



# Appendix to Changing Markets Cost of Littering in Spain

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### 1.1.1 Version Control Table

Version	Date	Author	Description
<b>V1.0 Final</b>	03/01/2021	John Carhart	An annex to Changing Markets' Spanish Litter Cost report. This paper details the supporting calculations for Box 2 of Changing Markets' report.

# Introduction

This report serves as an appendix to Box 2 of Changing Markets' *More Trash, more Cash: Who's really behind the plastics crisis in Spain* report.<sup>1</sup> This appendix will further describe the costs of managing litter in Spain and provides background calculations and sources used to estimate the cost of managing street and beach litter in Spain for 2019.

## Background

The European Union (EU) has begun to focus on managing littered items and their potential hazard to the environment. The European Commission's Single Use Plastic (SUP) Directive names litter reduction as one of its policy goals, as the EU is concerned about both the expense of cleaning street litter and the negative externalities caused by litter when it finds its way into marine environments.<sup>2</sup> For example, it is estimated that fisheries in the EU lose around 1% of total revenues from catches of the EU fleet due to litter.<sup>3</sup>

Packaging products, and to a greater extent plastic packaging, are consistently mentioned as some of the most common litter items found in European seas.<sup>4</sup> Furthermore, street cleaning operations in Spain can cost municipalities from approximately €30 to over €100 per person per year.<sup>5</sup> Litter is therefore an important environmental and financial concern for municipalities.

This brief estimates the total cost of managing packaging and beverage container litter in Spanish municipalities' street and beach cleaning programs. Deep sea litter costs have not been calculated as, while there is data on the potential externalities of litter in the ocean, actual litter cleanup costs for the deep sea were not available. However, removing litter from the deep sea is an area of concern as well, which may incur substantial costs.<sup>6</sup> Litter data in general is scarce in most countries, which can make mass flow calculations and material monitoring difficult.

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<sup>1</sup> <http://changingmarkets.org/wp-content/uploads/2021/02/MoreTrashMoreCash.pdf>

<sup>2</sup> <https://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy.pdf>

<sup>3</sup> Ibid.

<sup>4</sup>

[https://publications.jrc.ec.europa.eu/repository/bitstream/JRC108181/technical\\_report\\_top\\_marine\\_litter\\_items\\_eur\\_29249\\_en\\_pdf.pdf](https://publications.jrc.ec.europa.eu/repository/bitstream/JRC108181/technical_report_top_marine_litter_items_eur_29249_en_pdf.pdf)

<sup>5</sup> [https://transparentia-](https://transparentia-municipal.newtral.es/ranking/2020/G/functional/amount/163?utf8=%E2%9C%93&f%5Baarr%5D=&commit=Explorar)

[municipal.newtral.es/ranking/2020/G/functional/amount/163?utf8=%E2%9C%93&f%5Baarr%5D=&commit=Explorar](https://transparentia-municipal.newtral.es/ranking/2020/G/functional/amount/163?utf8=%E2%9C%93&f%5Baarr%5D=&commit=Explorar)

<sup>6</sup> <https://europe.oceana.org/en/publications/reports/espana-buceando-entre-plasticos>

# Cost of Managing Packaging Related Litter

## 2.0 Street and In-Land Packaging Related Litter Costs

The steps taken to calculate a cost of managing packaging related street, inland and beach litters were as follows:

- 1) Litter compositions were reviewed from street cleaning operations in a selection of municipalities.
- 2) Volume and weight-based calculations were applied to litter compositions to determine packaging and beverage materials cost impacts.
- 3) The compositions were applied to total street litter costs for Spain.

### 2.1 Street Litter Composition Review

Cleaning street litter in Spain includes various practices for both manually and mechanically removing ground litter. Examples of how municipalities deal with mismanaged litter include: manual flushing and picking of sidewalks, mechanical sweeping of roads and the use of hosepipes and jet washes.<sup>78</sup> Additionally, municipalities are also responsible for emptying litter bins.<sup>9</sup>

A literature review identified three studies that included data on litter composition each with a different methodological approach:

- Amigos de la Tierra (Friends of the Earth Spain) study completed in 2016. The study details street litter composition that was weight based and collected from three municipalities from multiple locations, from the ground and litter bins and on multiple dates.<sup>10</sup>
- University of Castellón in 2016 focused only on ground litter collected at one point in time in 30 different locations with the data collected by volunteer organizations.
- Rezero in 2014 had a higher material level breakdown of litter than the above but the data was not as granular as the Amigos de la Tierra study.<sup>11</sup>

Amigos de la Tierra study was chosen because it was weight based, carried out over a longer period and carried out by the municipality rather than volunteer organizations.

The Amigos de la Tierra study found that:

- 15-22% of street litter is packaging (including beverage containers) by weight.
- 10-18% of street litter is beverage containers.<sup>12</sup>

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<sup>7</sup> <https://mancoribera.com/servicios/limpieza/>

<sup>8</sup> <https://debarrena.eus/es/servicios/limpieza-viaria>

<sup>9</sup> [https://www.tierra.org/wp-content/uploads/2016/11/Informe\\_en\\_lata\\_y\\_en\\_botella.pdf](https://www.tierra.org/wp-content/uploads/2016/11/Informe_en_lata_y_en_botella.pdf)

<sup>10</sup> Ibid.

<sup>11</sup> Retorna 2014. IMPLANTACIÓ D'UN SISTEMA DE RETORN D'ENVASOS DE BEGUDES.

<sup>12</sup> [https://www.tierra.org/wp-content/uploads/2016/11/Informe\\_en\\_lata\\_y\\_en\\_botella.pdf](https://www.tierra.org/wp-content/uploads/2016/11/Informe_en_lata_y_en_botella.pdf)

Packaging includes plastic bottles, plastic cups, plastic trays, aluminum cans and foil, steel cans, cardboard, cartons/tetra-pack and glass bottles. Beverage containers include plastic bottles, aluminum cans, steel cans, cartons/tetra-pack and glass bottles.

The weight-based composition from Amigos de la Tierra was then converted into a volume based assessment as well as a hybrid – 50% weigh and 50% volume for the reasons provided below.

## 2.2 Street Litter Volume and Weight Composition Calculation

Three approaches were considered to attribute street litter cleaning costs to packaging and beverage container litter:

- Weight-based calculation.
- Volume-based calculation.
- Hybrid: 50% weight and 50% volume calculation.

Three calculation methods were considered because weight alone is not the most appropriate method to apportion costs. Collection vehicles and bins require emptying either because they have reached a weight limit or because they have become full. Taking a weight and volume-based assessment is important for packaging material as some materials such as glass bottles are heavy but not very voluminous while for others, such as plastics bottles, the case is reversed, they are light but take up a lot of space and cannot be easily compacted.

Litter composition data from Amigos de la Tierra was used as the starting point for the three approaches.<sup>13</sup> The Amigos de la Tierra study provides three weight-based litter compositions from the municipalities of Castellón, Valencia and Alicante on a detailed material level. The compositional study was converted in to a “by-volume” breakdown of litter by multiplying the litter composition weights by household bulk density data by material type.<sup>14,15,16</sup>

A third calculation was carried based provided averaging the weight and volume compositions. The third composition was used to apportion the total cost of litter cleaning into the costs of managing packaging and beverage containers, as it allowed both weight and volume to play a part in determining costs.

Using calculation method three 31-39% of total litter costs could be attributed to packaging, with a average value across the three municipalities of 37.1%. Beverage containers accounted for 18-29%, with an average value across the three municipalities of 25.9% of costs.

High and low estimates of packaging as a proportion of all litter are shown in Table 1. The high and low scenarios are based on the municipalities with either a higher or lower composition of

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<sup>13</sup> [https://www.tierra.org/wp-content/uploads/2016/11/Informe\\_en\\_lata\\_y\\_en\\_botella.pdf](https://www.tierra.org/wp-content/uploads/2016/11/Informe_en_lata_y_en_botella.pdf)

<sup>14</sup> <https://www.wrap.org.uk/sites/files/wrap/Bulk%20Density%20Summary%20Report%20-%20Jan2010.pdf>

<sup>15</sup> <https://www.sepa.org.uk/media/163323/uk-conversion-factors-for-waste.xlsx>

<sup>16</sup> <https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/prevencion-y-gestion-residuos/flujos/domesticos/fracciones/papel-y-carton/Que-caracteristicas-tiene.aspx>

packaging than the average of all three. The low and high estimates the compositions used to determine the range of costs of cleaning street litter.

**Table 1: Packaging and Beverage Container Percentage of Litter by Method**

	Low Packaging Scenario			High Packaging Scenario		
	Weight	Volume	50% Weight 50% volume	Weight	Volume	50% Weight 50% volume
<b>Non-Beverage Packaging</b>	5%	21%	13%	4%	15%	10%
<b>Beverage Packaging</b>	1%	26%	18%	18%	46%	29%
<b>All Packaging</b>	15%	47%	31%	22%	61%	39%

Source: Eunomia Calculations, Amigos de la Tierra (2016), WRAP (2010)

Appendix table A 1 includes average assessments on the percentage of litter which is beverage containers and non-beverage packaging.

The 50% weight and 50% volume calculation was used to apportion the percentage of total cost of managing street litter to packaging materials by multiplying the percentages by the total cost of managing street litter. This process is outlined in the next section.

## 2.3 Apportionment of Street Cleaning Costs to Beverage and Packaging Litter

Total street cleaning costs were obtained from a variety of sources including a study by Organization of Consumers and Users (OCU) on municipal spending,<sup>17</sup> Newtral’s Ránking de gastos en Limpieza viaria,<sup>18</sup> and individual municipal budgets.

<sup>17</sup> Hurle, 2019. OCU – Compra Maestro mayo 2019

<sup>18</sup> <https://transparentia-municipal.newtral.es/ranking/2020/G/functional/amount/163?utf8=%E2%9C%93&f%5Baarr%5D=&commit=Explorar>

The calculation was carried out using total street cleaning costs for 73% of Spain's population taken from Newtral's Ránking de gastos en Limpieza viaria database and extrapolating these to cover 100% of Spain's population. This calculation resulted in an estimated total cost of street cleaning of €2,684M.

Total street cleaning costs include non-litter related activities, such as street and pavement washing and clearing green areas. Reviews of Spanish municipal budgets and correspondence with waste management representatives from Retorna and Amigos de la Tierra did not produce detail on how costs could be attributed across the different cleaning activities.<sup>19</sup> Previous Eunomia research calculated that municipalities in the UK attribute 58% of their total street cleaning costs to litter cleaning.<sup>20</sup> Due to the lack of data in Spain this 58% figure from previous research was applied to the total street cleaning costs in Spain to produce a total litter cleaning cost estimate of €1,550M.

The percentages shown in Table 1 were then multiplied by this total cost figure. An example of the calculation is shown below:

- Packaging cost:  $37.1\% \times €1,550M = €575M$
- Beverage container cost:  $26.9\% \times €1,550M = €417M$

## 2.4 Street Litter Cleaning Cost Results

Table 2 presents a range of estimated costs for managing packaging and beverage related litter. This range takes into consideration the fact that some of the composition data was a city that had a very high level of tourism which is not necessarily reflective of the whole of Spain. The lower costs therefore have been calculated using litter compositions of cities excluding the city with the very high level of tourism whose litter composition contained a much higher proportion of beverage containers than the other cities'.

Removing this city's composition from the calculations lowered the total costs apportioned to beverage containers and packaging. Conversely, the high total costs are modelled including the city with high levels of tourism. While many Spanish cities are tourist-heavy and therefore may contain higher amounts of beverage containers in litter streams than assumed in the low-cost calculation, the exact value is most likely somewhere in the middle of the range presented.

The cost of non-beverage packaging decreases in the higher scenario, this is because there is a much higher prevalence of beverage containers in littered packaging stream when the city with a very high level of tourism is included, so while the non-beverage packaging costs are lower, overall packaging costs are higher. This is illustrated in the composition section in Table 1.

The estimated cost for cleaning packaging litter in Spain for 2019 can be found in Table 2, below and range from €477M to €603M for all packaging materials:

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<sup>19</sup> Correspondence with Joan Marc of Zero Waste Europe, Adriana Espinoza of Tierra

<sup>20</sup>Eunomia Calculations and Correspondence with Local Authorities

**Table 2: Cost of Street Litter Management in Spain (2019)**

Litter Category	Low Total Cost	High Total Cost	Low Cost per Capita	High Cost per Capita
Non-Beverage Packaging (€)	202M	153M	4	3
Beverage Containers (€)	274M	451M	6	10
All Packaging Materials (€)	477M	603M	10	13

Source: Eunomia Calculations, KIMO (2010), MITECO data

### 3.0 Cost of Managing Packaging Related Beach Litter

Beach litter cleaning costs were calculated in a similar method to street litter:

- 1) A review of available beach litter compositional data was conducted
- 2) The proportion of total packaging and beverage packaging within the total litter composition converted into weight and volume-based assessments.
- 3) Per Km and KM2 litter cleaning cost data was multiplied by total beach area and length to determine the total cost of cleaning beaches in 2019.
- 4) Weight and volume data was applied to the calculated total cost of litter on Spain's beaches to determine the cost of managing packaging and average litter on Spain's beaches.

### 3.1 Beach Litter Composition Review

Detailed beach litter compositions were provided by count from MITECO data via their e-litter app.<sup>21</sup> The data includes nearly 300 litter picks categorized as “shore litter” compositions. The calculate a mean composition, the litter picks where averaged together and used as the beach composition for this study. Other studies reviewed included Asensio-Montesinos et al., and the Spanish governments’ Programa de Seguimiento de Basuras Marinas en Playas.<sup>22,23</sup> The Asensio-Montesinos study did not have as many material categories as the MITECO data had, and the raw MITECO elitter data included data observations which are more recent than those published in MITECO’s 2019 report.

The MITECO data, which listed composition by material count, was then converted into weight and volume- based measures as detailed in the next section.

### 3.2 Beach Litter Volume and Weight Based Composition Calculation

Four approaches to producing a beach litter material composition were used:

- Count-based calculation
- Weight-based calculation
- Volume-based calculation
- 50% weight and 50% volume calculation

Average weights and volumes for each type of littered item e.g. the average weight and volume of a PET plastic bottle or aluminium can, was multiplied by the counts of each littered item in the composition to estimate both a weight and volume composition. A 50% weight and 50% volume calculation was also carried out for the reasons set out in the street litter section above. Average weights and volumes were taken from a number of sources including WRAP (2017), Keep Australia Beautiful (2019) and KplusV (2015).<sup>24,25,26</sup> The percentage of beach litter by county, weight, volume and using the 50:50 weight/volume split for beverage and non-beverage packaging is provided in Table 3.

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<sup>21</sup> <https://www.miteco.gob.es/es/ceneam/carpeta-informativa-del-ceneam/novedades/e-litter.aspx>

<sup>22</sup> Asensio-Montesinos et al. (2020). Beach Litter Composition and distribution on the Atlantic coast of Cadiz. <https://doi.org/10.1016/j.rsma.2020.101050>

<sup>23</sup> [http://marine-litterhub.com/wp-content/uploads/2019/10/informe2013-2018\\_ProgramaSeguimientoBasurasMarinasPlayas\\_Miteco.pdf](http://marine-litterhub.com/wp-content/uploads/2019/10/informe2013-2018_ProgramaSeguimientoBasurasMarinasPlayas_Miteco.pdf)

<sup>24</sup> Resource Futures for WRAP (2017), Litter Composition Study – Wales, March 2017

<sup>25</sup> [http://kab.org.au/wp-content/uploads/2019/03/2019\\_NLI17\\_18\\_EPORT.pdf](http://kab.org.au/wp-content/uploads/2019/03/2019_NLI17_18_EPORT.pdf)

<sup>26</sup> KplusV (2015) Kosten en omvang zwerfafval. Accessed: <https://kenniswijzerzwerfafval.nl/document/kosten-en-omvang-zwerfafval>

**Table 3: Packaging and Beverage Container Share of Beach Litter by Method**

Litter Category	By Count	By Weight	By Volume	50% Weight 50% Volume
Non-Beverage Packaging	32.2%	18.0%	26.7%	22.3%
Beverage Container	15.7%	20.7%	35.7%	28.2%
All Packaging Materials	47.9%	38.7%	62.4%	50.5%

Source: *Eunomia Calculations, Kimo (2010), Rezero (2014), KplusV (2015), KAB (2019)*

These compositional splits were then used to apportion the total cost of managing packaged related beach litter.

### 3.3 Total Beach Litter Cleaning Costs

#### 3.3.1 Cost per Kilometre and Square Meter

Two sources of costs were identified for beach cleaning:

- KIMO International, estimate the cost of beach cleaning in Spain as €13,200 - €87,500 per linear km.<sup>27</sup> In previous Eunomia research, the cost per km of cleaning a beach was calculated and estimated to be up to €40,000 per km for the EU (2018), a similar figure to that found in the KIMO data.<sup>28</sup>
- The Rezero's Catalan Deposit Return System Report provides costs based on beach area, rather than beach length for 2014.<sup>29</sup> The Rezero report recorded beach litter cleanup costs from three municipalities: Barcelona, Tarragona and Girona. The municipalities reported an average cost of €1.48 per m<sup>2</sup> of beach cleaned.

KIMO figures were used to calculate the range of costs for cleaning beaches in Spain, while Rezero data was used as a comparison point, rather than for further calculation of determining packaging litter costs.

#### 3.3.2 Spanish Coastline

Spain has approximately 8,000km of coastline.<sup>30</sup> An estimated 35% of Spain's coastline is composed of beaches, rather than rock faces and other terrain, which are terrain less likely to be

<sup>27</sup> [http://www.kimointernational.org/wp/wp-content/uploads/2017/09/KIMO\\_Economic-Impacts-of-Marine-Litter.pdf](http://www.kimointernational.org/wp/wp-content/uploads/2017/09/KIMO_Economic-Impacts-of-Marine-Litter.pdf)

<sup>28</sup> Eunomia 2018. Assessment of Measure to Reduce Marine Litter from Single Use Plastics\_Annex. [https://ec.europa.eu/environment/waste/pdf/Study\\_sups.pdf](https://ec.europa.eu/environment/waste/pdf/Study_sups.pdf)

<sup>29</sup> Retorna 2014. IMPLANTACIÓ D'UN SISTEMA DE RETORN D'ENVASOS DE BEGUDES.

<sup>30</sup> <http://www.ign.es/web/ign/portal/ane-datos-geograficos/-/datos-geograficos/datosGenerales?tipoBusqueda=longCosta>

littered on.<sup>31,32</sup> To calculate find the total length of beach coastline in Spain, the total coastline figure was multiplied by the beach percentage (35%) to give an estimate of just under 2,800km.

To link with the cost data, in addition to calculating the length of beach, we also calculated the total area of beaches in Spain. An average beach width of 38m was multiplied by the length of beaches in Spain to give a total beach area of 66,000 km<sup>2</sup>.<sup>33,34</sup>

### 3.4 Apportionment of Beach Cleaning Costs to Beverage and Packaging Litter

#### 3.4.1 Beach Packaging Litter Cost Calculation

The 2019 estimated cost of cleaning beach litter using the linear based approach, determined by multiplying the estimated beach coastline length of 2,800km by the low and high KIMO figures, adjusted for inflation, is €42M - €278M.

The estimated cost in the same year using an area based approach, calculated by multiplying the Rezero average cost of beach clean-up of €1.48 per m<sup>2</sup> 66,000 km<sup>2</sup> is €157M.

These three figures are detailed in Table 4 below. The cost using Rezero data is almost at the mid-point between the two KIMO estimates; as such, this cost was used in the main calculations.

**Table 4: Total Beach Litter Cleaning Cost Estimates by Method (2019)**

	KIMO Data Low	KIMO Data High	Rezero Data (central value)
<b>Total Beach Cleaning Costs (€)</b>	42M	278M	157M

Source: Eunomia Calculations, Kimo (2010), Rezero (2014), KplusV (2015), KAB (2019)

The beverage and non-beverage percentages detailed in Table 3 were multiplied by the total costs in Table 4 to estimate the cost of managing packaging and beverage container litter. An example of the calculation, using the Rezero cost, is shown below.

- Packaging beach litter costs = 50.5% x €157M = €80M
- Beverage Container Litter costs = 28.2% x €157M = €44M

<sup>31</sup> <https://www.climatechangepost.com/spain/coastal-erosion/>

<sup>32</sup> Schwartz, M. (2006) Encyclopedia of Coastal Science, Springer Science & Business Media. p147

<sup>33</sup> Valdemoro HI, Jiménez JA (2006) The Influence of Shoreline Dynamics on the Use and Exploitation of Mediterranean Tourist Beaches. Coast Manage 34: 405-423. doi. 10.1080/08920750600860324

<sup>34</sup> Jiménez, J.A., Valdemoro, H.I., Bosom, E. *et al.* Impacts of sea-level rise-induced erosion on the Catalan coast. *Reg Environ Change* 17, 593–603 (2017). <https://doi.org/10.1007/s10113-016-1052-x>

### 3.5 Beach Litter Cleaning Cost Results

Results for the cost of cleaning packaging and beverage container beach litter across Spain are included in Table 5 below.

**Table 5: Cost of Managing Beach Litter per Year (2019)**

Litter Category	Total Low	Total High	Per Capita Low	Per Capita High
Non-Beverage Packaging (€)	9M	62M	0.20	1.30
Beverage Container (€)	11M	78M	0.25	1.67
All Packaging Materials (€)	21M	141M	0.45	2.99

Source: Eunomia Calculations, KIMO (2010), MITECO (2020), Rezero (2014), KplusV (2015), KAB (2019)

Beach litter cleaning costs for packaging materials were then added to the street litter cleaning costs for packaging to arrive at a total management cost for packaging litter. This result is shown in the next section.

### 4.0 Total Cost

The estimated total costs of cleaning litter are provided in Table 6Table 6.

**Table 6: Total Litter Cleaning Costs per Year**

Litter Category	Total Low	Total High	Per Capita Low	Per Capita High
Non-Beverage Packaging (€)	211M	215M	4.20	4.30
Beverage Container (€)	285M	529M	6.25	11.67
All Packaging Materials (€)	496M	744M	10.45	15.97

Source: Eunomia Calculations, Newtral (2019), Amigos de la Tierra (2016), Rezero (2014), WRAP (2010)

## A.1.0 Appendix

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### A.1.1 Average Street Litter Composition

A 1 below shows the average percentage that packaging and beverage container litter are responsible for in street litter by method type.

#### A 1: Average Packaging and Beverage Container Litter as a Percentage of All Street Litter by Method

Litter Category	By Weight	By Volume	50% Weight 50% Volume
Non-Beverage Packaging	4.4%	18.7%	11.2%

<b>Beverage Container</b>	13.4%	33.7%	25.9%
<b>All Packaging Materials</b>	17.7%	52.4%	37.1%

Source: *Eunomia Calculations, Amigos de la Tierra (2016), WRAP (2010)*

## A.1.2 Additional Considerations

There are a number of factors that could influence the costs attributed to managing packaging related litter which could not be adequately calculated as part of this work, these include:

- The beach cleaning cost data which was originally researched by KIMO and Rezero were both estimated based on municipality surveys. It is possible that the total street cleaning budget may include some costs associated with cleaning of beaches. Reviews of municipal budgets were not able to confirm whether beach cleaning costs were included in total municipality street cleaning costs. Given the range of cost estimates, adding the street and beach costs together will still yield a useful estimate of total litter costs in Spain.
- Beach litter costs may include a cost for cleaning organic material, such as seaweed, from the beach. This cleaning of organic material could therefore be underrepresented in costs estimates when using a material composition to assign costs. However, no adequate estimate for the percentage of costs devoted purely to clearing organic debris could be sourced.

