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Short communication

# Estimating chemical ecotoxicity in EU ecolabel and in EU product environmental footprint

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ABSTRACT

The EU Commission Ecolabel and the Product and Environmental Footprint (PEF) aim at promoting the development and consumption of greener products. The product aquatic toxicity score from these 2 methods may lead in some circumstances to opposite conclusions. Although this could be interpreted as an inconsistency, the score should not be compared to each other but used in a complementary way. In short, CDV provided a "full" product formula aquatic toxicity score, even if some chemicals may never reach or persist in freshwater ecosystems. The USEtox® score, by integrating fate and exposure, focuses on the potential toxicity of persistent-water-soluble chemicals at steady state. Since no risk or safety assessment can be conducted with USEtox® nor with the CDV, both are a hazard-based scoring system. This short communication clarifies the difference between approaches underpinning the toxicity scores used in Ecolabel and PEF, providing guidance on how to interpret the results.

## 1. Introduction

There are currently more than 465 Green labels on the market from which the consumer can choose with the hope to make an environmentally friendly decision (Golden et al., 2010). Some of those labels are developed by governments, other by NGOs or by industries. All have the aim to promote the consumption of more sustainable products but they are all based on different set of criteria which can sometimes result in conflicting information to consumers (Dahl, 2010; Rahbar and Abdul Wahid, 2011). Although products with a green labels do not have yet a very high market share, they are clearly appealing to those consumers that wants to make a green buying decision (Hahnel et al., 2015). Moreover, market shares for this type of products are increasing every year, demonstrating the need to have clear and transparent product environmental information.

In Europe, the EU commission has proposed its own ecolabel scheme since 1992 with the aim to provide one single trustworthy label to consumers. 25 years later, the EU Ecolabel has about 40,000 products carrying the EU flowers (about 2000 licences for 12 product categories. Each product group must comply with a set of specific criteria, generally all based on a life cycle thinking approach (European Commission (EC), 2010; ISO, 1999).

In 2013, the European Commission has published its recommendations on the use of a common method to measure and communicate the life cycle environmental performance of products and organisations (European Commission (EC), 2013). This is an essential step towards a more coherent and harmonised way of measuring the environmental performance of products and organisations taking a life cycle assessment approach. The PEF is a comprehensive assessment, impact oriented, aiming at identifying hotspots within the life cycle of a product and at helping the selection of products with overall lower potential environmental impact. Ecolabel is a product issue-oriented approach, addressing specific environmental concerns identified by stakeholders. The continuous proliferation of different methods and initiatives to assess and communicate environmental performance is leading to confusion and mistrust (Gruère, 2015).

Both the EU Ecolabel and PEF aim at promoting the development and consumption of greener products and are both based on life cycle thinking. The PEF is purely a life cycle assessment method using EU commission specific developed guidelines (largely based on ISO 14040 (ISO, 2006). In contrast, the EU ecolabel contains several criteria to fulfil (as a pass/fail criteria) to become eligible to carry the EU flowers, which are product specific and issue-oriented (ISO, 1999).

The EU Ecolabel covers a wide range of product groups, from mass-market goods to tourist accommodation services. So far, criteria have been developed for 12 products groups (Cleaning Up, Do-it-Youself, Furniture, Textile and footwear, Lubricants, etc.). Each product group has its own set of criteria and the full description of those can be

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**Table 1**
List of impact categories of the PEF and the criteria to fulfil for EU Ecolabel for Detergent and cleaning products (European Commission (EC), 2018).

| Impact categories in PEF to assess Product-LCA | EU Ecolabel criteria for detergents and cleaning products |
|---|---|
| 1. Climate change | 1. Dosage requirements |
| 2. Ozone depletion | 2. Toxicity to aquatic organisms |
| 3. Ecotoxicity for aquatic freshwater | 3. Biodegradability (a: surfactants, b: organic compounds) |
| 4. Human toxicity – cancer effect | 4. Sustainable sourcing of palm oil, palm kernel oil and their derivatives |
| 5. Human toxicity – non cancer effect | 5. Excluded and restricted substances (a: specific excluded and restricted substances, b: hazardous substances, c: substances of very high concerns, d: fragrances, e: preservatives, f: colouring agents, g: enzymes, h: micro-organisms, i: corrosive properties) |
| 6. Particulate matter/Respiratory inorganics | |
| 7. Ionising radiation – human health effect | |
| 8. Photochemical ozone formation | 6. Packaging (a: Products sold in spray bottles, b: Packaging take-back systems, c: Weight/utility ratio (WUR), d: Design for recycling |
| 9. Acidification | |
| 10. Eutrophication – terrestrial | 7. Fitness for use |
| 11. Eutrophication – aquatic | 8. Automatic dosing system |
| 12. Resource depletion – water | 9. User information (a: Dosing instructions, b: Packaging disposal information, c: Environmental information) |
| 13. Resource depletion mineral, fossil | 10. Information appearing on the EU Ecolabel |
| 14. Land transformation | |

consulted on the EU Ecolabel website (http://ec.europa.eu/ecat/). For detergents and cleaning products, one criteria is focusing on the overall product freshwater ecotoxicity, looking only at the chemicals contained in the products, e.g. the formulation, via the Critical Dilution Volume (CDV) (n°1 in Table 1, right column) (European Commission (EC), 2018).

The CDVchronic [L] estimates the impact of a product on aquatic freshwater ecosystems through the calculation of the volume of natural water required to dilute a quantity of the product (or functional unit) down to a concentration without any foreseeable harmful impact on aquatic species (European Commission (EC), 2018).

$$\text{EU Ecolabel Total product toxicity score CDVchronic} = \sum \text{CDV}_i$$

and

$$\text{CDVchronic}_i = ((\text{Dosage}_i \times \text{DF}_i)/\text{TFchronic}_i) \times 1000$$

with:

$\text{Dosage}_i$: weight (in g) of substance i in the reference dose (the reference dose corresponds to the quantity of product needed for 1 wash cycle).

Degradation factor ($\text{DF}_i$) is an estimation of the degradation rate of a substance (*i*) in the aquatic environment. It results from tests assessing aerobic biodegradability (DF = 0.05 for readily biodegradable, DF = 0.15 for readily biodegradable falling the 10 days window, DF = 0.5 for inherently biodegradable, and DF = 1 for persistent).

Chronic toxicity factor ($\text{TFchronic}_i$) calculates the median value within each tropic level (fish, crustaceans or algae) using validated test results (NOEC or EC10) for chronic toxicity for substance (*i*). It is the lowest median (NOEC or EC10) of the trophic levels divided by the safety factor (SF), which depends on how many trophic levels are tested and whether chronic test results are available or not.

TF and DF are derived for two hundred seventy eight chemicals used in personal care and cleaning products and published in the Detergent Ingredient Database (DID list) (European Commission (EC), 2016).

In the PEF one impact category is also reporting the freshwater ecotoxicity Impact Score (IS) (n°3 in Table 1, left column). The IS is calculated from the USEtox® multimedia fate model (Fantke et al., 2017) that has been retained by the EU commission as the reference model to calculate the ecotoxicity impact category indicator (EC-JRC, 2012). In USEtox®, the freshwater aquatic toxicity impact of a product PEF, the mass of each chemical emitted from an EF is multiplied by its associated characterisation factor (CF) as follows:PEF Product ecotoxicity Impact Score (IS)

$$\text{IS} = \sum \text{i} \sum \times \text{CF}_{s,i} \times \text{M}_{s,i}$$

and

$$\text{CF}_{s,i} = \text{FF}_{s,i} \times \text{XF}_{s,} \times \text{EF}_{s,}$$

with:

s: index for substance

i: index for compartment

The Impact Score (IS) is expressed as a 'Comparative Toxicity Unit' (CTU) to stress the comparative nature of the impact score. It is expressed per 'functional unit' which in the case of detergent and cleaning products could be '1 wash cycle'.

The Characterisation factor (CF) are expressed in $m^3 \cdot day \cdot kg^{-1}$ per chemical (*s*) and emission compartment specific (i) and represents the potency of a chemical towards aquatic biota.

Fate factor (FF, in days) represents the residence time of the substance in a specific environmental compartment (air, water, sediment, soil) taking into account volatilization, sedimentation, (bio)degradation, sorption, and diffusive transfer between compartments. The fate factor is calculated at steady state using multimedia fate modelling (Brandes et al., 1996).

Exposure factor (XF, dimensionless) represents the fraction of chemical in dissolved form. This factor is calculated via a simple equation using adsorption coefficient on suspended particle, on dissolved organic matter and bioaccumulation into biota.

Effect factor (EF, in $m^3 \cdot kg^{-1}$) represents the toxicity of the substance to biota, expressed as the inverse of the HC50, calculated based on the species geometric means of chronic EC50 data (in $kg \cdot m^{-3}$).

A critical discussion of the methodologies underpinning these two scoring systems, and the limitations thereof, are outside the scope of the present article but can be consulted in recent publications by the authors (Saouter et al., 2011; Saouter et al., 2017a; Saouter et al., 2017b).

Although the two scoring systems rely on chemical toxicity and degradation, they are fundamentally different.

The first and most important difference is that the CDV from the EU ecolabel focuses on the chemicals contained in the product (its chemical composition) while the IS from USEtox method in PEF includes chemicals in the product and all other chemicals emitted from the entire product life cycle (cradle to grave, including the use phase and end of life stage of the product).

For the chemical toxicity score, as described above, the two schemes cover a range of chemical emissions of few dozens in the CDV/EU Ecolabel to up to 2000 (and more) for IS/PEF (Fig. 1).

The second important difference is how the toxicity score is calculated and what it means. The calculation of the IS from USEtox® and the CDV from the EU Ecolabel, although both labelled 'product toxicity', and both using the toxicity of the chemicals as input data, are based on two different approaches. Table 2 gives an overview of how both toxicity scores are based on.

In simple terms:

- CDV indicates how potentially toxic are the substances present in a product formula for the aquatic biota. However, the fate of the