INTEREST AND IMPLEMENTATION OF LCA-GIS COUPLING

SCORELCA seminar
Paris, 16/03/2017
CONTEX

- Directive 2001/42/CE: Assessment of effects of certain plans and programmes on the environment
- Commission EU, 2009: → Lack of methodological framework to apply the directive

Problem

Methodological developments necessary in order to adapt LCA for the evaluation of more complex systems

Relevance of GIS-LCA coupling?

- LCA: from « micro » to « meso » scale
  Proposition to extend LCA scope to the evaluation of territorial activities
OBJECTIVES OF THE STUDY

• Draw **state-of-the-art** of different GIS-LCA coupling approaches and identify the **differentiating criteria** for their implementation

• Define the **feasibility** of such coupling and realize **two practical case studies**

• Propose **recommendations** for the use of GIS-LCA coupling and **developments** for short- and mid- term
GIS PRESENTATION

- **Geographic Information System (GIS)** is a tool to capture, store, manipulate, analyze, manage, and present spatial or geographic data from numerous sources.

Map of monthly temperatures
Ref.: [http://www.cgiar-csi.org/data](http://www.cgiar-csi.org/data)

Map of urban areas
• Global Rural-Urban Mapping Project (GRUMP)
Information about global population, urban areas with resolution of 1 km
http://sedac.ciesin.columbia.edu/data/collection/grump-v1

• Socioeconomic Data and Application Center (SEDAC)
Map of land use, fertilizers use, etc. The Center depends on EOSDIS (NASA’s Earth Observing System Data and Information System) http://sedac.ciesin.columbia.edu/
• Harmonised World Soil Database (HWSD)
Map of global soil types with resolution of 1km, proposed by IIASA, FAO, ISRIC and JRC
http://soilgrids1km.isric.org/

• OpenStreetMap (OSM)
Voluntary contributions. OSM can be visualized online or called and used from GIS software.
http://www.openstreetmap.org
INTEREST OF GIS FOR LCA

Goal and scope of the study

Life cycle inventory

Life cycle impact assessment

Results interpretation
INTEREST OF GIS FOR LCA

- Territorial LCA?
- Sector?
- Data quality criteria?
- Impact categories?

Goal and scope of the study

Life cycle inventory

Life cycle impact assessment

Results interpretation

Relevance of GIS
Examples of GIS data for the inventory:

- Agronomic (field slope, soil types, crop types)
- Climatic (precipitations, temperatures)
- Distances calculation, transport network
- Urban (footprint, building types)

Source: Dresen and Jandewerth (2012)

Source: Eufrasio Espinosa and Stevenson (2013)
Examples of GIS data to spatialize characterization factors

**Acidification**
- Climate models
- Soil types

Source: Roy et al (2014)

**Water stress**
- Hydraulic model
- Precipitations


**Land use**
- Soil types
- Precipitations

Source: Núñez et al (2013)
Examples of results visualization

- Carbon footprint of Los Angeles buildings
  Source: Reyna and Chester (2013)

- Water stress of global crop production
  Source: Pfister et al (2011)
**GIS-LCA COUPLING**

**Coupling:** degree of interdependence between two or several software components

- **No coupling**
  - No interaction between components

- **Weak coupling**
  - Interdependance
  - Coordination
  - Information flow

- **Strong coupling**
  - Interdependance
  - Coordination
  - Information flow

**Interaction between software components**

**Implementation:**

- **Required computing competences**
- **Work load and time**
IMPLEMENTATION OF COUPLING

LCA software and databases

Ability to integrate GIS data/functionalities within LCA software tools:

- SimaPro:
  - No functionality

- GaBi:
  - Only ecoinvent v3 include GIS information, but not precise (country, region, « Rest of the World »)

- CMLA:
  - Functions available and in development
  - Open-source (possible development)

- umberto:
  - Possibility to include GIS data within ILCD and Ecospold 2 formats

Ability to integrate GIS data within LCA database:

- Only ecoinvent v3 include GIS information, but not precise (country, region, « Rest of the World »)
- Possibility to include GIS data within ILCD and Ecospold 2 formats
IMPLEMENTATION OF COUPLING

Case studies

Case study 1
➢ LCA of gasoline used as car fuel

- Strong coupling
- GIS use: LCI + LCIA
- Scale: region / continent
- Software: Brightway2 - QGIS

Case study 2
➢ LCA of buildings at city scale

- Weak coupling
- GIS use: LCI + visualization
- Scale: city
- Software: SimaPro - GRASS GIS / QGIS - R (Excel)
IMPLEMENTATION OF COUPLING

Lessons learned

GIS-LCA coupling allowed:

• Generate and spatialize inventory data
• Generate and spatialize characterization factors
• Visualize results with maps
• Automatize exchanges between LCA and GIS tools

Identified constraints for GIS-LCA coupling:

• Availability of precise and complete data at large scale
• Spatialization of background processes
• Computing effort to automatize interaction between tools
• Required GIS competences
RECOMMENDATIONS

Decision tree

Key factors:
- Goal and scope of the study
- Spatialized data amount
- Available competences and time
- Desired replicability
CONCLUSIONS

Interest of GIS-LCA coupling:

- Tackle lack of data (especially for territorial LCA)
- Solve spatial optimization problems
- Increase geographical representativeness
- Facilitate results communication

Limitations of GIS-LCA coupling:

- Geolocation of background processes
- GIS competences (scale harmonization, treatment)
- Computing competences (lack of software functionalities)
- Additional work and budget

Future potential improvements by:

- LCA scholars: Valid scale and user guide for CFs, Database improvement
- LCA software developers: Functions implementation
- LCA practitioners: Extend GIS competences