Life cycle Impacts of food waste: the case study of Hotels in Heraklion Crete

ΧΑΡΟΚΟΠΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ
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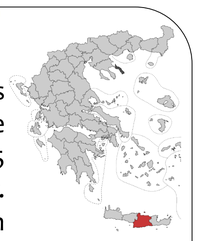
Abstract

The LCA is a methodology for examining the environmental impact associated with a cradle-to-grave product, process or service - from the production of raw materials to the final disposal of waste. The LCA was developed to address issues not addressed by other environmental management tools, such as statutory environmental impact assessment. It has been proven to be particularly useful as a technique for comparing two or more alternatives in terms of combined potential environmental impacts and ecological sustainability. The LCA is the focus of this work. The operating unit, in the specific case study, is defined as the management of food waste produced by 24 hotel units in Heraklion, Crete in 5 months from June 2019 to October of the same year. The environmental assessment includes environmental indicators and impact categories.

Methodology



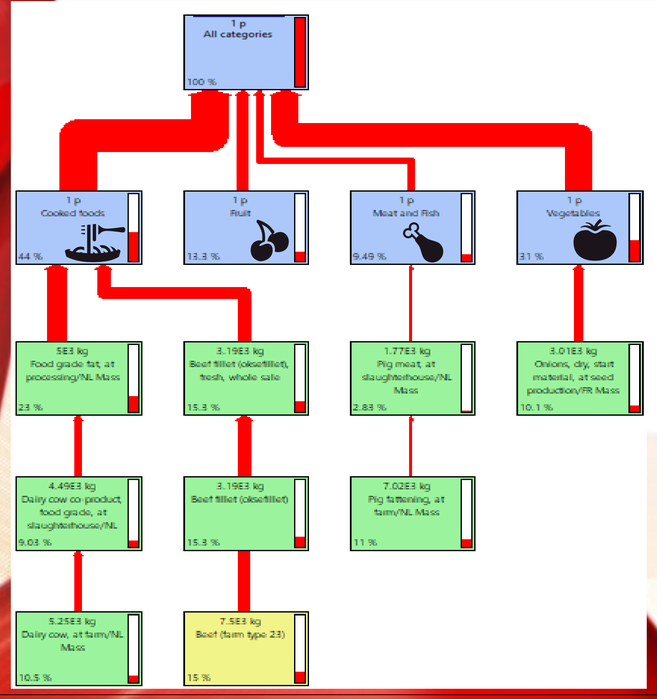
The operating unit, in the specific case study, is defined as the management of food waste produced by 24 hotel units in Heraklion, Crete in 5 months from June 2019 to October of the same year. The total amount of food waste, that had been collected and included in this case study is **136636.32** Kg and their detailed compositional analysis appears in the following table (table 1).

Common LCIA categories were examined with ILCD 2011 Midpoint+ V1.11 / EU27-2010 equal weighting method and include 16 categories of environmental indicators that appear in the horizontal axis of charts 1 and 3, according to the software used– SimaPro 9.1.1.1.

Life cycle interpretation is the last phase of an LCA where the results of the other phases are interpreted and further analyzed based on uncertainties and variables within the studies and on spatial and temporal explanatory evidence or hypotheses made in the study. Uncertainty indicates that LCA outcomes depend on standard options in the modeling process and occurs because different options have different outcomes. It is worth noting here that the current practice of waste management in Heraklion, Crete in the given period of time is the final disposal of waste in landfills.

Table 1: Compositional analysis of food waste

Food residues component category	Mean Composition	K g
Fresh vegetables and salads	13,92%	20077.91
Bread and Bakery	5,71%	8232.79
Fresh fruit	44,37%	63996.89
Meat and fish	4,90%	7069.32
Cooked meals and snacks	24,39%	35185.29
Dairy (excluding milk) and eggs	0,79%	1136.21
Condiments, sauces, herbs and spices	0,34%	494.73
Desserts	0,22%	318.93
Confectionery and snacks	0,09%	127.24
Other (not included to LCIA)	5,22%	5068.12
Total amount of countable food waste in LCIA		136639.32



Results

- According to **chart 1,** the food categories that contribute most to the increase in environmental impact are fruits, vegetables, meat and fish and cooked meals. The first two categories due to the increased amount recorded during the quantitative analysis and cooked meals because in addition to the raw materials used for their preparation, additional resources are used, such as water and energy.
- Chart 2 includes the same food categories as mentioned above. Here, it is found that cooked meals are those that have even a small burden on all environmental indicators examined.

Chart 1: Impact assessment chart of characterized results

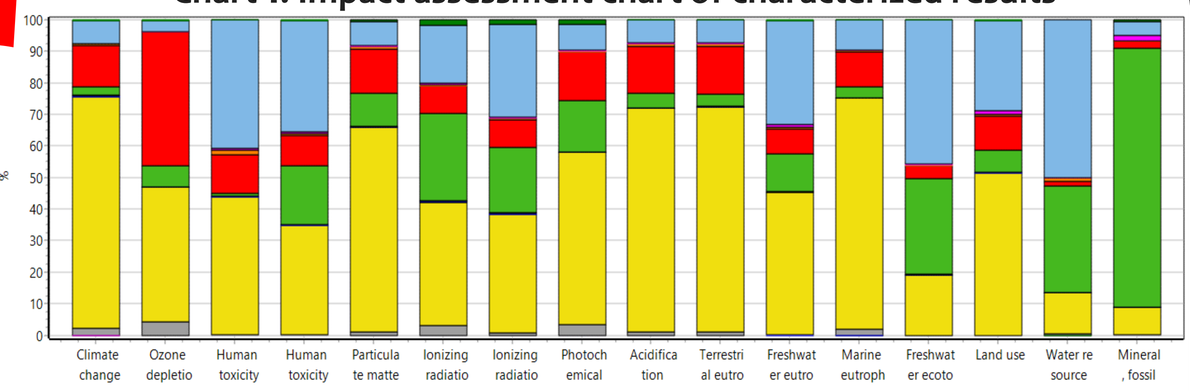


Chart 2: Impact assessment chart of single scores

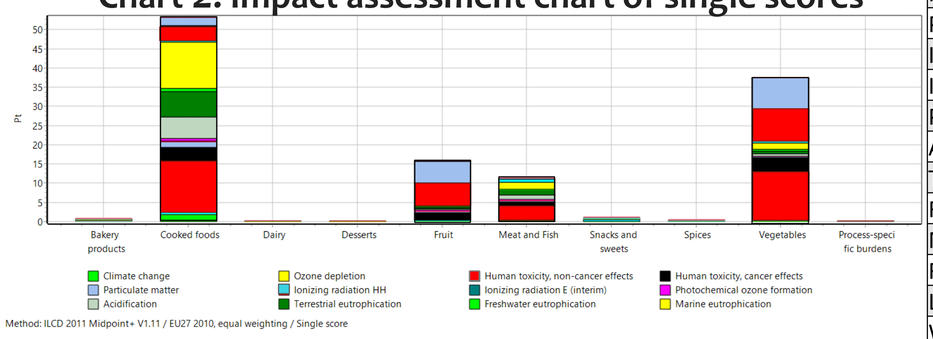
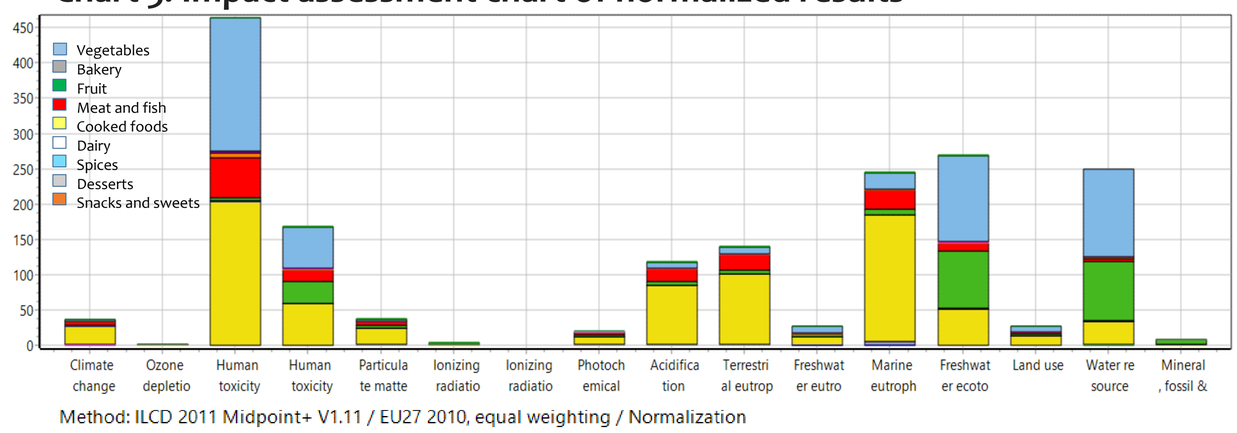


Table 2: Quantitate impact assessment by category

Impact category	Unit	Total
Climate change	kg CO2 eq	332632
Ozone depletion	kg CFC-11 eq	0,032288
Human toxicity, non-cancer effects	CTUh	0,247308
Human toxicity, cancer effects	CTUh	0,006211
Particulate matter	kg PM2.5 eq	140,6118
Ionizing radiation HH	kBq U235 eq	3506,114
Ionizing radiation E (interim)	CTUe	0,022772
Photochemical ozone formation	kg NMVOC eq	634,8972
Acidification	molc H+ eq	5572,845
Terrestrial eutrophication	molc N eq	24543,61
Freshwater eutrophication	kg P eq	39,38492
Marine eutrophication	kg N eq	4130,661
Freshwater ecotoxicity	CTUe	2351635
Land use	kg C deficit	1952039
Water resource depletion	m3 water eq	20343,49
Mineral, fossil & ren resource depletion	kg Sb eq	0,791204

Chart 3: Impact assessment chart of normalized results



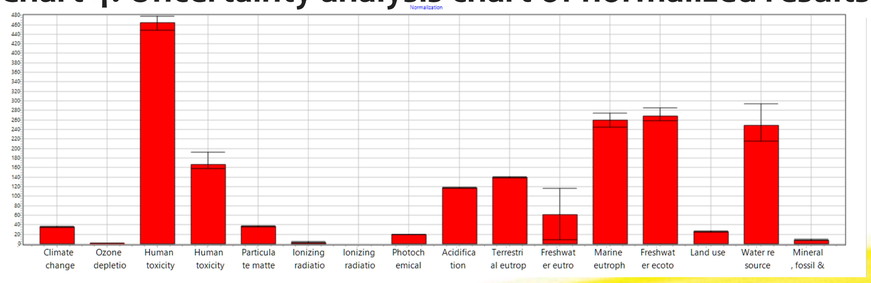
The main impact categories according to the data in **chart 3** are:

- human toxicity, with no cancer effect
- human toxicity with cancer effects
- marine eutrophication
- terrestrial eutrophication,
- freshwater Eco-toxicity
- water resource depletion

Uncertainty analysis

Uncertainty analysis (UA) is an additional tool for investigating model behavior and for evaluating the uncertainty and sensitivity of input parameters. The UA was performed to include the range of possible outcomes depending on the uncertainty (and variability) of the input data and to investigate the effect of the model's lack of knowledge or errors. The discrepancies in the main impact categories reported in chart 2 were found to be within acceptable limits.

Chart 4: Uncertainty analysis chart of normalized results



Conclusions

The sorting and measurement process gives a good idea of the main reasons behind food waste, allowing to stakeholders design and adopt appropriate actions to mitigate the waste. The main goal of measurement and of the LCA analysis is to understanding the problem of food waste generation and its mitigation. The reduction of food and waste losses is important in order to achieve the goals of sustainable development as in this way it could (European Commission, 2018): i) support the effort to resist and adapt the planet to climate change - Food waste alone produces about 8% of global greenhouse gas emissions; ii) strengthen the separation of edible food, in other words redistributing it to those in need, helping to eliminate hunger and malnutrition - approximately 43 million people in the EU do not have the financial means to buy a meal every other day; iii) guide farmers, sellers, businesses and households, to save money.

Acknowledgements

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U.A.S.W.A.M.C. United Association of Solid Waste Management in Crete

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