

Life Cycle Initiative DTU

# Modelling life cycle impacts of toxics on humans and ecosystems with the USEtox™ model

## 1-day course

Michael Hauschild  
Quantitative Sustainability Assessment  
DTU Management Engineering

USEtox™

DTU Management Engineering  
Department of Management Engineering

M. Hauschild  
12th Nov 2016  
DTU Lyngby  
9 April 2016

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# Characterisation

- how much does the emission contribute?

Quantitatively determine the impact score per environmental category

$$IS = \sum_i \sum_x CF_{x,i} \cdot m_{x,i}$$

IS = impact score  
CF = characterisation factor  
m = life cycle emission  
x = substance type  
i = compartment type

a **Characterisation Factor** is a quantitative representation of the (relative) hazardousness of a specific emission expressed in absolute metric or relative to a reference substance  
e.g. the human toxicity characterisation factor of benzene is 300 CTU

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# Meaning of characterisation factor?

Comparative human or ecotoxicity assessment

- Standardised unit world
- Unknown
- Unknown
- Emission
- Emission
- Unknown

⇒ Characterisation factor

- Support
- Foundation

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# Characterised impact profile

	Product A	Product B	Units
Global warming	170	448	ton-CO <sub>2</sub> eq
Stratospheric ozone depletion	0,12	0,08	kg-CFC-11eq
Photochemical ozone formation	143	415	kg-C <sub>2</sub> H <sub>4</sub> eq
Acidification	689	1808	kg-SO <sub>2</sub> eq
Nutrient enrichment	3220	4830	kg-NO <sub>3</sub> eq
Freshwater ecotoxicity	2,6 · 10 <sup>2</sup>	1,8 · 10 <sup>2</sup>	CTU <sub>e</sub>
Human toxicity	1,7 · 10 <sup>-3</sup>	7,7 · 10 <sup>-4</sup>	CTU <sub>h</sub>

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# Characterised impact score

$$IS = \sum_i \sum_x CF_{x,i} \cdot m_{x,i}$$

34 CTU<sub>h</sub>  
17 CTU<sub>e</sub>

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# Characterisation factor metrics

USES LCA: kg 1,4 DCB-eq/kg emitted  
EDIP: m<sup>3</sup> compartment/kg emitted  
IMPACT 2002+: kg chloroethylene-eq/kg emitted (HT)  
kg ethylene-eq/kg emitted (ET(aq))

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CTU<sub>h</sub>/kg = cases/kg emitted (HT)  
- estimated increase in morbidity in the total human population per unit mass of a chemical emitted  
CTU<sub>e</sub> = PAF · m<sup>3</sup> · day/kg emitted (ET(fw))  
- potentially affected fraction of species (PAF) integrated over time and volume per unit mass of a chemical emitted  
- No reference substance, unit has a clear meaning in itself

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## Multiple USEtox CFs

Human toxicity:  
 6 emission compartments (via two exposure routes)  
 2 types of effect (carcinogenic and non-carcinogenic) and total

Ecotoxicity:  
 6 emission compartments  
 1 endpoint compartment (freshwater)

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 Department of Management Engineering

M. Haschick  
 12th November  
 DTU Lyngby  
 9 April 2015  
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## Multiple USEtox CFs

Factors available from [USEtox.org](http://USEtox.org)

- Together with intermediate data (iF, FF, EF)
- Recommended and interim factors
- Thousands of substances
- Updated on annual basis

Underlying substance database also available

- Organics and inorganics

You can supplement with factors you calculate yourself

- Important to keep track of which parts of the impact is calculated using which type of factors (recommended, interim, own)

Recommended and interim factors under implementation in major LCA software tools

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