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Soil Organic Carbon, climate change, and soil quality: a mapping of existing methods for LCA

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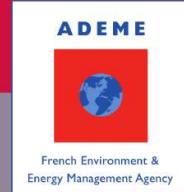
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Introduction

SOCLE, Soil Organic Carbon changes in LCA, which
Evaluations to improve environmental assessments?



Poster P07

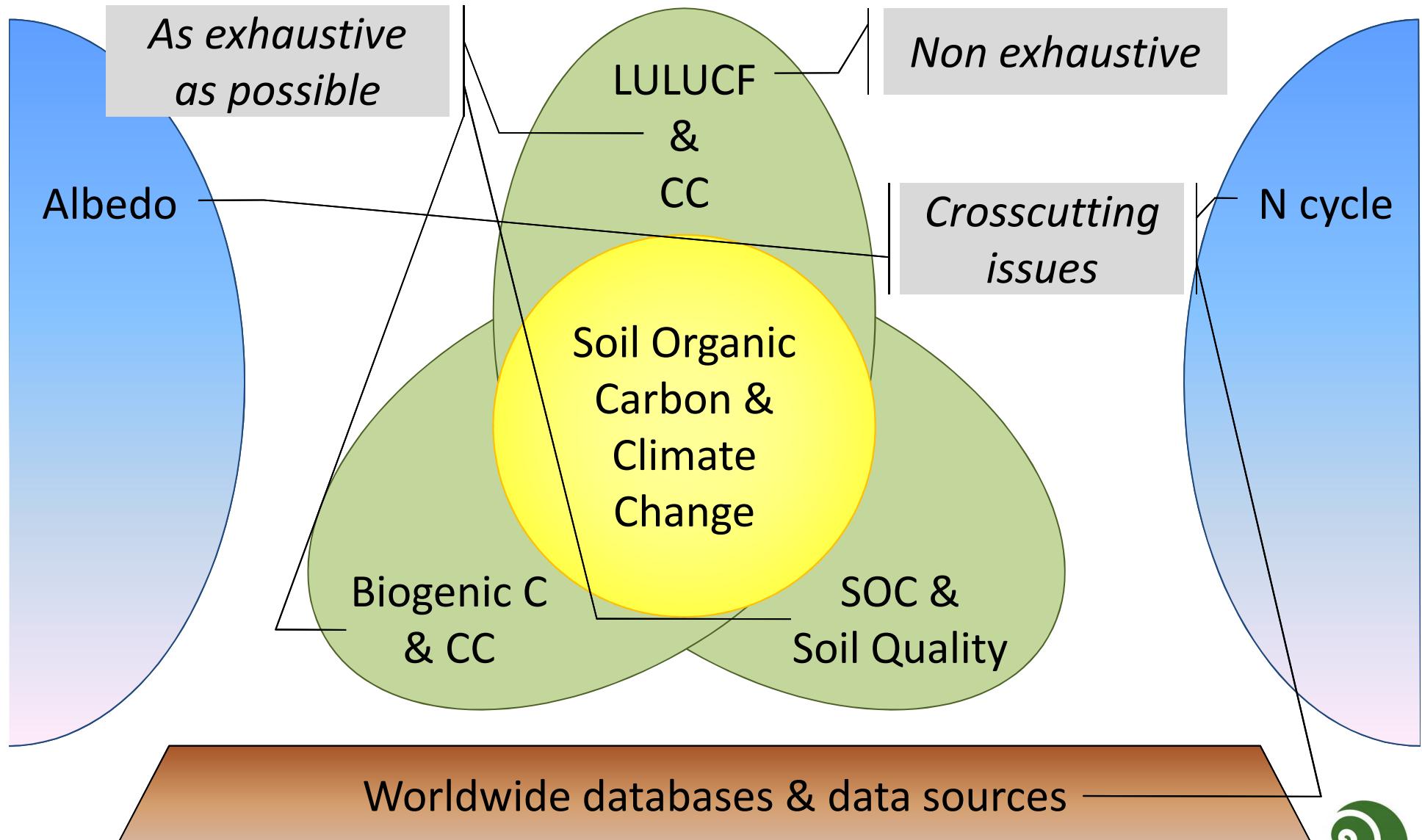
○ Context: ADEME SOCLE project

- *Scope:* Soil Organic Carbon & Climate Change impact
- *Objective:* Towards a consensual LCIA model
 1. Review of existing methodologies
 2. Testing on a variety of agricultural systems

○ Scope of this presentation

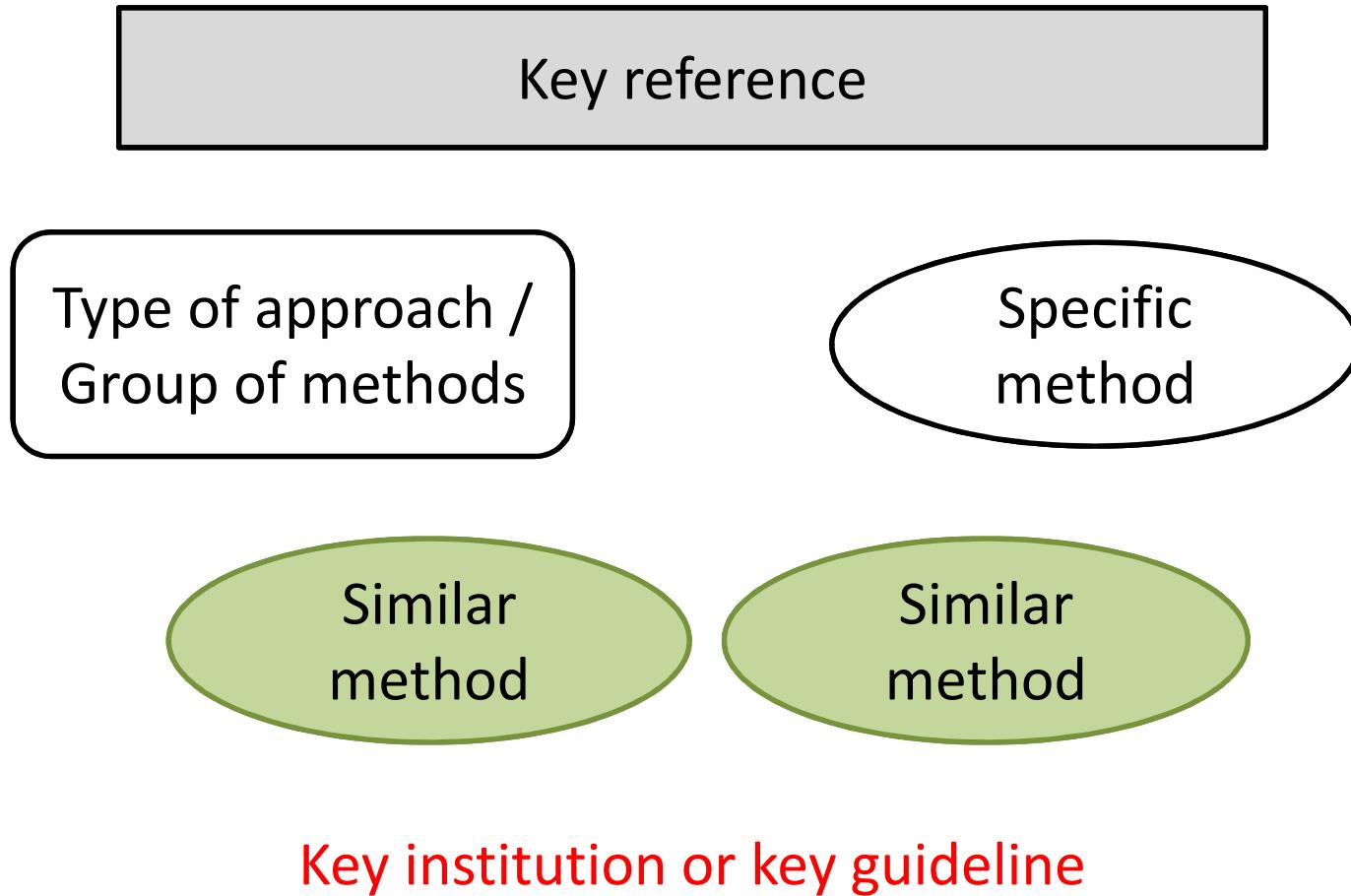
- Mapping of existing methods

Materials & Methods (1/2)



Materials & Methods (2/2)

○ Mapping caption



Local-scale
approach

National-scale
approach

Global-scale
approach

Observed
direct LUC

dLUC
Assessment
Tool
**(Agri Footprint,
PAS2050, PEF,
GHG Protocol,
ENVIFOOD
protocol, ...)**

Economic general
equilibrium model

MIRAGE

...

CAPRI

...

GLOBIOM

Economic partial
equilibrium model

LULUCF & Climate Change

IPCC, Guidelines for National GHG inventories, 1996 / 2006

T Stock difference
method

T Project
assessment
tools

T Gain-loss
method

T ILCD, CO₂ emissions
from transformation

O CDM ([UNFCCC](#))

VCS

EX-ACT
([FAO](#))

...

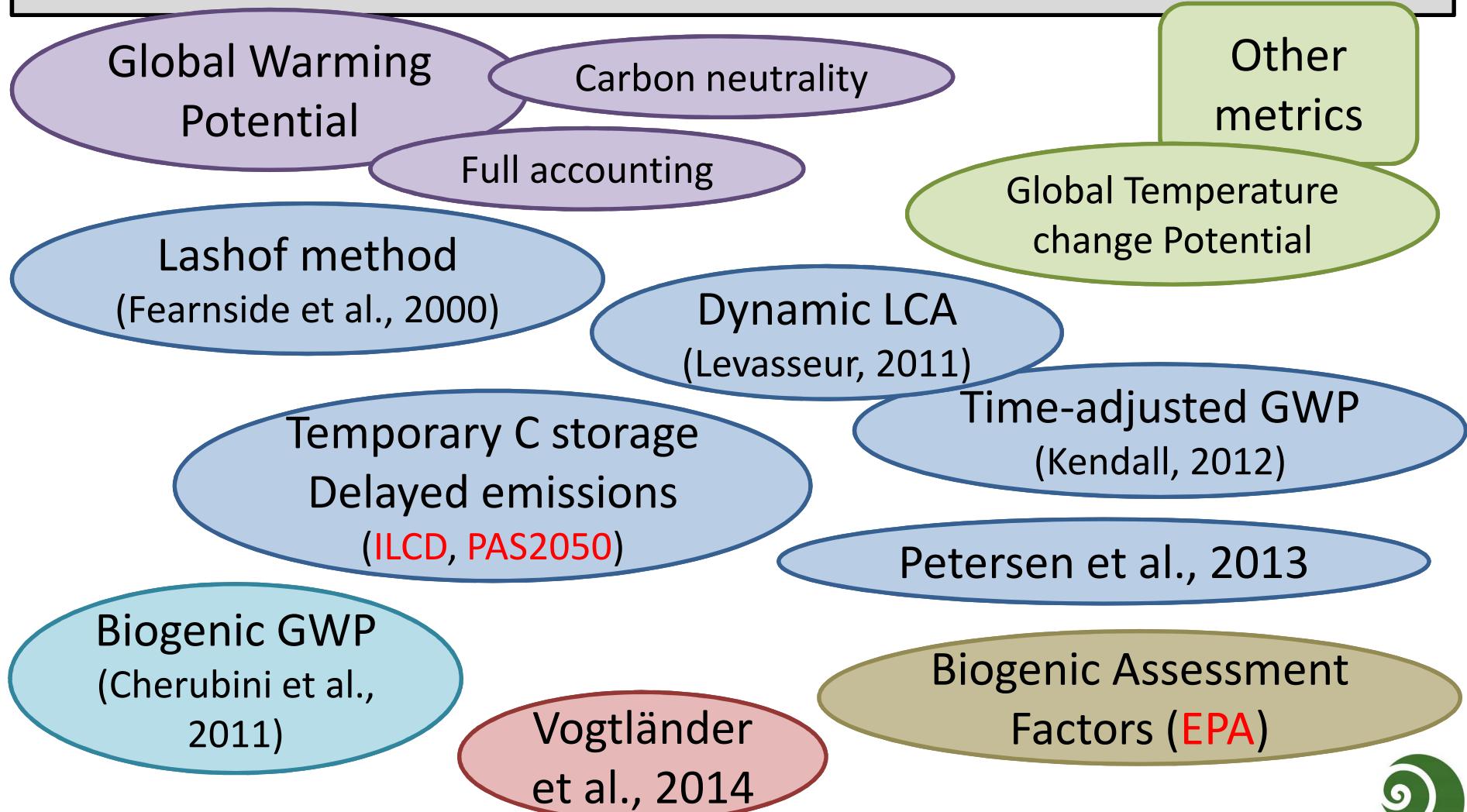
O Schmidinger
& Stehfest,
2012

Benoist &
Cornillier, 2016

Müller-Wenk &
Brandão, 2010

Biogenic Carbon & Climate Change

IPCC, Assessment Reports, 1990 / 1995 / 2001 / 2007 / 2013



SOC & Soil Quality

UNEP-SETAC, Land use framework, 2007 / 2013

LCA-oriented

Brandão & Milà i
Canals, 2013

Milà i Canals et al.,
2007 (ILCD)

Núñez et
al., 2013

Cao et al.,
2015

Cowell &
Clift, 2000

SALCA-SQ
(Oberholzer et al., 2012)

Gardi et al., 2013

Burkhard et al., 2012

...

LANCA®
(Beck et al., 2010;
Bos et al., 2016)

Saad et al., 2013

ACV-SOL
(Garrigues et al.,
2012, 2013)

Mostly based on soil
physico-chemical
properties

Global approach of
soil quality

Crosscutting issues

- Links between C & N biogeochemical cycles
 - Explicitly included in IPCC guidelines (2006)
 - Implemented in base CDM methodology: + 15.6% GHG
- Links between C sequestration & albedo
 - Some integrative studies
 - Muñoz et al. (2010): GWP method, **T** only
 - Bright et al. (2012): biogenic GWP method, **T** & **O**
- Worldwide databases & data sources
 - Most used databases: *IPCC* (C stock) + *FAO* (land uses)
 - Other potential sources: *HSWD* (*FAO*) (soil properties)

Conclusions & perspectives

- Better understanding of differences between methods, in terms of
 - Level 1: Conceptual baselines & underlying approaches
 - Level 2: Operational issues
- Next steps
 - Completing the mapping
 - Testing the differences between methods through a variety of agricultural case studies



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Thank you for your attention!

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○ research group for environmental life cycle & sustainability assessment



References

- Beck, T., Bos, U., Wittstock, B., Baitz, M., Fischer, M., Seldbauer, K., 2010. *LANCA - Land Use Indicator Value Calculation in Life Cycle Assessment*. Stuttgart, Germany.
- Benoist, A., Cornillier, C., 2016. *Towards a consensual method to assess climate change impacts from bio-based systems*, in: *26th SETAC Europe Annual Meeting - Environmental Contaminants from Land to Sea: Continuities and Interface in Environmental Toxicology and Chemistry*. Nantes, France.
- Bos, U., Horn, R., Beck, T., 2016. *LANCA - Characterization Factors for Life Cycle Impact Assessment - Version 2.0*. Stuttgart, Germany.
- Brandão, M., Milà i Canals, L., 2013. *Global characterisation factors to assess land use impacts on biotic production*. Int. J. Life Cycle Assess. 18, 1243–1252. doi:10.1007/s11367-012-0381-3
- Bright, R.M., Cherubini, F., Strømman, A.H., 2012. *Climate impacts of bioenergy: Inclusion of carbon cycle and albedo dynamics in life cycle impact assessment*. Environ. Impact Assess. Rev. 37, 2–11. doi:10.1016/j.eiar.2012.01.002
- British Standards Institution, 2011. *PAS 2050:2011 - Specification for the assessment of the life cycle greenhouse gas emissions of goods and services*. London, United Kingdom.
- Burkhard, B., Kroll, F., Nedkov, S., Müller, F., 2012. *Mapping ecosystem service supply, demand and budgets*. Ecol. Indic. 21, 17–29. doi:10.1016/j.ecolind.2011.06.019

References

- Cao, V., Margni, M., Favis, B.D., Deschênes, L., 2015. *Aggregated indicator to assess land use impacts in life cycle assessment (LCA) based on the economic value of ecosystem services.* J. Clean. Prod. 94, 56–66. doi:10.1016/j.jclepro.2015.01.041
- Cherubini, F., Peters, G.P., Berntsen, T., Strømman, A.H., Hertwich, E., 2011. *CO₂ emissions from biomass combustion for bioenergy: atmospheric decay and contribution to global warming.* GCB Bioenergy 3, 413–426. doi:10.1111/j.1757-1707.2011.01102.x
- Clift, R., Brandão, M., 2008. *Carbon storage and timing of emissions - a note by Roland Clift and Miguel Brandao,* CES Working Paper 02/08. Guildford (Surrey), United Kingdom.
- Cowell, S.J., Clift, R., 2000. *A methodology for assessing soil quantity and quality in life cycle assessment.* J. Clean. Prod. 8, 321–331. doi:10.1016/S0959-6526(00)00023-8
- EC-JRC, 2010. *International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance.* Luxembourg City, Luxembourg.
doi:10.2788/38479
- EC-JRC, 2011. *International Reference Life Cycle Data System (ILCD) Handbook - Recommendations for Life Cycle Impact Assessment in the European context.* Luxembourg City, Luxembourg. doi:10.278/33030
- Fearnside, P.M., Lashof, D.A., Moura-Costa, P., 2000. *Accounting for time in mitigating global warming through land-use change and forestry.* Mitig. Adapt. Strateg. Glob. Chang. 5, 239–270. doi:10.1023/A:1009625122628

References

- Gardi, C., Jeffery, S., Saltelli, A., 2013. *An estimate of potential threats levels to soil biodiversity in EU*. Glob. Chang. Biol. 19, 1538–1548. doi:10.1111/gcb.12159
- Garrigues, E., Corson, M.S., Angers, D.A., van der Werf, H.M.G., Walter, C., 2012. *Soil quality in Life Cycle Assessment: Towards development of an indicator*. Ecol. Indic. 18, 434–442. doi:10.1016/j.ecolind.2011.12.014
- Garrigues, E., Corson, M.S., Angers, D.A., van der Werf, H.M.G., Walter, C., 2013. *Development of a soil compaction indicator in life cycle assessment*. Int. J. Life Cycle Assess. 18, 1316–1324. doi:DOI 10.1007/s11367-013-0586-0
- IPCC, 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Institute for Global Environmental Strategies (IGES), Hayama, Japan.
- Kendall, A., 2012. *Time-adjusted global warming potentials for LCA and carbon footprints*. Int. J. Life Cycle Assess. 17, 1042–1049. doi:10.1007/s11367-012-0436-5
- Koellner, T., de Baan, L., Beck, T., Brandão, M., Civit, B., Margni, M., Milà i Canals, L., Saad, R., Maia de Souza, D., Müller-Wenk, R., 2013. *UNEP-SETAC guideline on global land use impact assessment on biodiversity and ecosystem services in LCA*. Int. J. Life Cycle Assess. 18, 1188–1202. doi:10.1007/s11367-013-0579-z
- Levasseur, A., 2011. *Développement d'une méthode d'Analyse du Cycle de Vie dynamique pour l'évaluation des impacts sur le réchauffement climatique*. Université de Montréal.

References

- Milà i Canals, L., Bauer, C., Depéstele, J., Dubreuil, A., Freiermuth Knuchel, R., Gaillard, G., Michelsen, O., Müller-Wenk, R., Rydgren, B., 2007a. *Key elements in a framework for Land Use Impact Assessment within LCA*. Int. J. Life Cycle Assess. 12, 5–15.
- Milà i Canals, L., Romanyà, J., Cowell, S.J., 2007b. *Method for assessing impacts on life support functions (LSF) related to the use of “fertile land” in Life Cycle Assessment (LCA)*. J. Clean. Prod. 15, 1426–1440. doi:10.1016/j.jclepro.2006.05.005
- Müller-Wenk, R., Brandão, M., 2010. *Climatic impact of land use in LCA—carbon transfers between vegetation/soil and air*. Int. J. Life Cycle Assess. 15, 172–182. doi:10.1007/s11367-009-0144-y
- Muñoz, I., Campra, P., Fernández-Alba, A.R., 2010. *Including CO₂-emission equivalence of changes in land surface albedo in life cycle assessment. Methodology and case study on greenhouse agriculture*. Int. J. Life Cycle Assess. 15, 672–681. doi:10.1007/s11367-010-0202-5

References

- Myhre, G., Shindell, D., Bréon, F.-M., Collins, W., Fuglestvedt, J., Huang, J., Koch, D., Lamarque, J.-F., Lee, D., Mendoza, B., Nakajima, T., Robock, A., Stephens, G., Takemura, T., Zhan, H., 2013. *Anthropogenic and Natural Radiative Forcing*, in: Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M. (Eds.), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 659–740. doi:10.1017/CBO9781107415324.018
- Núñez, M., Antón, A., Muñoz, P., Rieradevall, J., 2013. *Inclusion of soil erosion impacts in life cycle assessment on a global scale: application to energy crops in Spain*. Int. J. Life Cycle Assess. 18, 755–767. doi:10.1007/s11367-012-0525-5
- Oberholzer, H.-R., Freiermuth Knuchel, R., Weisskopf, P., Gaillard, G., 2012. *A novel method for soil quality in life cycle assessment using several soil indicators*. Agron. Sustain. Dev. 32, 639–649. doi:10.1007/s13593-011-0072-7
- Petersen, B.M., Knudsen, M.T., Hermansen, J.E., Halberg, N., 2013. *An approach to include soil carbon changes in life cycle assessments*. J. Clean. Prod. 52, 217–224. doi:10.1016/j.jclepro.2013.03.007

References

- Saad, R., Koellner, T., Margni, M., 2013. *Land use impacts on freshwater regulation, erosion regulation, and water purification: a spatial approach for a global scale level*. Int. J. Life Cycle Assess. 18, 1253–1264. doi:10.1007/s11367-013-0577-1
- Schmidinger, K., Stehfest, E., 2012. *Including CO₂ implications of land occupation in LCAs—method and example for livestock products*. Int. J. Life Cycle Assess. 17, 962–972. doi:10.1007/s11367-012-0434-7
- US EPA, 2014. *Framework for Assessing Biogenic CO₂ Emissions from Stationary Sources*. Washington DC, United States of America.
- Vogtländer, J.G., van der Velden, N.M., van der Lugt, P., 2014. *Carbon sequestration in LCA, a proposal for a new approach based on the global carbon cycle; cases on wood and on bamboo*. Int. J. Life Cycle Assess. 19, 13–23. doi:10.1007/s11367-013-0629-6