Implementation of water and carbon flows in the ecoinvent database

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The ecoinvent Centre
Structure of the ecoinvent database v3

• The ecoinvent database v3 is organized in independent activities

• Activity: transforming, market, treatment...

Activity

Exchanges from environment

Intermediate exchanges (from other activities)

Exchanges to environment

Reference product

By-products / Wastes
Exchanges properties

- mass and elementary composition
- carbon content
- density
- prices...

Exchanges from environment
Intermediate exchanges (from other activities)

Activity

Exchanges to environment
Reference product
By-products / Wastes
Wet, dry, water mass and water content

Wet mass (WM)

Water mass (W)

Dry mass (DM)

Water content (U)

Water mass (W)

Dry mass (DM)
Relationship among WM, DM, W, U

<table>
<thead>
<tr>
<th>Wet mass (WM)</th>
<th>Dry mass (DM)</th>
<th>Water mass (W)</th>
<th>Water content (U)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WM</td>
<td>WM-W</td>
<td>W</td>
<td>W/(WM-W)</td>
</tr>
<tr>
<td>WM</td>
<td>DM</td>
<td>WM-DM</td>
<td>(WM-DM)/DM</td>
</tr>
<tr>
<td>WM</td>
<td>WM/(1+U)</td>
<td>U*WM/(1+U)</td>
<td>U</td>
</tr>
<tr>
<td>W+DM</td>
<td>DM</td>
<td>W</td>
<td>W/DM</td>
</tr>
<tr>
<td>(W/U)+W</td>
<td>W/U</td>
<td>W</td>
<td>U</td>
</tr>
<tr>
<td>(1+U)*DM</td>
<td>DM</td>
<td>DM*U</td>
<td>U</td>
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</table>
Carbon content in ecoinvent

- Carbon content is expressed per DM
- Biogenic carbon comes from plants and animals
- Fossil carbon comes from fossil fuels and calcium carbonate
- Bias: forget your presupposed ideas!
Obtention of carbon contents

Product composition

Chemical (loose)
- Chemical formula
- Exact formulation: stochiometry, reactions... (ecoinvent v2 reports, Ullmann)

Agricole/Wood
- Composition: FAO, US food database
- ecoinvent v2 reports

Complex
- Raw materials in product
- ecoinvent v2 reports

Homogeneous assumption for carbon content in:
- proteins,
- carbohydrates,
- fats
(ecoinvent v2 reports, Journal of Biochemical and Biophysical Methods)
An example: Fatty alcohols

<table>
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<th>Type</th>
<th>Description</th>
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<td>Fatty alcohol from coconut oil</td>
<td>AE3, AE7, Fatty alcohol sulfate</td>
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<tr>
<td>Fatty alcohol from palm kernel oil</td>
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<tr>
<td>Fatty alcohol from palm oil</td>
<td>AE11, Fatty alcohol sulfate</td>
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<tr>
<td>Fatty alcohol petrochemical</td>
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C content: assumptions

- Coconut oil production / Palm (kernel) oil production
- Natural gas production
- Methanol production
- Oil refining
- Methyl ester production
- Methyl ester hydrogenation
- Fatty acid splitting and hydrogenation
- Fatty alcohol production
- Fatty alcohols, from palm (kernel) oil, coconut oil

Most common fatty acids were considered saturated

Standard length of C-14 considered (based on ecoinvent report).

Biogenic/fossil origin of C

Fatty acid splitting and hydrogenation
27%

Through Methyl ester production
73%

Fatty acid

\( \text{CH}_3 \text{COOH} \)

Fatty alcohol

\( \text{CH}_3 \text{CH}_2\text{OH} \)

Methyl ester

\( \text{CH}_3\text{COO-CH}_3 \)

Methanol

\( \text{CH}_3\text{OH} \)
Exchanges with the environment: new questions

- Use chemical formula
- Use implemented calculations

Otherwise...

Define most common species
- Check compartment
- EPA, EEA, UGSC

- Biogenic/Fossil
- Sometimes not determined...

How to deal with that?
## Biogenic versus Fossil

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Table from: Steinberger et al., 2010, Ecological Economics 69:1148–1158.

- C content in biomass assumed 50%
- DM assumed 90%
- High (85% C) and low (60% C) carbon fossil fuels
- Limestone C content considered 11.7%

Limestone (ecoinvent data) 0.3
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Conclusion

Exchanges  Product system

water & carbon contents

water & carbon contents
To know more about ecoinvent v3...

- ...and about ecoEditor
- ecoEditor presentation: April 6th, ROOM B, 12:30!!