UNCERTAINTY, VARIABILITY AND CONTRIBUTION-TO-VARIANCE ANALYSIS: IT'S NOT JUST INVENTORY DATA

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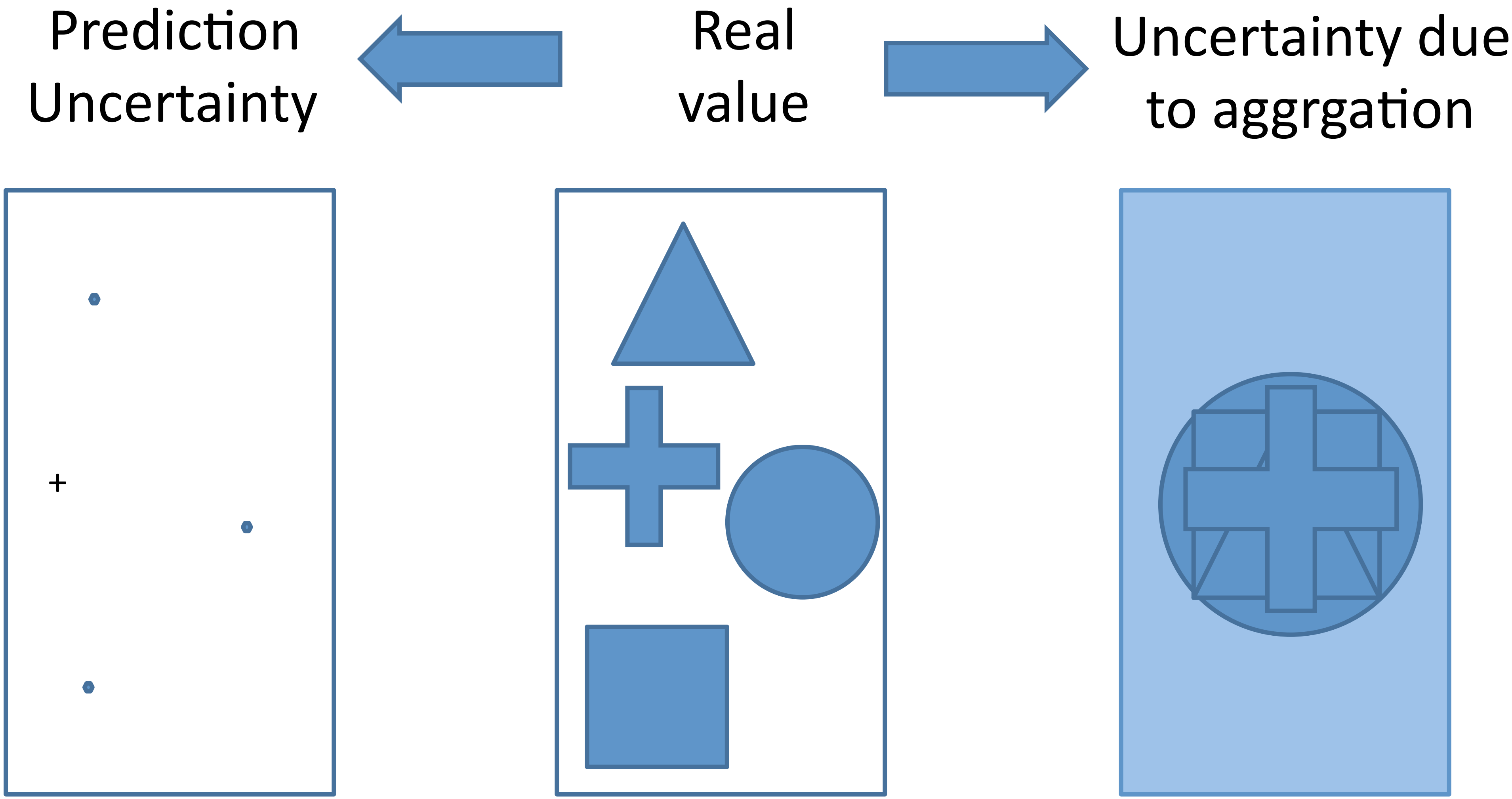
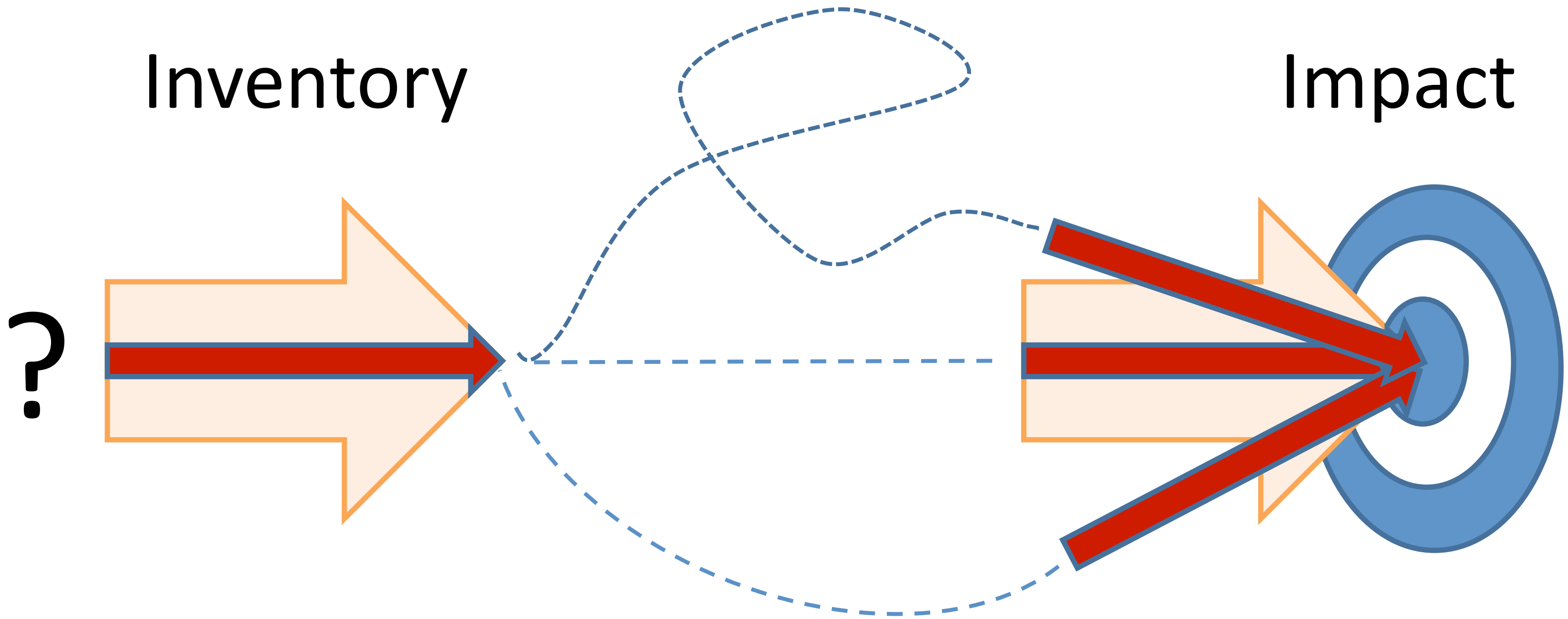
Uncertainty in LCA

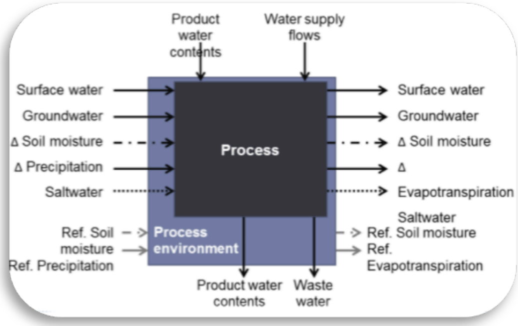


Certainty in LCA



Uncertainty assessment in LCIA methods is essential: e.g. LIME method, or Geisler et al. 2005

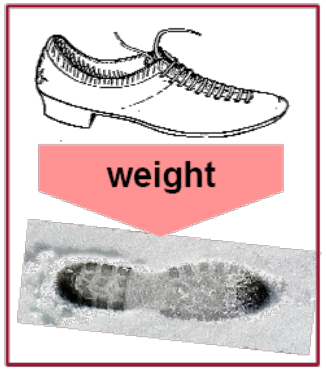
Inventory Issues



- Uncertainty mainly provided by pedigree matrix
  - Many points address variability (i.e. spatial, temporal and technological)
  - basic uncertainty of environnemental flows (ecoinvent) accounts for variability (e.g. for water)

- Datasets typically aggregated on country or even global level
  - Variability induced uncertainty might exceed prediction uncertainty

Impact assessment



- Uncertainty is not provided in most cases
  - Specific work on some categories (e.g. toxicity, water consumption)
  - LIME methodology includes uncertainties (Itsubo and Inaba 2012)
  - CML allows generic uncertainty assessments
  - In EI99 and ReCiPe different «cultural perspectives» address some uncertainties

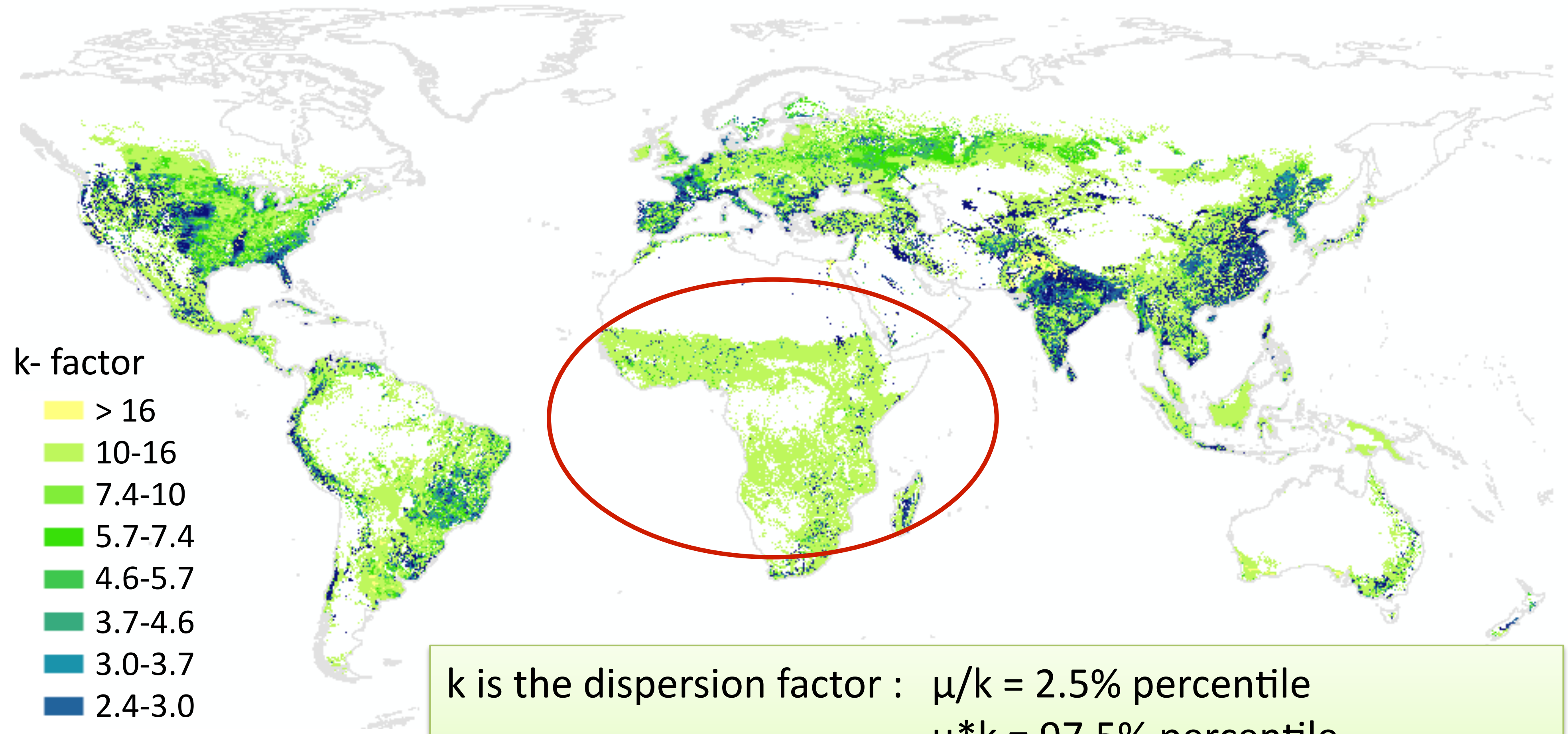
- CF are typically aggregated on global or continental level
  - Variability induced uncertainty is not addressed
  - Archetypes (e.g. high / low pop densities)

Example:
Water consumption of crop production

- Inventory data:
  - Very high spatial variability (climate dependent)
  - High prediction uncertainty (management dependent)

- Characterization factors:
  - Relatively high spatial variability (climate dependent)
  - Very high uncertainties in cause-effect models (input parameters as well as models)

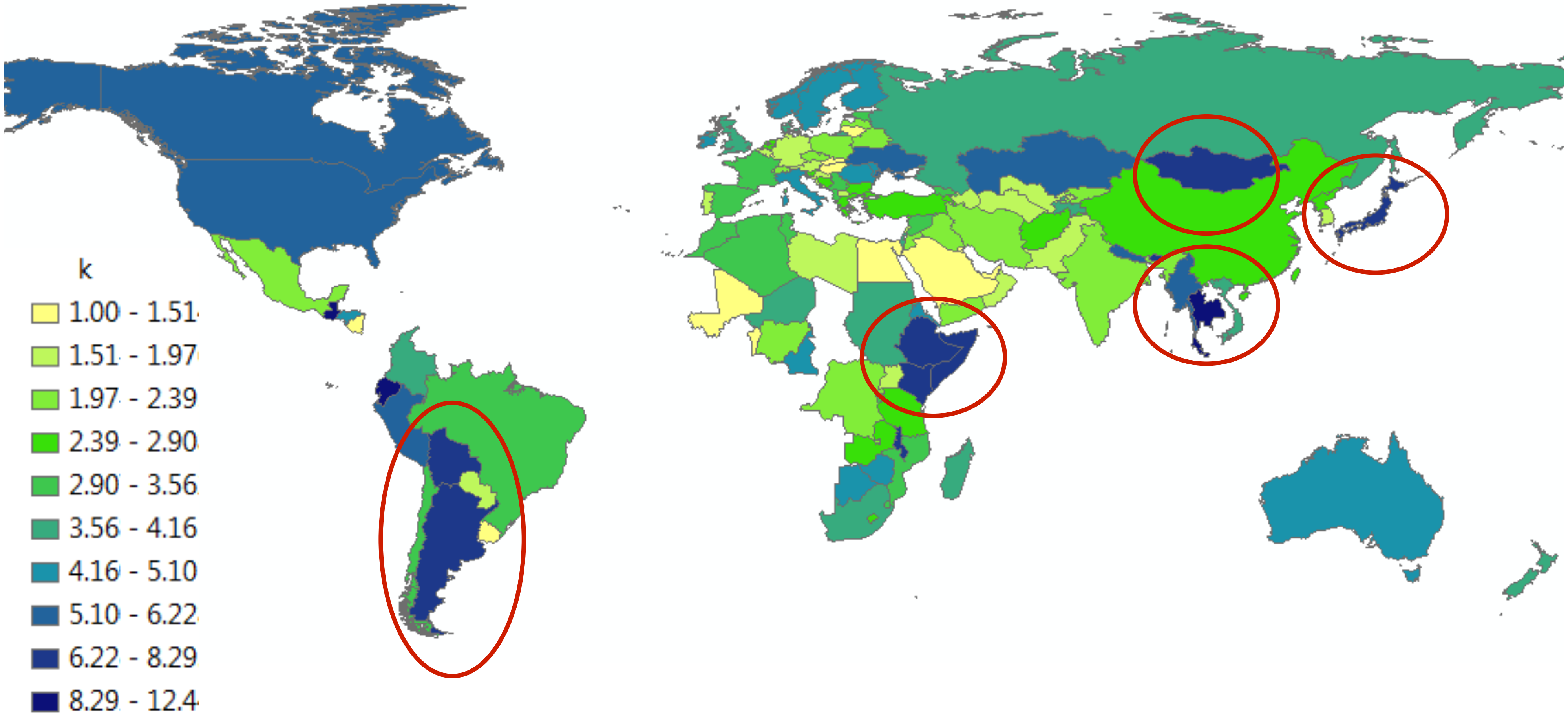
Prediction uncertainty of water consumption in crop production



k is the dispersion factor : μ/k = 2.5% percentile
μ*k = 97.5% percentile
k = 10 means the 95% CI spans over two orders of magnitude

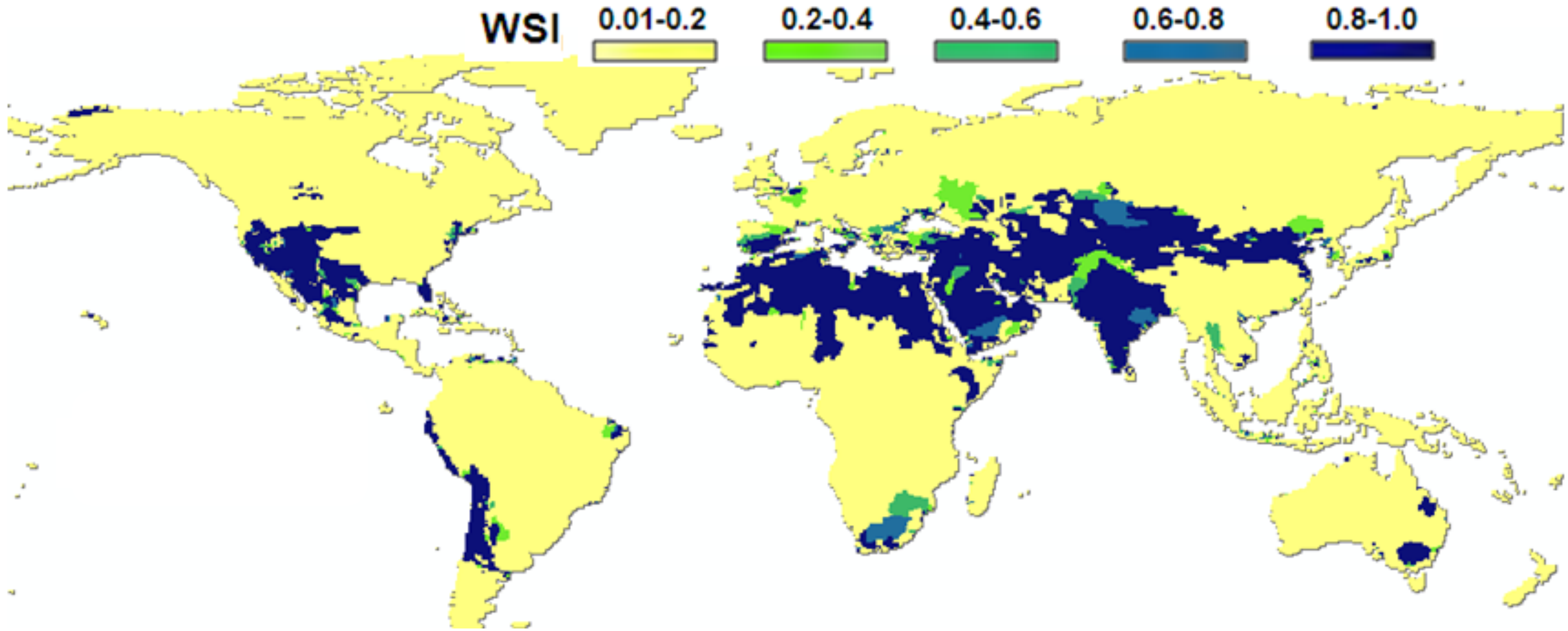
Case of wheat production

Aggregation to country level (production-weighted average)

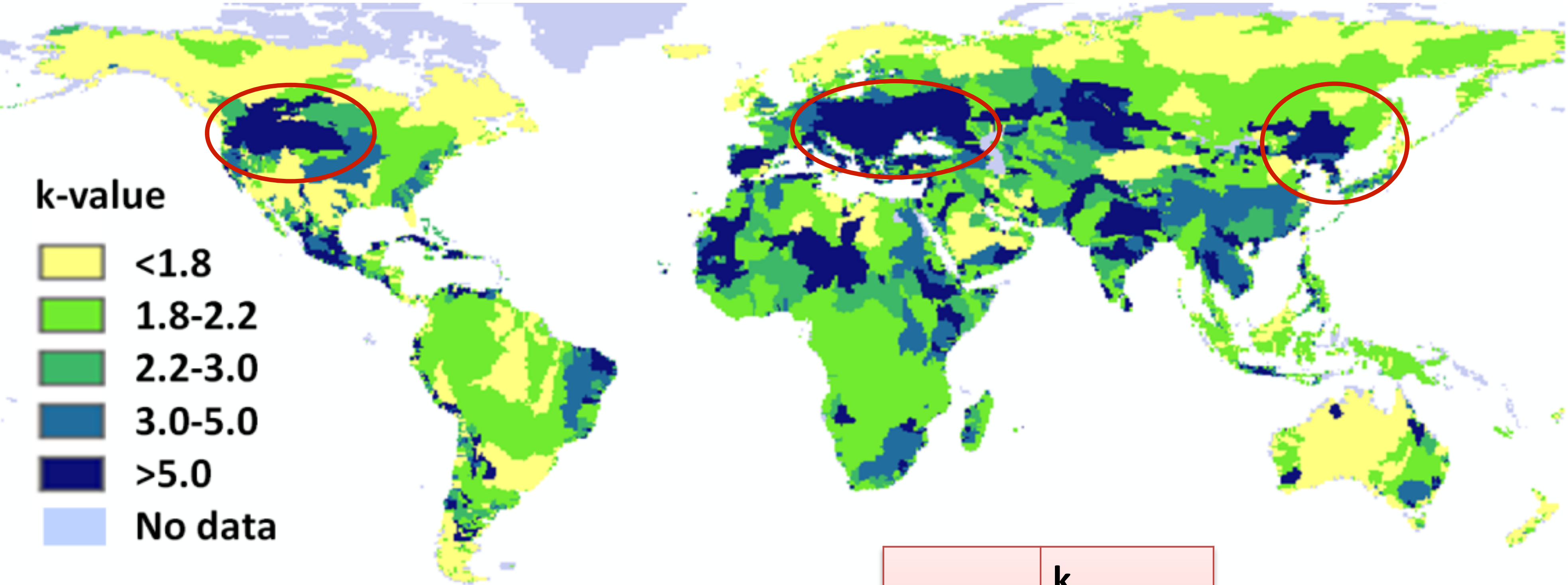


Impact assessment (midpoint)

Water stress index (WSI) Range: 0.01 – 1.00



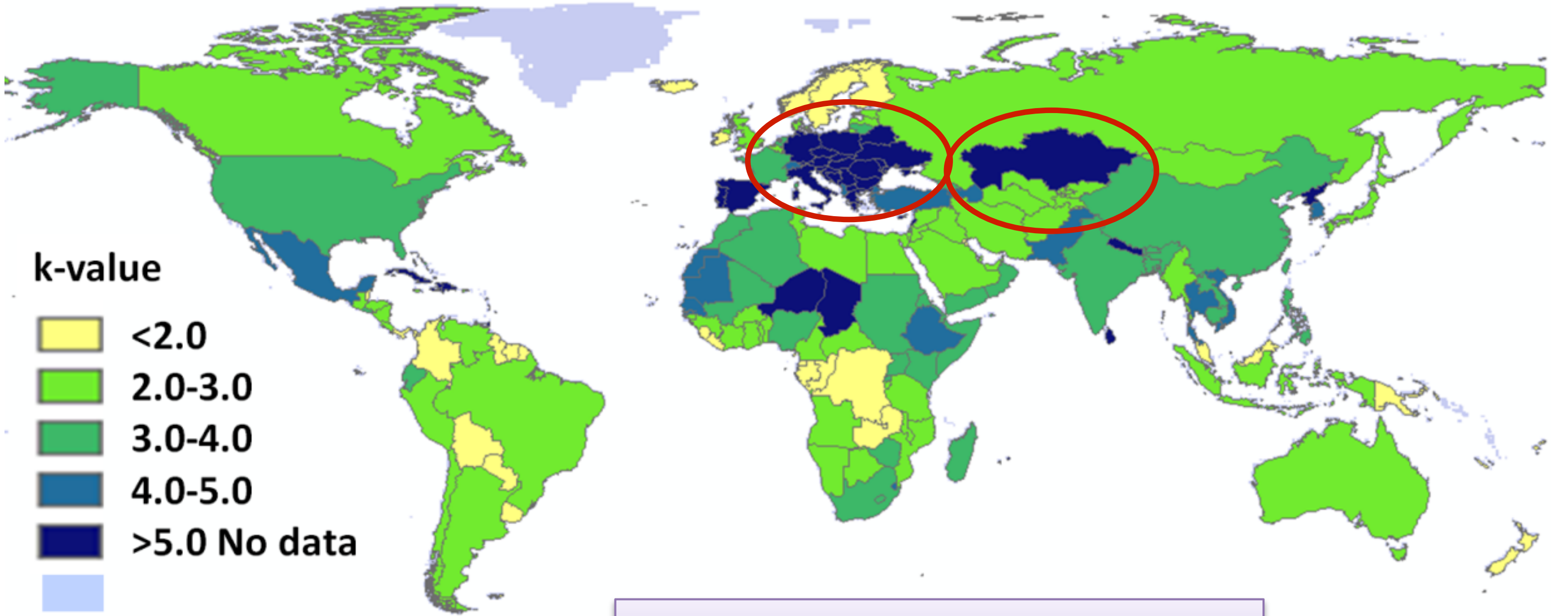
Related uncertainties: WSI



	k_{WSI}
Average	2.76
Min	1.68
Max	12.20

Uncertainty due to aggregation (Variability)

k-value caused by the **aggregation** of watershed to country resolution for **midpoint**



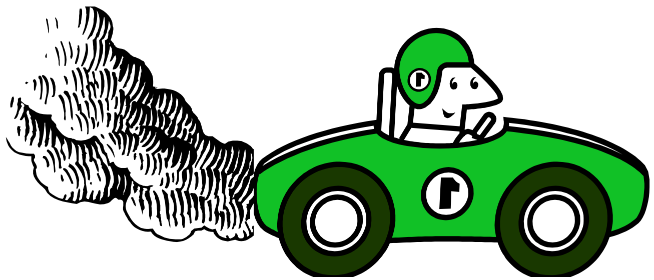
k of global production: **2.2**

Report: http://www.ifu.ethz.ch/ESD/downloads/Uncertainty_water_LCIA.pdf

Contribution to variance analysis

- Based on Geisler et al. 2005 and Mutel et al. 2013
  - Quantify relevance of uncertainty

- Example: GWP comparison of a «person*km», transported by a **natural gas** and a **biogas** car
  - Analysis of the difference
    - Avoids correlated uncertainties
    - Problem of uncorrelated flows



Assessing GWP endpoint effects: Natural gas minus Biogas in car

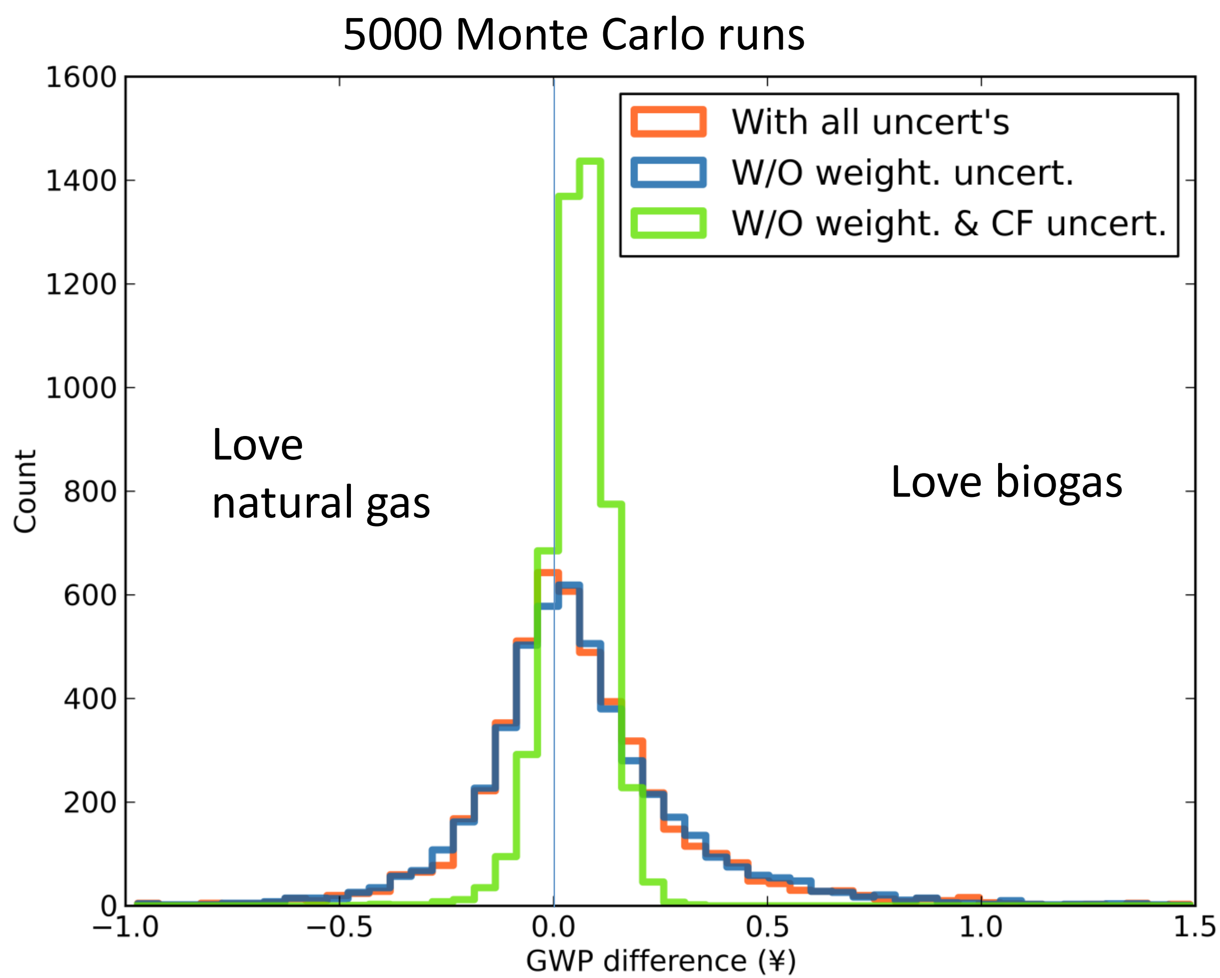
Inventory: **ecoinvent** 2.2
LCIA: **LIME** method

Mean: 0.06 ¥
Median: 0.06 ¥
STD: 0.07 ¥

22% chance that Biogas is worse

Mean: 0.06 ¥
Median: 0.03 ¥
STD: 0.27 ¥

41% chance that Biogas is worse



Contribution to Variance result

64.2%	CF:CO2 fossil
10.2%	CF:CH4 biogenic
9.2%	CF:CH4 biogenic (low pop density)
4.9%	Technosphere:CH4 production mix
4.1%	Biosphere:CH4 biogenic (biogas from biowaste)
3.8%	Biosphere:CO2 (nat gas car operation)
0.9%	Technosphere: Operation of nat gas car per pkm
0.5%	CF:CO2 (high pop density)
0.4%	Technosphere: Operation of biogas car per pkm
0.02%	Weighting

98.2% of Variance

>84% is CF

<16% is LCI

Conclusions

- Uncertainties of impact assessment needs to be included
- Aggregation induced uncertainties and model uncertainties should be reported separately
  - Reveals specific improvement options
- Contribution to variance analysis identifies most relevant aspects for improving the study
- **Low** uncertainty shows **high** trust, **no** uncertainty means **no** trust

THANKS FOR YOUR ATTENTION!

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