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Enhancing Land Use Change modelling with IO data

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5,533	56,581	2,823			2	7	9	93	1	U		1	•	1,305
394	2,932	0	0	0	453	55	46	17	9	0	0	0	0	428
525	1	0	0	0	604	206	62	223	76	0	0	0	1	
-70	2	654	202	89	452	780	166	338	17	80	980	1106	1208	12,937
0	350	120	341	122	287	303	109	159	187	608	432	0	1203	1100
0	890	580	65	230	78	45	567	420	0	0	0	0	0	0
5	206	15	0	0	31	67	80	961	8	0	0	1	1	2
0	2	4	0	2	4	24	358	82	905	0	0	1	2	123
0	0	0	0	0	2	12	1	69	47	19	0		0	5
0	0	0	0	0	0	13	198	190	62	0	0	2	0	18

Background and purpose

The importance of LUC

- 11% of global GHG emissions*
- 62% of global biodiversity loss (58% nature occ and 4% GHG)**
- 260,000-600,000 per year mortality from landscape fires***
- LUC is too important to be left out of LCA!
 - If left out

- \Rightarrow misleading decision support
- If not included correctly

This presentation shows

- How to model iLUC
- How the 2.-0 LCA iLUC model has been improved using IO data
- How the 2.-0 LCA iLUC model has been integrated with EXIOBASE

** Calculated using EXIOBASE v3 (with integrated iLUC) and Stepwise 1.6 (Weidema 2009, Using the budget constraint to monetarise impact assessment results. Ecological Economics 68(6):1591-1598).

^{*}IPCC (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.

The 2.-0 LCA iLUC model: crowdfunded project

- Aalborg University, Department of Planning and Development, AAU (plan.aau.dk)
- Aarhus University, Department of Agroecology Agricultural Systems and Sustainability (scitech.au.e)
- Arla Foods (arla.com)
- Asplan Viak (asplanviak.no)
- Centre for Environmental Policy, Imperial College London (imperial.ac.uk)
- Concito (concito.dk)
- CSIRO (csiro.au)
- DuPont Nutrition and Health (dupont.com)
- DONG Energy (dong.dk)
- ecoinvent (ecoinvent.org)
- Mahidol University, Department of Civil and Environmental Engineering (eg.mahidol.ac.th/)
- IFP Energies nouvelles (ifpen.fr/)
- Miljögiraff (miljogiraff.se)
- National Agricultural Research Center, Japan (naro.affrc.go.jp)
- Niras (niras.dk)
- NSW Department of Primary Industries (dpi.nsw.gov.au/)
- PRé Consultants (pre-sustainability.com/)
- PT SMART (smart-tbk.com)
- Round Table on Sustainable Palm Oil, RSPO (rspo.org)
- Sustainability Consortium (sustainabilityconsortium.org)
- Swedish University of Agriculture Sciences, SLU (slu.se)
- TetraPak (tetrapak.com)
- Unilever (unilever.com)
- United Plantations Berhad (unitedplantations.com)
- University of Copenhagen, The Faculty of Life Sciences, LIFE (life.ku.dk)

More info at:

https://lca-net.com/clubs/iluc/

Schmidt J, Weidema B P, Brandão M (2015). *A framework for modelling indirect land use changes in life cycle* 3 *assessment*. Journal of Cleaner Production 99:230-238



Direct and indirect land use changes

Effect of 1 ha additional rapeseed field somewhere?



The 2.-0 LCA iLUC model

- Explained in two bullets
- Link between **land using activities** and **<u>iLUC</u> = global market**
- Market output = sum of all land supplies



Supply of land

Transformation Intensification

Schmidt J, Weidema B P, Brandão M (2015). A framework for modelling indirect land use changes in life cycle assessment. Journal of Cleaner Production 99:230-238

Limitations of current LUC practice

- PAS2050, GHG protocol, PEF Guideline, PalmGHG...

2018

Example: 1 ha year crop

- Choose amortization period (e.g. 20 years)
- Determine to include or exclude LUC
- If LUC included, identify C-stock before and after LUC
- GHG-emissions from LUC = $\Delta C \times (44/12) \times (1/20)$

Limitations

- Amortization period in the *past* relevant?
- Amortization period is arbitrary (why 20 years?)
- Arbitrary reference scenario (historical C-stock)
- Ignoring trade with crop products

Implications

- Overestimating LUC at the frontier
- Ignoring iLUC for established land
- Lack of causality



Data for the 2.-0 LCA iLUC model

- How much land is created in year 2011 from:
 - Transformation of non-use to arable
 - Intensification of land already in use
- ILUC emissions
 - Carbon stocks for all land cover types
 - Intensification emissions
- Potential productivity of land in different countries
 - NPP_o for land cover types and countries \Rightarrow Satellite & GIS data



- \Rightarrow land-eq (next slides)
- \Rightarrow land-eq (next slides)
- \Rightarrow IPCC*
- \Rightarrow IPCC* model + fertilizer



- Free download: exiobase.eu
- **Granularity:** 200 products x 164 activities
- Geography: 43 countries + 5 RoW regions
- Time: 2000-2011
- Extensions
 - Waste: 17 homogenous fractions
 - Emissions: 62
 - Resources: 37
 - Land use
 - Value added (EUR)
 - Labor inputs (hours)
- Unit of product flows: EUR, kg, MJ

Data for all crops

- Production vield
- Land use

Land using activities in all countries

- Rice
- Wheat
- Cereal grains, other
- Vegetables, fruit, nuts
- Oil seeds
- Sugar cane, sugar beet
- Plant-based fibers
- Crops, other
- Meat, cattle
- Meat, sheep, goats, other
- Milk
- Forestry



- the most complete and accurate LCA database available

Can it be used as an LCA database?

- Available for SimaPro
- Scope
 - 7900 productive activities
 - 7900 national product markets
 - 290 final consumption activities
 - Adds up to global production and consumption (tonne, TJ, EUR)
- More consistent than process LCA (model, temporal, completeness)
- More aggregated than process LCA but can be detailed
- True coverage of global supply-chains
- True industry baselines provided as part of the database

EXIOBASE data for iLUC model



Integration of iLUC in EXIOBASE

- Supply of land
 - Transformation (one per country)
 - Intensification (one per country)
 - Market for land (one global)
- Use of land
 - All uses of land link to global market







Raw milk

Raw milk, kg CO2e/kg



CH4 N20 CO2 ILUC

- iLUC increases the GHG emissions with:
 - agricultural crops 100-200%
 - beef cattle 20-60%
 - pigs 40-80%
 - dairy products40-60%
 - wood products 50-300%
- primary plastics 2-15%

Conclusions

- iLUC model integrated in global LCA database
- Fit for LCA of agr products, food, biofuels etc.
- Accounts for all land uses in all countries



- Data
 - Internal EXIOBASE data: Transformation and intensification & land market
 - External data: Carbon stocks & Potential productivity of land





Thank you

More info: https://lca-net.com/clubs/iluc/

