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SewageLCI 1.0, an inventory model to estimate chemical specific emissions via sewage treatment systems

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INTRODUCTION

- Emissions of chemical compounds via sewage systems (SSs) to the environment are in LCAs typically handled solely by acknowledging chemical unspecific environmental burdens related with treatment of a functional unit specific volume of waste water, hence typically assuming 100 % removal of the chemical compounds present in the waste water undergoing treatment.
- Waste water treatment (WWT) models (e.g. BioWin and SimpleTreat) model degradation of chemical compounds in WWT plants with secondary/ tertiary WWT, i.e state-of-the-art WWT systems. None of the WWT models acknowledges that a considerable fraction of the World/European population is connected to less efficient WWT systems.
- Despite some chemical compounds only are being removed to a minor extent during WWT, the eco- and human toxicological impacts of the fractions not being removed during SS transport and WWT is thus typically not accounted for in LCAs.
- SewageLCI 1.0 is a new inventory model which facilitates emission calculations and provides emissions estimates for chemical compounds to air, soil and freshwater from SSs, taking into account the national setups of SSs, acknowledging the national variability in WWT efficiencies.

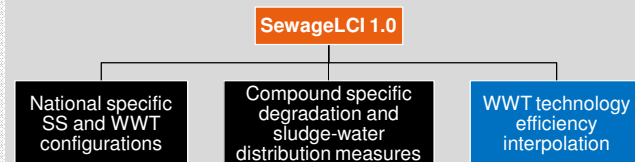
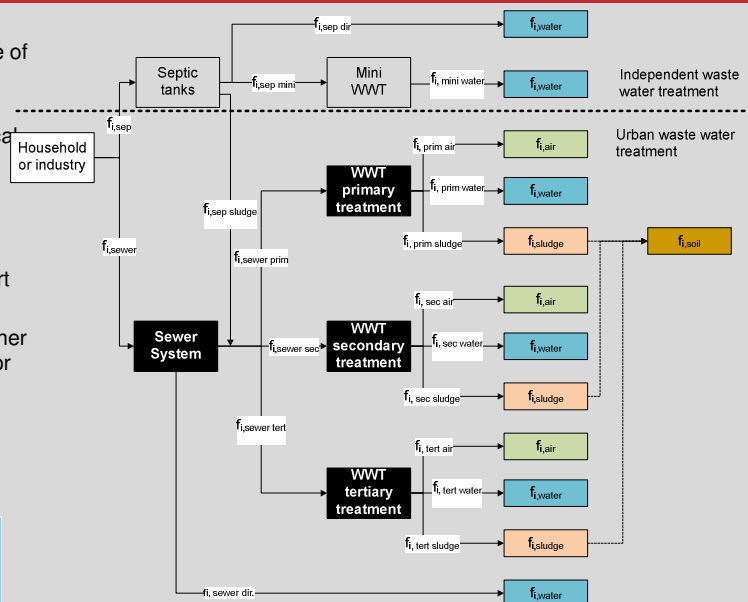
MODEL SETUP

The SewageLCI model relies on two sets of data

- Data set 1 - data describing the SS constellation (e.g. percentage of population connected to urban/independent WWT, percentage of the population emitting directly to environment etc.).
- Data set 2 - data describing to which extent the individual chemical compounds will undergo degradation during SS transport and WWT.

SewageLCI divides SS emissions between 2 systems:

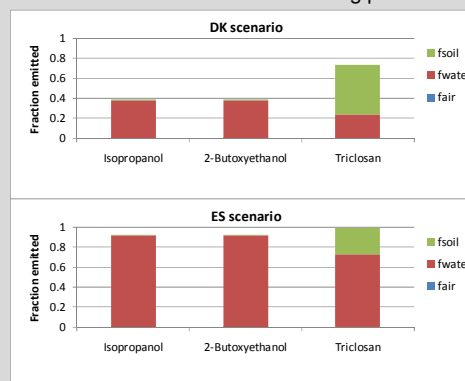
- System 1 - the independent SSs: emissions from this system occurs to surface water and in the form of sludge to the WWT part of the urban SSs.
- System 2 - the urban SSs: emissions from this system occurs either directly to surface water or via the WWT plants to surface water or air. If sewage sludge is amended to agricultural soil, emission to (agricultural) soil may also occur.



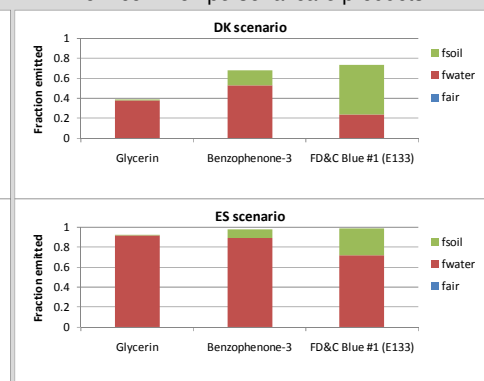
RESULTS

- Parameterization of the SewageLCI model was done based on most current EU summary statistics on national SS configurations and WWT in EU.
- The model was tested on emissions of two sets of 3 chemical compounds occurring in common cleaning products and/or common personal care products such as soaps.
- The emission patterns were calculated for both sets of chemical compounds with both Danish and Spanish configurations of the SSs and hence SewageLCI.
- For both sets of chemical compounds, emission fractions to soil ($f_{i,soil}$), surface water ($f_{i,water}$) and air ($f_{i,air}$) were calculated.

Emission patterns of chemical compounds from common household cleaning products



Emission patterns of chemical compounds from common personal care products



CONCLUSIONS

- Many chemical compounds are not removed 100 % during SS transport and/or WWT and are hence capable of contributing to toxicological impact categories after emission of the treated waste water to the environment, which is not acknowledged in most LCAs and in most cases resulting in an underestimation of the toxicological impacts induced by chemical compounds emitted to SSs.
- Emission patterns of chemical compounds from SSs are both chemical and national specific.
- Contrary to WWT models from chemical risk assessment SewageLCI 1.0 takes into account the national configuration of SSs and national WWT efficiencies and provides emission estimates for all relevant (emission) compartments, not only surface water.