LC-IMPACT

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With inputs from Francesca Verones, Mark Huijbregts, Chris Mutel
(and many others)

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Background

- Original Project – EU FP7 funded
- Duration: 2010-2013

Development and application of environmental Life Cycle Impact assessment Methods for imProved sustAinability Characterisation of Technologies
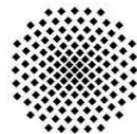
Overview

Impact categories

Climate change

Ozone depletion

Ionising radiation

Photochemical ozone formation

Particulate matter formation

Acidification

Eutrophication

Human toxicity

Ecotoxicity

Land stress

Water stress

Mineral resources scarcity

Areas of protection

Human Health

DALY

Ecosystem Quality

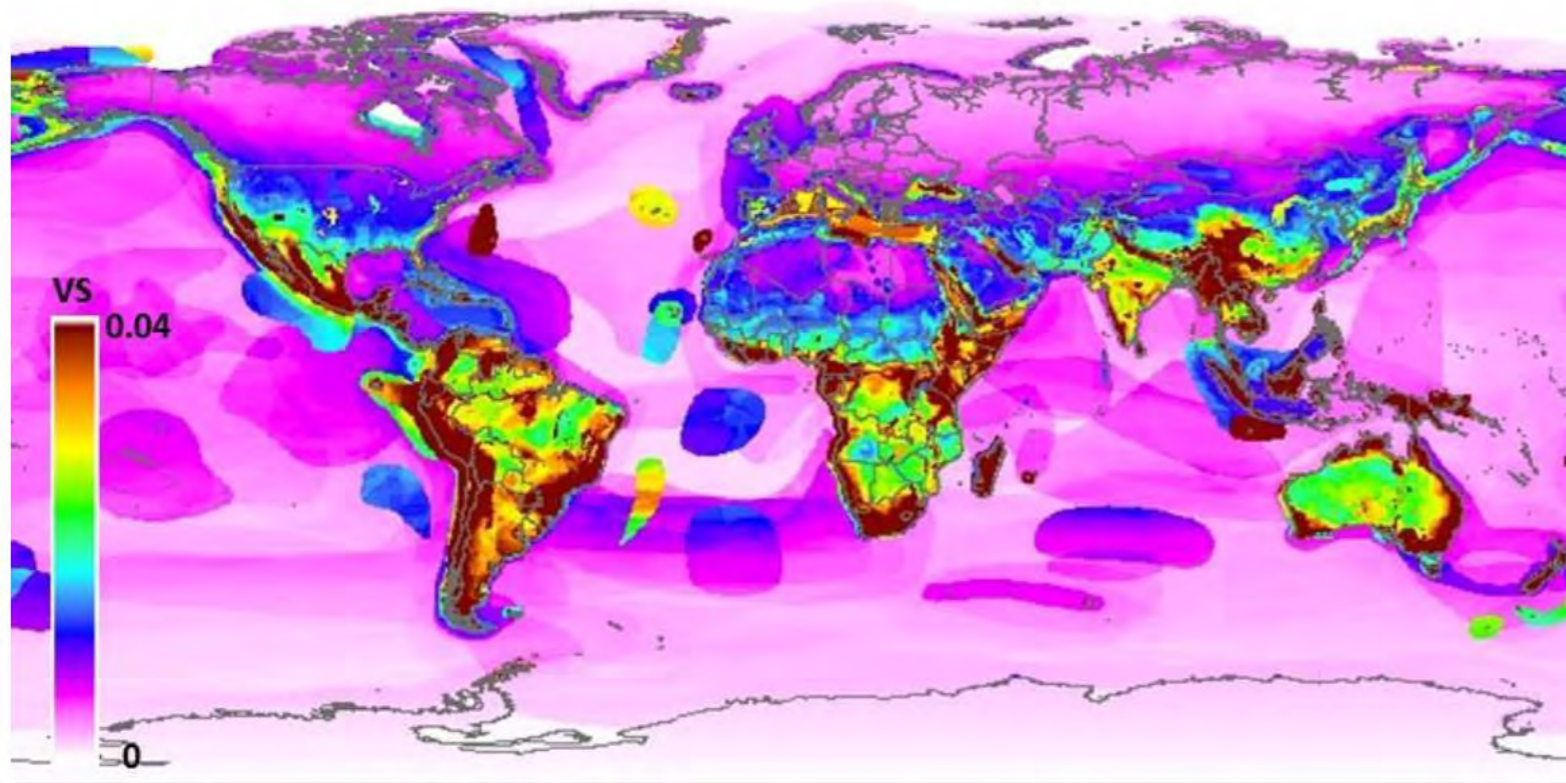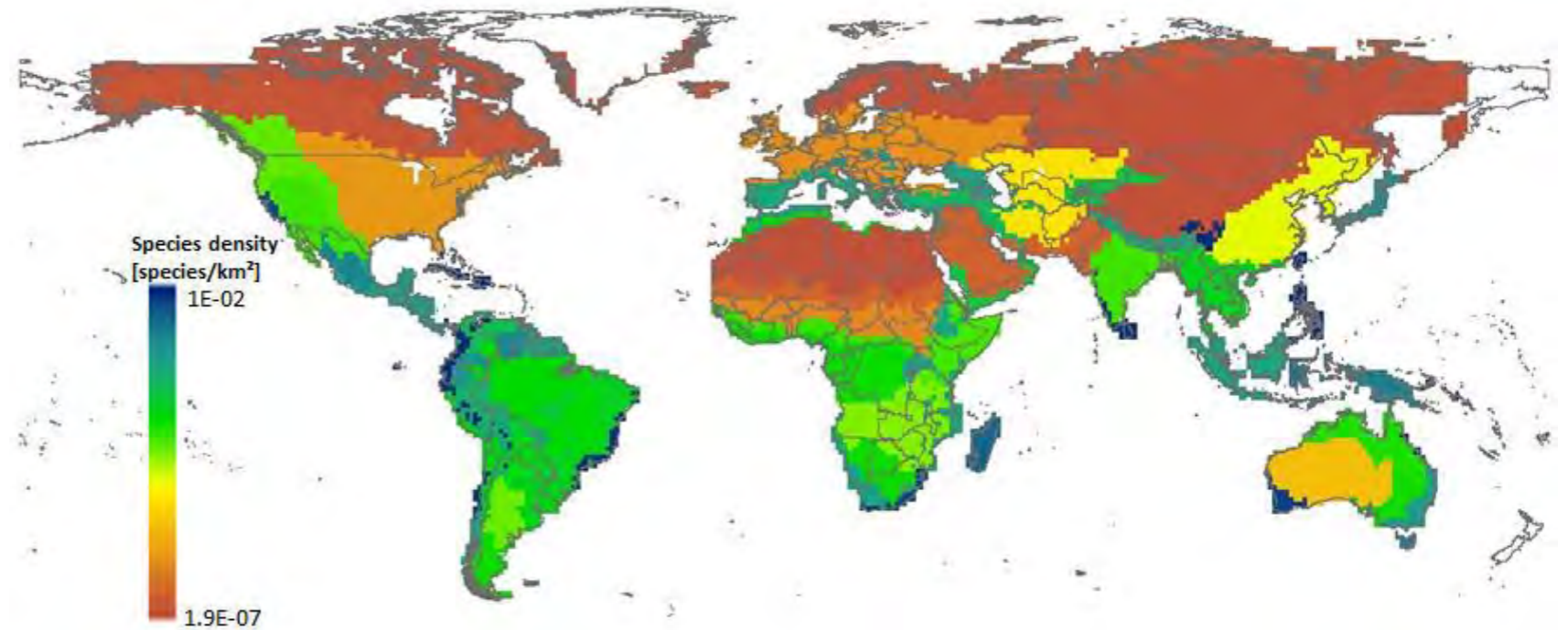Terrestrial Ecosystems

Freshwater Ecosystems

Marine Ecosystems

PDF

Natural Resources

kg$_{ore}$
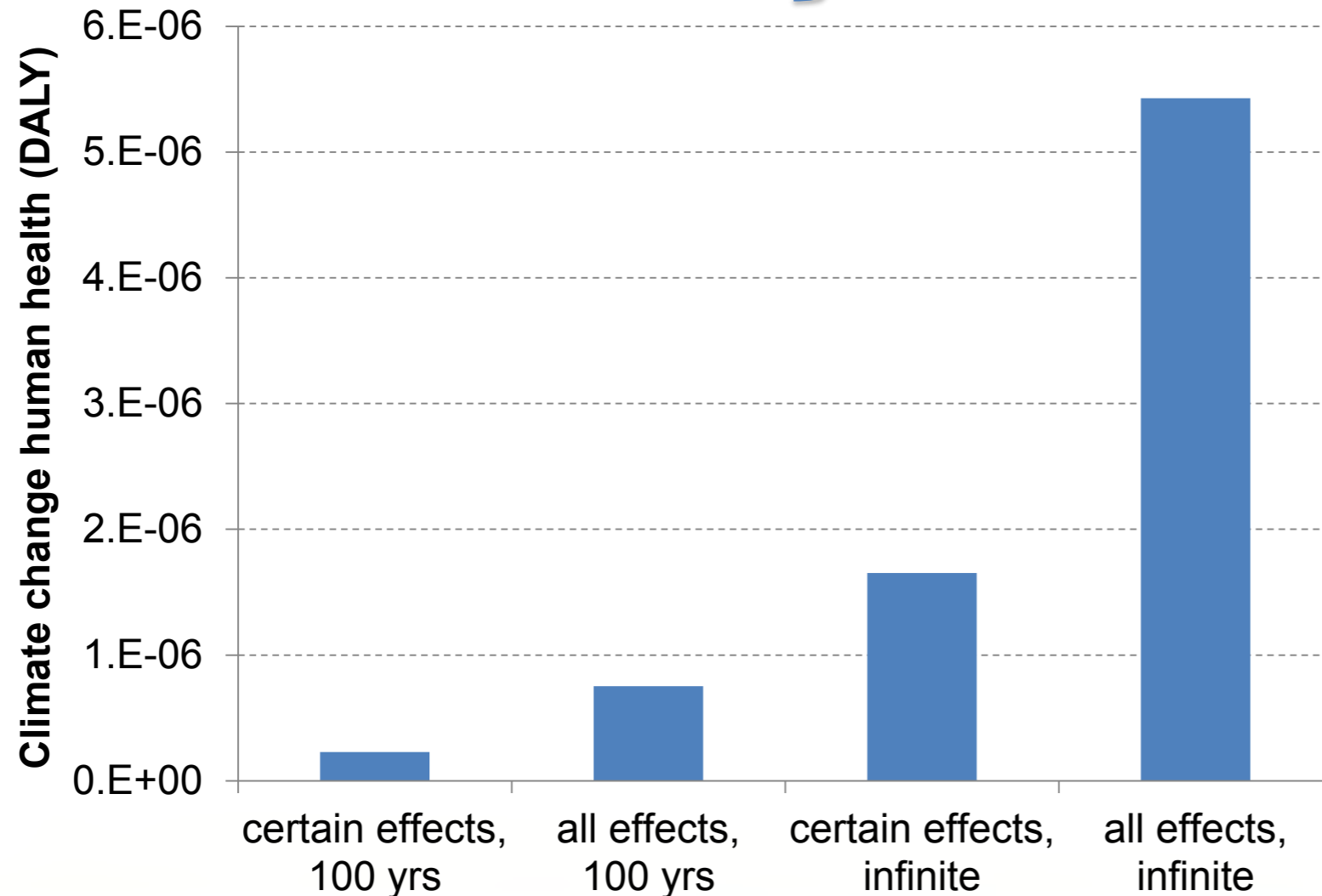
PDF ≠ PDF

- species density

- global vulnerability

Threat level
Geographic range area

Kier et al. (2009). PNAS 106(23): 9322-9327
Verones et al. (2015) Environ. Sci. Technol. 49(6): 3584-3592.

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Variability uncertainty - context

> ➢ Time horizon
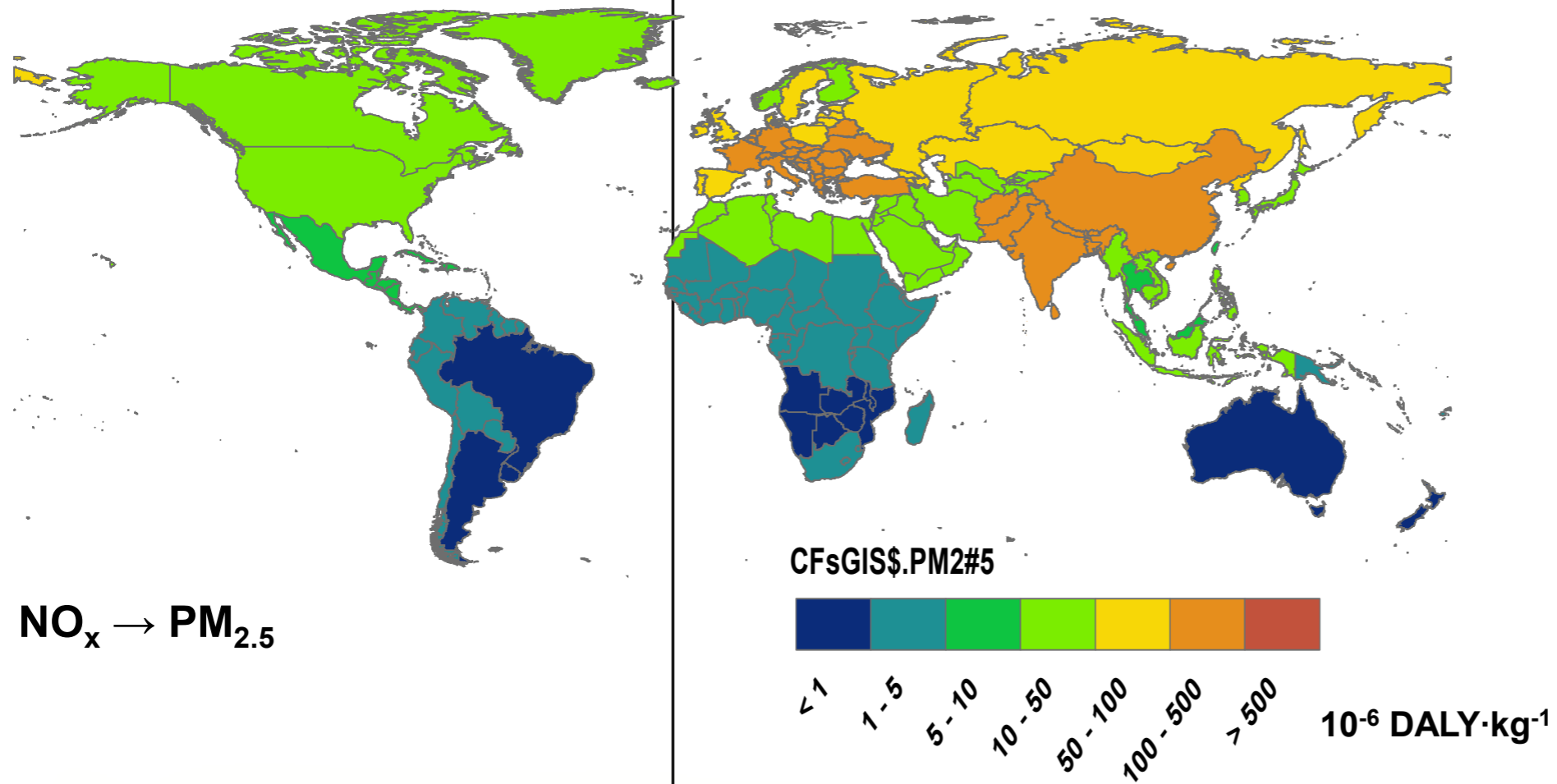> ➢ Certainty of effects

4 sets possible

FU: driving one passenger kilometer in a Euro5 car in Europe

Modularity of the CFs

Environmental mechanism	Time horizon	(Un)certain effects
Climate change (human health)	✓	✓
Climate change (terrestrial ecosystems)	✓	
Climate change (freshwater ecosystems)	✓	✓
Ozone depletion and ionizing radiation	✓	✓
Ozone formation (human health and eco)		
Particulate matter formation		✓
Terrestrial acidification		
Eutrophication		
Ecotoxicity	✓	
Human toxicity (carcinogenic)	✓	✓
Human toxicity (non-carcinogenic)	✓	✓
Land stress (occupation)		
Land stress (transformation)	✓	
Water stress (ecosystems)		✓
Water stress (human health)		
Metal depletion		✓

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Variability uncertainty – model structure

CFsGIS$.PM2#5

< 1	1 - 5	5 - 10	10 - 50	50 - 100	100 - 500	> 500

10^{-6} DALY·kg^{-1}

$NO_x \rightarrow PM_{2.5}$

Van Zelm et al. (2016). Atmos. Environ. 134: 129-137.
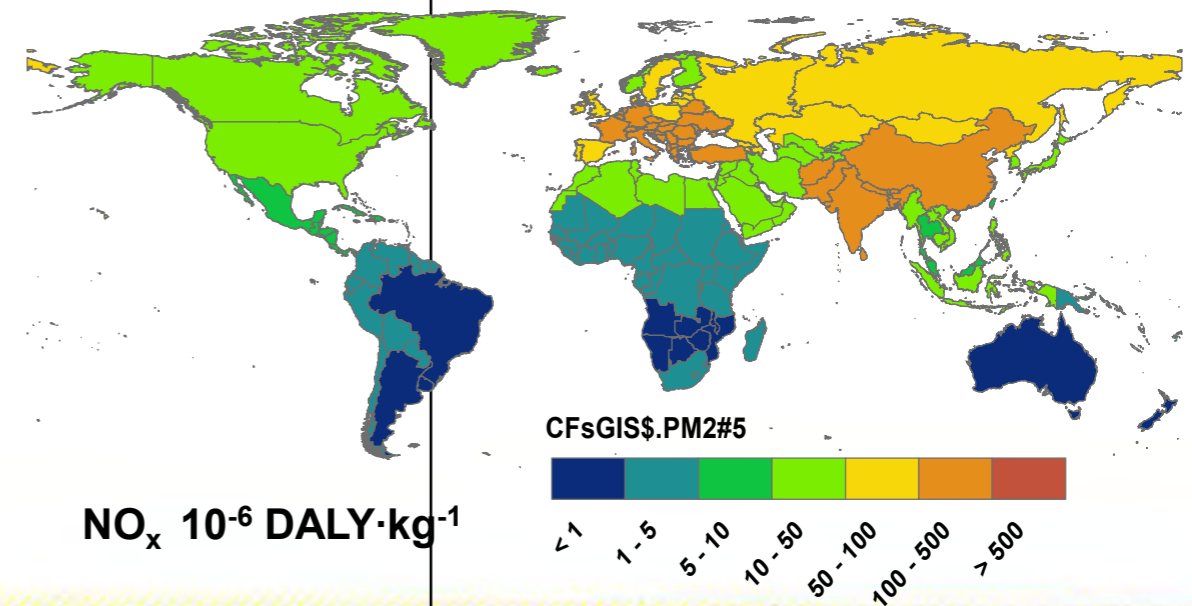
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Variability uncertainty - inputs

- Toxicity
  - 100,000+ chemicals
  - Limited availability toxicity data

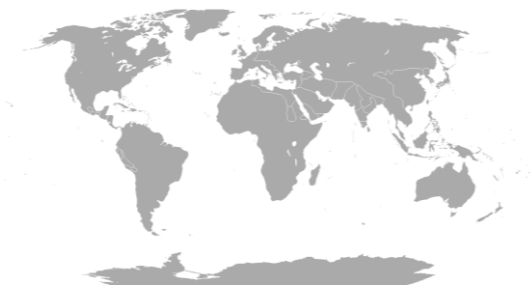Van Zelm et al. (2010). Environ. Sci. Technol 44: 1004-1009.

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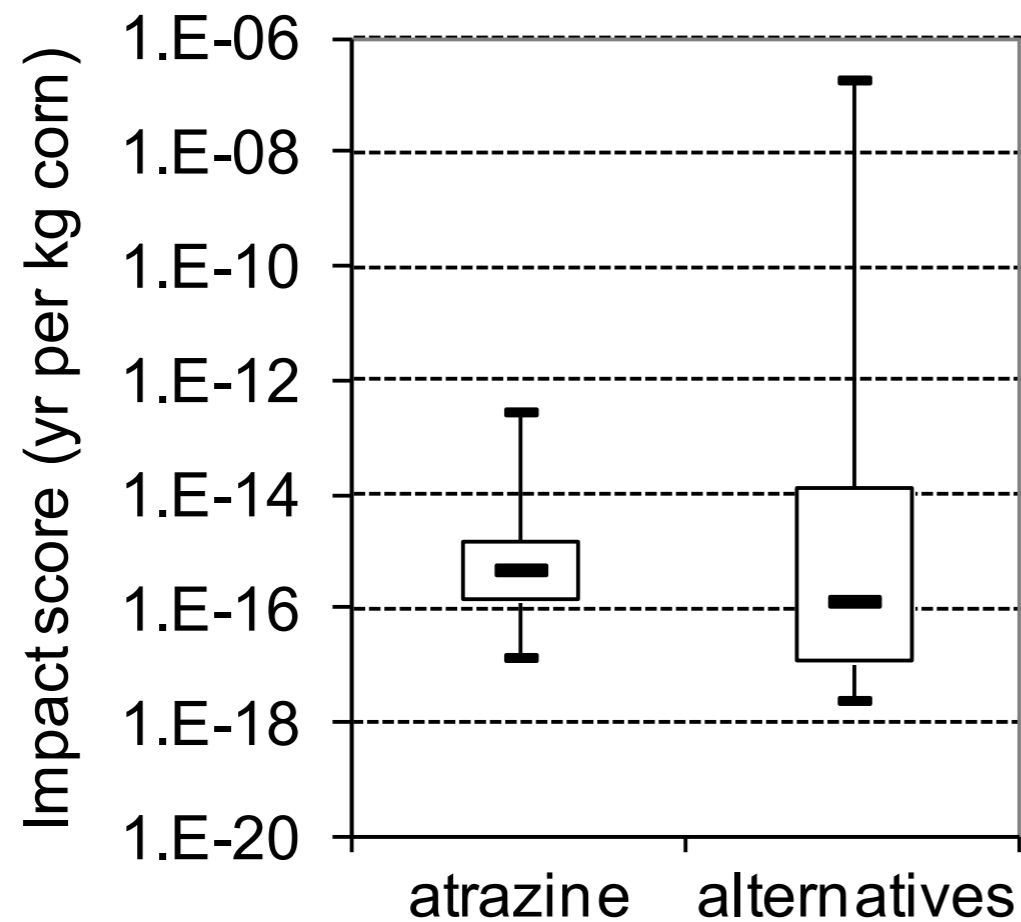
Regionalization: how?

- Going global first priority

- Many levels of regionalization

- **Best available global model**

CF [PDF$_{global}$·yr/m^3]
2.4E-11
0

Animal taxa

CF [PDF*yr/kg]
1.2E-09
0

NO$_x$

NO$_x$ 10^{-6} DALY·kg^{-1}

CFsGIS$.PM2#5

< 1 | 1 - 5 | 5 - 10 | 10 - 50 | 50 - 100 | 100 - 500 | > 500
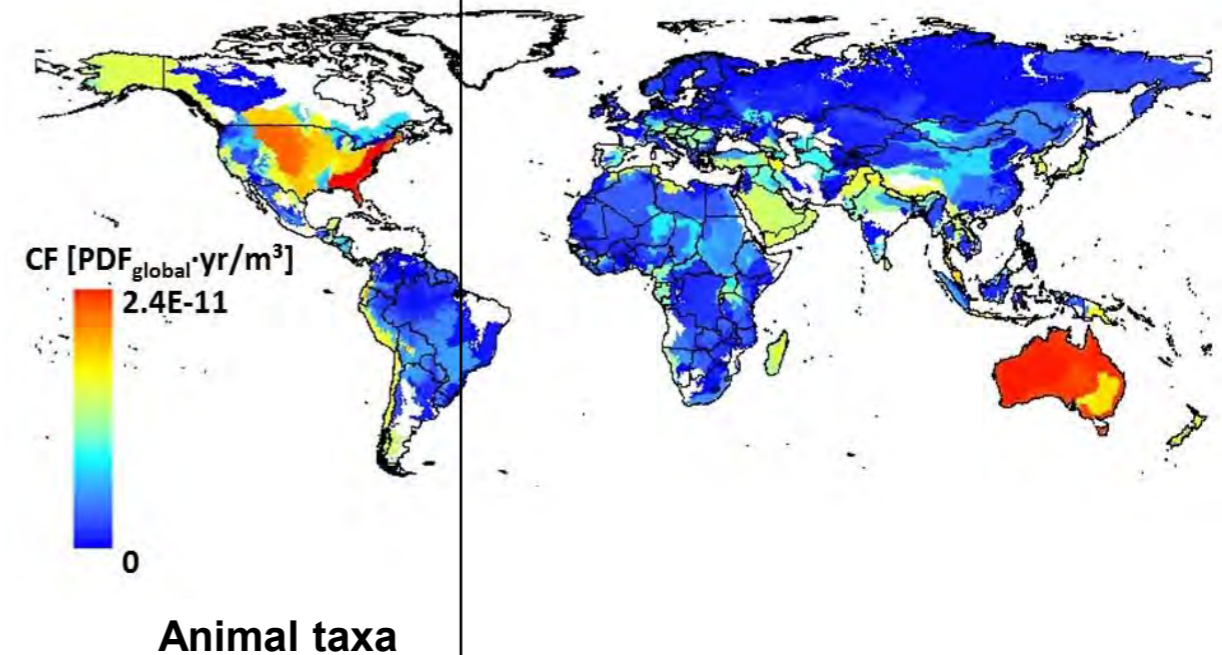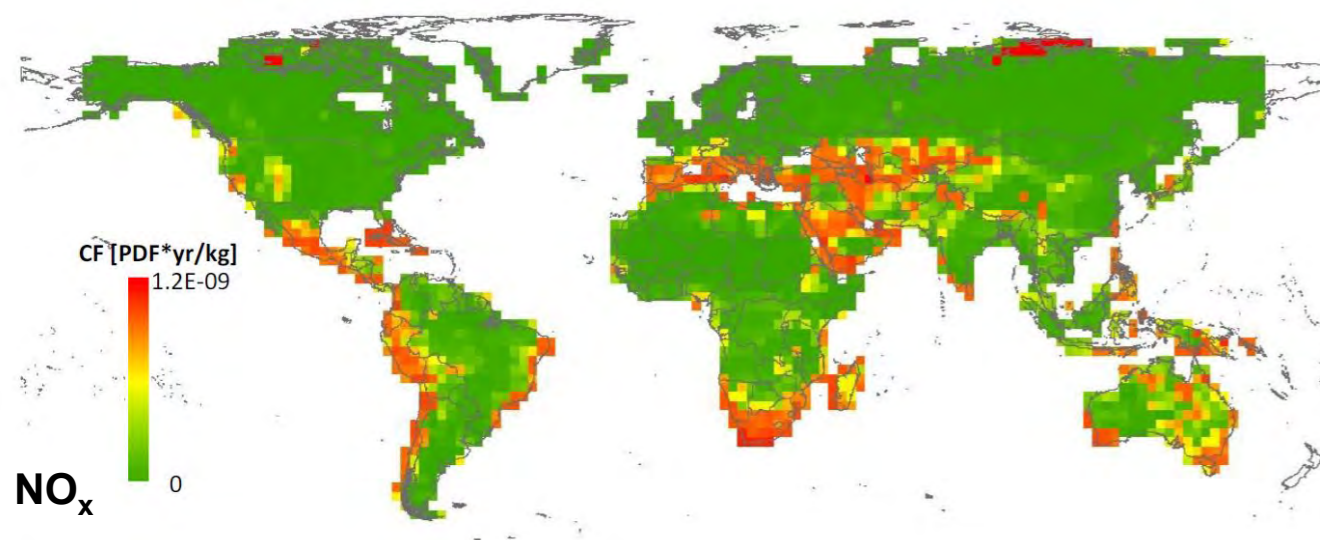
Regionalization

Climate change

Ozone depletion

Ionising radiation

Photochemical ozone formation

56 world regions   Particulate matter formation

2.0º x 2.5º   Acidification

449 freshwater ecoregions   Eutrophication

16 subcontinental regions   Toxicity

804 terrestrial ecoregions   Land stress

0.05º x 0.05º   11050 watersheds   Water stress

Mineral resource depletion

Aggregation

- For each impact category

  - Countries
  - Continents
  - World

  weighted averages
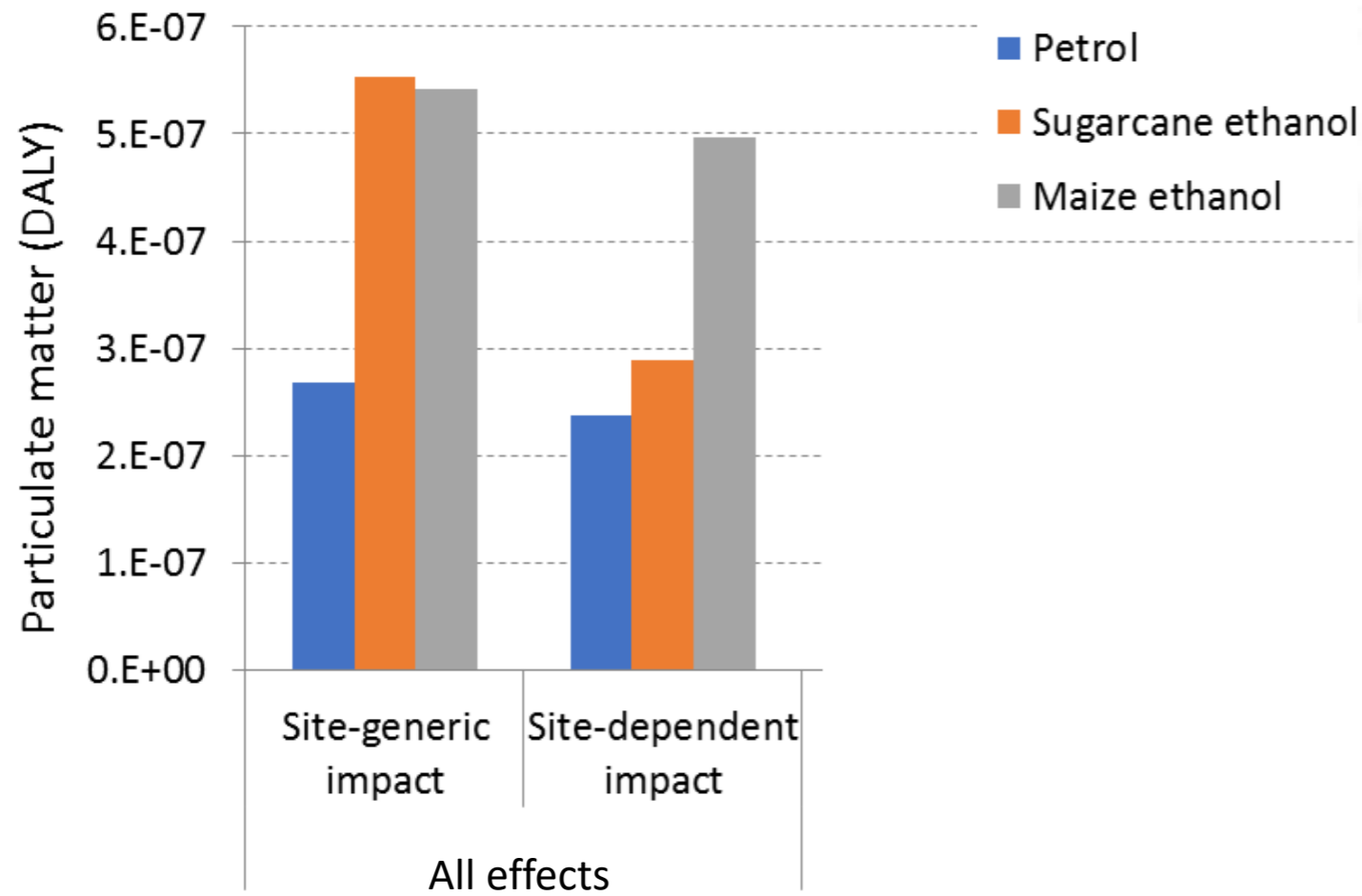
Relevance of regionalization

- FU: driving one passenger kilometer in a Euro5 car in Europe
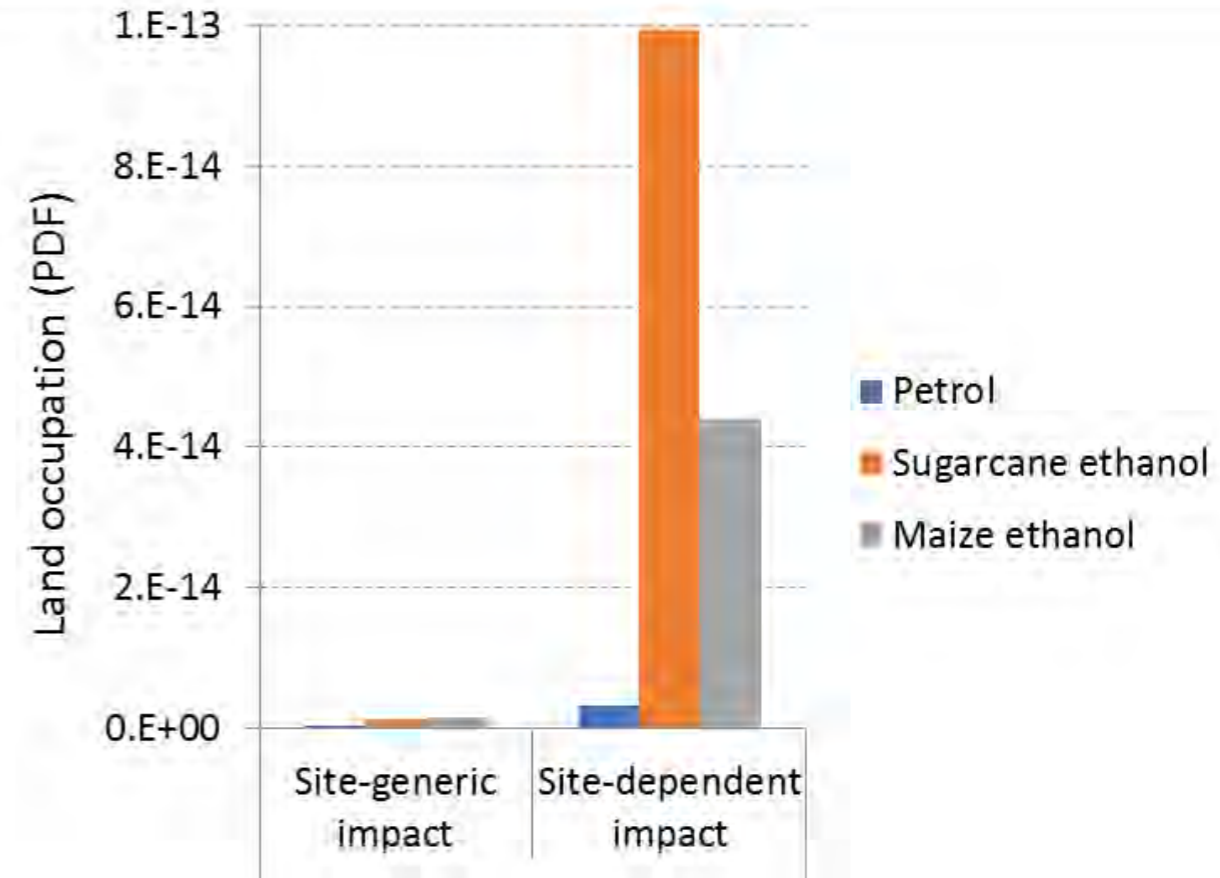

- Fuel options
  - low-sulfur petrol
  - Biofuel based on ethanol from Brazilian sugarcane
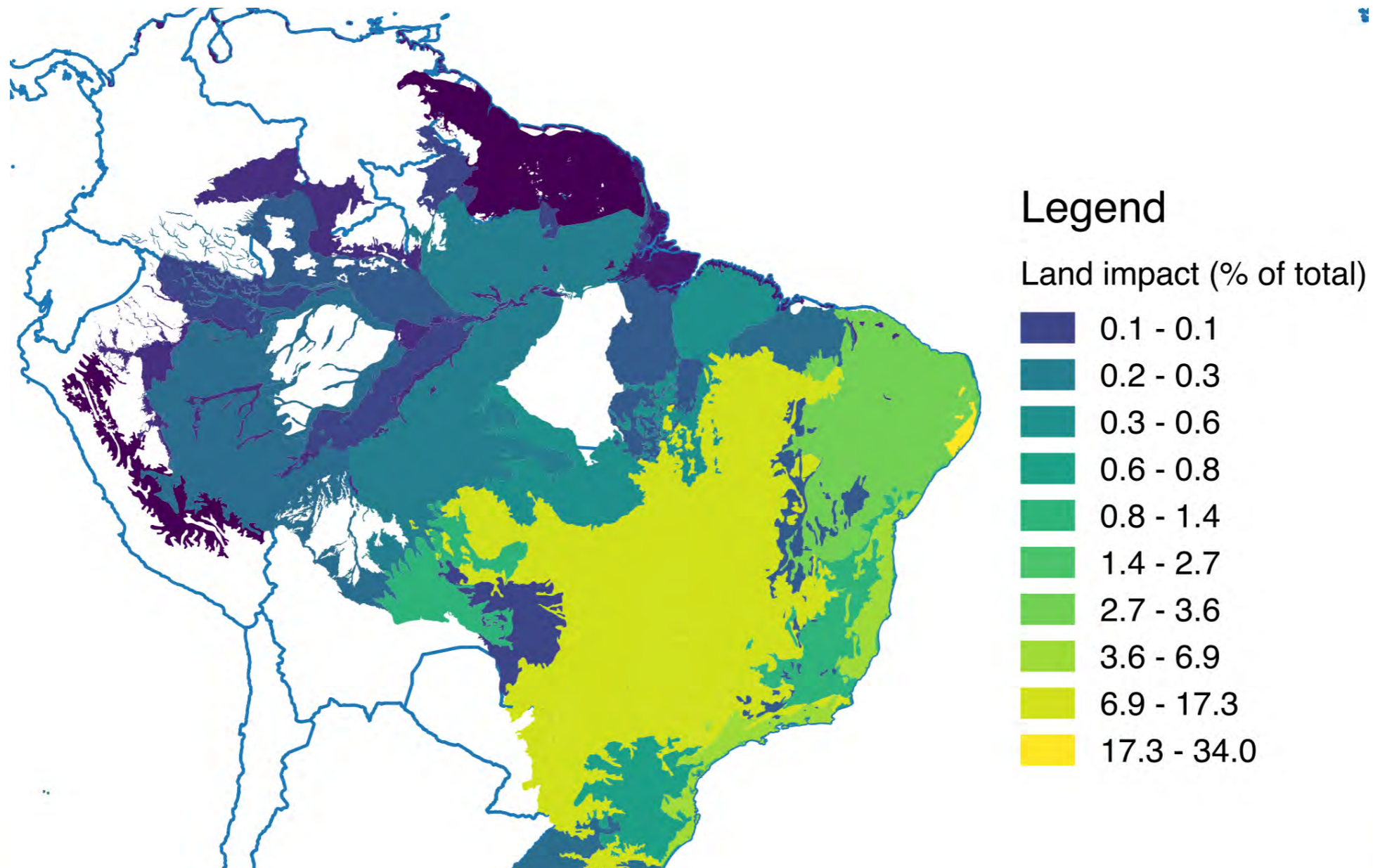 - Biofuel based on ethanol from US maize

Case results

Preliminary results

Land occupation impacts from sugarcane production in Brazil

Legend

Land impact (% of total)

- 0.1 - 0.1
- 0.2 - 0.3
- 0.3 - 0.6
- 0.6 - 0.8
- 0.8 - 1.4
- 1.4 - 2.7
- 2.7 - 3.6
- 3.6 - 6.9
- 6.9 - 17.3
- 17.3 - 34.0

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A living methodology

- New impact categories

- Regular updates

- Midpoint indicators

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Conclusions

- Preferred level of regionalization not the same for each impact category

- Other uncertainty sources important

- Use of regionalized factors could lead to other decisions

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