



The 6th International Conference on Life Cycle Management in Gothenburg 2013

A NEW SET OF VALUATION FACTORS FOR LCA AND LCC BASED ON DAMAGE COSTS – ECOVALUE 2012

*Göran Finnveden KTH Royal Institute of Technology, Division of Environmental *Strategies Research*. Drottning Kristinas väg 30. 100 44 Stockholm. goran.finnveden@abe.kth.se

Cecilia Håkansson KTH Royal Institute of Technology, Division of Environmental *Strategies Research*.

Maria Noring KTH Royal Institute of Technology, Division of Environmental *Strategies Research*.

Keywords: Weighting; Valuation; Impact assessment; LCA; LCC.

ABSTRACT

Weighting is often used in environmental systems analysis tools. One method is Ecovalue which in its first version was published in 2011. In this paper an updated version is presented. New factors are for exotoxicological impacts and for particulates. The factor for climate change has been updated. The updated set of valuation weighting factors also includes default values in addition to low and high values. The new set is matched with the Recipe methodology except for abiotic resources where Cumulative Exergy Demand is used. Results from an ICT product show that in this case climate change, toxic impacts and resources use are highlighted as important impact categories.

INTRODUCTION

In many environmental systems analysis tools, such as Life Cycle Assessment (LCA), Life Cycle Costing (LCC) and Cost-Benefit Analysis (CBA) weighting is used (Ahlroth et al, 2011). The purpose is to simplify the comparison between different impacts and alternatives. There are several methods available (Huppel et al, 2012) and they can give significantly different results. If the different weighting methods reflect different values, they should give different results. It is however interesting to note that many of the methods used have not been published in peer reviewed papers and may not include state-of-the art scientific methods and data.

In Ahlroth and Finnveden (2011) the valuation set Ecovalue08 is presented. It is a monetary weighting set using impact categories from LCA and values on the benefit loss caused by environmental degradation. The set includes the following impact categories: eutrophication, acidification, global warming, forming of tropospheric ozone, human toxicity and depletion of abiotic resources.

People's preferences changes with time, as does knowledge about environmental relationship. In this paper an updated version of Ecovalue is presented focused on Swedish conditions as

well as an improved number of impact categories. The paper also presents a case study where the weighting set has been used.

METHODS

Values from the earlier weighting set have been reconsidered based on more recent studies and two more impact categories have been added. The values have been adjusted to 2010 year's monetary value. In Ahlroth & Finnveden (2011) the values are presented in a range to reflect the uncertainty in the valuation studies. This updated version also includes a default value in order to increase the usability.

The updated weighting set was tested in a LCA case study by Achachlouei et al (2013) on reading a magazine on a tablet. In the case study the weighting set is combined with the characterization methods ReCiPe (Goedkoop et al, 2009) and Cumulative Exergy Demand (Bösch et al, 2006).

RESULTS

The updated valuation set

Abiotic resources. The value of abiotic resources in the Ecovalue method is based on the monetary resource value which consists of the difference between the market price and the marginal production cost. This value is regarded as reflecting the valuation of the resource and the exergy method is used as a characterization method (Ahlroth & Finnveden, 2011). The values in Ahlroth & Finnveden (2011) are kept, but a mean value of SEK 0.12/MJ is proposed.

Global warming. Since the last version of Ecovalue several studies have shown that the damage costs from global warming might be higher but also uncertain (e.g. (Ackerman & Stanton, 2012; Anthoff, Tol, & Yohe, 2009; Botzen & van den Bergh, 2012; Tol, 2010). A higher maximum value than the previous presented in (Ahlroth & Finnveden, 2011) is proposed based on the studies above. The new, maximum value is SEK 5.6/ton CO₂. The mean value, SEK 2.85/kg CO₂-equivalents, is proposed.

Photochemical oxidation. The values for photochemical oxidation remains the same in this version, SEK 14-40/kg C₂H₂-equivalents, but the mean value is proposed, SEK 27/kg C₂H₂-equivalents.

Acidification. No further valuation studies on acidification in Swedish conditions have been made since the last version of the valuation set and the suggestion is kept.

Eutrophication. The values presented in Ahlroth & Finnveden (2011) are regarded as relevant. The mean values, SEK 670/kg P for freshwater eutrophication and SEK 90 /kg N for marine waters are proposed.

Human toxicity. The value on human toxicity is based on damage costs from emissions of different heavy metals. Updates have been made regarding these damage costs valid for the EU (Bruyn et al., 2010) and based on their findings the value SEK 2.81/kg DB-equivalents is suggested.

Marine toxicity. Marine toxicity was not included in Ecovalue08. The introduced value is based on a recent valuation study on Swedish coastal waters where the impacts of tributyltin compounds (TBT) have been valued (Noring et al. 2013). The value estimated is SEK 12/kg 1,4 DB-equivalents.

Particles. Also the value of particles is a new contribution to the weighting set. European estimates on damage costs made by Bruyn et al. (2010) constitutes the basis for the proposed value of 273 SEK/kg PM₁₀-equivalents. This value describes regional impacts. If local impacts are of concern, the value could be significantly higher.

All the updated values are presented in Table 1.

Table 1. The updated weighting set.

Impact category	Weighting: mean value	Weighting: interval
Abiotic resources	SEK 0.12 /MJ	SEK 0.004-0.24 /MJ
Global warming	SEK 2.85 /kg CO ₂ -eq	SEK 0.1-5.6 /kg CO ₂ -eq
Photochemical oxidation	SEK 27 /kg C ₂ H ₂ -eq	SEK 14-40 /kg C ₂ H ₂ -eq
Acidification	SEK 30 /kg SO ₂ -eq	SEK 30 /kg SO ₂ -eq
Eutrophication, marine	SEK 90/kg N	SEK 90/kg N
Eutrophication, fresh water	SEK 670/kg P	SEK 670/kg P
Human toxicity	SEK 2.81 /kg 1,4 DB-eq	SEK 0.02-4.89 /kg 1,4 DB-eq
Marine water toxicity	SEK 12 /kg 1,4 DB-eq	SEK 12 /kg 1,4 DB-eq
Particles	SEK 273 /kg PM ₁₀ -eq	SEK 273 /kg PM ₁₀ -eq

Case study

The weighting set was applied on a study on reading a magazine on a tablet (Achachlouei et al, 2013) and results from the case study is presented in Table 2.

Table 2. Environmental impact from reading a magazine on a tablet Results weighted with Ecovalue12 and expressed as SEK per reader and issue.

Impact category	Climate change	Human toxicity	Photochemical oxidant formation	Particulate matter formation	Terrestrial acidification	Freshwater eutrophication	Marine eutrophication	Marine ecotoxicity	Cumulative Exergy Demand	TOTAL
Tablet magazine	0,52	0,88	0,01	0,09	0,02	0,13	0,02	0,05	1,11	2,83

DISCUSSION AND CONCLUSIONS

Valuation weighting factors will always be uncertain and care should be taken when conclusions are drawn. The case study indicates that Climate change, Human toxicity and

Resources are important impact factors. This seems like relevant results for the case study. The new weighting factors for ecotoxicological impacts and particulates are in this case study not insignificant but are not dominating the results. More case studies are however needed before any conclusions about the relative importance of different impact categories are. It would also be of importance to compare the results with other weighting methods as well.

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