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

1-day course

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Programme

9.00 General introduction (M. Hauschild)
- Programme
- Source to damage cause-effect chain relationship and modelling steps

9.20 Chemical fate modelling (M. Birkved)
- Overview of typical environmental mass balance concepts
- Introduction to transport and degradation rate calculations as well matrix solutions.

10.40 Break

11.00 Human Exposure Modelling (R. Rosenbaum)
- Overview of human exposure concepts
- Direct and indirect pathways
- Subsistence vs. production-based approaches to food-based exposures.

12.30 Lunch

13.30 Effects Modelling (S. I. Olsen and H. F. Larsen)
- Risk-based and DALY-based human toxic effect factors
- EC50-based ecotoxicity effect factors
- Characterisation factors

15.00 Calculation of characterization factors (M. Hauschild)
- Fate, exposure and effect modelling into unique metric

15.20 Break

15.40 Source to impact framework and uncertainty (R. Rosenbaum)
- Matrix approach, USEtox™ model

16.00 Overall Modelling with USEtox (All)
- Characterisation factors for human health impacts and ecotoxicological impacts

17.00 Course adjourned

Teachers

Morten Birkved
Assistant professor, system modelling and life cycle inventory analysis, environmental models

Ralph Rosenbaum
Associate professor, chemical-related impacts in life cycle impact assessment, involved in development of USEtox

Stig I. Olsen
Associate professor, human toxicology, decision support tools for management and development based on LCA

Henrik Fred Larsen
Senior research associate, ecotoxicology, use of LCA for optimisation of wastewater treatment systems

Michael Hauschild
Professor, life cycle impact assessment and sustainability assessment, involved in development of USEtox

In summary...

LCA aims to cover all relevant environmental impacts represented by impact categories and indicators
In order to avoid unwanted bias, best estimate is aimed for in the characterisation modelling
LCIA assesses impacts at midpoint or endpoint in impact pathway
Characterisation factors are substance-specific expressions of relative hazardousness or impact potential
Indicator scores are aggregated over the life cycle
Characterisation of chemical impacts inspired by ERA but fundamental differences exist

Characterisation
- how much does the emission contribute?

Quantitatively determine the impact score per environmental category

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

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

a Characterisation Factor is a quantitative representation of the (relative) hazardousness of a specific emission
e.x. the human toxicity characterisation factor of benzene is 300 CTU
Environmental impacts at endpoint
- Damage to human health (e.g. Years of Life Lost)
- Damage to ecosystem quality (e.g. Disappeared fraction of species)
- Damage to resources (e.g. Extra energy demand)
- Damage to the man-made environment (e.g. Euros)

Impact pathway for Human toxicity
- Ground-, fresh- or marine water
- Agriculture or natural soil
- Vegetation crop
- Domestic or industrial air
- Indoor air or workplace
- Food
- Inhaled exposure
- Inhalation exposure
- Other target organs
- Ingestion exposure
- Intake fraction
- Fate
- Exhalation
- Excretion
- Fraction transferred to n
- Chemical fate
- Human exposure
- Potency
- Effect factor
- EF
- Severity
- Disease severity
- Disease
- Overall other non cancer
- Overall respiratory inorganics
- Overal ionic radiation

Characterisation of eco and human toxicity
- Emissions into compartment m
- Time integrated concentration in n
- Fraction transferred to n
- Chemical fate
- Human exposure
- Potency
- Risk of affected persons
- Effect factor
- EF
- Severity
- Damage on human health
- Potentially affected fraction of species
- Severity
- Effect factor
- EF
- Intake fraction
- FF

Calculation of characterisation factors
9.20 Chemical fate modelling (M. Birkved) FF
11.00 Human Exposure Modelling (R. Rosenbaum) XF
13.30 Effects Modelling (S.I Olsen and H.F. Larsen) EF
15.00 Calculation of characterization factors (M. Hauschild) CF
15.40 Source to impact framework (R. Rosenbaum) CF
16.00 Overall Modelling with USEtox (All) CF = IF·EF CF = FF·EF