Environmental assessment of donation as a food waste prevention action

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Abstract

The present study is mainly focus on measuring the environmental benefit achieved by the implementation of surplus food donation actions, as well as on identifying the foods that have the greatest environmental footprint, so that they can be reduced as a matter of priority. The methodology followed during the study was based on Life Cycle Assessment (LCA) and the software used is Simapro and more specifically version 9.2.0.1. Specifically the selected method of evaluation is the ILCD 2011 Midpoint + V1.11 / EC-JRC Global, equal weighting, which is included in the Simapro software and includes the sixteen impact categories. The module was designed by taking into account both the composition of the menus and the total amount of food waste that has been prevented like the amount of waste that did not end up in landfills. From the evaluation should be noted that among the menus, the ones that have the greatest contribution to the environmental burden are: "Menu 1", which has as its main dish a quantity of beef, follows " Menu 3 "- based on fish and" Menu 4 ", with legumes as the main dish. It is also becoming clear that the meat-based menu is the one that has the greatest impact, as the lifetime requirements of a meat-based portion are increased. The main categories of environmental effects to which the above foods contribute with their production are: toxicity to humans with no cancer effects, freshwater ecotoxicity, toxicity to humans with cancer effects and depletion of water resources. With the redistribution of food, a net environmental benefit is achieved due to the prevention of landfill. The main categories of effects that are prevented through this alternative management can be prioritized as such: the exacerbation of the phenomenon of climate change, the toxicity to humans with cancer effects or not, freshwater ecotoxicity and the marine eutrophication. Indicatively, it was estimated that the operation of the second chance restaurant and the provision of 10,000 portions of food, prevents the creation of 19633.23 kg of equivalent carbon dioxide that would have been released even if this food waste was disposed of in a landfill.

Keywords: prevention, life cycle analysis, distribution.

Introduction

Awareness of food waste is growing worldwide and is considered such an important issue that it is part of the United Nations Sustainable Development Goals (UN). However, the waste of edible food is not just a waste management issue, but also raises critical questions of justice, especially given the large number of people worldwide living below the poverty line [1]. Of course, in addition to a formal goal, opportunities are also needed for food businesses, so that the food surplus that is created can be redistributed so as not to be wasted [2]. Encouraging environmentally friendly behavior is imperative to reduce food waste, but more practical measures such as tax incentives and policies can facilitate the implementation of more sustainable solutions. The food waste hierarchy ranks surplus food donations for human consumption as the next best strategy when food waste can not be prevented [3]. However, the effectiveness of food donation in terms of the amount consumed or food donation as a food waste management measure has rarely been evaluated.

Among restaurants, the potential legal liability that may arise from food donation is a common misconception. However, beyond the misunderstanding of possible liability, one of the most important obstacles for restaurants is the overall curation and preparation of the donated food / meals. Ready-to-eat food that is not served to customers can be considered a donation but, transport and storage infrastructure requirements are high for successful donation and restaurants tend to have less storage space than grocery stores or manufacturing facilities[4]. In a Food Waste Reduction Alliance survey, 43% of respondents surveyed reported transportation restrictions and 39% cited inadequate refrigeration and / or storage as challenges [5].

The use of new applications and online tools (platforms), which simplify the process of food donation and can help improve the perception of donations. Examples include Zero Percent, Food Cowboy and Copia, which facilitate the logistics process, such as product registration, communication between interested parties, receiving and delivering donations. They also monitor food donation quantities so that restaurants can benefit from tax breaks. In addition, because these occupational support systems must comply with legal restrictions, they are likely to reassure food professionals that health and food safety issues are adequately addressed. While another alternative is the cooperation with charitable organizations, such as those that have food distribution initiatives. Something similar is happening in Greece, mainly through the NGO "BOROUME".

More specifically, there are numerous volunteer groups and NGOs involved in the redistribution of surplus food worldwide, which by their action keep resources within the system and thus prevent and minimize the amount of waste that would otherwise be generated. Most food waste comes from later stages of the food chain, e.g. from factors such as restaurants and shops that can not sell food for various reasons, although they are often still of good quality [6].

More and more food redistribution actions are constantly being developed. A wide range of measures is implemented and the initiative to reduce food waste is taken by various actors, [7] (City Mission Stockholm Matsvinn Som Kommer Till Nytta) such as e.g. Grocery stores or restaurants that sell surplus food at a reduced price or provide leftovers to charities or social kitchens as well as applications that have information on where consumers can buy leftovers from restaurants at a reduced price[8]. The purpose is to prevent and avoid the production of food waste by providing meals to people in need.

However, the effectiveness of food donation in terms of the amount consumed or food donation as a food waste management measure has rarely been evaluated. Nevertheless, evaluation efforts have been made on food redistribution initiatives in terms of their effectiveness in terms of the mass of food rescued [9]. The present study focuses mainly on finding the environmental benefit achieved by the implementation of this action, as well as on identifying the foods that have the greatest environmental footprint, in order to reduce as a priority.

Methodology and definition of functional unit

The selected method of evaluation is the ILCD 2011 Midpoint + V1.11 / EC-JRC Global, equal weighting, which is included in the Simapro software package database and developed in 2011 by the European Union Research Center (JRC). It includes the following sixteen impact categories: climate change, ozone depletion (ODP), human toxicity with and without cancer effect, particulate matter, ionizing radiation HH and E, photochemical oxidation, acidification, terrestrial eutrophication, eutrophication eutrophication, freshwater ecotoxicity, land use, depletion of water resources and depletion of abiotic natural resources. The module was designed by taking into account both the composition of the menus and the total amount of food waste that has been prevented like the amount of waste that did not end up in landfills, since at the site of the project, this is the only way to manage generated waste.

According to the implementation of the action, 10,000 portions of food will be redistributed to people in need within the boundaries of the studied area. Assuming that the operation of the restaurant will cover the nutritional needs of an average adult, 6 different menus were formulated and evaluated based on the

National Greek Adult Nutrition Guide and meet the caloric needs of an adult. The distribution of the quantities was done according to the initial planning of the action, that is, the environmental evaluation of 10,000 portions of food was done. The menu composition is shown in detail in Table 1, and included basic food products such as meat, fish, legumes, cereals, bread and fruit.

TABLE 1: *Typical menus that cover the nutritional needs of an average adult and can be made available at the second chance restaurant (Based on the National Greek Diet Guide, http://www.diatrofikoiodigoi.gr/files/html/adults/files/assets/basic-html/index.html#1)*

Menu **1**	**mass (g)**	Menu **2**	**mass (g)**	Menu **3**	**mass (g)**
Beef meat	200	Chicken	200	Fish	200
White rice	150	Potatoes	150	Potatoes	150
Tomato paste	30	Tomatoes	150	Tomatoes	150
Iceberg lettuce	100	Cucumber	50	Cucumber	50
Food grade fat	100	Olive oil	100	Olive oil	100
White bread	100	White bread	100	White bread	100
Apple	180	Peach	100	Orange	100
Menu 4	**mass (g)**	**Menu 5**	**mass (g)**	**Menu 6**	**mass (g)**
Legumes	200	Pasta	200	Split peas	200
Cheese	150	Carrot	50	Cheese	150
Tomatoes	150	Cabbage	150	Carrot	50
Olive oil	100	Cheese	150	Lemon juice	100
White bread	100	White bread	100	White bread	100
Orange	100	Banana	100	Mandarin	150

Given the cost of raw materials for the configuration of the above menus and based on the study of the literature, but also the recommended analysis that has been carried out in other actions, the leftovers of meals based on meat and fish, tend be less than other meals consisting of legumes or pasta. Thus the final distribution and therefore the evaluation was based on the numerical distribution per menu provided, is the one shown in the following table 2.

Table 2: Distribution of food portions per available comparable menu.

	Number of portions		***Number of portions***
Menu 1	*1000*	***Menu** 4*	*2000*
Menu 2	*2000*	***Menu** 5*	*2000*
Menu 3	*1000*	***Menu** 6*	*2000*

The average weight of the edible foods that make up each menu is 810g (grams), and since the number of portions to be redistributed is 10,000, the module is defined as "the redistribution of 8100Kg of food through the second chance restaurant of the Municipality of Heraklion".

Results and discussion

Initially, a comparison is made between the available "menus" in order to determine the contribution of each to the environmental burden that is ultimately prevented through redistribution. The modeling concerns the really incoming raw materials and all the measurable parameters are finally reduced to environmental profit, as the food remains in the consumption chain through their re-disposal in the second chance restaurant. Thus, the graph of Figure 1 shows that comparatively between the menus, the ones that have the greatest contribution to the environmental burden are: "Menu 1", which has as its main dish a quantity of beef and has calculated values for all the studied categories of environmental impact, follows the "Menu 3" - based on fish and "Menu 4", with legumes as the main dish and since the portions distributed by it are comparatively twice the rest with the biggest impact

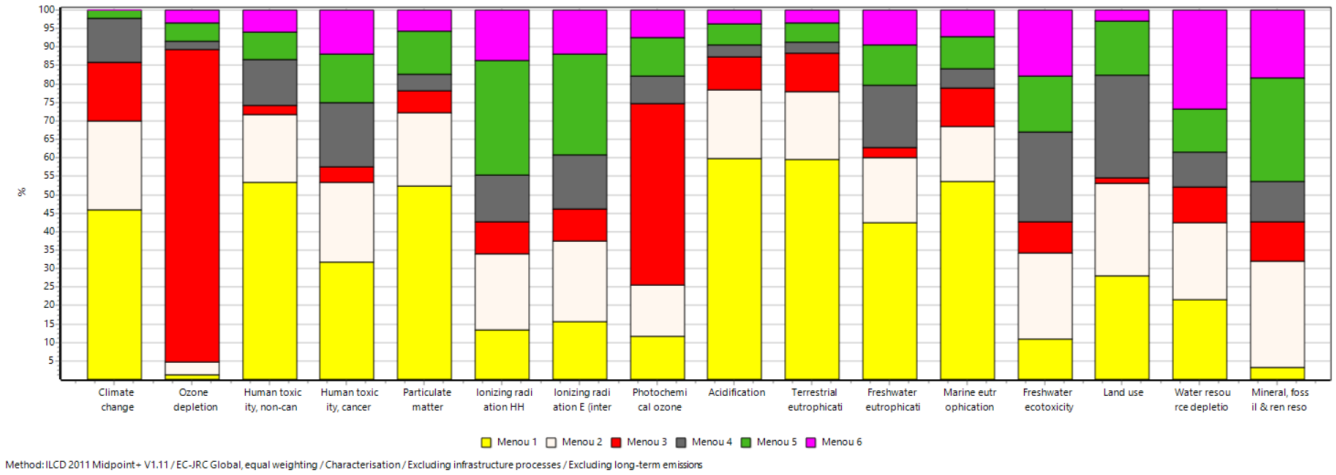

Figure 1: Study of all impact categories for the available menus of the social restaurant. (Characterization)

In addition, according to the normalized values, as shown in Figure 2, the main categories of environmental impacts to which food contributes with their production are toxicity to humans, non-carcinogenic effect, ecotoxicity of fresh water, toxicity to humans with carcinogenic action and depletion of water resources.

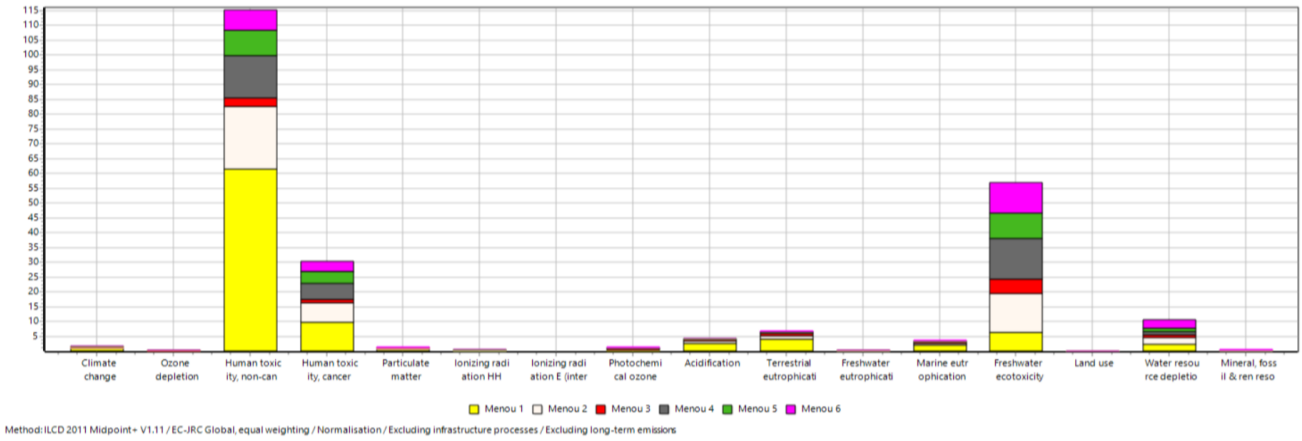

Figure 2: Study of all impact categories for the available menus of the social restaurant. (Normalization)

From the above diagram it is also clear that, as expected, the meat-based menu is the one that has the greatest impact, as the requirements throughout the life cycle of a meat-based portion are increased, as he is usually a top-class consumer. Based on its food chain, the resources needed for the development of a meat-producing animal, here beef, are sufficient and in addition it needs a specific processing process, in order to come in a form suitable for eating.

A more detailed report on the contribution of each menu to the possible and ultimately avoidable effects is given in the following flow charts (Figure 3).

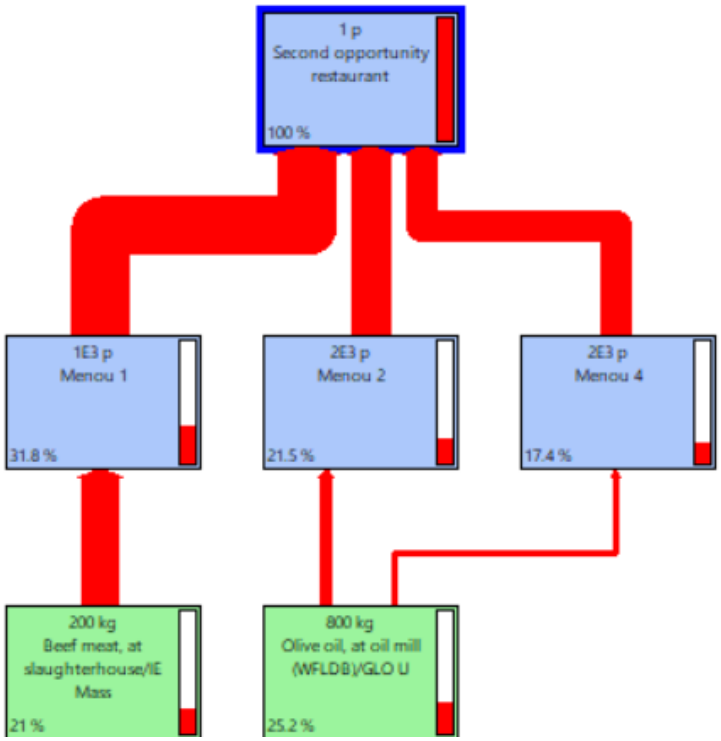

Figure 3: Indicative contribution charts of the studied variables by impact category- Human toxicity with cancer effect.

With the redistribution of food, a net environmental benefit is achieved due to their prevention from landfills. This is illustrated in Figures 5 and 6, which illustrate the quantitative effects of food waste disposal if these were not avoided.

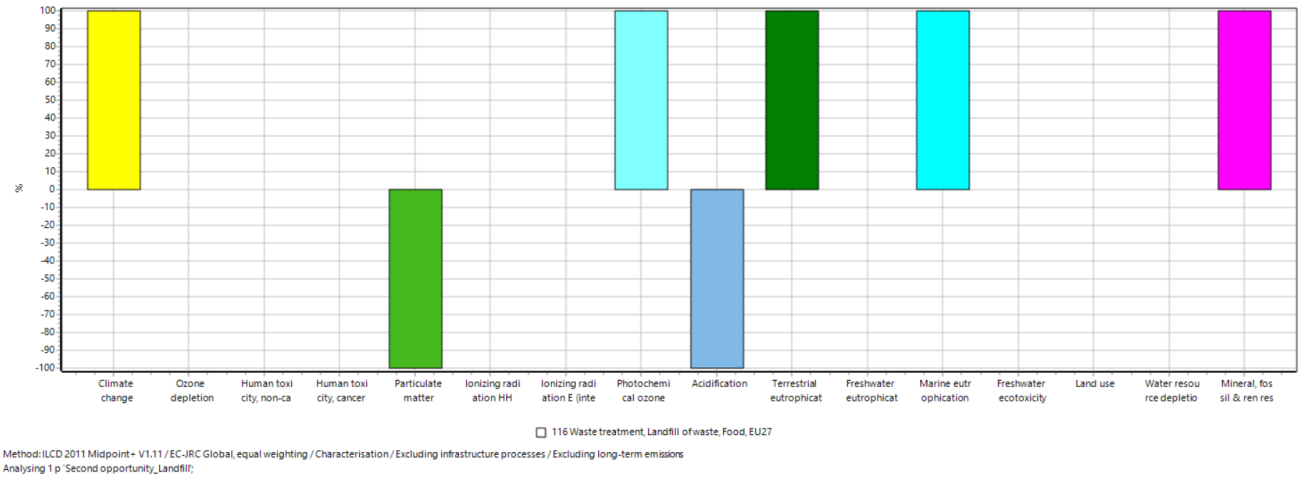

Figure 4: Characterization for the studied impact categories of food waste disposal in sanitary landfill.

Overall, the food surpluses that were redistributed, while otherwise they would end up in landfills, have the quantitative effects shown in the following table. According to the normalized diagram (Figure 6) of the scheme, the main categories of effects that were ultimately avoided, through redistribution are in order of priority, toxicity to humans without, but also with cancer effects, freshwater ecotoxicity and eutrophication of aquatic ecosystems.

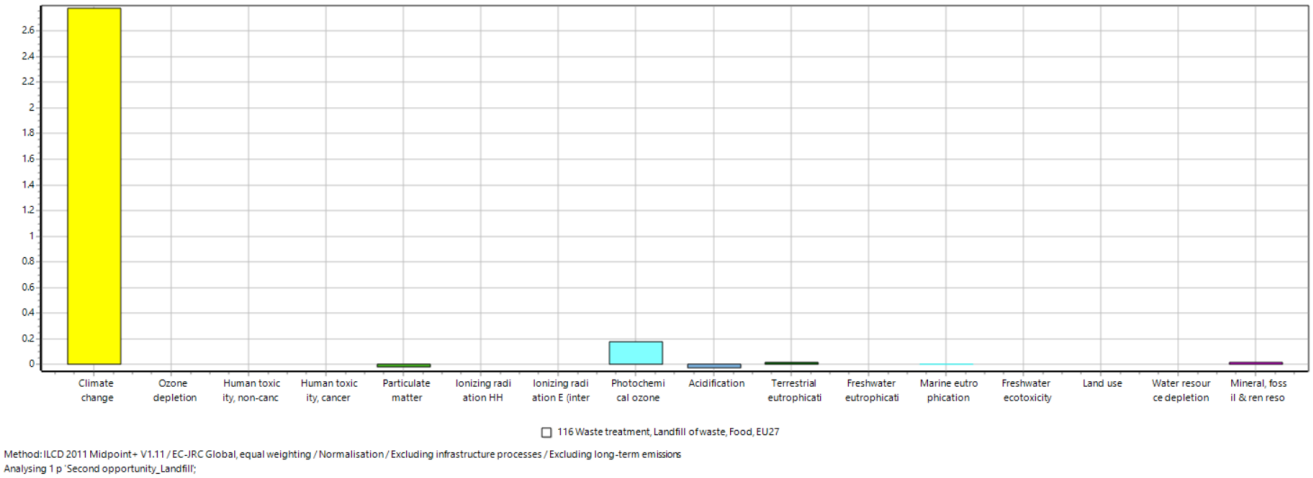

Figure 5: Normalization of the studied impact categories of food waste disposal in sanitary landfill.

According to the above in addition to the final disposal of food waste, their production has an important environmental footprint, in all indiscriminately studied categories. The normalized values of the diagram in Figure 6 show the significant contribution of food waste to the exacerbation of the phenomenon of climate change, when they are deposited in landfills. From the values of table 3, it can be seen that with the operation of the second chance restaurant, it prevents the creation of 19633.23 kg of equivalent carbon dioxide that would have been released even if this food waste was disposed of in a landfill.

Table 3: Quantitative assessment for avoidance achieved through the operation of the second chance restaurant.

Quantified impacts from food waste landfill (ILCD 2011 Midpoint+ V1.11 / EC-JRC Global, equal weighting

Impact category	Unit	Landfill Characterization	Landfill Normalazation
Climate change	kg CO2 eq	19633.23	2.78
Ozone depletion	kg CFC-11 eq	0.00	0.00
Human toxicity, non-cancer effects	CTUh	0.00	0.00
Human toxicity, cancer effects	CTUh	0.00	0.00
Particulate matter	kg PM2.5 eq	-0.08	-0.02
Ionizing radiation HH	kBq U235 eq	0.00	0.00
Ionizing radiation E (interim)	CTUe	0.00	0.00
Photochemical ozone formation	kg NMVOC eq	7.97	0.18
Acidification	molc H+ eq	-1.44	-0.03
Terrestrial eutrophication	molc N eq	2.24	0.01
Freshwater eutrophication	kg P eq	0.00	0.00
Marine eutrophication	kg N eq	0.16	0.01
Freshwater ecotoxicity	CTUe	0.00	0.00
Land use	kg C deficit	0.00	0.00
Water resource depletion	m3 water eq	0.00	0.00
Mineral, fossil & ren resource depletion	kg Sb eq	0.00	0.02

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