The impact of the 2008 economic crisis on waste production in Portugal

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Abstract

A key information for waste management in general, and the waste collection service in particular, is estimating waste generation. Past studies have demonstrated that waste generation is linked to consumption, which may be driven by habits or wealth. The present study explores the perturbation on the Portuguese families wealth created by the 2008 economic crisis to understand the relation with the generation of the various waste streams collected in the municipality of Cascais. The methodology comprised in calculating the Pearson correlations between the annual population, unemployment rate and gross domestic product and the corresponding waste generated between 2003 and 2018. It was possible to observe that the mixed waste and the number of unemployed had a strong negative relating while the gross domestic product and the bulky waste had a strong positive relation.

Keywords

Waste production; mixed waste; packaging waste; economy; gross domestic product; unemployment

1. Introduction

Since human activities always produce waste, including the non-commercial, its management is a basic need of modern communities. Waste generation is strongly related with population and economic

growths (EEA, 2003; Giusti, 2009) and is considered to be reflection of the degree of socio-economic development, industrialization and urbanization (Pires et al., 2011). Within this context, municipal waste management, in particular the components related with residential, leisure, education, health and other basic human activities, is deemed to be accounted as a public service. In fact, regardless of the waste management model implemented and the degree of participation of the private sector, the governments bear the responsibility for ensuring that the service is provided and controlling its quality and continuity.

From a sustainability point of view, the economic, environmental and social dimensions of waste management make it a challenge that governments, industry and researchers have been contributing to tackle. It has been demonstrated that the solutions adopted to manage the growing amounts of waste produced influence human health and the environment and could contribute significantly to resources conservations (Ngoc and Schnitzer, 2009). Providing a system for the communities to dispose of their waste and ensuring that the waste is then dealt with in a socially responsible, environmentally safe and economically viable way is becoming increasingly stringent requirement. In the EU, the waste management hierarchy set by the Landfill Directive recommends the decrease of waste quantity landfilled and the increasing in weight and preference for waste minimization, reuse and recycling alternatives.

Adequate planning and optimized operation waste management systems require an accurate knowledge of the amount and composition of waste generated. This requirement comprises the basic information needed for waste management and the demand for reliable and detailed data has increased over the last years along with the growing requirements that have and being set on waste management services. In many countries, there is legislation or regulation requiring the record of the waste generated (and waste composition also in many cases). In Portugal, the waste management utilities are required to communicate to the state regulator (ERSAR – *Entidade Reguladora dos Serviços de Águas e Resíduos*) the amounts of mixed and source segregated waste collected and/or treated every year, depending on the service provided by the utility. Waste generation forecast is also required by legislation or regulation in some countries. Germany is one of those, with the public authorities responsible for providing the waste management service (cities or counties) being required to assure "guaranteed disposal" for a period of 10 years in advance (Beigl et al., 2008).

Behavioural changes through education and awareness campaigns may take years, decades or even generations to occur. As such, if no significant change in context takes place on the waste producers or in the waste collection service, it is possible to assume that municipal waste generation will be driven by consumption, in particular the population evolution and the purchase power. In logical terms, this relation between consumption pattern and waste generation will be stronger for non-essential goods than for essential goods (e.g., food). The 2008 worldwide economic crisis, that affected significantly countries such as Portugal, presents a unique opportunity to observe the influence of the consumption related factors on waste generation. The present contribution looks at the relation between consumption

and waste generation in Cascais, a municipality in Portugal, observing that the relation is stronger for waste from non-essential goods (e.g., bulky waste, packaging waste) than for waste from essential goods (mixed waste).

2. Waste Generation Modelling

Obtaining reliable information on waste quantity and composition is difficult to achieve on a disaggregated level because the directed measurement of waste generation is not easy and, in many waste management schemes, impossible. Furthermore, nowadays most waste collection schemes have several parallel collection points (e.g., public curbside collection; civic amenity sites for green waste; bulky waste; private collectors of clothing textiles; take back by retailers). Measurement of waste generation on a single household is only available in rare situations, namely in areas equipped with Pay-As-You-Throw systems. The lack of detailed waste generation measurements hinders the possibility for monitoring and evaluating the disposal habits, changes and trends of individuals.

In this context, the relevance of modelling waste generation is paramount for planning and operating waste management, including: i) development of strategies to manage waste (Daskalopoulos et al., 1998); ii) estimate land demand for landfilling and other facilities/infrastructures (Leao et al., 2001); iii) design waste collection services (Grossman et al., 1974) and infrastructures (Dennison et al., 1996) or treatment facilities and capacities (Chang and Lin, 1997); iv) monitoring waste management performance (OECD, 2004); and v) estimate personnel and truck needs (Matsuto and Tanaka, 1993) and the corresponding operational costs (Grossman et al., 1974).

Beigl et al. (2008) and Kolekar et al. (2016) carried out reviews on waste generation modelling studies. Combined, they analysed 65 references on the topic and classified them according to the application area (spatial scale), the time series (time scale), the waste streams (disaggregation), the independent variables and the modelling methods. Regardless of the differences amongst the various research efforts in terms of the characteristics reported, it is interesting to notice a trend for resorting to artificial intelligence tools as modelling methods in the attempt to increase the resolution in space, time and disaggregation, noticeable in the more recent studies. However, it is possible to find in the literature more studies in the topic, both in recent years and before the reviews (e.g., Ghinea et al., 2016; Kannagara et al., 2018)

3. Case Study

Cascais municipality, covering an area of almost 100 km^2 and with a population of 211 714 inhabitants in 2018, is located in Portugal at approximately 30 km west of the capital city, Lisbon. The municipality

is divided into 4 parishes, with 2 of them resulting from the merge of the parishes of Cascais with Estoril and Carcavelos with Parede. The majority of the population is concentrated in the southern parishes (Cascais-Estoril and Carcavelos-Parede) along the coastline.

The waste collection is amongst the responsibilities of Cascais Ambiente and is collected through 4 main streams: i) mixed waste; ii) source segregated waste, namely paper, plastic and glass; iii) parks and garden waste; and iv) bulky waste. Two other waste streams are also collected, namely food waste (only for main producers – e.g., restaurants, shopping malls) and street cleaning (public waste containers). The average total solid waste collected yearly between 2003 and 2018 was 136 000 tonnes, of which the mixed and source segregated wastes amounted 84 000 tonnes. Analysing the time variation of the production rates of different waste streams it was possible to observe that the amount of mixed and segregate waste varied significantly with the 2008 crisis (Figure 1). A significant decrease on the amount of waste production was observed between 2008 and 2014-2015, followed by an increase with the economic recovery over the last years.

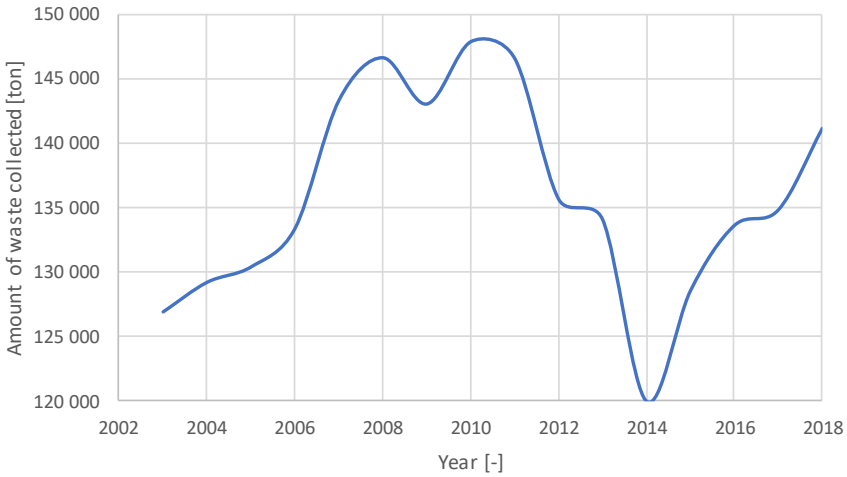


Figure 1 - Total waste collected in Cascais between 2003 and 2018.

Figure 2 details the average waste proportion in weight of the different waste streams collected in the municipality of Cascais. The mixed waste is the most significant waste stream and accounted between 76% in 2003 and 62% in 2010. In 2018, the proportion of mixed was 64% and there has been a clear declining trend since 2003. Part of this declining trend is explained by the increasing transfer of packaging waste to the segregate waste collection, mainly paper, plastic and glass, but there was also a decrease on the per capita waste generation from 554 kg/hab.year, in 2003, to 468 kg/hab.year, in 2018, with a minimum of 449 kg/hab.year in 2015 (only mixed and segregated waste streams).

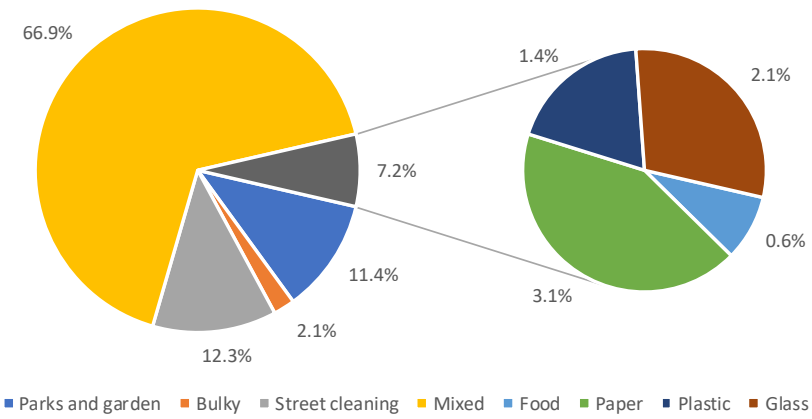
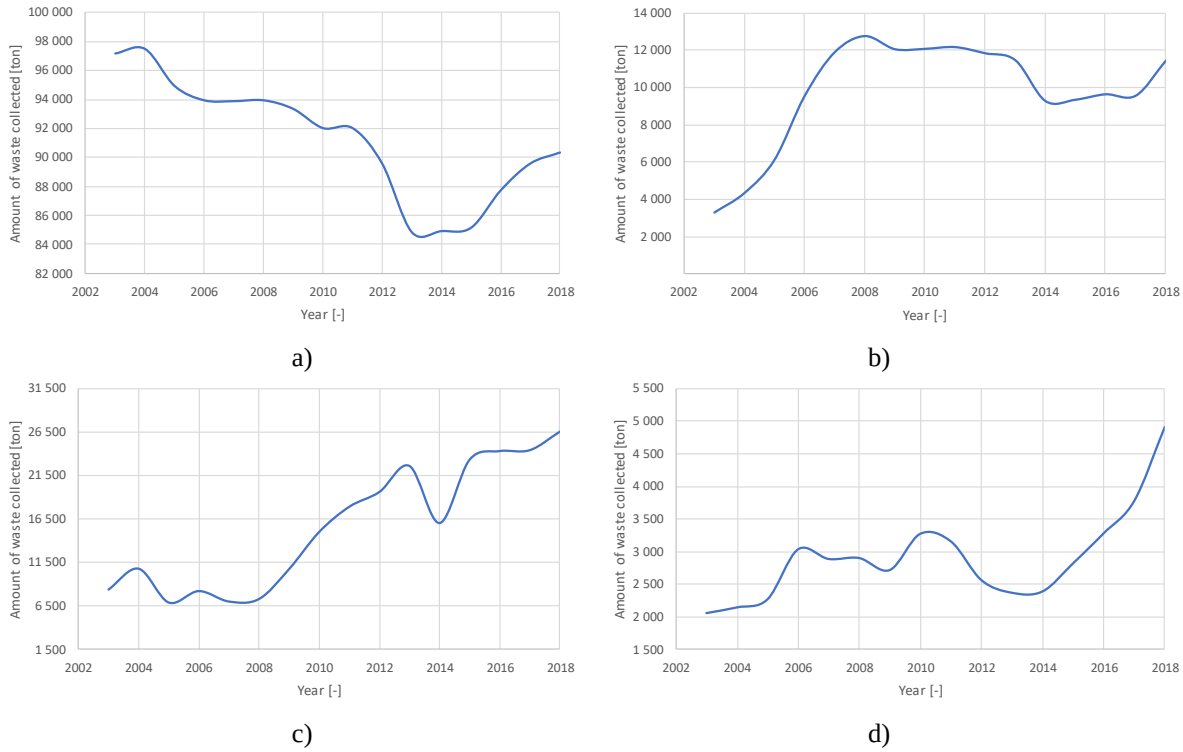
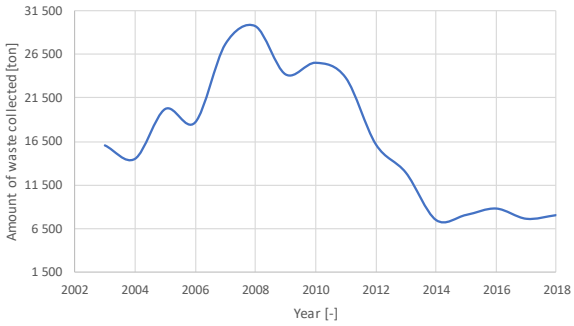


Figure 2 – Average proportion of the waste streams collected in Cascais between 2003 and 2018.

4. Results and Discussion

Figure 3 presents the waste generation evolution of the main waste streams between 2003 and 2018. It is noticeable the significant decrease on the mixed waste along with the increase on the segregate waste. The transfer of packaging waste from the mixed to the segregate until 2006-2008 was mainly driven by the improvement of the segregate waste collection service, coinciding with increasing regulation demands. The garden waste accounted for herein is mostly from the citizens, as the street cleaning. The growth in the former and decrease in the latter may be explained by a change of habits, namely the boom in growing vegetable gardens and less food consumption outside the houses. This trend for organic products and healthier lifestyle may be the most important factor underlying the garden waste and street cleaning pattern.

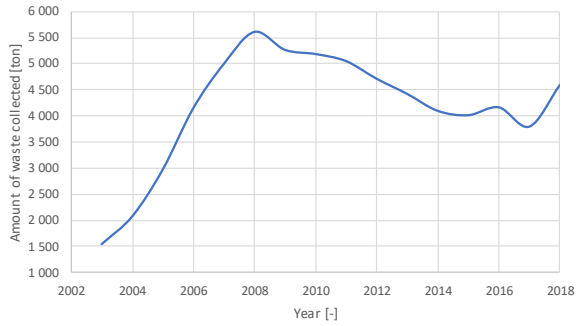




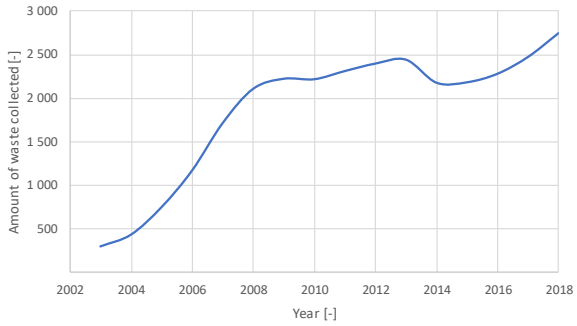
e)

Figure 3 – Waste generation between 2003 and 2018 for: a) mixed; b) segregated; c) garden; d) bulky; e) street cleaning.

Evaluating the segregated waste streams separately (Figure 4), except for food waste that is negligible. In the years 2008 and, specially, 2014-2015, there were clear changes on the mixed waste production rate and trend, respectively. With the exception of the plastic waste, the years 2008 and 2014-2015 marked inversions on the trends of the segregate waste streams. For the plastic waste stream, the years 2008 and 2014-2015 represented changes on the production rate, but a growing trend is present almost in all the time frame analysed. The years 2013 and 2014 were coincident with the peak of the economic crisis (2012 – lowest gross domestic product in purchase power parity; 2013 – highest unemployment rate), but the number reveal that the policies to reduce plastic waste are only achieving a reduction in the generation rate or a stabilization at most (around 10-12 kg/hab.year).



a)



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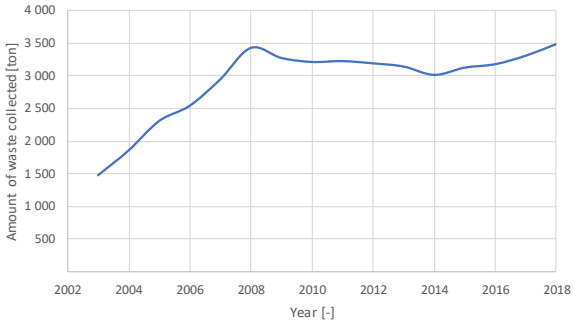

d)

Figure 4 – Waste production in Cascais between 2003 and 2018 for: a) paper; b) plastic; and c) glass.

Relating the amounts of waste produced with the gross domestic product in purchase power parity (GDP), the unemployment rate (UR), the population (Pop), high Pearson correlation coefficients were

obtained for the mixed and bulky waste streams (Table 1). Garden and street cleaning waste show a weak relation with the variables considered and opposite trends before and after 2008. It is probable that the underlying drivers for the generation of these waste streams are more related with individual behaviour changes. The total number of unemployed individuals (URxPop) present the strongest relation with the mixed waste generation. The relative purchase capacity of the families (GDP) highly related to the bulky waste generation. However, the relative variation between the highest and lowest amounts of mixed and bulky waste generated are 29% and 47%, respectively. This reveals that the waste generation related essential goods (food) that comprise a large portion of the mixed waste is less sensible to the crisis than the waste from non-essential goods that drive the bulky waste stream.

Regarding the main components of the segregate waste, namely paper, plastic and glass, the corresponding Pearson correlations are presented in Table 2. Regarding paper waste, there are strong Pearson correlations, but mixed trend before and after 2008, indicating that other factors are driving paper waste generation. Regarding plastic waste, population is observed to be the main driver. There is also high Pearson correlation with the unemployment rate, which may be related with the consumption essential (food packaging) and non-essential goods. Assuming that a significant portion of essential goods are in plastic and metal packages, the corresponding waste will always be driven by the number of individuals, but less if they are unemployed. Glass waste generation is driven by GDP, which is consistent with the fact that in Portugal the most significant source of glass waste are beverages, in particular alcoholic beverages.

Table 1 – Pearson correlation coefficients between the amount of waste collected and the GDP, UR and Pop.

Waste stream	Period	UR	GDP	Pop	GDPxPop	URxPop
Mixed	Total	-0.78	-0.41	-0.85	-0.71	**-0.82**
	Until 2008	-0.74	-0.95	-0.89	-0.94	**-0.93**
	After 2008	-0.52	-0.02	-0.63	-0.23	**-0.55**
	Average	-0.63	-0.49	-0.76	-0.58	**-0.74**
Segregated	Total	0.43	0.71	0.70	0.77	0.46
	Until 2008	0.52	0.98	0.99	0.99	0.83
	After 2008	0.18	-0.59	-0.77	-0.74	0.15
	Average	0.35	0.20	0.11	0.13	0.49
Garden	Total	0.67	0.25	0.82	0.61	0.71
	Until 2008	-0.85	-0.62	-0.57	-0.61	-0.85
	After 2008	0.19	0.33	0.89	0.57	0.23
	Average	-0.33	-0.15	0.16	-0.02	-0.31
Bulky	Total	-0.06	**0.79**	0.59	0.77	0.01
	Until 2008	0.52	**0.93**	0.88	0.92	0.78
	After 2008	-0.73	**0.74**	0.33	0.71	-0.71
	Average	-0.10	**0.84**	0.60	0.82	0.04
Street Cleaning	Total	-0.35	0.12	-0.32	-0.12	-0.36
	Until 2008	0.53	0.87	0.91	0.89	0.80
	After 2008	-0.13	-0.33	-0.84	-0.56	-0.17
	Average	0.20	0.27	0.04	0.17	0.32

Table 2 – Pearson correlation coefficients between the amount of segregate waste collected and the GDP, UR and Pop.

Segregated Waste	Period	UR	GDP	Pop	GDPxPop	URxPop
Paper	Total	0.33	0.74	0.64	0.76	0.37
	Until 2008	0.50	0.98	0.99	0.99	0.82
	After 2008	-0.04	-0.44	-0.90	-0.66	-0.08
	Average	0.23	0.27	0.05	0.17	0.37
Plastic	Total	0.63	0.67	**0.96**	0.91	0.68
	Until 2008	0.44	0.94	**0.99**	0.97	0.78
	After 2008	0.27	-0.19	**0.32**	-0.04	0.28
	Average	0.36	0.38	**0.65**	0.46	0.53
Glass	Total	0.46	**0.80**	0.88	0.93	0.52
	Until 2008	0.43	**0.96**	1.00	0.98	0.78
	After 2008	-0.57	**0.24**	-0.24	0.11	-0.58
	Average	-0.07	**0.60**	0.38	0.54	0.10

5. Conclusions

The 2008 economic crisis was particularly harsh in some countries, including Portugal, creating a peculiar context to assess the influence of economic indicators on waste generation. In fact, in a non-crisis context there have been over the last decades a regular and steady increase in wealth, consumption and waste generation, particularly municipal waste. The economic crisis created a rupture on this trend and the impact on waste generation from the consumption of essential goods (in particular food-related) and from the consumption non-essential goods (in particular food) was distinct. This was observed in the case study of Cascais analysed herein, particularly when comparing the mixed and bulky waste generation.

Nevertheless, there are other variables influencing waste generation that were not account for and may be difficult to do so. The developments in waste collection services (e.g., limitation of the distance between collection points), the changes in packaging waste legislation (e.g., the introduction of charges on plastic bags) and the growing awareness and conscientious behaviour.

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