Improving food waste quantification at municipal level to assess food waste prevention: A case study in the Basque Country

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Introduction: The problem of food waste is well-recognized as a global sustainability issue that is embodied in the United Nations' Sustainable Development Goal 12.3, which aims to achieve a 50% reduction in food waste by the year 2030. To achieve this, food waste quantification is an essential first step. However, data on food waste generation is mainly presented in the literature at a macro scale, resulting in limited data granularity and increased uncertainties in calculations (Corrado & Sala, 2018). To enhance the accuracy of food waste quantification it is fundamental to improve the process at lower scales, such as the municipal level.

This analysis is also necessary to better understand citizens' behaviour in terms of food waste generation in order to prevent it, which is critical since the household stage is the main contributor to food waste generation (Eurostat, 2023). The other 2 methods allowed by the EU Commission Delegated Decision 2019/1597 (European Commission, 2019) to measure food waste at households, surveys and diaries, are reported to underestimate food waste generation (van Herpen et al., 2019). This is mainly due to 1) participants are often individuals already concerned about the topic and thus not representative of the population, and 2) the introduced bias as consumers perform better than usual when feeling observed.

So, waste characterisation analysis is a more objective way to carry out this measurement properly and discern specific attributes such as the proportions of edible and inedible food waste. This is crucial to set and subsequently assess the effectiveness of food waste prevention actions at this scale. Nevertheless, not all municipalities characterise waste in the same way, and the diversity in waste collection methods and types of generators further affect the results. Consequently, these analyses are not always comparable, highlighting the need for standardisation to assess food waste generation reliably at municipal level.

Methodology: This study utilises data from different data sources and with different aggregation levels from 2 provinces in the Spanish region of the Basque Country: Bizkaia and Gipuzkoa, for the year 2022. Waste characterization data from both the biowaste and the residual waste streams have been collected and combined with waste generation data and geographical information to estimate the food waste generation. In Bizkaia, the waste characterization matrix from the municipality of Zamudio was employed. This matrix includes 17 waste categories for food waste, covering 6 food families clusters and distinguishing between cooked/non cooked, and edible/inedible. In the case of Gipuzkoa, the matrix comprises 6 waste categories for food waste, covering 3 food families clusters and also classifying according to cooking status and edibility, but with lower detail level.

To facilitate a comparative analysis of data from both provinces and address data heterogeneity, an initial adaptation of characterization matrices has been undertaken. The aim is to establish a common nomenclature for easy comparison of the initial data. In this common matrix, the least possible number of categories has been taken to maintain the waste classification as detailed as possible without losing information. The criterion followed was to use the most limiting initial characterization (lowest level of disaggregation) for the categories. In total, a characterization with 28 types of waste was obtained, with 4 categories for food waste.

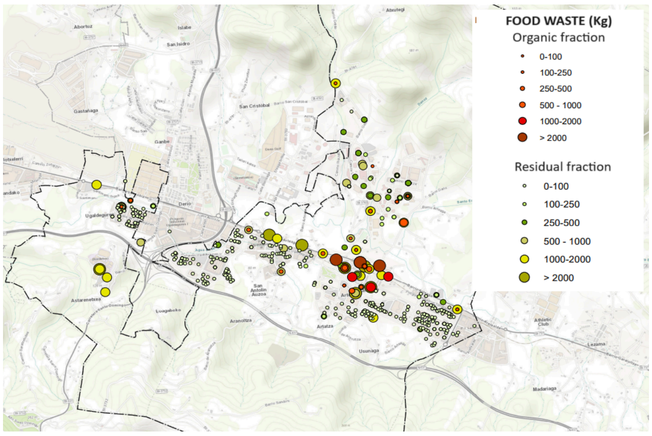
With the common waste characterization matrix established, the initial data from both regions have been adapted to it. So, the percentage that each category represented, on average, was calculated depending on the type of generator (domestic, industrial, and HORECA) and the waste fraction (biowaste, residual waste).

Another important variable to consider is the type of waste collection system: door-to-door, open containers, and closed containers affect the citizens' behaviour and therefore the waste generation patterns. This factor has also been included in the data analysis to ensure that the food waste quantification results are not biassed by it.

After aligning the characterization data for both regions with the common waste characterization matrix, the waste generation data from the regions available at different scales were multiplied by it in order to obtain the final food waste generation results. In the case of Zamudio data obtained using smart containers equipped with personal cards and trucks with scales to collect the waste using different circuits (differentiating by generator) were used to obtain generation data. As for Gipuzkoa, open data available in their public portal was used.

To ease the identification of critical points and plan efficient waste prevention actions, Geographic Information Systems were utilised. The spatial analysis and cartography material created was conducted by means of the software Arcgis 10.8.1.

Results and discussion: The results are presented in 2 geographical scales: municipal level (aggregated data) and street level (disaggregated data). They were cross-checked among them and with those from the study on food waste generation in the Basque country conducted by ELIKA et al. (2023) using surveys to compare both approaches. The percentages of edible and inedible food waste generated are shown in Table 1 for the municipal level.



In theory, Mendaro would be the municipality where food waste prevention performance is better, with only 6.84% of the food waste generated being edible. However, it is crucial to note that Zamudio's data quality is higher, since data traceability is at waste container level (Figure 1). This superior data precision may paradoxically result in apparently less favourable results. It is worth highlighting then that when a municipality measures food waste generation more effectively, it may falsely seem to perform worse than others.

Figure 1. Food waste generation in Zamudio at container level.

Table 1. Distribution of edible and inedible food waste generation at municipal scale.

Province			Gipuzkoa			Bizkaia
Municipality	Deba	Mendaro	Mutriku	Beasain	Donosti	Zamudio
Edible food waste	7.32%	6.84%	9.86%	21.98%	22.85%	26.81%
Inedible food waste	92.68%	93.16%	90.14%	78.02%	77.15%	73.19%
Ratio edible/inedible	0.08	0.07	0.11	0.28	0.3	0.37

Conclusion: This research work emphasises the need for a common standard waste characterization analysis methodology to successfully measure progress towards SDG 12.3 in an unambiguous manner. The study is constrained by data heterogeneity and origin, which hinder the comparability of results at quantitative level. Inconsistencies were found in some cases when comparing the same data from two different data sources.

In addition, the incorporation of container specific data proves to be advantageous. Although this equipment implies an additional cost, this approach allows for a more realistic allocation of waste generation, fostering equitable management expenses in services shared in the commonwealth. Moreover, it enables a more comprehensive spatial analysis, identifying patterns at neighbourhood or even street level. This provides potential benefits to improve urban waste management: flexibility to adjust the container volume and collection frequency, the implementation of Pay-As-You-Throw systems (including specific incentives to prevent FW) as well as planning appropriate awareness prevention campaigns.

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