INTEGRATING GIS-BASED REGIONALIZATION INTO LCA CALCULATIONS: THE EXAMPLE OF WATER

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The status quo

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Problem

Freshwater use

Wetlands
Spatial scale of water use

Watersheds?
Spatial scale of water use

Watersheds?

Watersheds

Autocorrelation-optimized
Watersheds?

Watersheds

Autocorrelation-optimized

-> Need GIS to work with water CFs
Challenges

Matching spatial scales
Challenges

Matching spatial scales

Spatial supply chain data
Two complete models
Two complete models

Two complete models

• Very powerful
• Not really LCA
• Very resource intensive

Two complete models

Regionalize entire foreground

Resources

Computer training
Regionalize entire foreground
Looking up lots of data

• Create foreground as set of separate data
  • Geocode and match in an easy GIS
  • **Quantum GIS** is open source, free, and easy
  • Also consider **Google Fusion Tables**
Looking up lots of data

• Create foreground as set of separate data
  • Geocode and match in an easy GIS
  • **Quantum GIS** is open source, free, and easy
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• Consider doing LCIA calculations in separate data
  • Import directly as EcoIndicator points
  • Easier than creating region-specific CFs in e.g. SimaPro
Regionalize entire foreground

• Can use existing workflows and LCA software
• Don’t have to include water in LCA inventories
• Resource use depends on breadth of foreground
• Difficult to iterate or include variations
• Can miss significant impacts
Sensitivity-driven selection

Highest sensitivity

Regionalize selected
Sensitivity-driven selection

Highest sensitivity

Regionalize selected
Sensitivity-driven selection

Highest sensitivity

Regionalize selected
Sensitivity-driven selection

Highest sensitivity

Regionalize selected
Sensitivity-driven selection

• Sensitivity-testing not built into most LCA software
• IA uncertainty not built into most LCA software
• Foreground and background
• Small regionalized data-entry
  • (assumes uncertain, aggregated CFs available)
Two complete models

Resources

- Regionalize entire foreground
- Precalculate geos
- Sensitivity-driven selection

Computer training
Precalculate geometry intersections

\[ h = CBA^{-1}f \]
Precalculate geometry intersections

\[ h_r = [\text{MGR}]^T \circ [\text{BA}^{-1} \text{diag}(f)] \]

\( G \) is the geographic transform matrix, from inventory spatial support to impact assessment spatial support.

\[
\begin{bmatrix}
\text{CH} & i & ii \\
\text{FR} & 0.5 & 0.5 \\
& 1 & 0
\end{bmatrix}
\]

Precalculate geometry intersections

- Little to no effort from practitioners
  - More effort from software developers
  - Precalculation by web service or method developers
Precalculate geometry intersections

• Little to no effort from practitioners
  • More effort from software developers
  • Precalculation by web service or method developers
• Difficult to add new locations
  • Stuck with pre-defined locations
Two complete models

Disruptive software

Regionalize entire foreground
Precalculated geos

Sensitivity-driven selection

Resources

Computer training
Disruptive software

• Inclusion of GIS functionality directly in LCA
  • or other way around
Disruptive software

• Inclusion of GIS functionality directly in LCA
  • or other way around

• Brightway2 is one such attempt
  • But regionalization is not scheduled for 2-3 months
Disruptive software

• Inclusion of GIS functionality directly in LCA
  • or other way around

• Brightway² is one such attempt
  • But regionalization is not scheduled for 2-3 months

• Inclusion of GIS increases data requirements
  • Shouldn’t just know countries
**Functional unit:**
- wheat grains conventional, Castilla-y-Leon, at farm: 1 kg

**Impact assessment method:**
- IPCC 2007: climate change: GWP 20a

**Monte Carlo results**
- **Median:** 0.81 kg CO2-Eq
- **Average:** 0.82 kg CO2-Eq
- **95% interval:** 0.75 - 0.9 kg CO2-Eq
Spatial supply chain data

• Water database in ecoinvent 3
• Global data on agriculture is available
• Country-level data on power production as well
• Eternal burden of LCA...
Thank you for your attention.

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