

MUNICIPAL WASTE IN CATALONIA (SPAIN): GENERATION AND RECYCLING RATES AS SUSTAINABILITY INDICATORS

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I. INTRODUCTION

Economic development of society is supported by a range of economic activities using a large amount of natural resources. These resources have been exploited throughout human history according to the available technology. Unfortunately, most of them are non-renewable resources because the generation rates are lower than the current extraction rates. One of the main features of the economically developed countries, as a consequence of using natural resources, is the production and consumption of a large number of products to satisfy their needs. Most of these products have a short life cycle and they could become a waste. Nevertheless, the total waste amount is also composed by the waste that is generated during the extraction and processing of raw materials. All human activities, including biological ones, generate residual products and some of them can be harmful to human health, animal and plant life and to the environment. Waste generation or what to do with the generated waste is an important issue at present because if there is no doubt that each territory has a limited capacity to receive socioeconomic activities (physical support) and transport and communication infrastructures, it seems evident that there is an also limited capacity to assume increasing amount of generated waste. For this reason, it is necessary to carry out a good waste management as well as policies to reduce total amount. Otherwise, it can become a serious environmental problem.

There is a wide typology of residual products with a different behaviour related to environmental agents, potential evolution over time and impacts on environment and human health. According to toxicity and hazard, waste is classified in three main groups: inert, special and non-special. In 2002, the European Waste Inventory (EWI) came into force and 20 categories were established, indicating required management: recovery, treatment and/or refuse disposal. Last category in the EWI (number 20) corresponds to the municipal waste, which includes waste originated from households and also the waste from commerce,

services and institutions. Municipal waste has grown dramatically in recent decades around the world, including in Spain, according to the 2009 Annual Report of Sustainability in Spain developed by the *Observatorio de la Sostenibilidad en España*. In 1990 around 12.5 million tonnes were generated while in 2007 the value exceeds 24.5 million tonnes. Distribution among Spanish population shows an increase in the amount per inhabitant from 323 kg/year in 1990 to 556 kg/year in 2007 (above EU-27 average). Municipal waste management has both environmental and economic costs. Nevertheless, they are more important if waste management is conducted to refuse disposal, either land filled or incinerated, than recycling. Most of municipal generated waste must be recycled but equally or more important than recycling is the reusing and the reducing of waste generation. The so-called triple R.

Taking as starting point the above information, the aim of this work is, first of all, to analyze the evolution of municipal waste generation and the recycling rates in Catalonia (Spain) and in its 41 counties and secondly, to establish the Catalan sustainability level by means of an indicator that combines the two mentioned variables (amount per inhabitant and recycling rate). The study period is 2000 and 2009 years.

II. SOURCES AND METHODOLOGY

Data have been obtained by means of two governmental institutions. Municipal waste data are available at the *Agència de Residus de Catalunya (ARC)* website, meanwhile population data are available at the *Institut d'Estadística de Catalunya (IDESCAT)* website. The *ARC* provides municipal waste data once a year on 31st of December. At present, household and commerce collection is not taken into account separately at the most of Catalan municipalities. For this reason and in order to achieve comparable results, we have used the data of total municipal waste, which are expressed in tonnes per year. Municipal waste is distributed among those which are collected separately (glass, paper, cardboard, plastic, organic matter, etc.) and those which are allocated to refuse disposal. Even that municipal waste generation per inhabitant/day is also supplied by the *ARC*, these data have not been used because municipal waste refers to 31st of December and population data to 1st of January. A new ratio has been calculated using as quotient the average between two consecutive years. The Population data of Catalonia and the 41 counties have been obtained through *IDESCAT* and they correspond to the sum of population of various municipalities. As it has been indicated previously, since 1996 population data correspond to the 1st of January. So if 2000 and 2009 are the analyzed years, the population collected data is from 2000, 2001, 2009 and 2010. Municipal waste generated during the whole 2000 (2009) has been imputed to the population average between 2000 and 2001 (2009 and 2010), both cases dated on 1st of January. Although we agree that it is not the optimal solution, especially when calculating a value (kg/inhabitant/day) based only on the registered population, it is a better approach than the *ARC* one. Results are shown using numerical representations (tables), as well as cartographic figures in order to compare between 2000 and 2009 years. The analyzed aspects are:

- a) Population and municipal generated waste trends.
- b) Ratio per inhabitant and day.

- c) Recycling rates.
- d) Organic waste collection.
- e) Regional sustainability level.

The sustainability level has been calculated by means of an indicator that combines total municipal waste generation per inhabitant and recycling rate. Five sustainability thresholds have been defined both for generation and recycling rate: very high, high, moderate, low and very low sustainability. At the same time, these labels have been associated with a numeric value (see Table 1 in the Spanish version). The overall sustainability has been obtained from the sum of the values of the two variables. Nevertheless, generated waste per inhabitant has more weight (1.5) than the recycling rate. Although there is no doubt that the increasing recycling rates are very important, even more important is to reduce the total generation. There are 25 possible combinations, each of them associated with very high, high, moderate, low and very low sustainability (see Table 2 in the Spanish version).

III. RESULTS

In 2000 the municipal waste generated in Catalonia was almost 3.5 million tonnes while in 2009, it was 4.2 million. That means 20.8% higher. However and for the first time in the last decades, waste generation amount in 2009 has been lower than previous year, when it exceeded 4.2 million tonnes. Nevertheless, important differences exist at regional level. Increasing rates are not equal around the 41 Catalan counties. There are relevant differences and whereas in some cases the increase has been lower than 15% (inland rural counties) in other cases the change has been up to 50% (*Conca de Barberà, Priorat* and *Ribera d'Ebre*).

It seems logical that municipal waste generation increase is due to another increase: population. Catalan population in 2009 is 18.7% higher than 9 years before, although rates have not been uniform across the territory. Population growth largely explains waste increases, but not totally, especially at the county level. The main reason is the coming of visitors, temporal residents and tourists. They all generate municipal waste that actually is imputed to resident people. At the same time economical variables have to be taken in consideration.

Municipal waste generation per inhabitant in Catalonia has risen from 1.51 kg/day in 2000 to 1.53 kg/day in 2009. Increase has been lower than 5% and it must be noted again the improvement in comparison with 2007 (1.64 kg/inhabitant/day). The Catalan Municipal Waste Management Program (*PROGREMIC*) target for 2012 is 1.48 kg/inhabitant/day. According to previously defined thresholds, 2000 and 2009 values are considered low sustainability (>1.50 kg/inhabitant/day). Nevertheless 22 of 41 Catalan counties achieve *PROGREMIC* target. The best rate corresponds to *Terra Alta* county (1.02 kg/inhabitant/day), and other 6 counties that have high sustainability level (<1.25 kg/inhabitant/day). On the other hand, sustainability in 19 counties is low or very low. In some cases, rate is higher than 2 kg/inhabitant/day: *Alt Empordà, Baix Empordà, Baix Penedès, Selva* and *Val d'Aran*.

People of these counties generate more waste than *Terra Alta* ones actually? Maybe they do, but are the differences shown real? Absolutely not, because total municipal waste

generated at *Baix Penedès* county computes to only 100.000 resident people while waste has been generated by a much larger population (tourists included). Comparing 2000 and 2009 values, opposite features are shown but the best and the worst counties in terms of waste generation per inhabitant are, practically, the same.

Recycling rate has improved significantly, almost twice, in the last years in Catalonia from a very poor 17.7% in 2000 to 37.5% in 2009. However, improving can be more significant according to potential recycling rate estimated in 80% of total municipal generated waste. Low values are due to recent past of selected municipal waste collection in Catalonia and also in the whole Spain, especially referring to the organic fraction. In terms of sustainability, recycling rate is considered very low (<20%) in 2000 and moderate (>35%) in 2009. At regional level, only 2 of the 41 Catalan counties recycled more than 20% in 2000 (*Alt Urgell* and *Garraf*), meanwhile the worst value was in *Baix Penedès* with only 1.9%. Despite recycling rates lower than 20% are maintained at 2 counties in 2009 (very low sustainability), in other 6 are higher than 50% (high sustainability). The best value corresponds to *Ribera d'Ebre* county with 556.9%, curiously the county with the highest municipal waste generation increase.

There is not doubt that organic fraction collection must play an important role in order to increase recycling rate. The *Agència de Residus de Catalunya (ARC)* estimates that organic fraction weight represents approximately one third of municipal generated waste, but this value may vary significantly taking into account social, cultural and economic aspects. Organic fraction collection in Catalonia began in 1996. Almost 30,000 tonnes were collected in 2000 (<1% of total municipal waste). This small value can be easily explained: organic recycling was available in only 71 of the 946 Catalan municipalities. Nevertheless, despite the amount collected in 2009 was 340,000 tonnes (and 574 municipalities), it only represents 8.1% of the total municipal generated waste.

Is the municipal waste generation increasing because of the glass, plastic o cardboard packaging? Is it increasing because life cycle of many products is short? Generation per inhabitant has increased, but are results biased by the presence of non-resident people? We can assume than in all the cases the answer is YES.

At this point, sustainability of the whole Catalonia and its 41 counties is assessed. It has been carried out by means of an indicator where municipal generated waste per inhabitant and recycling rate are combined according to the previously explained methodology. The results show a very low sustainability level (3.75) for Catalonia in 2000, as a consequence of the low sustainability level in waste generation (1.51 kg/inhabitant/day) and a very low sustainability level in recycling rate (17.7%). Municipal waste generation per inhabitant is 1.53 kg/day in 2009, but it is within the range of low sustainability (>1.50 and ≤1.75) and at the same time recycling rate has increased significantly until 37.5% (moderate sustainability). Although since year 2000 general sustainability level has improved (8.75 in 2009), it is already qualified as low.

There are important differences at regional level. Only four counties (*Gironès*, *Pla d'Urgell*, *Segarra* and *Terra Alta*) have a high sustainability level; but meanwhile in 2000 only 9 of them had a moderate sustainability level, 9 years later there are 20. On the opposite side, 15 counties had a very low sustainability level in 2000 and there are 8 in 2009.

IV. CONCLUSIONS

The analysis of the municipal waste generation in Catalonia between 2000 and 2009 shows a significant increase. Catalonia's population has also increased, although less than waste. Consequently, that means there had been an increase in generation per inhabitant in the last 9 years from 1.51 to 1.53 kg/day. However, the 2009 result has been better than the 2008 one. Target established by the *Agència de Residus de Catalunya* for 2012 is the reduction of the value to 1.48 kg/inhabitant/day.

Recycling rate has improved significantly during the last years (17.7 % - 37.5%), despite it is not a high value yet. Diminishing municipal waste sent to final disposal (landfilled or incinerated) is very positive in terms of economic and environmental aspects. There is no doubt that recycling rates would be higher when organic fraction will be collected at all Catalan municipalities.

Catalonia shows considerable differences at regional level (counties). Population and municipal waste generation increase has not been uniform, being more important in the coastal zone and in the regions where tourism activity has a significant weight in the economy. The highest ratios of waste generation (> 1.75 kg/inhabitant/day) are found in the most tourist counties placed on the coast and in the Pyrenees Mountains. On the other hand, the lowest values are in the westernmost region (rural area) of Catalonia. There are important differences in recycling rates: in some counties value is under 20% meanwhile in six are over 50%.

The sustainability level in Catalonia assessed by means of an indicator combining municipal waste generation per inhabitant and recycling rates in 2009 is moderate but it was very low in 2000. Results would be better if recycling rates will be improved (easy) and municipal generated waste per inhabitant (more difficult) will be reduced. The characteristic of indicator makes possible to update results and evaluate the Catalan and other regions sustainability level.

Finally, some questions have not been answered. The main one is related to calculation of municipal waste generation per inhabitant. At present, only the resident population is taken into account but there are some regions where an important portion of municipal waste generated by tourists and visitors. For this reason, it is required to work with data on a monthly basis, distributed by municipalities and, to have seasonal population data, which is more difficult but essential.

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