INTEREST AND IMPLEMENTATION OF LCA-GIS COUPLING

SCORE**LCA** seminar
Paris, 16/03/2017

SCORELCA

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CONTEXT

- **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

- **LCA: from « micro » to « meso » scale**

Proposition to extend LCA scope to the evaluation of territorial activities

Problem

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

Relevance of GIS-LCA coupling?

OBJECTIVES OF THE STUDY

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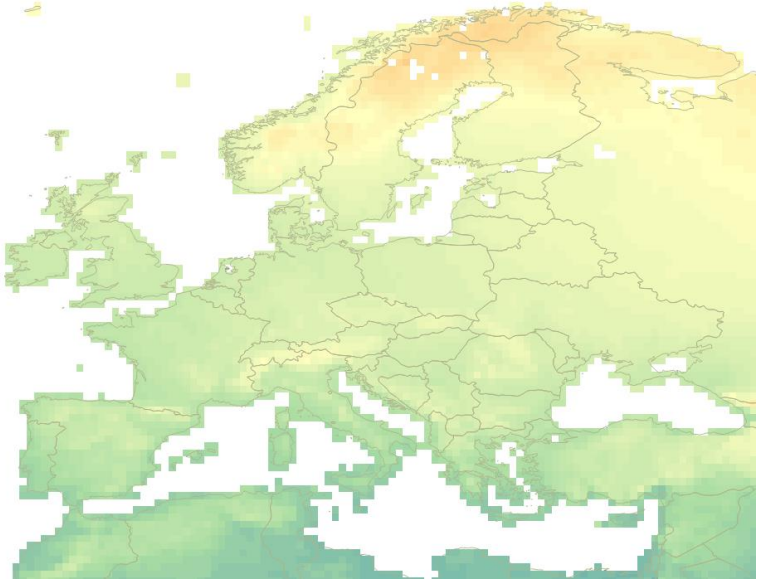
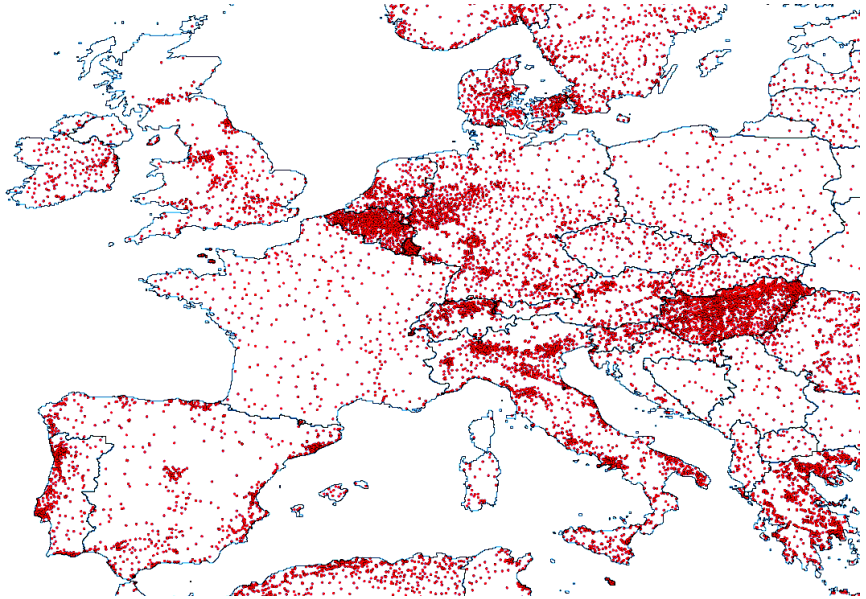
- Draw **state-of-the-art** of different GIS-LCA coupling approaches and identify **the differentiating criteria** for their implementation → WP1
- Define the **feasibility** of such coupling and realize **two practical case studies** → WP2
- Propose **recommendations** for the use of GIS-LCA coupling and **developments** for short- and mid- term → WP3

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



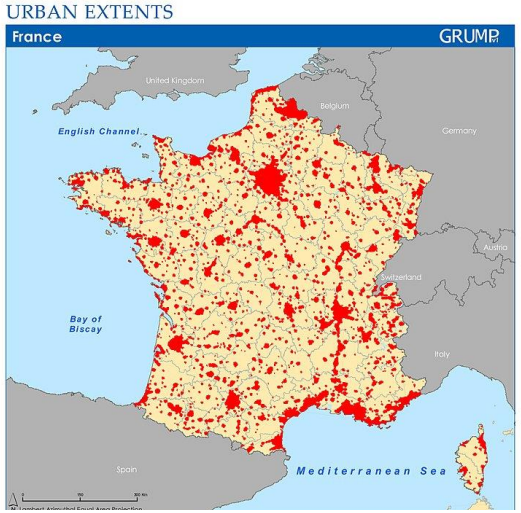
Map of urban areas
Ref.: http://sedac.ciesin.columbia.edu/data/collection/grump-v1

DATABASES

- **Global Rural-Urban Mapping Project (GRUMP)**

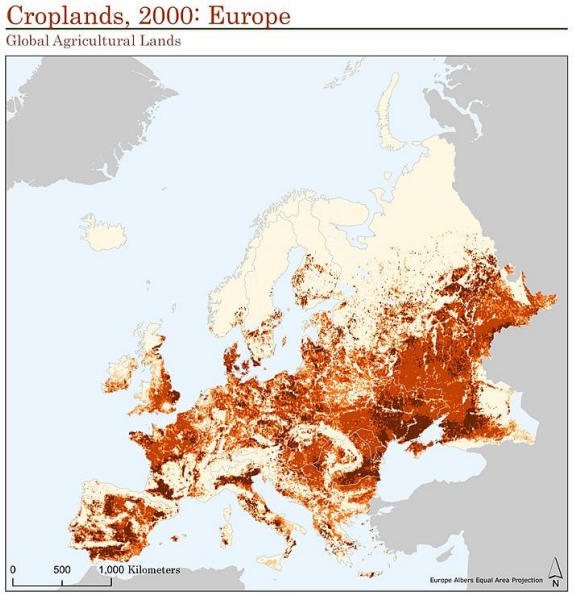
Information about global population, urban areas with resolution of 1 km

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/



DATABASES

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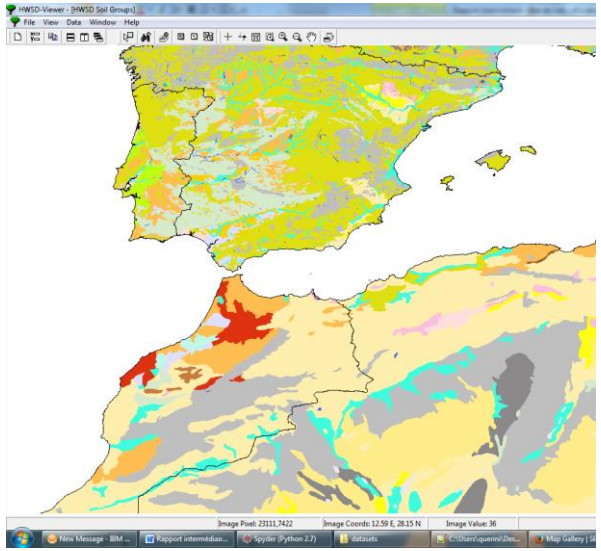
- **Harmonised World Soil Database (HWSD)**

Map of global soil types with resolution of 1km, proposed by IIASA , FAO, ISRIC and JRC

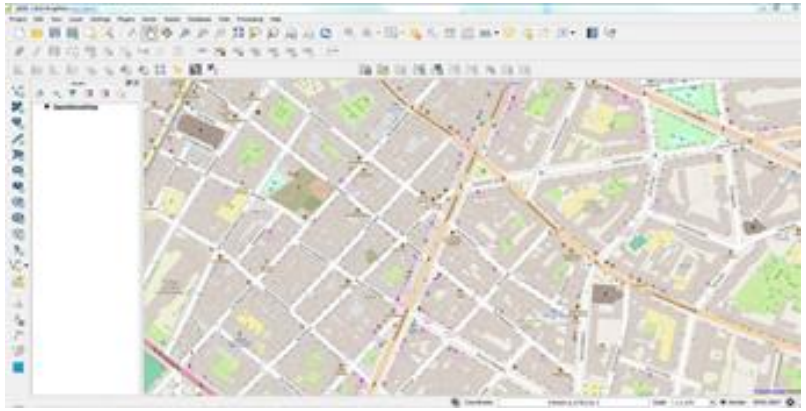
http://soilgrids1km.isric.org/



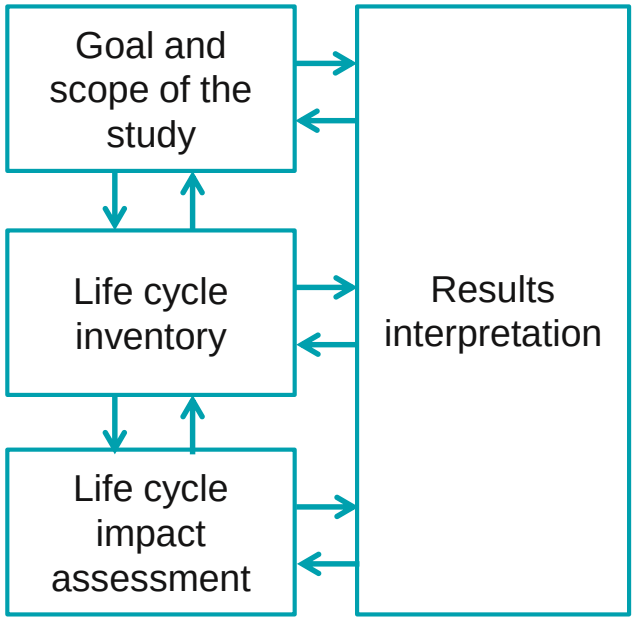
- **OpenStreetMap (OSM)**

Voluntary contributions. OSM can be visualized online or called and used from GIS software.

http://www.openstreetmap.org



INTEREST OF GIS FOR LCA

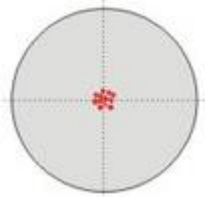


INTEREST OF GIS FOR LCA

- Territorial LCA?

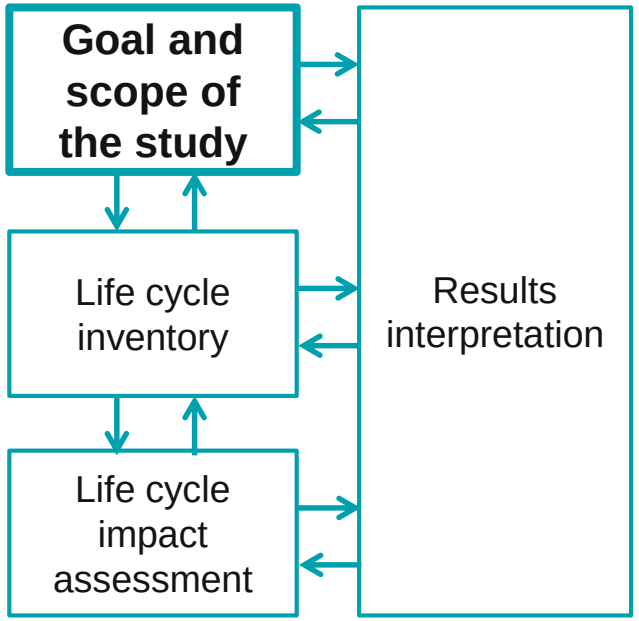
- Sector ?

- Data quality criteria?



- Impact categories?

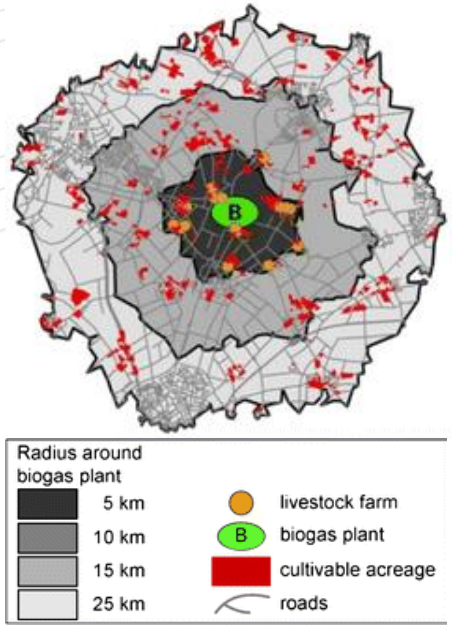
Relevance of GIS



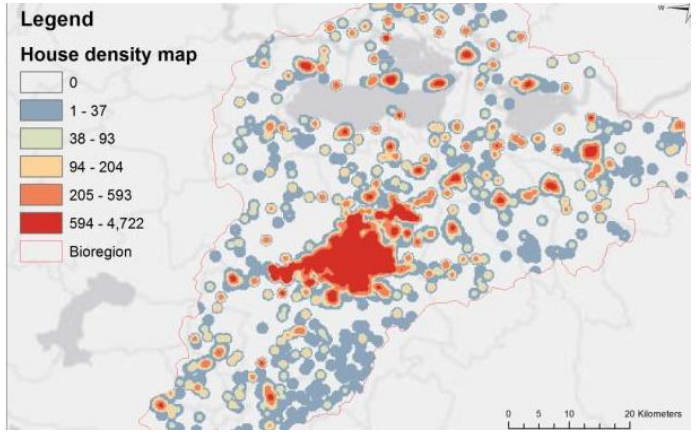
INTEREST OF GIS FOR LCA

Examples of GIS data for the inventory:

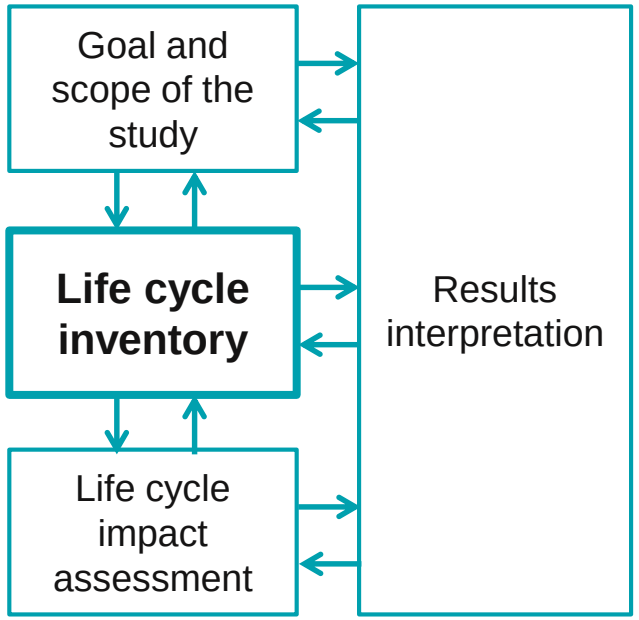
- Agronomic (field slope, soil types, crop types)
- Climatic (precipitations, temperatures)
- Distances calculation, transport network
- Urban (footprint, building types)



Source: Dresen and Jandewerth (2012)



Source: Eufrasio Espinosa and Stevenson (2013)



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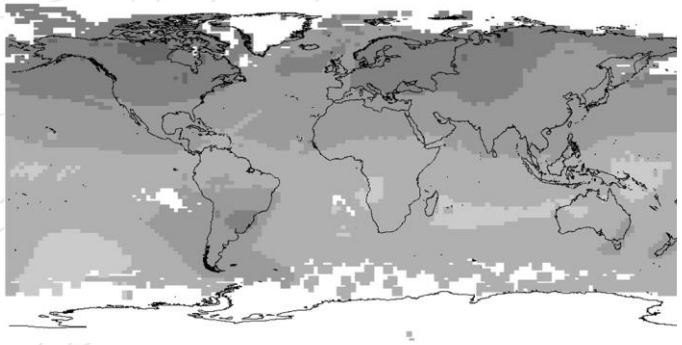
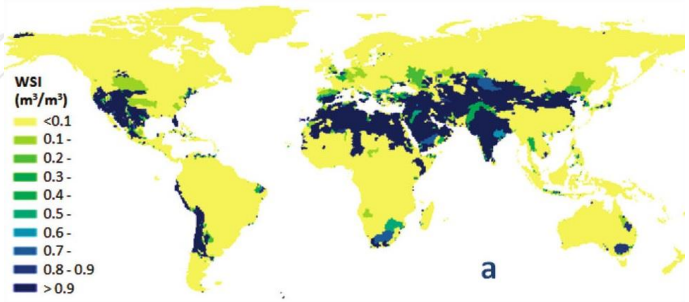
Examples of GIS data to spatialize characterization factors



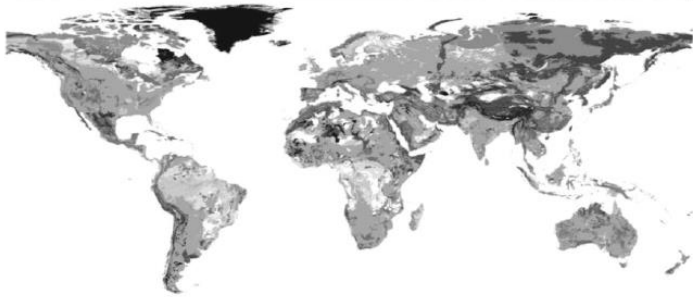
Acidification
- Climate models
- Soil types

Source: Roy et al (2014)



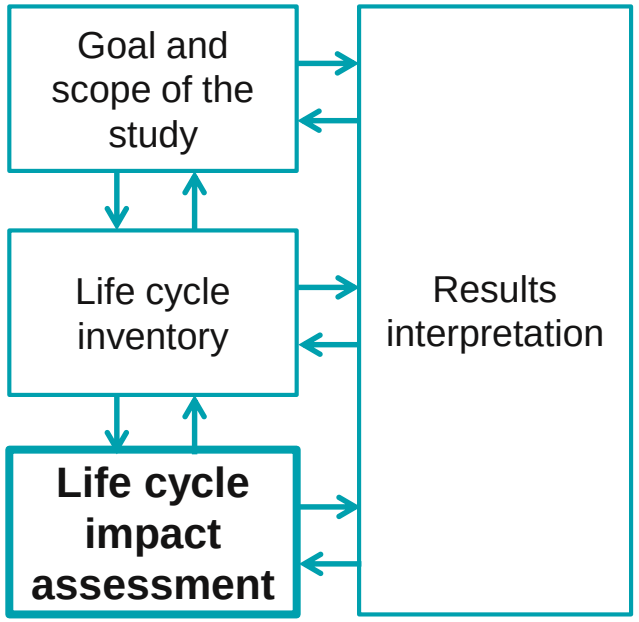
Water stress
- Hydraulic model
- Precipitations

Source: Pfister et al (2009)



Land use
- Soil types
- Precipitations

Source: Núñez et al (2013)



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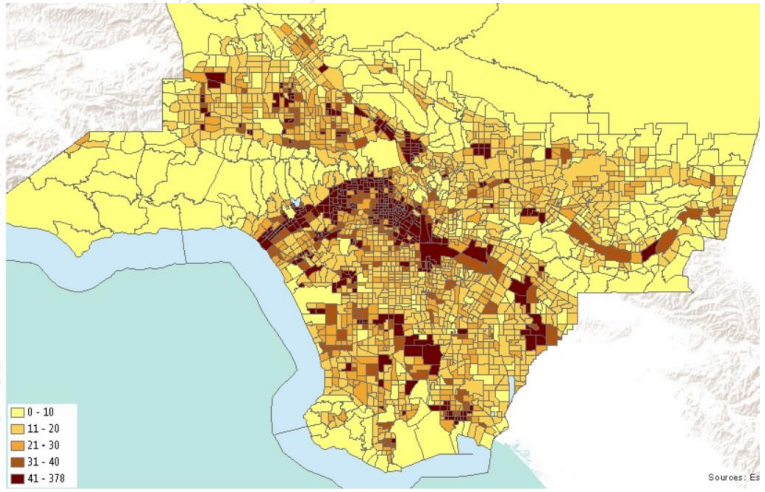
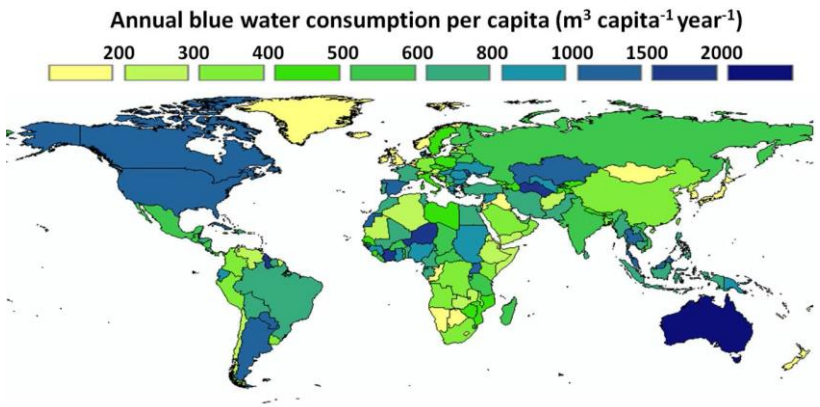
Examples of results visualization



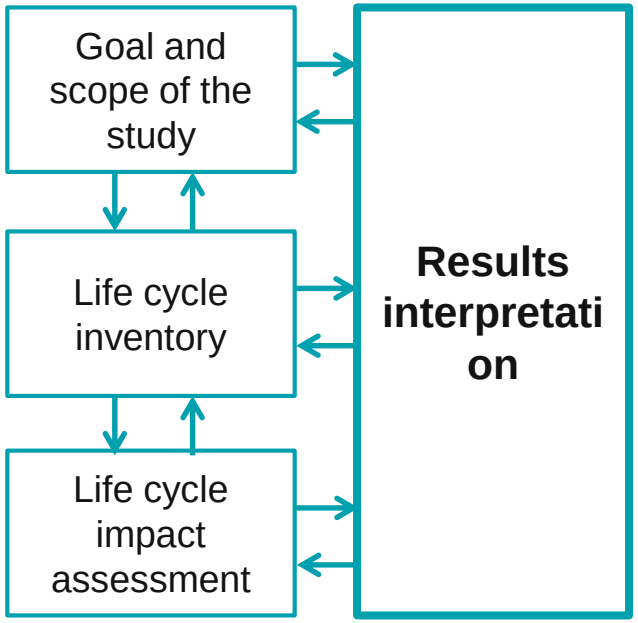


- Carbon footprint of Los Angeles buildings

Source: Reyna and Chester (2013)

- Water stress of global crop production

Source: Pfister et al (2011)



GIS-LCA COUPLING

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Coupling: degree of interdependence between two or several software components

No coupling	Weak coupling	Strong coupling
No interaction between components	- Interdependance - Coordination - Information flow	+ 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:

No functionality

SimaPro

CML CA

GaBi Product Sustainability Performance

umberto® know the flow.

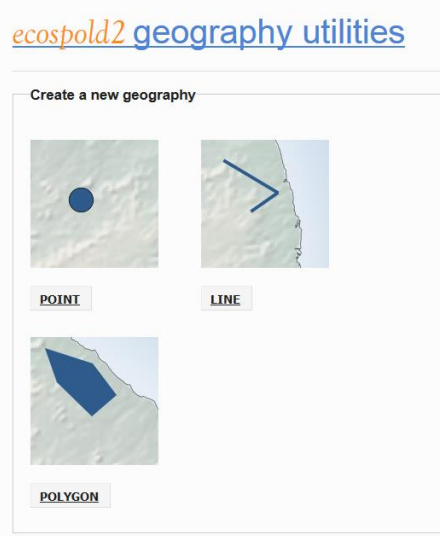
Functions available and in development
Open-source (possible development)

Brightway2

openLCA Framework

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

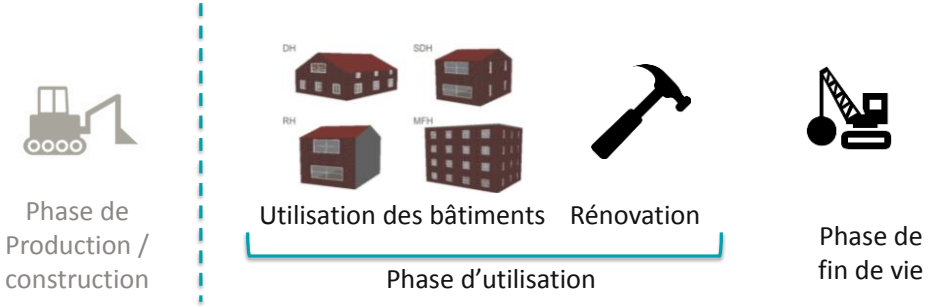
Case study 1

➢ 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 :

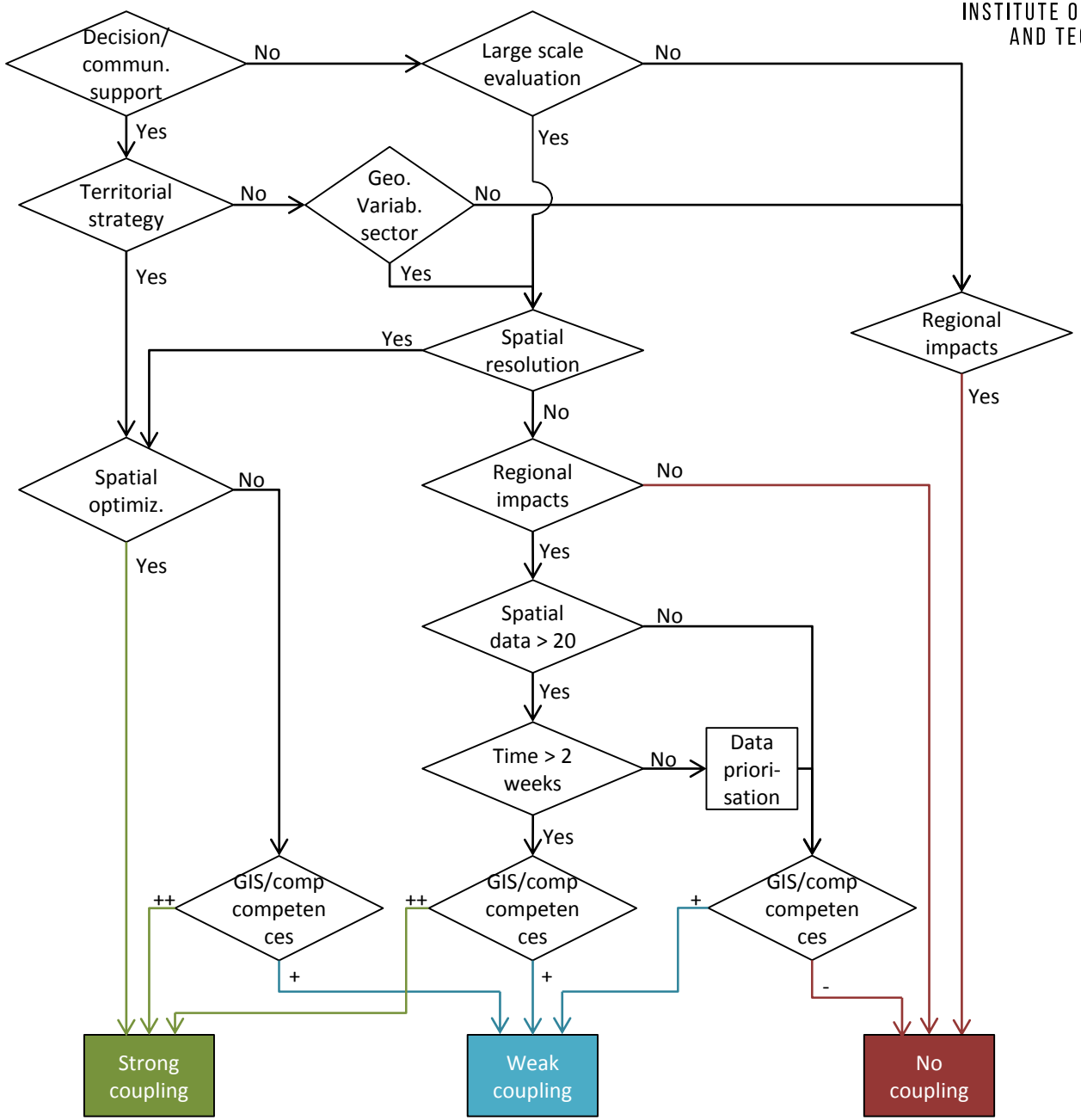
- Generate and spatialize inventory data
- Generate and spatialize characterization factors
- Visualize results with maps
- Automatize exchanges between LCA and GIS tools

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

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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; Functions implementation
- LCA software developers → Functions implementation
- LCA practitioners → Extend GIS competences