

## Research Article

# From the MSW Management to the Environmental Awareness and from the Organic Fraction (ORGANIC WASTE) to the Compost Quality

Guillermo Solar Olivares<sup>1</sup>, M Àngels Alió Torres<sup>1</sup>

<sup>1</sup> Universitat De Barcelona, Centre de Recursos per l' Ecologia Social (CRES), Catalunya, Spain<sup>2</sup> Institute of Water Modelling.

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## Abstract

Organic waste is the bigger fraction of waste and make compost it is one of the more efficient ways in Municipal Solid Waste (MSW) prevention models. We analyse the relation between the organic fraction and the compost resulting in six municipalities of Catalonia. The principal components of the environmental management are: professionals/technics, funds and political will. However, a fourth component is required: environmental education. The data were obtained from municipalities of the Àrea Metropolitana de Barcelona, the Agencia Catalana de Residuos, statistics organism and field work. The quality of the organic waste separation, we think it is related with the environmental education and, in particular with the environmentally conscious resulting of the non-formal education. Therefore, this study considers environmental campaigns develop by the municipalities in MSW prevention. The selection of the municipalities to study combines variables of population, total budget and how part of this funds is used by the environmental issues. We also selected municipalities to analyse different models of successful/unsuccessful in organic waste sorting at the source and good/bad compost production. In terms of waste prevention, we evaluated the organic waste composition (% of improper) of each municipality. The results suggest that the approach is effective to assess the level of variable's association and enable us to create patterns and relations between the variables evaluated like organic fraction collected, municipal management and the non-formal environmental education. Investment in environmental themes and awareness campaigns is not always directly related with a better sorting at the source of the organic waste, finally the sorting at the source quality is not directly related with the compost quality.

**Keywords:** Waste Management, Organic Waste, Compost, Environmental Education, Sorting at the Source.

## Introduction

Since ancient times humans have produced waste, and management of these increasingly in importance. We could make a description of the evolution of waste, from the earliest times to the present, but we need to take attention on how the authorities had adapting their *waste management system* to respond to these changes. On the other hand, we must consider urban development and how the authority of the administration of citizen services is organized. One of the ways that, today, and implemented in many places, is the administrative union in metropolitan areas. The Metropolitan Area of Barcelona (AMB), has been adapting and evolving to respond to the challenges that the administration demands (i.e. territory, environment, housing and transport, among others).

Waste and society, and the EA, collection, final disposal and waste treatment (e.g. compost), among others, are the variables under study on this this research, seeks the point of convergence to identify an appropriate model to support waste prevention.

Inside the structure of the ÀMB there are different municipal realities (i.e. geography, population and budget, among others). The study area is defined by the geographical extension of the municipalities of Sant Cugat del Vallés, Torrelles de Llobregat, El Prat de Llobregat, Gavà, Sant Adrià de Besòs y Montcada i Reixac (Figure 1).

This work carries out the waste prevention from two sides: The Environmental Education (e.g. scholar programs, visual campaigns, publicity) and, in the other hand, the quality of the waste separation, focussed in the organic waste sorting at the source. It is proposed as a direct relationship between the environmental education and the quality of the sorting at the source and, consequently, on the quality of

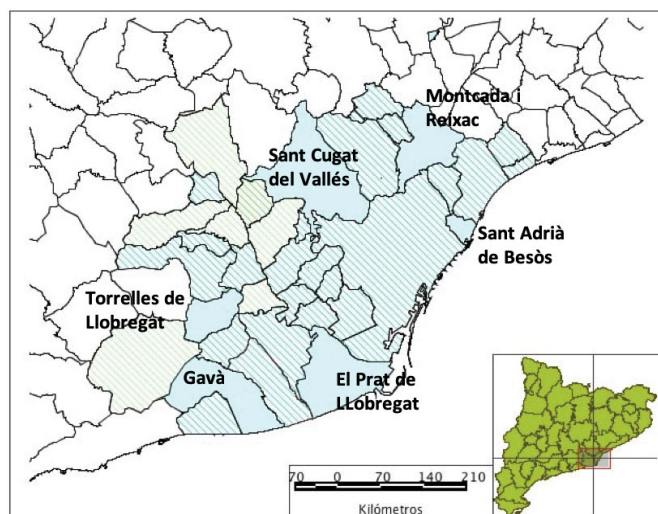


Figure 1: Study area (source: prepared by the authors)

the organic fraction. In addition, there has been an evolution in terms of environmental behaviour, linked to environmental education/

**\*Corresponding author:** Guillermo Solar Olivares, Universitat De Barcelona, Centre de Recursos per l' Ecologia Social (CRES), Catalunya, Spain, Tel: +34 600202906; Fax: +56 9 97931443; E-mail: guillermo.solar@gmail.com

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awareness campaigns that are maintained over time, giving continuity, and as result, persisting in the collective subconscious.

It is possible to think that, if there is a *political will* that develops constant and quality environmental campaigns (i.e. scholar or public) in different environmental issues, citizens will maintain a friendlier behaviour with the environment. With this, among other results, they are able to develop a separation in quality origin, which could affect the compost quality. [Figure 2]

In order to develop this research, we select 6 representative municipalities of the ÀMB and then, select data sources to collect, clean and proces. The data source was:

- Agencia de Residuos de Catalunya. Sistema Documental de Residus.
- Entitat del mediambient del Àrea Metropolitana de Barcelona.
- Instituto Cartogràfic de Catalunya.
- Instituto d'Estadística de Catalunya.
- Instituto Nacional de Estadística (España).
- Butlletí Oficial de la Provincia de Barcelona.
- Ayuntamientos de los municipios en estudio.

In addition, according to our experience, a good waste management integral system must have the following elements: (1) Professionals and technics, (2) founding (economical resources), and (3) political will.

Is task of the professional's team to identify the source of the waste and, more important: what? How much? And the quality of these waste. An interdisciplinary team should, always, consider the following questions:

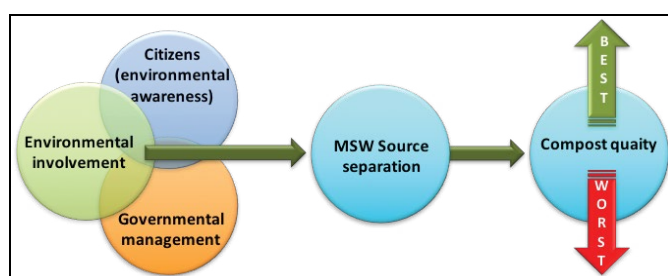
- What elements of the society generate most amount of MSW and what is the nature of these?
- How could these amounts be minimized?
- What role has the Recovery in the prevention model of MSW?
- Can the current waste management technology keep the pace to the technology offers by the consume society?

Once these questions had been answered, an integral MSW management plan can be designed and implemented.

## Waste Management and organic waste collect

In this research we consider as waste both the heterogeneous mass of waste from urban communities, and the accumulation of homogeneous agricultural and industrial waste too, among others.

The Catalan legislation defines *waste* as all those wastes generated in private homes, shops, offices and services, as well as those that do not fall into the category of special [1]. The use of the resources of the planet is something that comes from the most primitive societies, however, the problem of collection and disposal is a problem that is



**Figure 2:** Graphical representation of the hypothesis (source: prepared by the authors)

increased over time evolving to the present day. It is now imperative, on the one hand, to have a sustainable waste management system and, in the other hand, reduce the volume of waste generation.

A sustainable MSW cycle corresponds to all activities associated with the waste management in a compatible model with environmental concerns and public health, people's wishes and needs, reuse and recycle, or in one word: prevention [11].

About the organic waste, our research focus was placed on the household organic waste, those are constituted mainly by organic waste generated at the kitchen (cooking). Organic waste composition is analysed considering official characterization made by the Catalan Agency of Waste (ARC).

Organic waste collection is a critical factor inside the model and impacts on the compost result. Actually, the Metropolitan Area of Barcelona (ÀMB) implements a system of a selective collection, based in 5 fractions (i.e. paper and cardboard, light plastic, glass, organic and the rest). The common way is using waste containers in the street, whatever, door-to-door is an optional model used in some zones like small and rural towns, and additionally, clean points can receive, classify and storage these and another waste fraction (e.g. WEEEs, books, oils, batteries), and finally, others facilities, like *emergency points*, for subsequent transportation to recycle centres.

The principal difference between the door-to-door and other waste collection model like waste containers in the streets is that in the first, the collection can be developed in a more personalized way and allow an effective monitoring of the sorting at the source.

Both models are good and contribute for waste prevention, but if we see the organic waste collected in both models we can find qualitative difference, as we hope to demonstrate. The difference take root in that, the door-to-door system is that being a supervised collection model, then, the quality of the different fractions collected is higher than in an unsupervised model (i.e. waste container). The first one, allows to the waste collection personal, monitoring and warn to the users about the correct way to dispose the waste, in addition, strengthen environmental campaigns. On the other hand, waste containers receive, generally, all kind of waste because in its, there are not a person supervising the deposit by the citizens, leaving the quality separation linked to the user responsibility or social-environmental sensibility [1].

Must also be explored, in our context, that after the waste collection, the organic waste must be transported/transferred to a treatment facility (i.e. compost plant or an *eco-park*). In fact, in these plants is where the organic waste is transformed into compost, and at this point it is important to mention some differences between both. The quality can also depend on the processes that in each facility are implemented.

Among the main transformations we can found the valorisation, biological treatment and recycling.

Today, government policies focus on the *recycling business*, has given way to the *eco-parks*. An *eco-park* is a mega facility designed and built to treat the most quantity of recyclable materials from the MSW (on average of 260,000 tons/year), allows, for example, separate different plastics and pack it. In addition, inside its facilities, large quantities of compost it is produced. However, given the scale these facilities, and in addition, the large quantity and diversity of the origin of the organic waste (i.e. from varied municipalities), the quality is too a mixture of different qualities of organic waste and, if somewhat a big volume of compost, it is poor in quality and just it is useful to use as stabilized material in construction activities.

At the other end of the scenario we found the composting plants (i.e. Torrelles de Llobregat and Sant Cugat del Vallès). These plants,

in contrast to the eco-parks, are facilities specially designed and dedicated to the organic waste treatment. Compost process have been present in the environment, ever, and these processes is replicated in a compost plant like these, under T° and humidity control to help the process and also help avoid environmental damage [Figure 3]

The end result, the compost, should be of high quality, and often, can be distributed and marketed, in fact, the final compost can compensate the operation cost of the compost plant, reaching an “economical rentability” point [6,8].

Today, compost facilities are a valid option in any MSW management plan, allow even to generate a new marketable product.

In a local level, compost facilities should be an option for each municipality and adopt measures according to its determined needs. In this point, compost plants should be recognized for their ecological and environmental value over eco-parks. Today, it should rather as “more acceptable”, considering the environmental impact (i.e. environmental externalities), a compost plant over a landfill [8]. In addition, between the various uses of the compost it to improve the land for agricultural use, in fact, some researches prove the reduction of soil toxicity when it is mixed with the original soil [9].

### Environmental non-formal education

Non-formal education, since the early days of human age, is the knowledge transfer between different generation (i.e. oldest to youngest), sometimes by needs (e.g. knowledge of the activity/job for subsist, learning for personal vocation). With this evolution over time, education was organized, regulating and systematising.

As early as 1969, Bill Stapp [10] defined the environmental education as “*Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems and motivated to work toward their solution*”.

Something *more formal* experiences in terms of non-formal environmental education, or first experiences are associated with activities immerse in the nature, driven by academics (i.e. school innovating teachers, young researches), but, afterwards, begin to get support and institutional support, creating organizations and trying to coordinate these activities (e.g. the Council for Environmental Education in UK) [7]. Slowly, some NGOs beginning to emerge and start an environmental education program too, in coordination and, more important, in a gradual collaboration and complementation. Often dedicated on specific environmental campaign, but ever, maintaining the diffusion inside the non-formal parameters. Continuing, the non-formal environmental education is defined as

any learning process carried out through in a systematic program, not always evaluated, and that is not equivalent to an educational level, nor does it lead to an academic degree [3].

Following this premise, the role on the non-formal environmental education and its importance of learning, different concepts beginning to form (i.e. what learn, how learn, where learn, to who). Highlights the role of the United Nations (UN) in 1973 and the creation of The United Nations Environment Programme (UNEP). Corresponding the task of leading and encourage the participation of the citizens, promoting the preservation of the environment and the good management of natural recourses, giving to the nations and people the guidelines for this, the sustainable development.

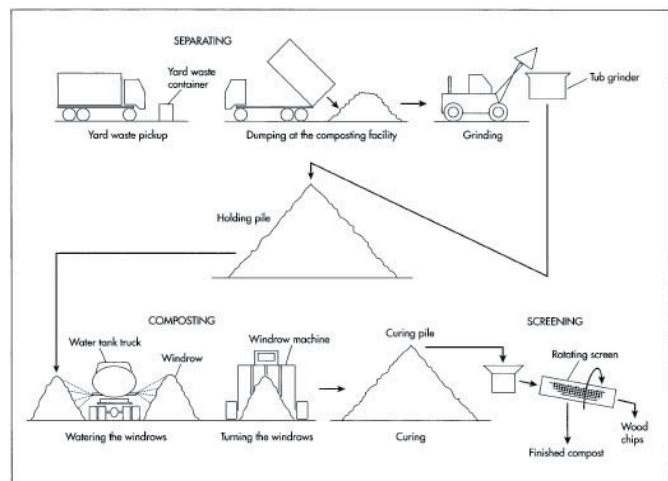
The environmental education gives an educational value to the task of analyse the environmental problems, give to their users, tools to address these problems and, many times, critical conflicts between the sustainable development v/s the progress. Hand in hand with the evolution of the Information and Communication’s Technologies (ICT), people has seen involved in a kind of rain of “conflict” information. In this scenario, the environmental education must recognize the conflict as a learning oportunity, giving tools to discriminate, evaluate, apply criteria and values to develop alternatives and take decisions. It should especially attention each one of the different thematic (e.g. sea, forests, air, soil), many times, these thematic need an interdisciplinary team (e.g. biologist, geography, geology) and, at the same time, should be addresses from different approach, conform their knowledge to the people who receive the lesson, attending not only the environmental focus, but addressing the political and economic issue, among others. The need to educate citizens (or future citizens) is a topic that, day to day, is increasingly and focused in the youngest generation (e.g. children and young people). The goal is to get a future generation, the citizens of the future, with a friendly behaviour, aware of the importance of the environmental care. When we talk about environmental education activities, we refer to:

- Activities, places and initiatives (e.g. ludic, role games) developed by GNOs, external of the formal sector.
- Promotion and support for selective waste collection campaigns.
- Environmental campaigns in others thematic (e.g. saving of water, energy or another).
- Environmental sensitive elements.

The actual environmental education is product of a large historic process, adding different sciences camps and engineering specialities, but, just when the ecology appear in the scenario, began to establish itself as we know today as that observes nature and its relation with humans, animals and all components of the biosphere, studies and diagnoses its condition to achieve its conservation and preservation, managing and connects the knowledge form different sciences areas of environmental interests [5].

An example of a complementary activity of environmental education, is the relation between a public organism and a school in a recycling campaign. In fact, promoting the sorting at the source at the school, scholars are stimulating social and environmental awareness and then, themselves transmit the message to its families, friends and social own ambit. Therefore, these activities are based on the scholar curriculum, promoting complementary activities for students, from the pre-scholar to secondary [4].

However, the local government –and highest instances– must check and regular these program/activities for the future citizens. In fact, according to its possibilities and local realities, promote a friendly transition to integrating and inclusive government model, from the local environmental management. These actions, in consequence, produce an eventual and real involvement in the processes of different



**Figure 3:** Diagram depicting the facility processing of yard waste into compost.

social agents (e.g. NGOs, groups and organizations) can propose, execute and develop within their own action areas, accord to their own models and philosophy too, ensuring that these groups share responsibility in their relation and participations degree with the local government and their social and environmental policies [5]. Then, the city town fulfils its audit role in the non-formal education system and, in addition, can help to guide the task to carrying the environmental education to the classrooms, finally, the city town it must become protagonist of the environmental campaigns, inside and outside, but focussed in the citizens. In Catalonia, the PROGEMIC [2], among its activity areas, argues is preferable the actions oriented to the citizen participation, this means that the success or failure of the selected waste model is product of the role and participation of the community and, inside these action, highlights the action in environmental education.

### Municipalities under study

The municipalities were selected according different reasons, but particularity, as well as other, for its administration, social, geographical limits, compost facilities and population. The selected municipalities were Sant Cugat del Vallès, Torrelles de Llobregat, El Prat de Llobregat, Gavà, Sant Adrià de Besòs and Montcada de Reixac. Table 1 lists, as a first proximity, the population of these municipalities.

For our research we considered the data in terms of percentage, this allow a comparison from percentages of quality and quantity in the analyse of the data collected.

A first point of comparison is the difference of the population between the municipalities, and the type of municipality (i.e. greater or lesser urbanized). For example, in one extreme we have Sant Cugat del Vallès, an active municipality, with young and active citizens and a richer economy class, with a defined town centre and universities, then the residential neighbourhoods. In the other hand, Torrelles de Llobregat, with a predominant older population and single familiar households, where it is still possible to find agricultural activity. In addition, in the last year there has been a significant increase in the migratory activity attracted by the peaceful and good life quality but maintain its jobs in other cities.

Another factor that reflects differences in the type of the selected municipalities, linked to the population of each one, is the municipal budget for environmental affairs. Naturally, a municipality with a greater population and surface area, should have a higher budget for environment and specifically for waste management. Also, and linked to the geographical scenario, a city hall would develop and implement a special waste collection model, appropriate to each reality.

Interestingly, to analyse the average income in each municipality, in one hand, a city with a higher education level would have a higher income too. Then, these people have a greater purchasing power and, in parallel, this person possibly received better opportunities. Finally, if these kinds of people are conscious of this condition, they could have greater environmental awareness. Unfortunately, the reality is far of the commented scenario, and worse, we can associate the purchasing power with a consumerist behaviour. Then, a high waste production in packaging it is expected. And more, people with a compulsive whirl of consumerism discard quickly their products that, in their minds,

are obsolete.

While the economic activities of each municipality are different and for this we never lose sight where are their economic resource (local and external). To this end, we have considered the mobility of the workforce.

Differences between municipalities, and their citizens, will be reflected in the waste production and, more important, in the composition of the total waste (i.e. percentage of each waste fraction) produced by each one. This conduct can be evaluated and associated as an average of each model in the research. This difference it is illustrated in [Figure 4]

The first thing that strike us is the difference of the waste quantity. Sant Cugat, in fact, broke the distribution of the rest of municipalities since 2005 to 2010. This would be explained by the kind of the city and its urban and planning differences. In one hand, Sant Cugat del Vallès is a big city, more active and with more mobility, and, in the other hand, Torrelles de Llobregat, explained by its nature and kind of municipality, like a village.

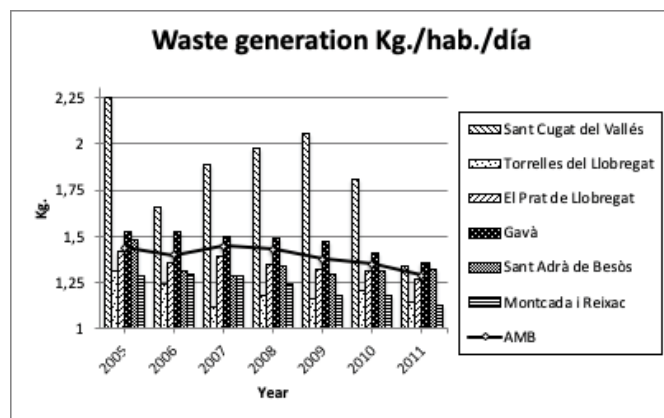
The organic waste of Torrelles de Llobregat and Sant Cugat del Vallès, is trated in its own compost plants. The rest of municipalities treat their organic waste in eco-parks (1 and 2). The organic waste is provided by the selective waste collection service and, on a smaller scale, from the green points. Our first theory, like an introduction is that the compost quality depends of the organic waste quality, and the organic waste quality depend of the sorting at the source quality.

A second approach its associated to the treatment facility, for effects of this research these values are exposed in Table 2.

### Results and Discussion

First of all, it is important to mention that the waste management in the different municipalities, goes from the door-to-door model, to the waste containers model, corresponding on many occasions with the urban planning of each city (e.g. streets, avenues or construction density). Mention also the difference between a large and small city. In addition, use of green points –fixed and mobiles– and, in some cities, emergency areas for dispose waste when ifs needed (e.g. larger weekends).

**Figure 4:** Waste production in the six municipalities under study (prepared by the authors).



**Table 2:** Compost plants characteristics (source: prepared by the authors)

Planta	In operation from	Tons/año FORM	Costo explotación
Sant Cugat del Vallès	2001	7.600	400.000 €
Torrelles de Llobregat	1997	4.500-5.000	s/i
Ecoparc 1	200	70.000	12.400.000 €
Ecoparc 2	2000-2004	74.500	s/i

**Table 1:** Municipalities population (source: prepared by the authors)

Municipality	2007	2008	2009	2010	2011	2012
Sant Cugat del Vallès	73.345	76.274	79.253	81.745	88.337	84.946
Torrelles del Llobregat	4.974	5.208	5.430	5.526	5.661	5.740
El Prat de Llobregat	62.663	62.899	63.418	63.434	63.499	63.162
Gavà	44.210	45.190	45.994	46.384	46.250	46.488
Sant Adrià de Besòs	32.734	33.223	33.761	34.104	34.157	34.482
Montcada i Reixac	32.111	32.750	33.453	33.656	34.232	34.689

## Waste Collection

Sant Cugat del Vallés was selected not just for its geographical and demographics characteristics, it is also for its collection waste model, similar to Torrelles de Llobregat, but maintains waste containers for the five common waste fractions (except Valldoreix neighbourhood, where it maintained the door-to-door collection). In turn, and considering the geographical extension, its divided in five sectors and circuits (i.e. two of them in the city centre and the rest out of the centre). A priori, we could think that the sorting at the source in residential zones is better than in the city centre, but results demonstrate the opposite of these. Organic waste and its quality are illustrated in Figure 5.

In the other side, the waste collection model of Torrelles de Llobregat is door-to-door across the city. The expectation is that the quality of the sorting at the source, and in fact the organic waste, have better quality than in the waste containers collection model. One of the qualities of the door-to-door collection model is the capacity to supervise the process and waste delivered by the user. Then, if the organic waste fail to comply with the minim standard, it is refused and returned to the user. The organic waste quality is illustrated in Figure 6.

Particularly striking is the high percentage of organic waste v/s the unfit of these fraction (i.e. inorganic waste), the proportion of organic waste did not fall below 90%, with a minimum of 90.71% on 2011 and

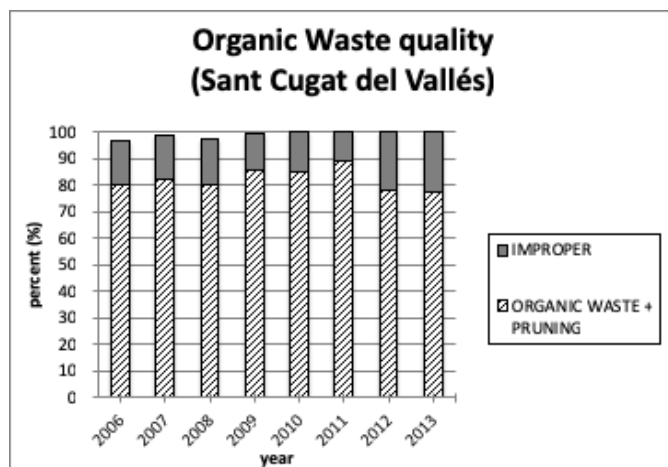


Figure 5: Organic waste characterization at Sant Cugat del Vallés (prepared by the authors).

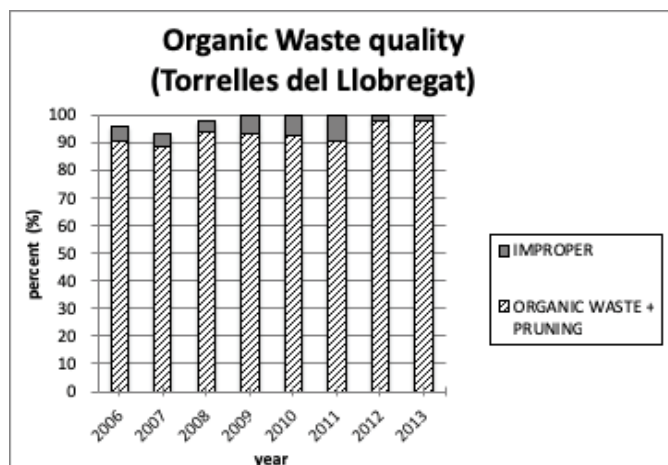


Figure 6: Organic waste characterization at Torrelles de Llobregat (prepared by the authors).

was improved in 2012.

The other municipalities (El Prat de Llobregat, Gavà, Sant Adrià del Besós and Motcada i Reixac), maintain a model based on the waste containers collection.

The focus for our research is the organic waste quality collected, the result of its characterization is presented below.

El Prat de Llobregat Figure 7 has been constantly improving since 2010, but, in 2013 reflects a decrease in the organic waste quality.

At Gavà [Figure 8], an improvement in a specific year is observed and it is noted for being an abrupt change, holding this result in below. However, in 2010 the results show a decrease in their quality and then a new increment, maintained to the end of this research.

In respect of Sant Adrà de Besós, an important improvement its observed in 2008, and a decrease since 2011 [Figure 9].

Closing this section, the first differences of organic waste can be observed, and, in advance, this waste can be processed in a compost plant or in eco-park, with a difference too, between twice facilities. Finally, the data of the organic waste of Montcada i Reixac can be appreciated in [Figure 10] Certainly, the illustrated differences are product, in part, for the life style and its activities of each city, sometimes very different (e.g. Torrelles de Llobregat v/s Sant Cugat del Vallés), and differences between the process for the organic waste (i.e. compost plant or eco-park).

In one hand we have an activity city, connected to the Metropolitan Area of Barcelona (Sant Cugat del Vallés), and, in the other hand,

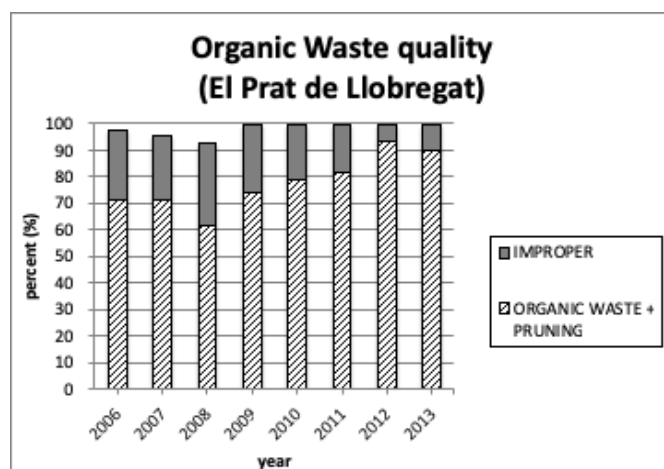


Figure 7: Organic waste characterization at El Prat de Llobregat (prepared by the authors)

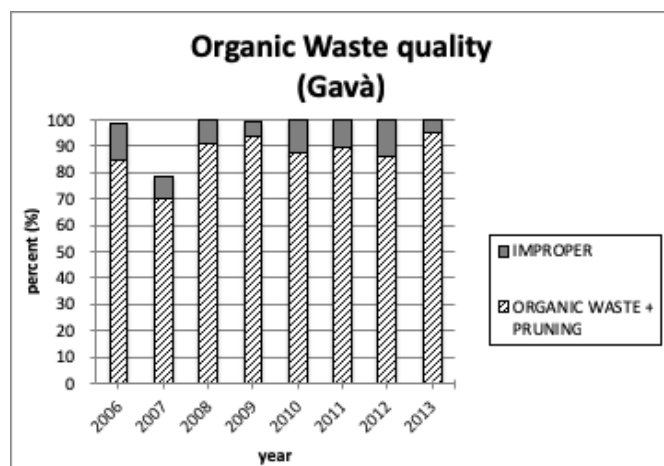


Figure 8: Organic waste characterization at Gavà (prepared by the authors).



Figure 9: Organic waste characterization at Sant Adrià del Besós (prepared by the authors)

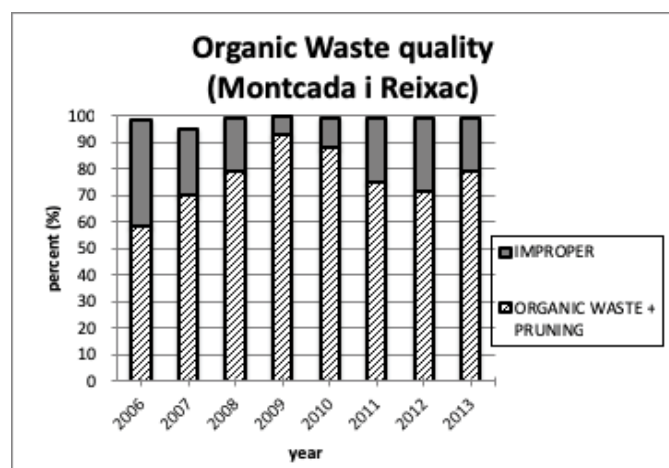


Figure 10: Organic waste characterization at Montcada I Reixac (prepared by the authors)

a small city, with a traditional family life style and closer to farm traditions, like family farming yet Torrelles de Llobregat).

It remains to explore the rest of cities of the Àrea Metropolitana de Barcelona, evaluating the differences about its population, urbanization, economic and social activities and, most important, its waste management.

### Environmental education from the city council

How much spent the city council in each city for environmental campaigns? That is the first question raised in this research, or at least in *environmental* management. Another way of addressing the question, and in fact, our approach, was to evaluate environmental affairs expenses, based in economic budgets and/or balances and then, to estimate how much to invest in environmental campaigns, this analysis is carried out in proportions terms. Take just the total investment, in numbers, it is not an equitable method considering the scale of the different municipalities under study. It is not the same and does not reflect the reality in similar conditions, for example, an  $x$  investment, for two different municipalities ( $A$  and  $B$ ), but the economic budget of  $A$  is three times upper than the  $B$  economy budget.

Data collection is presented on Tables 3-7.

The first thing that calls our attention here is the difference in the percentage (proportion) of the economic budget that each city hall investing in environmental issues. This may explain, a priori, the organic fraction quality in the same temporal window. It is worth noting that, in 2010 the town council of Torrelles de Llobregat do not to approve the municipal budget, then, the value for this case was 0

Table 3: Sant Cugat del Vallés expenses in environmental activities. (source: economic municipal budgets)

Municipality	Sant Cugat del Vallés			
	Year	Environmental budget.	% total budget	Per capita spending
	2005	17.878,39	0,01	0,25
	2006	45.789,69	0,04	0,62
	2007	64.637,31	0,07	0,87
	2008	104.057,39	0,09	1,36
	2009	89.732,91	0,08	1,13
	2010	267.794,74	0,29	3,28
	2011	170.788,03	0,18	2,05

Table 4: Torrelles de Llobregat expenses in environmental activities. (source: economic municipal budgets)

Municipality	Torrelles de Llobregat			
	Year	Environmental budget.	% total budget	Per capita spending
	2005	72.363,71	1,40	22,69
	2006	92.159,95	1,16	19,29
	2007	74.467,68	1,34	14,97
	2008	97.145,00	1,42	20,19
	2009	50.307,45	0,70	9,26
	2010	0,00	0,00	0,00
	2011	85.973,29	1,84	15,47

Table 5: El Prat de Llobregat expenses in environmental activities (source: economic municipal budgets)

Municipality	El Prat de Llobregat			
	Year	Environmental budget.	% total budget	Per capita spending
	2005	2.527.171	3,58	39,99
	2006	646.503	0,83	10,25
	2007	719.690	0,83	11,49
	2008	662.100	0,67	10,53
	2009	352.100	0,36	5,55
	2010	353.975	0,36	5,58
	2011	303.578	0,38	4,78

Table 6: Gavà expenses in environmental activities.(source: economic municipal budgets)

Municipality	Gavà			
	Year	Environmental budget.	% total budget	Per capita spending
	2005	4.890.632	9,15	110,62
	2006	2.023.839	3,41	45,45
	2007	1.961.422	2,58	43,90
	2008	2.229.600	3,52	49,34
	2009	2.399.505	3,20	52,17
	2010	2.597.136	4,22	55,99
	2011	2.564.618	5,31	55,45

Table 7: Sant Adrià de Besós expenses in environmental activities.(source: economic municipal budgets)

Municipality	Sant Adrià de Besós			
	Year	Environmental budget.	% total budget	Per capita spending
	2005	51.441,69	0,15	1,56
	2006	73.799,79	0,20	2,26
	2007	122.325,95	0,34	3,74
	2008	74.456,44	0,16	2,24
	2009	40.668,00	0,09	1,20
	2010	46.528,91	0,11	1,36
	2011	22.166,05	0,06	0,65

(zero).

Draw our attention the difference in *per capita spending*. Sant Cugat del Vallés has the lower spending, but this amount increasing year by year. At the other end of the sample, Gavà presented the higher

spending, but, in this case, we need to process the data with care, because the data source –on environmental expenses– has not the same quality in granularity of the data requested. It therefore decided to leave this data, because in the firsts economic budget the city hall of Gavà considered a low detail in the environmental subdivision item (i.e. just one value for this item associating subitems like collection, disposal, dump treatment and street cleaning, but do not indicate the proportion for each one), finally, the values were discussed in terms of the scale of expenditures and correlating rates and, that methodology reflect the reality in economic budgets and the per capita spending in environmental issues.

A simple way to compare and interpret the data presented above is evaluating and comparing how much each city hall spending in environmental awareness campaigns. On this type of data collection, it was found that the conduct of some citizens about waste prevention, and another environmental campaigns, could have an impact on waste prevention. Or in another words, when a city council makes, for example, a campaign about water-saving policies, may also induce environmentally friendly behaviour and, in general, all those whose support in a behaviour more sustainable, including, among others, the sorting at the source quality. Within the environmental awareness municipal campaigns, we can mention the following:

- Waste prevention campaigns at the Green-Commerce net (Xarxa de comerç verd).
- Support campaigns about sorting at the source, specially the organic waste and home-compost promotion.
- Support to local sustainability (e.g. energy and water use).
- Waste reduction in popular events (e.g. reusable cups).
- Partnership environmental campaigns (e.g. with *ecoembes*).

One factor that must to be highlighted is that, in some cases, results of an environmental campaigns are not related with the investment/spend. For example, the campaign “on vas envàs” (plastic-container, where do you go?) meant a high cost in media, include a lot of massive and varied diffusion material for the campaign. Nevertheless, and although the public perception was evaluated as a good campaign (with a 6 in a 1-10 scale), but the result was not satisfactory. In fact, in the post-evaluation the 42.3% of the citizens indicate that they do not think would change their habits.

Examples in environmental campaigns are present in the municipalities under study, we will comment some of them. At Sant Cugat del Vallès, in 2007, and for aim to the regulatory compliance, the sorting at the source campaigns called “A Mira-Sol, tots amb la selecció selectiva” (In Mira-Sol, all with *selective selection*) was launched after a study and diagnosis about the municipal solid waste management model (i.e. Diagnosi i Pla d’acció de la gestió dels residus municipals de Mira-Sol/ Diagnosis and Action Plan for the Municipal Solid Waste Management at Mira-Sol) and from a citizen consultation.

Torrelles maintains a regular fiscal spending by habitant, as a result of the economic crisis, it observed a small decrease, but the level of the total municipal spending remained stable. This effort maintain the quality of the organic waste collected in source or, in other words, the effort of Torrelles de Llobregat is not focused in highest campaigns, the effort is focused in campaigns that are maintained over time. The same city council has developed some campaigns focuses in reinforce a friendly behaviour with the environment. In addition, in Torrelles de Llobregat know that an integral campaign about environmental cares, and not just about waste.

For its part, El Prat de Llobregat has for 26 year an environmental education program, specially focused in the conservation of the Llobregat’s delta and, since 2002 has been implemented of the Agenda

21 of El Prat. During 2005-2006 developing a strong campaign oriented to further and increase the quantity and quality of the organic fraction collection at the source.

Another municipality that in previous section (organic waste quality) showed a marked improve was Sant Adrià de Besós. In its waste management, this municipality, draws our attention the continuous and diverse activities oriented in the environment but, ever linked to the citizen life quality, finally, these actions could lead to a strong environmental awareness and waste sorting at the source. These actions are addressed to various areas and was start in 2007.

With the presented examples is possible to appreciate the importance about the effort in environmental issues, the study cases demonstrate that the town council do not dedicate the same effort to environmental issues, still less that in sorting at the source campaigns, especially organic waste sort. In the other hand, the investment of funds in environmental issues, not ever achieve the best result in a better sort at the source.

The results allow us to generate a first model that demonstrate that, in fact, in short-term and medium-term when a city council invest and take a political compromise in education (specially in non-formal environmental education) would achieve, and in fact was observed in our study, an important improve on waste separation.

However, in general, the results suggest that the approach used is effective for an effective evaluation of simple patterns between non-formal environmental education, the govern effort and the citizen behaviour, in this case, environmental behaviour and particularly in sorting at the source of the organic waste.

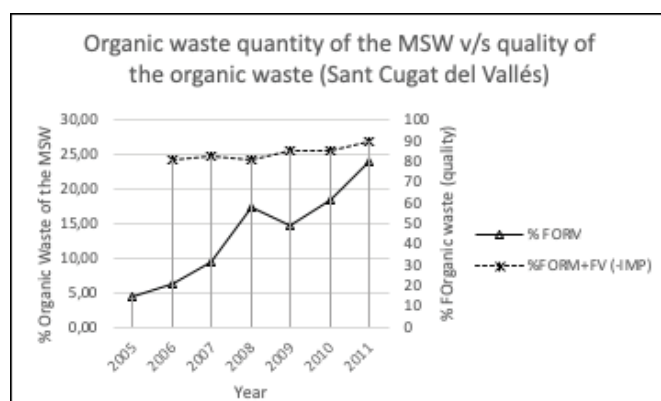
During the study, there has been evaluated the organic waste quantity, I addition we have been evaluate the quality of these fraction in a temporal window of the study. This approach allowed us to improve our proposed theory/model, comparing the organic fraction quantity and qualitative composition. In other words, it is not enough correlate the quantity of sorting at the source variables (organic waste respect about the total of municipal solid waste), it is necessary to evaluate the organic fraction quality [Figures 11-16].

## Conclusions

The more relevant results outcomes, in first instance, describe the citizens behaviour in relation with the sorting at the source. Just when the summary of different efforts (i.e. professionals, funds and political will), are oriented to the citizen, the result will reflect a best will reward socially and environmental responsible behaviour, and inside this, a best sorting at the source of the municipal solid waste.

### The results more important are:

- 1.- The non-formal Environmental Education is not a task that only



**Figure 11:** Ratio comparison of the quantity and quality organic waste collection at Sant Cugat del Vallés (Prepared by the authors).

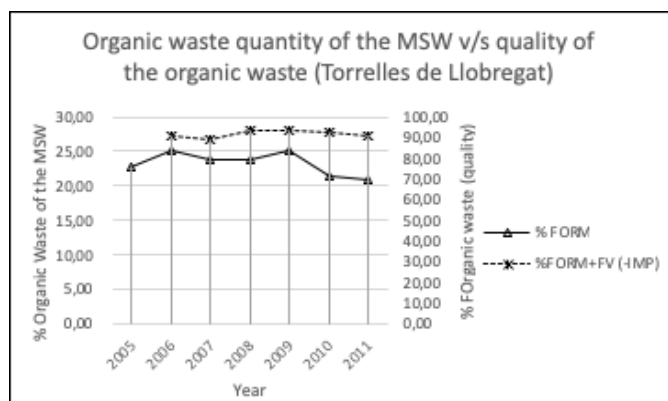


Figure 12: Ratio comparison of the quantity and quality organic waste collection at Torrelles de Llobregat (Prepared by the authors).

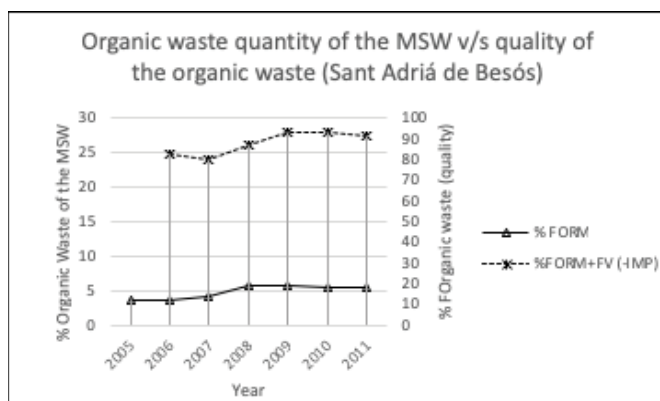


Figure 16: Ratio comparison of the quantity and quality organic waste collection at Sant Adrià de Besós (Prepared by the authors).

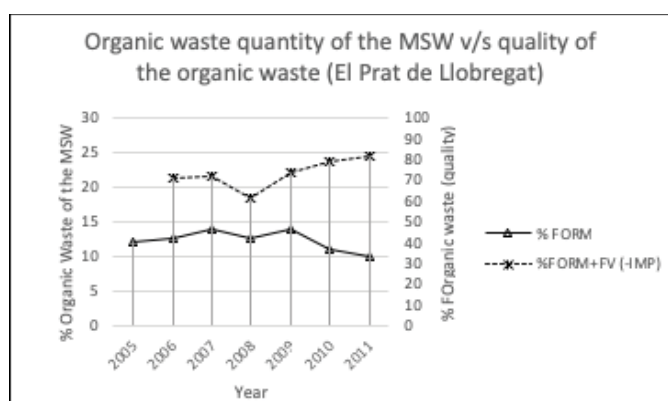


Figure 13: Ratio comparison of the quantity and quality organic waste collection at El Prat de Llobregat (Prepared by the authors).

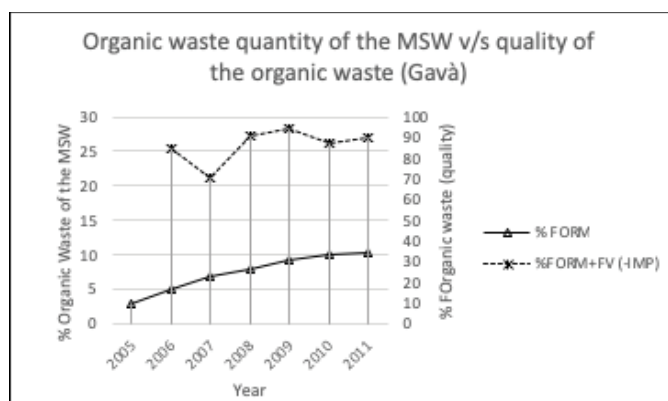


Figure 14: Ratio comparison of the quantity and quality organic waste collection at Gavà (Prepared by the authors).

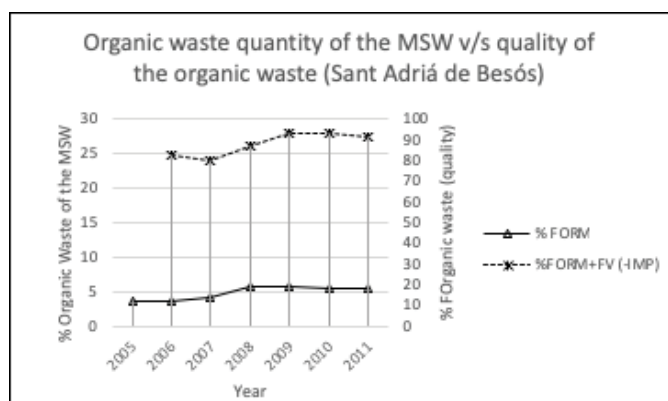


Figure 15: Ratio comparison of the quantity and quality organic waste collection at Gavà (Prepared by the authors).

incumbent to social institutions, but also on government instance as a whole. In fact, a correlation is necessary between government effort and the message for the citizens. That is necessary to make an evolution to a citizen compromised with social and environmental issues.

2.- Citizens have evolved its consumption pattern and, today, the organic waste fraction is scarcer in more active and developed urbanizations than that more traditional/rural life style.

3.- The number of fraction collected is correlated with the economic effort of some town councils, especially in campaigns, but is not a recognizable patron from the study focus.

4.- The organic waste fraction, no not direct relation with the economy effort about the environmental sensibilities.

5.- From the above points, we can add that the organic waste quality don not have relation with the number of the total fractions collected by the municipality, in other words, major percentage of organic waste of the total waste has no implication into the quality of the organic waste fraction.

6.- The town councils that maintain the economic effort in order to evolve in its collection waste model, focussed in improve the organic waste quality (e.g. Sant Cugat del Vallés and El Prat de Llobregat), presented the best evolution from a maintained environmental campaign.

7.- There are a difference in the environmental policies applied, by the particular situation/scenario of each municipality. For example, the effort of Torrelles de Llobregat it is focussed for maintain the quality of the process of sorting at the source (for this, they have a door-to-door collection model), in the other hand, El Prat de Llobregat focused this effort to improve the previous collection quality results, even reducing its environmental budget.

8.- Of the municipalities that compost in Eco-parks, the municipality of El Prat de Llobregat have the better result in sorting at the source –of organic waste fraction– demonstrating its high implication with the environment care (i.e. campaigns).

9.- It is imperative to have not only environmental education at the school (even the formal education), it is necessary to complement with non-formal education (e.g. scouts, excursion or sport club).

10.- It has been proven that environmental campaigns can be oriented not only in waste prevention, it could be appreciated how another environmental campaigns can impact in better citizens.

11.- The economic differences of the municipalities under study, do not have relation with the sorting at the source quality. In one hand, Sant Cugat del Vallés present a high income and is an active municipality (in terms of life style), but do not present a good organic



waste fraction. In the other hand, Torrelles de Llobregat, with a lower income, have the better organic waste fraction.

12.- Montcada I Reixac have demonstrate that a change in the citizen behaviour as a response of a specific campaign, however, because of the lack of data, we cannot be validated that que poor quality of the organic waste collection, is produced just for a low interest of the municipality to develop environmental education campaign, especially non-formal programs.

In this work have remained develop a more extensive study about the evolution along the time considering more variables (e.g. demographic, urban develop, social and economic variables, seasonal population and traditions and customs for each city), we believe that have a strong relationship with the quantity and quality of the organic waste fraction produced in each municipality.

### Acknowledgments

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### References

1. Alió Ma Àngels (2008) Una visió desde el anàlisi de las polítiques sobre el reciclae de residuos urbanos. *Scripta Nova*, revista electrònica de Geografia y Ciencias Sociales. Vol. XII, núm. 270 (148). Universidad de Barcelona. Catalunya.
2. Agència de residus de Catalunya. PROGEMIC, Programa de gestió de residus municipals a Catalunya 2007-2012. Generalitat de Catalunya. Departament de Medi Ambient i Habitatge.
3. Delgado E, Antilef A, Perez M, y Ortega, D Brújula (2012) Apuntes de apoyo para educadores ambientales. Ministerio del Medio Ambiente - Fundación Sendero de Chile. Chile.
4. Departamento de Control de la Contaminación, Área Residuos. Ministerio de Medio Ambiente de Chile (ex CONAMA). Chile. 2006
5. Gutiérrez J, Pozo T Modelos teóricos contemporáneos y marcos de fundamentación de la educación ambiental para el desarrollo sostenible. *Revista Iberoamericana de Educación*.
6. Ingelmo F., Canet R., Ibañez M. A., Pomares F. and García J. Use of MSW compost, dried sewage sludge and other wastes as partial substitutes for peat and soil. *Bioresource technology*. Elsevier Science Ltd. Great Britain. UK. 1998
7. Organización de Estados Iberoamericanos, para la ciencia y la cultura. Educación ambiental: Teoría y práctica. *Revista Iberoamericana de Educación*. Núm. 11. 1996.
8. Renkow M. and Rubin QR (1998) Does municipal solid waste composting make economic sense? *Journal of Environmental Management*.
9. Shiralipour Aziz, McConnel Dennis B, Smith Wayne H (1992) Uses and benefits of MSW compost: A review and an assessment. *Biomass and Bioenergy*. Vol 3. Great Britain. UK.
10. Stapp William B, Havlick Spenser, Bennet Dean, Bryan Jr. William, Fulton Jerome, et al. (1969) The concept of environmental education. *The journal of environmental education*. Vol 1 No 1, 30-31. USA.
11. Tchobanoglous George, Theisen Hilary and Vigil Samuel. *Gestión integral de residuos sólidos*. McGraw-Hill/Interamericana de España. 1994.