ROLE OF BIODIVERSITY IN LIFE CYCLE IMPACT ASSESSMENT THROUGH ECOSYSTEM SERVICES EVALUATION: A CASE STUDY ON CROPS POLLINATION AND CARBON SEQUESTRATION

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Context & Aim

Evaluating the benefits for human society linked to biodiversity requires to shift the assessment focus from the diversity in biodiversity components (e.g. number of present species or traits) to some features of specific biodiversity components associated with benefits (e.g. population of pollinators that pollinate crops). As a result, the assessment of Ecosystem Services (ES) in LCA has recently been promoted. In this sense, integrated methods for the characterization of ES at the life cycle impact assessment (LCIA) stage of LCA have to be developed. Our preliminary research, framed within the VALUES project, thus focused on the development of an integrated characterization model to assess the impacts of different land use changes on the provision of pollination and carbon sequestration services in Luxembourg. The following research questions were investigated:

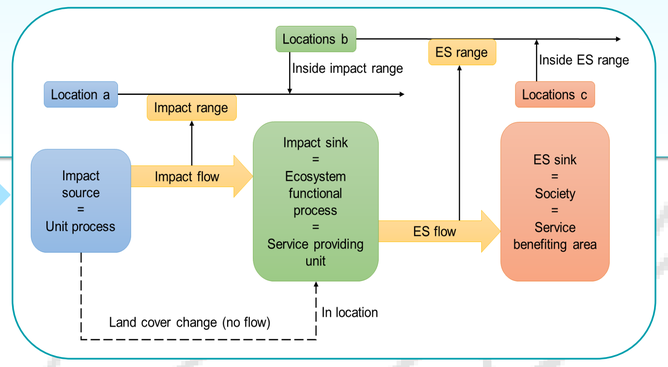
- **Theoretical approach**: Is it possible to suit an integrated model for the characterization of impacts on the provision of ES in the framework of LCIA?
- **Applicative approach**: What are the life cycle impacts on ecosystem services of the production of biofuel in Luxembourg?

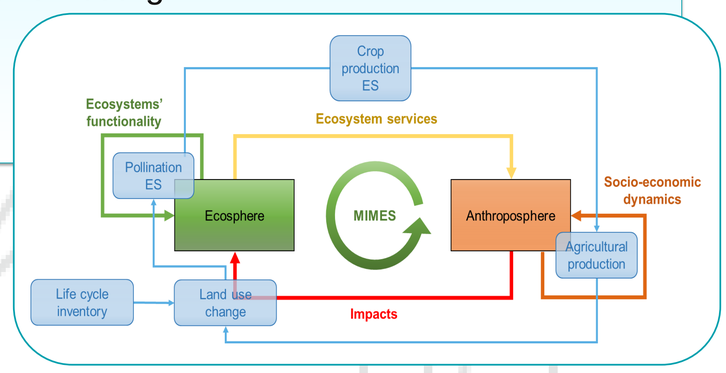
Methodology

A conceptual framework to support the characterization of ES

Key ES-specific concepts encompassed in this framework:

- The flow nature of ES
- Their beneficial value
- Their spatial and temporal scale-dependency

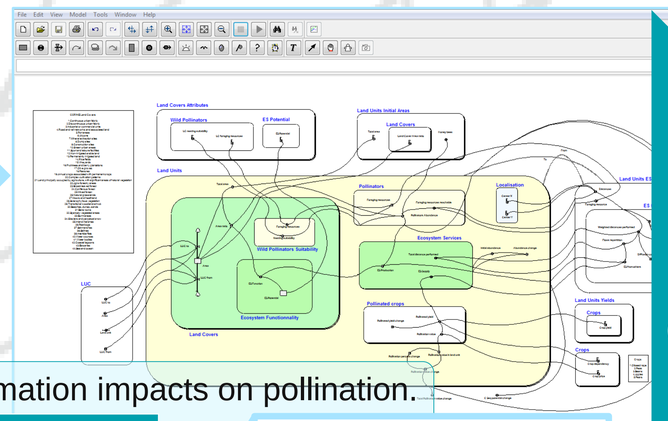




An LCIA methodology based on the MIMES model

MIMES[1] characteristics essential for the characterization of ES:

- Multi-scale
- Multi-functional
- Integrated and Dynamic
- Flexible



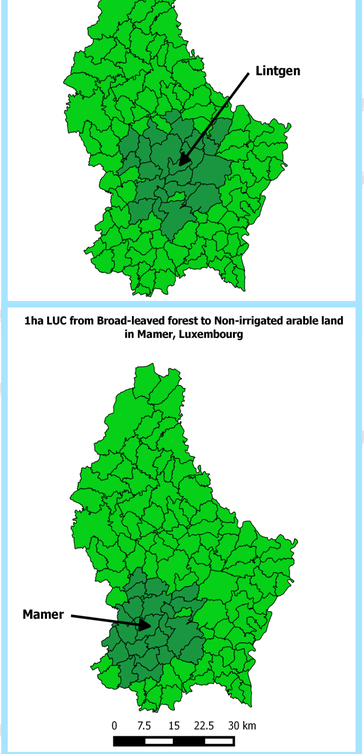
Allows the coupling of multiple and diverse models in a spatially explicit way

- Proxy-based ES models
  e.g. land cover potentials[2]
- Process based ES models
  e.g. InVEST pollination[3]
  Biome BGC C-seq[4]
- Economic models
- LUC models
- Demographic models

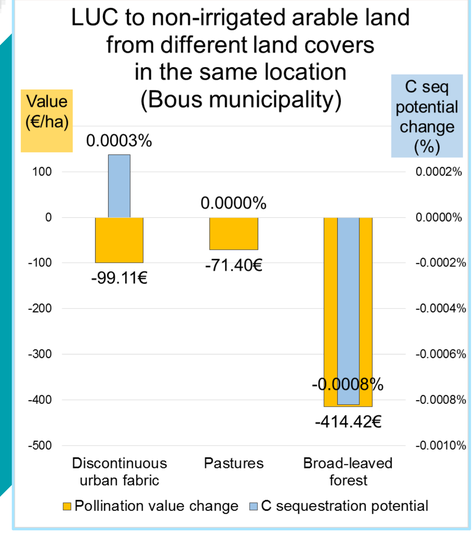
Case study: development of spatially-explicit CFs for land use transformation impacts on pollination.

Pollination value change in €/ha	To Discontinuous urban fabric	To Non-irrigated arable land	To Pastures	To Complex cultivation pattern	To Broad-leaved forest
From Discontinuous urban fabric					
From Non-irrigated arable land					
From Pastures					
From Complex cultivation pattern					
From Broad-leaved forest					

ES spatial flow



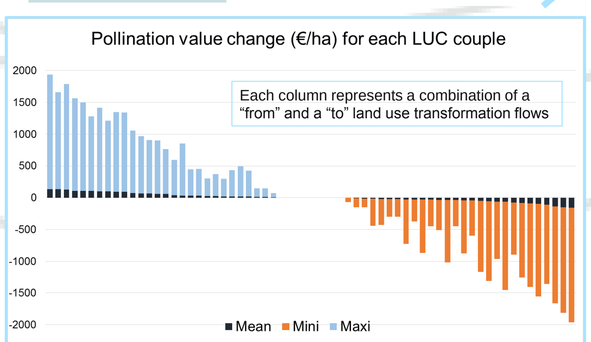
For the assessment of ES trade-offs and synergies

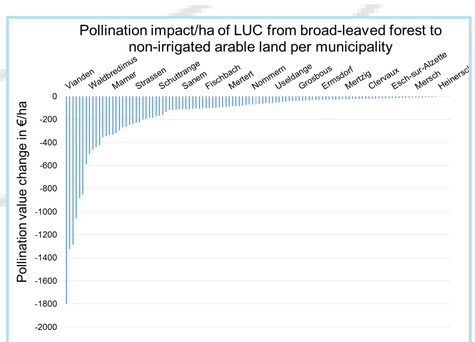


And the consideration of socio-economic development scenarios

- **Outlook**
  Scenarios development for the assessment of "ripple-effects" at several horizons

  Types of scenarios:
  - Climatic
  - Technologic
  - Demographic





Conclusion

An integrated approach seems promising to assess impacts on ecosystem services efficiently in the context of LCIA. Thanks to it, we could calculate spatially-explicit endpoint characterization factors (in €/ha) *a priori* useful to decision-making.

and Outlooks

- Implement environmentally-extended multi-regional input-output tables for the dynamic modelling of the Ecosphere ↔ Anthroposphere interactions.
- Develop a method for the consideration of local ES flows in an upscaling approach (in time and space).
- Simultaneously assess and correlate impacts on biodiversity.
- Translate the spatial heterogeneity of ES provision into sensitive, understandable and computable LCA characterization factors.

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More info at: http://www.fnr.lu/fr/Programmes-de-recherche/Programmes-en-cours/Projects/VALUing-Ecosystem-Services-for-environmental-assessment-VALUES

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1 Boumans et al. (2015) in *Ecosystem Services* 12:30-41
2 Burkhard et al. (2012) in *Ecological Indicators* 21:17-29
3 Lonsdorf et al. (2011) in *Natural Capital*, Oxford Press
4 Available @ http://www.ntsg.umt.edu/project/biome-bgc