European LCA methodology development, incl. ILUC effects

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Professor Bo P. Weidema

2.-0 LCA consultants

Overview

ILUC as the touchstone in recent LCA methodology developments in Europe:

- The PEF guideline
- Version 3 of the ecoinvent database
- EXIOBASE version 2

→ New options using global product balances for QA

- Using global balances in ILUC modeling
- Consistency in LCA and ILUC modeling

The PEF Guideline

Product Environmental Footprint (PEF) Guideline from the European Commission (2013)

- First European guideline that is closely aligned with the ISO 14040/44/49 requirements for consequential LCA modeling (although still a bit open for interpretation)
- With ONE exception: ILUC and carbon offsetting are required to be excluded from the LCAs (uses instead a 20-year amortization of land use)

Version 3 of the ecoinvent database

ecoinvent v3 (2013) by the Swiss-based ecoinvent Centre (now a non-profit association)

- Allows for the first time ever to perform process-based modeling with ISO 14040/44/49 consequential modeling algorithms applied consistently to the entire database
- Allows direct comparison with an attributional model based on exactly the same unit processes
- Such a comparison shows:
  - Large differences mainly for recycled products (as expected)
  - The importance of excluding activities that cannot be affected by a change, due to either market constraints or technological constraints
  - Here land use again turn up as one of the most important differences, with the consequential results showing two orders of magnitude higher impacts than in the attributional results, due to differences in ILUC

Version 3 of the ecoinvent database

However, again ILUC turns out also to be the contentious issue:

- The ecoinvent expert group decided that only direct LUC should currently be included in the calculated LCA results, fully allocated to the frontier crops, while ILUC is not automatically included in the LCA results
- This decision is now the topic of further scientific investigation with the aim of arriving at a consensus on the causal mechanisms for LUC

EXIOBASE version 2

EXIOBASE v2, financed by the EU: A global Hybrid (Physical and Monetary) Input Output Table (IOT)

- To be published in 2014 as an extension of the exclusively monetary global IOT EXIOBASE v1
- Brings the currently missing completeness to the ecoinvent process database
- Fully consistent with ISO 14040/44/49 consequential modeling → directly amenable for hybrid modeling
- Includes LU but no LUC and no land tenure markets

Summarizing these developments

- Strong harmonization in modeling principles
- Only ILUC modeling still controversial
- Better options for quality assurance using global product balances

- Next step: Application to ILUC…

3 approaches to include deforestation

- Amortization models (PAS2050, GHG-protocol, PEF Guide)
  - Full transformation impact allocated to frontier crops over amortization period
  - Lacking causality (ILUC, intensification); arbitrary amortization period
- Carbon debt models (Some biofuels studies)
  - Years before cumulative annual savings exceed full transformation impact
  - Lacking causality (ILUC, intensification); not compatible with LCIA (does not measure impact as such; comparison built-in)
- Accelerated deforestation models (Schmidt[et al.], Kløverpris[et al.], 2012/3)
  - *Annual* transformation impact (and intensification) linked to all uses of land
  - Causality based; assumes total deforestation level unrelated to current demand
  - Traditional LCA modeling principles (Schmidt et al. 2013)
  - Equilibrium models

Model for ILUC using traditional LCA modeling principles (Schmidt et al. 2013)

- Impacts of land use (demand for land) based on same modeling principles as any other use of capital goods in LCA
- All productive activities and markets are mass balanced
- Full elasticity of supply → No consumption effects
- Accounts for all current land use and all current land transformation, based on recent global statistics

Table 2: Area and productivity of existing land in use and creation of new land. The productivity is based on Haberl et al. (2007a). Land not in use and build-up land (estimated) are also included to have a total area that adds up to the world's total land area.

Land use class	**Existing land** Area (million ha)	**Existing land** NPP_0 (kg C ha-1)	**Land tenure market**	**New land** Area per year (million ha yr-1)	**New land** NPP_0 (kg C ha-1)
Cropland	1,527	6,110	Arable land	13.0	6,940
Intensive forest	201	7,200	Intensive forestland	3.75	7,200
Extensive forest	931	7,200	Extensive	3.86	7,200

The arable land tenure market

Land already in use

No effects

kg NPP-C/ha-yr

9330

X

Land use changes

Output	Flow	Unit
Expansion	a_3	kg NPP_0
Ressource inputs from nature		
Transformation from...	b_1	ha
Transformation to...	b_2	ha
Emissions		
e.g. CO_2	$b_{3...}$	kg

90

151

Intensification

Output	Flow	Unit
Intensification	a_4	kg NPP_0
Inputs from technosphere		
Diesel for traction	c_1	MJ
N-Fertiliser, as N	c_2	kg
Emissions		
e.g. N_2O, CO_2	$c_{3...}$	kg

Social/hunger effects

No effects - in the long term

0

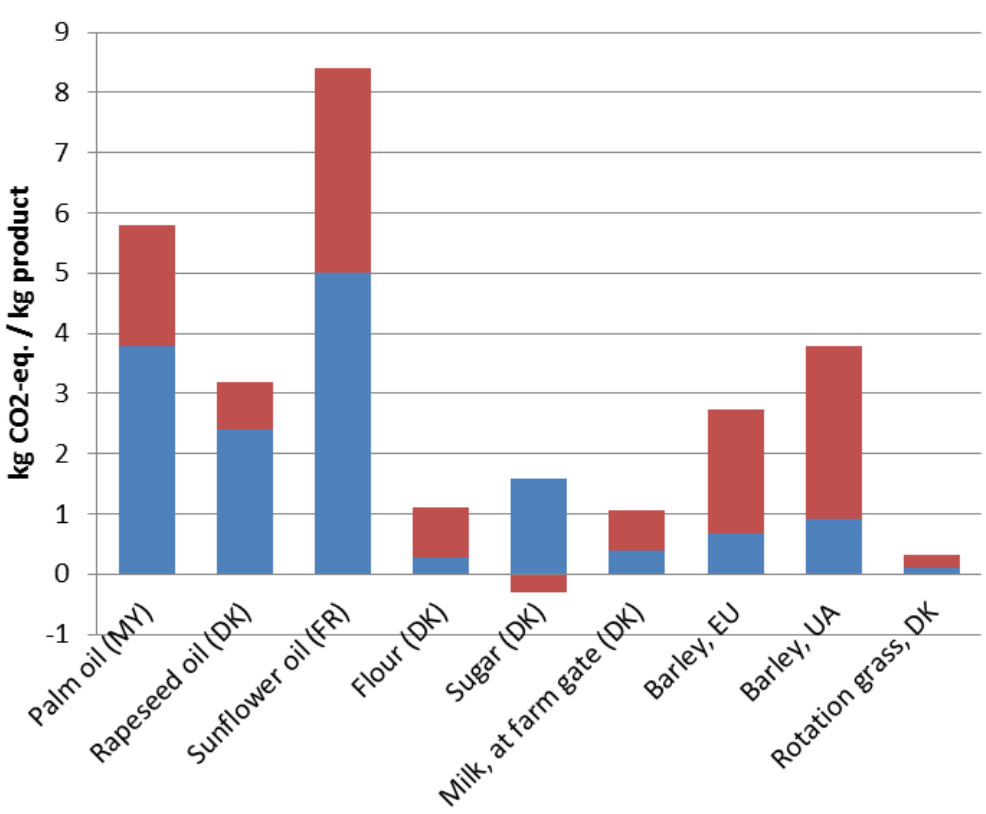
Land tenure market LCA activity

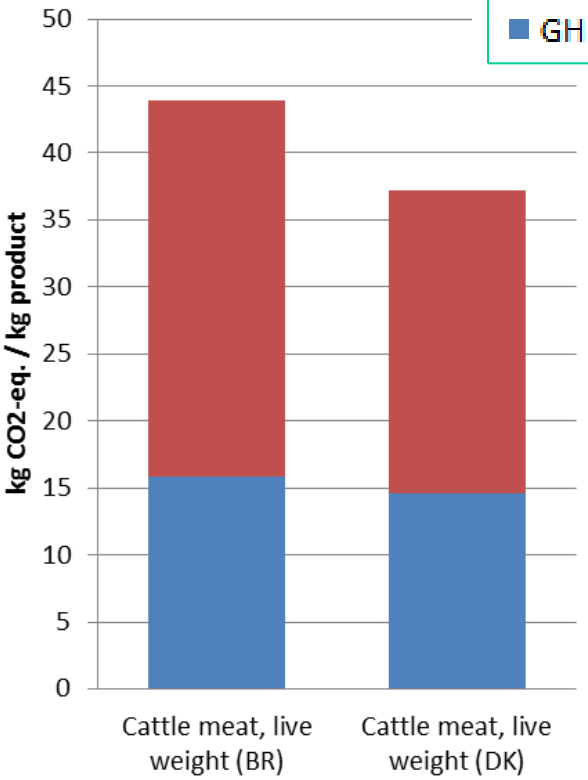
Output	Flow	Unit		Cons.	Attr.
Land tenure, NPP_0 as kg C	a_1	kg NPP_0	→ 1		
Inputs from technosphere					
Land already in use	a_2	kg NPP_0		0	0.97
Expansion	a_3	kg NPP_0		0.37	0.01
Intensification	a_4	kg NPP_0		0.63	0.02
Crop displacement	a_5	kg NPP_0		0	0

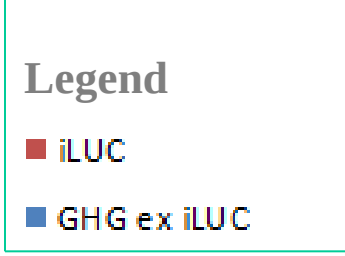
Input is assumed to be =0

Because of full elasticity assumption in LCA

Importance of indirect land use







LCA results are based on consequential (ISO 14040/44/49) modelling and are from:

- **Schmidt J H and Dalgaard R (2012)** · National and farm level carbon footprint of milk - Methodology and results for Danish and Swedish milk 2005 at farm gate. Arla Foods, Aarhus, Denmark
http://www.lca-net.com/ArlaMain
- **Dalgaard R and Schmidt J H (2012)** · National and farm level carbon footprint of milk - Life cycle inventory for Danish and Swedish milk 2005 at farm gate. Arla Foods, Aarhus, Denmark http://www.lca-net.com/ArlaLCI