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sustainability consulting + software

Regionalised LCIA implementation in LCA software for decision-making analysis in LCM

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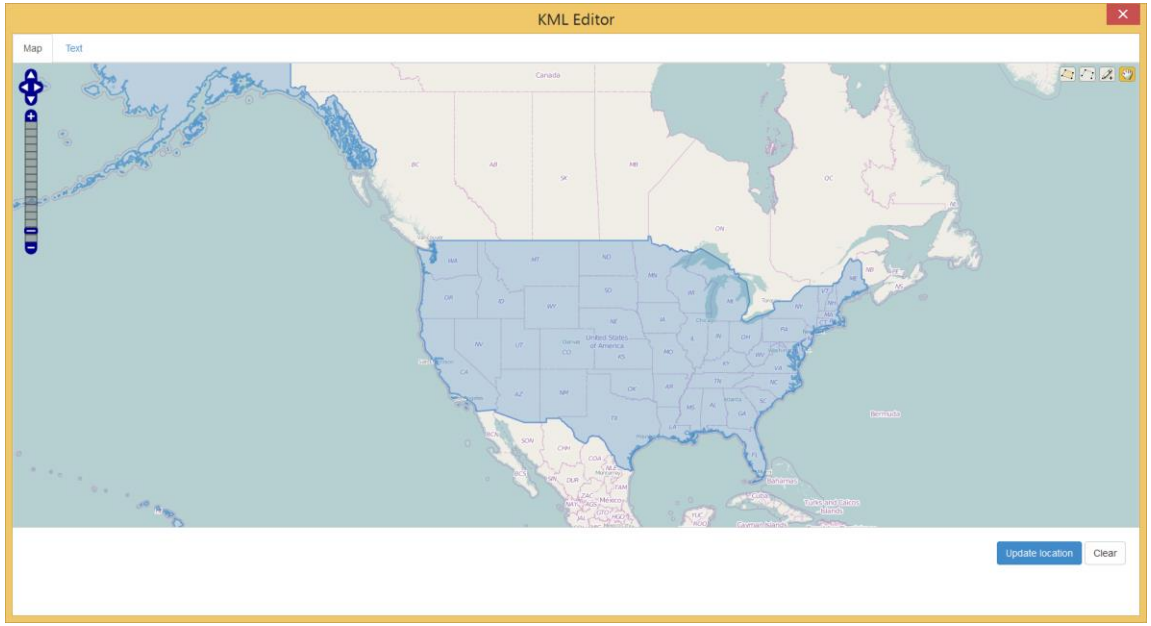
Content

- Regionalised LCIA in openLCA
  - Corn production case study
- The perspectives concept applied to regionalised LCIA
- Next steps and conclusions

Regionalised LCIA in openLCA

Regionalised LCIA in openLCA

- Inventory:
  - Extension of locations: KML editor



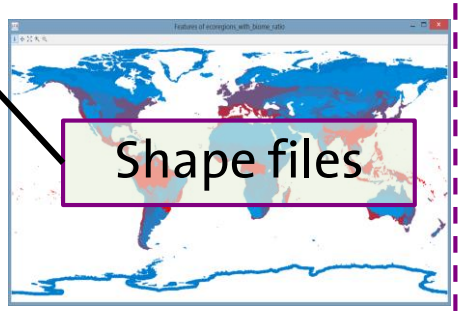
- LCIA methods:
  - Parameterisation of the models + GIS
    - Reduction of the amount of data which needs to be included in the method in openLCA

LCIA MODEL
(per substance i, impact category j)

Site-independent parameters ↔ Mathematical functions ↔ Site-dependent parameters

Default value

Shape files



Impact factors

Impact category: total - Land use

Flow	Category	Unit	Factor	Uncertainty
Occupation, arable	resource/land	UBP/m2*a	(0.60*ratio_biom)/s_area	lognormal: .

Example: Land use model from de Baan et al. (2012), as implemented in Ecological Scarcity 2013 (Frischknecht and Büsser Knöpfel 2013)

$$Eco-factor^{\mathrm{Re}gion\_1} = K^{\mathrm{Re}gion\_1} \cdot \frac{1 \cdot UBP}{F_n^{CH}} \cdot \left(\frac{F}{F_k}\right)^2 \cdot c$$

$$K^{biome\_i} = \frac{BDP^{biome\_i}}{BDP\_settlement\_area\_biome5} = \frac{BDP^{biome5} \cdot ratio^{biome\_i}\_to\_biome5}{BDP\_settlement\_area\_biome5}$$

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LCIA MODEL
(per substance i, impact category j)

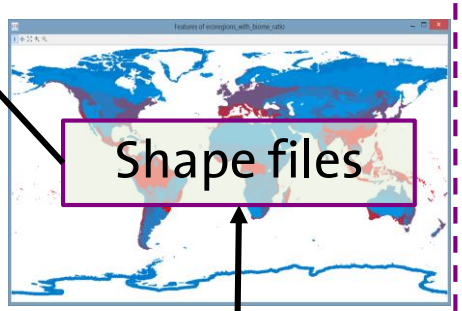
Site-independent parameters

Mathematical functions

Site-dependent parameters

Default value

Shape files



Impact factors

Impact category: total - Land use

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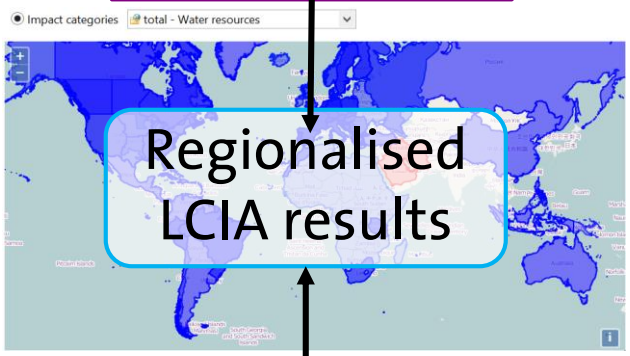
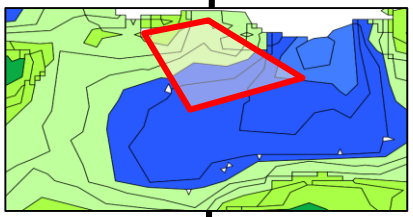
CF_{ijr}



Regionalised LCIA results



Inventory
(per substance i, location r)

KML data per location r

Case study: corn production, at farm gate

- Inventory:

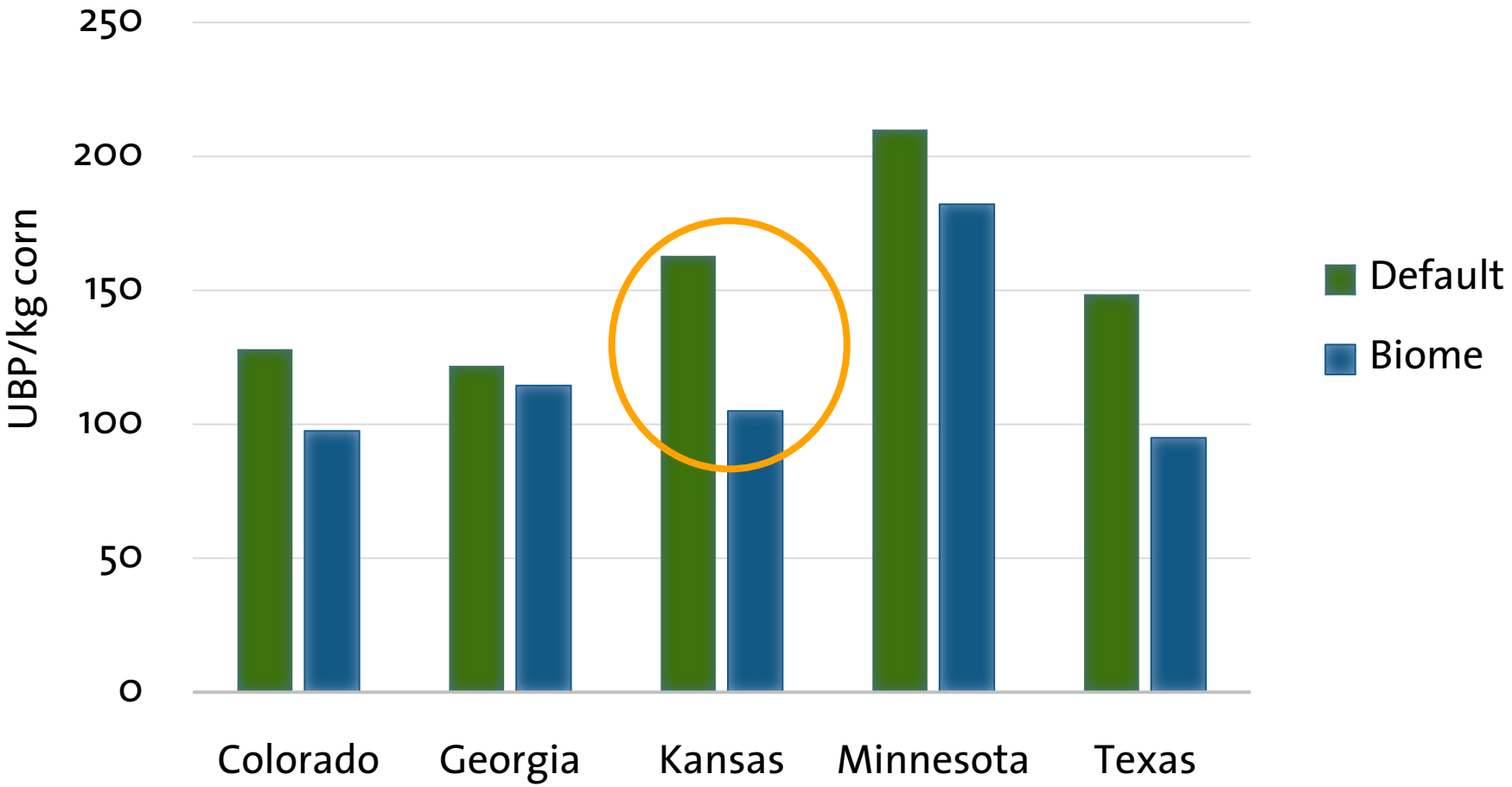
Functional Unit: 1kg corn grain, 85-91% moisture, at harvest Locations: Colorado, Georgia, Kansas, Minnesota and Texas		
System	**LCI data**	**KML data**
Foreground	USDA crop database	US Census Bureau
Background	ecoinvent 3.1 allocation, default	ecoinvent Geographies.xml

- Regionalised impact categories

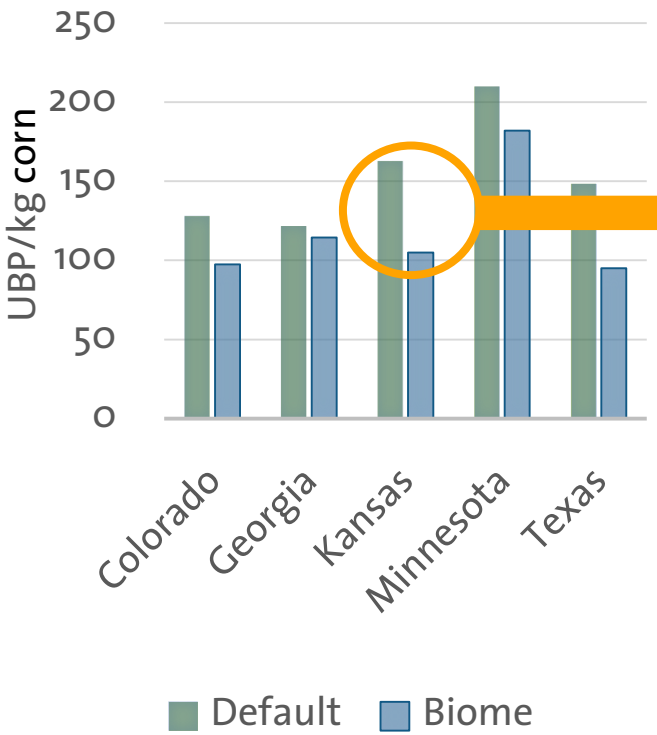
Impact category	LCIA method	Regionalised parameter
Land use	de Baan et al. (2012), as implemented in Ecological Scarcity 2013	Ratio of species densities of biomes 1 to 4 to species density in biome 5
Freshwater consumption	Ecological Scarcity 2013	Water stress index (WSI).

LCIA results: Land use

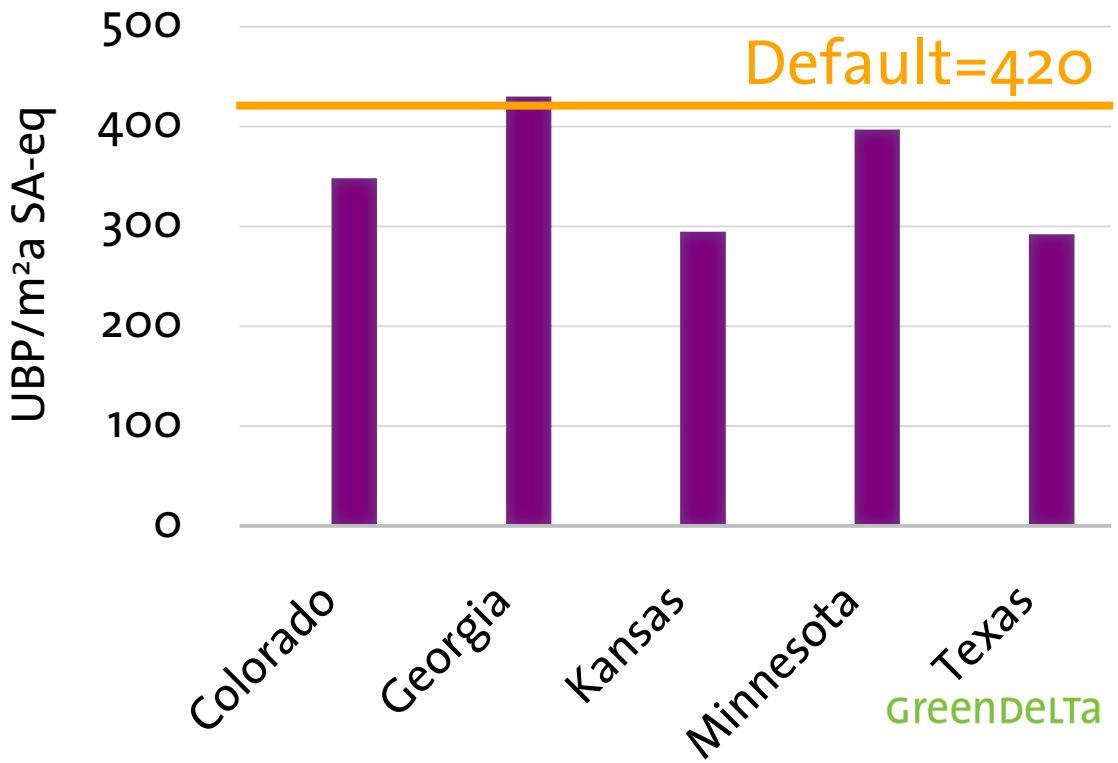
- Major contributor (>99%): corn grain production, at farm



LCIA results: Land use (II)



Characterisation factors
(Occupation, arable)



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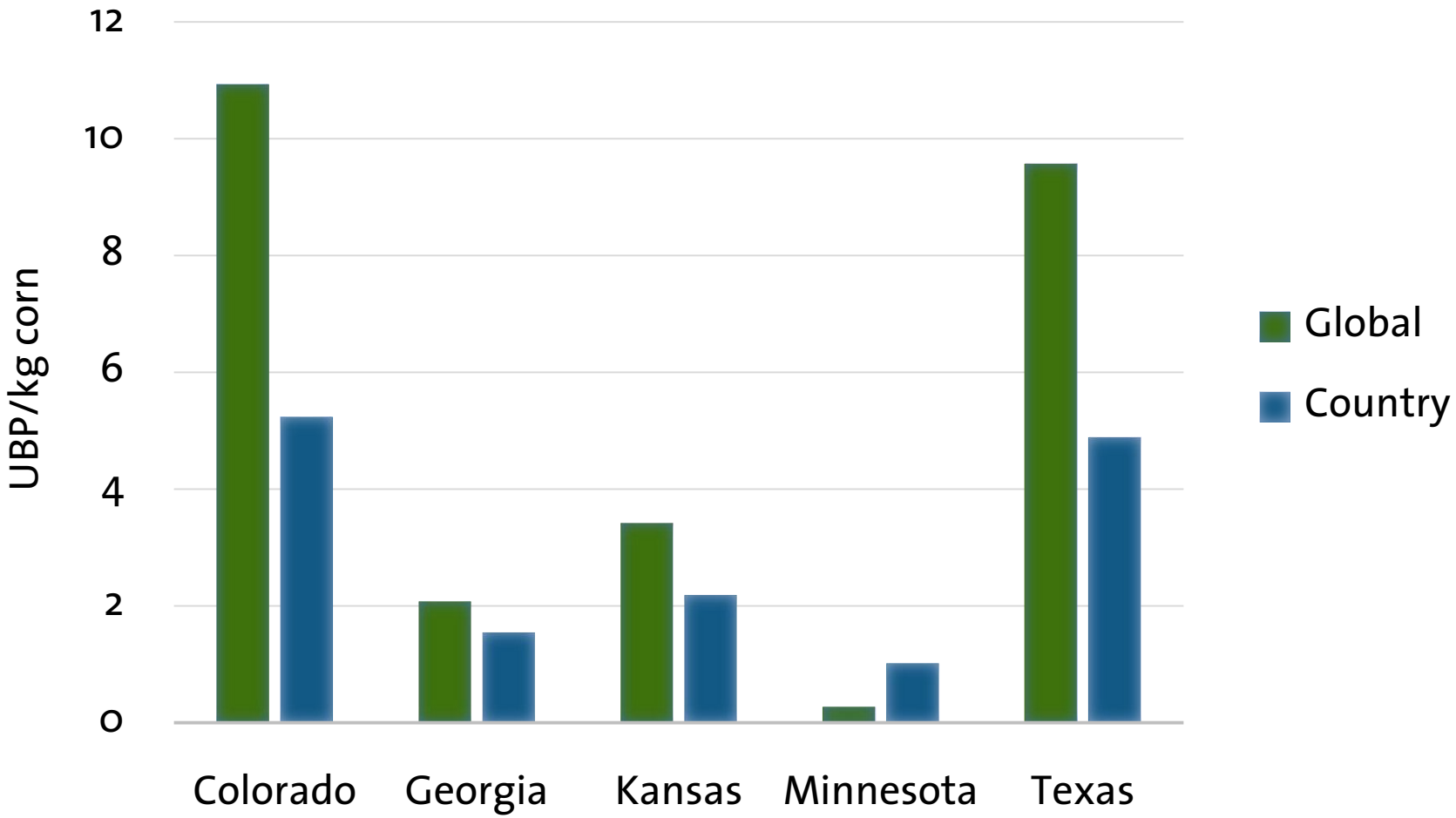
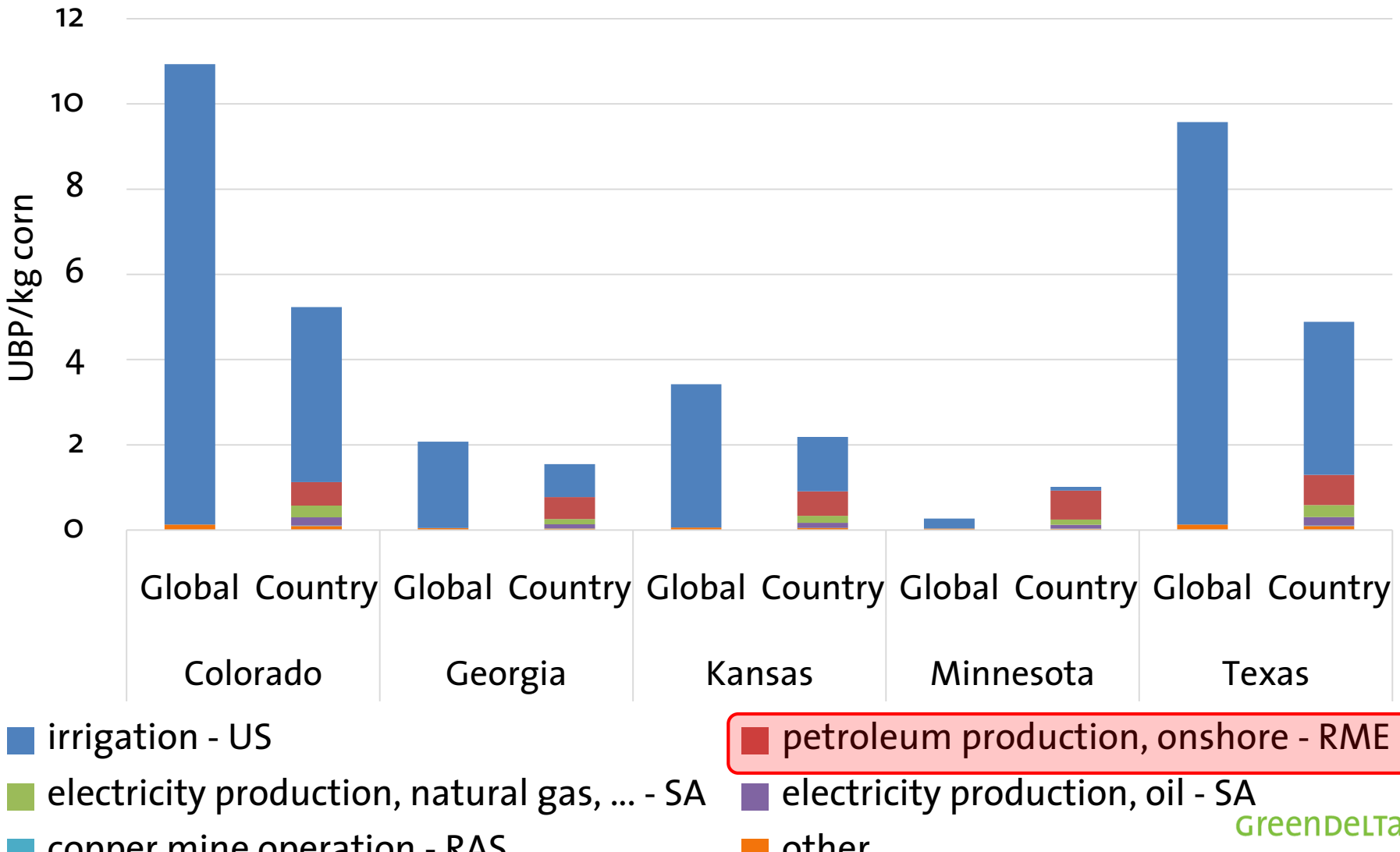
LCIA results: Freshwater consumption



Hotspots of freshwater consumption



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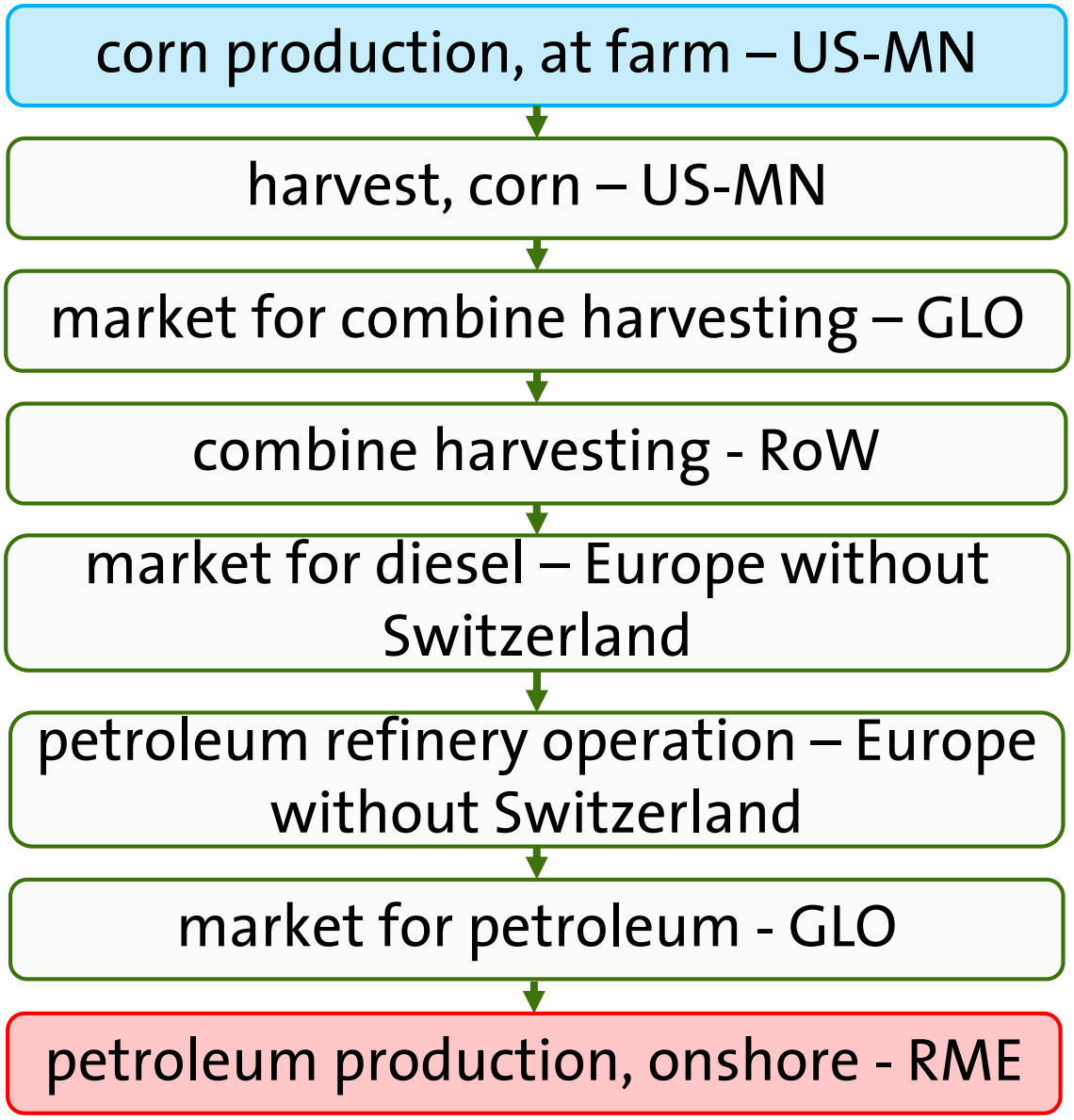
Where is the hotspot in the supply chain?



- Contribution to inventory: 0.11%
- Contribution to LCIA: 67%

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Proposal of improvement

- Should regionalised CFs be applied to flows from the background system?
  - Low inventory results may lead to high impact contributions
  - Spatial uncertainty distributions are not included in generic databases

→ The perspectives concept

The perspectives concept

Perspectives in LCA

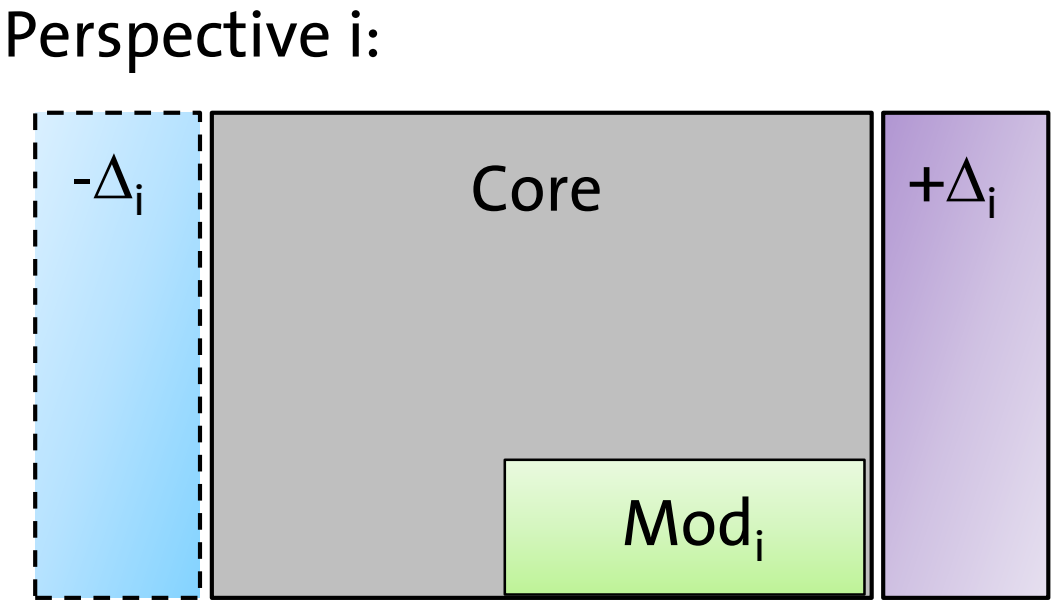
- LCIA: Hofstetter in 1998
  - “the cultural perspectives leading to models that depend on world views”

    → hierarchist, egalitarian and individualistic perspectives
  - Used in LCIA methods like ReCiPe or EcoIndicator

- LCI: Ciroth & Schebek in 2011
  - Modelling decisions may not fit for the specific case

    →Perspectives specify application contexts for data sets
  - Applied as proof of concept in the research project BioEnergieDat

Perspectives in LCI



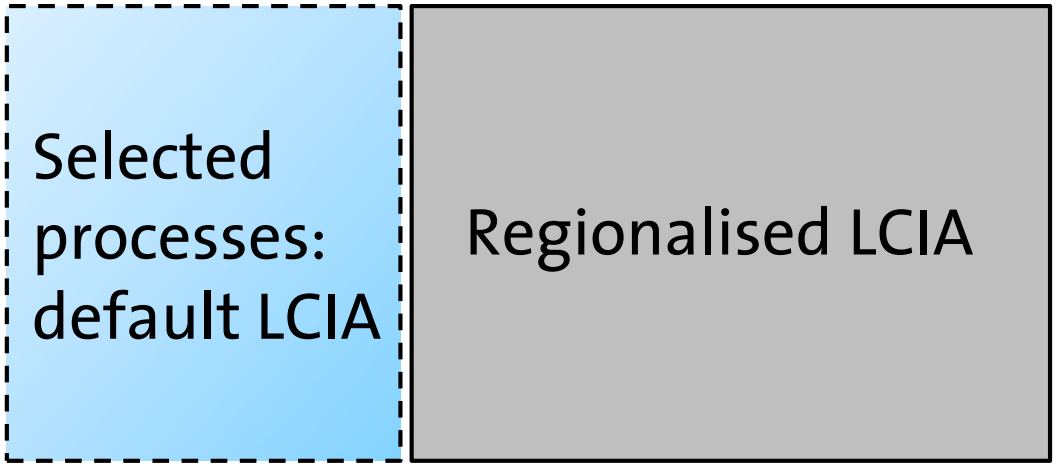
- Core: it contains aspects required by almost all perspectives
- Deltas: additions or omissions from the core
- Mods: modifications of aspects in the core (exceptions)

Perspectives applied to regionalised LCIA

- Fully regionalised perspective
  - Core: Regionalised LCIA

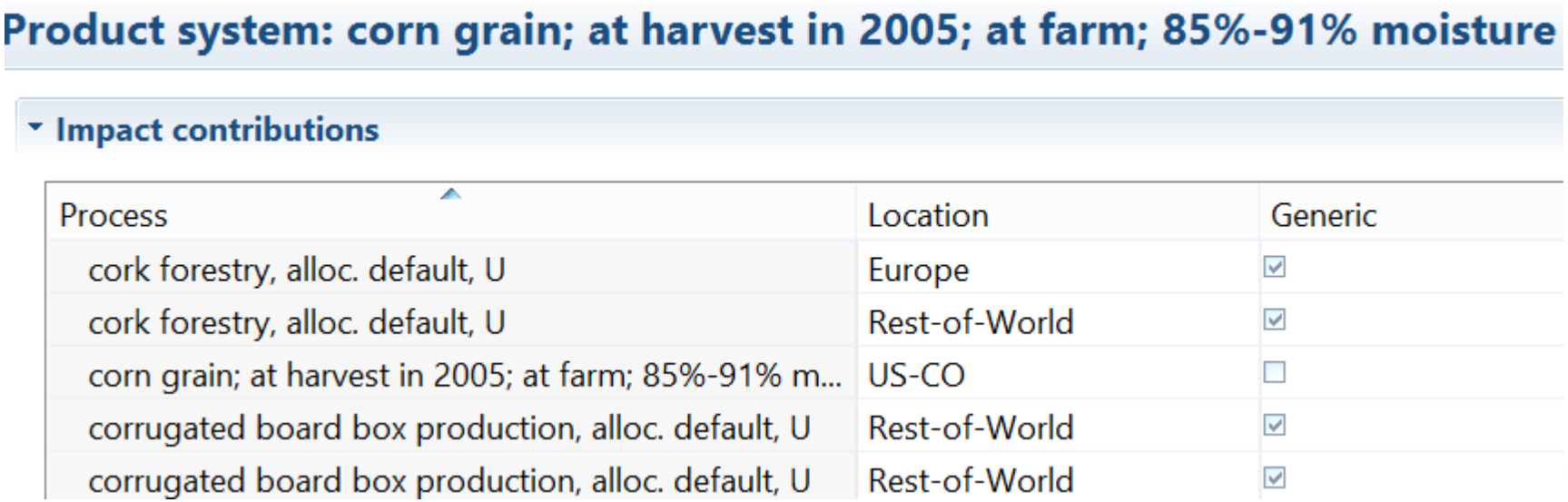
  → Regionalised CFs applied to all processes with a location defined
- Decision-making perspective
  - -Δ: Emissions from background datasets

  → Global CFs used for processes which location is not known by the user or do not contain spatial uncertainty



Perspectives implemented in openLCA

- Determine the type of CF (global, regionalised) to use depending on the dataset and product system
  - ❖ a dataset can be included in the background system of one study and in the foreground system of another
  - Specific editor containing all processes in the product system and their location

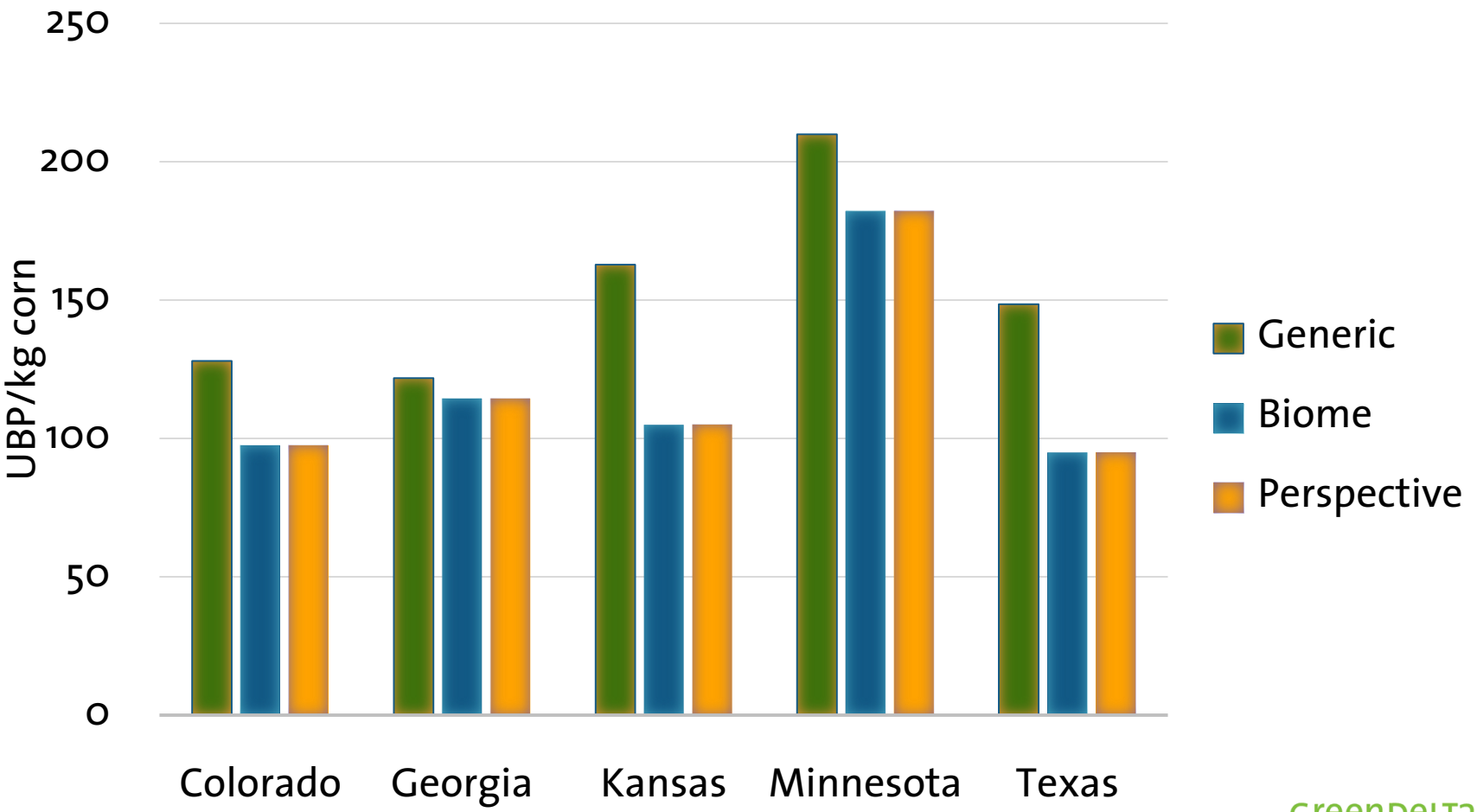


Perspectives implemented in openLCA (II)

- Determine the type of CF (global, regionalised) to use depending on the dataset and product system
  - Specific editor containing all processes in the product system and their location
  - In the model graph, it is possible to determine the “depth” in the supply chain where regionalised LCIA should be performed
  - Datasets can be identified by default as “background datasets” in the process level

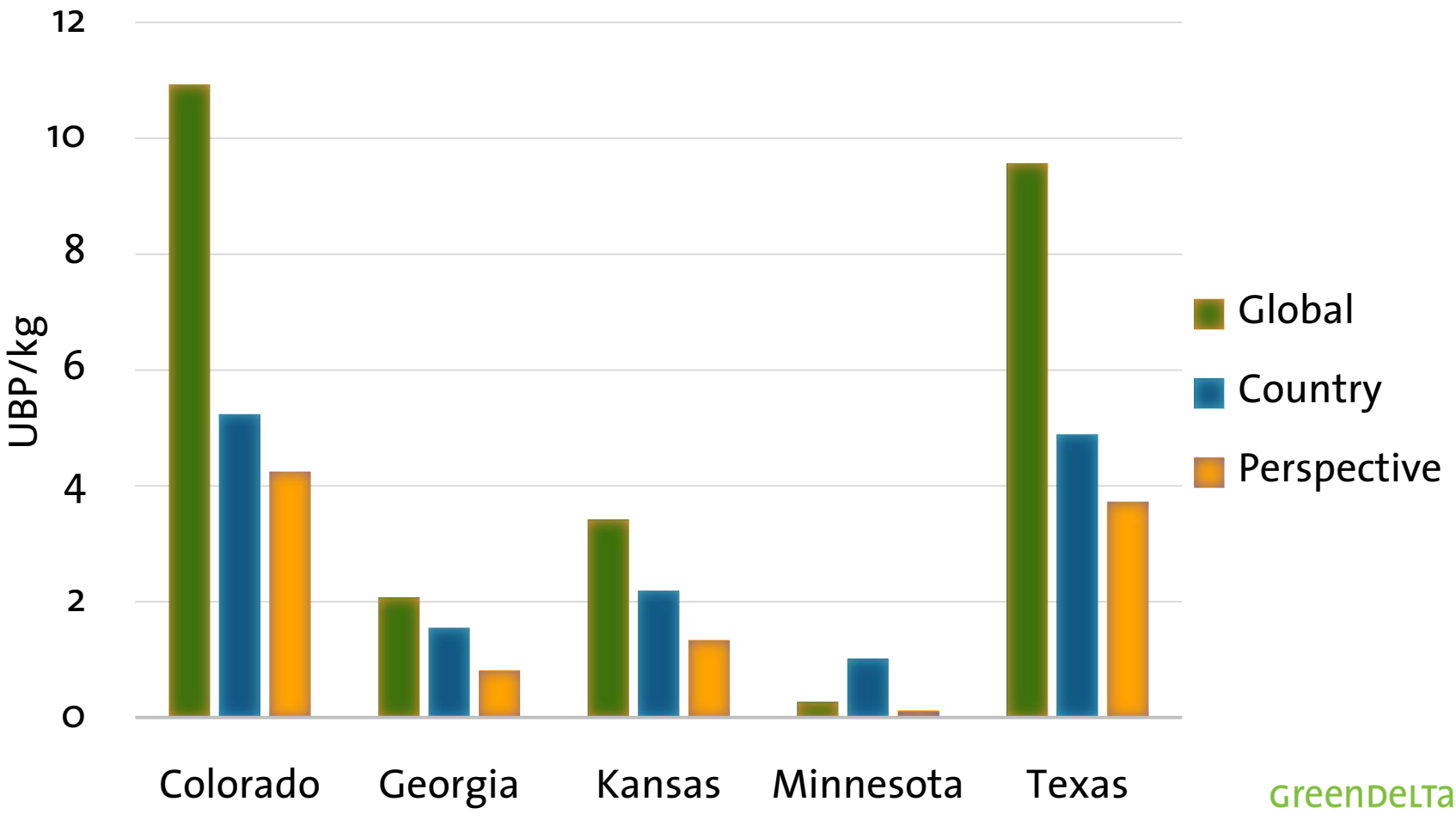
Case study results applying perspectives

- Land use



Case study results applying perspectives

- Freshwater consumption



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Conclusions and outlook

Conclusions

- Regionalised LCIA in openLCA works successfully without affecting significantly the calculation time required
  - Regionalised LCIA methods are welcome! (ideally, parameterised)
- Complexity added to the interpretation of results for decision-making
- The perspectives concept might be useful to adapt the LCIA calculation to the geographical relevance of each process

Next steps in software development

- Enhancement of uncertainty assessment of regionalised results

- Same regionalised parameters defined at different resolutions might be needed for a single product system

  →Ability to select the shape file (i.e. level of resolution) for a specific parameter depending on the process dataset

  - It will facilitate the use LCIA method developers own average estimations
  - Other option: weighted aggregations (e.g. emission proxies)

→Support welcome!

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Merci!

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