Regionalization Efforts in ecoinvent to Allow for Spatial Biodiversity Impact Assessment

LCA Discussion Forum

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Agenda

01 The Regionalization Challenge

02 Efforts at Inventory Level

03 Efforts at Impact Assessment Level

04 Conclusions and Further Plans

The Regionalization Challenge

Differences in Space

Activities/processes differ in space $\longrightarrow$ **different inventories in space**

- crop production with or without irrigation

- crop production with different yield/land use

Vulnerabilities/impacts differ in space $\longrightarrow$ **different characterization factors in space**

- different water scarcity in different watersheds

- different species richness in different ecozones

Currently, ecoinvent is limited in the former and does not make use of the latter.

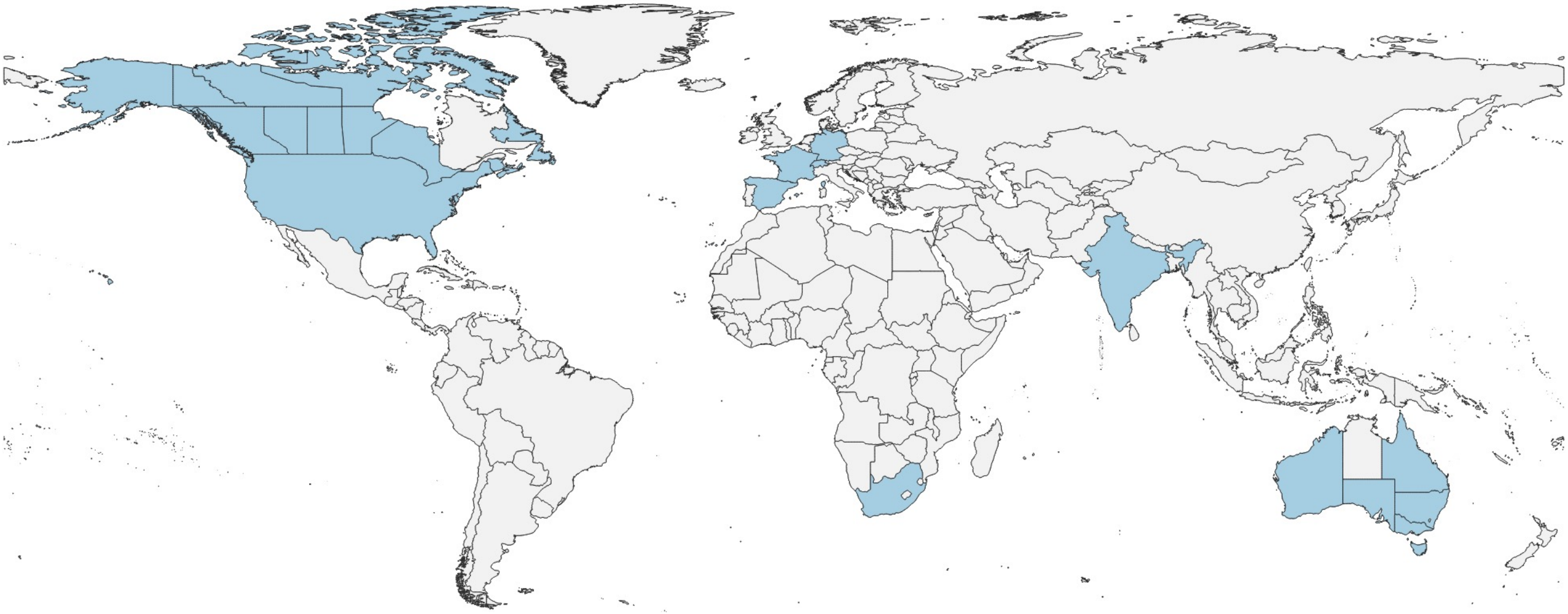
Efforts at Inventory Level

Regionalizing Inventories

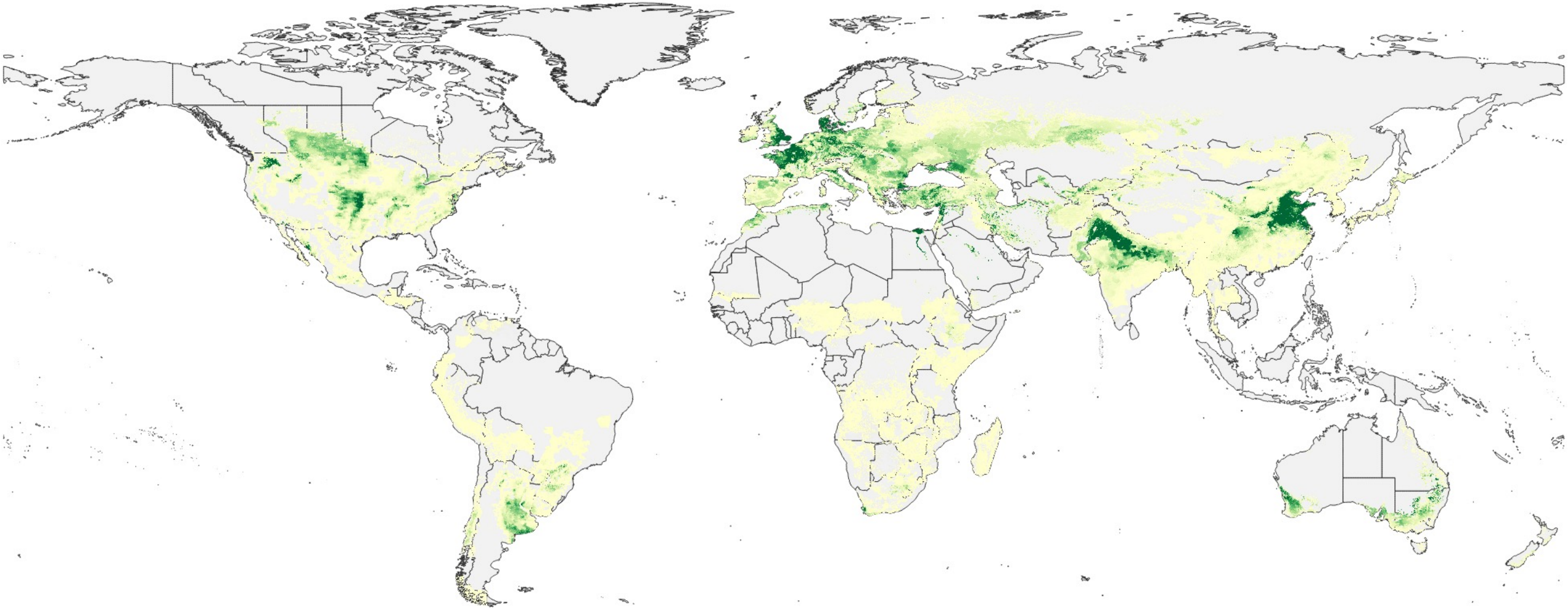
Different ways of regionalizing inventories

- Using regional data.
- Adapting available data to regional conditions: this can be a range from simple copy-paste using the regional electricity mix to having models for which parameters can be adjusted to local conditions (for example, irrigation type and amount).
- There are academic efforts to support regionalization of inventories, for example, using Input-Output tables (Peng and Pfister 2024) and trade data (“regioinvent” developed by Maxime Agez at CIRAIG).

Wheat Production in ecoinvent



Wheat Production Map (CROPGRIDS)



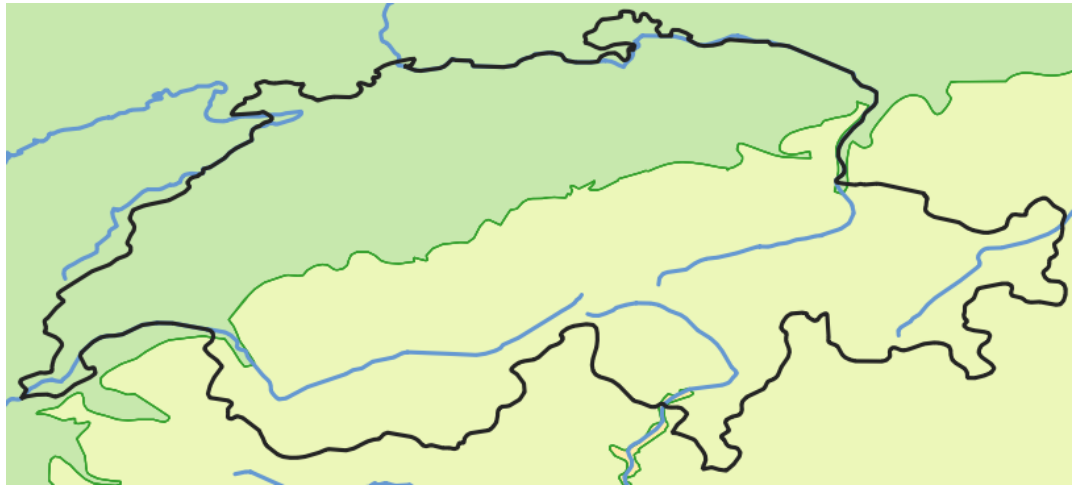
Efforts at Impact Assessment Level

General Approach: Weighting Maps

- The approach is based on Chris Mutel's work on regionalization; the latest publication can be found at https://eartharxiv.org/repository/view/5270/.
- The concept is not new and has been applied before, but – to our knowledge – not yet extensively and consistently to the ecoinvent database.
- Generally, maps representing an activity/process in space are used for weighting characterization factors at native spatial scale such as ecozones.
- These weighting maps
  - make the spatial distribution of inventories more explicit and
  - connect ecoinvent's spatial scale (countries/states) and the method's spatial scale (ecozones).

Different Native Spatial Scales

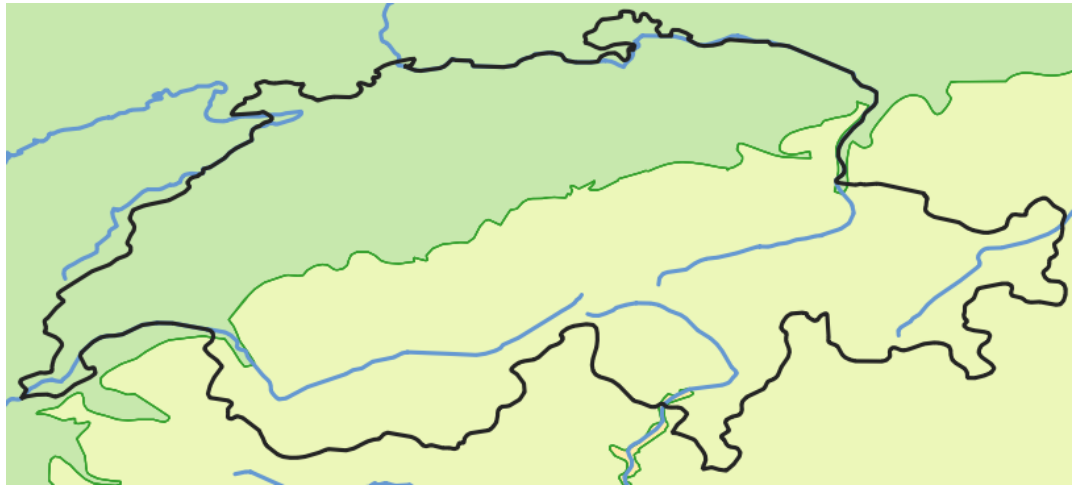
ecoinvent and ecozones



ecoinvent data only tells us in which country (or states) processes happen.

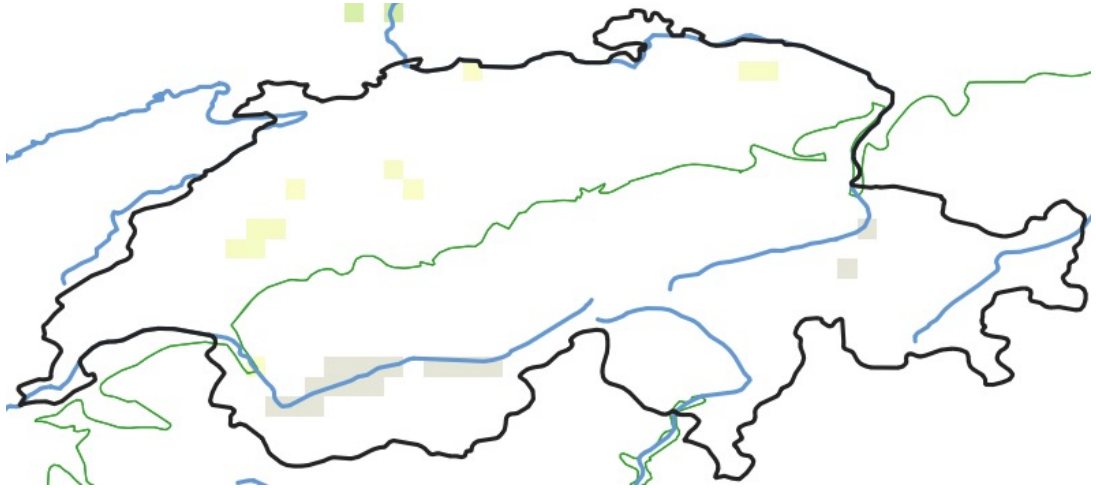
Connecting Spatial Scales: Weighting Maps

ecoinvent and ecozones



+

maize irrigated, area harvested



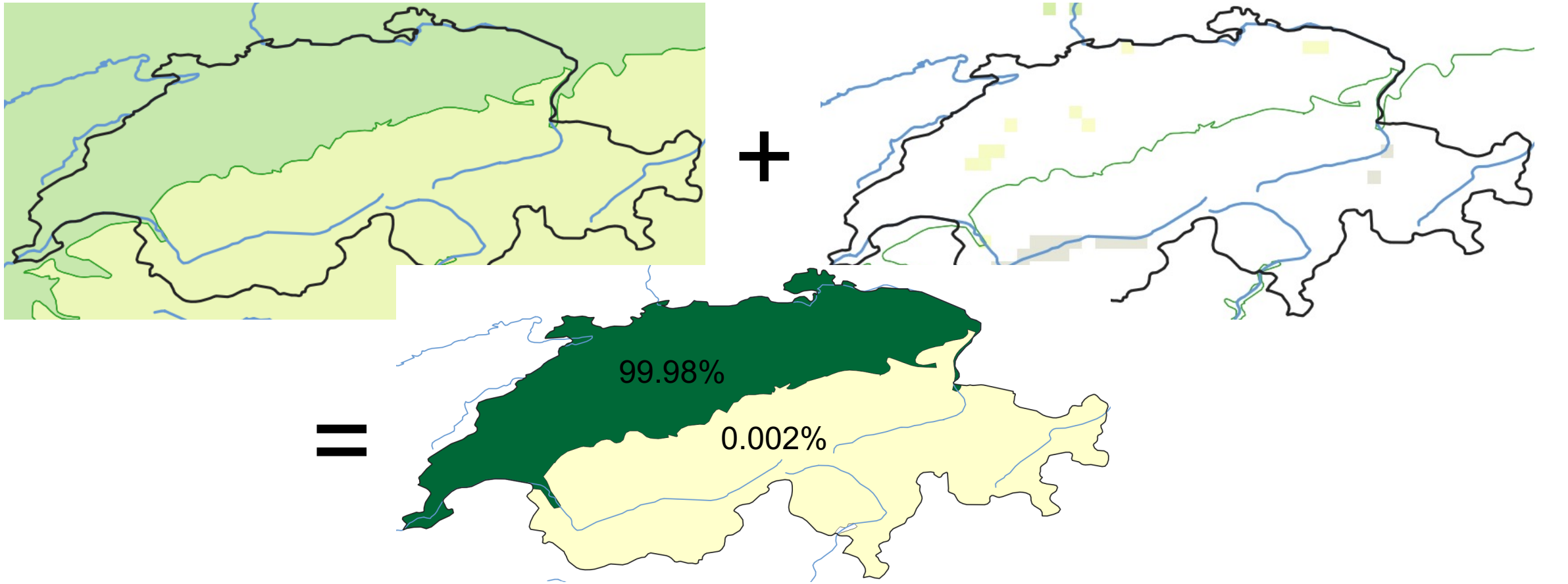
ecoinvent data only tells us in which country (or states) processes happen.

“weighting” maps tell us how much happens in which ecozone.

Weights for Calculating Regionalized CFs

ecoinvent and ecozones

maize irrigated, area harvested



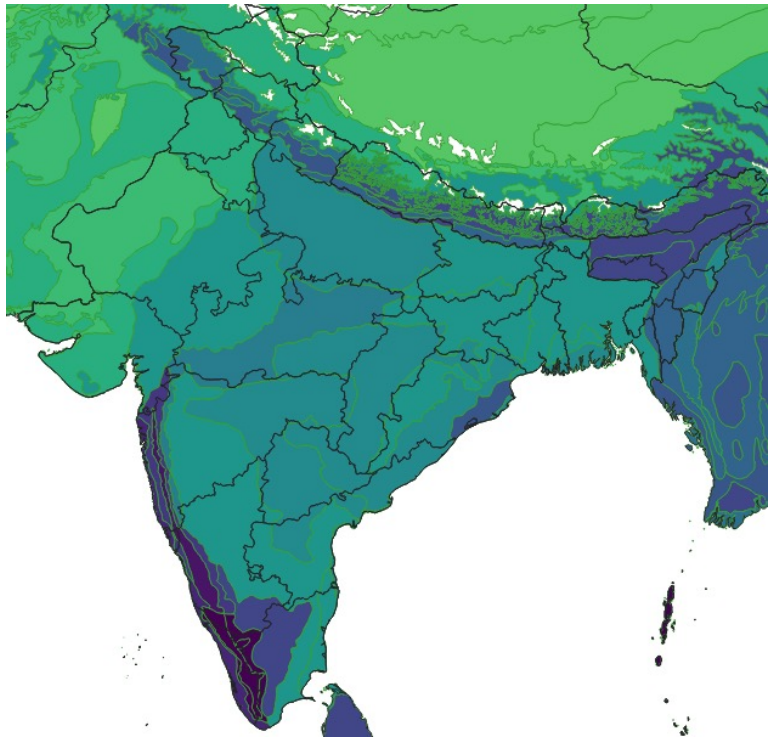
Regionalized CFs

- Weights for spatial intersections are calculated from weighting maps.
- These weights are used to calculate regionalized CFs.
- Ideally, these CFs are product- and elementary flow-specific (so potentially many weighting maps).
- Matrix calculations need to be adjusted for application of these CFs to the full ecoinvent database (regionalized CFs for a specific crop need to be applied to land use elementary flows in these specific crop production processes).

- There will be no regionalized elementary flows in inventories.
- Weights (per spatial intersection) can be made available for other users (or provided by them).

Regionalized CFs

CFs at native



Weights
(wheat irrigated, SPAM)

Regionalized CF

LCIA Results: Method

- Methods
  - There is a line of methods from *de Baan et al. 2013 to Chaudhary et al. 2015* to *Chaudhary & Brooks 2018*.
  - For now, we used ***Chaudhary et al. 2015*** as recommended by the Life Cycle Initiative.
- Occupation and transformation
  - For now, **occupation only**.
  - Transformation can be implemented following recommendations in ReCiPe 2016, which is only transformation *from* natural land.
- Average and marginal CFs: we used **average CFs**.
- CFs for different taxa: we used **taxa aggregated CFs**.

LCIA Results: Implementation

- We have calculated CFs for the 5 major crops (maize, rice, soybean, sugarcane, wheat) using crop specific maps.
- For everything else (“background”) we have used population density for calculating weights (logic: things happen where people live).

Example Results: Wheat, Irrigated

Process	Geography	Score with global CF	Score with regionalized CFs	Regionalized score/GLO score
wheat grain production, Swiss integrated production, extensive	CH	6.51	0.47	7%
wheat grain production, Swiss integrated production, intensive	CH	5.40	0.4	7%
wheat grain production	DE	6.69	0.7	10%
wheat grain production	FR	6.83	0.93	14%
wheat grain production	US	20.05	3.36	17%
wheat grain production	ES	12.77	3.01	24%
wheat grain production	IN	3.90	1.7	43%
wheat grain production	ZA	11.37	7.01	62%
wheat grain production	GLO	12.96	13.09	99%

Conclusions and Further Plans

Conclusions and Further Plans

Inventories

- Getting regionalized data is hard.
- We aim to adapt existing data to regional conditions by using models in inventory creation.

Impact Assessment

- The presented approach is feasible, but laborious. Hence our plan is
  - to start from global maps that we know (*a* map is better than no map);
  - to focus on water/land use and on agriculture and electricity first;
  - to use population density as a default weighting map for remaining processes;
  - to add and improve weighting maps over time.
- **Users will profit from better scores with every step we take.**
- **Collaboration in the community should be around weighting maps.**

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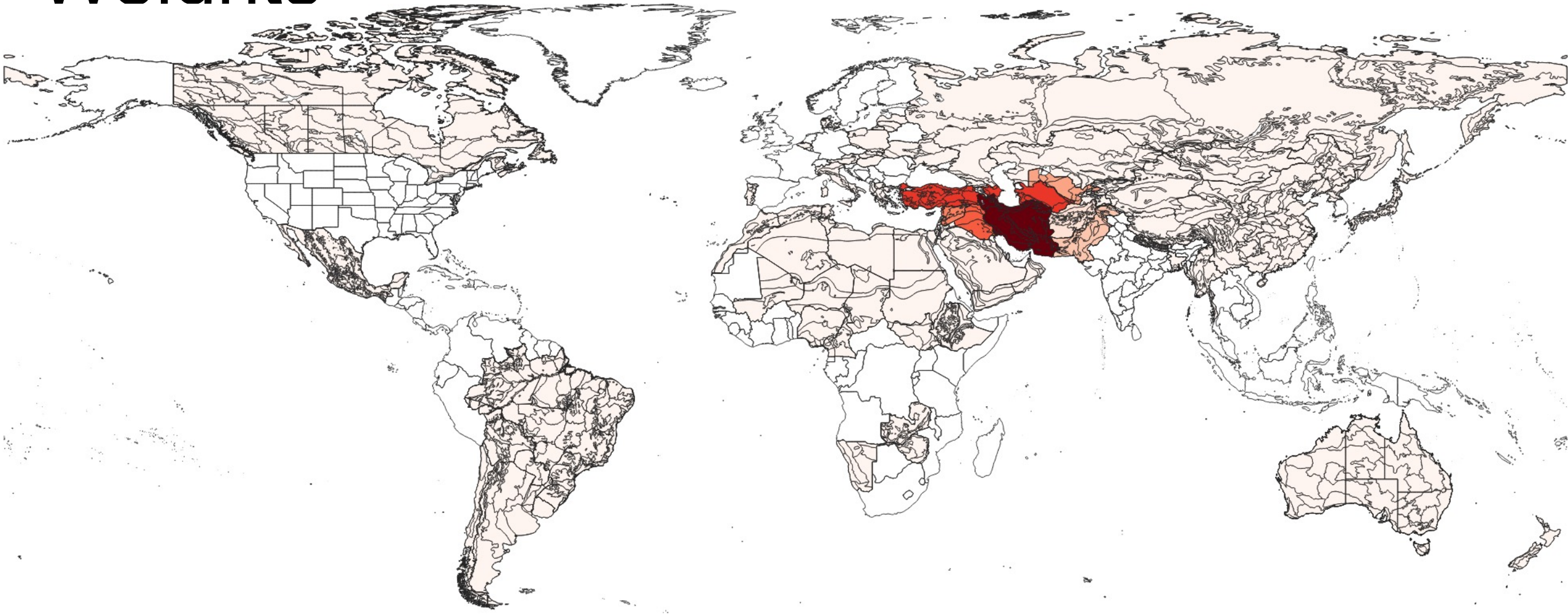
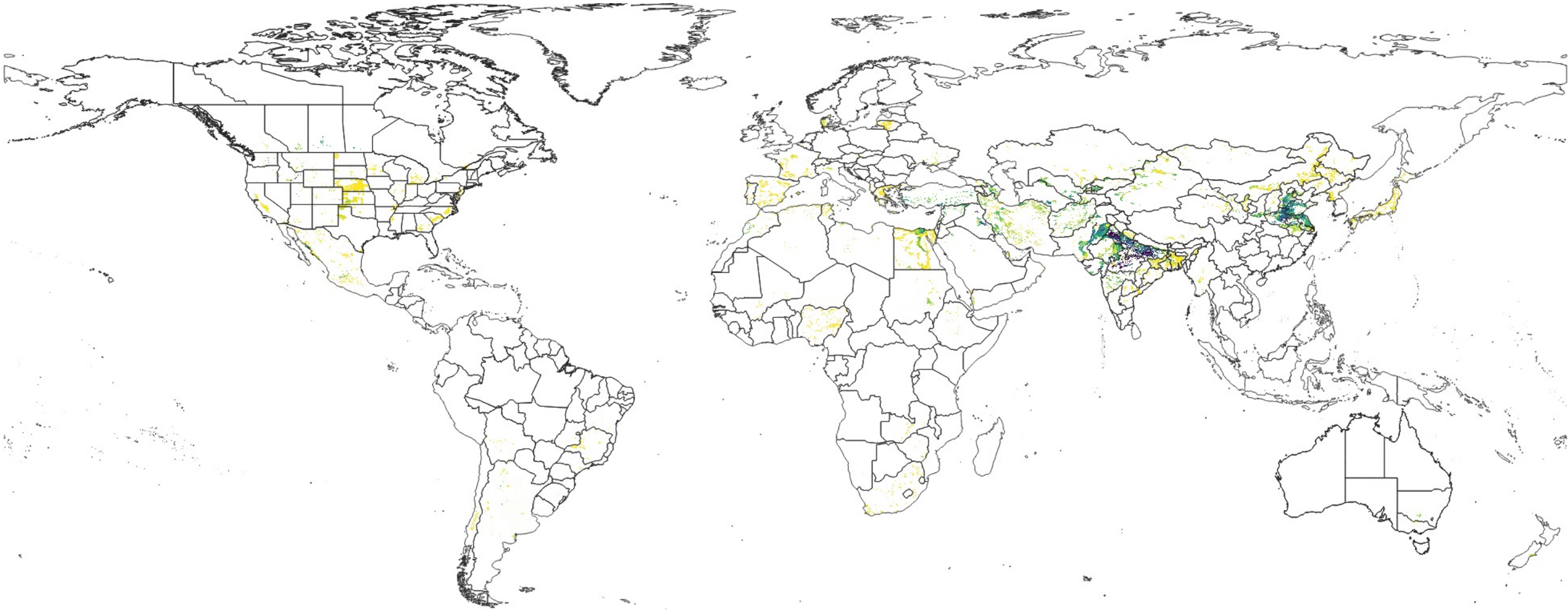
Backup Slides

Example of Current Coverage in ecoinvent

process	geography	irrigation	product
wheat grain production	AU-NSW	FALSE	wheat grain
wheat grain production	AU-QLD	FALSE	wheat grain
wheat grain production	AU-SA	FALSE	wheat grain
wheat grain production	AU-TAS	FALSE	wheat grain
wheat grain production	AU-VIC	FALSE	wheat grain
wheat grain production	AU-WA	FALSE	wheat grain
wheat grain production	Canada without Quebec	FALSE	wheat grain
wheat grain production	DE	TRUE	wheat grain
wheat grain production	ES	TRUE	wheat grain
wheat grain production	FR	TRUE	wheat grain
wheat grain production	GLO	TRUE	wheat grain
wheat grain production	IN	TRUE	wheat grain
wheat grain production	US	TRUE	wheat grain
wheat grain production	ZA	TRUE	wheat grain
wheat grain production, Swiss integrated production, extensive	CH	TRUE	wheat grain
wheat grain production, Swiss integrated production, intensive	CH	TRUE	wheat grain

Regionalized CFs: Global Weights





Learnings

Impact assessment

- There are discrepancies between ecoinvent and weighting maps, for example, crop maps have no data for irrigated production while the ecoinvent process includes irrigation.
- There are issues with global markets (for seeds or drying, for example) that feed into regional processes (as they dominate results).
  - Solution: regionalizing these markets on the inventory side.