



Chris Mutel :: Paul Scherrer Institut

Regionalized LCA

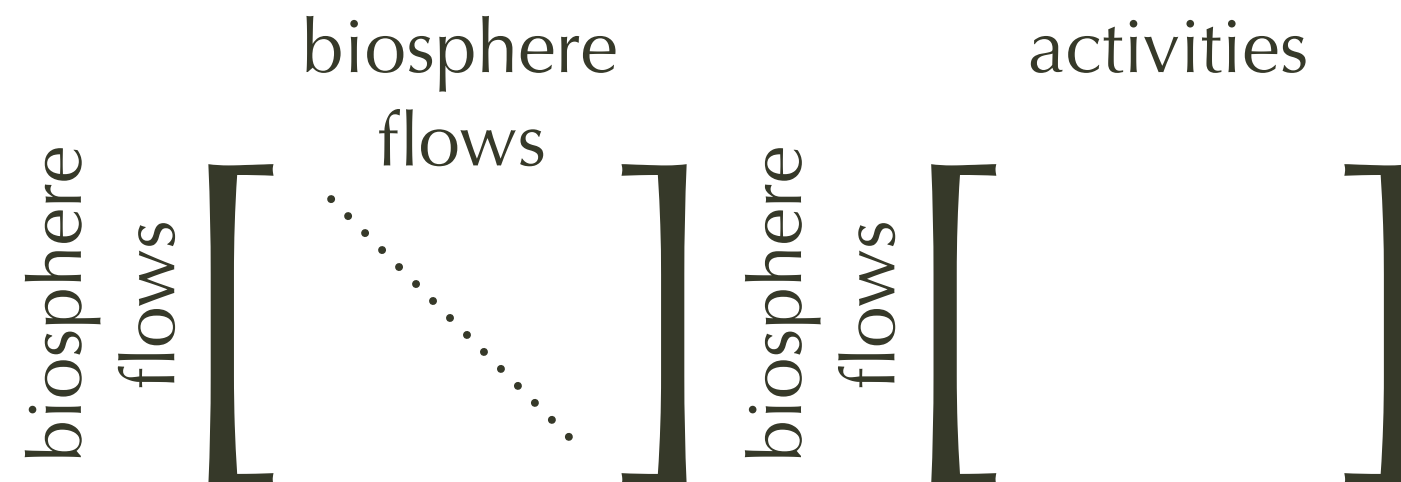
LCA Discussion Forum 64

March 30, 2017

Two problems for regionalized LCA

1. Calculation methodology

$$h = CB \cdot \text{diag}(A^{-1}f)$$

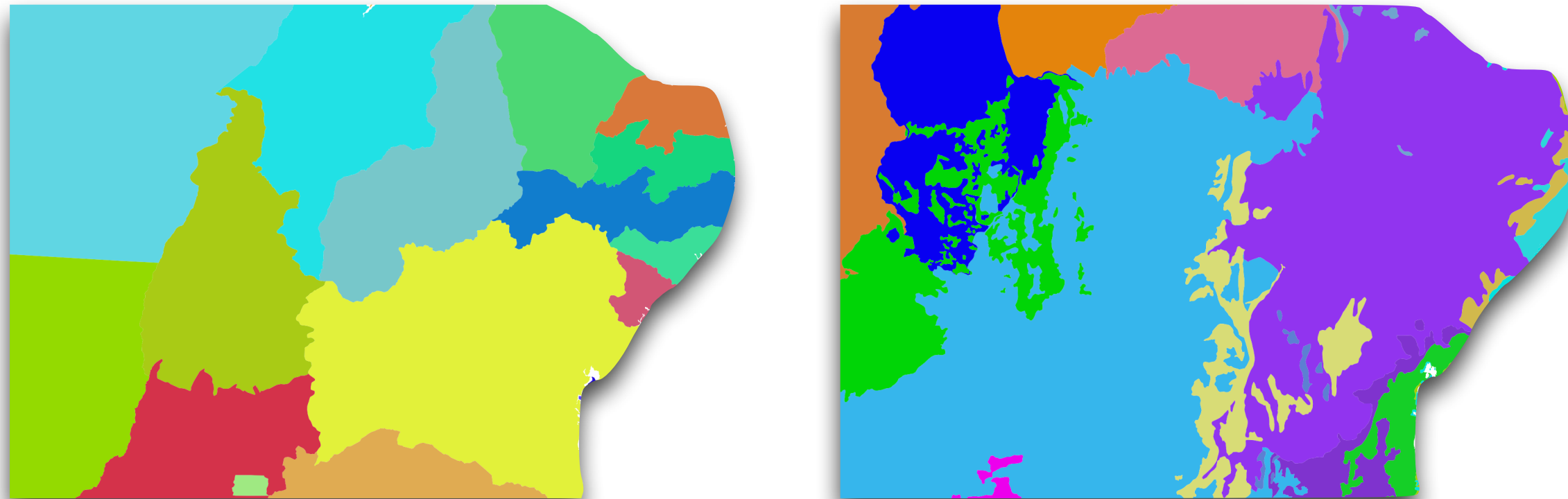



Two problems for regionalized LCA

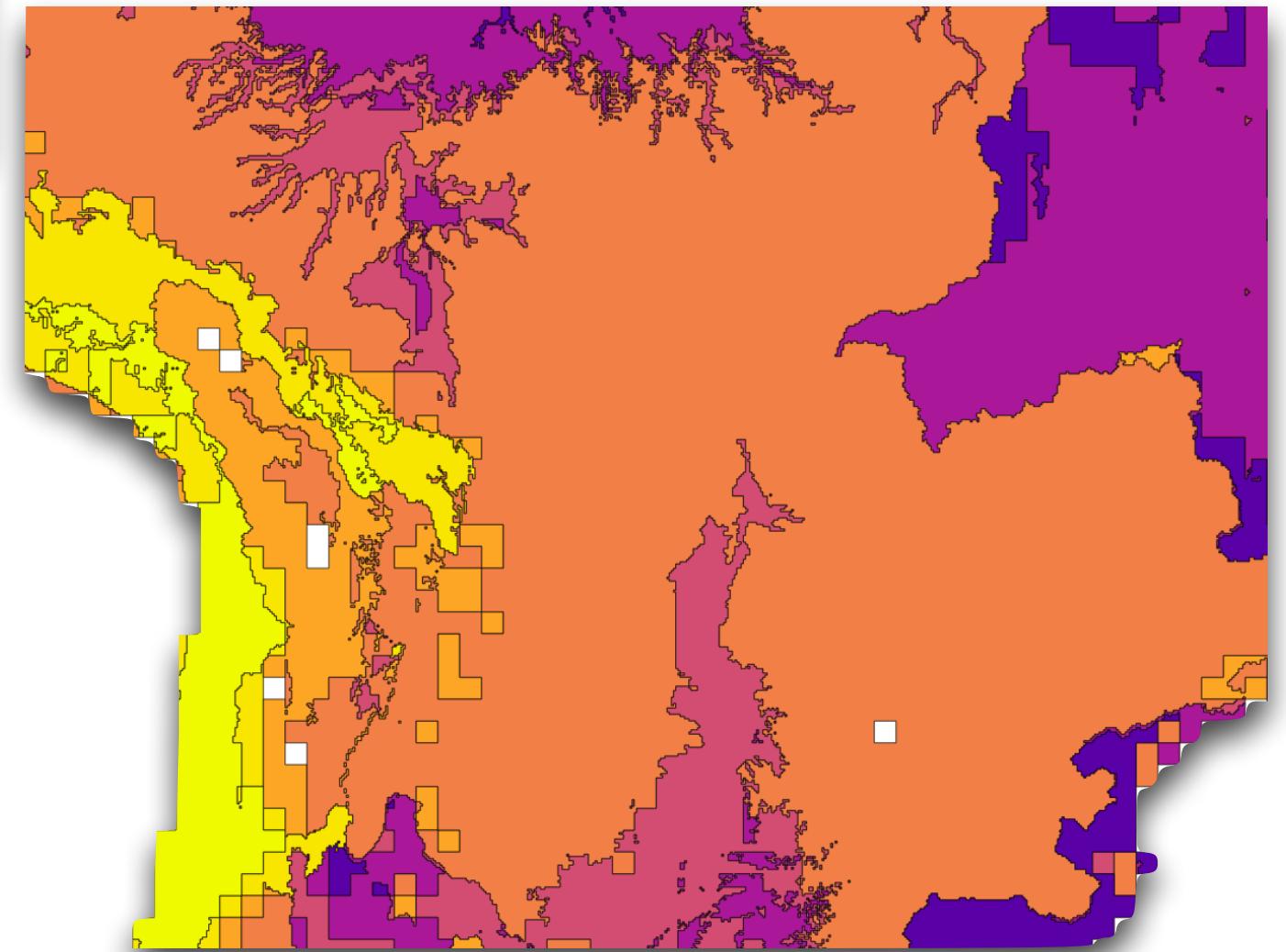
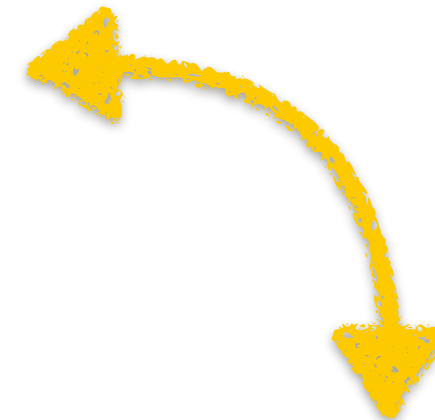
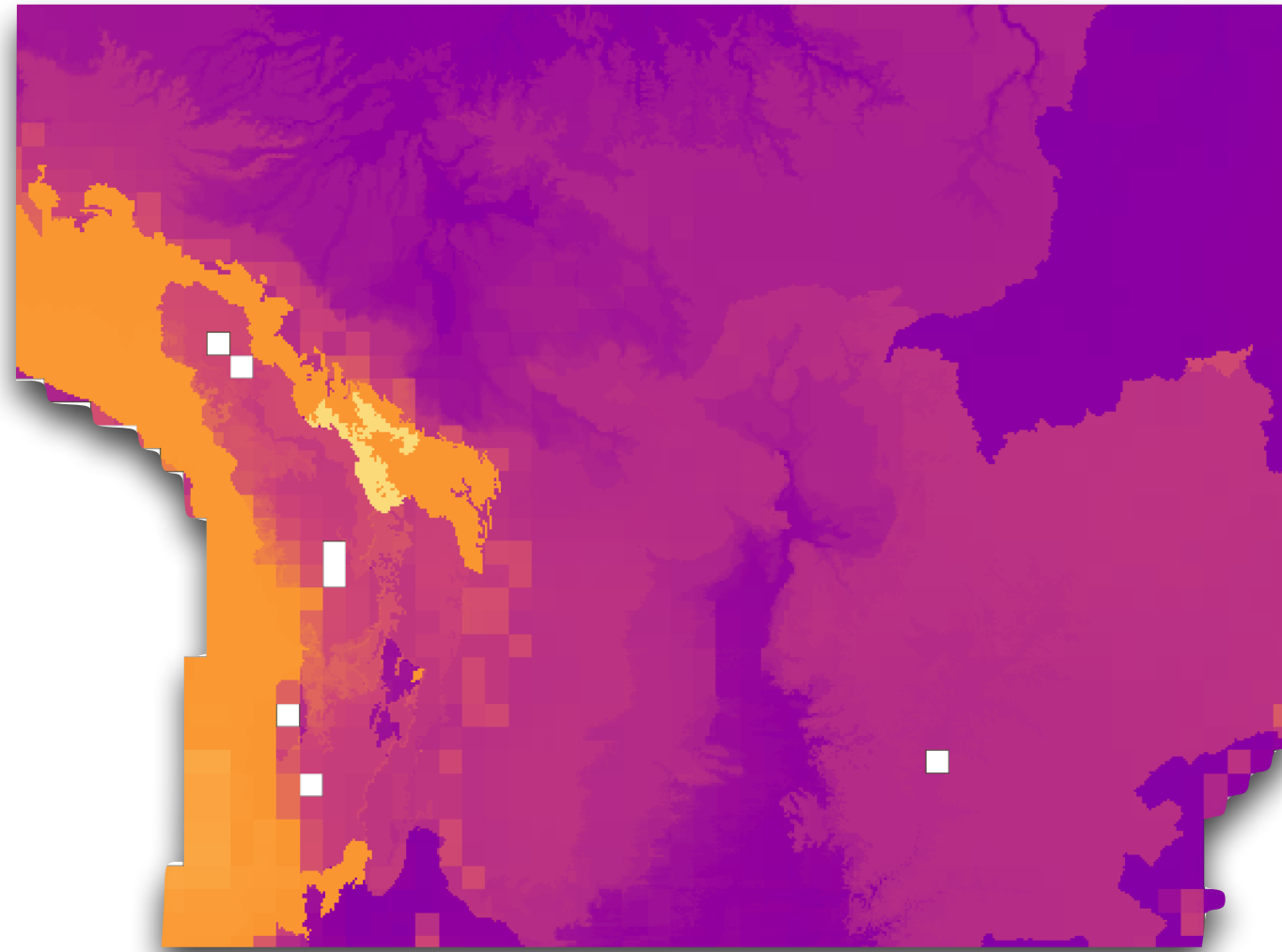
1. Calculation methodology

$$h = CB \cdot \text{diag}(A^{-1}f)$$

2. Matching two or more maps



Two ways to match maps



Convert all to raster
—or—
convert all to vector

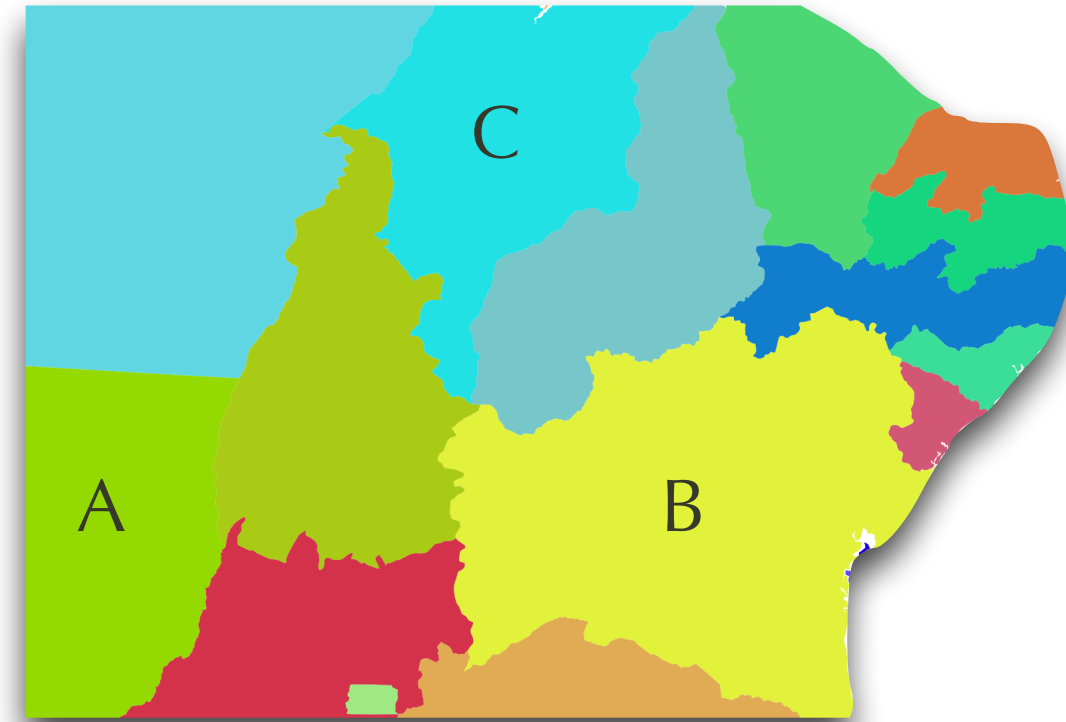
Advantages of vector-based calculations

- Can pre-calculate intersections



Advantages of vector-based calculations

- Can pre-calculate intersections
- Fits into matrix model



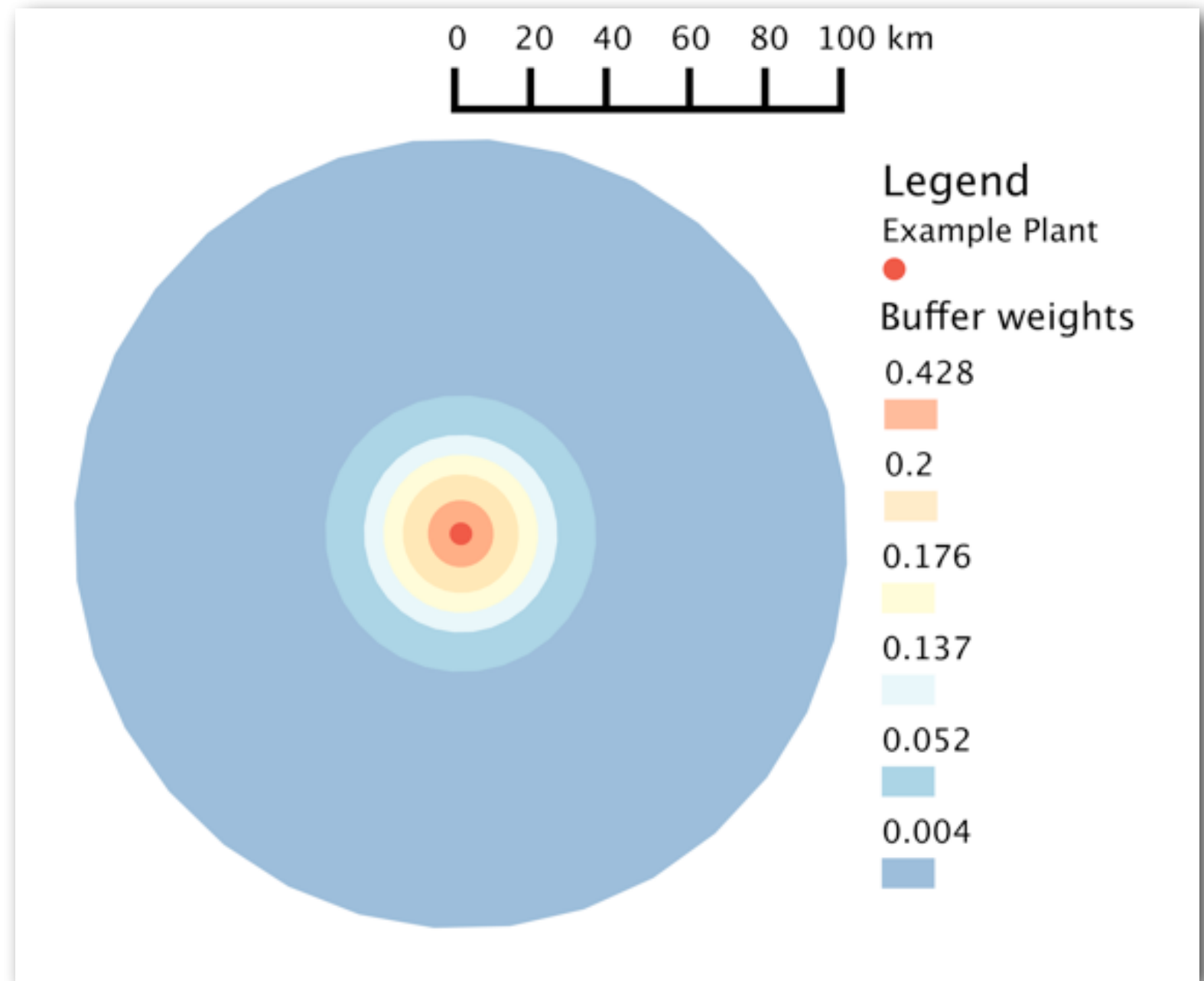
transforming activities

inventory spatial scale

	A	B	C
	1		
		1	
		1	

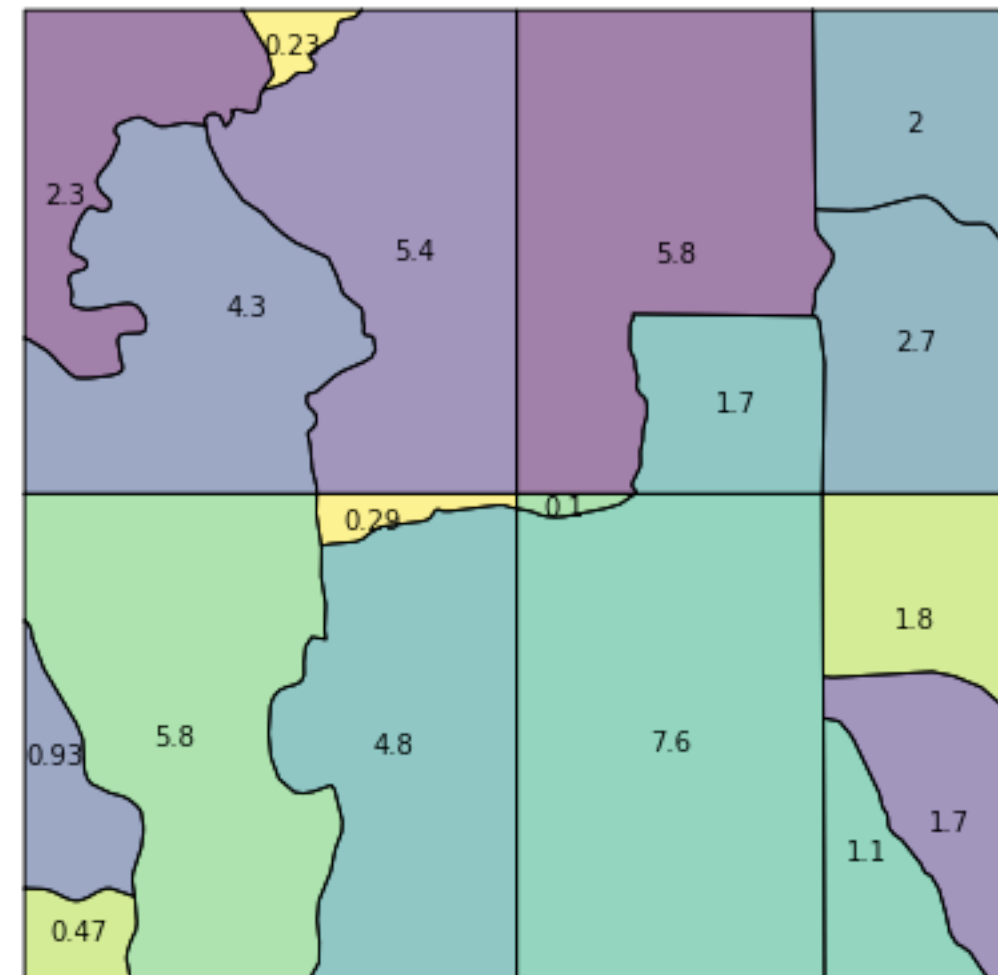
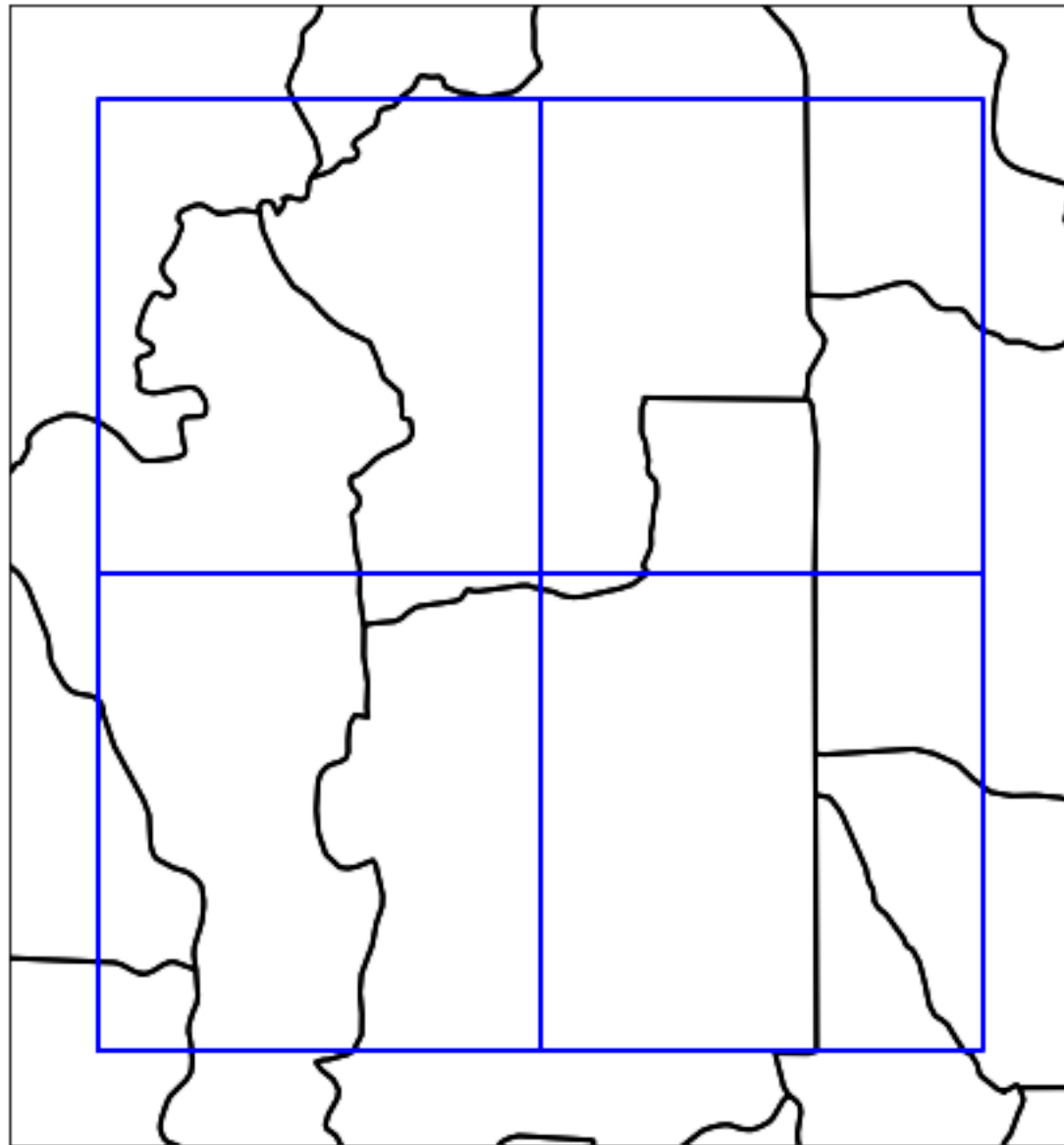
Advantages of vector-based calculations

- Can pre-calculate intersections
- Fits into matrix model
- Can include spatial uncertainty



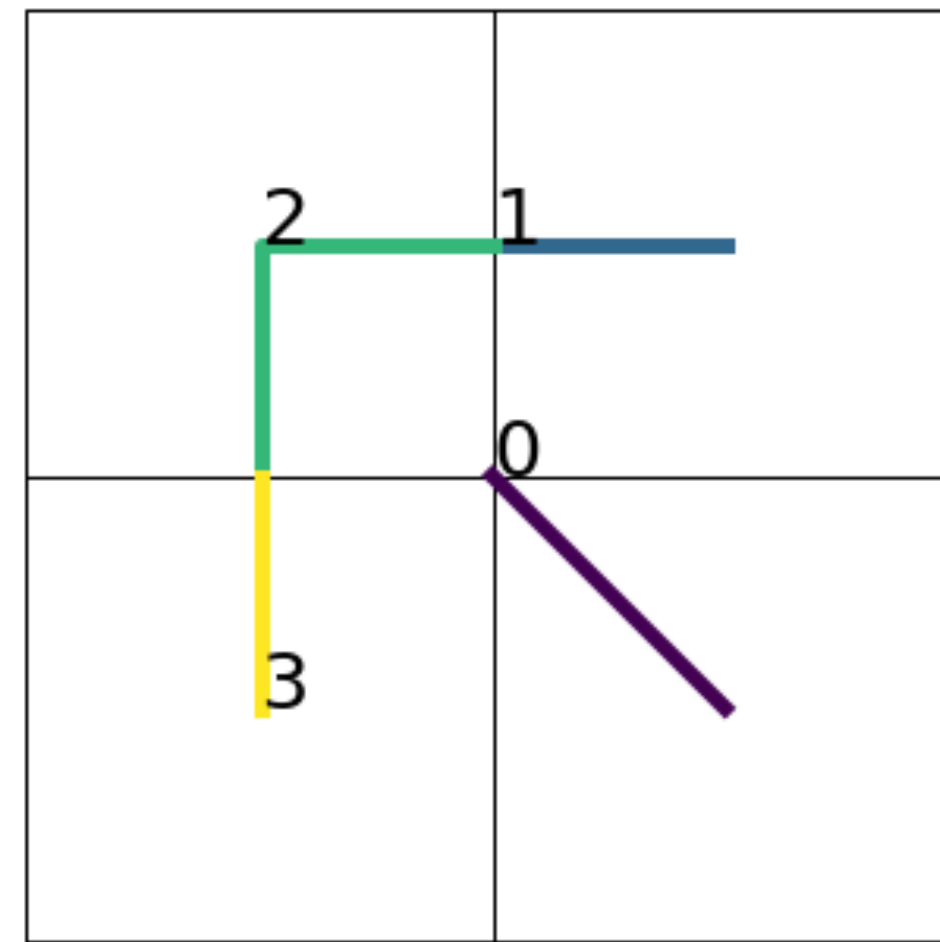
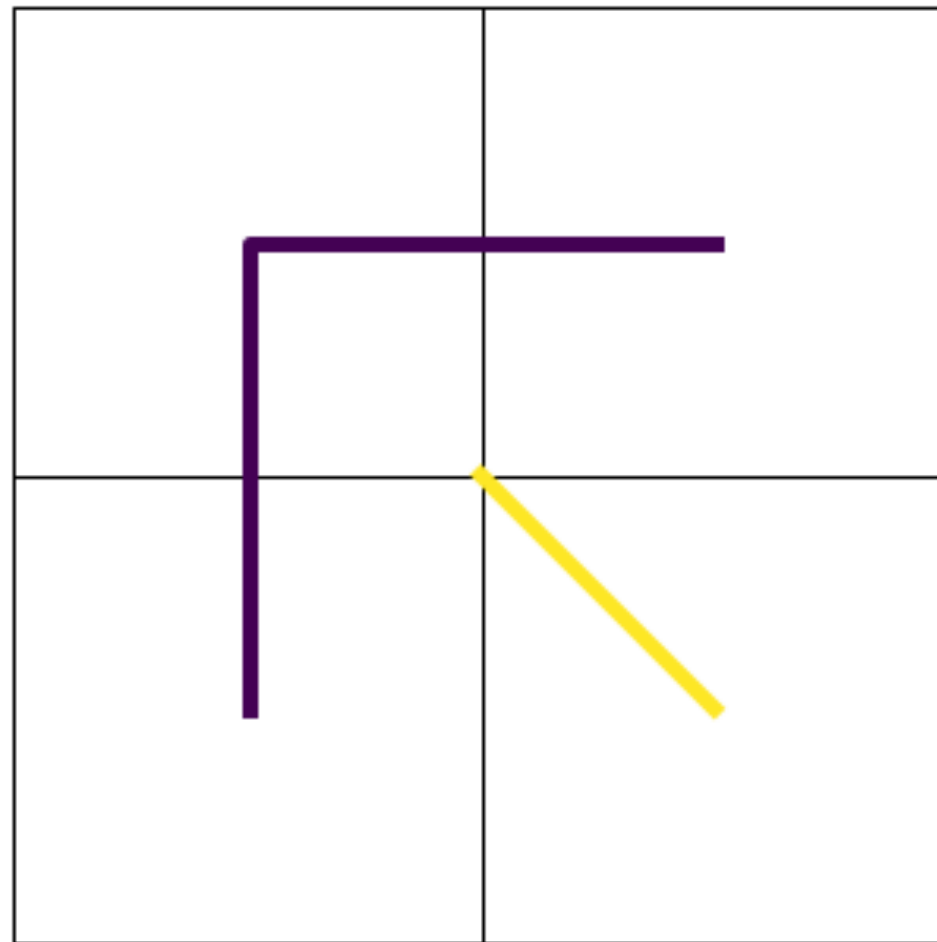
Pandarus: <https://github.com/cmutel/pandarus>

Intersections:



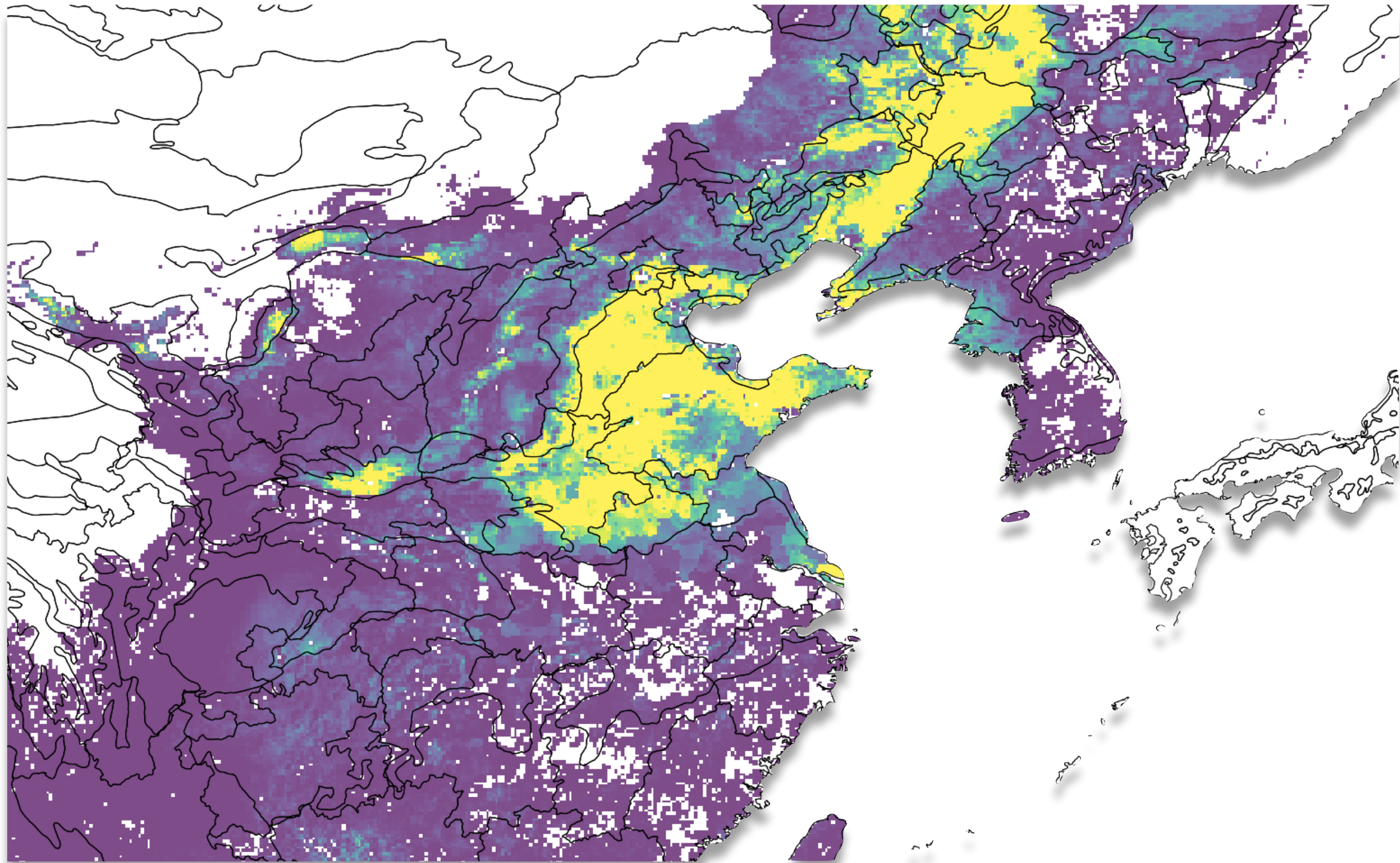
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Intersections:



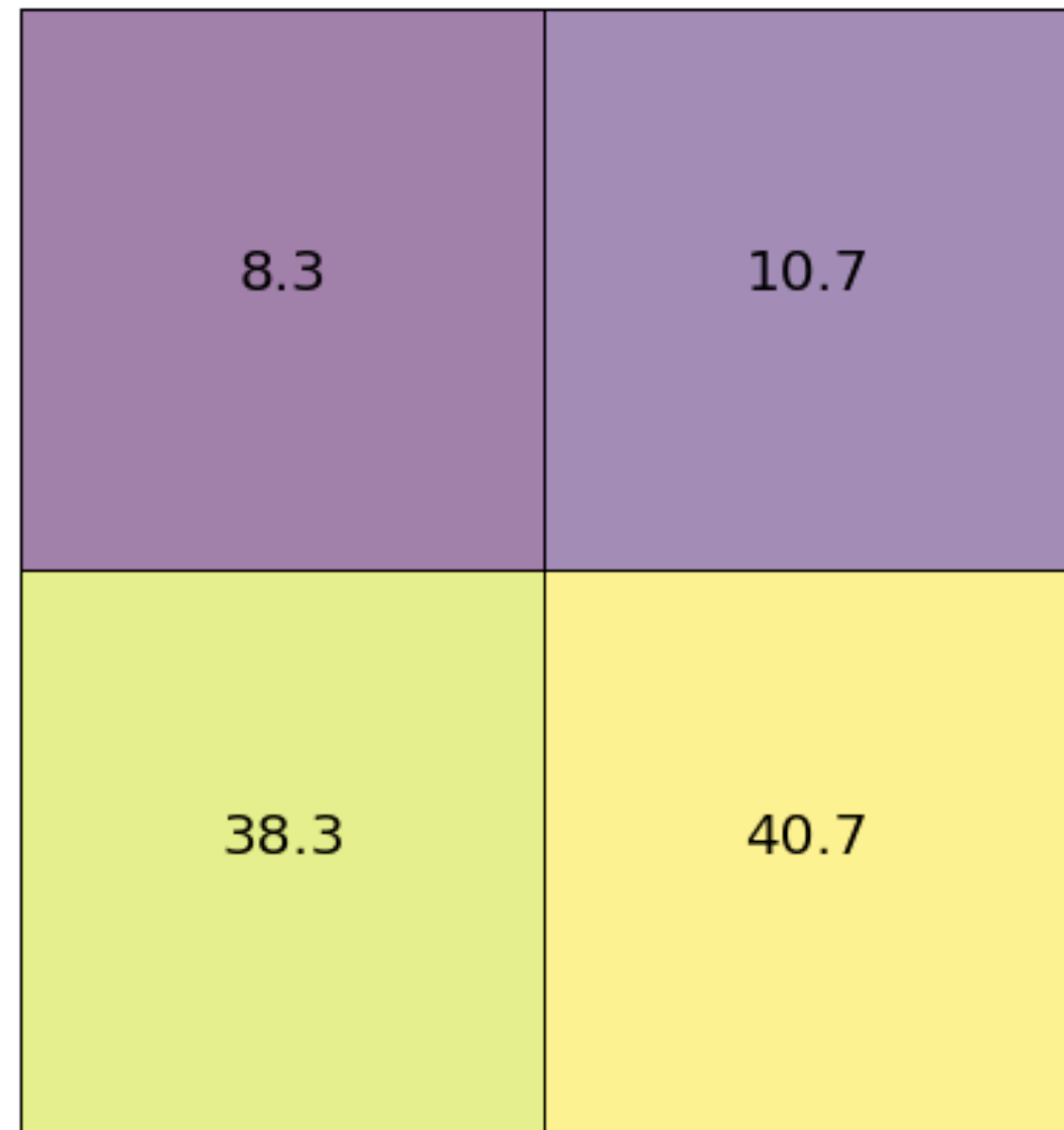
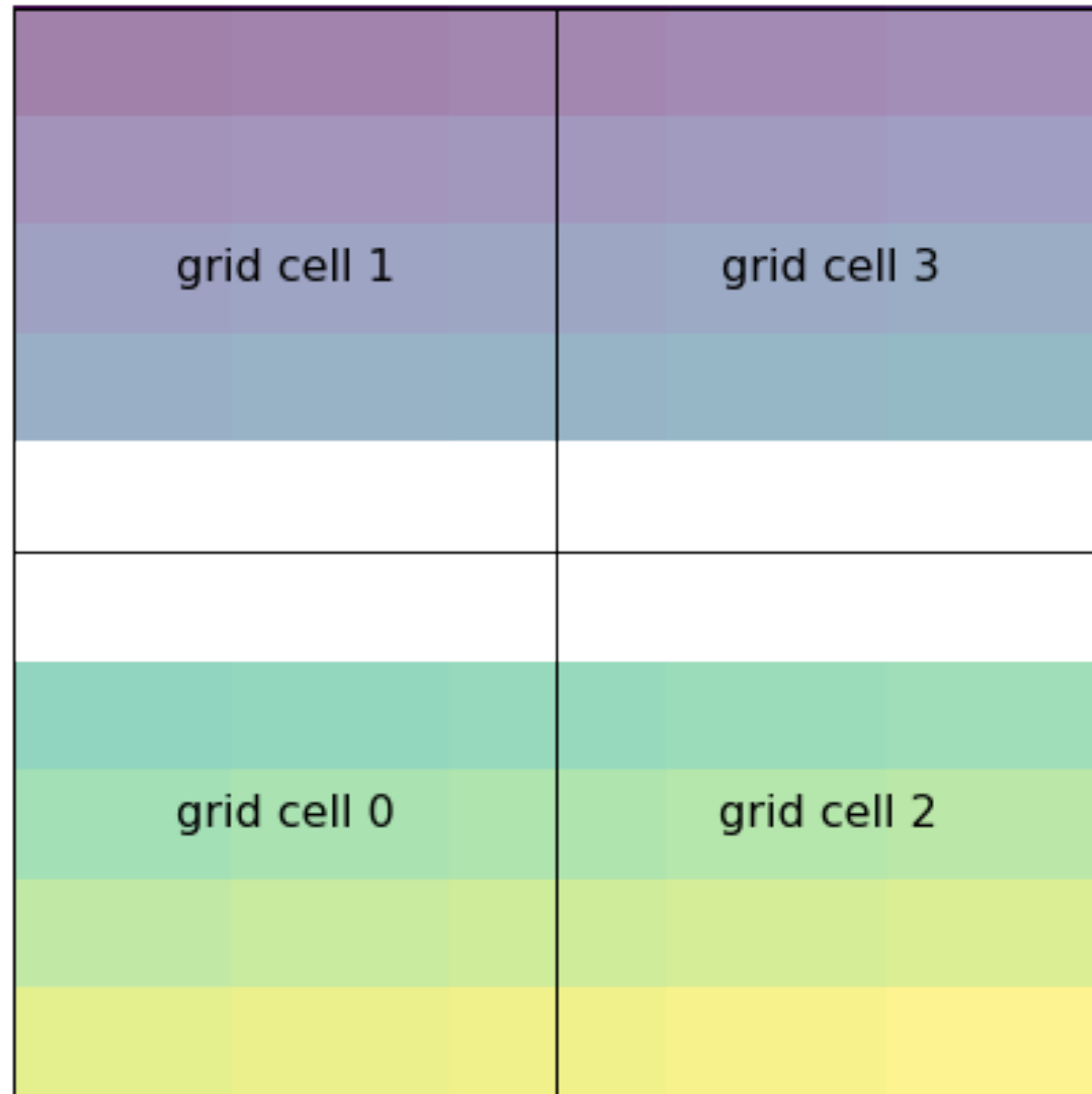
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Raster stats:



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Pandarus: <https://github.com/cmutel/pandarus>

- Outputs in standard formats (JSON, *not* Python)
- Documentation and test coverage
- Web service: https://github.com/cmutel/pandarus_remote
 - Available @ <https://pandarus.brightwaylca.org/>

```
job = remote.calculate_intersection("world", "ecoregions")
while job.status != 'finished':
    remote.intersection("world", "ecoregions")
```

Brightway2-regional: <https://bitbucket.org/cmutel/brightway2-regional>

$$h = [\mathbf{MNGLR}]^T \circ [\mathbf{B} \cdot \mathit{diag}(\mathbf{A}^{-1} f)]$$

transforming
activities

biosphere
flows

[]

transforming
activities

biosphere
flows

[]

- Supports multiple calculation methodologies
 - Single spatial scale
 - Area-based weighting
 - Background emissions-weighting
 - Raster weights (extension tables)

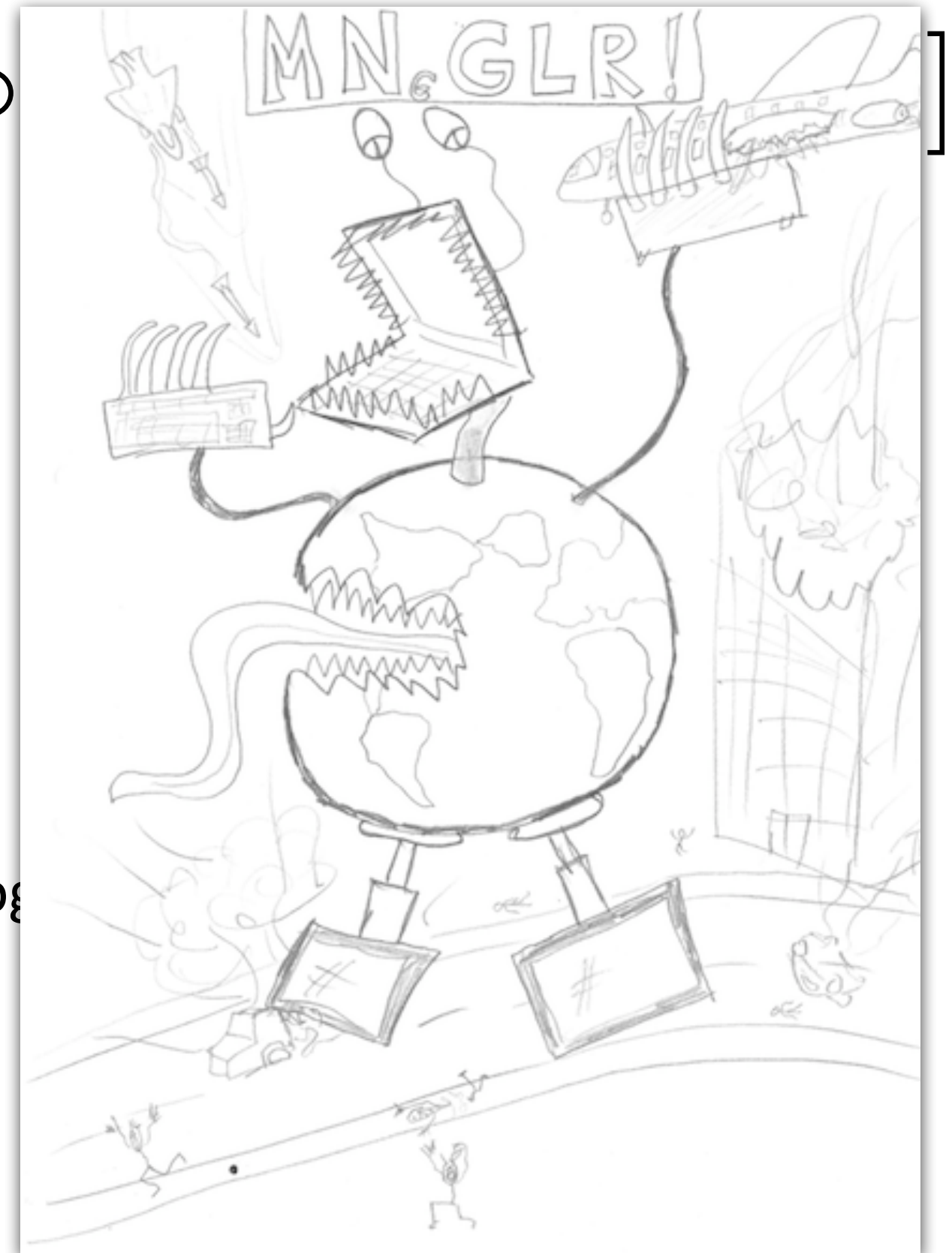
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$$h = [\mathbf{MNGLR}]^T \circ$$

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flows **[]**

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Brightway2-regional: <https://bitbucket.org/cmutel/brightway2-regional>

```
# Do irrigation with the sugar water intensity map, all others with the weighted pop density map
xt_ag = ExtensionTablesLCA(
    {'Fuel comparison', 'sugarcane transport'): 1},           Functional unit
    ('LC-IMPACT', 'Land Use', 'Occupation', 'Marginal', 'Core'), Method
    xtable='world-topo-ecoregions-sugarcane_landuse_intensity', Specific map of spatial "intensity"
    limitations={
        'activities': irrigation + crops,           Only include irrigation and farming activities
    }
)
xt_ag.lci()
xt_ag.lcia()

xt_others = ExtensionTablesLCA(
    {'Fuel comparison', 'sugarcane transport'): 1},           Functional unit
    ('LC-IMPACT', 'Land Use', 'Occupation', 'Marginal', 'Core'), Method
    xtable='world-topo-ecoregions-weighted-pop-density',       Generic map of spatial "intensity"
    limitations={
        'activities': irrigation + crops,           Everything but irrigation and farming activities
        'activities mode': 'exclude'
    }
)
xt_others.lci()
xt_others.lcia()

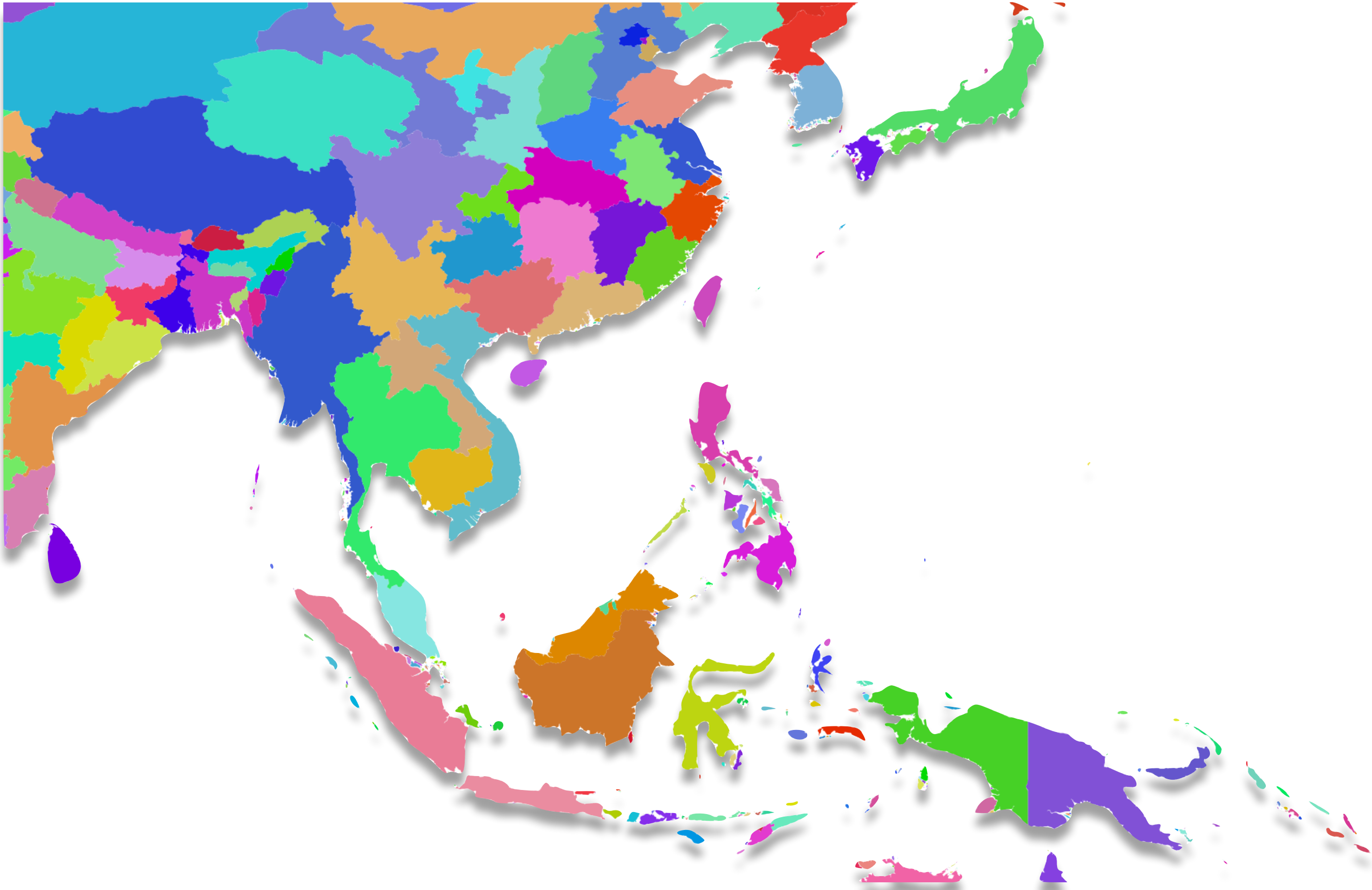
xt_ag.score + xt_others.score

9.718523293494226e-14
```

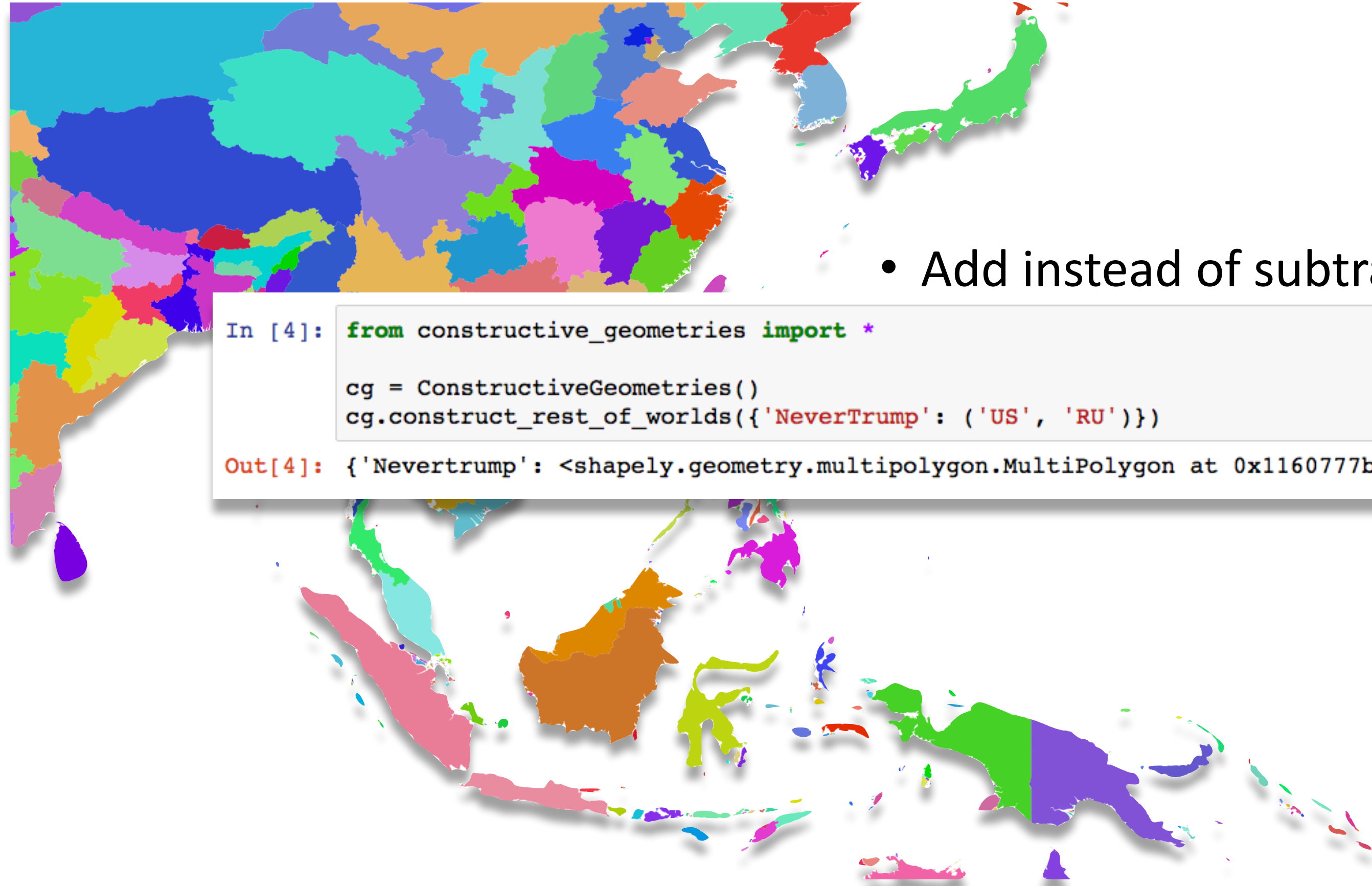
Ecoinvent-specific: Rest of the World (RoW)

- RoW defined *exclusively*, e.g. everything but CH, ENTSO-E...
- Same label used for many RoW locations
- Subtractions or differences in GIS error-prone

Constructive geometries: <https://bitbucket.org/cmotel/py-constructive-geometries>



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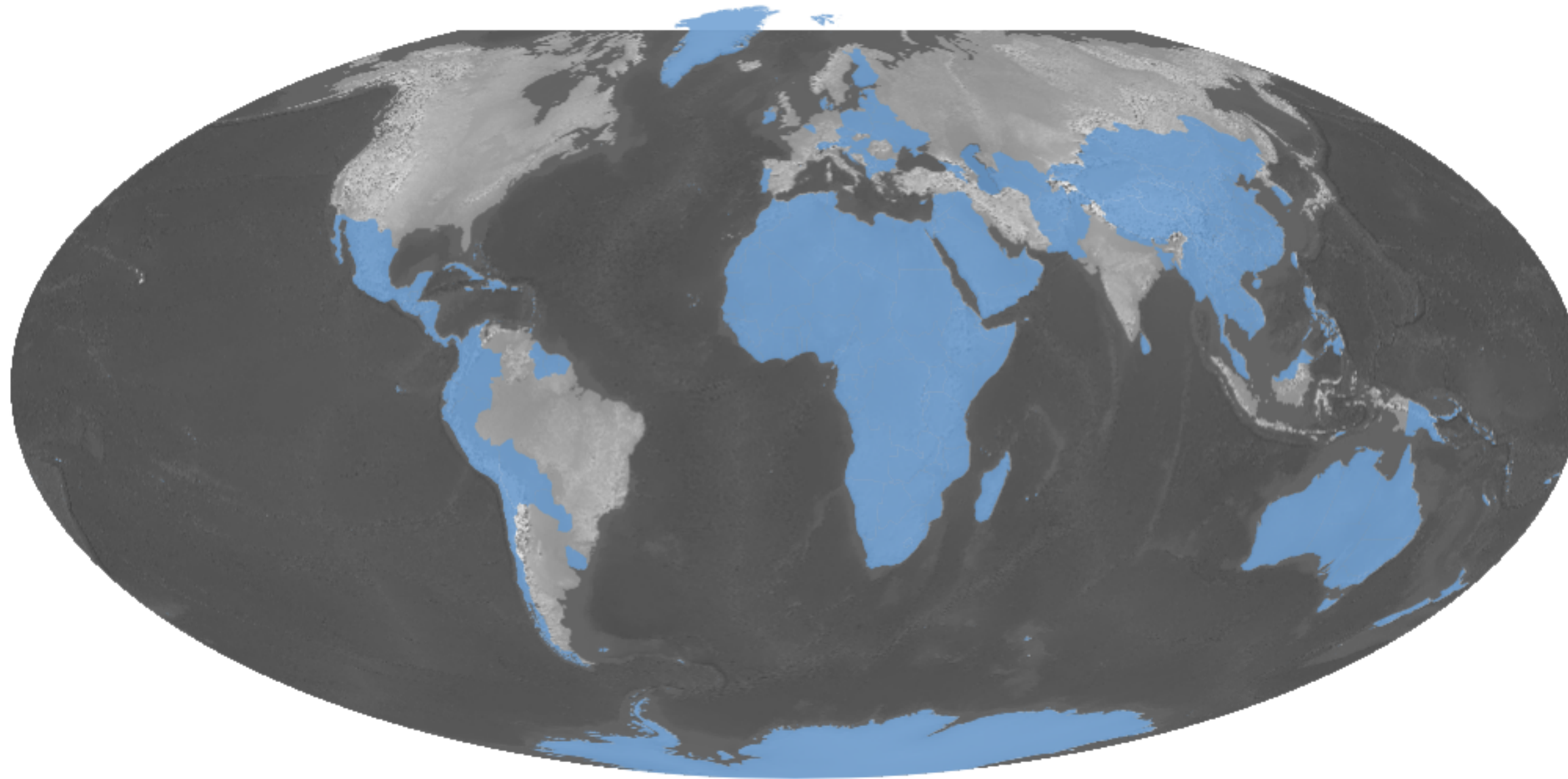
- Add instead of subtract

```
In [4]: from constructive_geometries import *  
  
cg = ConstructiveGeometries()  
cg.construct_rest_of_worlds({'NeverTrump': ('US', 'RU')})  
  
Out[4]: {'Nevertrump': <shapely.geometry.multipolygon.MultiPolygon at 0x1160777b8>}
```

Ecoinvent RoW report: <http://geography.ecoinvent.org/rows/>
See also: <http://geography.ecoinvent.org/report/#methodology>

Rest-of-World location: RoW-115

Excluded from this "Rest-of-World": CA-QC, IAI Area 2, without Quebec, IAI Area 3, South America, IAI Area 4&5, without China, IAI Area, EU27 & EFTA, IAI Area, Europe outside EU & EFTA



Markets

Activity Name

aluminium production, primary, liquid, Söderberg

Reference Product

aluminium, primary, liqu

Conclusions

- Regionalization now possible with one software framework
 - Notebooks on case study soon available
- Core regionalization functions available to all
 - Including web service API
 - Allows LCA software without GIS
- Open source GIS is hard
 - New knowledge domains
 - Real-world data is dirty
 - Need through documentation and testing
 - Twice the work, but necessary

URLs

- <https://github.com/cmutel/bw2-lcimpact>
- <https://github.com/cmutel/pandarus>
- <http://pandarus.readthedocs.io/>
- https://github.com/cmutel/pandarus_remote
- <https://pandarus.brightwaylca.org/>
- <https://bitbucket.org/cmutel/brightway2-regional>
- <http://brightway2-regional.readthedocs.io/>
- <https://bitbucket.org/cmutel/py-constructive-geometries>
- <http://geography.ecoinvent.org/rows/>
- <http://geography.ecoinvent.org/report/#methodology>