Regionalized LCI: how to address this challenge in large background LCI databases

LCA Discussion Forum

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Overview

- How ecoinvent provides regionalized inventory data

- The LCI-LCIA interface

- Using background data for regionalized Life Cycle Assessments – what to look out for

Regionalized LCIs in ecoinvent

- ecoinvent provides a **geography** for all datasets
  - Usually country level or continental region (e.g. RER)
    - E.g. 1800 European, 1600 CH, 190 DE, 52 GR, 245 IN
  - Other regions are possible, e.g. sub-national regions or watersheds
  - Also global datasets and Rest-of-the-world regions

- **Additional information** may be provided at a flow-specific level
  - Compartments/Subcompartments or exchange properties

Regionalized LCIs in ecoinvent

- Since version 3, ecoinvent aims to provide global coverage for all activities it offers

  - Reason: Users were commonly applying datasets from a **wrong geography** due to a lack of options
  - This leads to many RoW datasets – they are often only **extrapolated** and are not very region-specific!

- RoW datasets generally cover all regions of the world that are not covered by region-specific data

  - RoW for one activity is not always the same as RoW for another!

Regionalized LCIs in ecoinvent

- Check out geography.ecoinvent.org
  - Overview
  - Methodology
  - KML files
  - Images
  - RoW lookup

The input data and scripts to process, combine, and expo[...] freely available for download.

List of locations in ecoinvent

Countries

259 entities listed in ISO 3166-1:

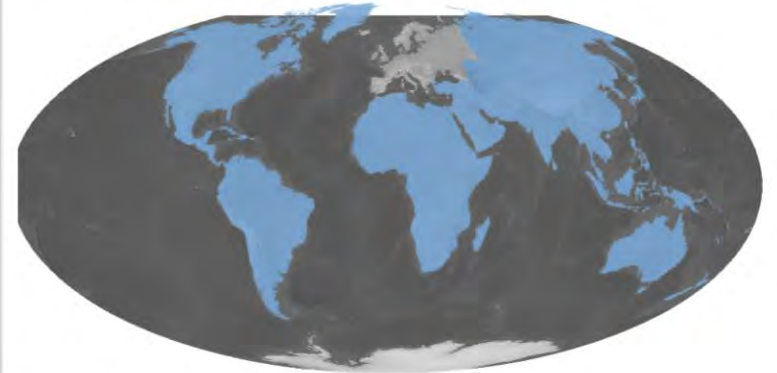|	
Afghanistan	Akrotiri Sovereign Base Ar[...]
Algeria	American Samoa
Anguilla	Antarctica
Armenia	Aruba
Austria	Azerbaijan
Bangladesh	Barbados

Rest-of-World location: RoW_140 | RoWs report

ower version: (0, 0, 'dev')

onstructive_geometries version: (0, 6, 4)

xcluded from this "Rest-of-World": AQ, AUS-AC, Bajo Nuevo, CH, Clipperton Island, Coral Sea Islands, Europe without Switzerland

coinvent 3.3 APOS

Activity Name		Refere[...]
cement, blast furnace slag 18-30% and 18-30% other alternative constituents to generic market for cement, unspecified		cement,
market for pulpwood, softwood, measured as solid wood under bark		pulpwo[...]
heat and power co-generation, natural gas, 50kW electrical, lean burn		heat, ce[...]
heat and power co-generation, natural gas, 50kW electrical, lean burn		electrici[...]
cement, blast furnace slag 31-50% and 31-50% other alternative constituents to generic market for cement, unspecified		cement,
petroleum refinery operation		diesel

Belarus   Belgium

Regionalized LCIs in ecoinvent

- The level of detail for a background database is critical
  - More detail can be added by users, but this can be very complex and cumbersome
  - However, more details than necessary increase complexity for all users
  - ecoinvent datasets need to work with a variety of software tools
- Some researchers have developed tools to disaggregate the data further to increase the quality of their assessments

India shows major **differences in production mixes**

🔥 **53%**

🌊 **47%**

⛟ **94%**

🌊 **6%**
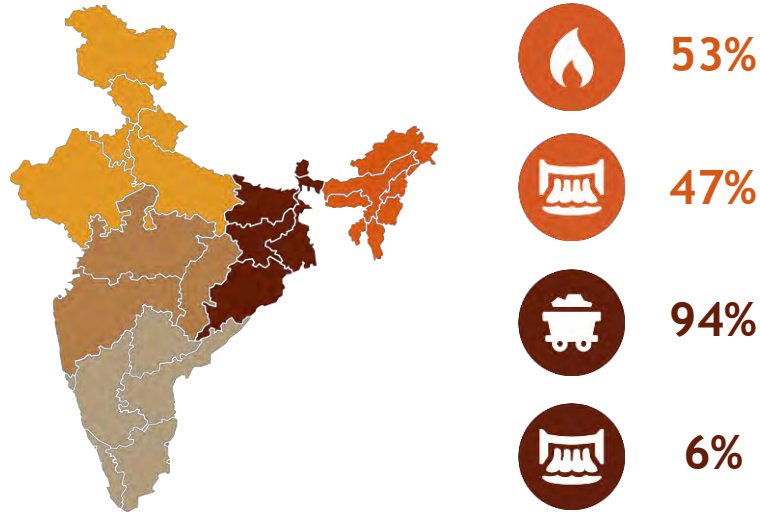
Questions

- Is **country level resolution too coarse** for Indian electricity?

- How do **environmental impacts change** with resolution?
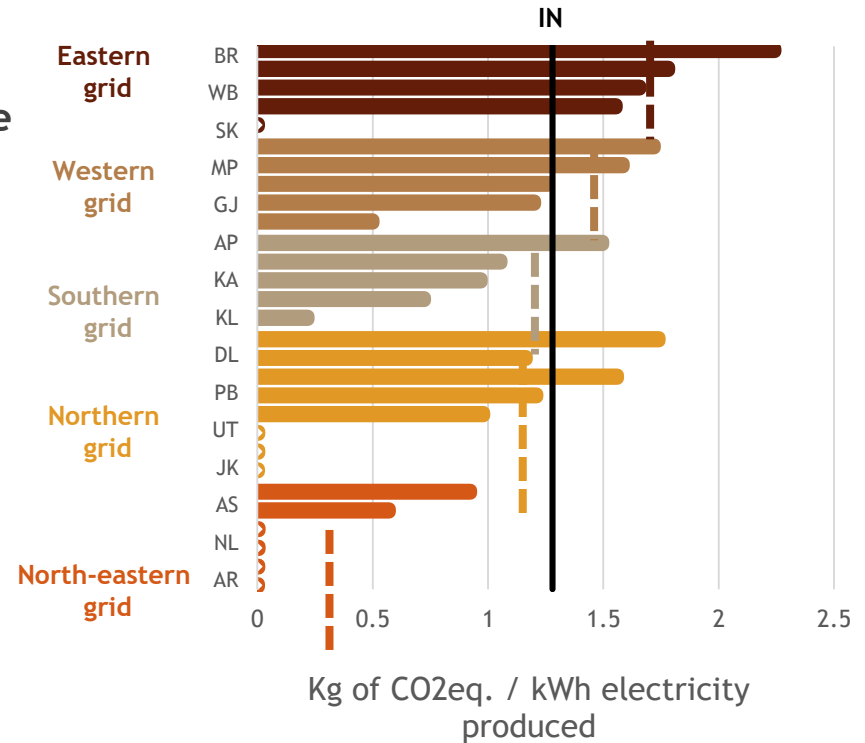
Electricity grids in India
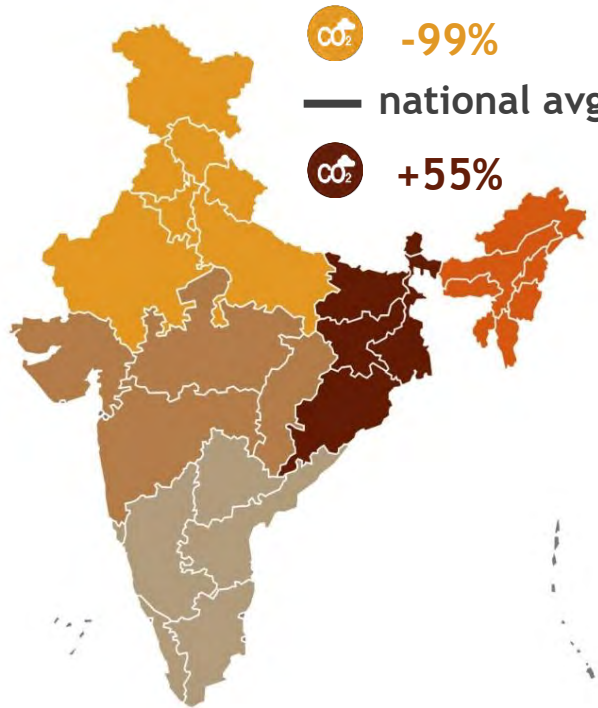
- Production mixes

- Key variables
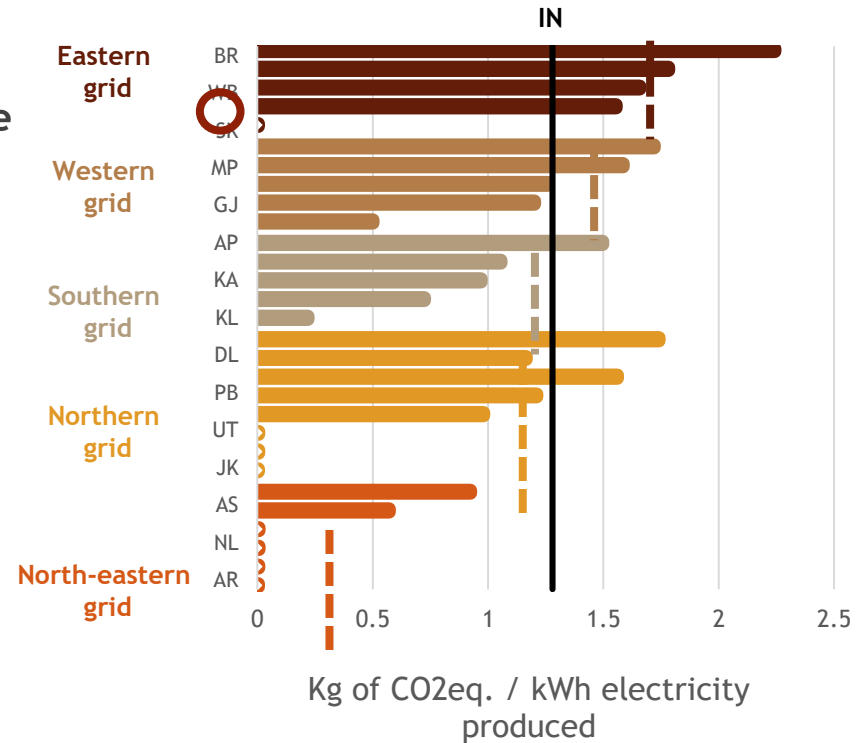
- Technical losses

- imports

Material, methods and results

Results: dramatic difference amongst states

CO₂ **-99%**

— **national avg. baseline**

CO₂ **+55%**

Eastern grid: BR, WB, SK

Western grid: MP, GJ

Southern grid: AP, KA, KL

Northern grid: DL, PB, UT, JK

North-eastern grid: AS, NL, AR

IN

Kg of CO2eq. / kWh electricity produced

Material, methods and results

Results: ferrochromium in theory and in reality

-99%

— national avg. baseline

+55%

+20%
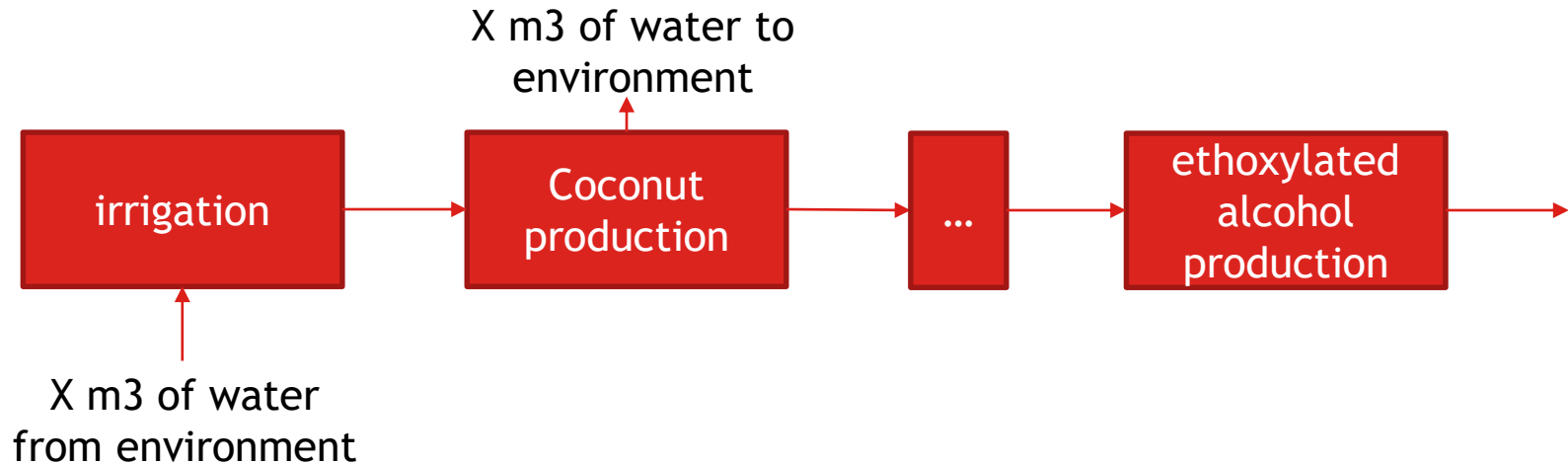
FeCr

The LCI-LCIA interface
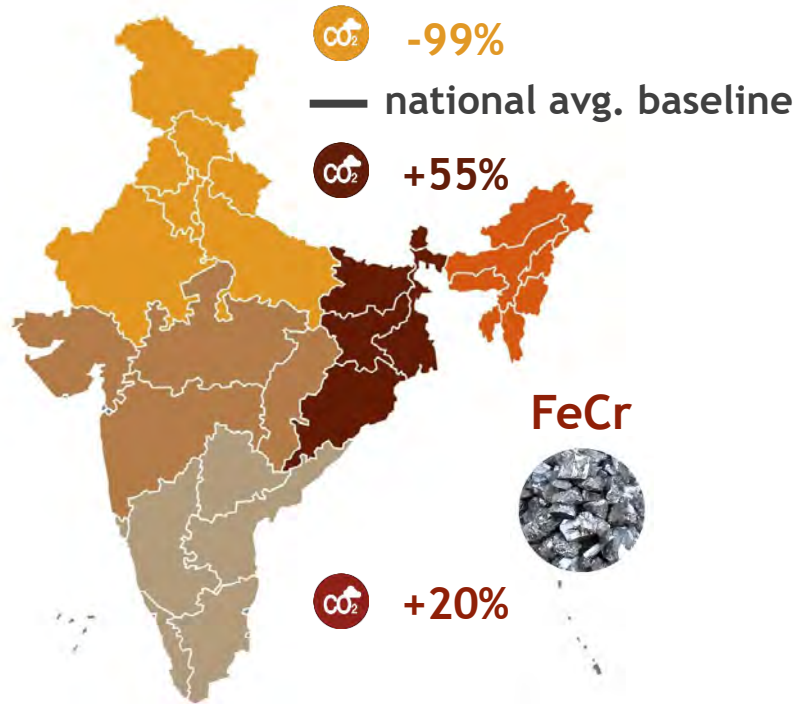
- Regionalized LCA requires regional data on inventories and on impacts

- The LCI-LCIA interface is at the moment still very rudimentary in practice
  - Regularly used information is in flow names and in compartments/subcompartments
    - Flows do not always have a geography field
  - Issues of mismatching/unharmonized names for these
  - ➢ Poor information carriers

The LCI-LCIA interface

- Modern data formats offer exchange properties, which can be used to convey more information to LCIA methods
  - Many methods do not make use of this, and methods differ in their approaches
- Format extensions could allow much more
  - E.g. Flow-specific regionalization information
    - Example: Pinpoint locations of power plants, but distribute the transport emissions included in the dataset
- Joint efforts needed
  - Life Cycle Initiative has a working group on this topic
    - Regionalization issues not discussed extensively so far

Trust in Transparency!

Regionalized LCA – data issues

- Regionalized LCA with background databases requires attention to the disaggregation level in the background database
  - Regional variations in emissions/relevant flows/suppliers
    - E.g. Indian electricity
  - Regional variations of impacts
- It is always helpful to check the origins of major impacts in the background
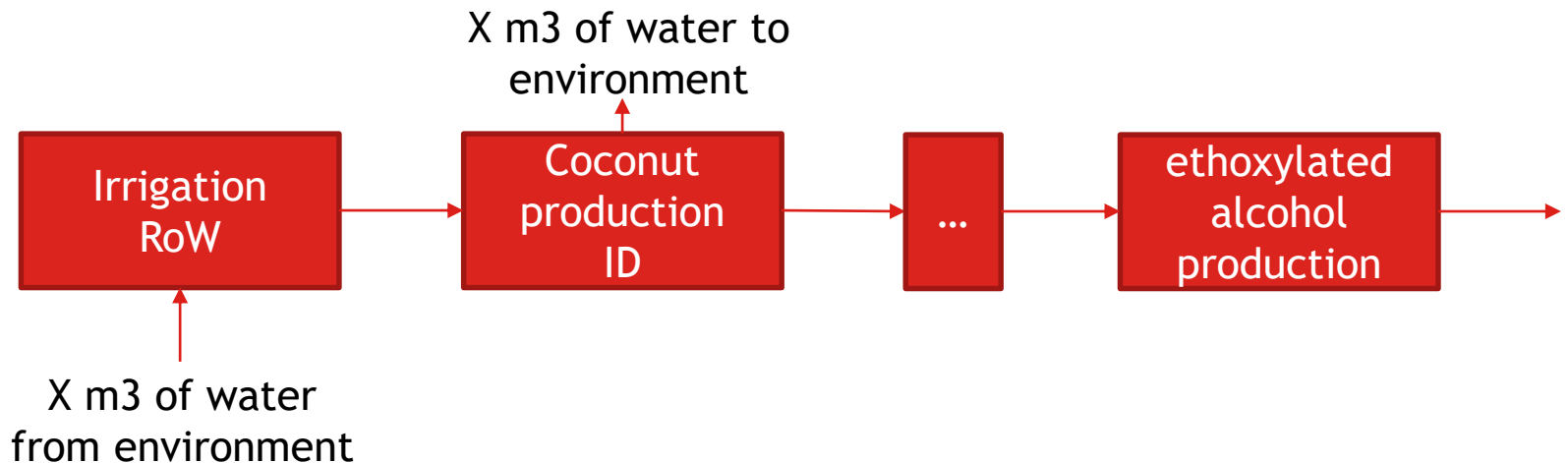
Example: ethoxylated alcohol

- ecoinvent is a data provider for the PEF pilot phase of the EC's Environmental Footprint project

  - Ethoxylated alcohol is a bio-based chemical that uses coconut oil as an input

X m3 of water to environment

```
              ┌──────────┐        ┌──────────────┐        ┌─────┐        ┌──────────────┐
              │irrigation│───────▶│  Coconut     │───────▶│ ... │───────▶│ ethoxylated  │───────▶
              └──────────┘        │  production  │        └─────┘        │   alcohol    │
                    ▲             └──────────────┘                       │  production  │
                    │                                                    └──────────────┘
```
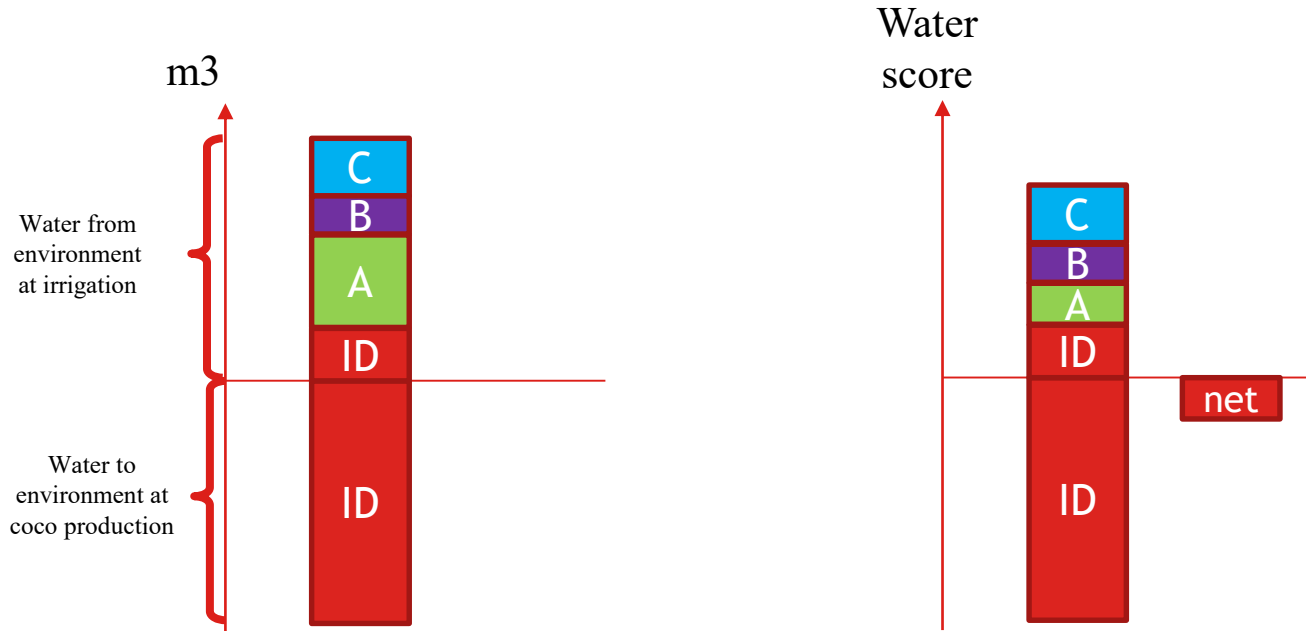
X m3 of water from environment

Example: ethoxylated alcohol

- Issues arose as we observed negative impacts for water use and consumption
  - Underlying cause was a geography mismatch
  - Other issues involving third-party PEF background data remain

X m3 of water to environment

| Irrigation RoW | → | Coconut production ID | → | ... | → | ethoxylated alcohol production | → |

X m3 of water from environment

Example: ethoxylated alcohol

The model said: "water was taken out of nature where it was not very scarce, and it was put back to nature where it was more scarce" → benefit to nature → negative score

Example: ethoxylated alcohol

- Solution: an Indonesian irrigation dataset was introduced
  - Existing datasets for e.g. Malaysia provided the process information
  - Simply "copy-paste" solution

- This highlights the underlying issue:
  - In current systems, the easiest solution is often the duplication of data to satisfy the algorithms
    - For a background database, dataset proliferation must be limited
    - The added level of detail is used in all calculations, not just where it is needed

- Reinforces the need for better approaches

Example: social impacts

- ecoinvent is working with the makers of the Social Hotspots Database (SHDB) to facilitate social LCA work on the foundation of the ecoinvent process network
  - Social impact assessments can have drastically different disaggregation needs than environmental assessments

- In addition to the SHDB, GreenDelta also provides **soca**, an add-on to the PSILCA database

Example: social impacts

- SHDB has information about risk of different adverse social effects of labor, per country and economic sector

- Risks were mapped to ecoinvent using price and CPC classification

- Ecoinvent datasets have GLO and other regions larger than the country resolution of SHDB

  - A weighted average of the risks of the covered countries was calculated using sector specific geographical distribution of economic activity

Example: social impacts

- For most datasets and indicator, the majority of social impacts currently come from GLO or RoW datasets
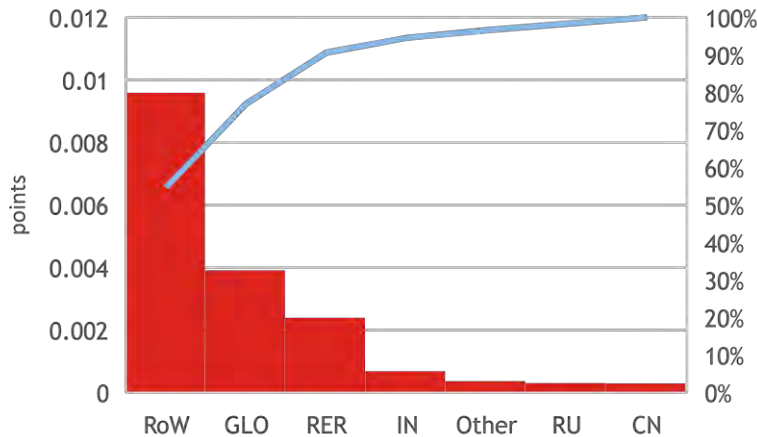
- Impact of *1 tkm of transport*, *freight*, *lorry >32 metric ton*, *EURO5*, *RER* on "Forced Labor" indicator

Example: social impacts

- environmental assessment regionalization levels are not generally adequate for social hotspot assessment
    - Working actively in a project to improve support for regionalized SLCA
    - High-quality support using only current systems would increase the dataset burden on environmental assessments
    - New solutions are under investigation

Conclusions

- Regionalized LCA falls down to the level of the lowest level of

  - LCIs
  - LCI-LCIA interface
  - LCIA methods
  - Software tools

Conclusions

- Background databases want to support regionalized LCA
  - Average user needs can hold back progress
    - Increasing number of datasets increases complexity
  - Advances can complicate work at the other stages unless they adapt as well

- Regionalization faces the "Chicken and Egg" problem on who moves first
  - More communication of needs from the LCIA methods required
    - Also: what is achievable
  - Joint discussions on the LCI-LCIA interface needed

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Thank you