Improvement of **Odor Assessment** in a **L**ife **C**ycle **A**ssessment Framework

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Introduction

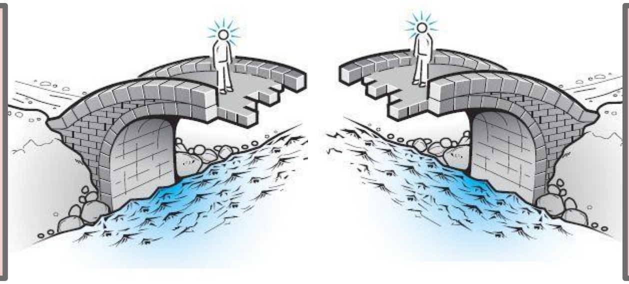
Many food production systems involve components that generate odor

Incidence of odor annoyance is increasing

Odor plays a role in the selection of technologies for manure and waste water management

AIM: develop simple method for odor midpoint assessment in life cycle assessment

Life cycle impact assessment methods



Research on odor threshold values

History

Heijungs et al. (1992):

- *OTV*: concentration (kg·m^{-3}) at which a chemical is detectable by 50% of the population
- Malodorous air = $\sum_i \frac{m_{i,air}}{OTV_{i,air}}$
- Does not consider persistence of odor

Marchand et al. (2013):

- Temporal component added
- USEtox (adjusted) as a basis for fate modeling of odorants
- Ultimate odor burden is expressed in terms of 11 different midpoint indicators

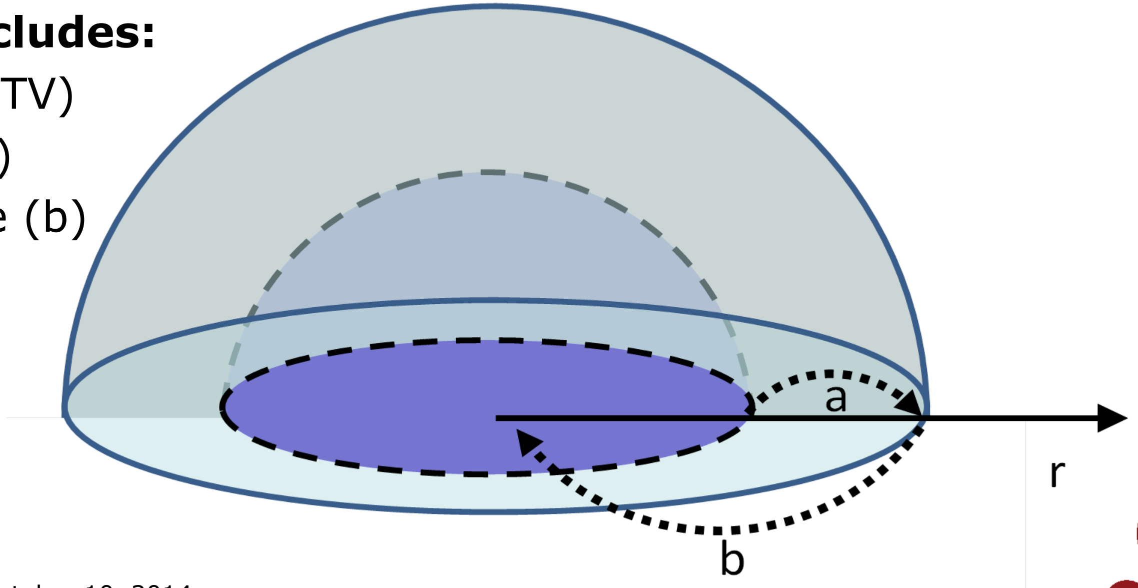
Methods

Non-site-specific midpoint method

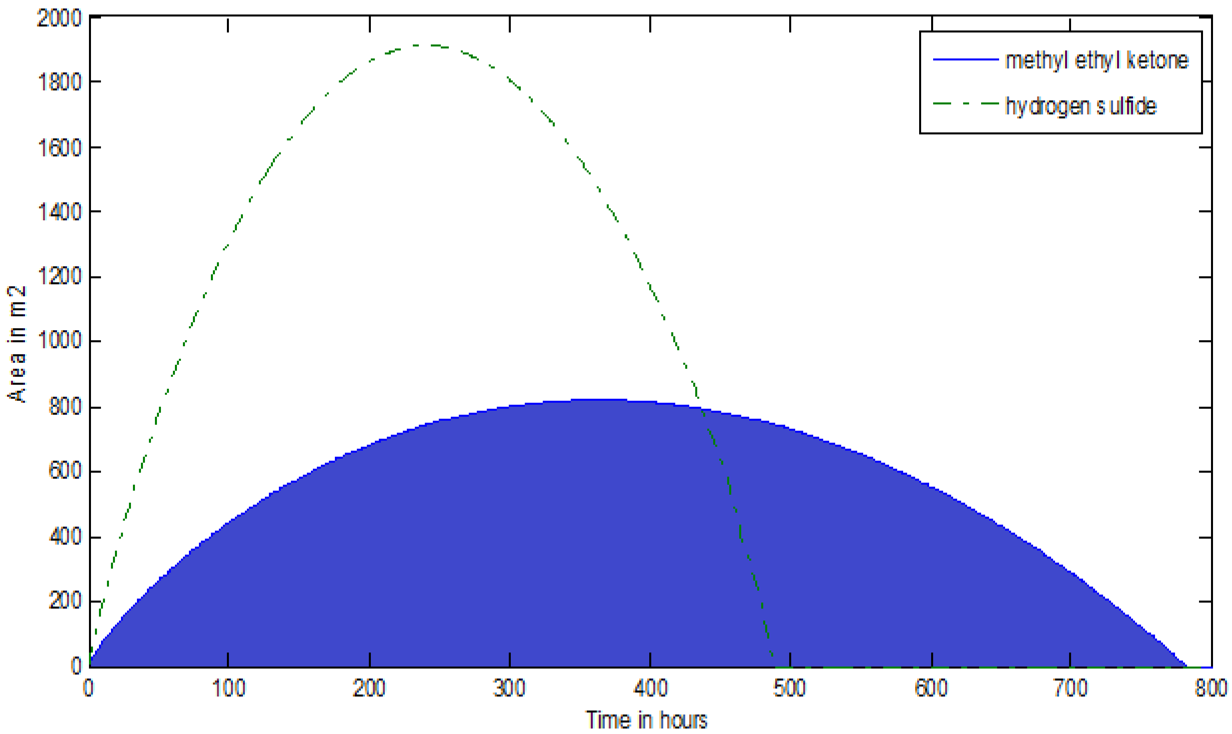
- Wind-induced turbulence not included (equal for all odorants)
- Focus on chemical specific factors causing an odorant's potential impacts
- Detection levels often orders of magnitudes lower than toxicological effects

Odor footprint includes:

- Odor potency (OTV)
- Diffusion rate (a)
- Degradation rate (b)



Results



	OTV	Diffusion	Degradation
Hydrogen sulfide	**LOW**	**HIGH**	HIGH
Methyl ethyl ketone	HIGH	LOW	**LOW**

Results

Characterization factors for 33 key odorants (Peters et al., 2014)

Expression of odor by Heijungs et al. (1992): "malodorous air" for H_2S is more than 2000 times higher than for butanone

Odor footprint of H_2S is 46% higher than butanone

Difference between these relationships is due to inclusion of diffusion and degradation in the latter (both high for H_2S)

Parameter	OTV	D	k_{OH}	Odor footprint	
Odorant	$g \cdot m^{-3}$	$m^2 \cdot s$	s^{-1}	$m^2 s$	kg H_2S-eq$\cdot kg^{-1}$
Hydrogen sulfide	**5.72×10^{-7}**	2.31×10^{-5}	7.05×10^{-6}	2.30×10^{9}	**1.00**
Butanone	**1.30×10^{-3}**	1.29×10^{-5}	1.80×10^{-6}	1.57×10^{9}	**0.68**

Discussion

Pathway for improvement of LCA methodology for odorous emissions

Advantage compared to…

… Heijungs et al.: **temporal aspect** of odorant impact **included**

… Marchand et al.: more **simple** implementation

Persistence of an odorant is **included**

Shortcomings:

- **Synergetic** effects **not included**
- Impacts of **degradation products not considered**
- **Other reactants** than hydroxyl radicals are **not included**

Conclusion

This **approach**…

… is an **improvement** of the **traditional LCA approach** for raking odorants, as not only the **potency** of an odorous emission is expressed, but also its **diffusion** and **degradation**

… is a **midpoint method** which may be **appropriate** for use when **odor impacts** are **considered significant** in a system to be analyzed using **LCA**, but a **site-generic approach** is needed

Interested? Read:

Peters G.M., Murphy K.R., Adamsen A.P., Bruun S., Svanström M., ten Hoeve M. (2014). Improving odour assessment in LCA - the odour footprint. Accepted by *Int J Life Cycle Assess*, 4 July 2014