PAUL SCHERRER INSTITUT

Chris Mutel :: Paul Scherrer Institut

Regionalized life cycle assessment in Brightway2

LCA Discussion Forum 69 Sept. 13, 2018

1. Convert inventory information

Convert names and locations to ecoinvent 3.5

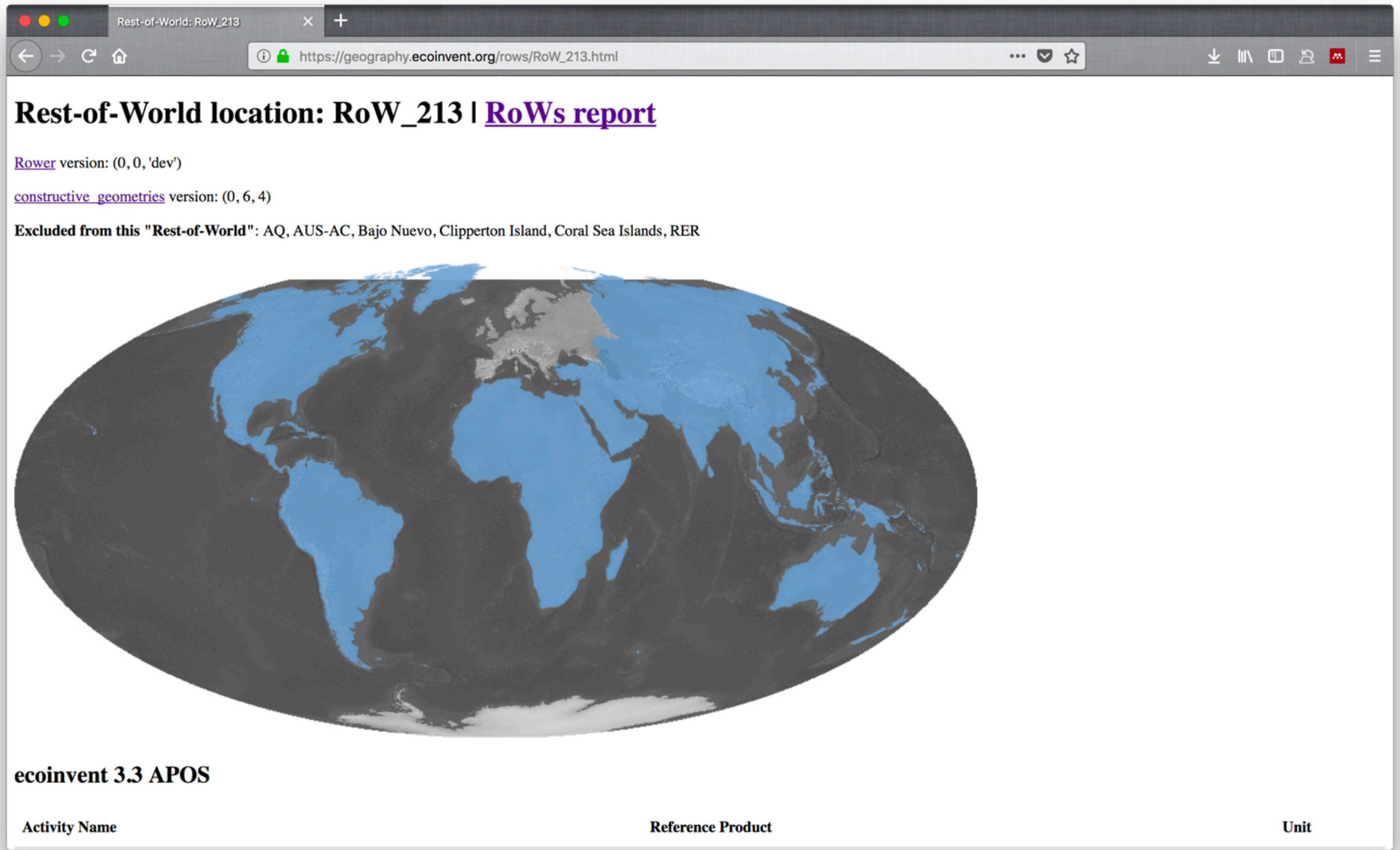
Copy/paste into “standard” BW2 template

Import and link against ecoinvent 3.5

	A	B	C	D	E	F	G	H
1	**Activity**	white rice, from dry milling,						
2	code	Dry milling US						
3	location	US						
4	production amount							
5	type	process						
6	unit	kilogram						
7								
8	**Exchanges**							
9	**name**	**amount**		**reference product**	**unit**	**database**	**location**	**type**
10	white rice, from dry milling, at plant		1		kilogram	AWARE Case Study	US	production
11	treatment of wastewater from maize starch pro		0.00097446		m3	ecoinvent 3.5 cutoff	RoW	production
12	rice production		1.3441	rice	kilogram	ecoinvent 3.5 cutoff	US	technosphere
13	heat production, natural gas, at industrial furna		1.0551		MJ	ecoinvent 3.5 cutoff	RoW	technosphere
14	transport, freight, lorry >32 metric ton, EURO3		0.067204		tkm	ecoinvent 3.5 cutoff	RER	technosphere
15	market for tap water		0.00097446		kg	ecoinvent 3.5 cutoff	RoW	technosphere
16	market group for electricity, medium voltage		0.17137		kWh	ecoinvent 3.5 cutoff	US	technosphere
17								
18	**Activity**	white rice, packed, at plant						
19	code	Packed rice US						
20	location	US						
21	production amount		1					
22	type	process						
23	unit	kilogram						
24								
25	**Exchanges**							
26	**name**	**amount**		**reference product**	**unit**	**database**	**location**	**type**
27	white rice, packed, at plant		1		kg	AWARE Case Study	US	production
28	white rice, from dry milling, at plant		1		kilogram	AWARE Case Study	US	technosphere

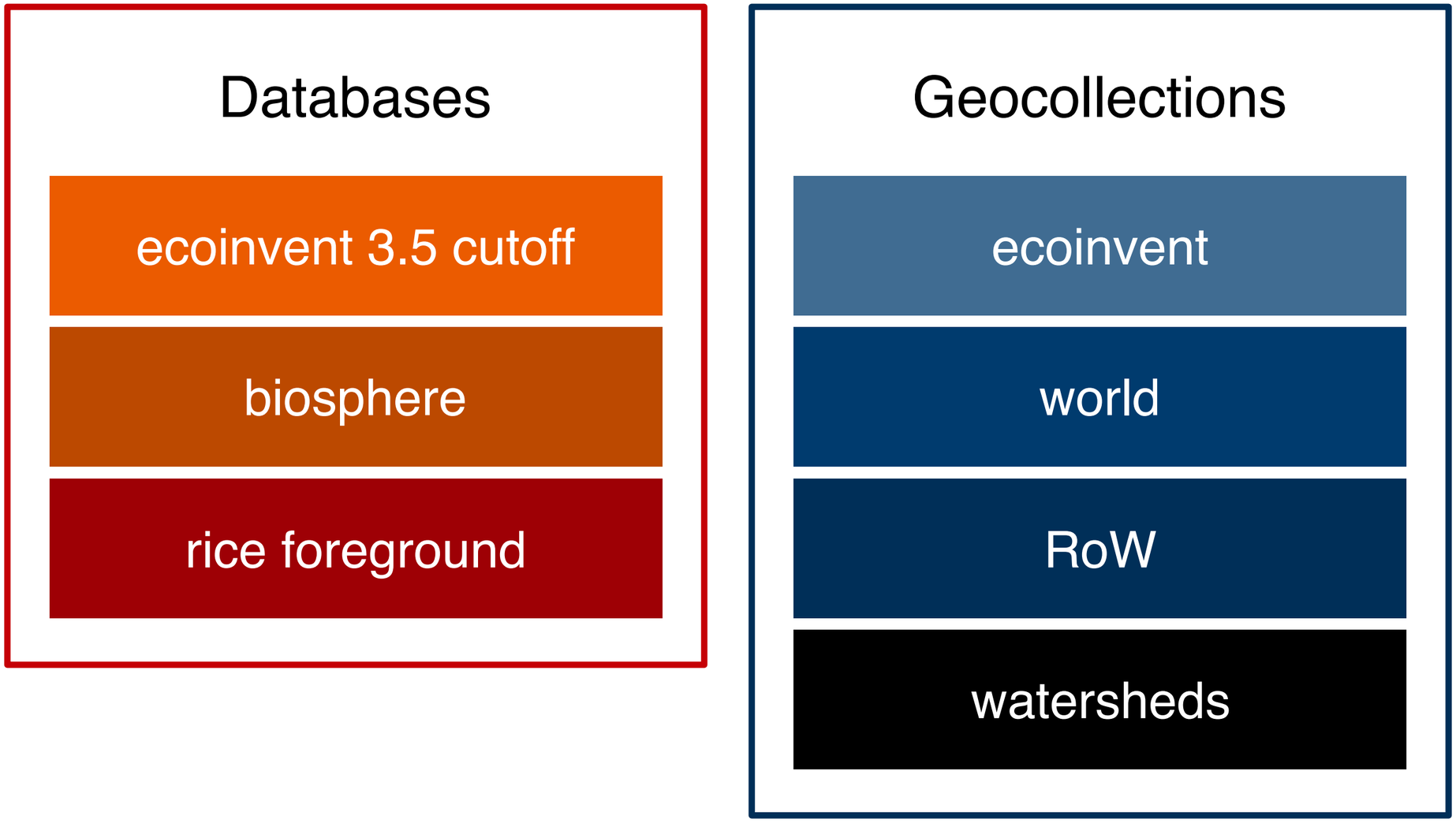
rice CN | rice US | +

2. Label ecoinvent Rest-of-Worlds

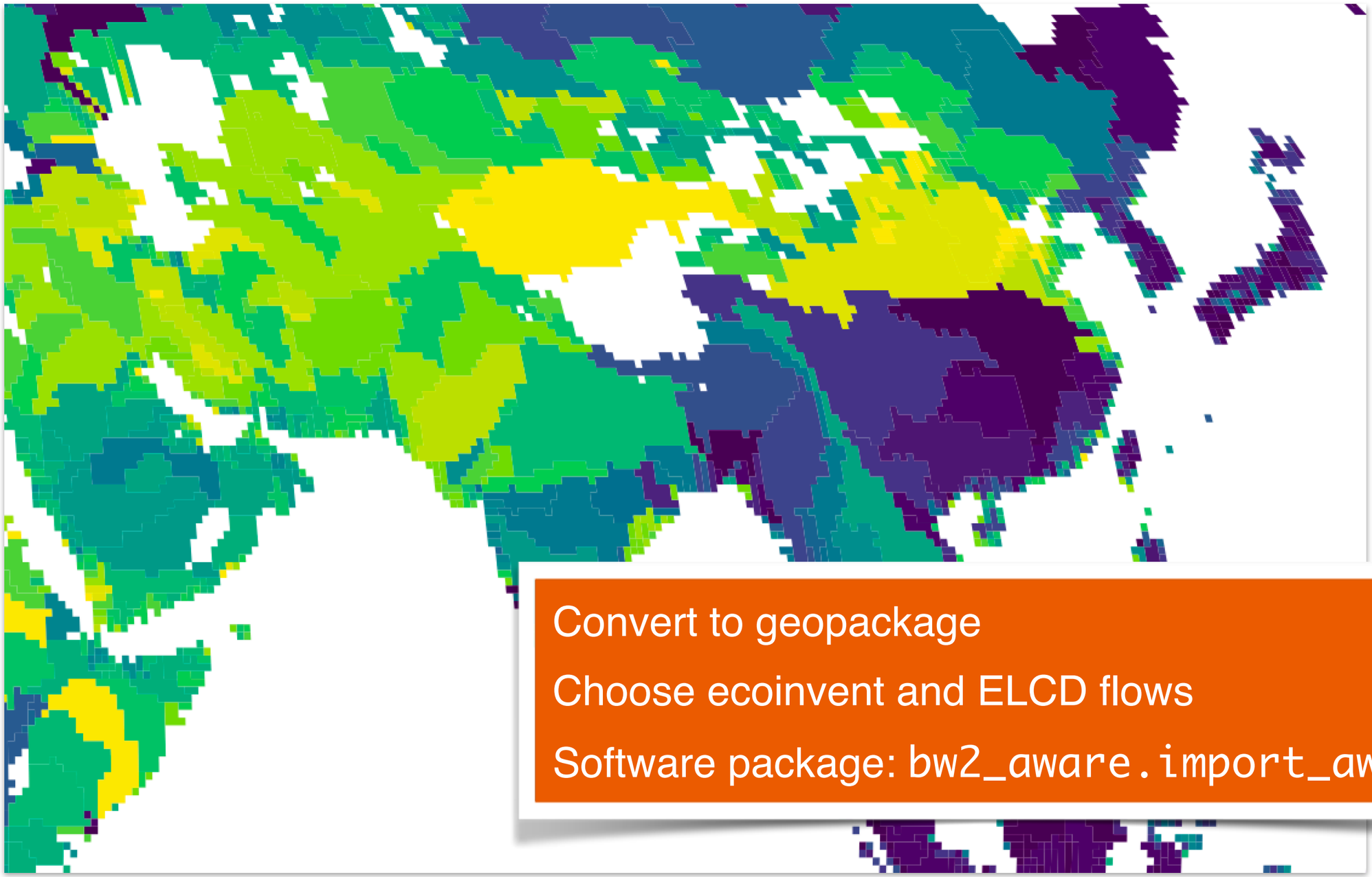


https://geography.ecoinvent.org/rows/

3. Label geocollections



4. Convert and import AWARE



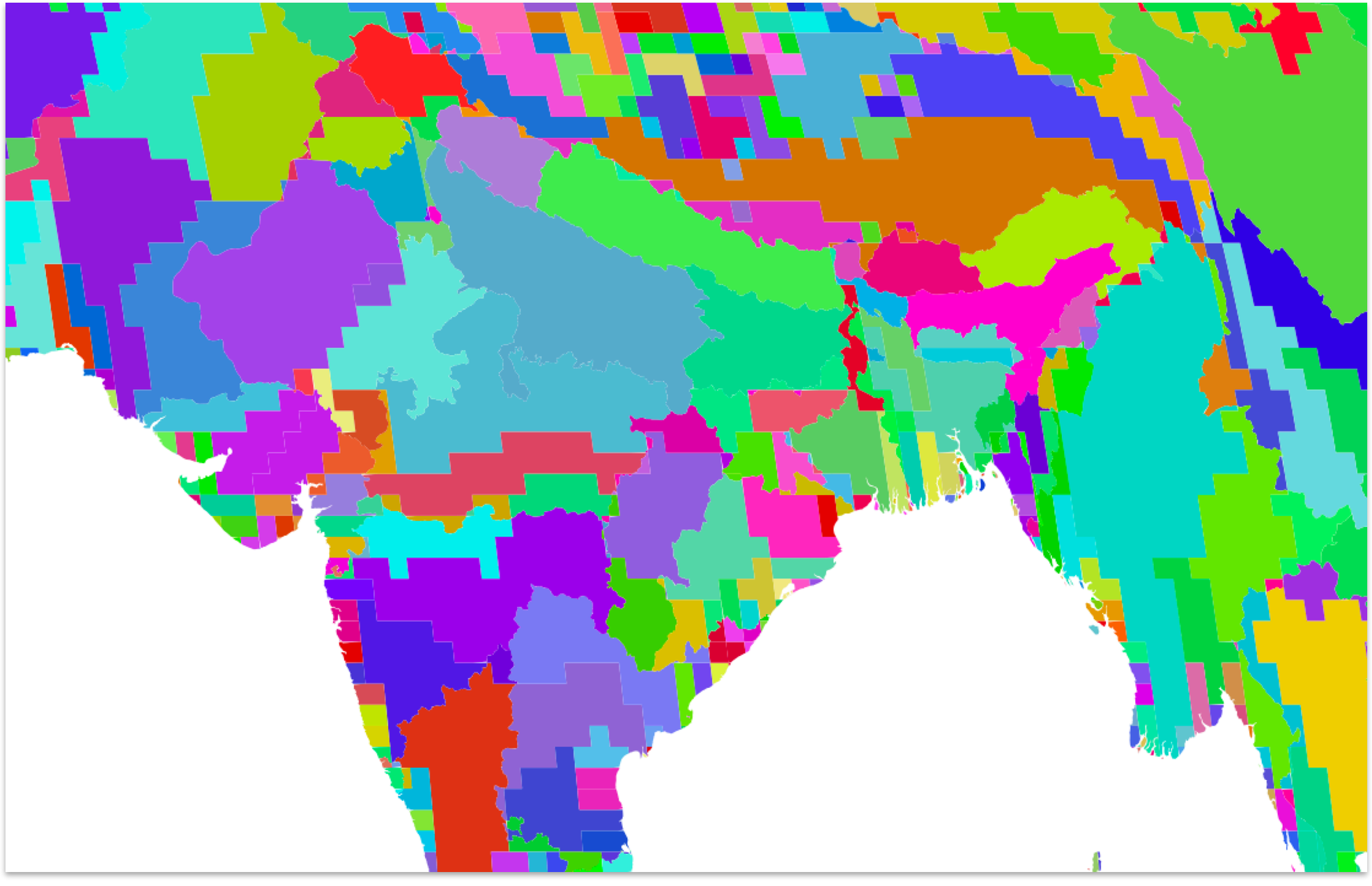
Convert to geopackage

Choose ecoinvent and ELCD flows

Software package: `bw2_aware.import_aware()`

https://github.com/cmutel/bw2_aware

5. Calculate intersection of inventory and IA scales



5. Calculate intersection of inventory and IA scales

Open source web service:

https://pandarus.brightwaylca.org/

https://github.com/cmutel/pandarus

JOSS
The Journal of Open Source Software

Pandarus: GIS toolkit for regionalized life cycle assessment

Chris Mutel[1]

1 Paul Scherrer Institut

DOI: 10.21105/joss.00244

Software

- Review
- Repository
- Archive

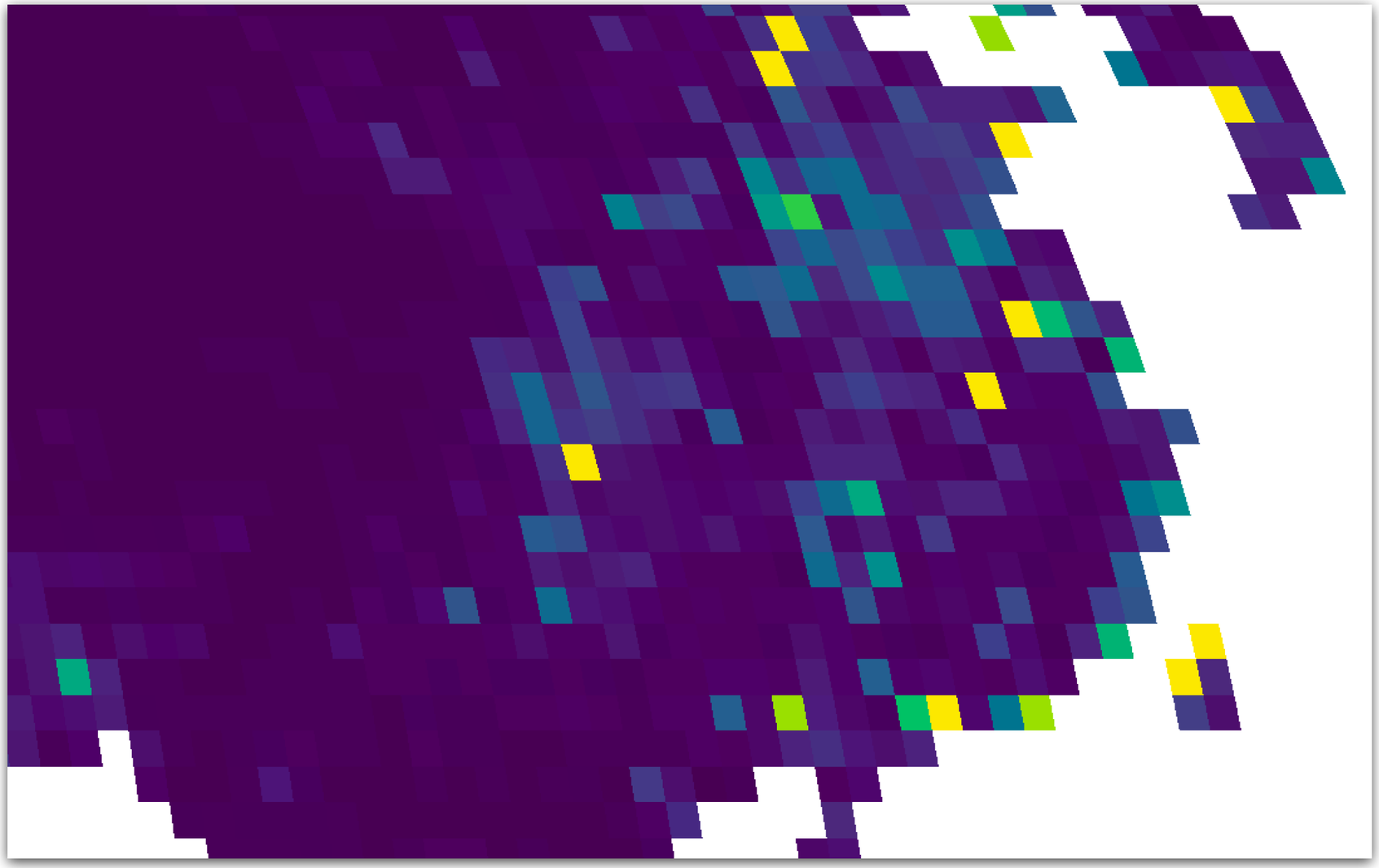
Summary

Pandarus is a GIS toolkit for regionalized life cycle assessment (LCA). It is designed to work with brightway LCA framework (Mutel 2012), brightway2-regional (Mutel 2014), and Constructive Geometries (Mutel 2015). A separate library, pandarus-remote (Mutel 2016), provides a web API to run Pandarus on a server.

In the context of life cycle assessment, regionalization means the introduction of detailed spatial information for inventory activities and impact assessment characterization maps. As these will have different spatial scales, GIS functionality is required to overlay these two maps. Pandarus can do the following:

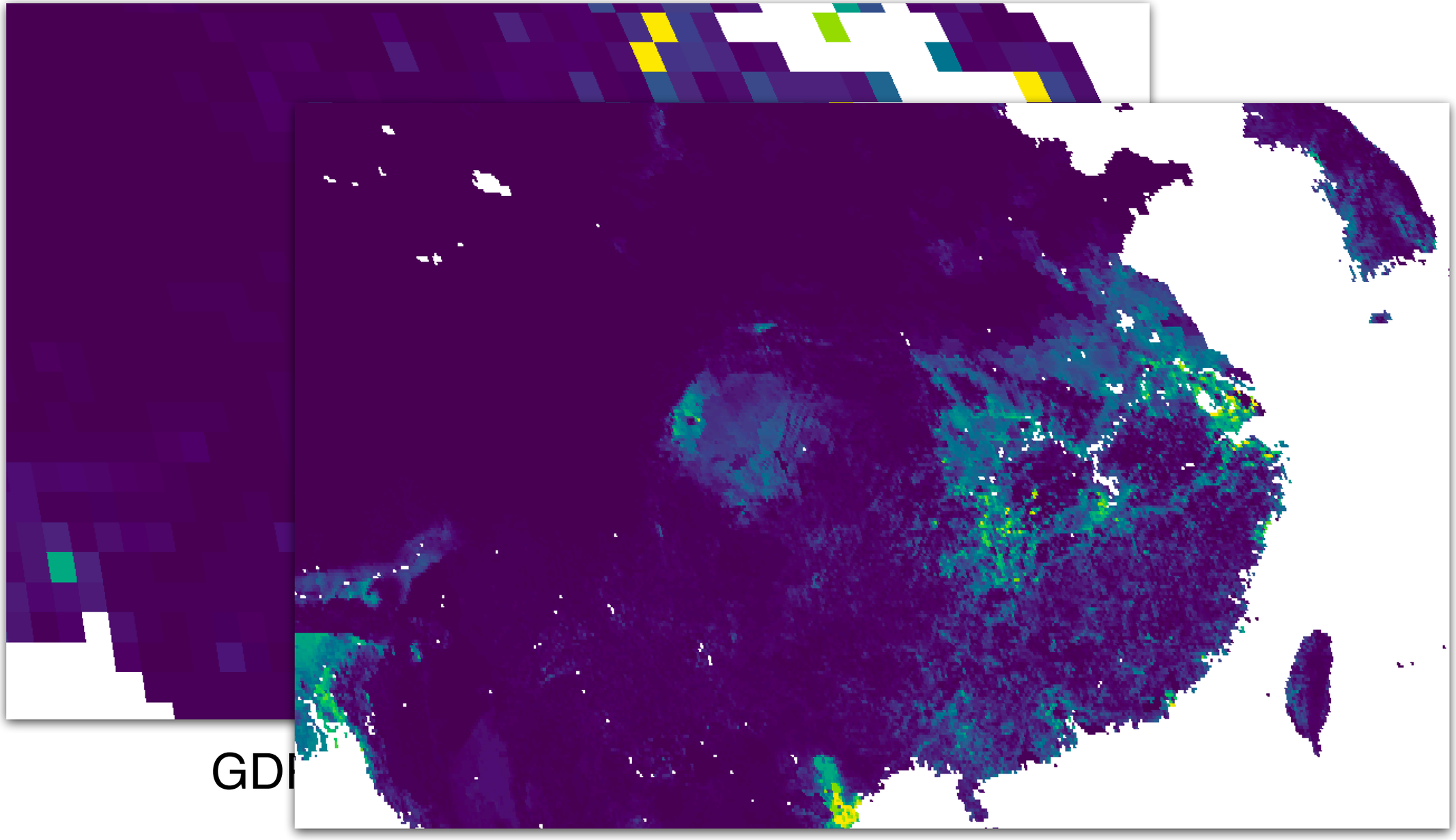
- Overlay two vector datasets, calculating the areas of each combination of features using the Mollweide projection.
- Calculate the area of the geometric difference (the areas present in one input file but not in the other) of one vector dataset with another vector dataset.

6. Choose detailed spatial scale



GDP-weighted population density

6. Choose detailed spatial scale



GDI

Rice intensity

7. Map activities to different spatial scales

Include:

- Rice intensity map
- Agricultural average characterisation factors

```
irrigation = [x for x in bw.Database("ecoinvent 3.5 cutoff")
              if x['name'] == 'irrigation']

rice_production = [x for x in bw.Database("ecoinvent 3.5 cutoff")
              if x['name'] == 'rice production']
```

Exclude:

GDP-weighted population density map

Non-agricultural average characterisation factors

8. Do regionalized calculations

$$h_r = \left[\mathrm{MN}_{dx}\mathrm{DXN}_g\mathrm{GR}\right]^T \circ [\mathrm{B} \cdot (\mathrm{A}^{-1} f)]$$

Inventory

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Inventory

Mapping

Inventory Processes to

Inv. Spatial Units

(1 or 0)

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Normalization

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Distribution

Inv. Spatial Units to

Extension Spatial Unit

(area)

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Extension tables values

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Extension tables values

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(area)

Geographic Transform

Extension Spatial Unit to

LCIA Spatial Units

(area)

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Inventory Processes to

Inv. Spatial Units

(1 or 0)

Extension Table

Extension tables values

Regionalized LCIA

Regionalized CFs

Distribution

Inv. Spatial Units to

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(area)

Geographic Transform

Extension Spatial Unit to

LCIA Spatial Units

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Processes

Flows

Processes

Flows

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$$h_r = \left[\mathrm{MN}_{dx}\mathrm{DXN}_g\mathrm{GR}\right]^T \circ \left[\mathrm{B} \cdot (\mathrm{A}^{-1} f)\right]$$

Processes

Flows $\begin{bmatrix} & \\ & \end{bmatrix}$

Processes

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$$h_r = \mathrm{R}^T \circ \left[\mathrm{B} \cdot (\mathrm{A}^{-1} f)\right]\mathrm{MN}_{dx}\mathrm{DXN}_g\mathrm{G}$$

IA spatial scale

Flows $\begin{bmatrix} & \\ & \end{bmatrix}$

IA spatial scale

Flows $\begin{bmatrix} & \\ & \end{bmatrix}$

Results

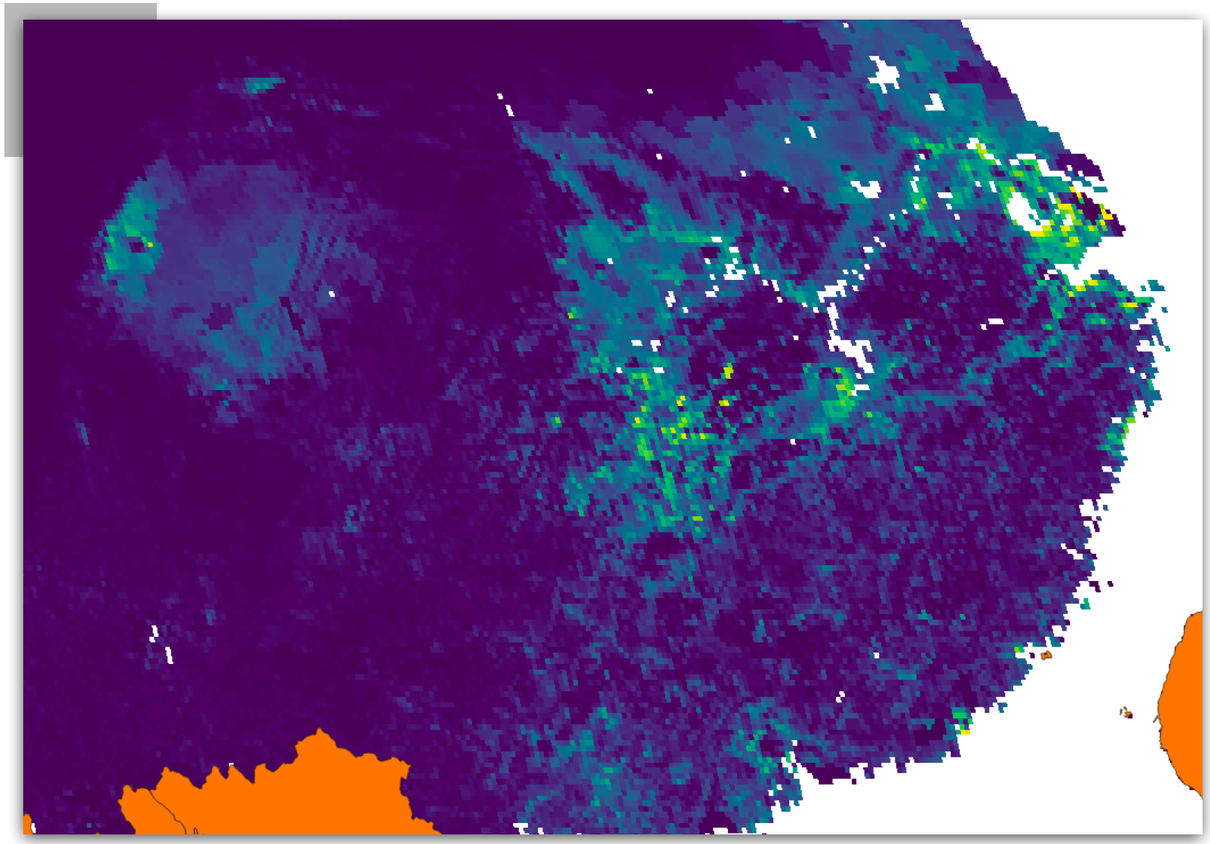
Rice consumed in China: 2.27 AMD

Rice consumed in Switzerland: 10.1 AMD

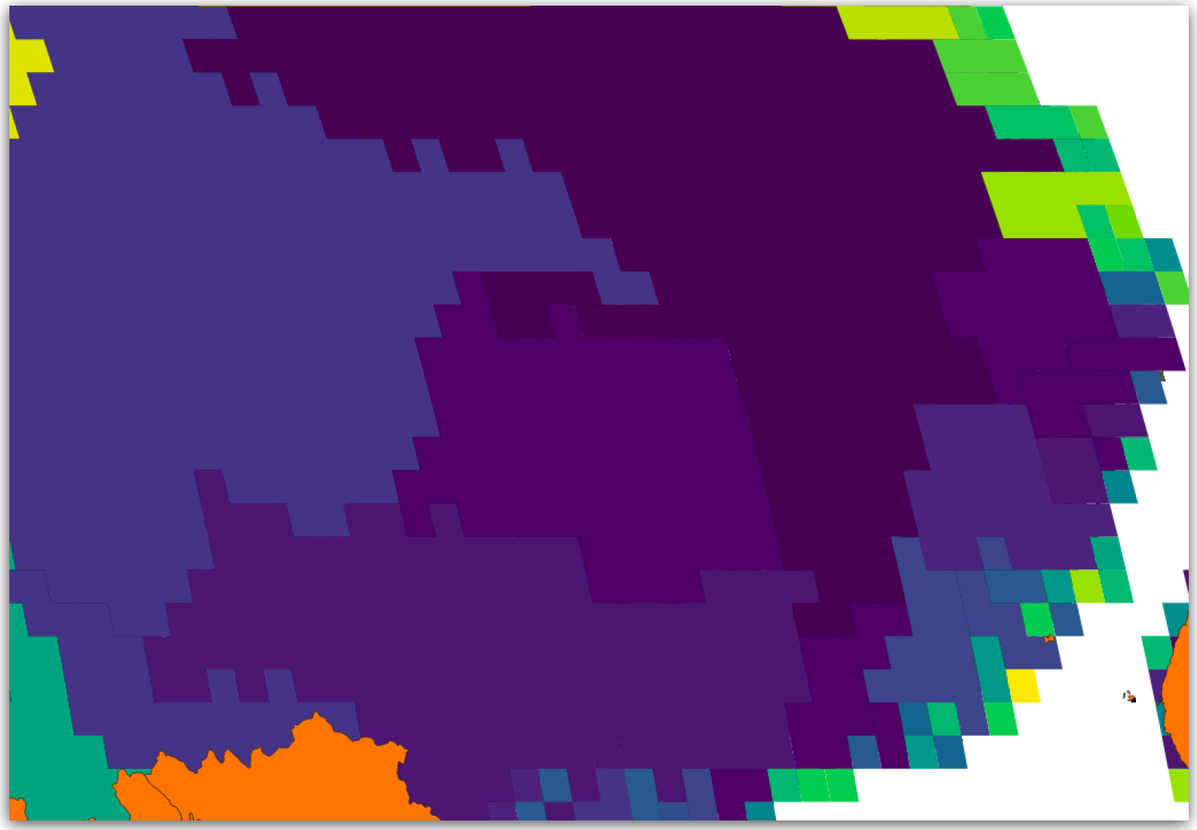
(Rice from USA)

99% of impact from rice irrigation in both cases

Results



Rice intensity



AWARE CFs (Ag.)

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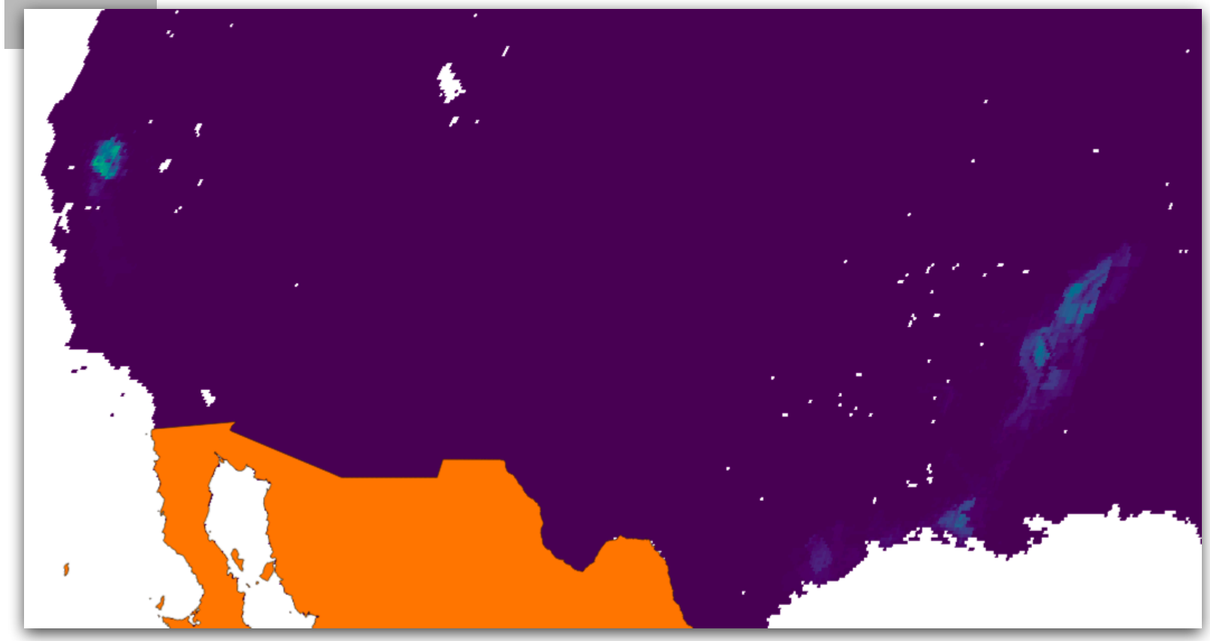

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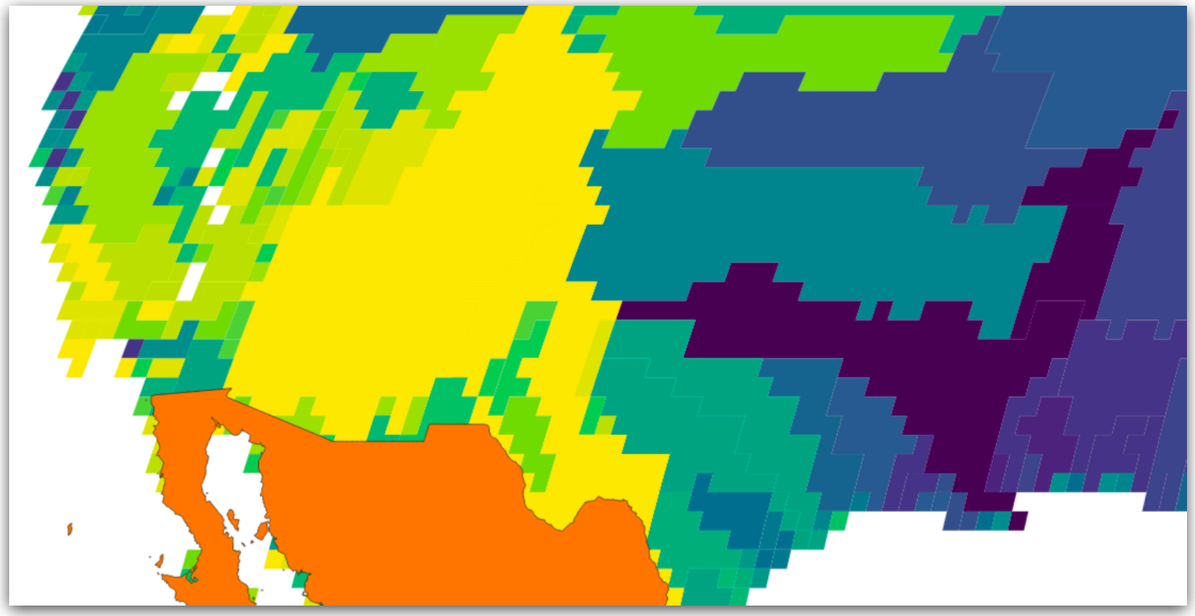

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Conclusions

- **Limited case study: Impacts dominated by one foreground process**
  - Could also apply e.g. LC-IMPACT (many impact categories)
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  - Monthly CF maps
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- **Large countries show limits of country-scale approach**
- **Results could be improved**
  - Monthly CF maps
  - Spatial pattern of rice irrigation
- **Open source toolchains for (regionalized) LCA are available**

Regionalized LCIA data format

Technical standards for regionalized LCIA method data interchange

Built on existing standards, e.g. CSV

Requires ecoinvent & ELCD flows

Requires versioning, integrity check, licensing

Version: 0.draft-1

Motivation

There is currently no standard
methods. This lack of standardization results in inconsistent implementation of LCIA methods and poor uptake of regionalization in general. This document provides a specification for a software- and database-independent data format for regionalized and site-generic LCIA methods. Its guiding principles are:

- Simplicity. Use the simplest and easiest approach and format whenever possible.
- Compatibility and consistency. This standard requires elementary flows be identified in both of the major nomenclature systems (ELCD and ecoinvent).
- Reuse of existing standards. This standard builds on top of existing widely-used standards for metadata (datapackage), CSVs, and GIS data (geojson, GeoTIFF).

Summary

An LCIA method is a directory with a set of files:

- `datapackage.json`: Describes the LCIA method metadata, including impact categories, elementary flows, spatial support, and uncertainty distributions.

https://github.com/cmutel/regionalized-lcia-data-standard

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Metadata (JSON)

CFs (CSV)

Spatial Scale (GeoJSON/GeoTIFF)

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