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ANNOUNCEMENT

USES-LCA 2.0—a global nested multi-media fate, exposure, and effects model

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1 The USES-LCA 2.0 model

The Uniform System for the Evaluation of Substances adapted for LCA purposes, in short USES-LCA, is a multi-media fate, exposure, and effects model (Huijbregts et al. 2000). The model USES-LCA is based on the (E)USES model family applied for risk assessment purposes in the European Union (Vermeire et al. 2005). It is one of the models involved in the development of LCIA toxicity consensus model USEtox (Rosenbaum et al. 2008). USES-LCA has recently been updated to USES-LCA 2.0 and contains a database of 3,396 chemicals. With this version, the user has now access to an easy-to-use model that calculates characterization factors for ecotoxicity and human toxicity on both the midpoint and endpoint level. For human toxicity, characterization factors for carcinogens, for non-carcinogens, and overall characterization factors are provided. Separate ecotoxicological characterization factors are provided for terrestrial, freshwater, and marine ecosystems. To obtain an overall ecotoxicological characterization factor on endpoint level, they are further aggregated on the basis of species density of terrestrial, freshwater, and marine ecosystems separately. Figure 1 gives a schematic overview of USES-LCA 2.0.

Compared to consensus model USEtox, the main extra features of USES-LCA are (a) next to midpoint characterization factors, endpoint characterization factors are also calculated; (b) next to freshwater ecotoxicity, seawater and terrestrial ecotoxicity are also addressed; and (c) various scenario assumptions can be tested by changing scenario settings (further details described below).

This note summarizes the USES-LCA 2.0 model as developed from the junction of the individual fate and intake part (Huijbregts et al. 2005b), human toxicological part (Huijbregts et al. 2005a), and ecotoxicological part (Van de Meent and Huijbregts 2005; Van Zelm et al. 2007; Van Zelm et al. 2009). Any further information on the calculation of the separate parts of the characterization factors can be found in these articles.

2 Fate and exposure factors

For ten emission compartments, including urban air, rural air, freshwater, and agricultural soil, USES-LCA 2.0 calculates by default environmental fate and exposure factors in multiple compartments and human intake factors for inhalation and oral intake using an infinite time horizon. Environmental fate and exposure factors express the change in the dissolved concentration in an environmental compartment due to an emission change. Human intake factors express the change in exposure of the total human population at continental, moderate, arctic, or tropic scale via ingestion, or inhalation due to an emission change in a compartment. Rain–no rain conditions are implemented in USES-LCA 2.0 according to the intermittent rain model as outlined by Jolliet and Hauschild (2005).

Due to the large uncertainty of modeling metal behavior in the environment, USES-LCA 2.0 includes the possibility to test the sensitivity of the metal characterization factors according to the following user-specific scenario options:

1. Oral intake via food by humans can be excluded for all metals, as it has been shown that the concept of bioconcentration, generally applicable for organic pollu-

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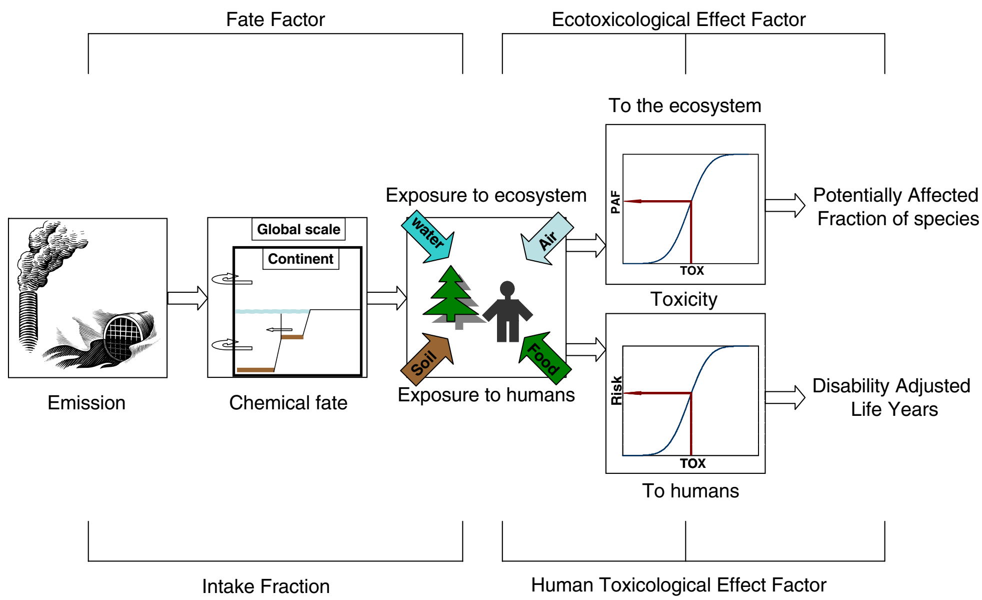
Fig. 1 Schematic representation of USES-LCA 2.0



tants, might not be applicable for inorganics (Hendriks and Heikens 2001; McGeer et al. 2003).

2. The oceanic compartment can be excluded for essential metals, i.e., cobalt, copper, manganese, molybdenum, and zinc, as additional inputs of essential metals in the oceans may not lead to toxic effects (Ligthart 2004).
3. A time horizon of 100 years instead of an infinite time horizon can be chosen. According to Ligthart (2004), it is advisable to perform a sensitivity analysis with the 100 years time horizon for the toxicity impact categories when metals have a dominant influence in the LCA results.

3 Human effect and damage factors

USES-LCA 2.0 calculates Human toxicological Effect and Damage factors (HEDFs) per chemical with information related to intake route (inhalation and ingestion), and disease type (cancer and non-cancer). Route-to-route extrapolation from inhalation to ingestion or vice versa is included when no data are available for either intake route, unless a chemical is known to have a local effect only. In these specific cases, no extrapolation is performed.

HEDFs on endpoint level express the change in damage to the total human population, expressed as disability adjusted life years (DALY), due to a change in steady-state exposure of the total human population. The HEDF consists of a disease-specific slope factor, and a chemical-specific toxic potency factor. USES-LCA 2.0 includes cancer-specific and non-cancer-specific slope factors, as calculated by Huijbregts et al. (2005a)[1]. The chemical-specific part refers to the average toxicity of a chemical towards humans, separately implemented for carcinogenic effects and effects other than cancer. To obtain HEDFs on a midpoint level, only the chemical-specific part is included.

Several scenario options can be set to calculate HEDFs in USES-LCA 2.0:

1. The user has the option whether to take into account years of life disabled (YLD) in the DALY calculations or to include Years of Life Lost (YLL) only.
2. Cancer effects can be excluded, depending on the level of evidence for carcinogenicity. This choice has been implemented following the IARC (International Agency for Research on Cancer) classification.

4 Ecological effect factors

Ecotoxicological effect factors (EEFs) on the endpoint level express the change in overall toxic pressure due to a change in the concentration of a chemical. The EEF consists of a slope factor, and a chemical-specific toxic potency factor that reflects the average toxicity of a chemical towards ecosystems based on single species toxicity data (Van de Meent and Huijbregts 2005). USES-LCA 2.0 uses by default a fixed value for the slope factor, as recommended by Van de Meent and Huijbregts (2005). The midpoint EEF is based on the chemical-specific ecotoxic potency only.

Several scenario options can be set to calculate EEFs in USES-LCA 2.0:

1. As an alternative for the default slope factor, Toxic Mode of Action (TMoA)-specific slope factors can be used for freshwater EEFs (see Van Zelm et al. 2007, 2009).

[1] Updated disease-specific factors were included according to chapter 7 in Goedkoop et al. (2009).

2. Chemicals for which toxicity data are available on a small number of species can be excluded by setting a minimum of tested species. Uncertainty in the chemical-specific toxic potency substantially decreases with the availability of ecotoxicity data for an increasing number of species (Van Zelm et al. 2009).

5 Availability

USES-LCA 2.0 is downloadable free of charge from: http://cem-nl.eu (products).

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