PUBLIC PERCEPTIONS AND ENVIRONMENTAL BURDENS OF WASTE PREVENTION BEHAVIOURS IN GREECE

I. Papachristou, K. Lasaridi and K. Abeliotis*

Harokopio University, School of Environment, Geography and Applied Economics

*Corresponding author: El. Venizelou 70, 17671 Athens, Greece, Tel. +302109549363, kabeli@hua.gr

Abstract

Waste prevention yields without any doubt to the reduction of waste. However, does it have a similarly positive impact on the overall environmental performance of everyday behaviours? Moreover, what do people perceive as an “environmentally friendly” prevention behavior? Gaps between people’s perception and actual environmental benefits from waste prevention may exist. In order to investigate those gaps between people’s perceptions, we compared people’s perceptions on environmental burdens among alternative choices and with the real environmental burdens based on the results of Life Cycle Assessment (LCA).

In order to compare people’s perceptions with LCA results in Greece, an online questionnaire was compiled. 322 people replied on their daily waste prevention behaviours. Quantitative data were also extracted from the questionnaire in order to support the LCAs that followed.

In addition, in order to assess the environmental performance of everyday activities, two case studies were selected: a) shopping bags, and b) refillable products. Alternative options were considered for each case. The functional unit was set up and LCA was conducted.

The results indicate that the two aforementioned waste prevention activities do yield to better environmental outcome. The results also indicate that people who are actively pursuing better environmental performance, are more likely to be engaged in waste prevention behaviours.

Keywords: waste prevention; life cycle assessment; shopping bags; refillable packaging

1 Introduction

According to Waste Framework Directive (2008/98/EC), waste prevention encompasses all the measures taken before a substance, material or product has become waste, that reduce the quantity of waste, the adverse impacts of the generated waste on environmental and human health or the content of harmful substances. A very common point of dispute in the Waste Framework Directive definition is the word "before", as it raises boundary issues. At times it is not easy to discern when a material/product exits its "tailored" useful life and enters a plain where it is treated as second hand material/product or waste. Thus, a key issue in waste prevention is its environmental assessment.

Prevention includes "reduction at source" and "reuse of products". Due to their diverse nature, waste prevention activities can be classified in a variety of categories (Salhofer et al. 2008): for instance, by material (e.g. paper, hazardous waste), by product (e.g. packaging, cups and plates), or by generation source (e.g. household, retailers).

The cornerstone of municipalities is the household unit. Waste prevention in the household level can be implemented via various behaviours. Based on the review of relevant literature, the most practiced are the following (Cox et al. 2010; Nessi et al 2012; Zorpas and Lazaridi 2013):

- Food waste prevention (e.g. Schneider, 2013);
- Prevention of excessive packaging;
- Using of multiple-use carry-bags;
- Repair and reuse of clothes, shoes, furniture;
- Repair and upgrade of electronic and electrical devices;
- Buying second-hand products;
- Buying less harmful products.

The aim of waste prevention measures is not just the reduction of waste; it is the prevention of the environmental impacts associated with the utilisation of resources during their entire life cycle. As Salhofer et al. (2007) mention that the assessment of a waste prevention activity can be performed (a) as a comparison of a material stream without or before setting a waste prevention measure and after that, and (b) as a life cycle approach to calculate the effect of a waste prevention measure. In this case, the whole life cycle i.e. upstream processes from the extraction of raw materials to production and distribution is included as well as the use phase and end-of-life management. To make a long story short, LCA is perfectly fitted for the environmental assessment of waste prevention activities. LCA is a tool for estimating the overall environmental impact of goods and services. LCA's goal is to compare the environmental impacts of different products and services that satisfy comparable needs.

In the remaining lines of this section, the application of LCA in waste prevention will be presented based on the review of the recent literature. In any case, prevention and its ranking in the waste hierarchy has only recently started to be studied by researchers, probably as an outcome of the policy makers focus on its effectiveness. As Gentil et al. (2011) mention, very scarce literature is found on the environmental assessment of waste prevention.

Very recently, Nessi et al. (2012) focused on the elimination of packaging for the supply of potable water in Italy. They compared the use of one-way virgin PET bottled water to the following waste prevention alternatives: (i) purified groundwater from the tap, (ii) purified surface water from public fountains, (iii) refillable glass bottled water, and (iv) refillable PET bottled water. The use of a straightforward LCA by the authors revealed that drinking of public network water from the household tap, be it groundwater or surface water, is by far environmentally preferable to drinking of water contained in one-way PET bottles.

Gentil et al. (2011) examine three waste streams, namely food waste, unsolicited mail and beverage packaging, in a fictional European municipality. Their modelling is based on central and northern European data. Waste prevention was modelled by evaluating (i) the environmental performance of the municipal solid waste management system, and (ii) the avoided material production, upstream from the prevented fractions. The authors demonstrated that if the prevention assessment is solely based on the waste management systems, there are only minor direct environmental consequences. On the other hand, the inclusion of avoided production (as a result of prevention measures) provided significant environmental benefits.

In an earlier publication, Salhofer et al. (2008) examine the prevention potential of five case studies in Austria: paper advertising material, beverage packaging, diapers, food waste and big events. The authors examined measures that did not require a reduction in consumption. They didn't engage an LCA in their research but focused only on the effects of the reduction of waste quantities. They identified that the highest prevention potential could be achieved by a reduction of food waste. However, the authors recognised that the case studies illustrated that waste prevention involves a lot of different players beyond waste management, as for example private households, food retailing or advertising industry, all of them having economic, ecological and social effects. Thus, the notion of a life cycle approach is introduced.

The aim of this research is the identification of the attitudes and behaviours of Greek consumers regarding the following prevention behaviours:

1) Use of muti-use shopping bags, and
2) Use of refillable packaging.

Then, the self-reported behaviours of the consumers are compared to the actual results of the LCAs performed for these behaviours, in order to check if there are real environmental benefits resulting from the actions of the consumers.

2 Methodology

In order to identify the attitudes and behaviours, a questionnaire was prepared. The questionnaire was administered in May 2014 both in person and via the internet using google forms. 322 persons replied fully, 146 via the internet and 176 via the printed version of the questionnaire. The goals of the questionnaire were:

- To identify the demographics of the sample,
- To identify the positioning of prevention in the waste hierarchy by Greek households,
- To estimate the weekly consumption of single-use carry bags,
- To identify the behavior of Greek household regarding the use of (i) multi-use shopping bags, and (ii) refillable liquid soap bottles, as an example of packaging waste.

In addition, an LCA of two aforementioned waste prevention activities was performed in order to quantify the environmental impacts generated by them. Finally, the results of the LCA were compared to the actual self-reported behavior of the respondents, in order to confirm that waste prevention behaviours are indeed beneficially for the environment. A similar approach has been introduced by Kurisu and Bortoleto (2012).

3 Results and discussion

After the demographic questions, the respondents were asked, starting from the top, to rank the following waste-related behaviours: (i) prevention, (ii) re-use, and (iii) recycling. The results are presented in Table

1. The results indicate that the respondents have a clear picture that prevention is the top priority. However, recycling, according to the consumers, is ranked second. This finding is opposing the ranks of the waste hierarchy.

Table 1 around here

Prevention of using single-use shopping bags made from polyethylene is among the top prevention priorities worldwide (Dikgang et al. 2012; Shoji and Susumu 2014). The first task was to estimate how many plastic bags are used per household on a weekly basis. 35.7% of the respondents replied 1-5 bags, 36.0% replied “6-10 bags”, while 22.6% replied “more than 10 bags”. 5.7% of the respondents did not know.

Next, the respondents were asked on how often they use multi-use carry bags. 5.1% replied “Always”, 16.5% replied “very often”, 40.0 % replied “often”, 31.8% replied “scarcely”, while 6.6% replied “Never”. The results indicate that there is still room of improvement regarding the use of multi-use bags for everyday shopping needs by the Greek consumers.

Packaging waste is another major topic in contemporary household prevention behaviours (Fredrik et al. 2014; Toniolo et al. 2013). The next question was about the use of refillable packaging for everyday household products such as liquid soap. 13.7% replied that they always uses refillable bottles, 37.1% replied that they use refillable bottles most of the times, 36.7% replied that they use refillable bottles sometimes, while 12.5% replied that they never use refillable liquid soap bottles. Despite the fact that 89.5% of the respondents replied, with various degrees of agreement, that they think that the use of

refillable bottles is an environmentally better choice, the behavior of the consumers does not really support this attitude. There is clearly a gap between the attitude and the actual behavior of the consumers.

3.1 Life cycle assessment results

In the following sections, the LCA results are presented. For each one of the case studies, the inventory table and the impact assessment results are given.

3.1.1 Inventory results for shopping bags

Five different shopping bag alternatives were compared. Among them, there were three single-use bag alternatives (made of polyethylene, polylactic acid, and non-bleached paper respectively) and two multi-use bags (made of non-woven and cotton respectively). Our questionnaire research yield that a Greek household consumes 390 single-use shopping bags per year. Therefore, this number is our functional unit for LCA purposes. For the paper single-use bag we assume that a single paper bag replaces two shopping bags made of polyethylene. For the multi-use bags, we assume that in a year's time the consumer will need three bags made of non-woven or a single bag made of cotton.

Based on these assumptions, the detailed inventory for the five bags is presented in Table 2. Only the material that the alternative bags are made of is considered in our analysis.

Table 2 around here

3.1.2 Inventory results for refillable bottles

Regarding the refillable bottles, two alternative scenarios were examined: the first one refers to a bottle of 250 mL of liquid soap with dosing pump, made of 36 g of PET. Its alternative is a container (250 mL content) made of 12 g of polypropylene.

3.1.3 LCIA results for shopping bags

The impact assessment method used was CML 2000 developed by the Centre of Environmental Science of Leiden University (Pré Consultants, 2003). The impact category indicators, included in the CML 2000 ready-made method, considered in our assessment, were: abiotic depletion factor (ADF), stratospheric ozone depletion potential (ODP), global warming potential for time horizon 100 years (GWP100), Marine aquatic ecotoxicity potential (MAETP), fresh water aquatic ecotoxicity potential (FAETP), terrestrial ecotoxicity potential (TEP), human toxicity potential (HTP), photochemical ozone creation potential (POCP), acidification potential (AP), and eutrophication potential (EP).

The impact assessment results for the five types of shopping bags are presented in Table 3 and depicted in Figure 1. These characterisation results indicate that the environmentally worse alternatives are the single-use bag made of polyethylene, depicted in dark blue colour, (in the abiotic depletion, marine aquatic ecotoxicity and photochemical oxidation categories) and the single-use paper bag, depicted in light blue colour, in all the remaining categories.

Table 3 around here

Figure 1 around here

In order to assess the most important impact categories, normalisation of the impact assessment results is performed based on the 1995 values for West Europe (Pré Consultants, 2003). Based on the normalization results (see Figure 2), the four most important impact indicators are: abiotic depletion (AD), marine aquatic ecotoxicity (MAET), acidification (ADP), global warming (GW100) and eutrophication. The normalized results for the remaining impact categories are negligible.

3.1.4 LCIA results for the liquid soap packaging containers

The impact assessment results for the two types of bottles are presented in Table 4.

Table 4 around here

Looking at the impact assessment results, the use of the refillable container (depicted in yellow colour in Figure 3) is environmentally preferable in all impact categories except marine aquatic ecotoxicity. Looking at the normalized results (Figure 4), the most important impact categories are abiotic depletion, acidification, global warming potential and photochemical oxidation.

4 Conclusions

An LCA has been conducted for two prevention practices, namely the use of multi-use shopping bags and the use of refillable packaging for liquid soaps. The LCA results yield that the use of multi-use shopping bags is environmentally preferable over the current practice of single-use polyethylene bags. In addition, the use of refillable liquid soap packaging is environmentally preferable.

These results are in good agreement with the actual consumer behavior reported via the use of the questionnaires. However, there is plenty of room for improving consumer behavior towards preventing waste generation from the use of single-use shopping bags and excessive packaging.

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Table 1. Replies of consumers regarding the ranking of environmentally-friendly practices.

	1st choice (%)	**2nd choice (%)**	**3rd choice (%)**
Prevention	64.38	16.78	18.84
Re-use	11.64	35.96	52.40
Recycling	24.32	47.26	28.42

Table 2. Inventory table for the five alternative shopping bags.

Bag	**Material**	**Weight per bag (g)**	**Total weight (g)**
A	Polyethylene	4	1,560
B	Non-wooven	46	138
C	Polylactic acid	4	1,560
D	Cotton	60	60
E	Paper (non-bleached)	47	9,165

Table 3. Impact assessment characterization results for the five shopping bag alternatives.

Impact category	**Unit**	**Bag A**	**Bag B**	**Bag C**	**Bag D**	**Bag E**
abiotic depletion	kg Sb eq	0,0688	0,00541	0,00486	0,00212	0,0182
global warming (GWP100)	kg CO2 eq	1,75	0,152	0,845	0,12	2,42
ozone layer depletion (ODP)	kg CFC-11 eq	x	x	3,06E-07	3,95E-10	1,17E-06
human toxicity	kg 1,4-DB eq	0,0381	0,00182	0,147	0,00336	0,252
fresh water aquatic ecotox.	kg 1,4-DB eq	0,00163	0,000167	0,00859	0,00207	0,023
marine aquatic ecotoxicity	kg 1,4-DB eq	323	5,94	127	5,15	153
terrestrial ecotoxicity	kg 1,4-DB eq	0,000382	3,38E-05	0,000993	5,16E-05	0,0015
photochemical oxidation	kg C2H2	0,000712	7,55E-05	0,000164	4,43E-05	0,000599
acidification	kg SO2 eq	0,0168	0,00182	0,0118	0,00104	0,0266
eutrophication	kg PO4--- eq	6,26E-05	4,71E-06	0,00203	0,00134	0,00464

Table 4. Impact assessment characterization results for the two liquid soap containers alternatives.

Impact category	**Unit**	**bottle A**	**bottle B**
abiotic depletion	kg Sb eq	0,00129	0,000411
global warming (GWP100)	kg CO2 eq	0,0839	0,0132
ozone layer depletion (ODP)	kg CFC-11 eq	x	x
human toxicity	kg 1,4-DB eq	0,00071	0,000158
fresh water aquatic ecotox.	kg 1,4-DB eq	2,35E-05	1,45E-05
marine aquatic ecotoxicity	kg 1,4-DB eq	0,0746	0,516
terrestrial ecotoxicity	kg 1,4-DB eq	1,76E-05	2,94E-06
photochemical oxidation	kg C2H2	6,07E-05	6,56E-06
acidification	kg SO2 eq	0,00108	0,000158
eutrophication	kg PO4--- eq	3,1E-06	3,85E-07

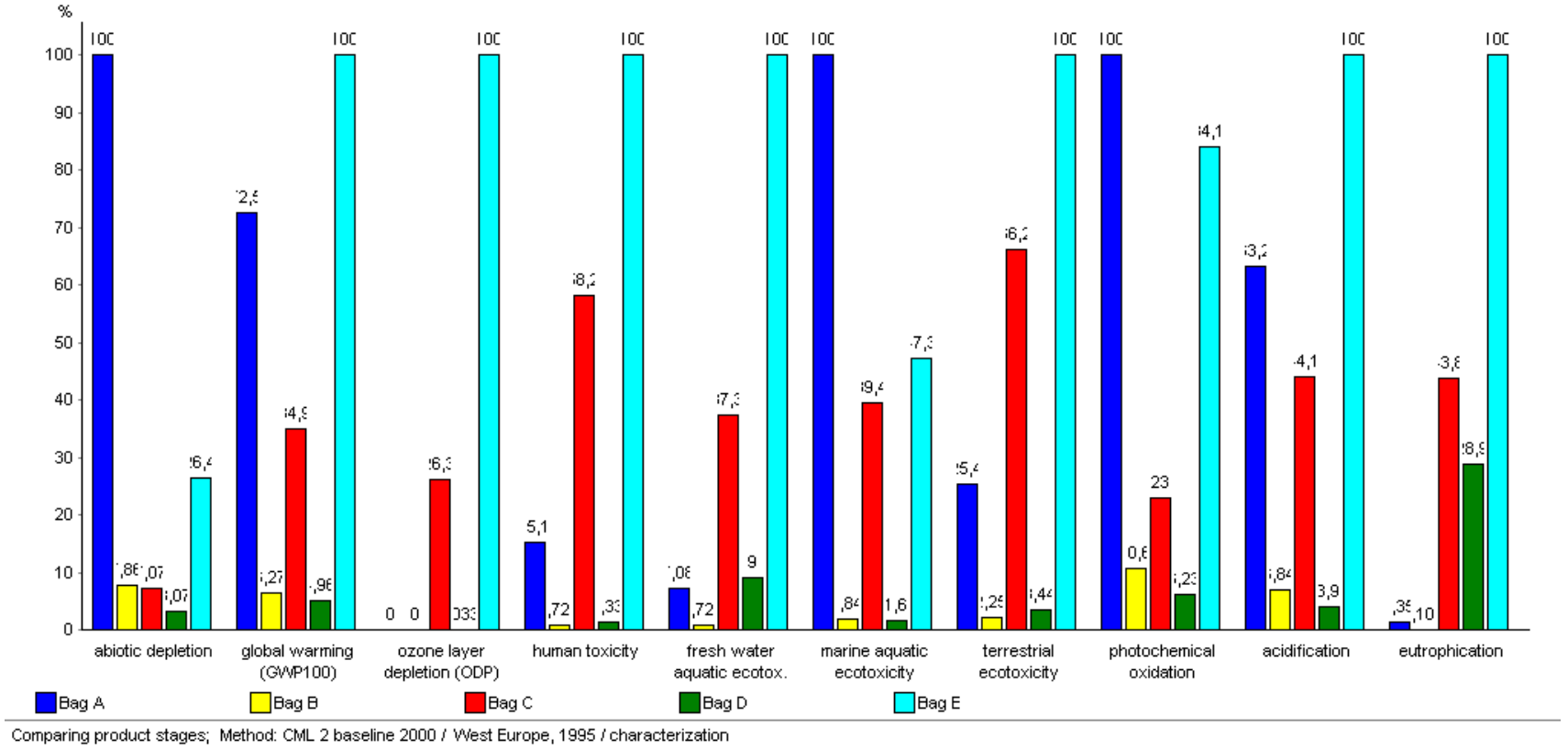

Figure 1. Impact assessment characterisation results for the five shopping bags alternatives.

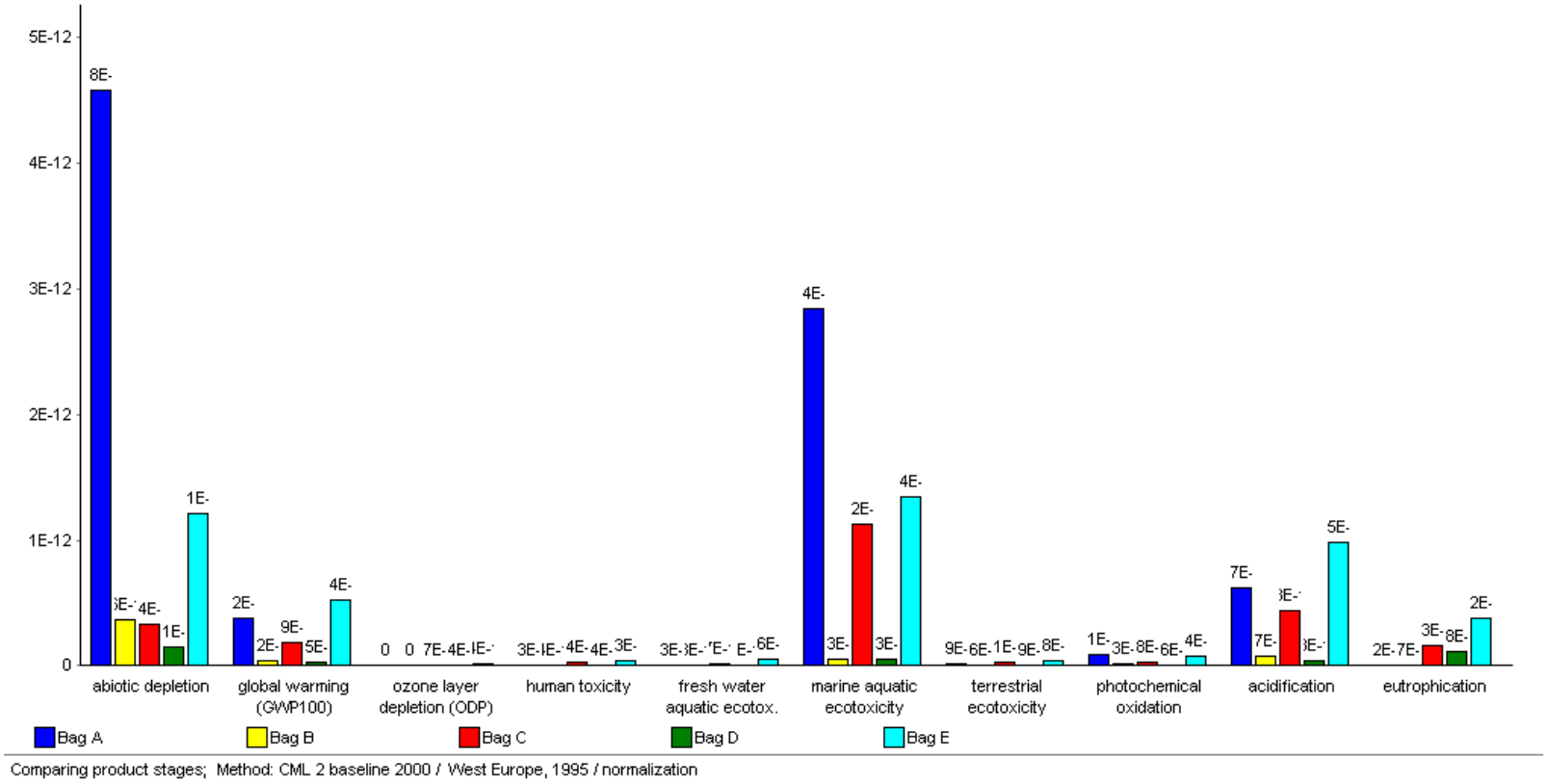

Figure 2. Normalised impact assessment results for the five shopping bags alternatives.

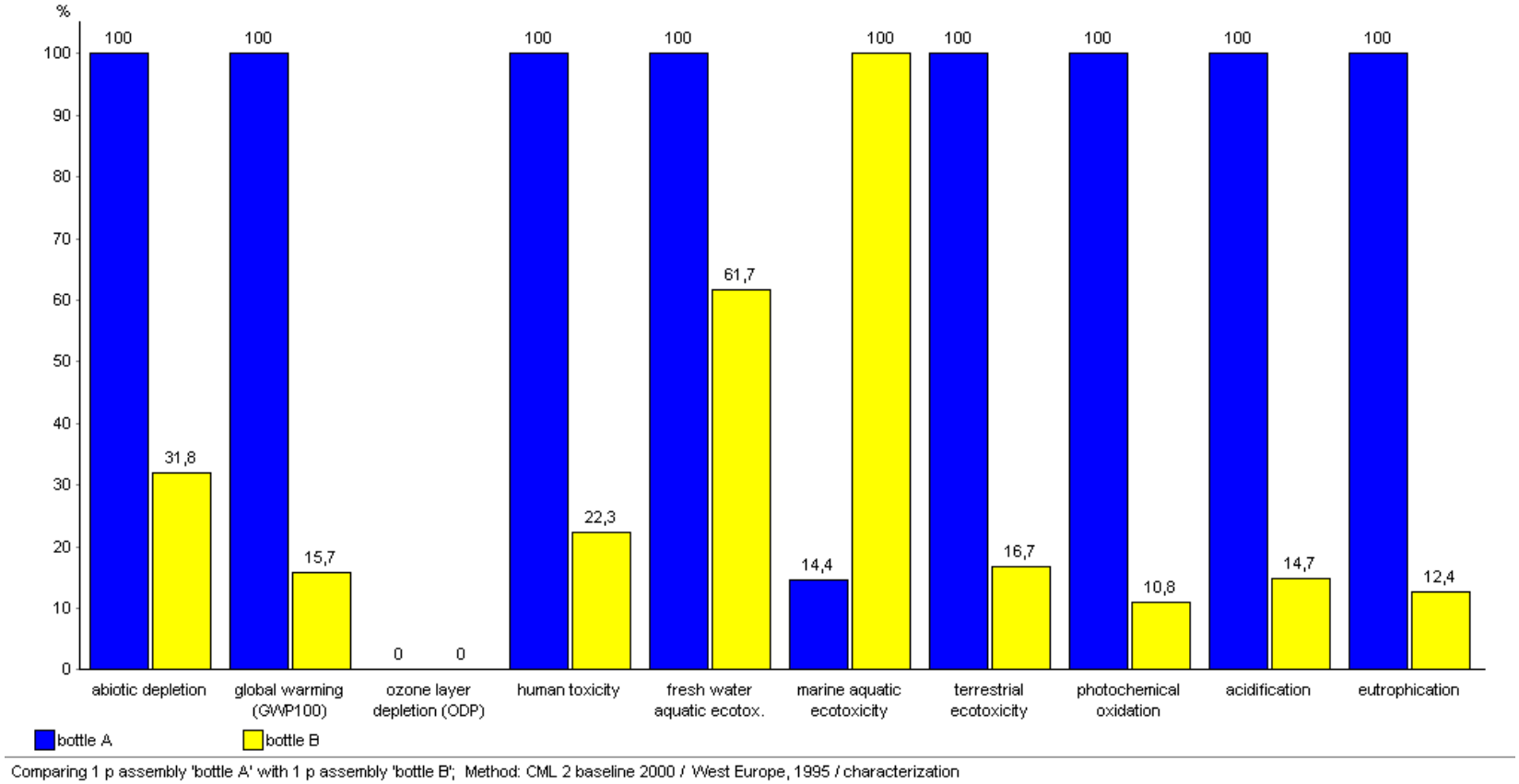

Figure 3. Impact assessment characterisation results for the two liquid soap containers alternatives.

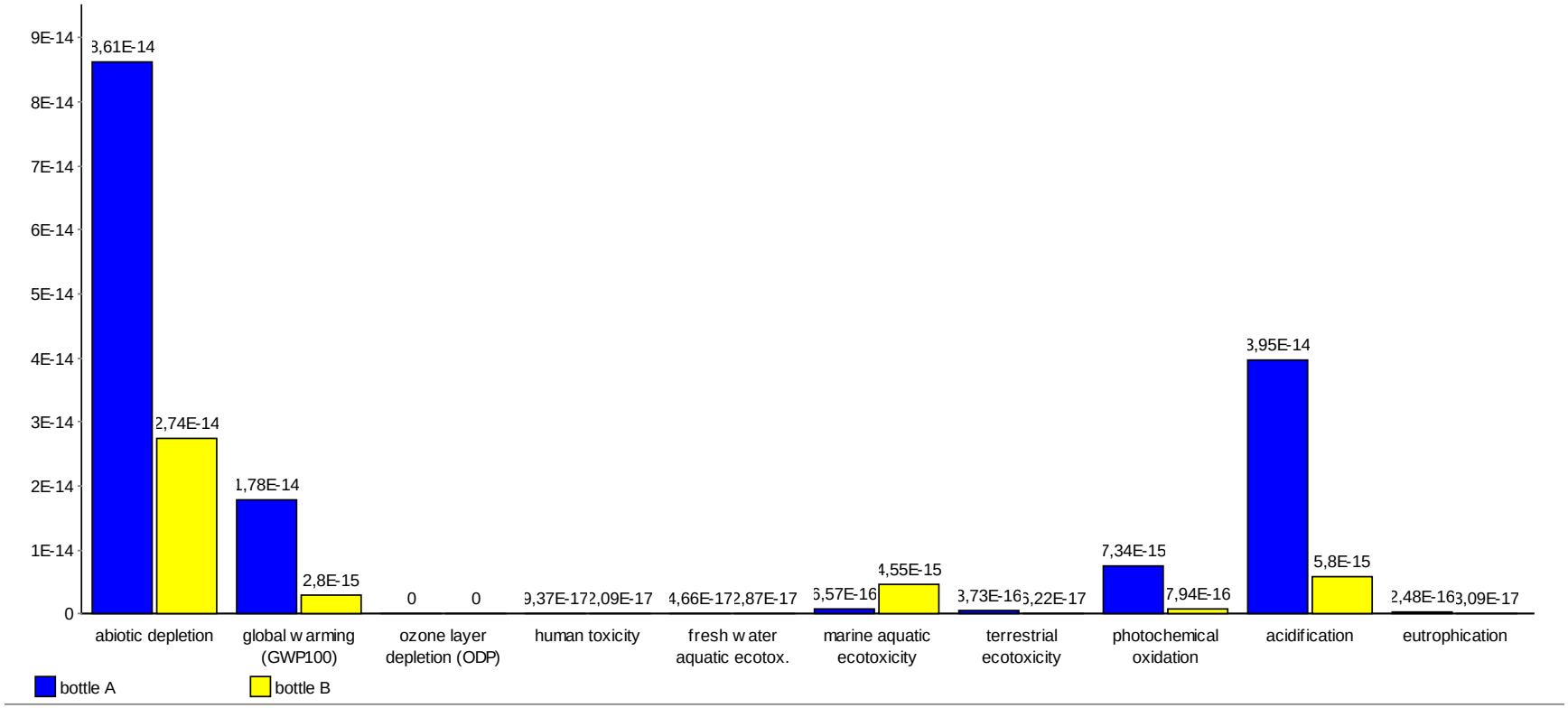

Figure 4. Normalised impact assessment results for the two liquid soap containers alternatives.