internalizing externalities. There are two ways to do it: following Pigou or following Coase (Riera, 1994).

Pigou (1920), in his work *The Economics of Welfare,* defined the concept of internalization of externalities for the first time. But it is not until 1970 that the EA is constituted as a discipline, specifically interested in environmental externalities. Pigou recognizes that market failures prevent the maximization of private welfare to match the maximization of social welfare (Pigou, 1920).

"All the involuntary effects on the welfare of people and companies are called externalities: positive, when they benefit others, and negative when they harm them. What matters is the negative externalities, as positive externalities do not cause problems, on the contrary, they help. Externalities are the private costs passed on to society that indicate a lack of adequacy with social ones. It is necessary, therefore, to internalize these individual costs that were left out of the market "*(Yu Chan, 2005: 180).* This procedure is carried out, in environmental matters, according to the Polluter Pays Principle. Adding the tax, the cost of production of the polluting company becomes greater as the benefit decreases to the same extent.

Coase (1960), in his article *The problem of the social cost*, shows that an external effect does not confront a private interest to a public interest but two private interests instead. This proposal reverses the moral sense that the polluter is the one who does the wrong and, therefore, has to pay. According to Coase, it would not matter who pays if society is viewed as a whole entity There is a neutrality in the solution. If the affected person is the owner of the resource, then the polluter pays to compensate for the pollution caused. If the polluter is the owner, then the affected person pays so that the polluter agrees to reduce his/her benefits with the reduction or interruption of production. Coase (1960) states that when pollution occurs, the solution of not producing or reducing production can harm the community. The interest of society as a whole must prevail over that of direct victims. Therefore, he considers Pigou's private cost comparison to social cost inadmissible.

For Coase, the relevant criterion for resolving externalities is the maximization of the collective product. Thus, what matters is not justice but the efficiency of the solution. These two interpretations generate different problems. Pigou's centralized environmental management policies are generally very onerous and have relative effectiveness, depending on State institutions. On the other hand, Coase's liberal policies bring about polluting rights, which legitimizes and reinforces pollution instead of reducing it (Yu Chan, 2005).

These statements are reinforced by the theory that natural resources do not belong to anyone. This eventually generates a "*tragedy*" since nobody takes care of them, which creates environmental problems such as externalities like waste. This results in the need to determine what should be maximized in the face of the problem of obtaining and using common goods. The main problem is a population growth that exceeds the existential limits of natural resources, and thus originate circumstances that give rise to several problems leading to social and shared tragedy. Such problems favor the economic aspect because of the need to obtain the greatest profit from common goods by only absorbing the positive effects and leaving the negative effects, such as externalities and pollution, to the rest of the population (Hardin, 1968).

Hardin's proposal sets the guidelines to direct all human actions establishing preventive and non-corrective measures. This is done with the support of the coercive participation of the State through the effective application of the law in the control and monitoring of common resources. Said participation is due to prior recognition by society.

As for RP, Hardin's proposal constitutes an ideal model to minimize and value waste due to preventive actions to control the production and consumption of goods that would generate waste in some of their life cycles. These actions also help monitoring and controlling regulatory compliance with respect to waste.

As noted in the previous section, the legal framework represents a central axis that provides the guidelines to determine what should or should not be met in the generator's handling of RP. In this sense and taking into account the need to economically value RP handling in the Cuitzeo region, it is necessary to know the DAP through the use of economic valuation methods.

7.3 Description and components of the Contingent Valuation Method

It has been said that the CVM is used to obtain direct information from individuals regarding a certain environmental reality. This method is applied in the present research to assess the generator's willingness to pay (DAP) for the handling of their RP. Likewise, it seeks to assess the DAP of those affected by such handling, whether affected in natural (in particular the soil) or social (such as health) ways, and how all of this is reflected in the sustainable development of the Cuitzeo region.

The CVM was first proposed by Ciriacy-Wintrup in 1947 as a means of estimating the demand curve for collective assets, with special emphasis on the benefits of preventing erosion. He noted that those benefits derived from this practice were of a public nature (for example, reduction of leaks of polluting substances into the streams). Then, he suggested that the only way to identify the demand for these assets was through personal interviews, where individuals were asked for their willingness to pay for accessing additional quantities of an asset (Hanneman 1994). Two decades later (1960) the CVM is retaken, and its application is sought in academic research. Davis (1963) measured the value of a recreational area in the USA for hunters and nature lovers using the travel cost method (Portney 1994).

One of the most influential studies was that of Krutilla (1967), who identified the importance of the development and maintenance of natural environments and suggested what is now known as existence value (value is what individuals grant to diverse species, unique natural environments or other assets just because they exist). It is also known as the non-use or passive value. Most of these methods have been used to know people's willingness to pay for assets such as: water or soil quality (Carson and Mitchell 1993), the conservation of endangered animal species (Boyle and Bishop, 1987), or to calculate the benefits of improving air quality (Ibarrarán, et al., 2003).

This method helps to calculate the probability of obtaining a positive or negative response to a question about the availability to pay for environmental improvements or the willingness to accept compensation for an environmental loss. It depends both on the socioeconomic characteristics of the respondent as well as the quality/quantity attributes of the environmental good that is offered (Riera, 1994).

The CVM consists of asking individuals for their DAP for additional amounts of a public asset, which in this case is the improvement in environmental quality. The people’s DAP depends on several factors such as their income, their attitude towards society and the environment, the level of information available, the spatial extent of the public asset and the frequency and intensity of its use. The central problem of the DAP is that individuals can intentionally distort their responses by adopting an opportunistic position (free riding). Interviewees may falsify their answers downward by fear of subsequent charges or the other way around, indicating very high values to emphasize their interest in the development of a certain program.

Finally, the willingness to pay not only reflects people’s tastes and preferences but also their level of income (Hanemann, 1994). Another way to approach the problem of assessing environmental improvements is to ask people how much they would be willing to accept (DAA) for giving up a given environmental benefit. To better assess the quality of the soil, one could ask how much they would be willing to accept for a small deterioration or how much they would have to receive for a small reduction in environmental quality. The DAA is not restricted by income as is the DAP.

Thus, it is not surprising that when people are asked about their willingness to accept, their responses are usually greater than those corresponding to their willingness to pay for the same change in the quality of the public asset but in the opposite direction. The differences between the DAP and the DAA are due to the initial allocation of property rights.

When individuals consider that a certain feature of an asset belongs to them, they are not willing to lose such right (Ibarrarán, et al., 2003). Nothing would be enough to compensate for an environmental loss because this is an implicit right for them. In conclusion, the loss of something that a person already has, such as pure air, is valued higher than the potential gain of something new, such as an improvement in air quality (Field 1995).

Several studies have been conducted so far to value the environment through contingent valuation. However, this method has been very controversial, and many specialists still doubt its validity. For this reason, the General Council of the National Oceanic and Atmospheric Administration (NOAA) was held in December 1993. Arrow and Solow participated in it to establish whether the contingent valuation was capable of providing values that were reliable enough to be used in the economic valuation of natural resources and environmental quality. The Panel concluded that the results of the CVM could produce sufficiently reliable estimators in the valuation of environmental assets and proposed a series of rules that should be observed for the correct application of CVM studies (Portney 1994).

Some of these rules will be mentioned later when the preparation of the survey is discussed. It should be clarified, however, that scholars have expressed some reluctance to using it as a basis to establish monetary compensation for environmental damage, i.e., the people's DAA.

Hanneman (1994: 19-43) mentions that the most common problems of the CVM are: a) The results are sensitive to the format of the surveys. The questions can alter the respondents' answers, the respondents may only seek to satisfy the interviewer without efforts, or the difficulty of the topic may force the respondents to falsify their answers; b) The survey itself may give value to the asset as it is being applied. The respondents may have not been aware of the asset's real value until they were asked about it. c) The results of the contingent valuation are not easily verified because there are no markets where values can be observed. It is recommended to verify results by indirect valuation methods.

On the other hand, Diamond and Hausman (1994) reject this method as inconsistent with economic theory. They argue that, when people express an asset's economic value, they most likely do so with strictly personal reasons in mind and not thinking about what is best for the country or the community in general. Another criticism of Diamond and Hausman (1994) is that the income effect is lower than would be expected if the true preferences were revealed.

They argue that their basis for doubting the validity of this method.is an income elasticity of the DAP lower than one. However, this is not entirely true. It can be observed in other studies that income elasticity (proportional change of an asset in response to a change in a person's income level) varies according to the asset but it generally remains in the same range. Even with altruistic collections, the income elasticity falls between 0.3 and 0.6 (Cutler et al. 1993, cited in Hanemann 1994).

For the purposes of the present research, the CVM will be considered a sampling technique based on the direct interrogation to people, current or potential consumers, to determine the following: their willingness to pay (preferences) to obtain an environmental asset or maintain existing ones, and their willingness to accept the loss. In other words, it will be used to determine the generators' DAP for RP handling since they are legally responsible for guaranteeing an environmentally sound handling of their generated RP.

The technique incorporates a detailed description given to the respondents of the environmental asset involved. In this case, the asset is life quality arising from the prevention of soil contamination and the reduction of risks, damages and health hazards. Then, they are asked to offer a value that they can choose from several options, or they can be asked about their willingness to pay for a specific amount (in which case, options of greater or lesser amounts are induced). Another possibility is to ask them to indicate the amount of compensation that they would claim for letting go of the environmental good or service. With appropriate questions, the contingent valuation can provide a very accurate estimate of the costs and benefits perceived by the components of society about environmental changes. It is the only method that allows to measure the values of choice in existence and provide a true measure of total economic value (Ibarrarán, et al. 2003).

The main point is to ask the respondents about their DAP. Most authors have chosen a process of offers or positions in which an initial price for the assets is offered. Then, the respondent indicates if the price is high or low, and the offer is adjusted accordingly until the respondent feels that the value of the good is well reflected. This method has been very much analyzed and criticized, reason why it is known as the bias of the starting point. If the initial offer is too low, the respondent's final value choice will be biased downwards and the other way around: if it starts too high, it will influence the final offer upwards (Boyle, et al. 1985:193).

The study by Seller, Stoll and Chavas used both an undisclosed format, where the respondent provided the valuation, and a format with fixed limits, where the respondent said yes or no to the proposed value (Seller, Stoll and Chavas 1983). In this exercise, the substantially different results obtained were revealing.

The authors concluded that the format without fixed limits can be unreliable due to the negative surplus of the consumer and the low results that it produced (Seller, Stoll and Chavas 1985: 175). However, there could be an alternative explanation for the low results of the survey without fixed limits and the relatively better performance of the survey with fixed limits.

First, individuals who have not assessed the good or service in a market context, may be unable to assign a value to it. Second, the survey with fixed limits may have a skewed starting point or it may be creating self-generated assessments depending on how the information is presented. A self-generated construction is one of the most important issues facing the CVM. *"The problem of specific valuation may be so far from the respondents' market valuation experiences as to consider them unable to respond with accuracy"* (Brockstael, et al., 1998: 25). There are proposals to provide prior information to the respondents, so they know what they are going to be asked and can respond appropriately (Thayer 1981). Another option is to interview only those who have proximity and, therefore, knowledge of this type of assets (Beasly, et al., 1986).

There are biases in the CVM such as the hypothetical bias, information bias and the interviewer's bias (Cronin 1982, Commings, et al, 1986). However, for the topic that guides the present research, RP generators previously know their responsibility for having an NRA.

The possibility of success of the CVM starts from the respondents' conditions and their familiarity with the environmental quality in question. For this reason, the method is feasible when it is used to know the effect on the sustainable development of the studied region and not to propose public policies (Eberle and Hayden, 1994).

With the support of the CVM, the aim is to have the necessary information to compare the dependent and independent variables and obtain an improvement in environmental quality on the basis of an econometric estimation. However, it is worth pointing out the possible biases faced by the research carried out.

7.3.1 Biases in the Contingent Valuation Method

The starting point of the CVM may be to estimate either the highest DAP or the lowest DAA of an individual for the provision or improvement of a non-market asset. The application of one or another modality depends to a large extent on the definition of the property rights on the good to be valued. An interesting polemic between the theoretical demonstration and the empirical evidence was held in the 1970s. Robert Willig (1976) showed that consumer surplus values obtained from inquiring about the highest DAP should be only slightly lower than those from inquiring about the lowest DAA.

However, the numerous applications carried out to determine the size of this bias found an excessive disparity of values. Much of the effort was directed towards minimizing the bias through a more careful wording of the survey.

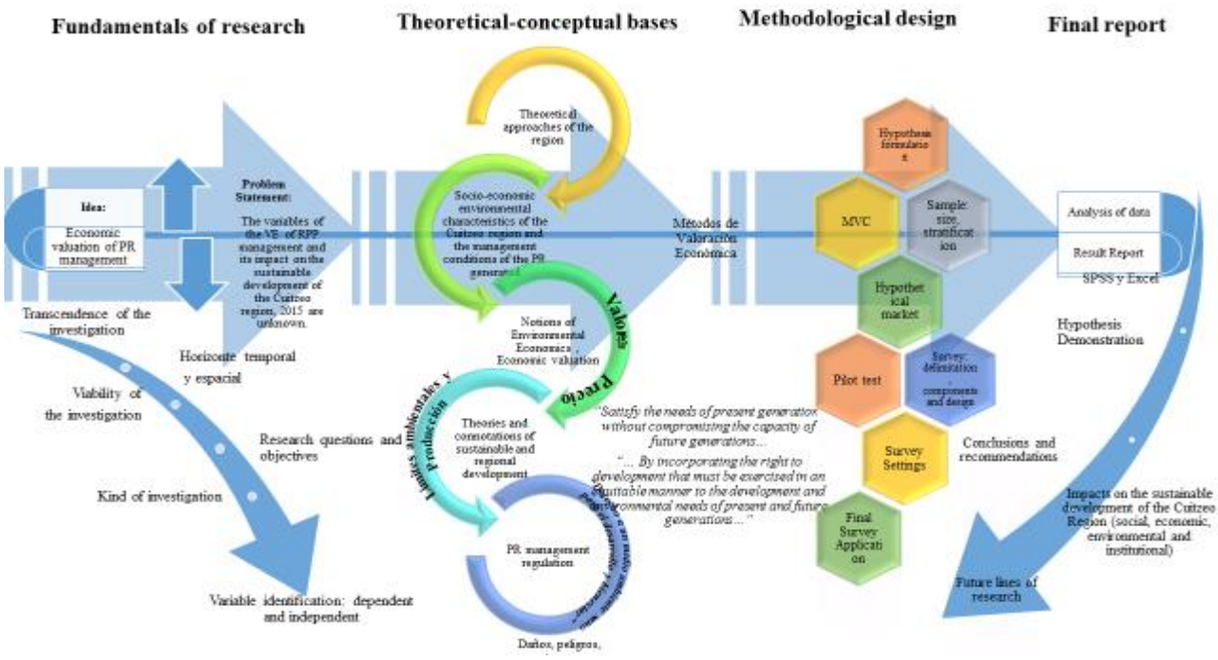
In addition, biases can be grouped into two groups: those coming from surveys of population samples and those derived from the hypothetical nature of the exercise. Another type of bias based on the incorrect perception of the context corresponds to the implicit clues for the evaluation and the complacency of the respondents with the promoters of the survey (Riera, 1994).

In order to reduce biases in the present research, the NOAA's suggestions are considered as follows: the survey must be personal; the application of the CVM must obtain the respondents' DAP considering a future event rather than one already occurred; and the hypothetical scenario on the expected effects described to the respondents must be precise and understandable. In the case of this research, the possible damages to health and soils are considered. Following these recommendations decreases the probability of obtaining erroneous information (Ibarrarán et al, 2003).

Another bias that should be considered in the present research is the initial bid. Giving an initial asset value to the individual creates a bias around said value. The auction (bidding game) also applies, consisting of forwarding a figure to the respondent that covers all the costs of the project. When the response is positive, then it is raised by a predetermined amount, and if it is negative, it is reduced until the respondent accepts (Azqueta, 1994).

For a greater precision of the methodology to be followed in the present research, see figure 8 regarding its application process.

Figure 8 Application process of the proposed methodology



Source: Author's own design, (2016)

7.3.2 Limits of the Contingent Valuation Method

The CVM attempts to measure changes in the well-being of people due to an increase or decrease in the quantity or quality of an asset (Riera, 1994). This measure is expressed in a person's highest amount of DAP. In the case of assets that do not involve a direct monetary cost for the consumer, the DAP for them is equivalent to the benefit that said consumer obtains. For this research, the asset that is sought to measure is RP handling. The factors to be considered are the generator's socio-economic conditions, the RP generation type and volume and the compliance with legal technical and operational provisions. The latter guarantee an environmentally sound RP handling and avoid risks, dangers and damages that reduce life quality in the studied region. As for the DAA, the aim is not to address it as part of the demonstration of the hypotheses raised in the research. There is a legal provision that forces generators and providers of RP collection, transport and final disposal to ensure their proper handling.

7.3.3 The Willingness to Pay

RP handling is sought to be assessed understanding that economic valuation is the important indicator of the environment in social welfare. In this case, RP handling constitutes a set of activities that must be carried out under parameters of environmental, economic, social and health efficiency so as not to cause adverse effects on society and the environment. It means to avoid damaging social welfare, understood as the set of factors that participate in the quality of life of people and that make them possess all those elements that give rise to tranquility and human satisfaction (Trapero, 2009).

As the region under study concentrates the largest number of RP generators in the state, it is pertinent to determine the DAP since they are handled correctly. This is because there are legal parameters that determine certain conditions that must be met under penalty of sanction. Determining the DAP for an environmentally sound RP handling will allow contrasting the generator's socioeconomic conditions with the legal dispositions, its degree of observance and the knowledge of the potential damages, dangers and risks to the environment and the health of the society settled in the region studied. Determining the relationship between the generator's socioeconomic conditions and the fulfillment of its responsibilities with the generated RP types and volumes will provide the elements to understand the degree of sustainable regional development of the region under study.

Riera (1994) sustains that there are two types of variations to the DAP: the compensatory and the equivalent. The former indicates a positive monetary compensation, i.e., the DAP for reaching a certain purpose in a good or service, and the latter is negative because it does not seek a certain purpose but an alternative to replace the good or service in question.

For the present research, the variation is compensatory because it seeks to know the DAP to reach a sustainable RP handling and enable an improvement in the life quality and welfare of the people in the Cuitzeo region. These circumstances constitute the axes of sustainable development that may be limited by an inadequate RP handling.

7.3.4 Aggregation

In the CVM, a sample of the population is asked about their willingness to pay for a specific good or service. Therefore, the survey provides a set of values, one for each person who has answered the assessment question.

For the corresponding value to be handled for the population as a whole, it is usually chosen either by the mean or by the median of the value obtained in the sample. Then, the value of the mean or median is multiplied by the number of people that make up the relevant population (Riera, 1994). If the number of times that has been revealed throughout the sample is calculated for each value, and the values are ordered from least to greatest, the so-called frequency distribution will be obtained. When this distribution presents an approximately normal or symmetric form, the mean and median values are very close.

In other words, for symmetric frequency distributions, both the mean and the median obtained from the sample are unbiased estimates of the population's true mean or median (Riera, 1994).

In the contingent valuation practice, the median usually corresponds to a more conservative estimate. In short, it is below the average since there is a greater number of low responses and a greater dispersion among high values.

The majority of researchers using contingent valuation choose to use the mean as a measure of aggregation. The mean can be used as an estimator of the average person’s DAP for a greater quantity or quality of a good or service. It can be multiplied by the relevant population to estimate the total value of a change in the good or service (Ibarrarán et al, 2003).

To address the scattered values, the number of times in which the values appear at both ends of the frequency distribution are usually made equal to zero. This results in less dispersion and, consequently, lower margins of error for the same level of confidence, which is especially attractive for statistical contrasts (Riera, 1994).

7.3.5 Hypothetical market to be considered

"One of the theoretical problems that first arose in the construction of hypothetical markets was the strategic behavior of the responses" (Riera, 1994: 21). This indicates that, since a hypothetical market is proposed, hypothetical answers can be expected from the survey that are different from reality and from the effective applicability of the CVM (Samuelson, 1954).

Later studies show that strategic behavior tends to be minimal in practice, and biases can be limited in the very questions (Riera, 1994). In the case this research, the hypothetical market is the one that offers a thorough RP handling service considering natural and social assets directly related to it, i.e., the effects on the environment and health.

Therefore, it seeks to know the DAP to achieve an environmentally appropriate RP handling and how this affects a life quality that will promote well-being and lead to the sustainable development of the region under study. For the application of the CVM in the problem sustaining this research, it is convenient to approach the characteristics to consider during the investigation.

7.4 Characteristics to consider in the application of the Contingent Valuation Method

This research seeks to apply the CVM in order to know the generators’ DAP for achieving an adequate handling of their generated RP. This is in consideration of their socioeconomic conditions, the applicable legal provisions, as well as the technical and operative management that they must perform to avoid sanctions and reduce risks to health and the environment.

7.4.1 Problem to be assessed

The aim is to economically evaluate the handling of RP based on the DAP for the environmentally appropriate management and disposition of the RP generated in the Cuitzeo region. It will be done through the application of the CVM, using a personal survey that will also seek to know the DAP, the generator's socio-economic characteristics, the level of knowledge of the RP types and volumes generated, as well as their impact on the environment and society. It will also aim at knowing several aspects such as: the level of compliance with the technical and operational provisions of RP handling; the level of knowledge of RP legislation; the event of any sanctions coming from the authorities; the event of any payment made for managerial or operational actions such as the establishment of a temporary warehouse as well as for legal procedures and advice; and the DAP for the performance of those steps for an adequate disposal of their RP.

Additionally, we seek to know the perception of the people surrounding the generators. The purpose is to observe their socioeconomic characteristics, their concern for the main environmental problems, if they identify generators close to them, and determine if they know the RP types and volumes that are generated in their surroundings and the possible impacts to the environment and society. Also, it seeks to know the DAP and the DAA to improve the handling conditions. This is only descriptive because the goal is to know the RP generation and handling parameters in the Cuitzeo region.

7.4.2 Research variables and indicators

The variables in this study represent factors that influence the research problem. They are defined as terms that can take differential or variant values; they are essentially of two types: dependent and independent. Due to the diversity of constants in the research, the variables adopt different roles, both dependent and independent. Basically, the dependent variables are the DAP for the management of RP and the DAP for the environmentally adequate disposal of the RP generated. Likewise, the independent variables are those that make up the socioeconomic characteristics of the generator (condition variables), the characteristics of RP generation (knowledge variables), the technical characteristics of RP handling (compliance variables), the characteristics of RP operative management (compliance variables) and the characteristics of the DAP for RP handling (knowledge and disposal variables) (see table 23).

Table 23 Main variables considered for the economic assessment of hazardous waste handling in the Cuitzeo Region

Variables				
Condition variable	Knowledge variable	Compliance variable	Compliance variable	Knowledge and willingness variable
Socioeconomic characteristics of the generator	RP generation characteristics	Technical characteristics of RP handling	Operational characteristics of RP handling	Characteristics of the DAP for RP handling
Age Gender Studies Income Dependents Housing Services Medical assistance Occupation	Types Volume CRETIB characteristics Health damage Environmental damage	Economic classification NRA Category COA Handling plan Binnacle Manifests Environmental insurance Service providers	Exclusive storage area Gutters Retention pit Retaining walls Signs alluding to dangerousness Extinguisher Packing Labeling Identification Service providers Handling phases	Knowledge of the legal provisions in the matter Fines/ PROFEPA Preventive administrative management Corrective administrative management Legal management Preventive operational actions Corrective operational actions Final disposition of RP

Source: Author's own design based on data from Agüero *et al*. (2005); Ajata (2008); Alberini (2007); Alcalá *et al.* (2012); Almansa y Calatrava (2000); Buenrostro e Israde (2003); Buenrostro *et al*. (2007); Canchari y Ortiz (2007); Castillo *et al.* (2013); Cerda *et al.* (2013); Cerda *et al.* (2013); Deatona y P. Hoehn (2004); De la Parra *et al.* (2010); Escobar (2007); Fierro *et al.* (2010); Fuentes y Serrano (2006); Gándara (2007); Geipel y Sauad (2014); Ibarrarán *et al*. (2003); Lladó y García (2004); Marzouk y Shumaa (2014); Ochoa (2010); Osorio y Correa (2009); P. Anex (1995); Saidón (2012); y Tzipi, *et al.* (2005). 2016

Each set of variables is made up of indicators that facilitate their study. An indicator is defined as the statistics, statistical series or any form of indication that facilitates studying where the objectives of an investigation are directed (Bauer, 1966). This way, indicators are considered as variables that represent other variables or set of variables in a study system (Achkar, 2005).

7.4.3 Sample and sampling

Hernández *et al. (2014:170)* indicate that "*for the process of sample selection, the cases on which the data will have to be collected must be defined (participants or other living beings, objects, phenomena, events or communities); the population must be delimited; the sample selection method must be chosen (probability or non-probability); the required sample size must be specified; and the selection procedure must be applied to obtain the sample."*

In the present research, the population universe to be considered is the number of RP generators in their micro, small and large modalities of the region under study. The sample selection method is probability sampling. It seeks to find a representative number of RP generators who according to the LGPGIR have similar obligations in the handling of their waste.

This goes according to their micro, small or large category. Finally, the research relies on a stratified sampling procedure because the generators in their different modalities are categorized based on their waste generation.

For this, it was important to avoid the three possible errors that Mertens (2005) indicates: rejecting or not choosing cases that should be part of the sample (participants that should be and were not selected); include cases that should not be there because they are not part of the population; or select cases that are truly ineligible. The above takes in consideration that the universe is limited to RP generators with NRA.

The purpose of selecting the sample is to extrapolate the results to whole research universe and thus make conclusions and recommendations according to the demonstration of the research hypotheses. The sample is a subgroup of the population; it can be a probability or non-probability sample. In probability samples, every element of the population has the same possibility of being chosen. The elements are chosen by defining the population characteristics and the sample size by means of a random or mechanical selection of the analyzed units (Hernández, et al., 2014).

Random samples guarantee the extrapolation of results. The random sample ensures that the important characteristics of the population are represented in their corresponding proportion. If 20% of the population has characteristic A (a certain age, a certain economic situation, etc.), another 20% with that characteristic will also be expected in the sample (Morales, 2012).

The probabilistic samples have many advantages, perhaps the main one is that the size of the error in our predictions can be measured. The main objective in the design of a probabilistic sample is to minimize this error, which is called standard error (Kish, 1995, Kalton and Heeringa, 2003, in Hernández, et al., 2014: 177).

In non-probability samples, the choice of elements does not depend on probability but on causes related to the research characteristics or on the person who makes the sample. Non-probability samples may be biased and, therefore, not representative of the general population since certain types of subjects predominate over others (Morales, 2012).

Morales (2012) points out three types of sampling: simple random, systematic and stratification sampling. The first one applies to small populations based on a raffle; the second is done by choosing a random number that is used as an interval; the third is recommended for large populations. Here, the population is divided into strata or segments according to some important characteristics for the specific research (gender, course, age, type of housing ...), and the sample should represent each stratum in their corresponding proportion.

The subjects are chosen randomly within each stratum. The strata are established according to important characteristics in their specific descriptive interest because the dependent variable may interfere with the strata if the entire population is to be considered.

For this research, the sampling is strategic according to: the RP generation characteristic, the number of generators, and the legal responsibilities of achieving a thorough waste handling. For this reason, 2273 generators are considered in the total universe. It is divided into three strata: micro generators, with a population of 1598; small generators, with a population of 637; and the large ones, with 38 generators. Stratification increases the sample's precision and entails a deliberate use of different sample sizes for each stratum. The purpose is to reduce the variance of each unit from the sample mean (Kalton and Heeringa, 2003).

In observance of the research objective, a technical-methodological design has been carried out to provide the necessary statistical analysis tools. These tools are used to know, explore, describe and compare the behavior of some variables with respect to others according to the results.

Prior to this, a survey was designed to bring together the elements of analysis and describe the problem. This methodological design is addressed in the following chapter; it describes the purpose of implementing the survey, the characteristics that were considered for its preparation and the design of the statistical models for analyzing the results.

7.5 Obtaining the sample for the application of the survey to hazardous waste generators in the Cuitzeo Region

The survey is applied to RP generators. They are responsible for an environmentally sound handling of their RP according to the normative parameters that regulate RP generation and control in Mexico, including the Cuitzeo region. In addition, generators are required to handle their waste under technical and operational parameters established by law, and they must pay for such handling. This will allow for an approach to first-hand information about which RP are generated and how they are being handled in the Cuitzeo region. This will eventually lead to a statistical analysis of these contributions and the presentation of a solution proposal.

In a second stage, and as a complement to the purposes of the survey, a specific survey will be applied to the people surrounding the RP generators. This will demonstrate their perception of RP handling and their DAP or willingness to be compensated for incorrect RP handling.

For application of the survey to generators, a sample stratification is carried out since all of the universe under studied has the common RP handling characteristic, therefore, all have NRA. In this context, a stratified probability sample is used, which considers segments or groups of the population (Hernández, et al., 2014).

Kish (1995) states that for certain number of sample elements $n = \Sigma nh$, the variance of the sample mean can be minimized if the sample size for each stratum is proportional to the standard deviation within the stratum, i.e., within the research.

$\boldsymbol{n} =$
$\boldsymbol{N} = 2273$
$\boldsymbol{e} = 0.05$
$\boldsymbol{z} = 1.96$
$\boldsymbol{pq} = 0.25$

$$n = \frac{N}{1+\frac{e^2(N-1)}{z^2pq}} = \frac{2273}{1+\frac{0.05^2(2273-1)}{1.96^2(0.25)}} \frac{2273}{=1+\frac{0.0025(2272)}{3.8416(0.25)}} \frac{2273}{=1+\frac{5.68}{0.9604}} \frac{2273}{=1+5.914} = \frac{2273}{6.914} = \mathbf{328.75} \quad (1)$$

Now, considering that the size of the sample for each stratum is proportional to the standard deviation within the stratum, it is appropriate to divide the result obtained (328.75) by the universe (2273), which equals **0.144**. This constitutes the constant fraction to obtain the sample size for each stratum.

Then, the population of each stratum is multiplied by the constant fraction to obtain the sample by stratum, that is:

Micro generators 1598 (0.144) = 230.1, rounded up to **231**

Small generators 637 (0.144) = 91.72, rounded up to **92**
Large generators 38 (0.144) = 5.47, rounded up to **6**
The above equals 329 stratified sample elements.

For the second stage, i.e., the survey for people surrounding RP generators, the same formula is applied considering the region's total population, which is 1,004,723.00 people. It results in a sample of 384.

$$n = \frac{N}{1+\frac{e^2(N-1)}{z^2pq}} = \frac{1{,}004{,}723}{1+\frac{0.05^2(1{,}004{,}723-1)}{1.96^2(0.25)}} \frac{1{,}004{,}723}{1+\frac{0.0025(1{,}004{,}722)}{3.8416(0.25)}} = \frac{1{,}004{,}723}{1+\frac{2{,}511.805}{0.9604}} \frac{1{,}004{,}723}{1+2{,}615.37} = \frac{1{,}004{,}723}{2{,}616.37} = \mathbf{384.01} \quad (2)$$

Once the sample is obtained, the next phase is the design of the pilot survey to be applied as a pilot test and analyzed through a statistical system. The following chapter describes the methodological design of the research.

7.6 Characteristics to consider in the preparation of the survey

Hernández *et al. (2014)* indicate that one of the most effective instruments for collecting data is the survey, which consists of a set of questions regarding one or more variables to be measured. The survey must be consistent with the approach of the problem and hypothesis (Brace, 2008).

The content of the questions in a survey depends on the aspects that will be measured. Two types of questions are considered: closed and open. Closed questions contain previously delimited categories or response options.

In other words, the respondents' answer options are presented, and they must circumscribe to them. They can be dichotomous (two response possibilities) or include several response options. In closed questions, the response categories are defined a priori by the researcher and are shown to the respondents, who must choose the option that best describes their response (Hernández, et al., 2014).

Gambara (2002) notes something that is very logical but can be fundamental if neglected. He says that when the questions have several options, they must collect all possible answers. However, there are closed questions where the participant can select more than one option or category of response (possible multi-answer). In other questions the respondent is placed on a scale.

The concept of scale (applied to measurement) can be defined as "the orderly succession of different values of the same quality" (Real Academia Española, 2001, page 949). It is a pattern, set or regular measure according to some standard or rate, with respect to a variable. Examples: temperature scale in centigrade degrees; intelligence scale; distance scale in kilometers, meters and centimeters; weight scale in kilograms, musical scale with octaves, among others.

Closed questions are easier to code and set up for analysis. Likewise, these questions require less effort from the respondents; they do not have to write or verbalize thoughts but only select the alternative that best synthesizes their response. Answering a questionnaire with closed questions takes less time than answering one with open questions. Likewise, closed questions reduce the ambiguity of answers and favor comparisons between them (Burnett, 2009 in Hernández, et al. 2014).

The main disadvantage of closed questions is that they limit the responses of the sample, and sometimes none of the categories accurately describes what people have in mind. What goes through the heads of the participants is not always captured. Their writing requires greater diligence and a deep knowledge of the approach by the researcher. To formulate closed questions, it is necessary to anticipate possible response alternatives. Otherwise, it is very difficult to raise them.

In addition, the researcher must ensure that respondents know and understand the response categories. For example, if the question is: "what is your favorite television channel?", it is very easy to determine the response options and make participants understand them. But if the question is about the reasons for such preference, then it is more complex to point out the options (Vinuesa, 2005, in Hernández, et al. 2014).

On the other hand, according to Hernández, et al. (2014), open questions do not define the response alternatives in advance, so the number of response categories is very high; it is theoretically infinite, and it can vary from one population to another. Open questions provide more extensive information and are particularly useful when there is no insufficient or null information about people's possible responses.

They are also useful in situations where an opinion or the reasons for a behavior are intended to be analyzed in depth. Their biggest disadvantage is that they are more difficult to code, classify and prepare for analysis. In addition, there may be biases arising from different sources. For example, those who face difficulties expressing themselves orally and in writing may not accurately convey what they really mean and cause confusion in their responses. Education level. the ability to use language and other factors can affect the quality of the answers. Likewise, answering open questions requires more effort and more time (Black and Champion, 1976, Saris and Gallhofer, 2007 in Hernández et al., 2010).

Choosing the type of questions for the survey will depend how much the possible answers can be anticipated, the time available to codify and the options to have more elaborate answers. A recommendation from Hernández et al. (2010) to build a survey is to determine, for every single variable, the type of question that is usually more reliable and valid to measure the variable according to the situation of the study (approach to the problem, characteristics of the sample, type of analysis to be made, etc.).

Frequently, closed questions are constructed based on open questions. In the pilot test, for instance, an open question can be created and applied, then the closed item is generated based on the answers obtained. The questions will respond to different needs and to the research problem. This means that the type of questions will be different in each study. Sometimes only closed questions are included, in other cases only open questions and sometimes both. In the specific case of this research, the survey consists of both open and closed questions because they meet certain characteristics based on the objectives set.

7.6.1 Components and modalities of the survey

Every survey has general (formal) and particular (substance) characteristics that must be interrelated to help the demonstration of hypotheses. Riera (1994) defines three types of surveys: personal, telephone and digital (sent by e-mail). The three versions have advantages and disadvantages. The tests carried out in this regard indicate that, for many assets, the values obtained through one or the other version are not significantly different. When the nature of the asset or the valuation scenario is somewhat more complex than usual, personal and mail surveys are the most advisable.

The problem investigated in this research suggests a specific attention for the types of generators and the volumes of RP. Therefore, the survey applied is personal because it allows to interact personally with RP generators and to inform them directly about the hypothetical market. Personal surveys have the ability to clear doubts that may arise in the questionnaire or in the mind of the respondent (Riera, 1994). They also allow to use graphic material to help understand the asset and the objective market simulation (Hernández, et al., 2014).

Finally, measuring the direct cost, personal surveys are the most expensive followed by telephone surveys, as long as they are conducted by professional interviewers as recommended. In this context, the survey will be applied personally in order to obtain a result that demonstrates the hypotheses and meets the objectives. The survey can be drafted once the assessment problem, the survey version and the sample are clearly defined (Riera, 1994).

7.6.2 Structure of the survey for generators

The proposed survey structure allows generators to be contextualized in their obligations according to their category. This leads to knowing their DAP for an environmentally sound RP handling and the costs that currently represent their generation. All this relates to the knowledge of possible impacts on the environment and people’s health, considering environmental, economic, technological, social and legal contents. The survey does not present introductory or descriptive paragraphs since it takes place directly between the generator and the researcher.

This reduces biases caused by diversified information. In addition, the researcher has previous information to achieve a closer approach to the generator, which helps solve possible doubts. Therefore, no use is made of interviewers or intermediaries.

From the first to the fourth part of the survey, the DAP for RP handling it is not directly inquired. This section is more focused on contextualizing the generator in a hypothetical RP handling market. Here technical and operational legal obligations, as well as their risks, dangers and damage to the environment and health are highlighted. The last part seeks to know what generators pay for RP handling and their DAP for complying with the hypothetically scenarios suggested from the first to the fourth part of the survey. For this reason, the cost of the valued asset -- RP handling -- remains open for generators to issue their opinion and thereby help reduce biases in the value considered. The above goes hand in hand with the criteria of Hernández, et al. (2014) and Riera (1994).

The structure of the survey consists of five sections. The first one focuses on the socioeconomic characteristics of RP generators: their age, gender, literacy level, income, economic dependents, occupation, employees in their charge, type of housing, services available in their home and medical services. This will allow demonstrating and contrasting the incidence of their socioeconomic conditions on their DAP for RP handling.

The second section refers to the characteristics of their RP generation. It aims at knowing if RP generators knows what RP are and their difference with RSU. It also inquiries about the volume and type of generated RP, where and how they are generated, their dangerous characteristics and the damages, dangers and risks that they represent to the environment and people's health. The third section inquiries about the technical characteristics of their RP handling to know the economic sector of their businesses, as well as their compliance with the legal obligations according to their category as RP generators.

The latter refers to their NRA if any, their categorization, COA, handling plan, RP register log, RP delivery-receipt manifests, environmental insurance and the existing authorizations (SEMARNAT and SCT) of the service providers they hire to collect, transport, store, treat, recycle and confine their RP. The fourth section refers to the operative characteristics of their RP handling to know the way in which the RP generated is handled, as well as the degree of compliance with the applicable regulations. Here, the questions ask about the following: any existing temporary RP storage; storage time (according to the LGPGIR RP C.R.E.T.I. storage must not be longer than six months, and RPBI storage has a period of less than six months); any existing retention pits, gutters, retaining walls, fire extinguisher and non-skid floors in their RP warehouse; if their RP are stored separately according to their CRETIB characteristics; if they are properly labeled and identified; if their warehouse is close to common areas such as offices, dining or reception rooms; if the next phase of their RP handling is known, or otherwise, determine how the generated RP are being stored; their DAP characteristics for RP handling to determine if generators know the legal bases that determine their obligations as generators; any inspection carried out by PROFEPA; any paid fines or financial penalties; any fees paid for legal actions and consultancies, whether preventive or corrective; how much they are paying for operative, administrative and legal RP handling.

The last section is intended to know their DAP for RP handling and disposal, as well as for management procedures and follow-ups on legal processes. Finally, this phase of the survey allows us to know the personal opinion of RP generators regarding what they would be willing to do to reduce the risks in both health and the environment when handling their RP.

7.6.3 Structure of the survey for the people surrounding hazardous waste generators

The purpose of the survey for the people surrounding the RP generators in the Cuitzeo region is to know their perception of RP handling as well as their DAP or DAA. The latter represents an economic remuneration to meet the social development indicator regarding social impacts of externalities known as RP.

The survey has three sections. The first one refers to the respondents' socioeconomic conditions (age, gender, education, occupation, housing, services and health). Here. income was discarded because it was observed through the pilot test that people did not want to answer that question, so the data will be obtained from official statistics.

The second section refers to their perception of RP generation. The questions asked are as follows: which environmental problem is of major concern (four are listed); which cause is the one that contributes most to polluting water and soil (four are listed); what are RP?; do you know if there are establishments that generate RP nearby?; how far are you form the establishment?; what is the establishment's main activity? (seven options are given); do you know what RP is generated by the establishment?; do you know if they are liquids or solids?; does the service provided by the generator represent a benefit?; how is their RP handling done?; do you know that RP can contaminate the soil?; do you know that RP can contaminate water?; do you know that RP can damage flora and fauna?; do you know that RP can harm your health?; do you think that the generator's RP handling affects your well-being?; do you know any damage, affectation or contingency caused by the RP handling of the nearby generator?

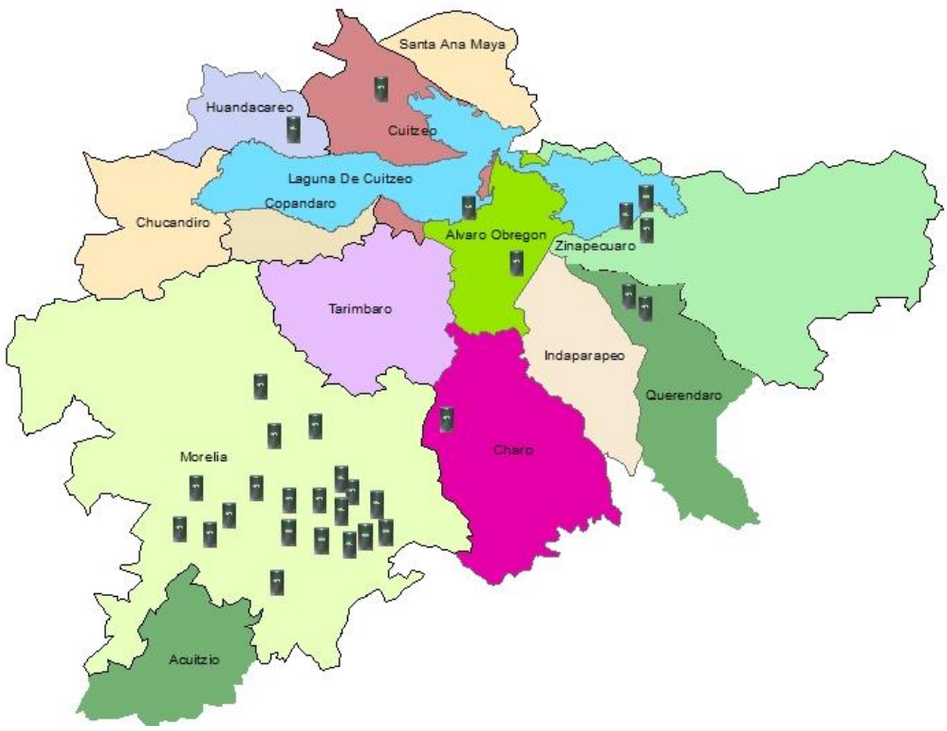
Finally, the third part refers to their perception of RP handling. They are asked the following:: if the know of any temporary RP storage belonging to the generator; otherwise, if they know how they store their RP (seven options are given); what they are willing to do to generate appropriate RP handling conditions (six options are given); what is their DAP (six options given); what is the amount of their compensation received, if any (six options are given).

7.7 The pilot test

The pilot test was only applied to RP generators in order to demonstrate the usefulness of the instrument in obtaining all necessary data to demonstrate the research objectives. A pilot test was given to 30 generators in the Cuitzeo region, out of which 20 were micro generators, nine small generators and one large generator.

They were distributed as follows: Alvaro Obregon (one micro generator), Charo (one micro generator), Cuitzeo (one micro generator), Huandacareo (one micro generator), Indaparapeo (one micro generator), Morelia (eleven micro, seven small and one large generator), Querendaro (one micro generator), Tarimbaro (one micro and one small generator) and Zinapecuaro (two micro and one small generator) (see Figure 9 on the location of generators). The results show that the proposed five-section survey is viable and feasible to know the handling of RP and the DAP for it. Some composition changes were made on questions and some adjustments in their order to give them consistency with the information sought. Likewise, specific annotations were made for the RPBI storage section.

Figure 9 Location of RP generators for the application of the pilot test, 2014



Source: Author's own design based on SEMARNAT through the National Inventory of Hazardous Waste Generation, (2016)

7.7.1 Results of the pilot test

Section I of the survey refers to the generators' socioeconomic characteristics. The respondents' ages range from 25 to 62 years old; all of them are literate; their education level goes from basic - 7%, middle-high - 43%, higher- 47% and incomplete - 3%; 23% have between 1 and 2 economic dependents, 73% have between 3 and 4 and 4% between 5 and 6 dependents; the income level of 57% of respondents ranges from $ 5,000 to $ 10,000 pesos per month, 30% of them receive between $ 1,000 and $ 5,000 pesos and only 13% have an income between $ 10,000.00 and $ 15,000.00 pesos per month.

Regarding occupation, 43% are in charge of a business, 37% are owners, 13% co-owners and 7% employees. 43% of respondents have 1 to 5 employees, 37% have 6 to 10 employees, 13% of respondents have no employees and 7% have more than 11 employees at their expense.

As for their housing conditions, 70% have their own home, 13% rent a home, 7% borrow one, 7% for other cases and 3% share a home. All of them have water, drainage, electricity and telephone services. In terms of health, 50% have an IMSS affiliation, 23% have private medical services, 20% have no medical services and 7% have popular medical services.

Section II of the survey refers to the characteristics of RP generation. It shows that 83% of respondents are aware of their RP generation, while 14% deny generating any RP and 3% do not know. The same percentages apply for respondents who know what RP they generate and the types and volumes of their generation.

On the other hand, 56% of respondents know the difference between RP and RSU, 37% say there is no difference and 7% do not know. As for the hazardous characteristics of waste, 50% are aware them, 40% are not aware of them and 10% do not know. In terms of corrosive RP, 57% do not know that their waste can have this characteristic, 33% know the characteristic but are not aware that their RP are corrosive and 10% are aware that they are corrosive. A for reactive RP, 57% do not know that they are reactive and 43% affirm that they are not reactive.

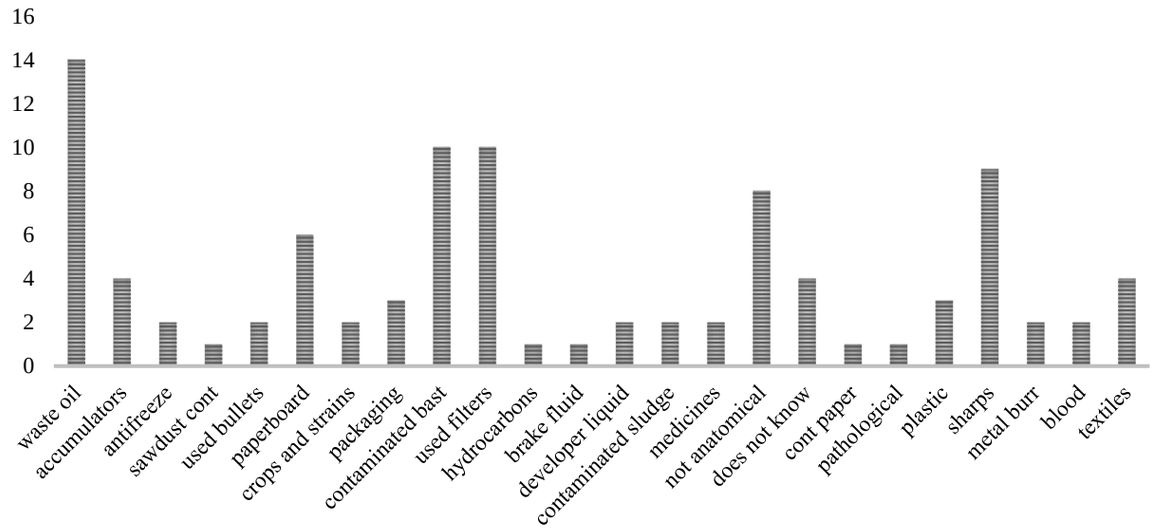
On the other hand, 57% do not know that their RP are explosive, 40% affirm that they are not explosive and 3% assure that their RP are explosive. 53% of the respondents do not know if their RP are toxic, while 34% affirm that they are not toxic and 13% do know that they are toxic. 53% of respondents do not known that their RP be flammable, while 30% of the respondents say that their RP are not flammable and 17% affirm that their RP are flammable. 56% of the respondent do not know if their RP are biological-infectious, 27% say that their RP are not and 17% know that their RP are biologically infectious. As for the damage that can be caused to health due to improper RP handling, 67% of respondents do know that they can cause such damage, 23% affirm that they do not cause damage and 10% do not know.

As for soil contamination cause by the improper RP handling, 56% do know about this possibility, while 27% assure that there is no damage and 17% do not know. 68% of respondents know that the improper RP handling can contaminate water, while 16% say they do not pollute water and 16% do not know. 57% of the respondents know that the inadequate RP handling can damage the flora and fauna, 23% assure that there is no harm and 20% do not know.

In terms of health, 53% know that poorly handled RP can cause intoxication, 30% say they do not cause poisoning and the remaining 17% do not know. 50% of respondents know they can cause cancer, 33% say it is not the case and 17% do not know.

These last figures are identical for the question of improper RP as a cause of death. For the last question in this block, regarding whether the respondent knows whether RP handling reduces risks to health and the environment, 60% said yes, 10% said no, and 30% do not know. Used oil stands out as the most generated RP. See Graphic 5 showing the generated RP declared by the respondents.

Graphic 5 Hazardous waste generated by the respondents in the pilot test, 2014



Source: Author's own design based on data from the pilot survey, (2014)

Section III of the survey refers to the technical characteristics of RP handling, showing that 73% of respondents have NRA, 20% do not have NRA and 7% do not know. 67% of the respondents do not know their category as RP generators, 27% do know it and 6% do not know about categories. 73% do not have an RP handling plan, 20% do have a PR handling plan and 7% do not know. 53% of the respondents do not have an RP logbook, 40% do have it and 7% do not know. About RP delivery-reception manifests, 73% do have them, 20% do not have them and 7% do not know. A for the COA and environmental insurance, 90% do not have them, 3% do have them and 7% do not know. Finally, they were asked if they knew whether the service providers hired for the collection, transport, stockpiling and final disposal of RP had valid authorizations from both SEMARNAT and the SCT. 53% did not know whether providers had such permits, 37% of respondents did know that the providers had the corresponding authorizations and 10% said that the hired providers did not have such permits.

Section IV of the survey refers to the operative characteristics of RP handling, showing that 67% of respondents have a temporary RP warehouse, and 33% do not have it. 63% of respondents do not store their RP for more than 6 months, 27% do store their RP for more than 6 months and 10% do not know. About the warehouse roofing, 57% do have a roof, while 40% do not have a roofed warehouse and 3% do not know.

A for having an extinguisher, 63% do not have an extinguisher, 34% do, and 3% do not know. Regarding the labeling of their RP, 60% do label them according to the LGPGIR, 37% do not and 3% do not know. 57% of the respondents state that they do identify their generated RP according to the law, 40% do not and 3% do not know. Regarding separating their RP, 60% do, 37% do not and 3% do not know. 63% state that their RP warehouse does not have signs alluding to waste hazardousness, while 34% do have them and 3% do not know. 67% of the respondents state that their warehouses do not have gutters, 30% do, and 3% do not know. On the other hand, 57% argue that their RP warehouse have no retaining walls, 36% do have them and 7% do not know. Regarding containment pits, 63% do not have them, 30% do, and 7% do not know.

They were asked if they hire providers of collection, transport, collection and final disposal of their RP according to the law and 73% declared yes, 20% said no, and 7% do not know. 73% of the respondents are unaware of the next phase of their hired providers' RP handling, 14% are aware of the next handling phase and 13% do not know.

As for the location of their RP warehouse, 67% of the respondents state that their warehouse is not located near offices, while 33% argue that they are close to offices; 100% state that they are not near the dining room; 57% respond that they are close to common areas, while 43% affirm that they are not close to common areas. It is important to mention that 17% of the respondents handle their RP as if they were RSU.

The last part of the survey refers to the characteristics of their willingness to pay for their generated RP handling. 67% of respondents do know the legislation in the matter, while the remaining 33% do not know it. Also, 53% state that they know the technical and operational obligations that they must fulfill, while 47% of the respondents do not know them.

Regarding whether they have been sanctioned by PROFEPA, 60% say no, 37% state that they have been sanctioned and the remaining 3% do not know. About sanctions, 55% have been sanctioned with a fine between $ 10,001 and $ 50,000 pesos, 36% has been sanctioned with a fine ranging from $ 1,000 to $ 10,000 pesos, the remaining 9% has been fined with over $ 50,000 pesos. As for payment for administrative procedures, 67% of the respondents said that they have paid third parties to perform these actions either as corrective or preventive measures, while 30% said they had not paid any management fee and 3% do not know.

As regards the preparation of the RP warehouse, 50% state that they have paid for their RP warehouse to comply with the LGPGIR, while 47% have not paid for it, and the remaining 3% do not know. Regarding the payment for legal attention to administrative procedures or advice, 57% state that they have not paid for it, while 40% have paid some legal service and the remaining 3% do not know. In terms of RP disposal, 73% of respondents argue that they have paid for these services, 23% have not and 4% do not know. 80% of the respondents confirm their DAP for RP handling as long as they are preventive actions that exempt them from PROFEPA's fines and penalties. 10% refute their DAP and another 10% are unsure.

The amounts of their DAP resulted as follows: for technical, operational and legal management, it ranged from $ 300 to $ 4,000 pesos per transaction; for RP disposal, ranges from $ 2.00 to $ 10.00 pesos per kilo / liter or its equivalent. In this regard, they stated that sometimes providers charge them for collection service up to $ 400.00, so they prefer to pay per kilo / liter or its equivalent, especially those generators in the health sector.

Finally, they were openly asked what they are willing to do to reduce health and environment risks derived from RP handling. They pointed out the necessity to perform preventive training, dissemination of applicable legislation, monetary collections, preventive inspections from authorities and free advice.

The pilot survey was applied during 2014, demonstrating the viability and reliability of its structure. There were some substantial (RPBI storage and estimated company income) as well as formal corrections (the elimination of the "I do not know" response column and some spelling errors). The instrument showed the capability of data collection to validate the research objectives. The research aims at demonstrating the relationship and dependency between the generators' DAP and their socioeconomic conditions, the types and volumes of generated RP, the compliance with technical and operational regulations, and their impact on the region's sustainable development.

The survey collected data that offered answers to the variables on the generators' socioeconomic conditions, the generation characteristics of RP (types and volumes) and the technical and operational characteristics of RP handling. Likewise, it has allowed to know the generators' attitudes towards the actions to be performed to properly handle their RP and avoid sanctions. The final application of the survey was not only based on a stratified sample of generators. The different industries of each municipality were also considered in a stratified approach. The purpose of this was having a stronger certainty of the types and volumes of generated RP since RP types depend on the economic activity.

7.8 Final restructuring of the survey to know the DAP for the handling of hazardous waste in the Cuitzeo region

The five final sections of the survey have different purposes. The first sector refer to the generators' socioeconomic characteristics and seeks to know their economic activity, their monthly income declared by the company, the age of the respondents, their gender, the degree of literacy, monthly income declared, economic dependents, occupation, employees under their care, type of housing and medical services.

The purpose of this is to demonstrate and contrast the impact of their socio-economic conditions with their DAP for their RP handling. The question regarding home services was eliminated because all the respondents agreed in the pilot survey that their house had drainage, water, electricity and telephone.

Section II of the survey refers to the RP generation characteristics. In this section we seek to know if the RP generator knows what RP are and their difference with RSU as well as the volume and type of their RP, where and how they are generated, their characteristics of dangerousness and the damages, dangers and risks that they represent to the environment and human health. The purpose of this is to demonstrate the preventive knowledge that every RP generator should have.

Section III refers to the technical characteristics of RP handling and consists of questions that seek to know the compliance of the LGPGIR in terms of the procedures and documents that every generator must have. These are: having NRA, categorization, COA, handling plan, RP logbook, RP delivery-receipt manifests, environmental insurance and corresponding authorizations for any hired service providers (SEMARNAT and SCT) to collect, transport, store, treat, recycle and confine their RP.

The purpose of this is to show the degree of environmental compliance in the matter of RP regarding the actions that every generator must take to avoid sanctions. In addition, it is an essential part to know the DAP for such procedures either performed on their own or by third parties. In environmental matters, this is fundamental because it makes it possible assure that RP generators have written information on how and how many RP they handle.

Section IV refers to the operational characteristics of RP handling and seeks to know the way in which the generated RP is handled as well as the degree of compliance with the applicable regulations. The purpose is to know the following: if they have a temporary RP warehouse; the storage period (according to the LGPGIR, RP storage should not be longer than six months, RPBI storage has a period of less than six months); if their RP warehouse has retention pits, gutters, contention walls, fire extinguisher, non-skid floors; if the RP are stored separately according to their CRETIB characteristics; if they are properly labeled and identified; if their warehouse is close to common areas such as offices, dining rooms or reception rooms; if the next phase of RP handling is known, or otherwise determine how their RP are being stored.

Two questions were added in this section. One refers to the storage time for RPBI (which according to the NOM-087-ECOL-SSA1-2002 must be less than fifteen days) and the second asks how they handle their RP in case of having a warehouse. The purpose of this section is to know how they handle their RP since damage, danger and/or risk to health and the environment depends on it. In addition, it can save them from future penalties.

Section V inquiries about their DAP for RP handling. The questions demonstrate the degree of knowledge of the RP generator on the legal bases that determine their obligations as a generator. It also shows any existing inspection by PROFEPA, if they have paid any fines or financial penalties, if they have paid for legal procedures and advise - whether preventive or corrective, how much they are paying for operational, administrative and legal RP handling.

The last section is intended to know their DAP for RP handling and disposal, as well as for management procedures and follow-ups on legal processes. Finally, this phase of the survey allows us to know the personal opinion of RP generators regarding what they would be willing to do or pay to reduce the risks in both health and the environment when handling their RP. The survey does not present introductory or descriptive paragraphs since it takes place directly between the generator and the researcher.

This reduces biases caused by diversified information. In addition, the researcher has previous information to achieve a closer approach to the generator, which helps solve possible doubts. Therefore, no use is made of interviewers or intermediaries.

7.8.1 Stratification for the application of the final survey

In order to achieve a better result of the survey, a stratified sample was obtained both for the categorization of the generator, and for the economic activity generating RP. The level of environmental compliance in RP handling depends on the category, according to the LGPGIR, and the stratification of the economic activity determines the type of generated RP. A total of 2273 generators were identified in the region under study. 38 of them are large, 637 are small and 1598 are micro. All of them have generated a total of 4, 861.90 tons of RP from 2004 to 2015 according to figures from SEMARNAT (2015).

Once the stratified sample of generators was obtained, the same procedure was carried out to obtain each industry' strata. This helped to know the number of interviews to be carried out by municipality and by sector. See table 25, which shows the main industries generating RP, the number of generators per industry and the number of surveys to be carried out per industry.

The total number of surveys was rounded up to 329. This number was then contrasted with the number of generators per municipality in the Cuitzeo region.

The same procedure was used for this based on data shown in Table 23 regarding the socio-economic activities of each municipality (see table 24). The result was the stratification of generators by economic activity (see table 25).

Table 24 Stratified sampling of economic activities in the Cuitzeo region, 2015

Activity	Number of surveys	Activity	Number of surveys
Food	6	Energy Generation	1
Automotive	2	Wood and Related Products	0
Plastic Items	2	Metallurgy	3
Metallic Items	1	Petroleum and Petrochemical	1
Cellulose and Paper	0	Paint and Ink	0
Cement and Lime	1	Textiles	1
Communications	0	Chemistry	2
Freezing / Ice Products	1	Commercial Services Generating RP	39
Construction	4	RP Handling Services	1
Electronic Equipment	1	RP Public Health Services	263
Exploitation of Material Banks	0	**Total**	**329**

Source: Author's own design based on data from SEMARNAT (2015).

Table 25 Stratification of generators by category in the Cuitzeo region, 2015

Municipality	Large			Small			Micro		
	Gen.	% Stratum	Number of Surveys	Gen.	% Stratum	Number of Surveys	Gen.	% Stratum	Number of Surveys
Acuitzio	0	0.146	0	0	0.146	0	4	0.146	0.584
Alvaro O.	2	0.146	0.292	4	0.146	0.584	19	0.146	2.774
Charo	0	0.146	0	2	0.146	0.292	9	0.146	1.314
Chucandiro	0	0.146	0	0	0.146	0	2	0.146	0.292
Copandaro	1	0.146	0.146	2	0.146	0.292	3	0.146	0.438
Cuitzeo	1	0.146	0.146	2	0.146	0.292	7	0.146	1.022
Huandacareo	0	0.146	0	0	0.146	0	8	0.146	1.168
Indaparapeo	1	0.146	0.146	0	0.146	0	8	0.146	1.168
Morelia	33	0.146	4.818	601	0.146	87.746	1463	0.146	213.598
Querendaro	0	0.146	0	1	0.146	0.146	6	0.146	0.876
Santa Ana Maya	0	0.146	0	0	0.146	0	12	0.146	1.752
Tarimbaro	0	0.146	0	12	0.146	1.752	24	0.146	3.504
Zinapecuaro	0	0.146	0	13	0.146	1.898	33	0.146	4.818
Total of generators									**2273**
Number of surveys									**329**

Source: Author's own design based on data from SEMARNAT (2015).

It should be noted that the figures have been rounded to determine the number of surveys. With that adjustment, the number of surveys results as follows: Acuitzio, one survey was carried out; Alvaro Obregon, four surveys were carried out; Charo, one survey; Copandaro one survey; Chucandiro none were completed; Cuitzeo, two were raised; Huandacareo, one; Indaparapeo, one; Morelia, five surveys were given to Large generators, eighty-seven to Small, and two hundred thirteen to Micro generators; Querendaro, one was completed; Santa Ana Maya, two; Tarimbaro, two were given to Small generators and three to Micro generators; Zinapecuaro, one Small and four Micro.

The result was 329 applied surveys. Once the generators' stratum and economic activity for each municipality was known, the survey for the period April-June 2015 was carried out.

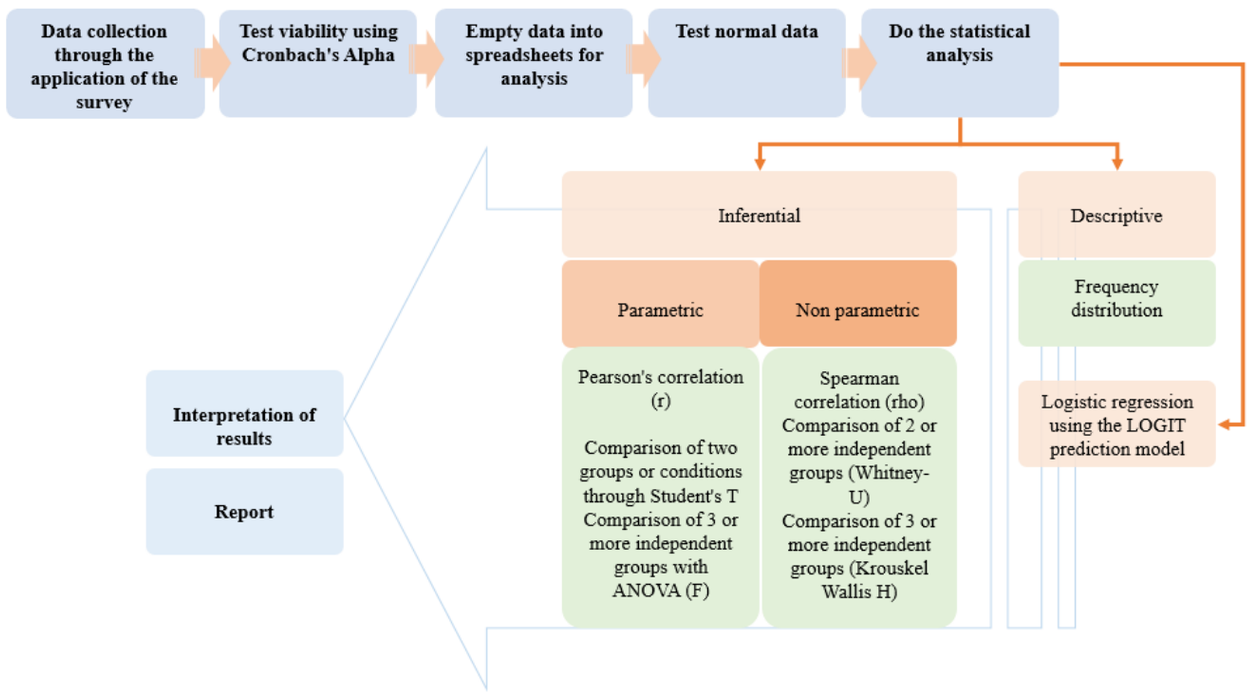
7.9 Design of the econometric technique to process data obtained from the final survey

The purpose of designing a methodological model is to demonstrate and verify the hypotheses raised in the research. So, the exploration, description, correlation and partial explanation of each of the elements that make up the variables are first approached to show the existence of a problem and its scope. The design of an econometric technique to process data obtained from the final survey is shown in Figure 10; it displays each step taken in the hypothesis validation process.

An econometric model is formed by one or several equations in which the explained or endogenous variable depends on one or several explanatory variables (Caridad, 1998). In general, econometric models are used as analytical tools that helps in decision-making both at a general economic level (macro) and at the level of business management (micro). There are different types of econometric models according to different research goals. The present study is aimed at obtaining an economic valuation of RP handling in the Cuitzeo region. Therefore, the econometric model selected will have to offer a description of the variables involved, their relation degree, the extent to which they differ from and infer in the hypotheses, and the level of dependency between each other (Burnside, 1996, del Oro et al., 2000 Pariani, 2004). The Excel spreadsheet and the statistical software called SPSS (Statistical Package for the Social Sciences) are used to achieve this goal.

An econometric model is defined based on an economic model (description and explanation of an economic, social and political system with practical interest) and complemented by the particular aspects of the system under study. Unlike economic models, econometric models offer more detailed conclusions. However, their validity is limited by referential systems and by expiration dates due to the system's own evolution (Pulido, 1987).

Figure 10 Stages of the statistical technique design to process data from the final survey



Source: Author's own design based on Toro, *et al*., 2010 and Riera, 1994. (2016).

Econometric models are generally used for some of the following activities, according to Toro, et al. (2010): a) structural analysis: Quantification of the relation existing in the analyzed period among the variables involved through the knowledge of the sign and value of the parameters considered. That is, how the variations of the explanatory variables affect the endogenous variable; b) prediction: Predict the values that the variable under study will take in the future and, c) simulation: Effects of several strategies arising from the explanatory variables on the endogenous variable. The research focuses on the structural analysis of data. For this research, a regression analysis is intended under a descriptive, correlative and partially explanatory statistic. It should demonstrate that RP handling in the Cuitzeo region depends on the generators' socioeconomic conditions, the type and volumes of generated RP and compliance with regulations.

By means of a multiple linear regression model (MLRM), the purpose is to explain the behavior of a certain variable, commonly called variable to explain, endogenous variable or dependent variable and represented with the letter *Y*.

It will be related to a set of explanatory variables *(Y) (X1, X2, X3 ...)* through a linear dependency relation (assuming *X1* = 1). This is applied to determine the existing relation among groups of variables in consideration of a weighting variable:

Starting from the basic model of simple and multiple linear regression:

Simple: $Y = a + bX$ Multiple: $Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3$ (3)

Adjusting the model to the number of variables: $Y = \beta_1 + \beta_2 \cdot X_1 + ... + \beta k \cdot X k + \mu$ (4)

Where:

Y = dependent variable
$X_1, X_2 \ldots X_k$ = independent variables
$\beta_1 + \beta_2 =$ parameters that measure the influence of explanatory variables
μ = disturbance or error term

For this research, it would be: $DAP = \beta_1 + \beta_2 E + \beta_3 GRP + \beta_4 DAP + \mu$ (5)

To determine the previous model, it is necessary to find the value of coefficients β1, β2, ..., βk. The linearity of parameters enables their correct interpretation in the model. The parameters measure the average intensity of the explanatory variables effects on the variable to be explained, and they are obtained by taking the partial derivatives of the variable to be explained with respect to each of the explanatory variables. To reach such an assumption, the SPSS software is used. It performs parametric and non-parametric statistical analyzes to enable exploration, description, comparison and prediction.

In addition, in order to correctly interpret the results, the multiple regression is made hierarchical according to the following model: $Y = B_0 + B_1 * X + B_2 * X + B_3 * X + B_4 * X + B_5 * X + E$, being Y = the dependent variable (DV), B_0= the constant, B_1, B_2, B_3, B_4 and B_5= the independent variables (IV), X= the prediction level, E = Error.

The analysis proceeds with the identification of the variables that make up the sets. They are entered into the software for the analysis described in the following section referring to the research results. The reliability and the consistency of the instrument were demonstrated through a statistical analysis.

7.10 **Application of the internal consistency method of the survey**

Firstly, an internal consistency method called *Cronbach's Alpha* was carried out to demonstrate the reliability of the instrument in support of the statistical program called by its acronym SPSS. The latter is used to make the analysis of the instrument more efficient and is based on the following equation:

$$\alpha = \left(\frac{k}{k-1}\right) \cdot \left(1 - \frac{\sum S_i^2}{S_{sum}^2}\right) \quad (6)$$

Being k the number of test items, S_i^2 the variance of the items, and S_{sum}^2 the variance of the total test. Therefore, the purpose is to measure he reliability of the instrument as a function of the number of items and the proportion of the variance.

The result must approach 1 to guarantee its reliability (Ledesma and Valero, 2002). Applying this test to measure the reliability of the instrument, a value of 0.847 was obtained, very close to 1, which indicates that the instrument is reliable, and it is feasible to statistically analyze the data (see table 27 on reliability statistics).

Table 26 Reliability statistics

Cronbach's Alpha	Number of elements
.847	60

Source: Author's own design based on data processing using the SPSS software (2016)

Once the reliability of the instrument has been demonstrated, it is necessary to know the normality of the data. Before beginning its processing and study, it is pertinent to perform a normality analysis, which allows to know the distribution of data in the cases presented.

According to González and Lévy (2006), a descriptive statistics test can be used to know the normality of data and make sure that its distribution is normal (Gaussian distribution).

This will show the asymmetric and kurtosis punctuation, which must approach 0 to have a normal distribution. Since data are representative of a sample, the range considered is -1 to 1.

This range allows to assume the normality of the population. it is shown that the population studied is symmetric and asymmetric with a kurtosis higher than the ranges considered. So, part of the groups of variables do not have that normal distribution, and their analysis must be based on an inferential versus a parametric type of analysis.

The groups of variables that do present symmetry and their kurtosis adheres to the ranges must be analyzed under the parametric inferential statistics scheme. Table 27 shows the normality ranges for each group of variables analyzed.

The Kolmogorov-Smirnov normality test is usually applied for samples greater than 50 cases, and the Shapiro-Wilk test is applied for samples smaller than 50 cases. As the cases analyzed are greater than 50 (for micro and small generators) and under 50 (for large generators), it is convenient to apply both tests and contrast the results with the normality test that only considers the asymmetry and kurtosis mentioned above.

The results of normality using the Kolmogorov-Smirnov and Shapiro-Wilk test show that there is normality in the data contained in section I (referring to the generators' socioeconomic characteristics).

But, it presents normality only for large generators in sections II (on their knowledge about RP generation and risks), III (referring to their knowledge of the technical obligations for RP), IV (on their knowledge of the operative obligations for RP), V_2 (about their DAP for management, consultancy and conditioning of the RP warehouse) and V_3 (on their DAP for each generated RP) (see table 28).

For the parametric analysis group, the research is based on the *Pearson*'s *correlation* (r), *Student's T, ANOVA's F* and *the Hierarchical Linear Regression.* For the non-parametric group, the *Spearman* (rho), *Whitney* (U) and *Krouskel Wallisis*(H) correlation analyses are used.

On the other hand, a logistic regression will be applied on dichotomous and categorical variables not presenting linearity through the $LOGIT$ prediction model in order to try and predict the variables' behavior.

This is to support a socially acceptable, environmentally adequate, and economically viable proposal for RP handling in the studied region.

Table 27 Exploratory statistics for the Normality Test

Totals part I				Totals part II			Totals part III			Totals part IV		
M	N	Valid	232	N	Valid	232	N	Valid	232	N	Valid	232
	Asymmetry		.018	Asymmetry		.537	Asymmetry		-2.544	Asymmetry		-.833
	Kurtosis		-.070	Kurtosis		-.572	Kurtosis		7.576	Kurtosis		.016
P	N	Valid	91	N	Valid	91	N	Valid	91	N	Valid	91
	Asymmetry		-.296	Asymmetry		.807	Asymmetry		.810	Asymmetry		.704
	Kurtosis		-.418	Kurtosis		-.685	Kurtosis		.190	Kurtosis		-.993
G	N	Valid	6	N	Valid	6	N	Valid	6	N	Valid	6
	Asymmetry		-.650	Asymmetry		1.438	Asymmetry		-.857	Asymmetry		-.608
	Kurtosis		-.006	Kurtosis		3.603	Kurtosis		-.300	Kurtosis		-.872
Totals part V_1				Totals part V_2			Totals part V_3					
M	N	Valid	232	N	Valid	232	N	Valid	232			
	Asymmetry		-1.272	Asymmetry		-.048	Asymmetry		1.744			
	Kurtosis		3.394	Kurtosis		.340	Kurtosis		1.479			
P	N	Valid	91	N	Valid	91	N	G=	Large			
	Asymmetry		.827	Asymmetry		3.057	Asymmetry		3.439			
	Kurtosis		-.866	Kurtosis		11.532	Kurtosis		11.044			
G	N	Valid	6	N	Valid	6	N	Valid	6			
	Standard error of asymmetry		.845	Asymmetry		1.302	Asymmetry		1.263			
				Kurtosis		2.247	Kurtosis		2.398			

Note: Highlighted boxes require a nonparametric inferential statistical analysis
Note: M= Micro, P= Small and G= Large generators

Source: Author's own design based on data from the survey and on González and Lévy (2006)

Table 28 Normality tests

Generator		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	Gl	Sig.	Statistic	gl	Sig.
I Socioeconomic Characteristics	Micro	.054	232	.096	.989	232	.071
	Small	.068	91	.200*	.977	91	.106
	Large	.181	6	.200*	.908	6	.421
II RP Knowledge Characteristics	Micro	.128	232	.000	.945	232	.000
	Small	.221	91	.000	.837	91	.000
	Large	.401	6	.003	.770	6	.031
III Technical Characteristics	Micro	.358	232	.000	.742	232	.000
	Small	.199	91	.000	.917	91	.000
	Large	.401	6	.003	.770	6	.031
IV Operational Characteristics	Micro	.160	232	.000	.907	232	.000
	Small	.225	91	.000	.841	91	.000
	Large	.179	6	.200*	.943	6	.680
V_1 Legislation Characteristics	Micro	.204	232	.000	.859	232	.000
	Small	.320	91	.000	.750	91	.000
V_2 Dap for Management	Micro	.094	232	.000	.967	232	.000
	Small	.201	91	.000	.682	91	.000
	Large	.271	6	.192	.881	6	.275
V_3 Dap for RP	Micro	.142	232	.000	.904	232	.000
	Small	.152	91	.000	.873	91	.000
	Large	.249	6	.200*	.905	6	.401

*. This is a lower limit of the true significance
a. Lilliefors' Correction of significance
Note: Highlighted boxes indicate normality in the data

Source: Author's own design based on data from the survey (2016)

The research approach towards the perception of RP generators in the Cuitzeo region to know their RP handling methods and their DAP is not so widely studied. It deserves more than an exploratory analysis, so we proceed to perform a thorough analysis of the results by means of a descriptive study and a frequency distribution analysis based on data normality and the instrument's reliability.

Chapter VIII The handling of hazardous waste in the Cuitzeo region based on the application of the Contingent Valuation Method

8.1 Descriptive analysis and frequency distribution

Once the normality of data has been analyzed, it is convenient to start with a descriptive analysis and distribution of frequencies. The latter can be observed in greater detail in the spreadsheet presented in the descriptive Annex segmented by generator. It particularly describes values of means, medians, modes and standard deviations. Then, it is convenient to analyze the behavior of data from percentages and frequencies.

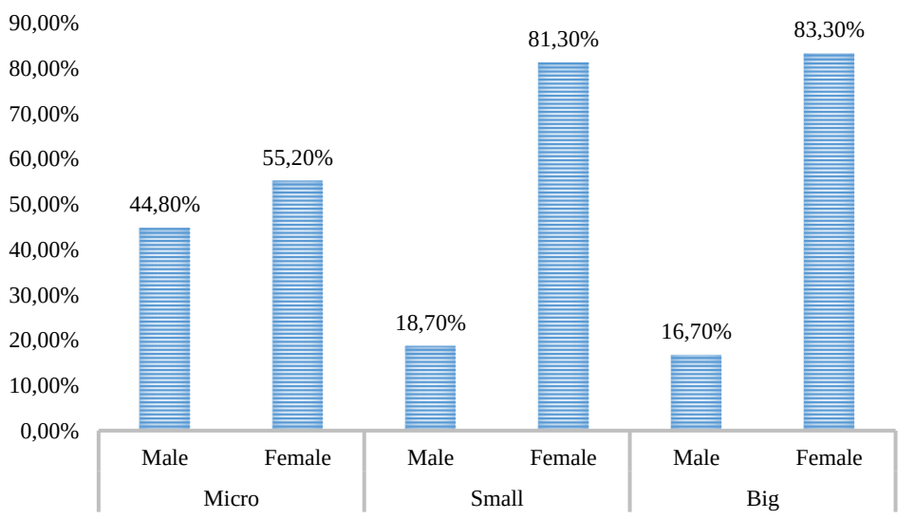
The meaning of the survey goes beyond knowing the DAP for RP handling in the Cuitzeo region. It includes items that seeks information on the generators' socioeconomic characteristics, their degree of knowledge of what PR are, their characteristics of danger, and their possible impacts and effects on the environment and the society.

In addition, the instrument will reflect the generators' knowledge of their technical and operational obligations to the legal provisions. In this respect, the instrument defines if they have paid for management and preparation of the temporary RP warehouse, for fines imposed by PROFEPA and their DAP for proper RP handling. Dankhe (1986) argues that some descriptive studies seek to specify the important properties of individuals, groups, communities or any other phenomenon that is subject to analysis (Dankhe, 1986). They measure or evaluate several aspects, dimensions or components of the phenomena to be investigated (Hernandez et al., 2014).

The first section of the survey seeks information on the generators' socio-economic characteristics and consists of 13 items. Two of them are open, two are dichotomous and 9 are multiple-choice with 5 response options. The initial analysis of this section focuses on data from dichotomous and multiple-choice items; then the open-response items are analyzed.

First, it can be seen that the female gender predominates in the generators surveyed, both for micro, small and large RP generators (see Graphic 6). This shows a possible inclination of the balance towards the female gender in RP handling in the business and industrial sector of the Cuitzeo region. However, this premise is not part of the research hypothesis, so its relevance only lies in showing the respondents' gender.

Graphic 6 Percentage of gender by generator category



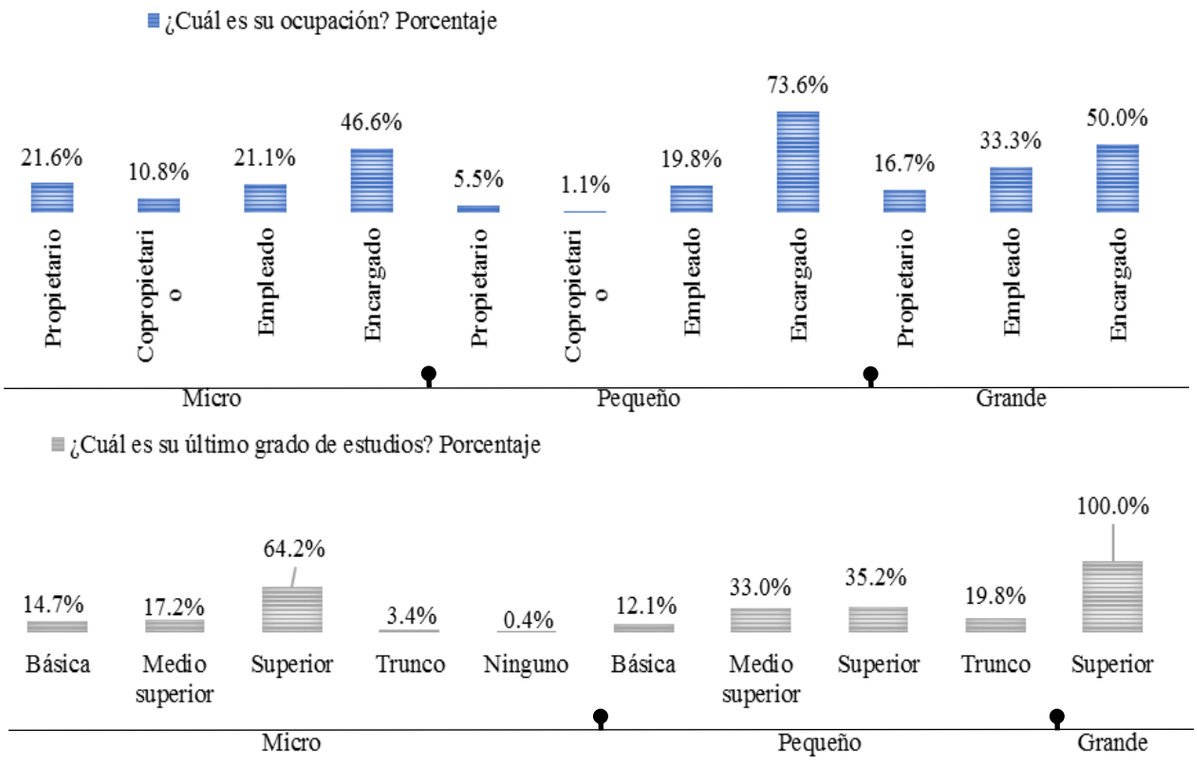
Source: Author's own design based on data from the survey (2016)

On the other hand, results show that the age of respondents ranges between 18 and 72 years; all of them are literate, and their main economic activities are from the health and automotive sectors. In addition, the predominant occupation in the three generator categories business clerk (micro show 46.6%, small show 73.6% and large are 50%).

Also, the predominant education level for the three categories is the higher level with 64.2% for micros, 35.2% for small and 100% for large. These answers imply that those in charge of RP handling have the basic knowledge to do it properly and avoid damages to the environment and society (see Graphic 7).

The results show that 42.7 of micro generators do not have employees under their charge; 46.2 of the small ones have from one to five; and 50% of large generators also have from one to five employees in their charge. This is due to the size of the establishment; generally micro generators are family or small-scale establishments.

Graphic 7 Description of affirmative answers segmented by generator from section I of the survey, referring to their knowledge about RP generation and risks, 2015



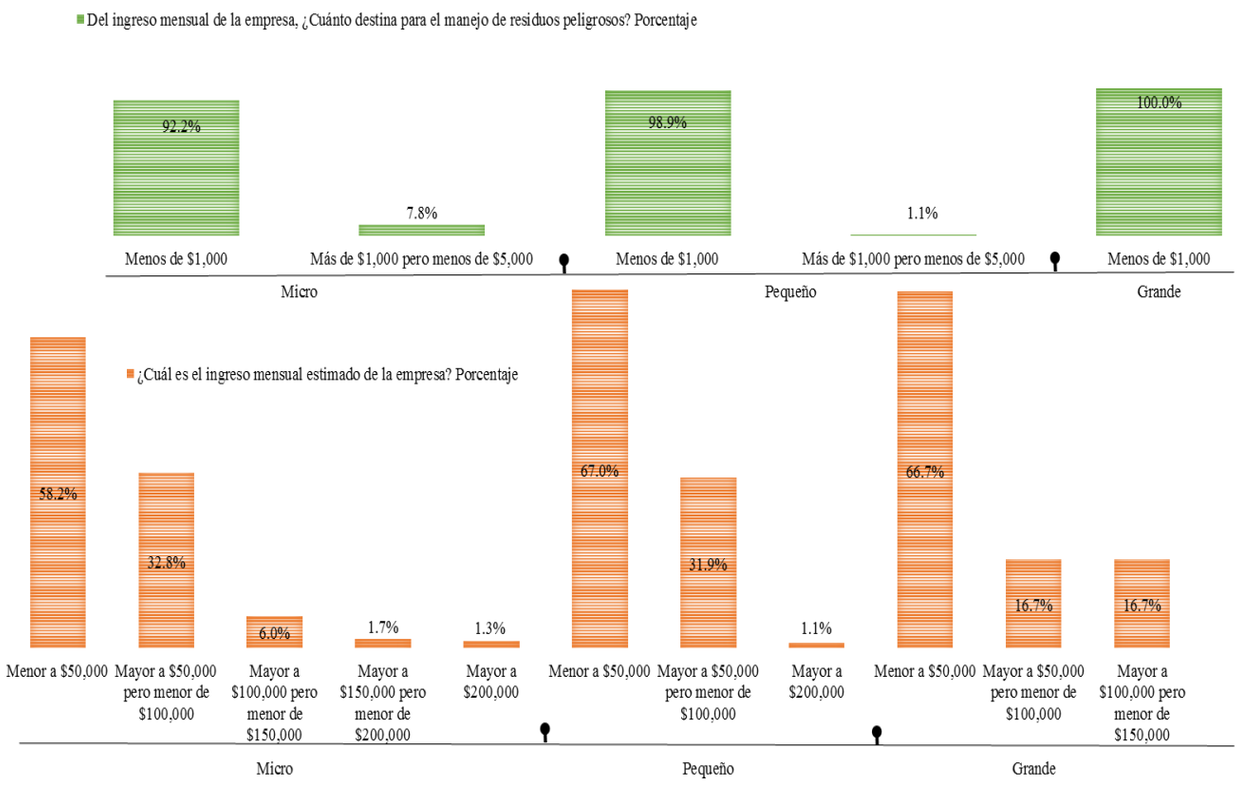
Source: Author's own design based on results from the survey. 2016

Regarding company income and what portion of it is allocated to RP handling, the result obtained is relevant. A constant is evident in all three generator categories since they claim to earn less than $ 50,000 pesos per month (58.2% micro, 67% small and 66.7% large). In addition, the three categories mostly allocate less than $ 1,000 pesos per month to RP handling (92.2% for micro, 98.9% for small and 100% for large).

This could mean that the State's current security conditions influenced the generators' responses. However, the answers are convenient since they provide a general picture of their earnings' share used in RP handling. Then, knowing their DAP for RP handling becomes relevant. This perception is indicated in Section V of the survey results and analyzed below (see Graphic 8).

In order to contrast the company vs. the respondents' personal income, they were asked to indicate their monthly personal income range. 51.3% of micro generators responded that their monthly income is < $ 5,000, while 49.5% small generators said they had a monthly income of <$10,000, just like large generators. They were asked to state the number of economic dependents. All three categories that indicated from three to four economic dependents (t60.8% for micro, 63.7% for small and 50% for large generators).

Graphic 8 Description of affirmative answers segmented by generator from section I of the survey, referring to company monthly income and amount allocated to RP handling, 2015



Source: Author's own design based on results from the survey, (2016)

The above that the monthly income of the respondent and their economic dependents may be sufficient to fulfill the needs of an average family. However, this perspective only serves as a basis to know the generators' socioeconomic conditions based on a general overview.

The two last questions in section I, ask about their kind of housing and medical care. 41.8% micro and 50% large generators affirmed to own a home, while 41.8% of small generators indicated that they rent one. Regarding medical care, the three generator categories mostly agreed that the service is provided by the IMSS (55.6% for micro, 56% for small and 66.7% for large generators).

Section II of the survey aimed at knowing the extent to which generators know and differentiate waste types and volumes, their characteristics of danger and the damage to the environment and society.

For the most part, all three generator categories do know what waste and RP are. They also know that they actually generate RP. About RP volume, small and large generators show that they do know heir RP volume, while only 25.8% of the small ones know it.

In addition, they claim to know the CRETIB characteristics of their RP, indicating to a large extent that they are explosive, toxic and flammable. This situation deserves close attention since explosive RP are dangerous and need special care. Generators of toxic and flammable RP from the automotive industry such as used oils, filters, tow, break pads, cardboard, plastic contaminated with oil, etc., are well aware regarding the effects caused by RP generation and handling on soil, water, flora, fauna and health (intoxication, cancer or transmission of contagious diseases).

Mostly small and large generators show knowledge of the damages and possible affectations. However, micro generators show a knowledge trend below average (see Graphic 9). Regarding question 19 of the instrument, aimed at knowing the type of RP generated and identified by generators, large generators identify oil, textiles, cardboard, paper, plastic and non-anatomical waste as their main RP. Small generators claim to generate mostly used oil, filters, textiles, sprays, cardboard, paper, solvents, paint chips, batteries, antifreeze, sludge, and very little RPBI. Micro generators claim to generate mostly used oils, filters, and grease.

However, about 33% of respondents generate different types of RP from those they indicate. Examples of this are: metal containers (6%), used tires (1%), antifreeze (1%), solvents (6%), cans (2%), contaminated cardboard (10%), paint buckets (5%), used batteries (8%), wood (2%), sprays (1%), pathological residue (3%), photographic liquid (3%)), acids (1%), resins (1%), non-anatomical RPBI (4%), puncturing waste (2%), expired medications (5%), crops and strains (1%), textiles/tow (13%), used filters (3%), spark plugs (1%), sawdust (3%), grease (3%) and used oils (7%). This percentage was verified at the time of conducting the survey.

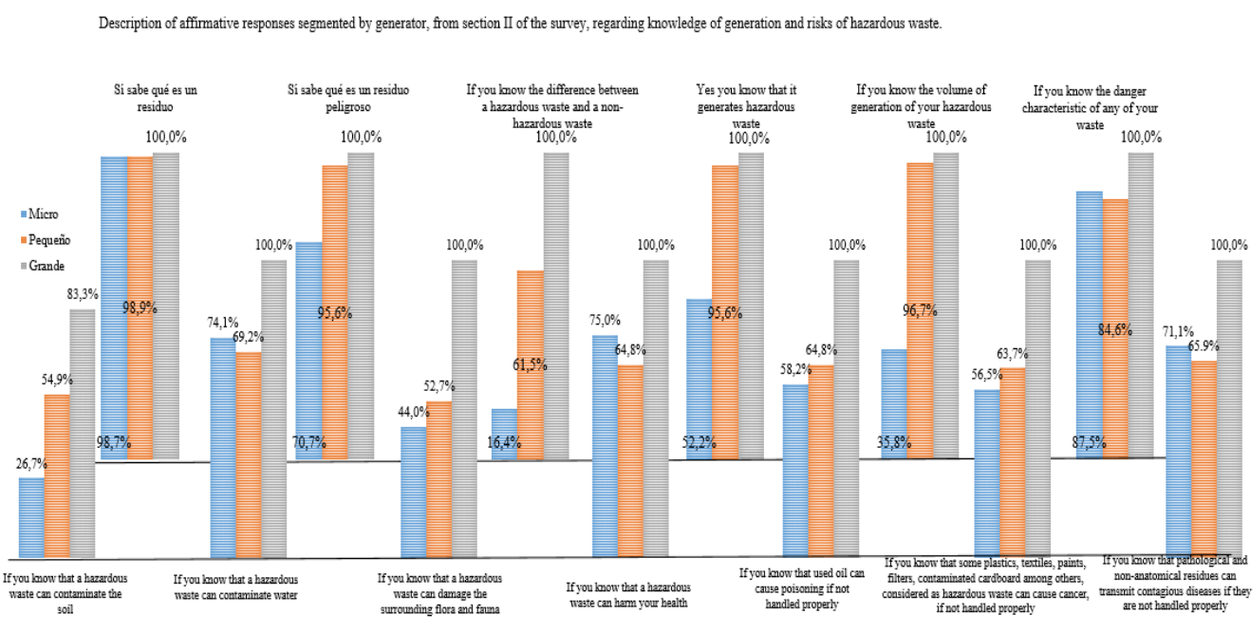
These percentages represent respondents that do not know their RP types and volumes or the way they are handled. This is because 17% handle them as RSU.

These answers show that solid RP such as filters, tow, textiles, cardboard, plastics, packaging, etc., are the most common in the region under study.

This estimate is different from that published by SEMARNAT, which indicates that oil used is the RP with the highest generation range. Of course, the dependency estimation may be due to reports from generators, who tend to indicate only used oil as their main RP.

However, the application of this instrument in a personal and direct way provides complementary information and demonstrates that their contaminated solids represent the RP with the highest generation levels as opposed to official estimates (see Graphic 10 and table 29).

Graphic 9 Description of affirmative answers segmented by generator from section II of the survey, referring to their knowledge about RP generation and risks, 2015



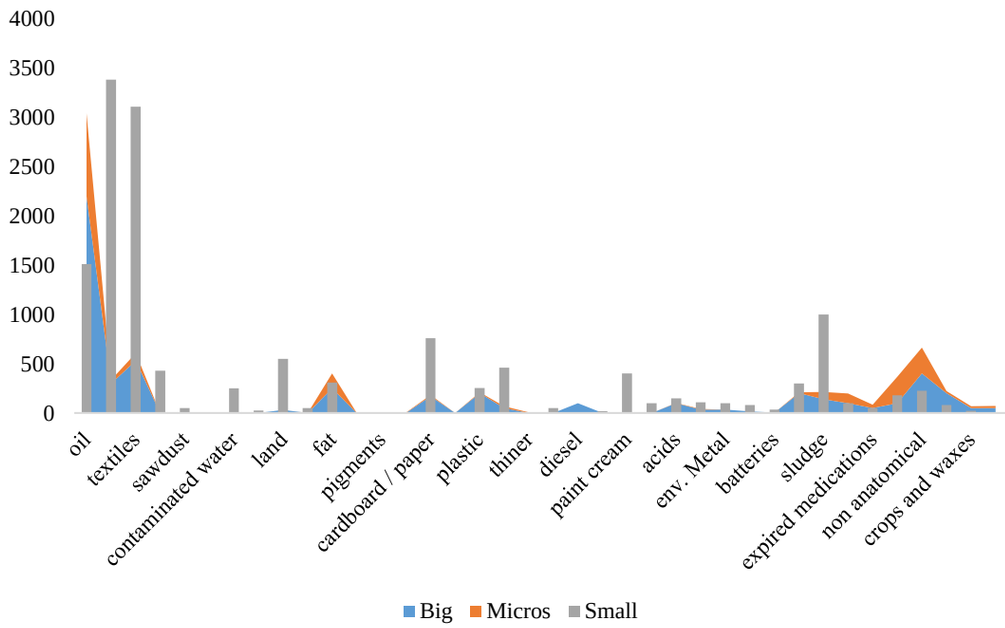
Source: Author's own design based on results from the survey (2016)

Table 29 Percentage of hazardous waste generated by municipality in the Cuitzeo region, 2015

Municipality	Oils	Solids	Rpbi	Others
Acuitzio	0%	0%	0%	0%
Alvaro Obregon	2.00%	1.95%	0.60%	11%
Charo	0%	0%	0.10%	0%
Chucandiro	0%	0%	0%	0%
Copandaro	0.60%	2.60%	0%	4%
Cuitzeo	0.40%	0.05%	0.20%	0%
Huandacareo	0%	0%	0.20%	0%
Indaparapeo	0%	0%	0.20%	0%
Morelia	93.00%	88.00%	97%	74%
Querendaro	0%	0%	0.30%	0%
Santa Ana Maya	0%	0%	0.40%	0%
Tarimbaro	3.00%	6.00%	0.40%	0%
Zinapecuaro	1.00%	1.40%	0.70%	11%

Source: Author's own design based on results from the survey (2016).

Graphic 10 Types and volumes of hazardous waste generated by respondents, 2015



Source: Author's own design based on results from the survey (2016)

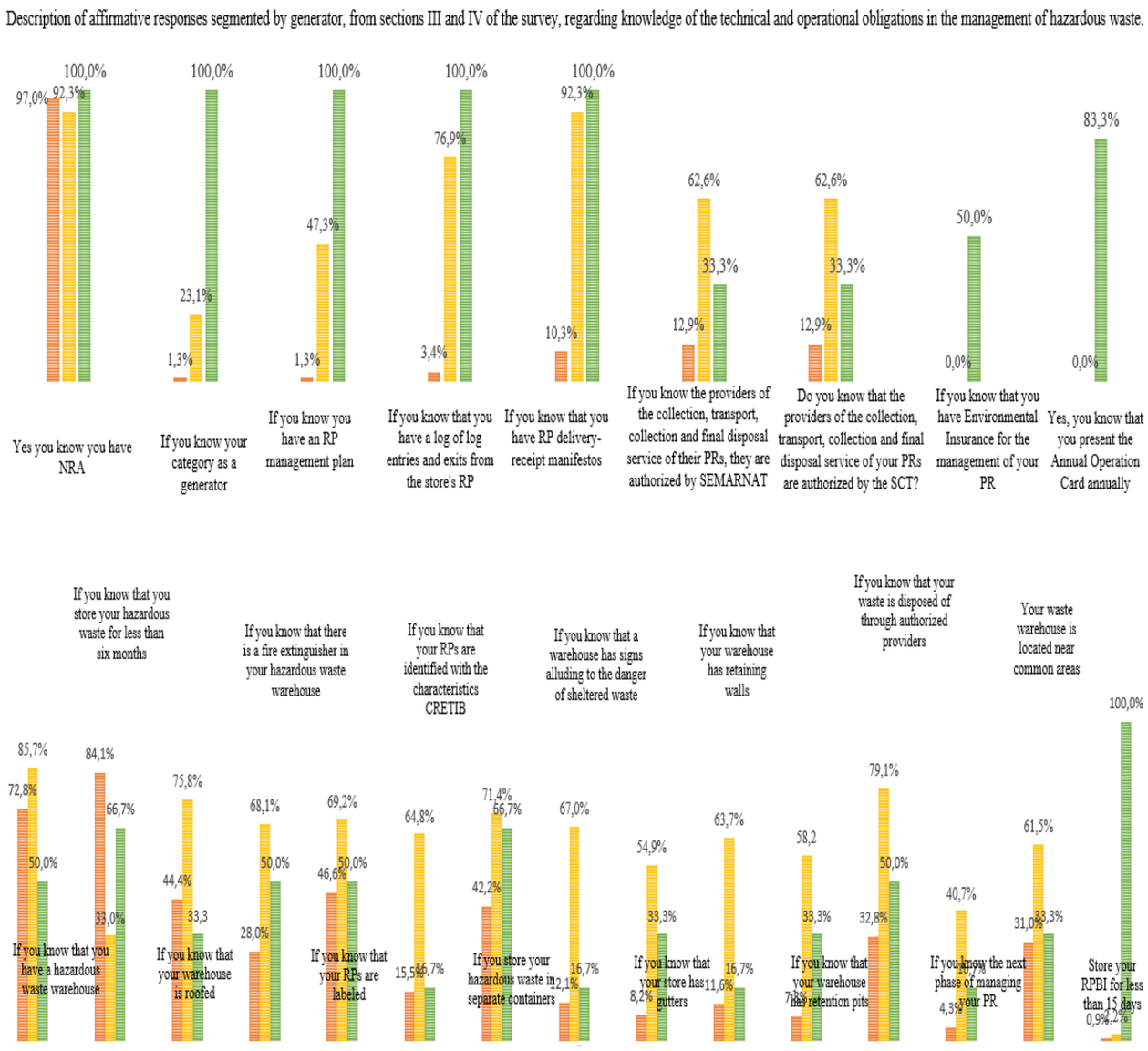
Sections III and IV of the survey were designed to know the generators' degree of instruction on LGPGIR's technical and operational obligations. This information includes knowing if they have NRA, manifests, a logbook, categorization, handling plan, temporary waste storage, among others. As per the results obtained, all three generator categories know that they have NRA; 100% of large generators know that have a generator category; all large generators are also aware of having a handling plan, 1.3% of micro generators know about it as well as 47.3% of small generators.

As for their RP logbook and manifests, most small and large generators do know that they have them; only small generators stated their knowledge about hired RP handling service providers having or not having the necessary authorizations. Regarding large generators' obligations to have environmental insurance and COA, respectively 50% and 83.3% of them know about them (See Graphic 11).

Graphic 11 also shows the affirmative results for section IV of the survey. It shows that more than half of all generators have an RP warehouse and, except for small ones, store their waste for less than six months.

About the characteristics of the warehouse, the answers show that most small generators indicated that their warehouses are roofed, have an extinguisher, signs alluding to danger, gutters, retaining walls, retention pits, and their RP are labeled and separated, but they located near common areas. In addition, they dispose RP through authorized providers, and 40.7% of them know the next phase of their handling; this is the highest percentage of all three generators categories. On the other hand, micro and small generators confirmed to comply with storing conditions in a lower percentage. However, 66.7% of large generators label and separate their RP, and 100% of them store RPBI for less than 15 days.

Graphic 11 Description of affirmative answers segmented by generator from section III and IV of the survey, referring to their knowledge on technical and operational obligations in RP handling, 2015



Source: Author's own design based on results from the survey (2016

It should be noted that the breach of the conditions of RP storage provided by the LGPGIR and its Regulation (Article 82), will cause the establishment of administrative procedures entailing an economic penalty for each irregularity, ranging from 30 to 50 thousand days of current Minimum Wage, according to the LFPA and LGEEPA.

Said storing conditions include covered, restricted area with signs alluding to danger, extinguisher, retention pits, retaining walls, gutters, RP perfectly separated, identified and labeled with the name of the waste and its CRETIB characteristics. Waste storing should be for less than six months and disposed through duly authorized service providers. Generators must know the next phase of their RP handling and not must not be located close to common areas.

As for RPBI storage, NOM-087-SEMARNAT-SSA1-2002 indicates their storage period will be determined according to the number of beds or sample analyses carried out in the health center.

Three levels are defined for the above: level I includes from 1 to 5 beds and/or 1 to 50 samples per day, their storage will not exceed 30 days; level II covers from 6 to 60 beds, 51 to 200 samples per day, or vivariums generating 25 to 100 kilograms of RPBI per month, their storage will not be longer than 15 days. Finally, level III includes centers with more than 60 beds, more than 200 samples per day, and/or more than 100 kilograms of RPBI per month, their storage will not exceed 7 days (NOM-087-SEMARNAT-SSA1-2002).

The above indicates that the largest generator surveyed from the health sector fails to comply with this provision. It claims to store RPBI for more than 15 days, exceeding the expected 7-day storing period. There are medical centers considered small generators but belonging to level III. So it can be deduced from the surveyed industries that four out of the eight respondents do not comply with this regulation.

Regarding micro generators of RPBI, the surveyed establishments were: 22 veterinarians 1 tattoo center, 33 biological laboratories and blood banks, 12 x-ray laboratories, 8 hospitals, 13 pharmacies, 1 bird breeding and sale center, 63 doctor offices and 13 clinics. Results showed that the hospitals could be considered in level II; according to the answers, 99% of them store their RPBI for more than 15 days, and only 1% stores them for less than 15 days.

For those cases where they do not have a temporary RP warehouse, 54% of respondents openly declared to store them in trash containers and dispose them in the same way, 14% do it in plastic containers, 13% in cardboard boxes, 6% in metal containers, 4% leave them outdoors, 3% throw them into the sewer and 1% store them in cans.

These answers lead to the establishment of a hypothetical market aimed at offering and demanding a good, i.e., RP correct handling. Its value will depend on legislation compliance, avoiding sanctions and the so-called strategic bias since responses do not include specific amounts. It is up to the respondents to declare their compliance with the regulations, which must be known to them since they all have a prior NRA.

Finally, section V of the survey has three primary purposes. First, it is oriented to knowing how much generators knew of the existence of the RP legal framework; second, if they had been inspected by PROFEPA and, third, if they had paid for warehouse conditioning, legal advice and environmental management. Additionally, the section inquires about the respondents' DAP for management, warehouse conditioning, legal advice and RP disposal. Finally, it asks about the MHP for all previous premises.

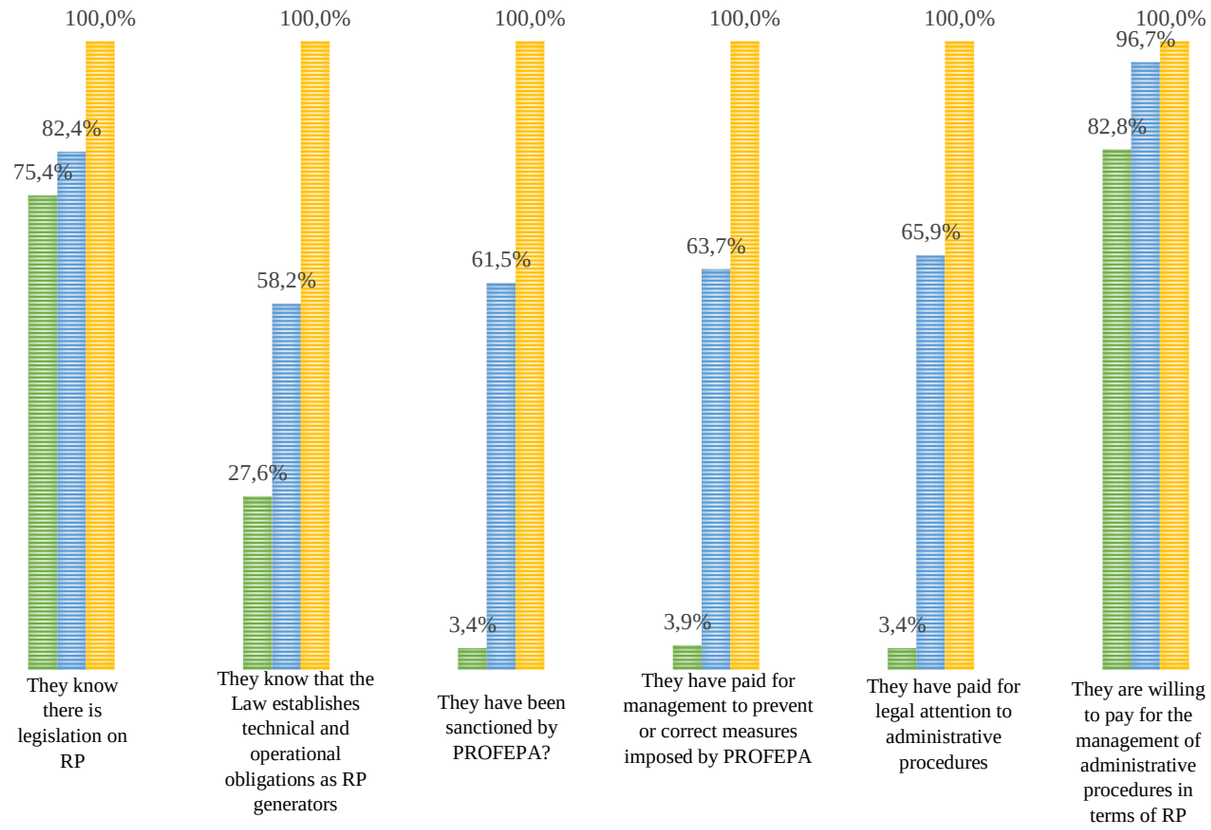
First, it is shown that large and small generators know about the LGPGIR, its technical and operational obligations, have been sanctioned by PROFEPA and have paid for legal attention and administrative procedures.

Micro generators say they do know about the LGPGIR, but only 27.6% of them know their technical and operational obligations. Moreover, less than 4% of them have been sanctioned by PROFEPA and have paid for management and legal advice.

The relevant aspect of this part of the section is that all three generators categories have a DAP for the management of pending administrative procedures.

This shows that even though 80% of them do not comply with the legal provisions, they are aware of this and would like to observe the provisions of law (for more details, see Graphic 12).

Graphic 12 Description of affirmative answers segmented by generator from section V_1 of the survey, referring to their knowledge on RP legislation, inspections from PROFEPA and their DAP for administrative procedures, 2015



Source: Author's own design based on results from the survey (2016)

Regarding the DAP and the MHP for administrative procedures, RP warehouse conditioning, legal advice and RP disposal, DAP is $2,531.65 for micro, $6,851.93 for small and $16,350.66 for large generators on average.

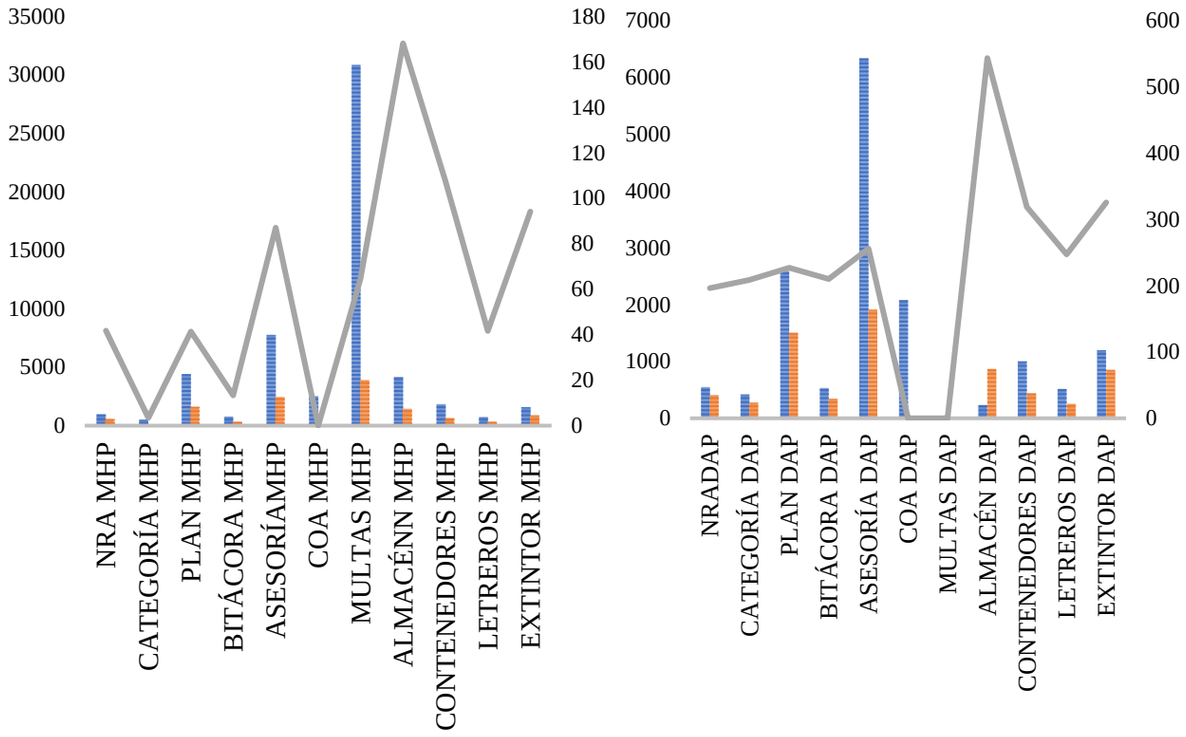
The above can be seen in table 30, which shows averages broken down by management. Graphic 13 shows the MHA per generator. Large and small generators have paid more for PROFEPA fines, legal advice and handling plans, while micro generators present a higher MHP for temporary RP warehouse conditioning. This is because micro generators have not shown much knowledge of technical obligations.

Table 30 Averages for technical and operational management paid by waste generators, 2015

Gen.	NRA	Category	Plan	Logbook	Advisory	COA	Warehouse	Cont.	Signs	Extinguisher	Average
Micro	$196.12	$208.62	$226.72	$209.91	$255.81	0	$543.10	$318.75	$247.19	$325.43	$2,531.65
Small	$410.98	$274.72	$1,504.00	$343.40	$1,910.00	0	$865.93	$441.31	$252.19	$849.40	$6,851.93
Large	$550.00	$416.60	$2,583.00	$533.30	$6,333.30	$2,083.30	$2,333.30	$1,000	$516.66	$1.20	$16,350.66

Source: Author's own design based on results from the survey (2016)

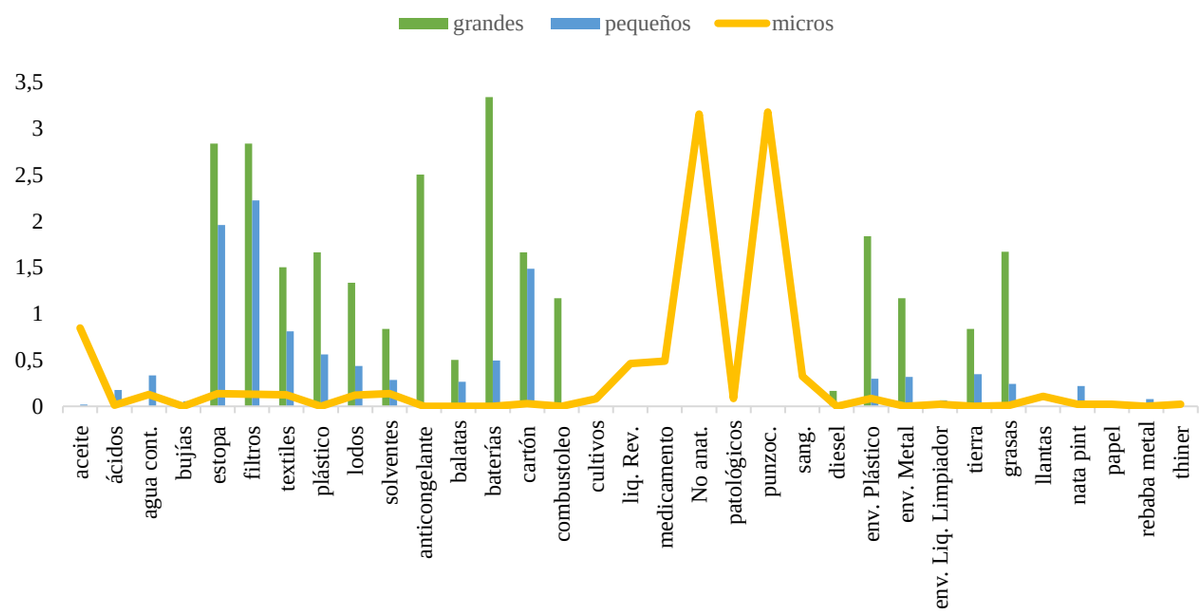
Graphic 13 MHP and DAP tendency for the handling of hazardous waste in the Cuitzeo region, 2015



Source: Author's own design based on results from the survey (2016)

Regarding the DAP for RP disposal, results showed as follows: large generators' DAP is more than $ 3.00 for used batteries, more than $ 2.50 for filters, tow and antifreeze, more than $ 1.50 for plastic containers, contaminated grease, textiles, plastics, sludge and contaminated cardboard; little generator' DAP is more more than $ 2.00 per kg. for used filters, up to $ 2.00 for tow, $ 1.50 for the contaminated cartons and less than $ 1.00 for textiles, plastic, sludge, batteries, brake pads, metal containers, grease and contaminated dirt. Micro generators' DAP for a non-anatomical or puncturing RPBI kilo or liter is higher. In addition, their DAP used oil disposal is about $ 1.00 per liter (see Graphic 14).

Graphic 14 Amounts generators have been paid and are willing to pay for RP handling in the Cuitzeo region, 2015



The last question was aimed at knowing what generators are willing to do to properly manage their RP. 41% of them are willing to set up the RP warehouse according to the provisions observed in article 82 of the LGPGIR Regulation; 6% show a DAP for legal and administrative advice; 0.20% intend to adjust to government programs on waste; 1% will be advised, 10% require training; 0.20% will analyze the legislation; 8% will elaborate or apply an RP handling plan; 2% will request tax incentives for complying with their RP handling; 6% require courses; 0.20% will seek PROFEPA's certification as a clean industry; 0.20% will carry out a chemical analysis to determine the dangerousness of their RP; 17% will hire RP collection and handling services; 1% require an environmental assessment and compliance diagnosis; and 7% will not do anything to improve or change their handling conditions in accordance with the provisions of the Law.

For more details, see Annex IV containing the SPSS spreadsheets, which detail the frequency and descriptive tables of each part of the survey. Once the frequencies have been analyzed and each *item* described, it is convenient to proceed with the correlative, parametric and nonparametric inferential analyses.

8.2 Inferential statistical analysis

In order to know the distribution of data, it was decided to perform the normality test (Gaussian distribution). According to González and Lévy (2006), this test allows knowing the distribution of data, which must approach 0 to have a normal distribution. However, since they are representative or sample data, the range considered is -1 to 1; this range implies the population's normality. The results show normality only among certain groups according to the generators'category. That is, the values of the variable groups for micro and small generators show ranges close to 1, but only for variable group I, referring to the generators' socioeconomic characteristics, the significance is > 0.05 (sig. 0.096 for micro and 0.200 for small generators. Large generators, on the other hand, present normality in almost all variable groups, showing values close to 1 and significance > 0.05 for groups I, IV, V2 and V3 (sig. 0.421, 0.680, 0.275 and 0.401, respectively). For groups II and III, the significance is <0.05 (0.031 and 0.031 respectively) despite showing statistics close to 1.

This allowed us to direct parametric and non-parametric inferential statistical analyses, and the decision was to perform correlation, comparison and prediction analyses.

8.2.1 Inferential statistical analysis of correlation

This analysis is presented to show the relation between variables without defining their causality. We have chosen to perform this analysis under a parametric scheme using *Pearson's* analysis (r) and a non-parametric scheme using *Spearman*'*s* analysis (rho).

A statistically significant correlation coefficient value will indicate an existing relationship between the variable groups; it is indicated with a value close to one, regardless of its sign. Hopkins *et al.* (1997) indicate that correlation coefficients describe the magnitude and direction of an association between two variables. The latter is indicated with an absolute value, i.e., if r is close to one, it shows a high relation between y and x. If r approaches 1, it means that the higher values of x are associated to the higher values of y; if r approaches -1, it means that a variable's higher values are associated with another variable's lower values. That is, when they increase in one variable, they decrease in another.
To perform the respective correlation, it is convenient to indicate that there are three categories of generators. This involves segmenting the correlation analysis between each group, and correlation analyses *r* and *rho* should be used since there are parametric and nonparametric data.

The results show a significant low correlation tendency among variable groups with both *r* or *rho* for all three categories of PR generators. However, there are groups that present moderate, good and excellent correlations both with *r* and *rho*. In the case of micro, small and large generators, better correlation scores are observed with *rho* for all low, moderate and good correlation. It is noteworthy that all three categories present a good correlation between variable groups III and IV. In addition, in the case of small and large generators, the *r* correlation is better, and it is presented as a good correlation between more variable groups. Also, large generators show an excellent correlation between variable groups I and V_3 (see table 31).

Based on these premises, several parametric and nonparametric tests have been carried out to compare the different variable groups analyzed.

Table 31 Correlation *r* and *Rho* for the three categories of hazardous waste generators, 2015

Generator's category	Pearson Correlation (*r*)				Spearman Correlation (*rhr*)			
	Low	Moderate	Good	Excellent	Low	Moderate	Good	Excellent
Micro	I-II, I-V_2, II-V_3, III-V_2, IV-V_1	II-V_1, II-V_2, III-IV, V_1-V_2	III-IV		I-II, I-V_2, II-V_3, III-V_1, IV-V_1, IV-V_3, V_3-V_2	II-V_1, II-V_2, V_1-V_2	III-IV	
Small	I-II, I-V_2, II-I, II-V_2, II-V_3, III-V_2, III-V_3, IV-V_1, V_1-V_2, V1-V3, V_3-IV, V_3-V_2	II-III, III-IV	II-V_1, III-IV,		I-II, I-IV, I-V_1, II-V_2, II-V_3, III-I, III-V_1-III-V_2, III-V_3, IV-II, IV-V_1, V_1-V_3, V_1-V_2, V_1-V_3	I-III, II-V_1, V_1-III	III-IV	
Large	II-V_2, II-V_3	I-II, I-V2, V_3-III	I-III, I-V_3, III-IV, III-V_2, IV-V_2		I-II, I-IV, II-IV, II-V_3, III-V_2, IV-V_3, V_2-V_3	I-II, I-V_2, III-I, III-IV, III-V_3, IV-V_2	II-V_2	I-V_3

Source: Author's own design based on results from the survey, their analysis on SPSS and according to Velazco (2012), 2016

8.2.2 Inferential statistical analysis of comparison

A comparison analysis displays the behavior of one group in relation to another; they are generally presented to demonstrate the hypothesis (Briones, 2002). For the case of this paper, the purpose is to perform parametric and non-parametric inferential statistical comparison tests to know the association degree between variable groups.

The parametric comparison analysis of two groups or independent samples is performed using the *Student's T* test. Three assumptions must be fulfilled in it: data normality, the homogeneity of variances and the independence of observations, i.e., they must be different samples. This test is applied on normally distributed data and searches for any existing differences between generator categories and variable groups. For this reason, micro and small generators were compared with variable groups I and III. In addition, small generators were compared with large generators for groups I, II, IV, V_2 and V_3 in view of correlation *r* test results.

The results show that comparing micro and small RP generators with variable group I, there is a variance equality of 0.05. However, *Student's T* test's sig. is < 0.05, which shows a difference between the groups. Likewise, these groups were compared with variable group III, showing that there is no variance homogeneity, so the groups are different.

Small and large RP generators were compared with variable group I. This indicated a homogeneity of variances (P-Value> 0.05, with a score of 0.448) and a sig. of *Student's T*> 0.05 indicating an equality between the groups. As for variable group II, these two generator categories were compared, resulting in no variance homogeneity for presenting a P-Value < 0.05. However, *Student's T* sig. is > 0.05, which indicates equality between these groups.

These generator categories were compared with variable group IV. The results showed indicated a homogeneity of variances (P-Value> 0.05, with a score of 0.951) and a sig. of *Student's T* > 0.05 indicating an equality between the groups.

Small and large RP generators were compared with variable group V_2. This indicated a homogeneity of variances (P-Value > 0.05, with a score of 0.253). However, the *Student's T* sig. is < 0.05, which indicates a difference between the groups.

Finally, small and large RP generators were compared with variable group V_3, resulting in a non-homogeneity of variances because the P-Value is < 0.05 (0.016) and *Student's T* sig. is < 0.05, which shows that there are significant differences between these two groups.

These results show that there is a significance between groups, especially between small and large RP generators. However, the variable groups show some significant differences that indicate the need to treat each generator category separately.

It is convenient to perform a nonparametric analysis for two groups or conditions and for independent samples. For this, the Mann-Whitney test (*U*) is performed to compare groups III and IV, which showed the highest *rho* correlation between micro and small generators. This resulted in a *U* value for group III of 1735.5 with an asymptote significance of .000, which indicates a difference between the groups compared.

Likewise, these two generator categories were compared for variable group IV, resulting in a *U* value of 4777.5 with an asymptote significance < 0.05, which also indicates a difference between the compared generators.

On the other hand, observing the best *rho* correlation, we proceeded to compare small with large generators for variable groups I, II, III, IV, V_2 y V_3, resulting in an equality for variable groups I (with a *U* score of 232 and a P-Value > 0.05 = 0.53) and IV (with a *U* of 159.5 and a score of .085). In addition, there was a difference between groups II, III, V_2 and V_3. Group II had a *U* score of 139.00 and a P-value of 0.03; group III had a U-score of 31.500 and a P-Value < 0.05; group V_2 showed a *U* of 50.5 with a P-Value of 0.01; and group V3 indicated a *U*score of 119.5 with a P-Value < 0.05.

As can be seen, RP generator categories present considerable differences in the analyzed variable groups. There is an option to analyze all the three categories with respect to all variable groups. For this purpose, the decision was to perform the *ANOVA* test of one factor, considering all variable groups as dependent and all generator categories as a contrast factor.

It is observed in this analysis that, the homogeneity of variances is < 0.05, so the assumption is not met. However, the literature suggests that it is convenient to review the Post hoc tests, which offer combinations between variable groups, and the Games-Howell statistics for cases where equal variances are not assumed (Jornet et al., 2016).

These scores offer a correction of the results' degrees of freedom. It is appreciated that the *ANOVA F* scores offer a P-Value < 0.05, which indicates to the naked eye that there is a difference between the groups compared. However, analyzing the *ANOVA*'s Post Hoc tests, a P-Value < 0.05 (0.000) shows for variable group I in the Games-Howell statistics between micro and small generators. This shows a difference between these groups. However, the Games-Howell scores for this same variable group show a P-Value> at 0.05, for micro and large, as well as for small and large generators. This shows the equality of groups.

In the case of variables group II and III, the Games-Howell score shows a marked difference between all generator categories, presenting a P-Value < 0.05. Regarding variable group IV, a P-Value < 0.05 is observed between micro and small RP generators, which denotes a difference between these groups. However, between large and small, as well as between small and large generators, the P-Value is > 0.05, which can be interpreted as an equality between the groups.

Regarding the set of variables marked with number V_1, the Games-Howell scores show a significant difference between all generator categories with a P-Value < 0.05. As for variable group V_2, all present significant differences except for the comparison between small and large generators. Finally, the Games-Howell scores for variable group V_3 show an equality between the generator categories with a significance> 0.05.

The *ANOVA* test showed no homogeneity of variances between the analyzed groups; then, the *Kruskal-Wallis* (*H*) test was performed. It consists of a non-parametric analysis to know the equality or difference between groups. The results show a significant difference among generator categories due to the asymptotic significance values < 0.05.

In order to compare variable groups and generator categories with respect to their DAP, a non-parametric test was carried out between groups V_2, referring to their DAP for management and technical/operational actions, and V_3, referring to their DAP for each generated RP.

Results show a variance equality between V_2 micro generators and variable groups I, III and IV. Also, there is a difference of group V_2 with II and V_1. Regarding variable group V_3, there is an equality with groups I and III and differences with groups II, IV and V_1. This is in consideration of a P-Value of 0.05.

For small generators, there is an equality (with a P-Value> 0.05) of group V_2 with I, II, III, IV and V_1. Group V_3 only shows equality with groups I and V_1 and differences with groups II, III and IV. As for the comparison of large generators using the *H* test, variable groups V_2 and V_3 show an equality with groups I, II, III, V_1 with a P-Value > 0.05.

This allows to infer that the DAP of all three categories, both for the management and for the final disposal of their RP, is feasibly linked to the socioeconomic, the compliance with technical and operational provisions, and the knowledge of the legal provisions variables. These arguments evidence the fact that if the legal provisions are known, it is feasible to properly handle RP and pay for their final disposal and for the necessary steps to reduce their negative impacts on the environment and society.

Now, in order to know how much a group of variables contributes to the prediction of an assumption based on other variables, it is convenient to apply a Linear Regression. It aims to test different parametric statistical models for predicting qualitative variables from certain quantitative variables. It uses different variables to know the behavior of one variable according to another (Devore, 2005 in Cardona, et al., 2013).

The purpose is to perform a Multiple Hierarchical Regression Model (MHRM) between variable groups by generator category. This will allow for a certain prediction on the effects of independent variable groups on the dependent variable, ranking each variable group's contribution to said prediction. Groups V_2 and V_3 are used as dependent and groups I, II, III, IV and V_1 as independent variables. The Durbin-Watson test score was > 1,000 and < 3,000, depending on the generator category.

More results show that the Durvin-Watson test scores fall between the ranges of 1,000 and 3,000 for all generator categories. This indicates an independence of errors, so the assumption of independence of errors showing the relation between variables is accepted (Cardona, et al., 2013).

The *R squared* presents different ranges according to the generator category. The value for large generators is greater since the variance of the independent variable can be explained in more than 72% (75.8% for V_2 and 72.7% for V_3) with the set of variables considered independent. However, in the case of small generators, it is noticeable that the *R squared* value is greater for variable V_2 than for variable V_3 (14.7% and 7% respectively). The same trend is observed for micro generators, who present a greater value for V_2 (31.4%) than V_3 (8.4%). In all cases, independent variable groups (I, II, III, IV and V_1) explain the variance of dependent variable groups (V_2 and V_3). So the DAP, both for warehouse management/conditioning and for RP disposal, is related to socioeconomic characteristics, knowledge of RP generation and impacts, knowledge of technical/ operational obligations and knowledge of legal provisions.

Regarding *ANOVA*'s *F* and sig., a significance below 0.05 would indicate that the model improves with the independent variables. In the case of micro generators, variable groups I, II, II, IV and V_1 are < 0.05. This indicates that they improve the model, so the model is effective. As for small generators, the significance is below 0.05 for variable V_2 and above 0.05 for variable V_3. They present a lower level If only variables I, II and III are used, but this does not mean that the model is incorrect. In the case of large generators, the significance is greater than 0.05, meaning that not all the independent variables improve the prediction. In fact, the significance index improves using only variable group I.

The t-scores in the MHRM model indicate that the variables significantly contribute to the prediction. This indicates that the values obtained can be generalized in the population when the P-Value of sig. is < 0.05 (Cardona, et al., 2013). Thus, the significance level for micro generators can be generalized to the population, while the significance for small and large generators does not present an important contribution. This due to the sample number, so it is convenient to perform a logistic regression for values > to 0.05 and for significant variables.

Finally, the multicollinearity statistics indicate whether or not there is a significant correlation between the endogenous variables, i.e., the independent variables. If there were any, the prediction using the dependent variable would lose value. If the variance inflation factor (VIF) is applied, the allowed ranges should be less than 10. Otherwise, there would be a multicollinearity between independent variable groups (Cardona, et al., 2013). Results show that VIF values for all generator, both for variables V_2 and for V_3, are lower than 10. This indicates that the assumption of non-multicollinearity between variables is met.

The significance of *F* in *ANOVA* is 0.00 for the five variables used, so it significantly improves the prediction of the dependent variable. *F* is 20.657 and significance is <0.01. Regarding *t* and the significance considered in the table of coefficients, it is noteworthy that these elements indicate how much the results obtained can be generalized to the population. In said table, *t* is .852, -5.210, -2.204, 2.379 and -3.317 with a significance of .385, .000, .029, .018 y .001. Except for the .385 value (generators' socioeconomic characteristics), the predictions obtained from the variables can be generalized to the population.

The VIF it indicates whether or not there is multicollinearity of data and for that, the values must be lower than 10 (Cardona, et al., 2013). The resulting values range between 1.048 and 2.515. This indicates that the assumption of non-multicollinearity of data is met (I = 1.048, II = 1.501, III = 2.515, IV = 2.164 and V1 = 1,745). So, there is a relationship between the dependent and the independent variables. Thus, it is possible to infer that RP handling is a function of these variables, especially in relation to the DAP for such handling. Finally, the results shown in the constants must be substituted in the model to make a prediction. It is just enough to replace the values of *B* and indicate the expected *X* value (see Table 32).

Table 32 Multiple Hierarchical Regression between variable groups and generators, 2015

Generator	**VD**		**Durbin-Watson**	**R squared**		**ANOVA**		
						F		**Sig.**
Micro	**a)**	V_2	1.587	314 (31.4%)		20.65		0.00
		V_3	1.775	084 (8.4%)		4.125		0.01
Small		V_2	1.620	147 (14.7%)		2.930		0.017
		V_3	2.217	070 (7.0%)		1.278		0.281/.106 (I, II, III)
Large		V_2	2.145	758 (75.8%)		.758		0.678/.217 (I)
		V_3	2.145	727 (72.7%)		.665		0.713/.073 (I)
Generator	**VD**		**Constant**	**I**	**II**	**III**	**IV**	**V_1**
Micro	**b)**	V_2	10163.774	5.710	-112.612	-219.238	74.064	-199.616
		V_3	5.341	.018	-5.89	1.104	-.470	.916
Small		V_2	25559.271	-.96.567	-19.056	-740.48	272.02	-526.83
		V_3	30.0000	.005	-.219	-.690	-.108	-.156
Large		V_2	59594.12	-504.1	488.09	1764.07	-1411.42	--
		V_3	-100.74	.443	-2.095	17.609	-2.752	--
Generator	**VD**		**Coefficients**	**I**	**II**	**III**	**IV**	**V_1**
Micro	**c)**	V_2	***t***	.852	-5.210	-2.204	2.379	-3.317
			Sig.	.395	.000	.029	.018	.001
			VIF	1.048	1.501	2.515	2.164	1.745
		V_3	***t***	.359	-3.602	1.467	-1.998	2.013
			Sig.	.720	.000	.144	.047	.045
			VIF	1.048	1.501	2.515	2.164	1.745
Small		V_2	***t***	-2.081	-.014	-.216	.202	-.223
			Sig.	.040	.922	.189	.138	.107
			VIF	1.059	2.104	2.637	1.821	1.871
		V_3	***t***	.064	-.698	-.767	-.367	-.301
			Sig.	.949	.487	.445	.714	.764
			VIF	1.059	2.104	2.637	1.821	1.871
Large		V_2	***t***	-.447	.067	.126	-.756	--
			Sig.	.716	.958	.920	.588	--
			VIF	6.427	2.539	9.200	4.266	--
		V_3	***t***	.185	-.126	.557	-.651	--
			Sig.	.883	.920	.676	.633	--
			VIF	6.427	2.539	9.200	4.266	--

Source: Author's own design based on results from the survey (2016)

It was observed that the group variables are not homogeneous among generator categories. A logarithmic regression is applied to make a more accurate prediction. It allows knowing the behavior of dichotomous categorical variables. The *LOGIT* model allows to approach this induction based on nonparametric statistical analyses.

8.3 Predictive statistical analysis through Logistic Regression

The Logistic Regression (LR) model allows knowing the behavior of a variable. The *Chi-square* and its P-Value < 0.05 are considered to indicate the extent to which variables explain the proposed model. In addition, *Cox Snell*'*s R squared*, and *Negelkerke*'*s R squared* are taken into account. They indicate that the higher the *R squared*, the more explanatory the model is. The LR approach will also provide a percentage indicating the behavior of the dependent variable. The *Chi-square* significance and the *Wald* value are taken into account to know if the results can be generalized to the population. Finally, the LR model indicates the prediction LOGIT considered in the Exp (B) values. If it is < 1, it will indicate that as the independent variable increases, the dependent variable will decrease. If the value is > 1, it will indicate that as the independent variable increases, so will the dependent variable (De la Fuente, 2011). The LR model was used to detect DAP and RP handling events in the region under study. There are categorical variables that must be analyzed by this means.

The analysis will provide: a level of prediction on the DAP in relation to the generators' socioeconomic conditions (I); their knowledge of RP (II); their compliance with the technical provisions (III); compliance with the operative provisions (IV); their knowledge on RP legislation and their DAP for an environmentally sound handling (V1).

First, an analysis of data on micro generators is performed. Thus, it is convenient to analyze the DAP both for RP management and disposal according to the generators' socioeconomic characteristics. It can be seen in Block 0 that 58.1% of generators would pay more than $ 2,500 for RP actions. In addition, the *Wald* score indicates that the results can be generalized to the population (5.786) having a significance of .016 (< 0.05). However, it a value of 59.478 shows in the *ROA*'*s Statistical Efficiency Test*, with a significance of .105. This means that the variables considered do not significantly contribute to the model; *Negelkerke's R squared* value explains 31.6% of the independent variable's variance (.316). It can be inferred that, if the value of the independent variable increases, that is the socioeconomic characteristics of the generator, the DAP for RP management will increase as well. Also, as the score of knowledge on RP generation increases, the DAP for RP procedures will decrease according to the Exp (B) of .270.

About 64% of respondents show a DAP for RP managerial procedures if more variables are included besides the knowledge of RP generation (II) such as: compliance with the technical (III) and operational (IV) provisions, knowledge of the legislation, and the DAP. If there is an increase in the knowledge of operational obligations, legislation and RP generation, the DAP for managerial procedures will be reduced. But, if the compliance with technical provisions increases, the DAP for managerial procedures will increase as well.

Regarding the prediction of the DAP for RP managerial procedures and their effects, it is observed that about 63.5% of respondents have a DAP of more than $ 2,500. According to the *ROA Statistical Efficiency Test*, there is a significant improvement in the prediction of the occurrence probability in the dependent variable categories (Chi-square of 16.636, with a significance of .03 (< 0.05). So *Negelkerke*'*s R squared* value indicates that the proposed model explains 097% of the the dependent variable's variance (.097).

In addition, an increase in the value of knowing that improper handling of RP and contaminated solids contaminates water, flora and fauna and causes cancer, will also increase the DAP for RP procedures. An increase in the awareness of RP generation, improper handling of RPBI, their pollution of soil and their harmful effects on health by intoxication and transmission of diseases will reduce the DAP for RP handling. Regarding the knowledge that RP can contaminate water, it is appreciated that more than 74% of respondents know it. In addition, the proposed model together with *Negelkerke's R squared* explains the variance of the dependent variable by 6%.

Regarding the prediction of the DAP for gender-related management, the results show that this DAP would be less in the hands of the male gender (Exp B of .253). Micro generators were asked about their DAP for RP administrative or technical procedures according to their knowledge on RP generation, compliance with technical and operative norms, and their knowledge on such legislation. 82.8% of them have a DAP for such procedures; this argument is being explained by 08% based on the dependent variable's variance in consideration of the *Negelkerke's R squared* score.

A Multinomial Logistic Regression Model is considered in three scenarios: pay nothing for RP handling, pay up to $ 2,500 and pay more than $ 2,500. It is observed through the application of this model that an increase in the level of compliance with technical provisions would raise the payment for these actions up to $ 2,500. This argument can be generalized to the population obtaining a significance < .05 (.005).

Finally, a Binary Linear Regression Model is used to know the DAP for environmentally appropriate RP disposal in relation to the micro generator' socioeconomic conditions. The results show that 76.2% of them have a DAP of up to $5 pesos per kilo / liter / piece of generated RP. This DAP will be increased as their education level, their occupation conditions, their company's monthly income, their housing and their medical care improve as well. This is observed according to the table of variables from the test equation. It can also be generalized to the population having a significance < 0.05. In addition, the *Negelkerke R squared* value indicates that the model explains 54.7% of the dependent variable's variance (.547).

A different LR shows that 63.4% of respondents have a DAP for RP up to $ 5 pesos, and there is a potential increase in the DAP for adequate RP disposal with increases in their knowledge of RP generation, their level of compliance with operational provisions and their knowledge of the legislation. This is justified and can be extended to the population since it has a *Chi-square* of 15.969 with a significance below 0.05 (0.003). The *Negelkerke R squared* explains 11.8% of the dependent variable's variance (DAP per RP).

An LR model shows that 62.8% of respondents have a DAP for RP up to $5 pesos, and the increase of this DAP would entail increases in their knowledge about RP generation, their knowledge of how and why they contaminate the soil as well as knowledge on how it damages health. This can be generalized to the population since the *Chi-square* value is 19.972 with a significance of 0.10 which turns out to be P <0.05. According to *Negelkerke's R square,* the proposed model explains 14.6% of the dependent variable's variance.

An LR model was also applied on data from small RP generators. The model considered their DAP for managerial procedures according to their education level, occupation, their company's monthly income, their monetary allocations to RP handling, housing and medical care. Results showed that 65.2% of respondents in Block 0 have a DAP, according to said variables, of up to $ 6,500 pesos. However, the *Chi-square* value is 23.236, which indicates that the relationship is not significant since the P-Value is > 0.05 (.079). It can be inferred from this that the independent variables do not explain the DAP for RP procedures. In this respect, *Negelkerke's R squared* is .317, which indicates that the model explains the dependent variable's variance by 31.7%.

As for the classification table of block 1, an inferred value of 74.2% of the model's functionality is given. The DAP for management will increase as the respondents' education level, occupation, and their company's income increase. This is based on the value of Exp (B), which indicates that housing and medical care do not contribute to the model.

The LR model was also applied on the DAP for procedures according to their knowledge of RP generation and their effects on the environment and society. 67.4% of respondents have a DAP for RP procedures up to $ 6,500 pesos according to the independent variables considered. The displayed *Chi-square* significance is > 0.05, (.96), and the *Negelkerke R squared* value infers that dependent variable's variance is explained by 11.5%. These values are lower and show that the degree of knowledge on RP generation and their impacts on the environment and society are not decisive of their DAP for RP handling. However, the values of Exp (B) indicate that awareness of the damage to the flora, fauna, and health can increase the DAP for RP handling.

The intention was to know the DAP for RP handling according to the respondents' awareness of it, their compliance with technical and operational legal provisions and their knowledge of RP legislation. However, the LR model indicates that 65.2% of respondents have a DAP up to $ 6,500 pesos according to the independent variables considered, but this is not significant due to the P-Value > 0.05 and a *Chi-square* of .192.

The *Negelkerke R squared* score is only .071, which indicates that the independent variables explain 0.7% of the dependent variable's variance. In addition, based on the Exp (B) value that allows inferring the behavior of the independent variables, it is appreciated that increasing awareness of RP technical provisions, their DAP for RP procedures will also increase.

However, if awareness of RP generation and their impact on the environment and society increases, compliance with technical obligations and knowledge of the legislation will not increase their DAP for managerial procedures. The same can be inferred from the LR model proposed between the dependent variable: compliance of the technical provisions (III) and variables: awareness of RP generation and their impacts (II) and knowledge of legislation (V_1).

The resulting significance was < .05 (.001) and a *Chi-square* score of 13.348. *Negelkerke*'*s R squared* value indicates that the proposed model explains 21% (.210) of the dependent variable's variance (III). Also, the behavior of variable III according to the generators' socioeconomic conditions (education, occupation, company's monthly income, company's monetary allocations to RP handling) was reviewed. 78% of respondents would comply with RP handling technical provisions of RP management. *Chi-square*'s value was 18.5543 and its significance .029, which is <a .05. *Negelkerke's R squared* was .283, which indicates that the model explains the variance of dependent variable III by 28.3%.

In a predictive way, the Exp (B) value shows that their level of compliance with RP obligations techniques will increase as the company income, the monetary allocations to RP handling, their education level and occupation conditions increase.

The purpose was to predict the DAP for environmentally sound RP handling according to the generators' socioeconomic characteristics (I), their awareness of RP generation and their impacts (II), as well as their compliance with obligations (III, IV and V_1). 62.9% of respondents' DAP for RP handling was more than $ 10 pesos considering the proposed independent variables. The significance is low, but it remains above the .05 P-value. *Negelkerke's R squared* was.278, which indicates that the model explains the dependent variable's variance by 27.8%. According to the Exp (B) value, it is feasible to infer that, if their education level and occupation conditions increase, their DAP for RP handling will increase as well.

Regarding the behavior of the dependent variable (DAP for RP handling) as a function of variable II, it can be seen that the *Chi-square* significance is .061. This indicates that the prediction based on the variables involved is not significant. The *Negelkerke R-squared* score was 216, indicating that the dependent variable's variance is explained by 21.6% based on the model considered.

However, the LR model proposed between the DAP for RP and variables III, IV and V_1 is effective. 62.9 of respondents have a DAP of more than $ 10 pesos based on said variables. The significance of *Chi-square* is < 0.05 (.038), and *Negelkerke R squared* is .155 (15.5%), which explains the variance of the dependent variable. Furthermore, it can be inferred from the Exp (B) value that if all independent variables (III, IV and V_1) increase, the DAP for environmentally adequate RP handling will increase.

Finally, applying the LR model on large generators, the data showed some homogeneity, features. For this reason, the results of some LR models are limited to variables without redundancies. As for the prediction of the DAP for RP procedures in relation to compliance with technical (III) and operational (IV) provisions, knowledge of legislation, and DAP (V_1), it was observed that 83.3 % of respondents have a DAP for RP procedures of up to $17,000 pesos according to data reported in Block 1 of the model. However, the P-Value is > 0.05 (.148) with a *Chi-square* value of 3.819. *Negelkerke's R squared* was .628, which indicates that the model explains the variance of the dependent variable by 62.8%. In addition, the of Exp (B) value indicates that, if compliance with technical responsibilities increases, the DAP for technical procedures will also increase.

On the other hand, about 50% of respondents' DAP for procedures is more than $17,000 according to their education level, occupation and income. In addition, Block 1 of the model presents a *Chi-square* of 8.318 with a significance of .081, and *Negelkerke's R-square* value is 1,000, which indicates that 100% of the model explains the variance of the dependent variable.

Now, he DAP for RP handling in relation to education level, occupation and income shows a percentage of 66.7% of participants whose DAP for RP handling is more than $15 pesos per kilo, liter or piece. The *Negelkerke's R squared* in this case is 1.000, which indicates that the independent variables explain the dependent variable by 100%. As for the DAP for RP handling, a prediction percentage of 83.3% can be seen in terms of variables II (awareness of RP generation and their impacts), III (compliance with technical provisions), IV (compliance with operational provisions) and V_1 (knowledge of the legislation and DAP).

The *Negelkerke's R squared* value indicates that the independent variables explain the dependent variable by 56.6% (.566). Also, the value of Exp (B) indicates that, if awareness of RP generation and their impacts as well as compliance with technical obligations increase, the DAP for an environmentally sound RP handling will increase a well.

Conclusions

The management of RP today represents an important challenge that at world level has sought to address under the scheme of sustainability, considering the efficiency of production processes and consumption, awareness and education of society, the carrying capacity of the environment, technological advances that allow the minimization and valorization of waste and the incorporation of control measures in legislation; Mexico, has not been the exception, since 1971, has sought to control the effects of waste, although at that time, control was carried out through health authorities, represents a precedent of the need to control the management and generation of waste that obeyed the provisions of the CPEUM which since 1917 incorporated the concern of environmental limits in Article 27 to point out the need to regulate the use of natural elements susceptible of appropriation

There is currently a broad legal framework in environmental matters, particularly the LGPGIR published in 2003, the Regulation of this Law, published in 2006 and the LFRA, published in 2013; as well as a set of NOM's that in accordance with the provisions of the LGEEPA seek to safeguard the Constitutional guarantee concerning the human right to a healthy environment for development and well-being, a guarantee that was developed before the international influence of the protection of the environment as an essential basis for quality of life and social welfare from the Brundtland Report.

In this context, the need to regulate waste arises as a reaction to the damage, dangers and risks they cause to society and the environment, because the generation of these is in function with anthropogenic activities and that under the principles that in nature there are no waste because the function of the whole is implicit in a perfect cycle and, the prevention principle that promotes the adjustment of anthropogenic activities to the limits of environmental load, it is necessary to analyze the problems of waste management and generation according to a given space and time, because it is not possible to generalize the environmental, economic and social conditions and characteristics of any place; Therefore, the research was focused on the study of a particular region, which for the state of Michoacan represents particular economic, political and social functions, due to the density of population located in the region, close to 254 inhabitants per km2, which promotes the concentration of waste generators and thus makes it possible to impact in one way or another in the sustainable development of the region.

The Cuitzeo region obeys the regionalization carried out in the state of Michoacán in 2004 that sought to integrate spaces according to its economic, social and political conditions, the region is conformed by thirteen municipalities that represent 6.7% of the state territory, has an area of 3,940.44 km2 and concentrates 1,061,011.In this sense, it follows the contributions of Moreno and Florescano, 1973; Dollfus, 1976; Coraggio, 1979; Unikel, 1981; Ortega, 1993; Palacios, 1993; Young, 1992; Boudville, 1996; Jalowiwcki, 1998; Rionda, 2006, among others, the Cuitzeo region obeys the spatial limits due to its homogeneity that has allowed it to become one of the main regions in the state of Michoacán and that besides constituting a pole of population attraction due to the location of the state capital in the region, influences the economic, social and political movements that impact the entire state.

The Cuitzeo region has a high percentage of service sector workers (63%), about 16% of the population is engaged in manufacturing activities, while 9% is engaged in agriculture, essentially in Chucándiro and Copándaro; This indicates that due to social activity, the Cuitzeo region is dedicated to providing services that, regardless of the economic turn of events, generate waste, in particular RP, a situation that must be addressed around the management conditions provided for by legislation, so as not to affect the natural conditions of the region, Due to the fact that it still conserves 35% of natural soils of which more than 26% are forest and 8% of water within which important bodies of water are located, such as Lake Cuitzeo, considered the second most important in Mexico, has an estimated surface area of 420 km2, its main environmental function is to regulate the climate of the basin, the livelihood of fishermen and irrigation of surrounding areas.

However, today it has important effects, not only by the discharge of domestic wastewater, but also by the discharge of serious pollutants from industries and agricultural activities, which release heavy metals such as cadmium, mercury, radon and fluorine, representing a latent risk to society throughout the region and a polluting factor of natural elements.

In this sense, waste management, particularly those with one or more hazardous characteristics such as corrosive, reactive, explosive, toxic, inflammable and biological, must be analyzed and addressed in order to promote valorization and minimization actions, based on a true diagnosis that contrasts the generation estimates issued by official authorities such as SEMARNAT with the activities carried out in the Cuitzeo region; Therefore, the research sought to analyze the problem of RP management in the Cuitzeo region through one of the economic valuation methods, which was the one that offered the necessary elements to provide real data of generation, compliance, management and DAP in RP matters.

The methods of economic valuation are born in the light of the EA that seeks to highlight the value of the environment through the internalization of externalities, however, the fundamental premise of the EA had as a starting idea the premises raised in the classic and neoliberal postulates, the first sought to operationalize through the idea that natural elements are infinite, so the main factor was the expansion in the territory of population centers with large industries, which justified the saying that the areas with large chimneys represented progress, considering at all times that nature was at the instrumental benefit of man to be exploited, manipulated and modified.

This idea was due to a historical event, the Industrial Revolution, which, in addition to propitiating accelerated environmental deterioration, brought about the need to interpret the activity of the market, in terms of supply and demand. Therefore, it is not strange that great postulates emerged to define development, the premises of Lewis in 1955; Schumpeter in 1958; Kaldor in 1961; Adelman in 1964; Bénard, Kalecki, Leontief and Tinbergen in 1965; Bangs in 1968; Currie in 1966, proposed to define development to which, in general and with different variants, they identified it with the growth of the value of economic production, which also facilitated its measurement.

At the same time, the proposals of Rostow's linear model (1960) which visualized economic growth as a sequence of stages ranging from traditional, start-up, take-off, maturity to mass consumption; in addition, the premises of François Perroux (1955) who, in his "Theory of the Poles of Development", sought to define the order of growth through concentration in place.

All this had as its central axis the anthropogenic activity that required services and products, in spite of the environmental limitations. Unfortunately, until the seventies, environmental protection was consolidated due to the social pressures of environmental groups that began to act in the fifties. This was done with the backing of the neoclassical current that proposed that the problems of pollution and degradation of ecosystems could be resolved by incorporating the principle of conservation of matter into the economic process.

The above is significant because it not only addresses the problem of waste disposal, but also seeks to solve a problem of common order, which exceeds the limits of ownership, because it deteriorates the environment and puts at risk the quality of life of those who live in it, speaking of every living being, not just man. This was due to spatial pressures that made it necessary to rethink social, economic, environmental and institutional dynamics. For this reason, the thinking that defined sustainable development began to consider incorporation rather than distribution, consumption, wealth, quality of life, social welfare, in harmony with environmental value.

In this sense, it began to regulate the types of resources, imposing tariffs or taxes to those that were not renewed, making tangible a difference of accepted and recognized utility, therefore, the need arose to internalize the costs and benefits of environmental deterioration. This regulation had to be made according to the dispositions of the State -proposed by Pigouviana (1962)-, which through taxes or subsidies obliged the agents that propitiated externalities to pay the costs of their proceeding, this premise, today is a clear antecedent of the international principle of "the polluter pays".

However, the recognition of these premises of internationalizing externalities, remain outside the Coase Theorem (1960) which addresses the social cost through the recognition of the need for State regulation in its coercive form of externalities that represent an absence of property rights, leading to the lack of established prices of such externalities. However, Coase's Theorem is limited in its scope, because it is not only the lack of prices, it is also necessary to address and include in a regulatory framework the situations of benefit of those who internalize their externalities, for the case of Mexico, the proposal is to encourage the application of tax incentives to those who internalize the costs of externalities.

In this sense and taking into account the research premise, Coase's proposal in relation to Environmental Economics provides the necessary elements to consider the value of the management of the P.R. generated in the Cuitzeo region, which is not only based on the disposal of waste, but also on all those activities of reduction or minimization, separation, collection and final disposal of waste, under parameters of environmental, economic, technological and social efficiency; As can be seen, the economic value of RP management is a challenge that should not be limited to the willingness to pay or to be compensated for waste management. Added to this are the contributions of the new economic geography highlighted by Paul Krugman in 1999, who in turn relied on the contributions of Marshall, Myrdal, Kaldor, Von Thunen, Cristaller and Losh, all of them emphasizing the value of space. This is clearly reflected in the problem studied, because the concentration of RP generators obeys population dynamics, constituting a problem in two senses, the first, because they propitiate the attraction of new RP generating establishments that seek to offer new and/or better services or products, and in the second, because these concentrations of both generators and the population, increase the risk of affecting the environment and society, before the undue handling of RP due to undue exposure; in addition to the parallel consequences, such as RA, sanctions, fines, charges, environmental accidents, environmental damages, etc., as well as the parallel consequences, such as AR, sanctions, fines, charges, environmental accidents, environmental damages, etc., because these concentrations of both generators and the population increase the risk of affecting the environment and society due to the undue handling of RP due to undue exposure.

One way to approach the valuation of the costs represented by the management of RP is through the economic theory that through the EA offers various valuation methods that seek to highlight certain perspectives of those involved, in particular, it was observed that, in the literature, In the investigation, this environmental improvement was based on the fact that it was not sanctioned by PROFEPA, through compliance with regulations, not damaging natural elements and avoiding damage to health.

The application of the MVC was made in the Cuitzeo region, because this region fulfills the conditions of spatiality, dependence and heterogeneity that has been theoretically analyzed of the region construct, becoming a bioregion that by its environmental, social, economic and institutional peculiarities is constituted as that parametric perception that allows to know, singularize, distinguish, typify and classify the social features of the Cuitzeo Region; In addition, there is the phenomenon of attraction of the masses according to spatialization, because it concentrates the greatest number of RP generators, a total of 2273 generators, representing the total of the state of Michoacan, 42% of large generators, 51% of small and 41% of micro generators of RP, distributed mostly in the Municipality of Morelia, as well as Tarímbaro, Álvaro Obregón and Zinapécuaro; generating about 8,861.90 tons of RP, which represents 40% of the total RP generated in the state.Los principales giros económicos generadores de RP es el de servicios, donde impera el sector salud, así como el de servicios mercantiles, alimentos, automotriz, entre otros. According to estimates by SEMARNAT, the main RP generated is used oil with a generation of more than 5,570.00 tons, followed by solids such as cardboard, plastic, tow, filters, textiles, etc., whose estimate approximates 3,125 tons of RP.

The need to analyze the problem not only of the generation, but also of the management of RP in the Cuitzeo region was due to different reasons, the first of which was the fact that there are few economic valuation studies in the field of RP, only 24% of the analyses of waste valuation study the problem related to RP; In addition, another reason is that the Cuitzeo region is the main region that concentrates the greatest number of RP generators in the state of Michoacán; another reason is that there is no clear knowledge of the normative provisions on RP that translate into valorization and minimization actions, putting at risk and danger the natural elements of the region and the quality of life of the people who live in it. To analyze the problem, the application of the MVC was carried out with the support of a survey, which in its pilot phase was applied to thirty generators chosen at random in the region, bringing as a consequence, the viability of the instrument to be applied definitively, not before restructuring two questions that are not precise. The final survey was applied in support of stratified sampling for both generators and economic turns, under the premise that the category of generators influences the number of responsibilities that must be fulfilled according to the LGPGIR, also in consideration of the economic turn that, depending on the activity developed, will also be the types and volumes of RP generated. Of the total number of generators, 2273, 38 in the category of grades; 637 in the category of small and 1598 micros, a stratified sampling was carried out that resulted in the application of the survey for 6 large generators, 92 small and 231 micros.

In addition, the economic turnaround was stratified, obtaining that in Acuitzio a survey would be applied, in Álvaro Obregón four surveys, in Charo one survey, in Copándaro one survey, in Chucándiro none was carried out, in Cuitzeo two surveys would be carried out, in Huandácareo one, in Indaparapeo one, in Morelia, for large generators five surveys, for small eighty-seven, and for micro two hundred thirteen; in Queréndaro one, in Santa Ana Maya two; in Tarímbaro two for small generators and three for micros, and in Zinápecuaro one for small and four for micros. Resulting in 329 surveys. The survey was structured into five sections, the first referred to condition variables, where the socioeconomic characteristics of the generator were considered; in the second section, allusion was made to knowledge variables and included characteristics of RP generation; the third and fourth sections referred to compliance variables, the first to technical compliance characteristics and the second to operational compliance characteristics, and finally, the fifth section referred to knowledge and disposition variables and included the characteristics of DAP for the management of RP. The survey was applied from the period April-June 2015 obtaining that:

- The majority of people surveyed were female (63% of respondents); the average age of the respondents is 44; everyone could read and write, which facilitated the explanation of the hypothetical market; the main economic turns belonged to the health sector and the automotive, this in attention to the NRA of the respondents; the degree of studies of the respondents was the highest in the majority, only 0.5% belonging to micro generators, had no studies. The majority of the interviewees were in charge of the establishment, only 17% (in the case of large generators), 5% in the case of small generators and 22% in the case of micro generators, were owners of the establishment. The monthly income of the company is less than an average of $50,000, while what they use from that income to manage the RP does not exceed $1,000 per month. For their part, the income of those surveyed is mostly between $5,000 to $10,000 pesos per month. With regard to housing, it was noted that the majority is private and the medical care service is provided by the IMSS.

- Regarding the characteristics of RP generation, it was observed that those surveyed know what a waste is and what a RP can be; however, they do not distinguish their difference, which leads them to fall into the vice of handling them in the same way, a fact that was verified due to the fact that micro generators mainly handle RP as RSU.

- Few of the respondents know the volume of RP they generate, either they do not know which RP they generate or they do not know how many they actually generate, because at the time the survey was conducted, they stated that they generated only some type of RP and it was observable that they generated more RP. With respect to hazard characteristics, respondents stated that their RP are generally toxic, flammable and biological. They know that the management of their RP can contaminate water and damage their health, but they are unaware of the obligations they must fulfill to guarantee such a circumstance. Unlike the SEMARNAT estimates, the result was that the main RP generated is made up of solid RP (filters and textiles), followed by used oil and BIPRs mainly generated in micro-generating establishments, but which are not reported.

- With respect to sections III and IV, it is observed that, first of all, the large RP generators comply in a greater percentage with the legal provisions, and affirm that the service providers of the management of their RP do not have the authorizations from the SEMARNAT and the SCT; on the other hand, the small generators comply with and have NRA, categorization, RP registration logs, manifestos, and know that the service providers of the management of their RP do have the respective authorizations. The micro generators show a considerable degree of ignorance and non-compliance with the legislation on waste, only it is observed that most have NRA, ignoring and non-compliance with the rest of the provisions. In addition, it can be seen that most of the three types of generators have a temporary RP storage, with respect to the storage time of the waste, it is observed that the large and micro store them for less than six months, while the majority of the small ones store their RP for more than six months, which makes them worthy of a sanction, according to the Regulation of the LGPGIR. In contrast to the above, on the roof of the warehouse, it is the small ones that show the majority of the warehouse is roofed, while the large and micros surveyed who do not have a roofed warehouse can be sanctioned by the authority. Another of the obligations is to have a fire extinguisher, it can be seen that the large and small do comply in their majority, while the micros only 28% of those surveyed say they have a fire extinguisher.

- With respect to the identification, labelling and separation of RP, it is observed that most of the generators that comply are the small generators, while the large ones show that most do not label the containers with the CRETIB characteristics, in addition to not separating their RP adequately and not placing hazard signs from the protected RP in the temporary warehouse; In these same conditions are the buses, which also about 53% do not label the RP they generate and 88% of those surveyed state that they do not have signs alluding to the dangerousness of the RP generated and stored in the warehouse. This puts health and the environment at risk because it is unknown which wastes are protected, whether they are corrosive, reactive, explosive, toxic, inflammable or biological-infectious; in addition, they have been fined by PROFEPA.

- The results show that the majority of the large and micros surveyed do not have gutters, retaining walls and retention pits to minimize the risks in the management of RP, highlighting that more than 88% of the micro generators do not comply in this sense with the LGPGIR, its regulations and other applicable provisions and an average of 72% of the large generators have this type of irregularities. On the other hand, small generators show that an average of 59% comply with the applicable legal provisions.

- The results show that more than 50% of the large and small generators have contracted to provide the service of collection, transport, storage and final disposal of the RP they generate, while micro generators have contracted only 33%. However, in the survey they were asked if they knew of the next phase of management of the RP that they delivered to the service providers, with an average of 79% responding that they did not know and were aware of this phase, i.e., they do not know what is done with the RP that collect them in violation of the responsibility established in article 42 of the LGPGIR, which indicates the responsibility of knowing the next phase of management of the RP when they are available through service providers.

- In addition to the foregoing, it is observed that, on average, 42% of those surveyed state that their RP warehouse is close to common areas, which contradicts the provisions of article 82, section I of the LGPGIR Regulation which provides that the warehouse must be separated from the production areas, services, offices and storage of raw materials or finished products; this puts the environment and society at risk due to the possibility of damage.

- In the case of the storage of the RPBI, the results show that the large generator surveyed belonging to the health sector does not comply with this provision, because it exceeds its storage for 7 days, stating that it stores the RPBI for more than 15 days. There are medical units considered to be small generators, but which are at level III, so that, from the turns surveyed, it can be deduced that four of the eight surveyed do not comply with this regulation. Regarding RPBI's micro-generating establishments, 22 veterinarians were surveyed; a tattoo center; 33 analysis laboratories and blood bank; 12 x-ray laboratories; 8 hospitals; 13 pharmacies; 1 poultry breeding and sale center; 63 consultories and 13 clinics or health centers; observing that, of all of them, hospitals could be considered within level II that indicates the and that according to the answers, 99% keep their RPBI for more than 15 days, only 1% store them for less than 15 days.

- For cases where there is no temporary RP storage, respondents openly stated that 54% store them in rubbish containers and dispose of them in the same way; 14% in plastic containers; 13% in cardboard boxes; 6% in metal containers; 4% in the open; 3% in sewers and 1% in bins

- With respect to the last section, it can be seen that the large generators know the technical and operational obligations, have been sanctioned by PROFEPA, have paid for administrative formalities, for legal attention and conditioning of the warehouse; they also pay for the disposition of their PS and are DAP for pending administrative formalities.

On the other hand, the micros show an average of 28.75% knowledge of the law, of their obligations and of what they have paid and are DAP; a situation that evidences the need to attend to this sector considered as a micro, because they do not comply with the regulations and put society and the environment at risk.

– The results obtained show that the average MHP for large generators does not exceed $30,000 (in Mexican currency), the average small generators have paid $4,000 and the micros have paid less than $200.00. It is also observed that, for the management of the management plan, legal advice, fines and warehouse, more has been paid than for the NRA, category, logbook and COA (this only applies to large generators).

With respect to the DAP, it is observed that, on average, the large generators are DAP $16,350.66, the small $6,851.93 and the micros $2,531.65; the large and small generators are DAP more for legal advice (>$6,000 and >$2,000, respectively); while the micros are DAP more for the conditioning of the temporary warehouse of RP (>$500); with respect to the fines, it is observed that the large generators on average have paid close to $30,000. It is observed that the micro generators are not DAP by categorization, logbook, signs alluding to the dangerousness of the RP sheltered in the warehouse and COA, however, there are DAP amounts that do not exceed $250.00 per management; the small generators invest more in the conditioning of the warehouse and for their part the large generators are DAP more in advice, COA, management plan, containers of RP and extinguisher.

– Finally, it is observed that large generators pay more for the disposal of used batteries, plastic and metal containers, tow, filters, antifreeze and contaminated grease; small generators pay more for the disposal of used filters, tow and contaminated cardboard; and micro generators pay more for filters, medicines and used tires. The three categories coincide in paying less than $0.50 per litre of used oil, RP which is most frequently generated in the region.

Regarding the DAP, it is observed that the large generators are DAP more than $3.00 for used batteries, more than $2.50 for filters, tow and antifreeze; more than $1.50 for plastic containers, contaminated greases, textiles, plastics, sludge and contaminated cardboard; the small ones are DAP more for used filters (more than $2.00 per kg); up to $2.00 for tow, $1.50 for contaminated cartons and less than $1.00 for textiles, plastic, sludge, batteries, ballasts, metal containers, grease and contaminated soil. The micro ones are DAP more per kilo or liter of RPBI of the category not anatomical and sharp, in addition they manifest their DAP more by the disposition of used oil, near $1.00 per liter.

– Within what they are willing to carry out actions to adequately manage their RP, it is observed that 41% are willing to condition the RP warehouse with the provisions of Article 82 of the LGPGIR Regulations; 6% are DAP for legal and administrative advice; 0.20% intend to adjust to government programs on waste; 1% will be advised, 10% require training; 0.20% will analyze the legislation; 8% will elaborate or apply a RP management plan; 2% will request fiscal incentives for complying with the management of their RP, 6% will request courses; 0.20% will seek certification as a clean industry before PROFEPA; 0.20% will carry out a chemical analysis to determine the dangerousness of the RP; 17% will contract the provision of services for the collection and management of RP; 1% require an environmental evaluation and compliance diagnosis and 7% will do nothing to improve or change their management conditions according to the Law.

– With respect to the survey applied to people around the RP generators, it is observed that the age of those surveyed ranges from 15 to 82 years old, the majority were women, representing 54%, with respect to education, 36% have a higher education level, while 35% have a higher secondary education, 17% basic education, 9% have a truncated education and 3% have no education at all; 50% are employees, with their own home that has all the services and their medical care is provided mostly by the IMSS. The environmental problem they perceive to be of most concern is water scarcity with 63% and RP pollution with 21%.

The causes that contribute to the contamination of water and soil show that they are primarily garbage and the spillage of waste, most do not know what a RP is and the existence of establishments close to them that generate RP. Of those surveyed who locate the RP generators, 40% say that they are no more than 50 meters away from their home, with the health sector being the main economic turn they observe generating RP, as well as the automotive sector. The majority state that they do not obtain any benefit from the service provided by the generator; however, the majority consider the management of the generator's RP to be good.

- It is observable that the majority of those surveyed say they know that a RP can damage and contaminate water, soil, fauna and flora and their health, however, the vast majority do not consider this to be harmful to their health, even though they have observed contamination of soils, water, spills, fires, damage to the respiratory tract and to the landscape. Regarding the knowledge of how RP are stored, the majority do not know the storage conditions, therefore most of them state that they ask the generator to comply with the normative dispositions referring to the RP; in addition, regarding the DAP more than 90% would not pay for the handling of the RP of the generators, however, the majority would like to be compensated. However, it is necessary to know other statistical values in a descriptive manner, such as the mean, error, median, fashion, standard deviation, variance, kurtosis, major and minor ranges, and confidence level.

- The impacts that can have an impact on development are of four categories: the first, regarding water and soil contamination, mainly; the second, regarding the economic approach, the RP management represents a cost that in the first instance is covered by the generator, when carrying out technical managements such as the NRA, the categorization, the COA, the management plan, the logbook, the environmental insurance, the contracting of providers of the service of collection, transport, collection and final disposal of the RP; Also, it represents a cost when having to condition the RP warehouse according to the specifications established by the LGPGIR Regulations; to this is added the economic cost in case of administrative procedures that require legal attention and to cover economic fines fined by PROFEPA. The social cost, not so perceived by the people surrounding the RP generators, represents an existing circumstance due to the costs of soil remediation by the authority (SEMARNAT) and the cleaning of wastewater, in which liquid RP are deposited such as solvents and used oil.

- In addition, the non-quantifiable risk of people handling RSU, generally mixed with RP. Finally, the institutional impact represents a reason for regulating the management of RP, through the reform of the LGPGIR with respect to the obligations of generators, the establishment of mechanisms for valorization and minimization, and the obligatory reporting of how the RP generated are managed; this with the simultaneous application of public environmental policies on waste involving all sectors, through the principle of shared but differentiated responsibility, making feasible the implementation of a National Program for the Management of RP. This allows demonstrating the hypothesis proposed, in the sense that in order to achieve an environmentally adequate management of the RP, the level of knowledge of the obligations established by the LGPGIR is considered, because it stipulates the technical and operative managements necessary to guarantee that the management of RP does not cause effects to the environment and society; in addition, the socioeconomic conditions of the generator determine the level of compliance with said law and make the adequate management of the RP possible.

With respect to the DAP, applying the RL LOGIT, it can be appreciated that of the three categories of generators, the large and the micro would be DAP more as long as the socioeconomic conditions, the knowledge of the types, volumes and impacts of the RP to the environment and society, the fulfillment of the technical and operational obligations, as well as the knowledge of the law do not improve, while the small ones show increase in the DAP for management and disposition of RP if the economic conditions increase, the fulfillment of the technical dispositions and the knowledge of the law. This allows us to assume that of the groups that have a higher index of generators and a higher index of RP generated, strategies can be applied to improve their level of compliance, knowledge and DAP for an environmentally adequate management of the RP they generate. In this way, it is possible to avoid incurring in the figure of the RA and therefore being sanctioned by the coercive authorities.

Recommendations

The analysis of the RP management in the Cuitzeo region allowed an approach with the RP generating sources, knowing their perspectives of the effectiveness of the managements and legal application, as well as the costs that represent for them to carry out an adequate management of the RP generate, in addition, with the complementary application of the survey to the people next to the generators, it has been possible to verify that they do not perceive the social cost of the inadequate management of the residues, in spite of the fact that they know the possible damages to the environment and society; Therefore, it is elementary to carry out actions not only to value and minimize RP, but also to raise awareness and educate in this matter that involves all related sectors in a participatory and responsible manner; the proposals are the following:

- Courses, forums and workshops on participation in hazardous waste management, with the objective of making known the normative bases that establish the technical and operative obligations of RP management for generators, service providers, the authorities responsible for its control (SEMARNAT) and surveillance (PROFEPA) and society as an agent of social participation. In the first instance, this has been requested by those surveyed and by the business organizations that have supported the investigation, aware of the legal vices that hinder the Constitutional effectiveness of guaranteeing a healthy environment for development and well-being.

- Elaboration and application of a transversal Plan for the management of hazardous wastes that starts from a diagnosis of the generation and forms of waste management and proposes feasible solutions according to the economic, environmental, social, political and technological conditions of Michoacán. This is in accordance with the principle of concurrence in the participation of the control and surveillance of RP management with the federation and municipality. The transversal RP management plan will make it possible to know the way in which the residues of all generators are managed, which must be constantly updated.

- Creation of a Network of sectors in the management of RP that functions as an autonomous body to business and government institutions that offers precise guidance in the management of RP, providing specialized legal advice, constant training on reforms, derogations, abrogations or legal initiatives in the metería, execution services in the construction of temporary RP warehouses, in addition to serving as a means of contacting providers of waste collection, transport, collection and final disposal services who have the necessary authorisations to carry out their activity and who, by means of an established contract, offer their service to the micro-generators of RP by means of payment per litre/kilo of RP. Another purpose of the network is to ensure the updating and implementation of the cross-cutting RP management plan.

- Elaboration of a georeferencing map of the RP generators in the state of Michoacán, which will not only allow each generator to be located, but will also effectively attend any contingency or accident related to RP, taking into consideration the environmental and social characteristics of the site.

- Legal reforms to the LGPGIR that incorporates the obligatory nature of all RP generators to report on the management given to the RP generated, either through the waste management plan, the waste log, COA, or updating the NRA.

References

ABARCA, A. B., y Díaz, D. (2005). El bienestar social: su concepto y medición. Psicothema, 17(4), 582 589.

ACHKAR, Marcel; CantonV.; Cayssials, R., Domínguez, A., Fernández, G. y F. Pesce, (2005) Indicadores de Sustentabilidad. Laboratorio de Desarrollo Sustentable y Gestión Ambiental del TerritorioDepartamento de Geografía. Facultad de Ciencias. UdelaR En: Ordenamiento Ambiental del Territorio. Comisión Sectorial de Educación Permanente. DIRAC, Facultad de Ciencias. Montevideo. Pp. 104.

AGNEW, J. Livingstone, D. y Rogers A. (Eds.) (1997) Human Geography: An Essential Anthology, Oxford y Massachusetts, Blackwell publishers.

AGÜERO, A.A.; Carral, M.; Sauad, J.J. y L.L Yazlle (2005). Aplicación del método de valoración contingente en la evaluación del sistema de gestión de residuos sólidos domiciliarios en la ciudad de Salta, argentina. Revista Iberoamericana de Economía Ecológica 2, 37-44.

AGUILERA, Klink, F. (1992). La preocupación por el medio ambiente en el pensamiento económico actual. Información Comercial Española, (711), 31-41.

AGUILERA, Klink Federico y Alcántara Vicent (comp.) (1994) De la economía ambiental a la economía ecológica, Barcelona: ICARIA: FUHEM, 1994, 408. Pp. 21.

AJATA, Arghata Claudia (2008). Aplicación del método de valoración contingente por la disponibilidad a pagar en el servicio de aseo urbano en la localidad de Huanuni del departamento de Oruro. Universidad Técnica de Oruro, Facultad De Ciencias Económicas, Financieras Y Administrativas. Bolivia.

ALBERINI Annay Frost Shelby (2007). Forcing Firms to Think About the Future: Economic Incentives and the Fate of Hazardous Waste. Environmental and Resource Economics (2007) 36,451–474.

ALCALÁ, Valdivia Ramón; Abelino Torres Gonzalo; López Santiago Marco A y Zavala Pineda María J. (2012) Valoración económica del reciclaje de desechos urbanos. Rev. Chapingo vol.18 no.3 Chapingo agosto-diciembre 2012 http://dx.doi.org/10.5154/r.rchscfa.2010.07.044.

ALCARAZ, Vera Jorge Víctor (2015), Comentario personal emitido el 27 de febrero del 2015.

ALFIE, Cohe Miriam (1994). Violencia Ecológica vs. Desarrollo Sustentable. Revista Violencia y derechos humanos. UAM. Pp. 63

ALIER, Martínez Joan (2000). Ecología Política, cuaderno de debate internacional. Editorial Icaria, Barcelona. 2000.

ALMANSA C. y Calatrava J. (2001) Aplicación del método de valoración contingente a la valoración económica de las externalidades generadas en los proyectos de restauración hidrológica forestal. Departamento de Economía y Sociología Agrarias de la Junta de Andalucía. Centro de Investigación y Desarrollo Agrario. Camino de Purchil s/n 18.080 (Granada). Tel: 958/ 267311 y fax: 958/ 258510.

ALMANSA Sáez, M.C.; (2001). Valoración económica del impacto ambiental en el contexto del análisis coste-benteficio: aplicación al proyecto de restauración hidrológico forestal de Lubrín (Almería). Universidad de Córdoba.

ALMANSA Sáez, M.C. y Calatrava Requena, J; (2001). El problema del descuento de beneficios y costes ambientales en el análisis coste-beneficio: consideraciones sobre alternativas metodológicas. Comunicación presentada al IV Congreso de Economía Aplicada, 7-9 junio, Reus (Tarragona)

ALPA, G., Compendio del Nuovo Diritto Privato, UTET, Torino, 1985, Pp. 409.

AMBIENTAL MICHOACANA, recolectora de residuos peligrosos, 2009.

ANGLÉS Hernández, Marisol, (2009). Sustancias Peligrosas, Riesgo y Salud en México, Marco Normativo. Pp. 28.

ANTÚNEZ, Sánchez Alcides Francisco (2011). Generalidades históricas de contemporaneidad en la dimensión social – Valorativa y jurídica del medio ambiente. Una apreciación en la primera década del siglo XXI de la problemática ambiental. Nómadas. Revista Crítica de Ciencias Sociales y Jurídicas. Núm. Especial: América Latina (2011). http://dx.doi.org/10.5209/rev_NOMA.2011. Pp. 379.

ARROW, K. J. (1950). A Difficulty in the Concept of Social Welfare, Journal of Political Economy, 58 (4), 328-346.

AYRES, R. U., Kneese, A. V., y d'Arge, R. C. (1970). Aspects of Environmental Economics. A Materials Balance-General Equilibrium Approach.

ÁVALOS, Rodríguez María Liliana (2011) Tesis de grado de maestría: Falta de certeza jurídica en el control de residuos peligrosos de pequeños generadores en México. CIDEM.

ÁVILA, H. (Comp.) (1993). Lecturas de análisis regional en México y América Latina. Ciudad de México, Universidad Autónoma de Chapingo.

AZQUETA Oyarzun, A.; (1996). Valoración económica de la calidad ambiental. McGraw Hill. Madrid. Pp. 299.

AZUELA, Antonio y Cancino Miguel Ángel (2007). Los Asentamientos Humanos y la Mirada Parcial del Constitucionalismo Mexicano, en el libro La Constitución y el Medio Ambiente. Instituto de Investigaciones Jurídicas. UNAM, 2007.

BARRAZA, M. A. 2014. Posicionamientos epistemológicos desde una perspectiva doctoral. Universidad Pedagógica de Durango.

BASTÍAN Celis Huaiquila F. (2009) Contaminación de aguas subterráneas por hidrocarburos líquidos livianos en fase no acuosa. Departamento de Ingeniería Civil, Facultad de Ingeniería, Universidad de Concepción, Edmundo Larenas 215, Barrio Universitario, Concepción (bcelis@udec.cl). Ciencia Ahora, nº 22, año 11, septiembre 2009.

BASSOLS Batalla, A. (1993). Geografía y subdesarrollo: México y el mundo (No. 910.72 B3 1993).

BASURTO, González, Daniel (2015) La nueva Ley de Responsabilidad Ambiental. Tercera Cumbre Internacional de Procuradores y Fiscales Ambientales: propuestas para fortalecer la justicia y gestión ambiental en Iberoamérica. Universidad Autónoma de México, noviembre 4 del 2015.

BAUTISTA, L. E. D. (2011). Reflexiones sobre la medición del progreso y bienestar. Realidad, Datos Y Espacio Revista Internacional De Estadística Y Geografía, 4.

BERGSON, A. (1938). A Reformulation of Certain Aspects of Welfare Economics, Quarterly Journal of Economics, 52: 310-334.

BLACK y Champion, 1976; Saris y Gallhofer, 2007 en Hernández, R. (2010). Metodología de la Investigación, Quinta Edición. McGRAW-Hill Interamericana.

BOISIER, Sergio (2001). Biorregionalismo: la última versión del traje del emperador, Territorios 5, Bogotá, CIDER, Universidad de los Andes. Territorios, (5), 115-142.

BOISIER Sergio (1999). Desarrollo (local): ¿De qué estamos hablando? Santiago de Chile.

BORJA, Soriano, B., y Soriano, M. M. B. (1953). Teoría general de las obligaciones. Pp. 240.

BOUDVILLE, S. R. (1996). Problems of regional economic, Edimburgo, 1996) citado en Salguero Cubides JORGE, Y COLABORADORES. ENFOQUES SOBRE ALGUNAS TEORÍAS REFERENTES AL DESARROLLO REGIONAL. Pp. 14 Y 15.

BOULDING, K. (1966). The economics of spaceship earth. Recuperado el 15 de octubre de 2011, de: http://dieoff.org/page160.htm

BOYLE, Kevin J. y Richard C. Bishop (1987). Valuing wildlife in benefit-cost analyses: a case study involving endangered species. Water Resources Research vol. 23, no.5: 943-950.

BOYLE, K. J., Bishop, R. C., y Welsh, M. P. (1985). Starting point bias in contingent valuation bidding games. Land economics, 61(2), 188-194.

BRACE, Ian (2002) Questionnaire Design: How to Plan, Structure and Write Survey Material for effective market research. Second edition.

BRIONES, Guillermo (2002). Metodología de la investigación cuantitativa en las ciencias sociales. Arfo Editores, composición electrónica.

BRISEÑO, Ruíz José, Álvarez de Flores Raquel (2006) Modelos de desarrollo y estrategias de integración en América Latina: una revisión crítica, Cuadernos sobre relaciones internacionales, regionalismo y desarrollo. 1 (1), 63-88.

BROCKSTAEL, N. E., McConell, K. E. y Strand, I. E. (1988) Benefits from Improvements in Chesapeake Bay Water Quality. Prepared for U.S. Environmental Protection Agency under contract Nº CR-81-811043-01-0.

BROWN Weiss, Edith (1989). En imparcialidad con las generaciones futuras: Derecho Internacional, Patrimonio Común y Equidad entre Generaciones. United Nations University, Tokio, Japan.

BUENAÑO, Gilberto (2013) Valoración del Ambiente: Reto Actual de la Economía. Centro de Estudios Integrales del Ambiente de la Universidad central de Venezuela. Consultado el 03 de julio del 2014.

BUENROSTRO Otoniel e Israde Isabel (2003) La gestión de los residuos sólidos municipales en la cuenca del lago de Cuitzeo, México. Rev. Internacional de Contaminación Ambiental 19 (4). Pp.161-169, 2003.

BUENROSTRO, Delgado Otoniel; Ojeda Benítez Sara y Márquez Benavides Liliana (2007). Comparative analysis of hazardous household waste in two Mexican regions. Waste Management 27, 792–801.

BUNGE, Mario (1985), Economía y Filosofía. Madrid, Tecnos. Pp. 123.

BURNSIDE, C., (1996). Production function regressions, returns to scale, and externalities. Journal of Monetary Economics Pp. 37, 177-201.

CANACINTRA. Cámara Nacional de la Industria de Transformación, Delegación Morelia, 2009-2011.

CANCHARI Silverio Godelia y Ortiz Sanchez Oswaldo (2007). Valorización de los residuos sólidos en la ciudad universitaria de la Universidad Nacional Mayor de San Marcos. Revista del Instituto de Investigaciones FIGMMG. Cardona, M., D. F., González R., J. L., Rivera L., M., y Cárdenas V., E. (2013). Inferencia estadística-Módulo de regresión lineal simple. Bogotá: Editorial Universidad del Rosario.21, 95-99.

CAPEL, H. (1981) Filosofía y Ciencia en la geografía contemporánea: una introducción a la geografía. Barcelona, Barca nova. Temas universitarios.

CÁRDENAS, M. (2004). Industria Minera de los Materiales de Construcción: su sustentabilidad en América del Sur. CEPAL, Seie E: Recursos naturales e infraestructura, número 76 , 8-46.

CARDONA Madariaga, D. F., González Rodríguez, J. L., Rivera Lozano, M., y Cárdenas Vallejo, E. (2013). Inferencia estadística-Módulo de regresión lineal simple.

CARMONA, M. D. C. (2016). La responsabilidad ambiental y el principio de quien contamina, paga. En CARMONA Lara, María del Carmen (1998). Notas para el análisis de la responsabilidad ambiental y el principio de quien contamina paga a la luz del derecho mexicano, en Responsabilidad jurídica en el daño ambiental, Instituto de Investigaciones Jurídicas, UNAM, México, 1998, Pp. 55.

CARSON, Rachel (1962). Silent Spring, Boston: Houghton Mifflin.

CARSON, Richard T. y Robert C. Mitchell (1993). The value of clean water: the public's willingness to pay for boatable, fishable, and swimmable quality water. Water Resources Research vol. 29, no. 7: 2445-2454.

CARRASCO David, Alan F. (2004). Sistemática para el desarrollo económico local. Ponencia presentada en el Encuentro Internacional Virtual de la Universidad de Málaga organizado por el grupo eumed.net Desarrollo local en un mundo global. Málaga, España.

CARRIZALES Leticia, Batres Lilia, Ortiz de María, Mejía Jesús, Yáñez Leticia (1999). Efectos en salud asociados con la exposición de residuos peligrosos. Universidad Autónoma de San Luis Potosí. Pp. 13-17.

CASTÁN Tobeñas, Vid (1982) Derecho Civil Español, común y foral, 13ª. Ed., T. I, Vol. 2°., Madrid, Ed. Reus, 1982, Pp. 89.

CASTILLO, Ponce Ramón A., Camargo Negrete Gustavo y María de Lourdes Rodríguez Espinosa (2013) La disposición de residuos peligrosos en la frontera norte de México: El caso de Baja California. Estudios Fronterizos, nueva época 14 (27), 9-29.

CASTORIADIS, Cornelius. (1980). Reflexiones sobre el desarrollo y la racionalidad, en el mito del desarrollo. Kairós. Pp. 212.

CCA, A. C. (2004). Residuos y contaminación Industriales. CCA: CCA.

CEC.ORG. (2010). Residuos y contaminación industriales. El mosaico de América del Norte: panorama de los problemas ambientales más relevantes. Comisión para la Cooperación Ambiental. 2010.

CEPAL (1989). Estudios e Informes de la CEPAL. El Medio Ambiente como Factor de Desarrollo. Naciones Unidas, Santiago de Chile.

CEPAL (1990). El Desarrollo Sustentable: Transformación Productiva, Equidad y Medio Ambiente. Pp. 28-40.

CEPAL. (1993). Sustancias y desechos peligrosos: impacto del movimiento transfronterizo hacia la región de América Latina y el Caribe y posibles acciones preventivas y de control. CEPAL: CEPAL.

CEPAL/GTZ. (1997). Gestión Ambientalmente adecuada de residuos sólidos: un enfoque de política integral. CEPAL-GTZ ,

CEPAL/GTZ. (2008) Guía para decisores análisis económico de externalidades ambientales. Unidas, Santiago de Chile, 2008.

CERDA Arcadio; García Leidy; Bahamondez Alejandra y Viviana Poblete (2010). Disposición a pagar para mejorar la calidad del aire en Talca, Chile: comparación entre usuarios y no usuarios de chimeneas a leña. Red de Revistas Científicas de América Latina, el Caribe, España y Portugal Sistema de Información Científica 72, 195.

CFPC. Código Federal de Procedimientos Civiles. Publicado en el Diario Oficial de la Federación el 09 de abril del 2012.

CHO, S., Kim, J., Park, H. C., y Heo, E. (2015). Incentives for waste cooking oil collection in South Korea: a contingent valuation approach. Resources, Conservation and Recycling 99, 63-71.

CHORLEY, J. y Haggett P. (1969) Integrated Models in Geography, Worcester and London, Methuen.

CLAWSON, Marion and Jack L. Knetsch (1966). Economics of Outdoor Recreation. Washington, D.C.: Resources for the Future.

COASE Ronald. H. (1960). The problem of Social Cost. Journal of law and economics, Vol. 3 (oct., 1960). Pp. 1-44. Published by: The University of Chicago Press. http://www.jstor.org/stable/724810.

COMERCIO EXTERIOR, vol. 42, número 3. México, marzo de 1992, Pp. 207-216.

CONABIO. Contaminación y lagos salinos, 2005.

Conferencia de Río sobre Medio Ambiente y Desarrollo (1992).

Convenio de Basilea sobre el Control de los Movimientos Transfronterizos de Desechos Peligrosos y su Disposición (1989).

Convenio de Estocolmo sobre contaminantes orgánicos persistentes (2001)

Convenio de Róterdam (1980)

CORAGGIO, José Luís (1974). Hacia una revisión de la teoría de los polos de desarrollo, en Planificación regional y urbana en América Latina, ILPES/Siglo XXI editores, México. Pp. 46.

CORTINAS, de Nava Cristina (1997). Residuos peligrosos en el Mundo y México. SEMARNAT-INE-SEDESOL, Pp. 9, 10, 15 y 16.

CORTINAS, de Nava Cristina y Mosler, C. (2000). Programa Universitario de Medio Ambiente-UNAM, 2000, Pp. 379-403.

CORTINAS, de Nava Cristina (2005). Desarrollo urbano, residuos y Contaminación, SEMARNAT, Pp. 6

CORTINAS, de Nava Cristina (2005). Implicaciones de la regulación de los residuos peligrosos, SEMARNAT. Pp. 3.

CORTINAS, de Nava Cristina (2006). Carácter ambiental de las leyes. SEMARNAT, 2006. Pp. 5.

CORTINAS, de Nava Cristina (2006). Marco Lógico para Determinar los Aspectos a Cubrir en la Legislación de los Residuos, 2006, Pp. 3, 5, 7 y 17. México.

CORTINAS, de Nava Cristina (2006). Casos exitosos de minimización de residuos, SEMARNAT, 2006, Pp. 10.

CORTINAS, de Nava, Cristina (2006) Bases para legislar la Prevención y Gestión Integral de Residuos. SEMARNAT, primera edición 2006, http://www.semarnat.gob.mx. Pp. 6, 7, 20, 21.

CORTINAS, de Nava, Cristina (2010). Regulación de los residuos peligrosos en México, SEMARNAT, primera edición 2010. Pp. 30.

CORTINAS, de Nava Cristina (2013) Indicadores de la Gestión Integral de Residuos. INECC-SEMARNAT.

COSSER, Lewis A. y Rozenberg, Bernard (1994). Sociological Theory: A Book of Readings, Waveland Press. N. Y.

COURT, A. T. (1939). Hedonic Price Indexes with Automotive Examples. The Dynamics of Automobile Demand, New York: General Motors Corp, Pp. 99-117.

COUTOA Nuno; Valter Silva, E. Monteirob, A. Rouboaa (2013). Hazardous waste management in Portugal: An overview. Energy Procedia 36 (2013) 607 – 611.

CPEUM. Constitución Política de los Estados Unidos Mexicanos, publicada en el Diario Oficial de la Federación el día 05 de febrero de 1917.

CRONIN, F. J. (1982). The household's decision to accept or reject a conditional transfer offer. Southern Economic Journal 49, 1, 218-234.

Cumbre de Johannesburgo sobre Desarrollo Sostenible (2002)

CUMMINGS, R. G., Brookshire, D. S., y Schulze, W. D. (1986). Valuing Public Goods: An Assessment of the Contingent Valuation Method. Totowa, NJ: Rowman and Allenheld.

DA COSTA, P. (1998) El concepto de región y su discusión, en Uribe G. (Comp). Cuadernos de geografía brasileña. Centro de Investigación Científica "Ing. Jorge L. Tamayo". Ciudad de México, Pp. 47-67.

DALY, Hernan E. (2002). Desarrollo Sustentable, School of Public Affairs University of Maryland.

DAMIGOS, D., Menegaki, M., y Kaliampakos, D. (2016). Monetizing the social benefits of landfill mining: Evidence from a Contingent Valuation survey in a rural area in Greece. Waste Management, 51. Pp. 119-129.

DANKHE, G. L. (1976). Investigación y Comunicación, en C. Fernández-Collado y G. L. Dankhen (Eds.). La comunicación humana: Ciencia social. México, D. F. Mc Graw-Hill de México. 51, 385-454.

DAVIS, R. (1963). The Value of Outdoor Recreation: An Economic Study of the Maine Woods, PhD thesis, Harvard University.

DEATONA, B. James y P. Hoehn John (2004). Hedonic analysis of hazardous waste sites in the presence of other urban disamenities. www.elsevier.com/locate/envsci Environmental Science y Policy 7 (2004) 499–508.

DELACÁMARA, Gonzalo (2008). Guía para decisores: Análisis económico de externalidades ambientales. Comisión Económica para América Latina y el Caribe (CEPAL). Desarrollado en el contexto del Programa de Cooperación entre el Ministerio Federal de Cooperación Económica y Desarrollo de Alemania (BMZ), a través de su agencia de cooperación Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) y la CEPAL, llamado Modernización del Estado, desarrollo productivo y uso sostenible de recursos naturales, GER/05/001.

DE LA FUENTE Fernández, S. (2011). Regresión Logística. España: Facultad de Ciencias Económicas y Empresariales, UNAM-Universidad Autónoma de Madrid. Disponible en http://www.estadistica.net/ECONOMETRIA/CUALITATIVAS/LOGISTICA/regresion-logistica.pdf Accesado: 21/01/17.

DE LA PARRA, Rentería Carlos A.; Rodríguez Lepure Ana L. y Pacheco Pedraza Alberto (2010). Disposición a pagar por el servicio de limpia en la Ciudad de Tijuana. Diagnóstico de los residuos sólidos urbanos en Tijuana, Baja California. D.R. © 2010, El Colegio de la Frontera Norte Carretera escénica Tijuana-Ensenada, km. 18.5 San Antonio del Mar.

DE LA TORRE, R. (2009). La medición del bienestar y el progreso social. Realidad, Datos Y Espacio Revista Internacional De Estadística Y Geografía, 18.

DEL ORO, C., Rodríguez, R., Riobóo, J., (2000). Estimación de la curva de Engel: Un enfoque no paramético y su aplicación al caso gallego. Estudios de Economía Aplicada Pp.16, 37-61.

DIAMOND, Peter A. y Jerry A. Hausman (1994). Contingent valuation: is some number better than no number. Journal of Economic Perspectives vol. 8(4): 45-64.

DÍAZ, López Mario Alberto (2004) Desarrollo Sustentable: pasado, presente y futuro. Facultad de Ingeniería y Arquitectura-UR. Ingenierías, octubre-diciembre 2004. Vol. 7 (25),17-23.

DIAZ Martín, Rodrigo (2015) Responsabilidad ambiental, consultado en http://xlcatlin.com/fast-fastforward/articles/la-ley-mejicana-de-responsabilidad-medioambiental en julio del 2016.

Diccionario de la Real Academia Española, 22ª edición, Madrid, Espasa-Calpe, 2001, Pp. 1164 y 1340

D.O.F. Diario Oficial de la Federación (2004) Regionalización para la planeación y desarrollo efectuada y publicada el día 15 de julio del 2004, por parte del gobierno del Estado de Michoacán de Ocampo.

D.O.F. Diario Oficial de la Federación (2012). Decreto por el que se declara reformado el párrafo quinto y se adiciona un párrafo sexto recorriéndose en su orden los subsecuentes, al artículo 4o. de la Constitución Política de los Estados Unidos Mexicanos. Publicado el 8 de febrero del 2012.

DOLLFUS, Olivier (1976). Espacio geográfico, México: Ediciones geográficas. George Pierre, Barcelona, citado Giménez, Gilberto, Apuntes para una Teoría de la Región y de la identidad regional, 1994, Pp. 165.

EBERLE w. David y F. Gregory Hayden (1991) Crítica de la valoración contingente y del coste del viaje como métodos para la evaluación de los recursos naturales y los ecosistemas. En el libro de la Economía Ambiental a la Economía Ecológica de Federico Aguilera Klink y Vicent Alcántara (Comp.). Barcelona: ICARIA: FUHEM, 1994.

ESTRATEGIA REGIONAL DEL GOBIERNO DE MICHOACÁN, ENFOQUE ESTRATÉGICO PARA LA GESTIÓN DE LAS SUSTANCIAS QUÍMICAS A NIVEL INTERNACIONAL, 2005. Estrategia regional del gobierno del Estado de Michoacán, Desarrollo regional para la región III Cuitzeo, 2005, Pp. 16 y 24

ESCOBAR, Ninel (2007) ¿Qué determina la imposición de multas?: Evidencia del Programa Federal de Inspección Industrial en la ciudad de México. Instituto Nacional de Ecología. Gaceta de Economía Año 16, Número Especial, Tomo I.

ESQUEDA Walle Ramiro (2015): Análisis espacial del desarrollo a nivel municipal, Revista OIDLES, n. 18 (diciembre 2015). En línea: http://www.eumed.net/rev/oidles/19/tamaulipas.html

FERNÁNDEZ, Roberto (2000). Gestión Ambiental de Ciudades: teoría crítica y aportes metodologicos, 1° edición, PNUMA. 2000.

FERREIRA, S., y Marques, R. C. (2015). Contingent valuation method applied to waste management. Resources, Conservation and Recycling. 99, 111-117.

FIELD, Barry. Economía Ambiental, una introducción. Mc Graw-Hill. Colombia. 1995.

FIERRO Ochoa, Aurora, Armijo de Vega Carolina, Buenrostro Delgado, Otoniel y Valdez Salas Benjamín (2010) Análisis de la generación de residuos sólidos en supermercados de la ciudad de Mexicali, México. Revista Internacional de Contaminación Ambiental. 26 (4), 291-297.

FISCHER W. David (1970). Sobre los problemas de medición de los beneficios y los costes ambientales. Social Science en information 13(2) Pp. 95-105. En el Libro de la Economía Ambiental a la Economía Ecológica, 1994.

FMI. Fondo Monetario Internacional. Memorándum enviado el 12 de diciembre de 1991.

FOLADORI Guillermo y Naína Pierri (Coord.) (2005), ¿Sustentabilidad? Desacuerdos sobre el desarrollo sustentable, Colección América Latina y el Nuevo Orden Mundial. México: Miguel Ángel Porrúa, UAZ, Cámara de Diputados LIX Legislatura, ISBN 970-701-610-8.

FOLADORI, G., y Tommasino, H. (2000). El concepto de desarrollo sustentable treinta años después. Desenvolvimento e Meio Ambiente, 1, 41-56.

FUENTES Perea, Luz Amparo y Serrano Pedraza Ana Milena (2006). Valoración Económica de los Impactos Socioeconómicos y Ambientales ocasionados por el Manejo de los Residuos Sólidos Urbanos en el Relleno Sanitario "La Esmeralda" del Municipio de Barrancabermeja: Aplicación del Método Multicriterio. Universidad Industrial de Santander Escuela de Economía y Administración Facultad de Humanidades, Bucaramanga. Colombia.

FURTADO Celso, Teoría y política del desarrollo Económico, Edit. Siglo XXI, 13ra; edición, 1987.

GAGLIAS, A., Mirasgedis, S., Tourkolias, C., y Georgopoulou, E. (2016). Implementing the Contingent Valuation Method for supporting decision making in the waste management sector. Waste Management, 53, 237-244.

GAMBARA, H. (2002). Métodos de Investigación en psicología y Educación. Cuaderno de prácticas (3ª edición). McGraw-Hill: Madrid.

GÁNDARA, Fierro Guillermo (2007). Valoración monetaria de la contaminación por incineración y vertido de residuos sólidos urbanos. Instituto Tecnológico y de Estudios Superiores de Monterrey.

GARCÍA, García José Odón (2009) Desarrollo Humano y Convergencia Regional en Michoacán, 1980-2005. Tesis para obtener el grado de doctor en Desarrollo Regional, del Instituto de Investigaciones Económicas y Empresariales, de la Universidad Michoacana de San Nicolás de Hidalgo, Michoacán, México. Pp. 130.

GARCÍA, García, José Odón, y Carrillo, Silva, E. (2006). Relación urbano rural y medio ambiente en la región centro de Michoacán, México. Ponencia presentada en el Tercer Encuentro Internacional sobre Desarrollo Sostenible y población. Realizado del, 6, 06-07.

GARCÍA, Antonio (1978). Elementos para una teoría latinoamericana del desarrollo, en Alonso Aguilar, Paul A. Baran, Antonio García y otros (1978), Crítica a la teoría económica burguesa, Editorial Nuestro Tiempo, México, Pp. 218.

GARCÍA Colín Leopoldo y Bauer Ephrussi Mariano (1996). Energía Ambiente y Desarrollo Sustentable (el caso de México). UNAM Programa Universitario de Energía, El Colegio Nacional de México. Pp. 92.

GARCÍA, Máynez Eduardo. (2000). Introducción al estudio del derecho, Editorial Porrúa. Pp. 36, 78, 131, 136, 169, 186, 198, 317 y 339.

GARFIAS y Ayala, Francisco Javier y Barojas Weber Luis (1995) Residuos peligrosos en México. SEMARNAT-INE.

GEIPEL, Verónica y Sauad Juan José (2014). Valoración económica y financiera de la Gestión Integral de Residuos Sólidos Urbanos en el Valle de Siancas. Municipio de El Bordo. Revista de Divulgación 01-2014. Escuela de Recursos Naturales Ingeniería en Recursos Naturales y Medio Ambiente 1, 49-56.

GIDDENS y Hutton. (2001). El mundo en el límite: la vida en el capitalismo global. Tusquets, Barcelona.

Gobierno del Estado de Michoacán (1989). Historia General de Michoacán, Morelia, Mich., tomos I y II.

GODÍNEZ Enciso, Juan Andrés (1995). Desarrollo económico y deterioro ambiental: una visión de conjunto y aproximaciones al caso mexicano. En gestión y Estrategia. UAM Azcapotzalco, México, D.F. No. 7, art.6. Enero-junio 1995. On-line http://www.azc.uam.mx/publicaciones/gestion/num7/art6.htm, consultado en línea el 20 de mayo del 2013.

GOLDSMITH, Edward (1974). A blue print for survival, New York: Signet.

GONZÁLEZ, Márquez José Juan (2003) La responsabilidad por el daño ambiental en América Latina. Programa de las Naciones Unidas para el Medio Ambiente.

GONZÁLEZ, N., Abad, J., y Lévy, J. P. (2006). Normalidad y otros supuestos en análisis de covarianzas. Modelización con estructuras de covarianza en Ciencias Sociales. Temas esenciales, avanzados y aportaciones especiales, 31-58.

GONZÁLEZ, M. (2000). El ambiente como bien jurídico. Revista Mexicana de Derecho.

GLIGO, N. (2001). La Dimensión Ambiental en el Desarrollo de América Latina. Comisión Económica para América Latina y el Caribe (CEPAL), Santiago de Chile.

GRINNELL, R. y Unral Y. (Eds.). Social Work: Research and evolution. Quantitative and qualitative approaches. Pp. 438-449. N. Y. Oxford University Press.

GUDYNAS, Eduardo (2004). Ecología, Economía y Ética del Desarrollo Sostenible. Montevideo: Coscoroba, CLAES.

GURRIERI, Adolfo (1982). Prebisch, Raúl. El desarrollo económico de la América Latina y algunos de sus principales problemas. La obra de Prebisch en la CEPAL, Fondo de Cultura Económica, Serie Lecturas, Número 46, México, Pp. 15, 99–155.

GUTIÉRREZ Garza Esthela (2008). De las Teorías del desarrollo al desarrollo sustentable, historia de la construcción de un enfoque multidisciplinario, Instituto de Investigaciones Sociales,UANL, Revista Trayectoria, año IX, No. 25 de sep-dic 2007. Vol. XI, No. 39. Pp 21-35.

GTZ, (1998). Asociación de Cooperación Técnica Alemana. Manual de minimización, tratamiento y disposición: concepto de manejo de residuos peligrosos e industriales para el giro químico. Comisión Ambiental Metropolitana. 1998.

HANNEMANN, Michael W. (1994). Valuing the environment through contingent valuation. Journal of Economic Perspectives vol. 8(4), 19-43.

HANLEY, N., Wright, R. E., y t, V. (1998). Using choice experiments to value the environment. Environmental and resource economics, 11(3-4), 413-428.

HARDIN, Garret (1968). The Tragedy of the Commons.

HERMANSEN Tormod, (1969). Development Poles and Development center in National and Regional Development, United National Research Institute for Social Development, Ginebra.

HERNÁNDEZ-Sampieri, Fernández, C. y Baptista, P. (2014). Metodología de la Investigación. Sexta edición. McGraw Hill Education. Material complementario de Hernández-Sampieri (2014), consultarlo en http://novella.mhhe.com/sites/000001251x/student_view0/

HERNÁNDEZ, Sampieri Roberto, Collado Fernández Carlos y Lucio Baptista Pilar (2003). Metodología de la Investigación. Mc Graw-Hill Interamericana, México, D. F. Tercera edición.

HIDALGO, Capitán Antonio Luis (1998) El pensamiento económico sobre desarrollo. De los mercantilismos al PNUD. Universidad de Huelva.

HIDALGO, Tuñon, Alberto (2000). Teorías, historia y modelos de desarrollo: Una interpretación. El Basilisco: revista de filosofía, ciencias humanas, teoría de la ciencia y cultura, 28:4. Universidad de Oviedo. ISSN 0210-0088.

HIERRO Sánchez Pescador, L. L. (2000). Conceptos jurídicos fundamentales: De las modalidades deónticas a los conceptos de derecho y deber.

HOPKINS, K. D., Hopkins, B. R., y Glass, G. V. (1997). Estadística básica para las ciencias sociales y del comportamiento. Prentice-Hall Hispanoamericana, pp. 1997-406.

HORTON, Paul B. y Chestet L. Hunt (1985). Sociology. Mc Graw-Hill. N.Y.

HOTELLING, H. (1931). The economics of exhaustible resources. The Journal of Political Economy, nº 2, vol. 39.

IBARRARÁN, María Eugenia, Islas Iván y Mayett Eréndra (2003). Valoración económica del impacto ambiental del manejo de residuos sólidos municipales: estudio de caso. Gaceta Ecológica.. SEMARNAT. Red de Revistas Científicas de América Latina, el caribe, España y portugal 67, 69-82.

INDICADORES SOBRE EL DERECHO A UN MEDIO AMBIENTE SANO EN MÉXICO. Vol. 1. Colección Indicadores de Derechos Humanos. Oficina del Alto Comisionado. México. 2012. Pp. 58.

INE (2009). Instituo Nacional de Ecología, Estudio de pruebas piloto para el tratamiento de los residuos peligrosos de Cromatos de México, mediante la aplicación de sulfuro de socio. SEMARNAT-INE-GTZ. 2009.

INE-SEMARNAT, (2001). Minimización y Manejo Ambiental de los Residuos Sólidos, primera edición, Pp. 57.

INE-SEMARNAT (2006). Promoción de la Minimización y Manejo Integral de Residuos Peligrosos.

INE-SEMARNAT (2007). Evaluación de los Posibles Impactos Adversos al Ambiente en el Manejo de Residuos Peligrosos. http://www2.inecc.gob.mx/publicaciones/libros/345/evalua.html

INEGI Y COFOM, 2001.

INEGI (2010) XIII Censo General de Población y Vivienda 2010, Michoacán, INEGI.

INEGI. (30 de junio de 2013). Costaría a México 6.9% de su PIB asumir daños ambientales.

INEGI (2000) Indicadores de Desarrollo Sustentable en México. Instituto Nacional de Estadística, Geografía e Informática

JALOWIECKI, Bohdan (1998). Społeczne wytwarzanie przestrzeni [Construcción social del espacio], KiW, Warszawa

JARDON, Juan. (1995). Energía y Medio Ambiente una perspectiva económica y social. México.: Edit. UNAM, México. Pp. 100.

JIMÉNEZ, Peña Adulfo (1996). Reflexiones jurídico ambientales acerca del Sector Residuos, sustancias químicas y riesgo. México: Lex, Difusión y Análisis, Suplemento Ecología, México.

JORNET, J. M., Such, J. G., y Bakieva, M. (2016). Los resultados de aprendizaje como indicador para la evaluación de la calidad de la docencia universitaria. Reflexiones metodológicas. Revista Iberoamericana de Evaluación Educativa 5(2), 1-17.

JURADO, S. (2005). Educación popular para el desarrollo rural en comunidades cafeticultoras del Istmo de Tehuantepec en Oaxaca. Bachelor Thesis of Agricultura Engineering by Facultad de Estudios Superiores Cuautitlán de la UNAM, México.

KALTON y Heeringa, (2003) en Sampieri Hernández Roberto (2010) Metodología de la Investigación. Quinta edición. Mc Graw Hill/INTERAMERICANA EDITORES, S.A. DE C.V. A Subsidiary of The McGraw-Hill Companies, Inc.

KERLINGER, F. N., y Lee, H. B. (2001). Investigación del comportamiento: métodos de investigación en ciencias sociales. México: McGraw-Hill/Interamericana Editores. SA Cultura España-Norussis, MJ (2006) SPSS Modelos avanzados, 15.

KISH (1995) en Sampieri Hernández Roberto (2010) Metodología de la Investigación. Quinta edición. Mc Graw Hill/INTERAMERICANA EDITORES, S.A. DE C.V. A Subsidiary of The McGraw-Hill Companies, Inc.

LEDESMA, R., Molina, G., y Valero, P. (2002). Análisis de consistencia interna mediante Alfa de Cronbach: un programa basado en gráficos dinámicos. Psico-USF, 7(2), 143-152.

LEFF, Enrique (1993). La Dimensión Cultural del Manejo Integrado, Sustentable y Sostenido de los Recursos Naturales en Leff, E. y J. Carabias (Coord.) Cultura y Manejo Sustentable de los Recursos Naturales. CIIH-UNAM. México.

LESTER, Lave Gestión ambientalmente racional de las sustancias químicas desde la perspectiva de la industria, SEMARNAT-INE, México, 1997, Pp. 15.

LEWIS, W. A. (1957). Teoría del desarrollo económico. El Trimestre Económico, 24(96 (4), 454-467.

LFRA. Ley Federal de Responsabilidad Ambiental (2013), publicada en el Diario Oficial de la Federación el día 7 de junio del 2013. México.

LGEEPA. Ley General del Equilibrio Ecológico y Protección al Ambiente, artículo 3, Fracción I, publicada en el Diario Oficial de la Federación el día 28 de enero de 1988. México.

LGPGIR. (08 de octubre de 2004). Ley General para la Prevención y Gestión Integral de Residuos. Ley General para la Prevención y Gestión Integral de Residuos . México: Camara de Diputados.

LONDOÑO Toro, B. (1999). Responsabilidad Ambiental: nuevo paradigma del derecho para el siglo XXI. Estudios socio-jurídicos, 1(1), Pp. 134-161.

LÓPEZ, Levi Liliana y Ramírez R. B. (2012) La región: organización del territorio de la modernidad, en Territorios. Bogotá, 27. Pp. 21-46.

LÓPEZ S. Luis Pedro y Ferro N. Alejandro. (2008). Derecho Ambiental. 1ª Edición. México. Pp. 60, 77, 78, 283, 285.

LLADÓ, Verdejo Agenor Alberto y García Rodríguez José Félix (2004). Costo efectividad en el manejo de los residuos peligrosos biológico infecciosos en un Hospital General. Red de Revistas Científicas de América Latina, el Caribe, España y Portugal Sistema de Información Científica 10(3), 282-287.

KRUTILLA, V. John (1967). Conservation Reconsidered en The American Economic Review. Vol. 57, No. 4 (Sep. 1967). Pp. 777-786. JStore. http//www.jstor.org/.

MACHÍN, Hernández María Mercedes y Casas Vilardell Mayra (2006). Valoración económica de los recursos naturales: Perspectiva a través de los diferentes enfoques de mercado. Publicado en Revista Futuros No. 13. Vol. IV. 2006. http://www.revistafuturos.info

MÁRQUEZ, Romegialli Fernando (2004) Manejo seguro de residuos peligrosos. Departamento de ingeniería química de la Universidad de Concepción, Chile. Consultado el 14 de octubre del 2013 http://www2.udec.cl/matpel/cursos/residuos_peligrosos.pdf

MARTÍNEZ de Anguita d'Huart, P. M. (2004). Economía ambiental y ordenación del territorio. Ecosistemas: Revista científica y técnica de ecología y medio ambiente, 13(1), 12.

MARTÍNEZ (1991). Impacto de uso de las aguas residuales del río Grande de Morelia en el Distrito de Riego 020 del Valle Morelia-Queréndaro. Facultad de Química, Escuela de Biología y Escuela de Ingeniería Civil. Universidad Michoacana de San Nicolás de Hidalgo. Morelia, Michoacán.

MARZOUK Mohamed y Shimaa Azab (2014). Environmental and economic impact assessment of construction anddemolition waste disposal using system dynamics. Contents lists available at ScienceDirect Resources, Conservation and Recycling journal home page: www.elsevier.com/locate/resconrec.

MEADOWS, Donella H., Dennis L. y William W. Behrens (1993). The limits of growth. A report for the Club of Rome Orojct on the predicament of mankind. London: Potomac.

MEIXUEIRO, Nájera Gustavo (2008). Documentos selectos de desarrollo regional y políticas públicas. Pp. 223.

MÉNDEZ, Delgado y Yizhou: (2007) Técnicas de análisis regional aplicadas en tres regiones del Oriente de China. Edición electrónica gratuita. Texto completo en www.eumed.net/libros/2007b/.

MERTENS, Donna (2005) en Sampieri Hernández Roberto (2010) Metodología de la Investigación. Quinta edición. Mc Graw Hill/INTERAMERICANA EDITORES, S.A. DE C.V. A Subsidiary of The McGraw-Hill Companies, Inc.

MIHOTEK B., Kathy (s/d) Entre la realidad y la teoría del desarrollo regional. El caso del Municipio de San Javier, Santa Cruz, Bolivia. Oaxaca, México: División de Posgrado del Instituto Tecnológico de Oaxaca. Pp. 2-13. En García Melchor Nicasio (2014) El desarrollo y sus adjetivaciones: comunitario, local y regional. Perspectivas teóricas y prácticas. Universidad de Guanajuato, primera edición, diciembre del 2014.

MISHAN, E.J. (1967). Pareto Optimality and The Law, Oxford Economic Papers, noviembre, Pp. 255-287

MONCAYO, Jiménez, É. (2008). Nuevas teorías y enfoques conceptuales sobre el desarrollo regional: ¿hacia un nuevo paradigma? Revista de economía institucional, 5(8).

MORALES, Vallejo Pedro (2012) Estadística aplicada a las Ciencias Sociales Tamaño necesario de la muestra: ¿Cuántos sujetos necesitamos? Universidad Pontificia Comillas • Madrid • Facultad de Humanidades (Última revisión, 13 de diciembre, 2012

MORENO Toscano, A., y Florescano, E. (1973). El sector externo y la organización espacial y regional de México (1521-1910) Ponencia presentada en el IV Congreso Internacional de Estudios sobre México. Santa Mónica, Calif.

MÚNERA, López María Cecilia (2001). El desarrollo desde una perspectiva semántica y discursiva. Pp. 2. Universidad Nacional de Colombia, Sede Medellín. Facultad de Arquitectura, Escuela del Hábitat, agosto 16 del 2001.

MÚNERA, Osorio Juan David, Correa Restrepo Francisco Javier (2009). Un análisis de la aplicación empírica del Método de Valoración Contingente. Semestre Económico, vol. 12, núm. 25, julio-diciembre, 2009. Pp. 11-30. Universidad de Medellín. Colombia.

MUÑOZ, Piña Carlos. (1995). Residuos Peligrosos en México, México D. F. SEMARNAT-INE.

MYRDAL, Gunnar (1957). Economic Theory and Underdevelope, regions, produce General Dukworth y Co, Ltda., London.

NEEF, Manfred Max. Elizalde Antonio, Hopenhayn Martín. (1986). Desarrollo a Escala Humana, en DEVELOPMENT DIALOGUE, Fundación Dag Hammarskjold, Uppsala, Suecia.

NEMI DIB, Juan Antonio (1995). Residuos Peligrosos en México (Taller para el Desarrollo Sustentable Residuos Peligrosos). Horizontes Jurídicos, SEMARNAP, 1995. Pp 109-126.

NISBET, Roberto (1980). Historia de la idea de progreso. Barcelona: GEDISA.

NOM-052-SEMARNAT-2005.

NOM-053-SEMARNAT-1993

NOM-054-SEMARNAT-1993

NOM-055-SEMARNAT-2003

NOM-056-SEMARNAT-1993

NOM-057-SEMARNAT-1993

NOM-058-SEMARNAT-1993

NOM-083-SEMARNAT-2003

NOM-087-ECOL-SSA-1-2002

NOM-098-SEMARNAT-2002

NOM-141-SEMARNAT-2003

NOM-133-SEMARNAT-2000

NOM-138-SEMARNAT/SSA-2003

NOM-147-SEMARNAT/SSA1-2004

OCDE. (2000). Strategic Waste Prevention, OECD Reference Manual. Env/Época/PPC.

OCHOA, Guarachi Lucia Dora (2010). Valoración económica de los factores relacionados al reciclaje en el municipio de El Alto. Universidad Mayor de San Andrés Facultad de Ciencias Económicas y Financieras. Bolivia.

OMS, Organización Mundial de la salud. (2002). Preparemos Ambientes Saludables para los Niños. Accesado:https://www.unicef.org/spanish/specialsession/docs_new/documents/child_friendly_ssoc_outcome_sp.pdf Consultado en junio del 2016.

OSLENDER, U. (2002). Espacio, lugar y movimientos sociales: hacia una espacialidad de resistencia. Scripta Nova: Revista electrónica de geografía y ciencias sociales, (6), 115.

ORNELAS, Delgado Jaime (2008). Teorías del Desarrollo en América Latina. Pp. 5, 9.

ÓRNELAS, Delgado Jaime (2013). De nuevo sobre el desarrollo: Nota con fines didácticos. Pp. 41-71. En Aceves, López Liza y Sotomayor Castilla Héctor (2013) Volver al desarrollo o salir de él. Límites y potencialidades del cambio desde América Latina. Ediciones E y C.

ORTEGA Noriega, Sergio (1993) Un ensayo de historia regional. El Noroeste de México 1530-1880, México, UNAM. Pp. 10.

ORTIZ Monasterio F., Cortinas de Nava C., Maffey García L., (1987). Manejo de los desechos industriales en México. Fundación Universo XXI.

ORTIZ Paniagua, Carlos Francisco e Infante Jiménez Zoe T. (2008). Valoración Económica y Diseño de Indicadores como Instrumentos de Política para la Gestión del Desarrollo Sustentable. Revista Nicolaita de Estudios Económicos, Vol. III, No. 1, enero-junio de 2008, Pp. 67-85.

OSORIO Múnera, Juan David y Correa Restrepo, Francisco Javier (2009). Un análisis de la aplicación empírica del método de valoración contingente. Semestre Económico Universidad de Medellín, 12(25), 11-30.

P. ANEX, Robert (1995). A Travel-Cost Method of Evaluating Household Hazardous Waste Disposal Services. Journal of Environmental Management (1995) 45, 189–198.

PALACIOS, Juan José. (1993). El concepto de región en Héctor Ávila Sánchez, (comp.), Lecturas de análisis regional en México y América Latina, México, Universidad Autónoma Chapingo. p.104.

PARIANI, A., (2004). Optimización de producciones complementarias y complementarias y competitivas en el noreste de la Provincia de la Pampa. Departamento de Producción Animal. Universidad de Córdoba, Córdoba. España, Pp. 351.

PEARCE, D.W., Cline, W.R., Achanta, A.N., Fankhauser, S., Pachauri, R.K., Tol, R.S.J. y Vellinga, P. (1996). The Social Costs of Climate Change: Greenhouse Damage and the Benefits of Control, en Bruce, J.P., Lee, H. y Haites, E.F. (eds.) Climate Change 1995: Economic and Social Dimensions -- Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change, Pp. 179-224. Cambridge: Cambridge University Press.

PEARCE, D. And Turner. (1993). Economía de los Recursos Naturales y Ambientales. Colegio de Economistas de Madrid.

PEARCE, D.W. (1975), Los límites del análisis coste-beneficio como guía para la política del medio ambiente, Hacienda Pública Española nº 37, Pp. 61-71.

PEREIRA, P. Z. 2011. Los diseños de método mixto en la investigación en educación: Una experiencia concreta. Revista electrónica Educare Vol. XV, No. 1 (15-29).

PIGOU, A. (1962). The Economics of Welfare. Macmillan, London. Versión en castellano publicada por Ed. Aguilar, Madrid, 1946 (a la que corresponden las páginas citadas en el texto).

PIGOU, A (1974). Introducción a la Economía. Ariel, Madrid.

PNUD. Programa de las Naciones Unidas para el Desarrollo. Desarrollo Humano en Chile 1996, PNUD, Santiago de Chile, 1996.

PORTNEY, R. Paul 1994. The contingent valuation debate: why economist should care. Journal of Economic Perspectives, vol. 8(4): Pp. 1-17.

PONCE Nava, Diana Lucero, 2012. Procuración y Acceso a la Justicia Ambiental y Territorial en México, México, Instituto de Investigaciones Jurídicas, UNAM.

PREBISCH, Raúl (1981). Capitalismo periférico. Crisis y transformación. México: Fondo Cultura Económica.

PREBISCH, Raúl (1949/1982). El desarrollo económico de la América Latina y algunos de sus principales problemas, en Adolfo Gurrieri (compilador). La obra de Prebisch en la CEPAL, Fondo de Cultura Económica, Serie Lecturas, Número 46, México, Pp. 99–155.

PREDUR. Programa Estatal de Desarrollo Urbano del estado de Michoacán de Ocampo, 2009-2030.

PREZIOSA, M. (2005). La Definición de Resonsabilidad Social Empresaria como tarea Filosófica. The bi-annual academic publication of Universidad ESAN, 10(18-19), Januar and December. Responsabilidad de la empresa en la sociedad. Buenos Aires: Ariel Sociedad Económica, Pp. 61-83

Programa Frontera 2012.

PNPGIR. (2008) Programa Nacional para la Prevención y Gestión Integral de Residuos de la SEMARNAT, publicado en el 2008, Pp. 30.

Protocolo de Kyoto (1998)

PULIDO, A., 1987. Modelos econométricos, Ediciones Pirámide, S.A., Madrid.

RAMÍREZ, R. C. G. (2010), Desarrollo económico y medio ambiente: realidad y perspectivas globales. 2010

RESTREPO, I. B., Rathje, G., Restrepo, W. I., Bernache, G., y Rathje, W. (1991). Los demonios del consumobasura y contaminación (No. 628.44 R47).

RIERA, Pere (1994). Manual de Valoración Contingente. Consultado en la web el día 3 de julio del 2014.

RIONDA, Ramírez Jorge Isauro (2006). Teorías de la Región. http://www.eumed.net/jirr/pdf/0329.pdf, consultado el 21 de julio del 2014.

RIONDA, Ramírez Jorge Isauro (2005). Contextos del Desarrollo Regional En México.

RODRÍGUEZ, Castellanos Arturo (2008). Crisis financiera y Globalización: un análisis de sus factores determinantes. Pp. 159-183

RODRÍGUEZ Jiménez, J. J., e Ibardien Gulías, A. (1999). Residuos peligrosos; caracterización, tratamiento y gestión. Síntesis, en CICEANA, C. D. (2010). Saber más… Generación de residuos sólidos no peligrosos.

ROJAS, Orozco Cornelio (2003). El desarrollo sustentable: nuevo paradigma para la administración pública. Primera edición 2003, Instituto Nacional de Administración Pública A. C. Cuajimalpa, D. F., México. Pp.17-23, 84-110.

ROSTOW, Whitmn Walt (1960) Las etapas del crecimiento económico, Cap. XIII en: El proceso de crecimiento económico, Madrid.

RUIZ, J., Bravo, M., y Loaeza, G. (2001). Cubiertas vegetales y barreras vivas: tecnologías con potencial para reducir la erosión en Oaxaca, México. Terra, 19(1), Pp. 89-95.

SACHS, Ignacy y Paulo Freire Vieira (orgs.) (2007). Rumo a ecossocioeconomia:teoria e prática do desenvolvimient. São Paulo:Cortez.

SAIDÓN, Mariana (2012). Environmental valuation of waste recycling: The case of Quilmes, Argentina. Economía, 37 (34), 33-53.

SAMUELSON, Paul A. (1954). Pure theory of public expenditure. The Review of Economics and Statistics vol. 36 (Pp. 387-389).

SAMUELSON, P. (1947), Foundations of Economic Analysis, Harvard University Press.

SÁNCHEZ, A. Gándara (2011). Conceptos básicos de gestión ambiental y desarrollo sustentable, S. y. Distrito Federal: Secretaría de Medio Ambiente y Recursos Naturales, Instituto Nacional de Ecología.

SÁNCHEZ Arellano José (1996). El concepto de región en la actual perspectiva chapaneca. Algunas reflexiones sobre la particularidad de su uso. En Rodríguez y Rodríguez, Salvador et al. (coord.) (1996). El desarrollo regional en México. Antecedentes y perspectivas. México: UNAM-AMECIDER.

SÁNCHEZ, Martin M. J., Rodriguez-Cruz M. S., Andrades M. S., y Sanchez-Camazano M., (2006). Efficiency of different clay minerals modified with a cationic surfactant in the adsorption of pesticides: Influence of clay type and pesticide hydrophobicity. Applied Clay Science, 31, 3-4, Pp. 216-228

SCARINCI, Paola (2004). Responsabilidad empresaria-responsabilidad personal. Paladino, M. La responsabilidad de la empresa en la sociedad, Ariel Sociedad Económica, Buenos Aires

SCHUMPETER, Joseph A (1970). Problemas teóricos del desarrollo económico, en Guillermo Ramírez (compilador), Lecturas sobre desarrollo económico. Escuela Nacional de Economía, UNAM, México, Pp. 91–94.

SCHUSCHNY, Andrés y Soto Humberto (2009) Guía metodológica. Diseño de indicadores compuestos de desarrollo sostenible. Comisión Económica para América Latina y el Caribe (CEPAL). Publicación de las Naciones Unidas. Mayo de 2009. Impreso en Naciones Unidas, Santiago de Chile.

SACHS, Ignacy y Paulo Freire Vieira (Orgs.) (2007), Rumo à ecossocioeconomia: teoria e prática do desenvolvimient, São Paulo: Cortez.

SEERS Dudley. (1970). The Meaning of Development, en Revista Brasileira De Economia, vol.24, # 3, Fundaçao Getulio Vargas, Río de Janeiro, Brasil.

SELLER, C., Stoll, J. y Chavas, J. P. (1985). Valuation of Empirical Measures of Welfare Change: A Comparison of Nonmarket Techniques. Land Economics (May). Nº 61. Pp. 156-75.

SOLOW, R.M. (1974). The economics of resources or the resources of economics, American Economic Review, vol. 64, Pp. 1-14. Versión en castellano en El Trimestre Económico, vol. XLII (2), nº 166, abril-junio, 1975

SEMARNAT (2000). Programa para la Minimización y Manejo Integral de Residuos Industriales Peligrosos en México, Pp. 49-57.

SEMARNAT (2001). Minimización y manejo ambiental de los residuos sólidos, primera reedición 2001. México. D.F. Pp. 227.

SEMARNAT (2005). La Gestión Ambiental en México, Pp. 268.

SEMARNAT-INE (2009). México cuarta Comunicación Nacional ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático, primera edición 2009. Pp. 207.

SEMARNAT. DGGIMAR. (2016) Dirección General de Gestión Integral de Materiales y Actividades Riesgosas de la SEMARNAT.

SEN, Amartya (2000). Desarrollo y Libertad. Barcelona: Planeta.

SEPLADE (Secretaría de Planeación y Desarrollo Estatal), 2004, Nueva Regionalización para la Planeación y Desarrollo del Estado de Michoacán, Gobierno del Estado de Michoacán de Ocampo, Morelia, Michoacán.

SILKS, L. David (1968). Enciclopedia internacional de las ciencias sociales, vol. XII, EUA, The MacMillan Company and The Free Press, Pp.379.

SOLARI A.R. Franco J. y Jutkowitz (1976). Teoría, acción social y desarrollo, Siglo XXI EDITORES, MÉXICO Pp. 91.

SOTOLONGO y Delgado, (2006). Complejidad y Medio Ambiente. En publicación La revolución contemporánea del saber y la complejidad social. Hacia unas ciencias sociales de nuevo tipo.

SUNKEL Osvaldo y Pedro Paz (1970). El subdesarrollo latinoamericano y la teoría del desarrollo, Siglo XXI Editores S.A., México y Editorial Universitaria S.A., Santiago de Chile. Pp. 22-380.

TAMAYO y Tamayo, Mario (2003) El proceso de la investigación científica. Editorial Limusa, S.A. de C.V. 2003, México. Pp. 42-63.

THAYER, M. A. (1981). Contingent Valuation Techniques for Assessing Environmental Impacts: Further Evidence. Journal of Environmental Economics and Management (March). Nº 8. Pp. 27-44.

TRAPERO, J. B. P. (2009). La medición del bienestar social: una revisión crítica. Estudios de Economía aplicada, 27(2), 299-324.

TOLMOS, R. (2002). Desafíos y propuestas para la implementación más efectiva de instrumentos económicos en la gestión ambiental de América Latina y el Caribe: El caso del Perú. División de Medio Ambiente y Asentamientos Humanos. Santiago de Chile, enero del 2002.

TORO, P., García, A., Aguilar, C., Acero, R., Perea, J. and Vera, R. (2010). Modelos econométricos para el desarrollo de funciones de producción. Working Paper 13, vol.1/2010. Departamento de Producción Animal. Universidad de Córdoba (España).

TZIPI Eshet, Ofira Ayalon, Mordechai Shechter (2005). Valuation of externalities of selected waste management alternatives: A comparative review and analysis. Resources, Conservation and Recycling 46, 335–364.

UNIKEL, Luis (1975). Políticas de Desarrollo Regional en México, 1975. Pp. 143-182.

UNIKEL, Luis (1981) Desarrollo urbano en América Latina. Col. Lecturas económicas No. 15. Ed. Fondo de CULTURA ECONÓMICA. MÉXICO

VÁZQUEZ-Barquero Antonio (1993). Política económica local. La respuesta de las ciudades a los desafíos del ajuste productivo, Editorial Pirámide, Madrid, España.

VISCUSI, W. K. (1993). The value of risks to life and health. Journal of economic literature, 31(4), 1912-1946.

VIVIEN, Franck-Dominique, 2000, Economía y ecología, Quito, Ediciones ABYA-YALA.

www.semarnat.gob.mx

www.giz.de/cinvestav.mx/publicaciones/avayper/mayjun/RESIDUOS

www.aregional.com, 2006.

www.conabio.gob.mx/institucion/conabio_espanol/doctos/lagos.html

www2.udec.cl/matpel/sustancias

www.quiminet.com

www.tramites.semarnat.gob.mx/index.php/2012-11-06-21-50-20#page

www2.inecc.gob.mx/,

www.databank.bancomundial.org/data/reports.aspx?source=Indicadores, consultado en julio del 2015.

www.gob.mx/cofepris/

www.biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/libros2009/CD001026.pdf

www.eea.europa.eu/publications/92-9157-202-0/3.7.pdf

www.ceja.org.mx, consultado en julio del 2015

www.ceja.org.mx/ en mayo del 2016

www.cambiodemichoacan.com.mx/nota-226085

YU CHANG, Man (2005) La Economía Ambiental, obtenido el 4 de junio del 2014 en: www.estudiosdeldesarrollo.net.

YOUNG, Van Eric, (1992). Mexico’s region comparative history and development, San Diego, Center for U.S. Mexican Studies. Pp. 30.

WALLERSTEIN, I. (Coord.) (1996), Abrir las Ciencias Sociales. Ciudad de México, Centro de Investigaciones Interdisciplinarias en Ciencias y humanidades. UNAM, siglo XXI.

WEISBROD, B. (1964). Collective-consumption services of individual-consumption goods. Quarterly Journal of Economics 78 (1964). Pp. 471-477.

WILLIG, Robert D. (1976). Consumer's surplus without apology. American Economic Review vol. 66, núm 4 (Pp. 587 - 597).

Acronyms

ACB	Cost-Benefit Analysis
BID	Inter-American Development Bank
BM	World Bank
CANACINTRA	National Chamber of the Transformation Industry
CCDS	Consultative Council for Sustainable Development
CDMALC	Commission on Development and Environment of Latin America and the Caribbean
CEPAL	Economic Commission for Latin America and the Caribbean
CMMAD	World Commission on Environment and Development
CNUMAD	United Nations Commission on Environment and Development
COA	Annual Operating License
CPEM	Political Constitution of the State of Michoacán
CPEUM	Political Constitution of the United Mexican States
CRETIB	Corrosive, Reactive, Explosive, Toxic, Flammable and Biological Infectious
DAA	Willingness to accept
DAP	Willingness to pay
DOF	Official Journal of the Federation
EE. UU	United States of America
FMI	International Monetary Fund
GTZ	Gesellschaft Für Technische Zusammenarbeit
IDH	Human Development Index
INEGI	The National Institute of Statistics and Informatics
INGRP	National Inventory for Hazardous Waste Management
LAPPNEM	Environmental Law for the Protection of the Natural Heritage of the State of Michoacán
LFMN	Federal Law of Metrology and Standardization
LFPA	Federal Environmental Protection Act
LFPCCA	Federal Law to Prevent and Control Environmental Pollution
LGEEPA	General Law of Equilibrium and Protection of the Environment
LGPGIR	General Law for the Prevention and Integral Management of Waste
LPGIRM	Law for the Prevention and Integral Management of Residues of Michoacán
MDL	Clean Development Mechanism
MVC	Contingent Valuation Method
NOM`s	Mexican Official Standards
NRA	Environmental Registration Number
NRDC	Council for the Defense of Natural Resources
NWF	National Wildlife Federation
OMS	World Health Organization
ONU	United Nations Organization
PEA	Economically Active Population
PIB	Gross Domestic Product
PNPGIR	National Program for the Prevention and Integral Management of Waste
PNUD	United Nations Development Programme
PROFEPA	Federal Prosecutor's Office for Environmental Protection
RETC	Pollutant Release and Transfer Register
SEMARNAT	Ministry of the Environment and Natural Resources
STPS	Ministry of Labour and Social Welfare
SUMA	Secretariat of Urbanism and Environment
VEE	Economic Valuation of Externalities

Glossary

Environment: The set of natural and man-made or man-made elements that make possible the existence and development of human beings and other living organisms that interact in a given space and time (LGEEPA, 1988).

Waste Management: A set of actions aimed at recovering the economic value of waste through reuse, remanufacturing, redesign, recycling and recovery of secondary materials or energy (SEMARNAT, 2014).

Co-processing: Environmentally safe integration of waste generated by a known industry or source, as input to another production process (LGPGIR, 2003).

Final Disposal: Action of permanently depositing or confining waste in sites and facilities whose characteristics allow preventing its release to the environment and the consequent effects on the health of the population and the ecosystems and their elements (LGPGIR, 2003).

Generation: Action of producing waste through the development of production or consumption processes (LGPGIR, 2003).

Generator: A natural or moral person who produces waste through the development of production or consumption processes (LGPGIR, 2003).

Integral Waste Management: An articulated and interrelated set of normative, operative, financial, planning, administrative, social, educational, monitoring, supervision and evaluation actions for waste management, from its generation to its final disposal, in order to achieve environmental benefits, the economic optimization of its management and its social acceptance, responding to the needs and circumstances of each locality or region (LGPGIR, 2003).

Large Generator: A natural or legal person generating an amount equal to or greater than 10 tonnes by total gross weight of waste per year or its equivalent in another unit of measurement (LGPGIR, 2003).

Incineration: Any process to reduce the volume and decompose or change the physical, chemical or biological composition of a solid, liquid or gaseous waste, by thermal oxidation, in which all combustion factors, such as temperature, retention time and turbulence, can be controlled in order to achieve the efficiency, effectiveness and environmental parameters previously established. This definition includes pyrolysis, gasification and plasma only when the fuel by-products generated in these processes are combusted in an oxygen-rich environment (LGPGIR, 2003).

Waste Law: General Law for the Prevention and Integral Management of Waste.

Integral Management: The activities of reduction at the source, separation, reuse, recycling, co-processing, biological, chemical, physical or thermal treatment, collection, storage, transport and final disposal of waste, individually carried out or combined in an appropriate manner, to adapt to the conditions and needs of each place, fulfilling objectives of valorization, sanitary, environmental, technological, economic and social efficiency (LGPGIR, 2003).

Microgenerator: An industrial, commercial or service establishment that generates up to four hundred kilograms of hazardous waste per year or its equivalent in another unit of measurement (LGPGIR, 2003).

Small Generator: A natural or moral person who generates an amount equal to or greater than four hundred kilograms and less than ten tons in total gross weight of waste per year or its equivalent in another measurement unit (LGPGIR, 2003).

Management Plan: Instrument whose objective is to minimize the generation and maximize the valorization of solid urban waste, special waste and specific hazardous waste, under criteria of environmental, technological, economic and social efficiency, based on the Basic Diagnosis for Integrated Waste Management, designed under the principles of shared responsibility and integrated management, which considers the set of actions, procedures and viable means and involves producers, importers, exporters, distributors, traders, consumers, users of by-products and large waste generators, as appropriate, as well as the three levels of government (LGPGIR, 2003).

Recycling: Transformation of waste through different processes that allow it to restore its economic value, thus avoiding its final disposal, provided that this restitution favours savings in energy and raw materials without harming health, ecosystems or their elements (LGPGIR, 2003).

Remediation: Set of measures to which contaminated sites are subjected in order to eliminate or reduce contaminants to a safe level for health and the environment or to prevent their dispersion in the environment without modifying them, in accordance with what is established in this Law (LGPGIR, 2003).

Waste: Material or product whose owner or holder discards and which is in a solid or semi-solid state, or is a liquid or gas contained in containers or deposits, and which may be susceptible of being valorized or requires to be subjected to final treatment or disposal in accordance with the provisions of this Law and other ordinances derived therefrom (LGPGIR, 2003).

Special Handling Waste: Waste generated in production processes that do not meet the characteristics to be considered as hazardous or as solid urban waste, or that is produced by large generators of solid urban waste (LGPGIR, 2003).

Hazardous Waste: Are those that possess any of the characteristics of corrosivity, reactivity, explosiveness, toxicity, flammability, or that contain infectious agents that confer danger, as well as containers, containers, packaging and soil that have been contaminated when transferred to another site, in accordance with what is established in this Law (LGPGIR, 2003).

Urban Solid Waste: Waste generated in homes, resulting from the elimination of the materials used in their domestic activities, the products they consume and their containers, packaging or packages; waste from any other activity within establishments or on public roads that generates waste with household characteristics, and those resulting from the cleaning of roads and public places, provided that they are not considered by this Law as waste of any other kind (LGPGIR, 2003).

Shared Responsibility: Principle through which it is recognized that urban solid waste and special waste management are generated from the performance of activities that satisfy society's needs, through value chains such as production, processing, packaging, distribution, consumption of products, and that, consequently, their integral management is a social co-responsibility and requires the joint, coordinated and differentiated participation of producers, distributors, consumers, users of by-products, and of the three orders of government as appropriate, under a scheme of market feasibility and environmental, technological, economic and social efficiency (LGPGIR, 2003) (LGPGIR, 2003).

Reuse: The use of a previously used material or waste, without a transformation process (LGPGIR, 2003).

Treatment: Physical, chemical, biological or thermal procedures, by means of which the characteristics of the residues are changed and their volume or dangerousness is reduced (LGPGIR, 2003).

Valorization: Principle and set of associated actions whose objective is to recover the remaining value or calorific power of the materials that compose the waste, through their reincorporation in productive processes, under criteria of shared responsibility, integral management and environmental, technological and economic efficiency (LGPGIR, 2003).

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What is your added value with respect to other techniques?

Clearly focus each of its features

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Table 1.1 Title

Variable	Descripción	Valor
V_V	Volumen de Venta	20000
P_V	Postura de venta	490.61
V_C	Volumen de Compra	20000
P_c	Postura de Compra	485.39
P^{Uh}	Precio último Hecho	491.61
V_o	Volumen Operado	1241979
P_u	Precio/Utilidad	0
P^{VL}	Precio/Valor Libro	0
U_a	Utilidad p/Acción	0
V^{La}	Valor Libro p/Acción	0

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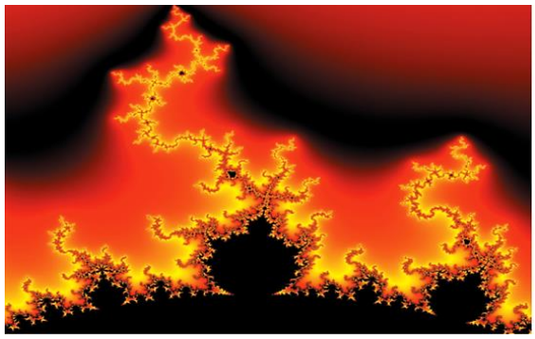
Figure 1.1 Title



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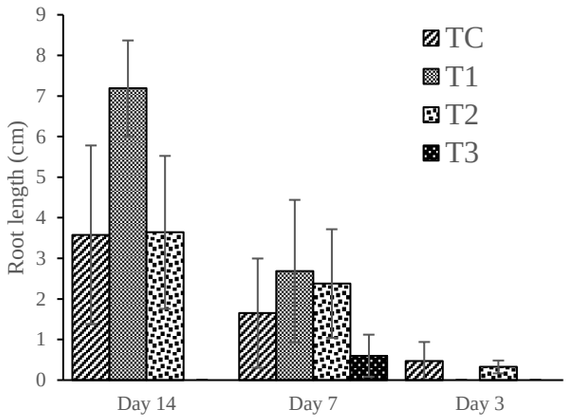

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Must be editable and number aligned on the right side.

Methodology

Develop give the meaning of the variables in linear writing and important is the comparison of the used criteria.

Results

The results shall be by section of the Chapter.

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Tables and adequate sources

Thanks

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Explain clearly the results and possibilities of improvement.

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4. Results
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