Mapping the land-use footprint of Brazilian soy embodied in international trade

A spatially explicit approach based on open data

Objective

- Agricultural commodities are embedded in complex supply chains, creating highly localized environmental pressures driven by global consumption. Adequately tracing biomass flows from local production to consumption regions is thus key for assessing the spatial heterogeneity in resource footprints.
- This work aims to provide a transparent and reproducible approach to tracing biomass flows and the related land-use footprints at a high level of spatial detail, applied to the Brazilian soybean complex.
- The framework can serve as a blueprint for the extension to other agricultural products or regions and for the linkage of resulting land-use pressures to related environmental impacts such as deforestation or biodiversity loss.

Contribution

- Existing approaches to spatially explicit footprinting either rely on non-transparent methods and costly microdata or only perform a rough downscaling from the national to the local level.
- This work combines
  - spatially explicit modelling of the full subnational soy supply chain at the level of 5572 Brazilian municipalities
  - quantification of related land-use pressures at a high spatial resolution (30m)
  - a direct interface to the multi-regional physical input-output model FABIO, enabling consumption-based footprint analyses
  - a fully transparent open-data approach

Workflow

Infrastructure: R and GAMS

1 Completing the subnational data basis

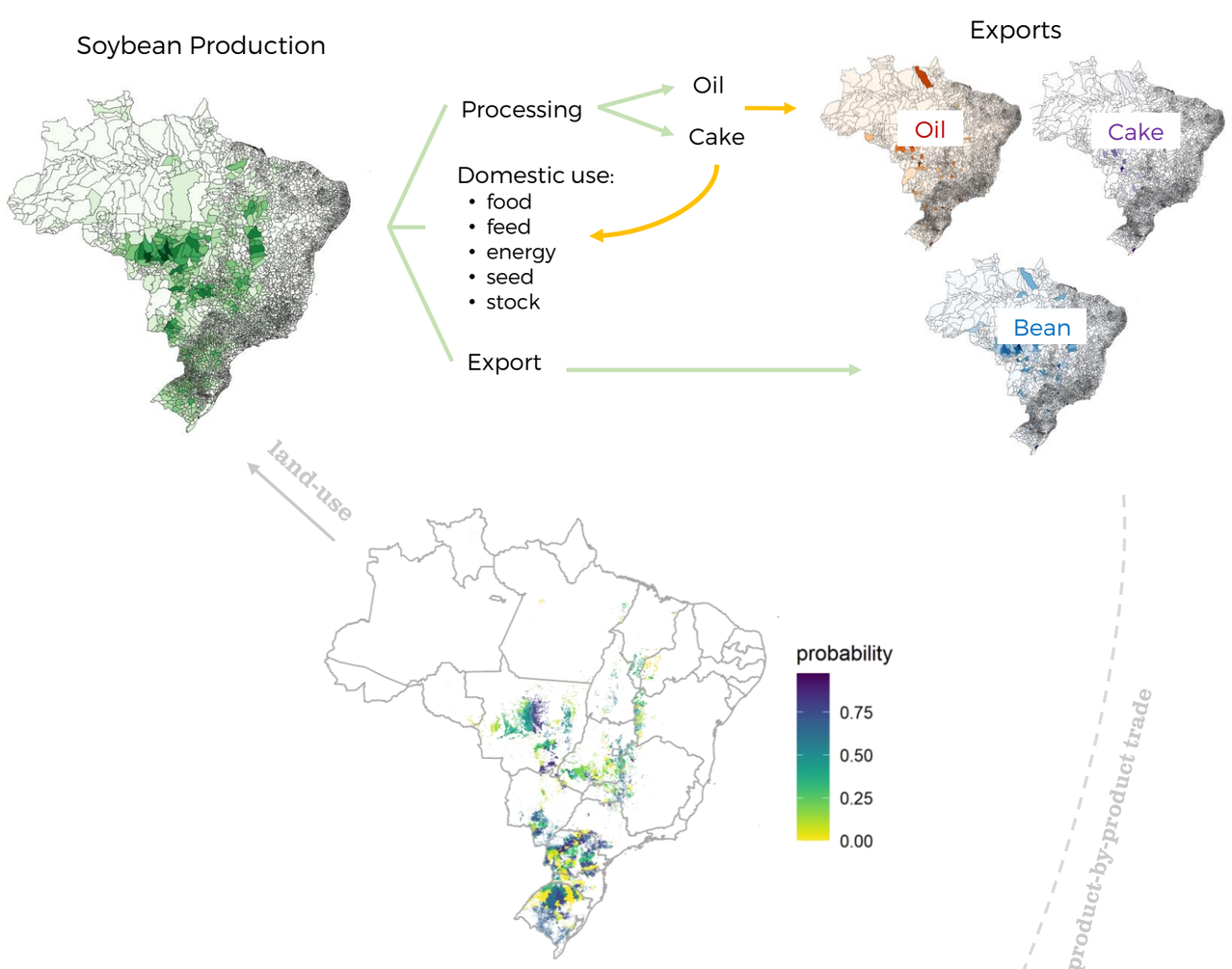
- Municipal soybean production and trade data are available
- Other relevant supply and use items, including the production and use of soy oil and cake, are estimated, using a variety of statistical and geographic data
- National aggregates are harmonized with FAO commodity balance sheets

	Supply		Use						
	Product-ion	Import	Process-ing	Food	Feed	Seed	Energy	Stock change	Export
Soybean									
Soy oil									
Soy cake									

available · estimate · not relevant

2 Modeling subnational flows

- Municipal supply is spatially allocated to municipal use (either domestic, processing or export) by means of a multi-modal transport optimization framework
- The model is based on national road, rail, and waterway networks and minimizes overall transport cost while satisfying a series of constraints
- Linking the resulting subnational flows to export data already allows to trace soybean flows from the municipality of production to export destination countries
- The sensitivity of outcomes to parameters and model specifications is tested



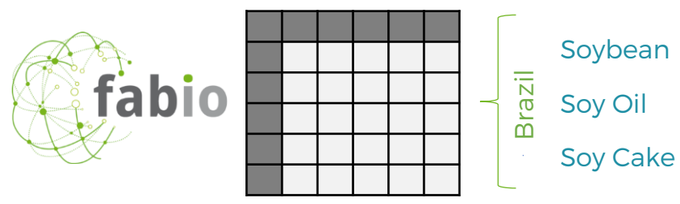
Land-use probability for exports to China

3 Linkage with gridded land-use

- Municipal soybean production can be directly linked to the high-resolution (30m) land-use grid from MapBiomas
- Each soy pixel can be assigned a probability of being used for exports to a chosen destination

Next Linkage with FABIO

- The subnational supply chain results fully conform with the structure of FABIO and can be integrated into the multi-regional physical input-output table
- This will allow to trace soy flows via embodied products to the final consumer and to quantify consumption-based footprints at an unprecedented level of detail



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OPEN ACCESS: code and data will be made available on https://github.com/fineprint-global