

**Exploring Land-Use Dynamics
through Agent-Based Modelling:**
First evidence from the EuropeLAND
case studies in Austria and Romania

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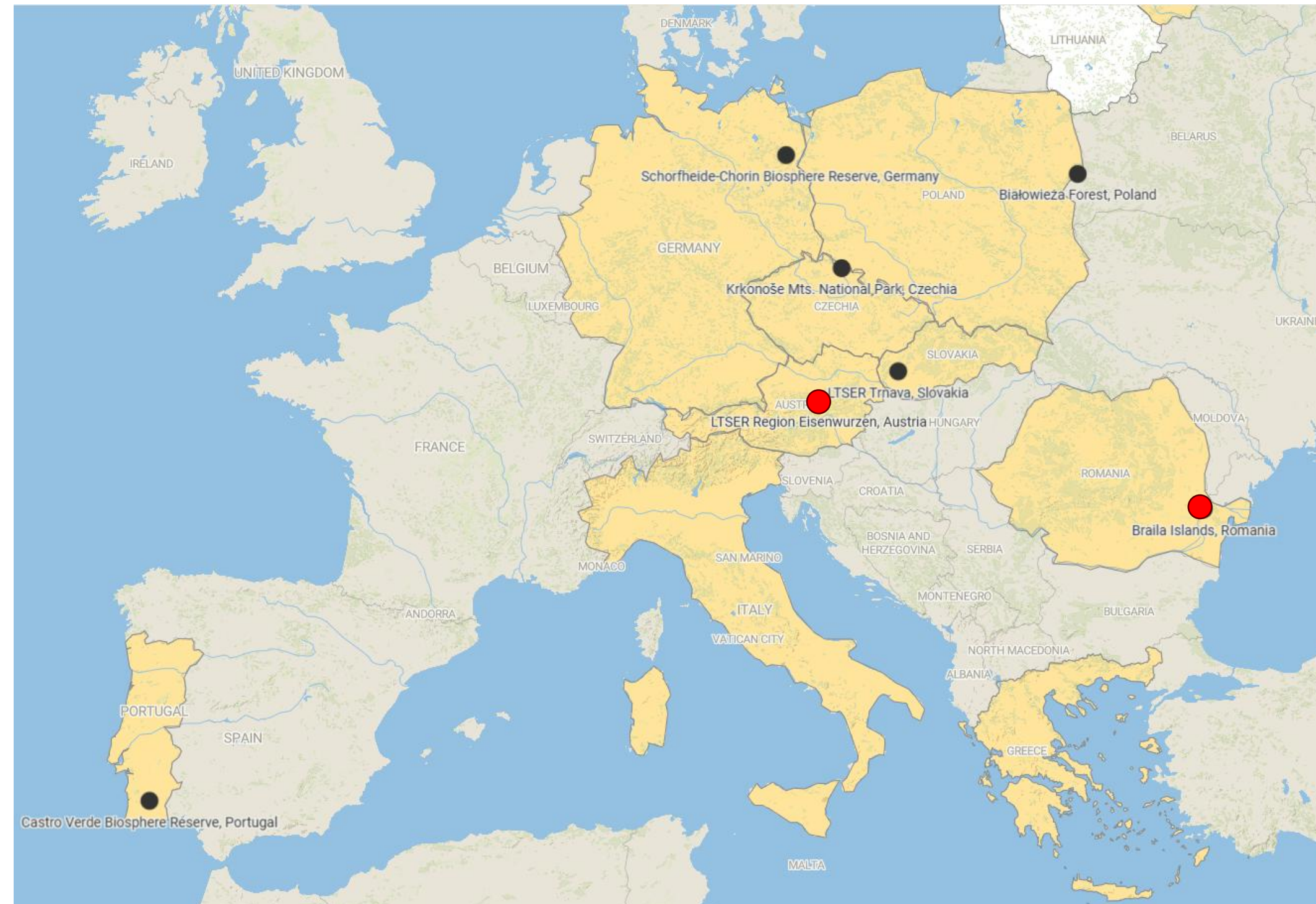
Science
for a
[cooler
future]

Agenda

- Introduction
- Agent-based modelling
- The SECLAND ABM
- EuropeLAND Case studies Eisenwurzen (AT) and Braila County (RO): overview and results
- Q&A

EuropeLAND: linking WP2, WP3 and WP5

- WP2
 - IACS land use maps
- WP3
 - Interviews and Workshops with farmers and land use experts
- WP5
 - Land use modelling with the SECLAND ABM
- Case studies
 - LTSER platform Eisenwurzen
 - Braila county



Source: <https://europe-land.eu/de/about-europe-land/>

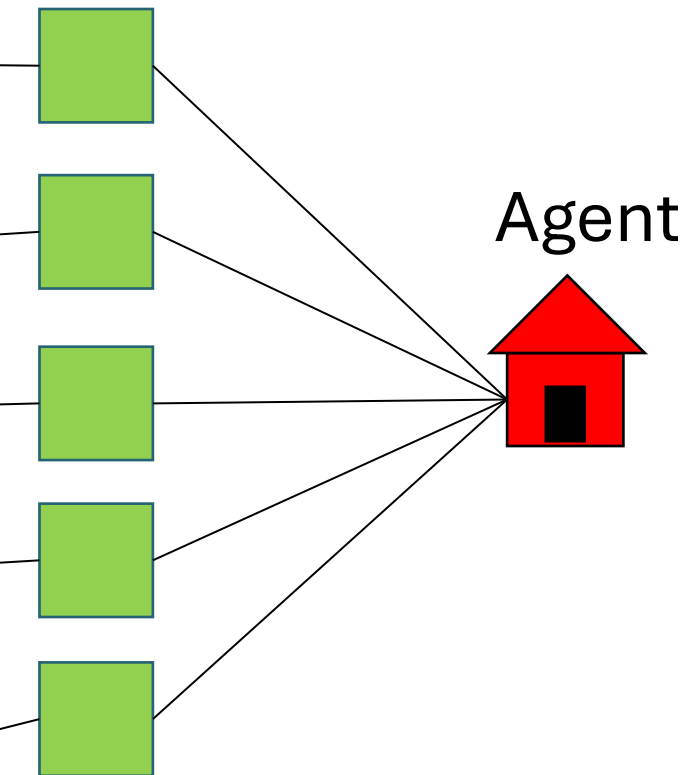
From real world to model world



„real world“



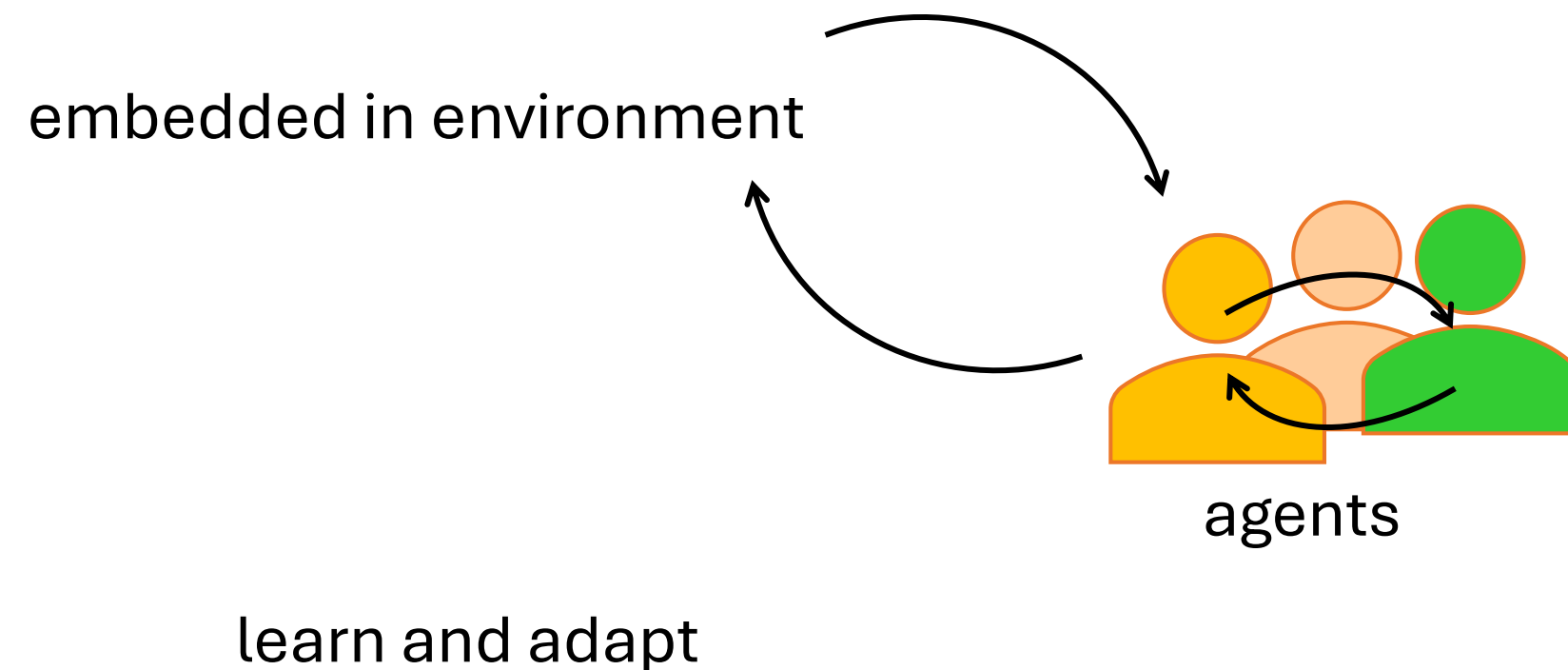
GIS



Agent-based model (ABM)

What is agent-based modelling?

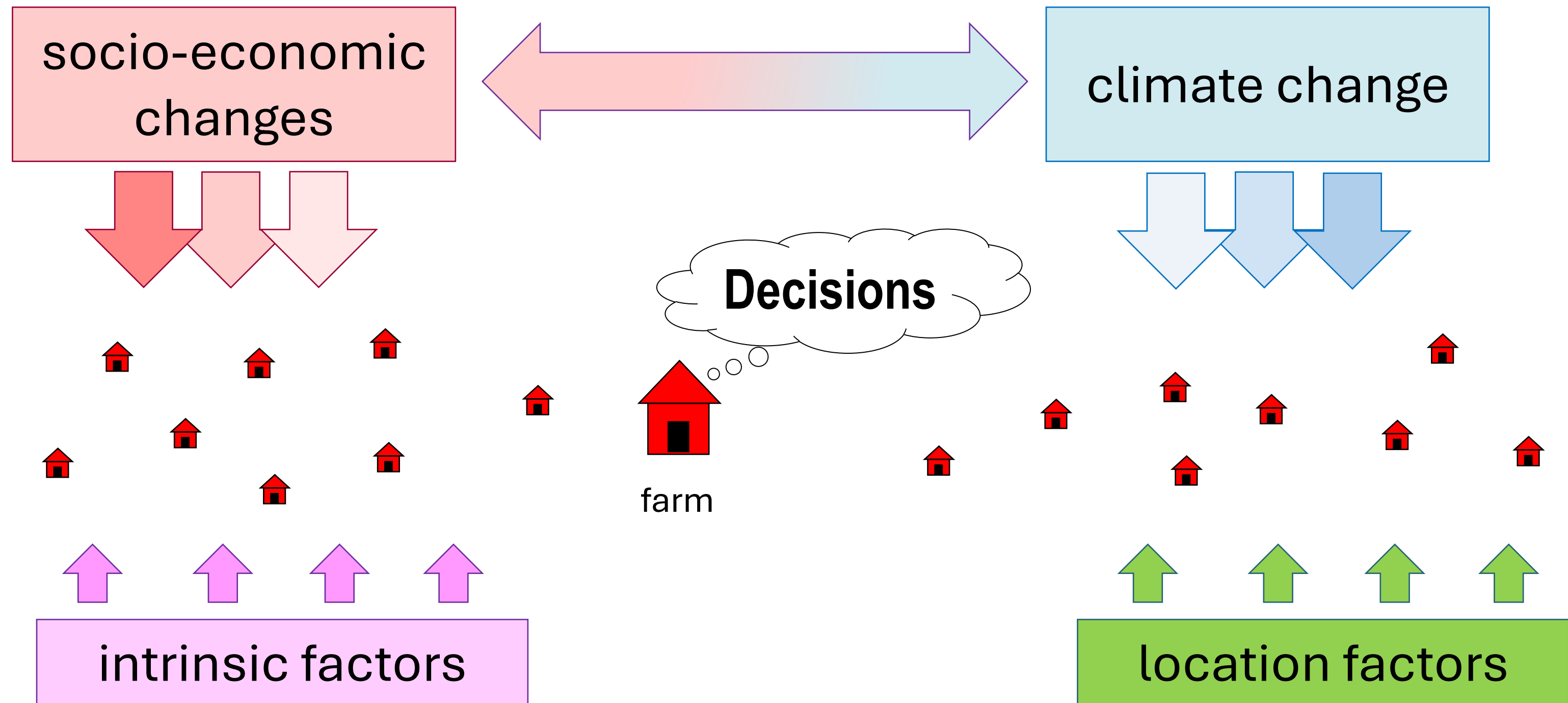
- Actors' perspective
- 1970s: artificial intelligent research and computer sciences
- Agents represent real-world actors and their interactions



autonomous and self-directed

decision-making lead by
characteristics and rules

Framework



SECLAND: a Socio-ECological LAND use ABM

- Model development since 2017

- Egger et al., 2022; 2023

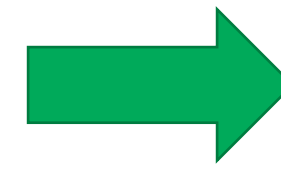
- Spatially-explicit land-use model

- Connected to GIS parcels
 - IACS maps

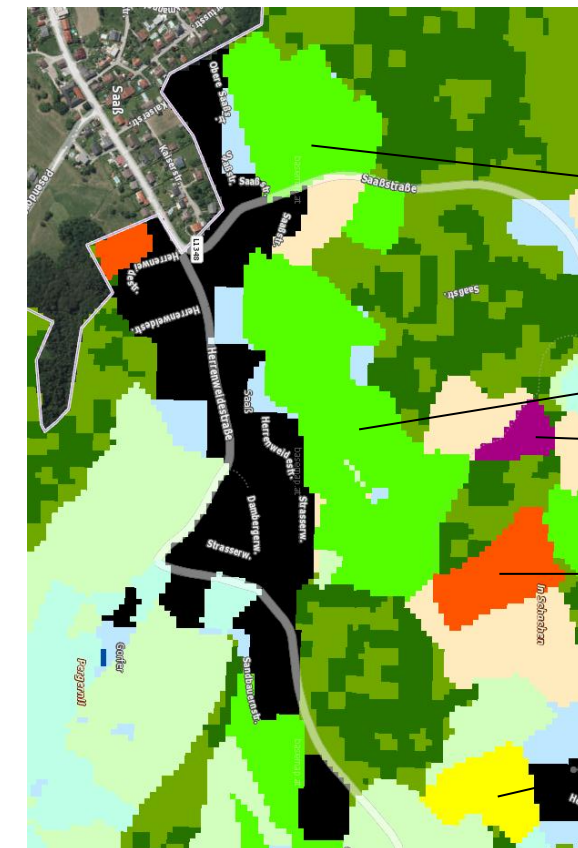
- Interface

- Diverse inputdata
 - Input for other models
 - Stakeholders

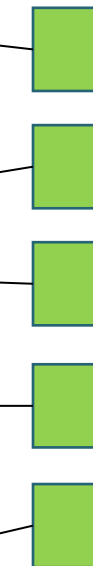
Original implementation in NetLogo
(<https://ccl.northwestern.edu/netlogo>)



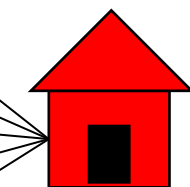
Refactored in Agents.jl (Julia)
(<https://juliadynamics.github.io/Agents.jl/>)



Primary keys



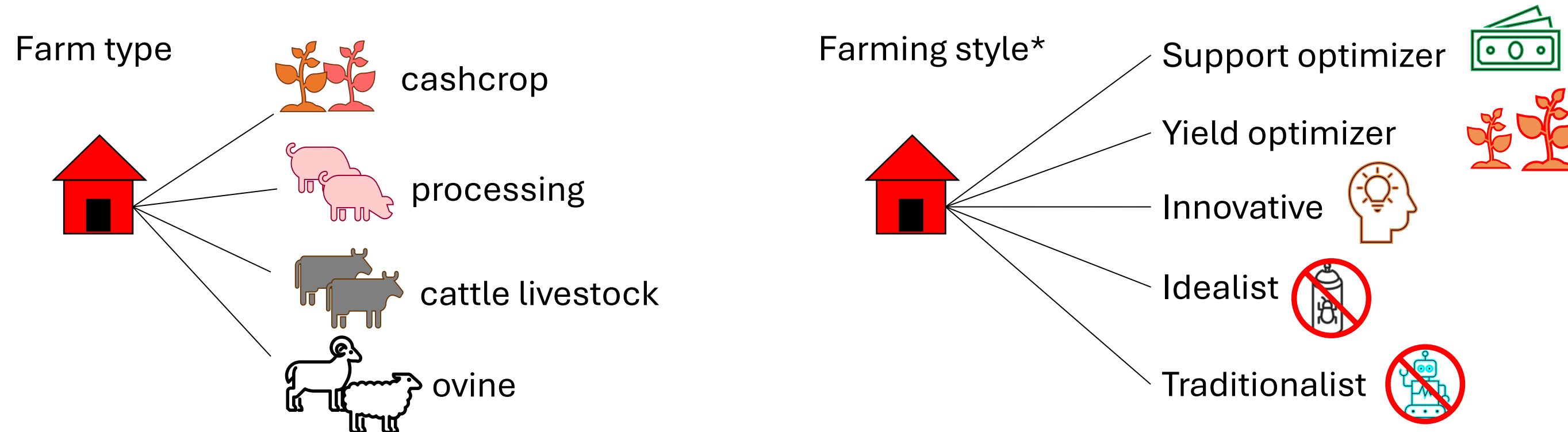
agent



ABM

SECLAND ABM – Agents and Goals

- Agent characteristics are case study specific

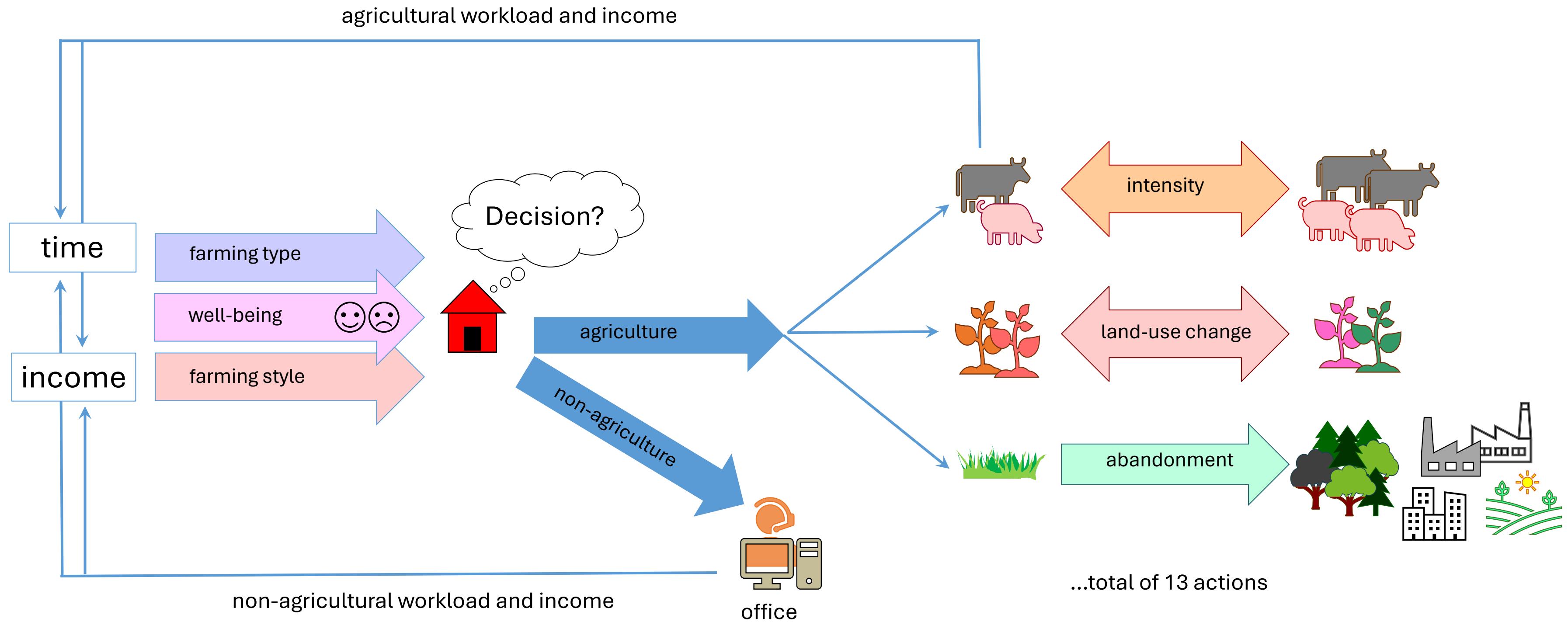


Goals

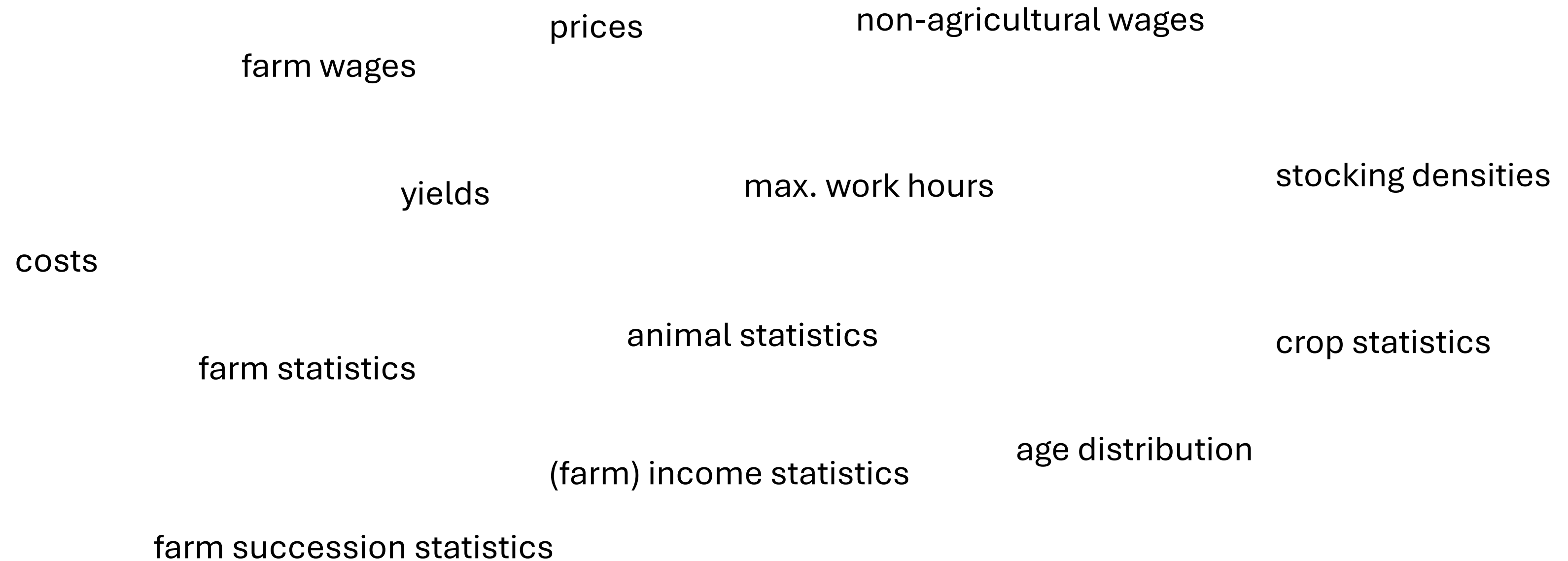
- well-being through a balance between desired minimum income and maximum workload
 - absolute and relative thresholds
- agents take decisions to achieve/maintain their well-being

*Based on Schmitzberger et al. (2005)

SECLAND ABM – Model structure



SECLAND: Inputdata



SECLAND: Inputdata

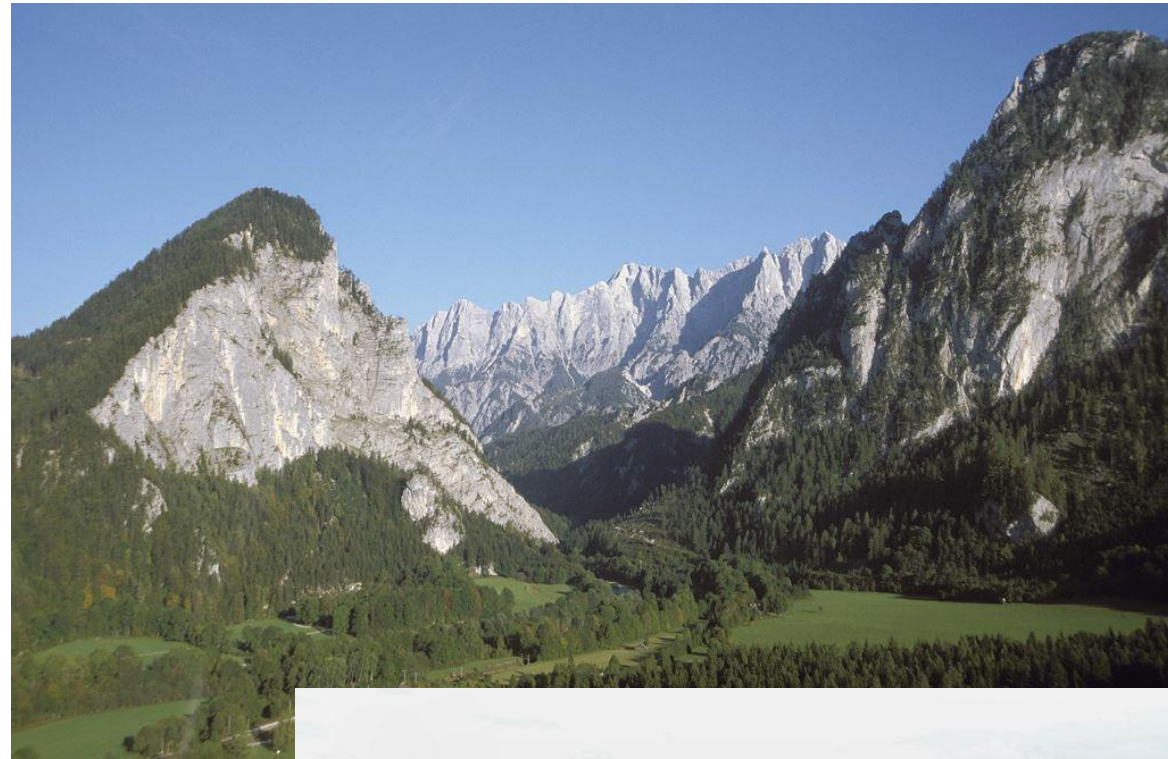
Quantitative

- Lokal, regional, national statistics
- Reports
- Surveys
- Publications
- Own calculations

Qualitative

- Expert Interviews
- Land user interviews
- Survey
- Feedback from local EuropeLAND partners

Case study: Overview



Eisenwurzen



Source:<https://www.lter-austria.at/ltser-plattform-eisenwurzen-ew/>



Braila



Source:<https://restore4life.eu/monitoring-sites/monitoring-site-5-braila-island-romania/>

Case study: comparison

Eisenwurzen

- 5,904 km²
- 311,243 residents
- Livestock (cattle), processing (pigs) and cashcrop
- Family farms only
- Includes the Kalkalpen and Gesäuse National Parks, and the “Steirische Eisenwurzen” Nature and Geopark

Source: <https://deims.org/d0a8da18-0881-4ebe-bccf-bc4cb4e25701>, 29.09.2026

Braila

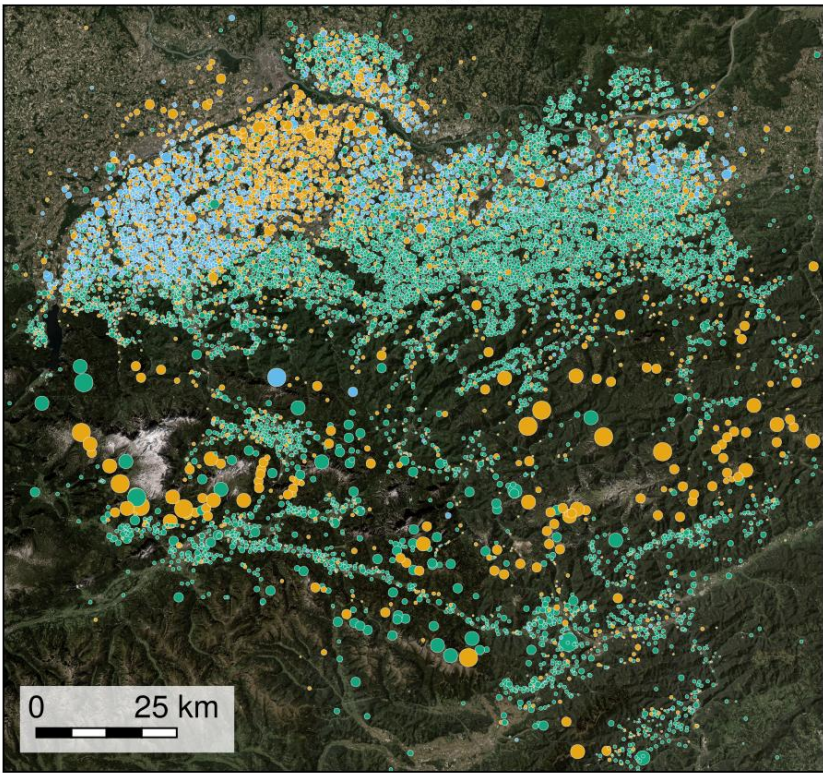
- 4,766 km²
- 344,862 residents
- Cash crop, livestock (ovine)
- Large number of small family farms (mostly <10 ha) and a few large business farms (up to 56,000 ha)
- Includes Balta Mică a Brăilei Natural Park

Source: <https://romaniadategeografice.net/unitati-admin-teritoriale/judete/judete-b/braila/> ,
29.09.2026

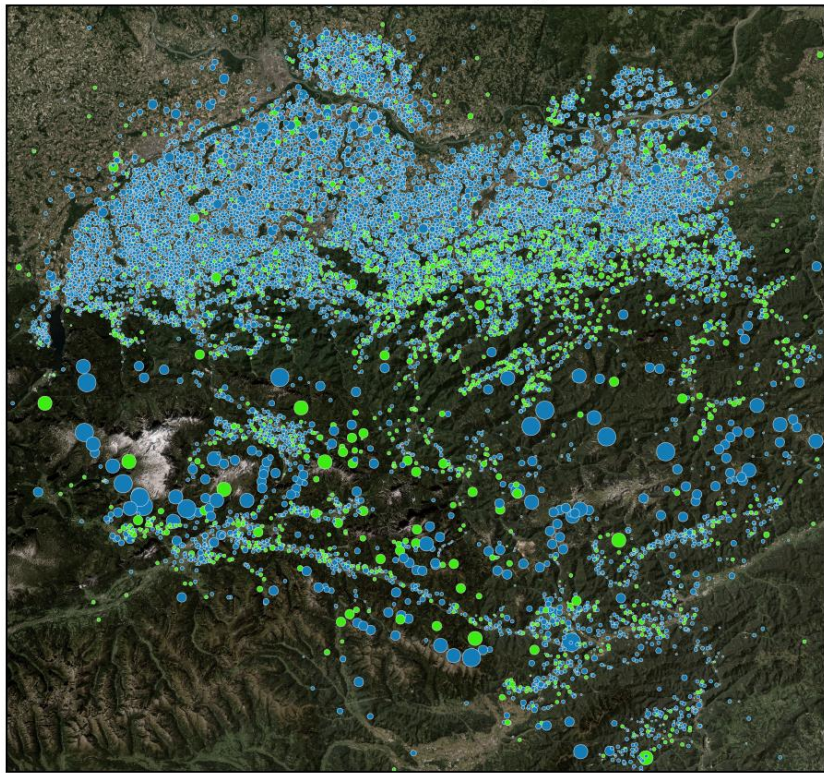
Case study overview

Eisenwurzen: Farms in 2015

Farm type



Production style



Farm type

• cashcrop • livestock • processing

Production style

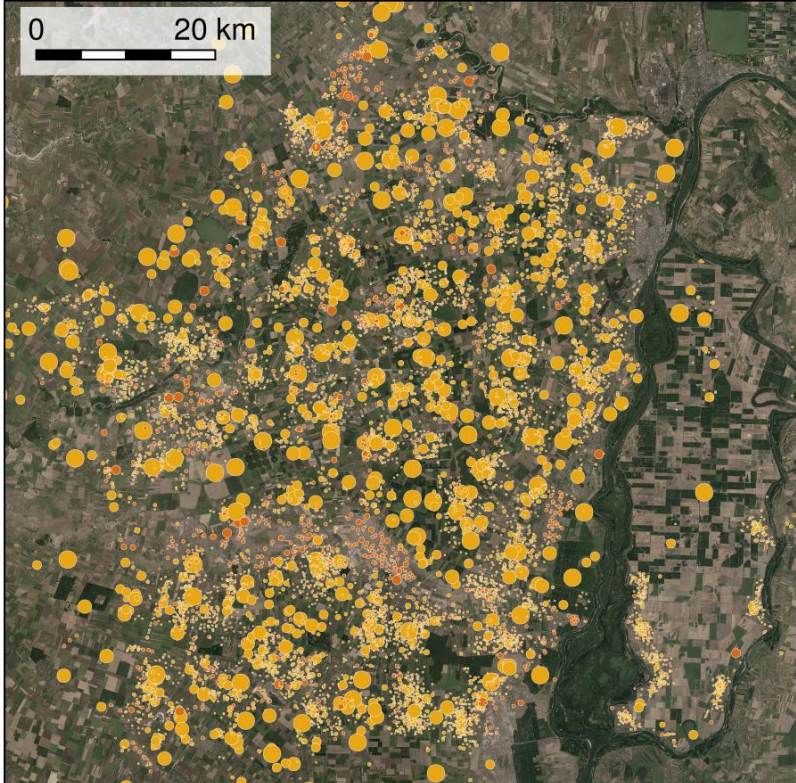
• conventional • organic

Farm size (markers 2x)

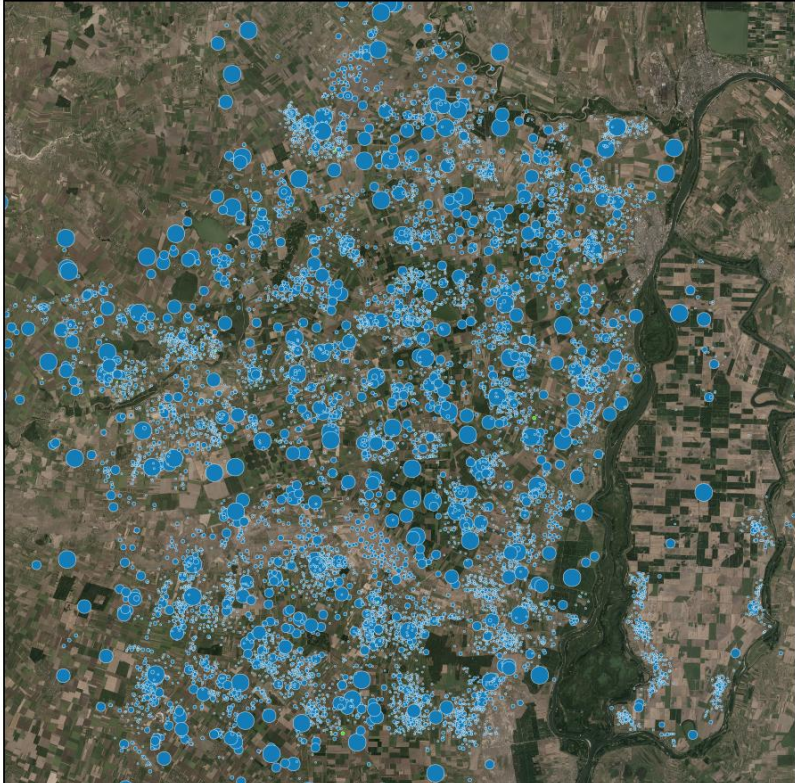
• 0-10 ha • 10-50 ha • 50-100 ha • 100-300 ha • 300-600 ha • >600 ha

Braila County: Farms in 2019

Farm type



Production style



Farm type

• cashcrop • ovine

Production style

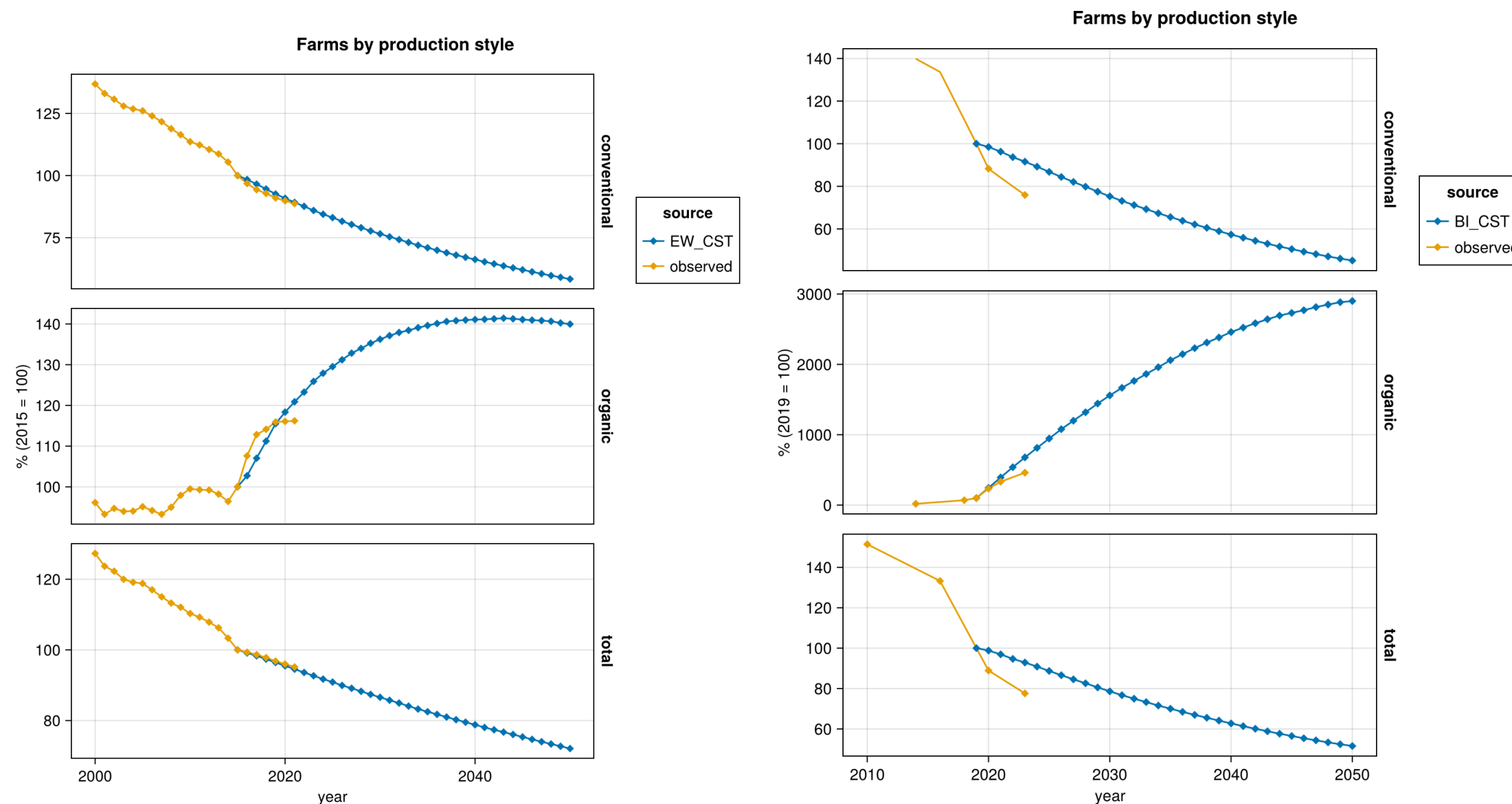
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Farm size (markers 2x)

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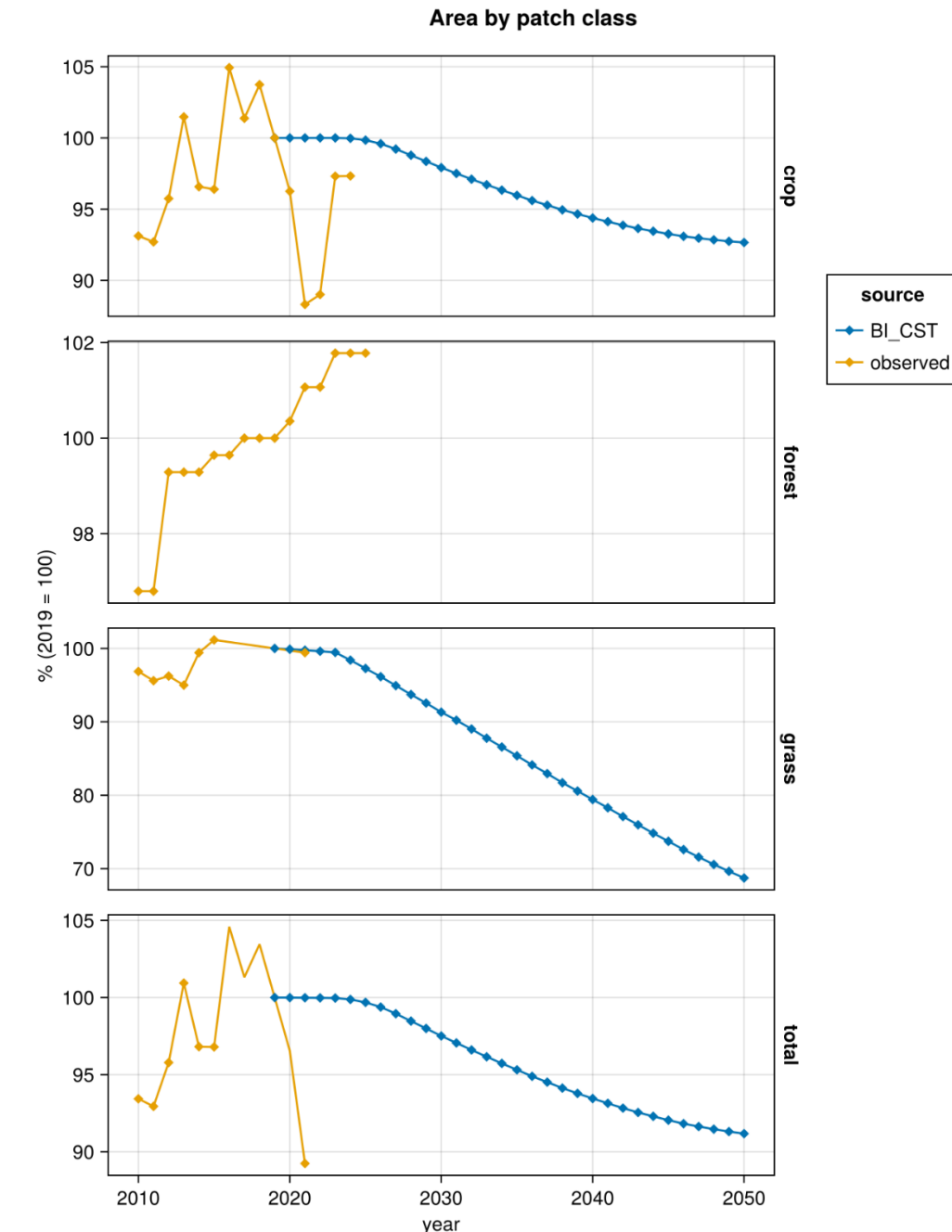
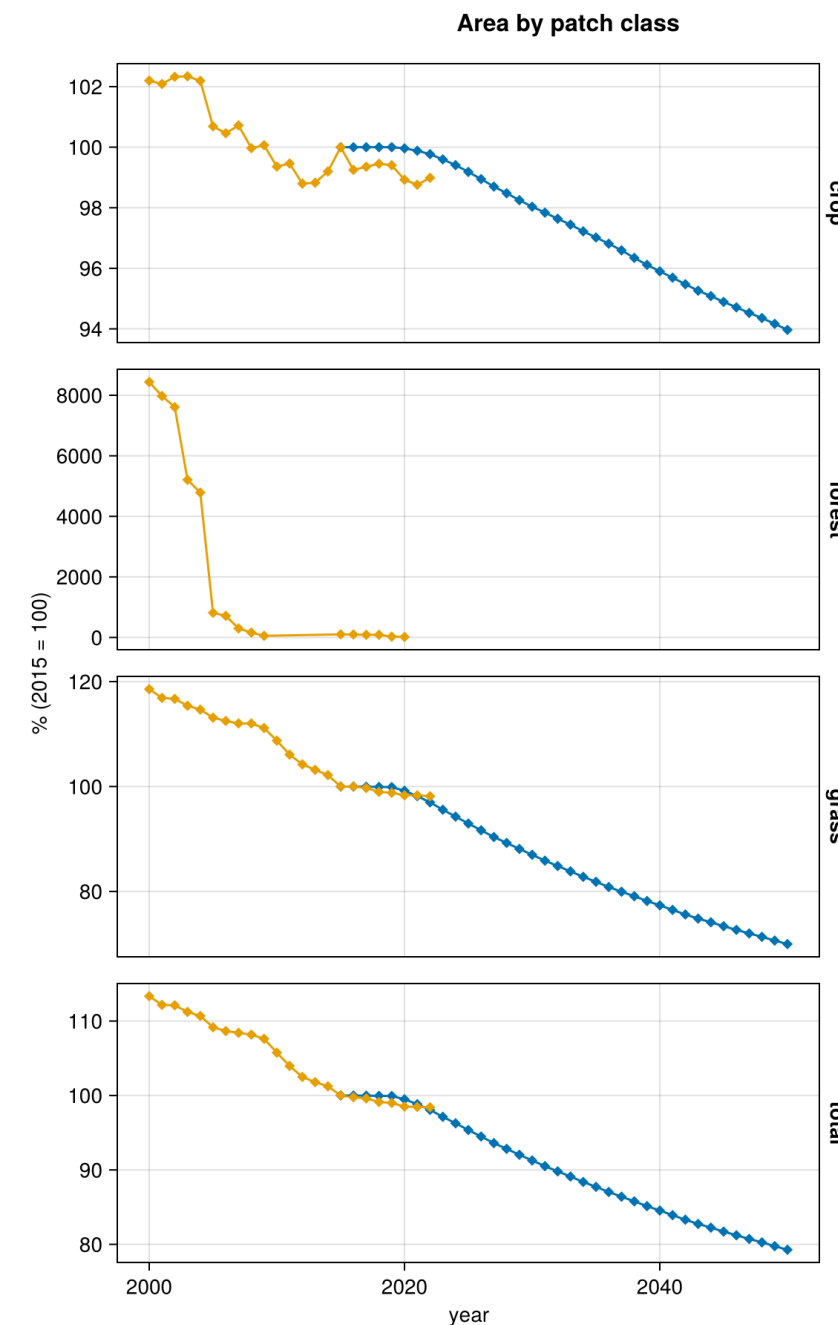
Calibration

- Models are usually evaluated by their **predictive power**
- How well can the model replicate historical trends?
- ABMs require **calibration** of their many parameters to fit to observed trends
- Current strategy is to manually adjust parameters with least empirical knowledge and highest impact
 - **farming style distribution, decision probabilities and happiness**



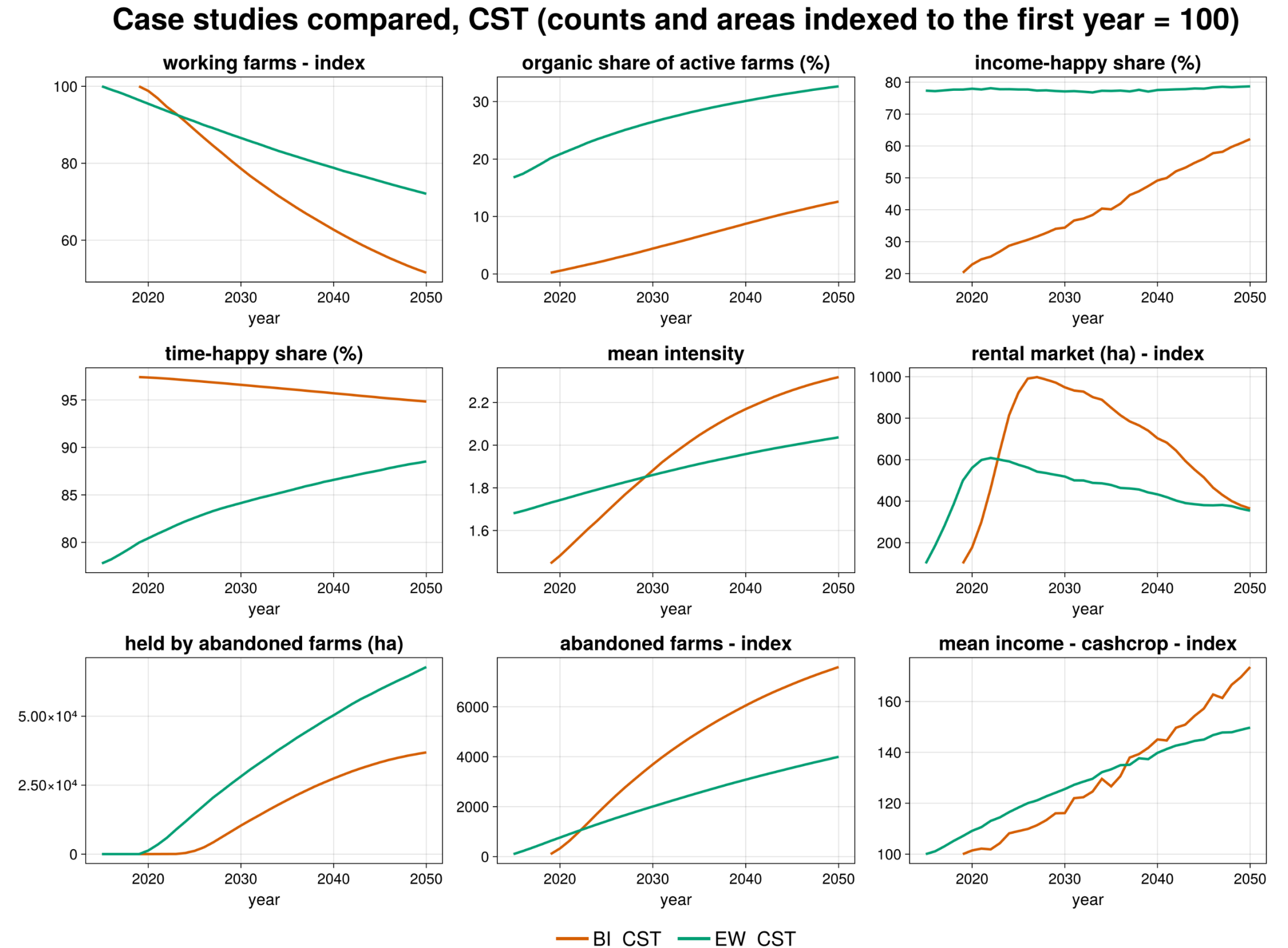
Calibration – Issues and ongoing work

- Observation data event driven and noisy
- ABM start late due to data requirements
- Which parameters have highest impact / uncertainty?
 - ⇒ Sensitivity Analysis (Morris for screening / Shapely for interactions)
- What combinations of parameter values lead to matching histories?
 - ⇒ Wave-based history matching
 - ⇒ Semi-automated calibration
- Guarantees that model match the system?
 - ⇒ **No**

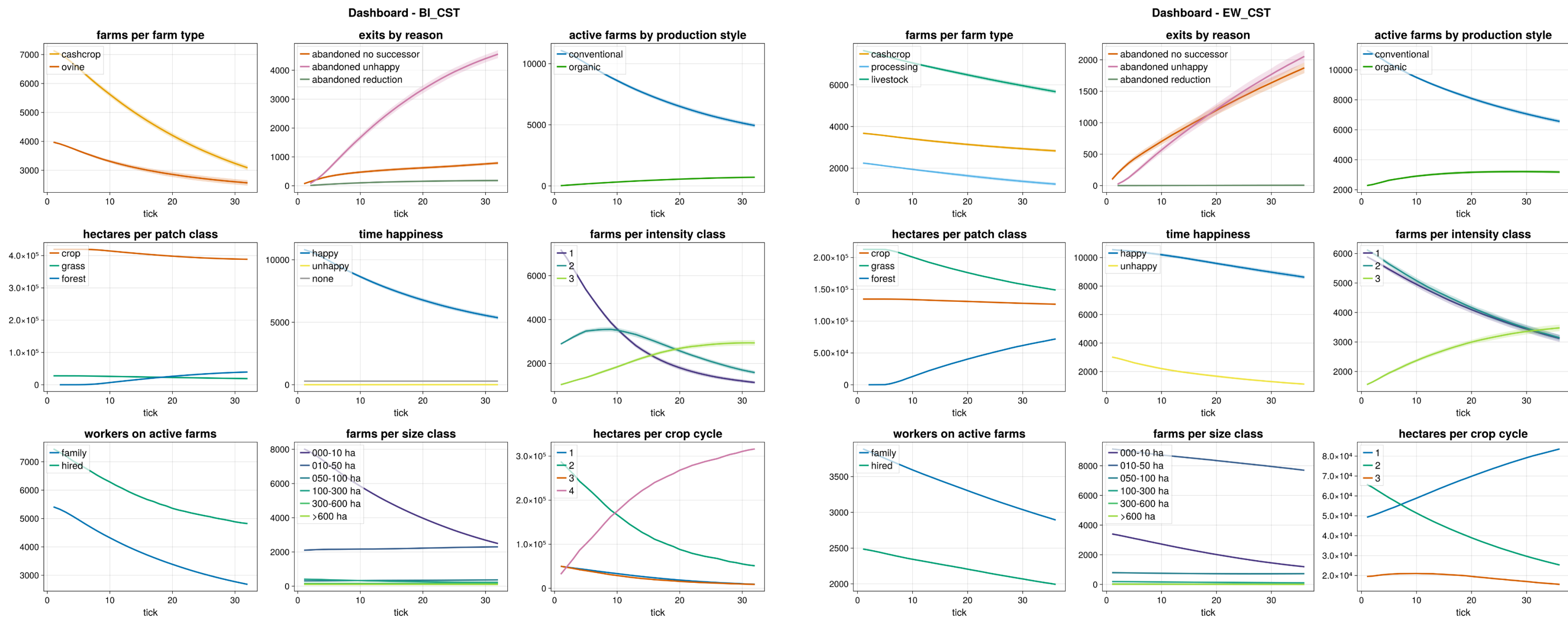


Preliminary results for BI / EW case study

- Only "Constant" scenario – parameters stay the same over the whole model run
- Calibration / input preparation not fully finished
- Model tracks all fields and agent properties and averages results over multiple runs
- Results are detailed, but not all details are meaningful

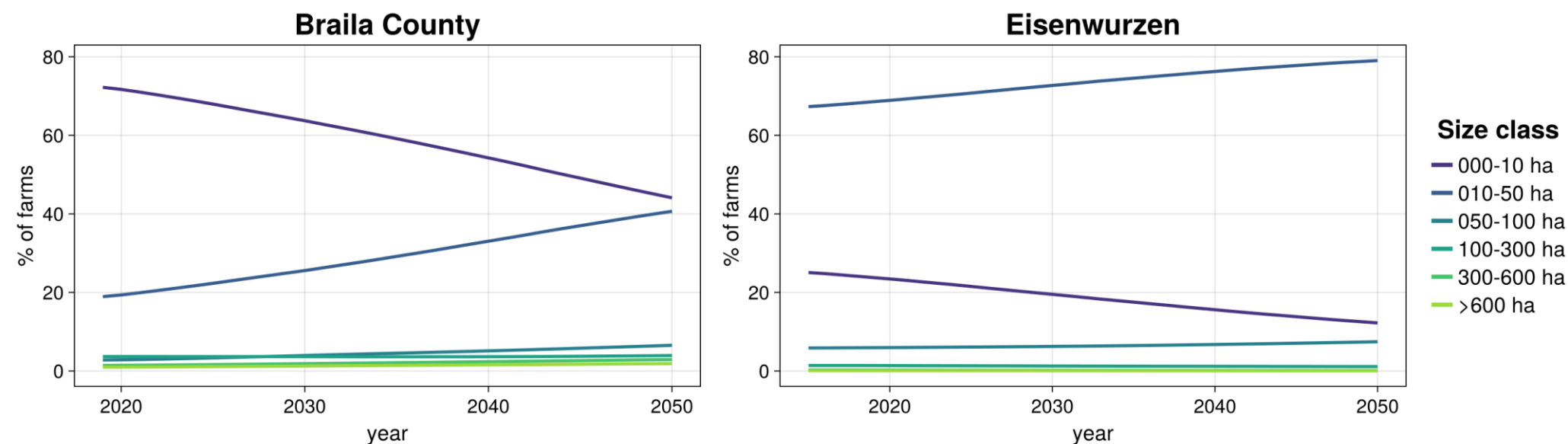


Preliminary results

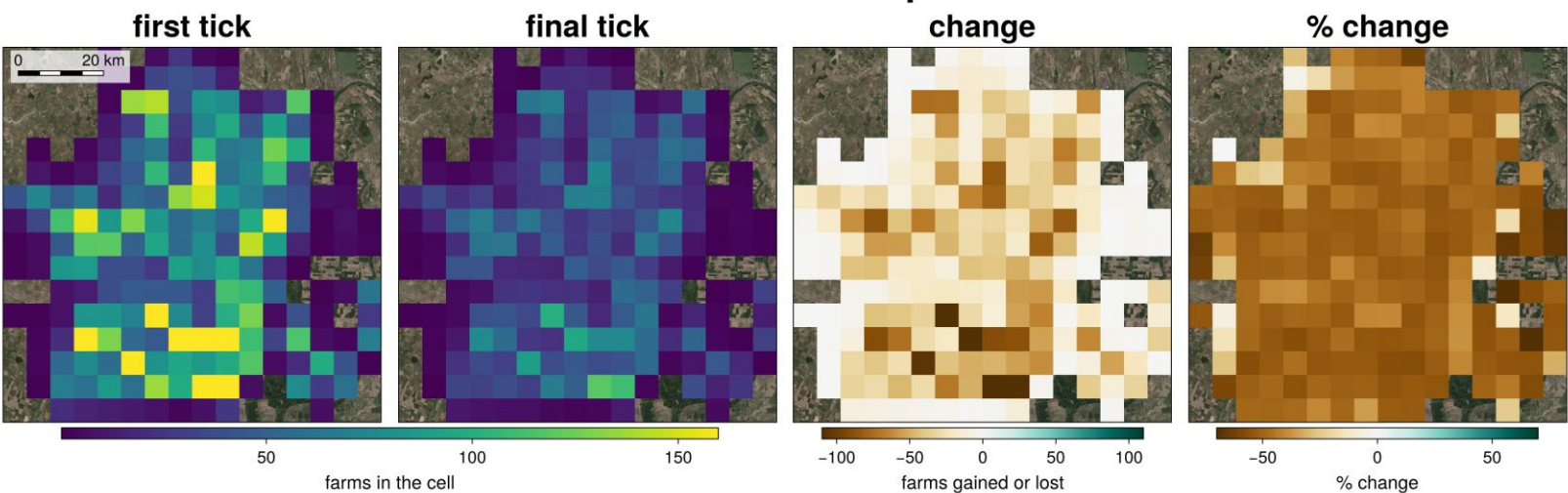


Preliminary results

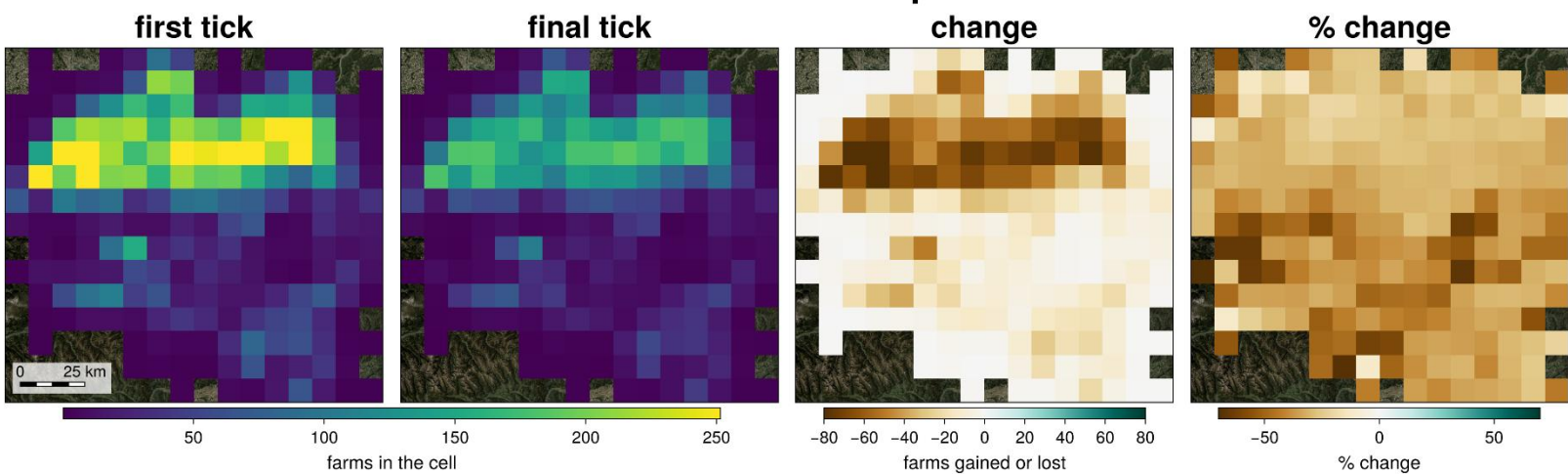
Farms per size class



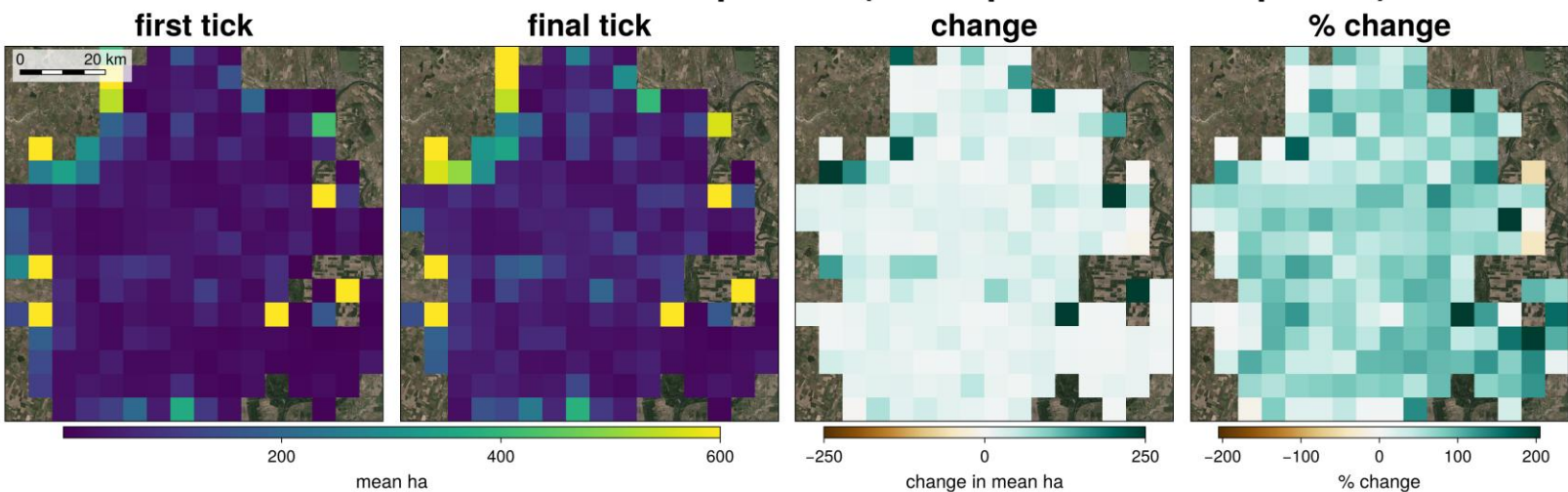
Braila Island: Farms per cell



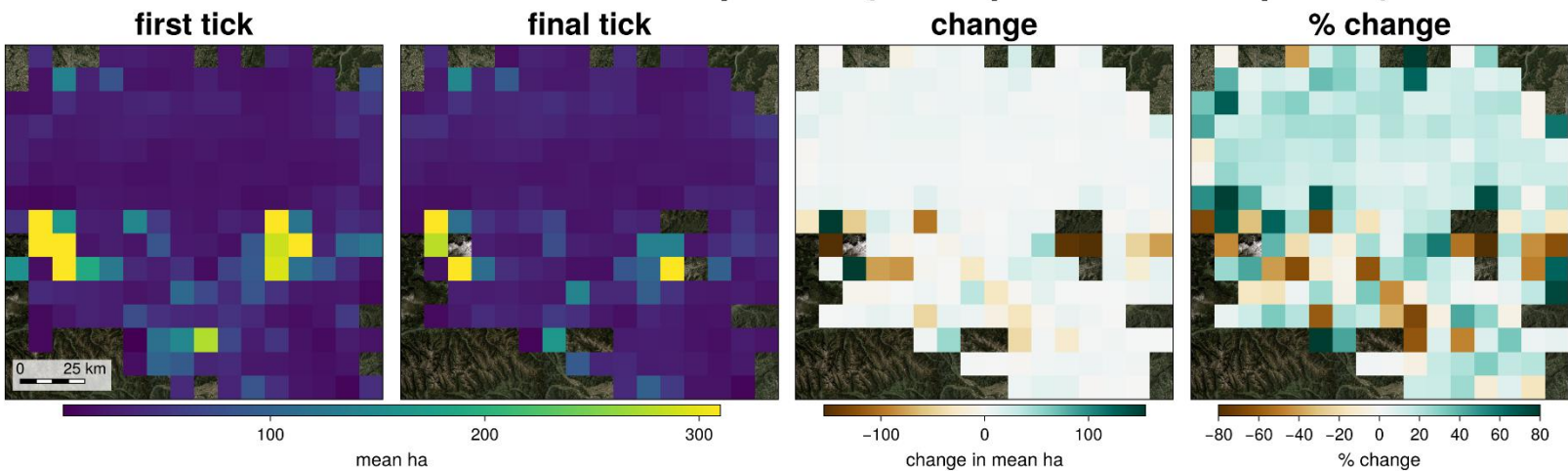
Eisenwurzen: Farms per cell



Braila Island: Mean farm size per cell (one representative replicate)

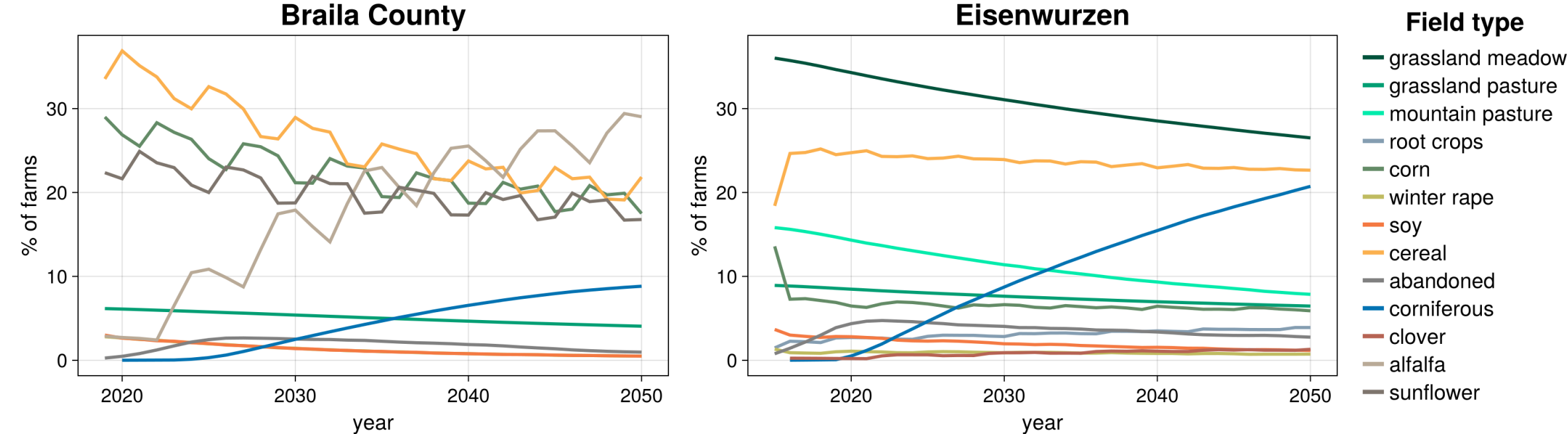


Eisenwurzen: Mean farm size per cell (one representative replicate)

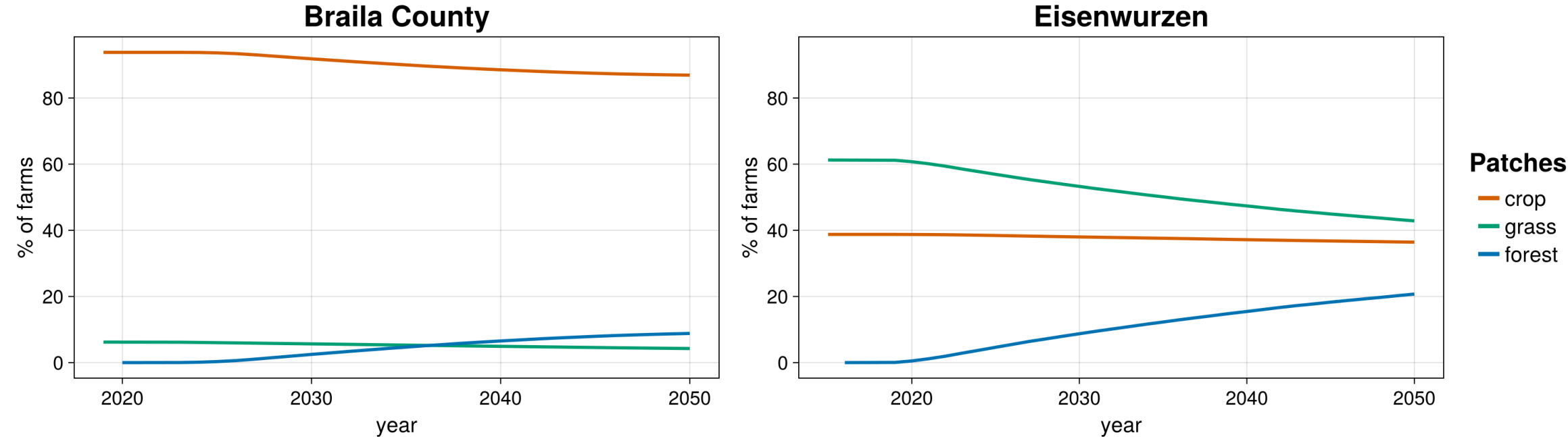


Preliminary results

Field types

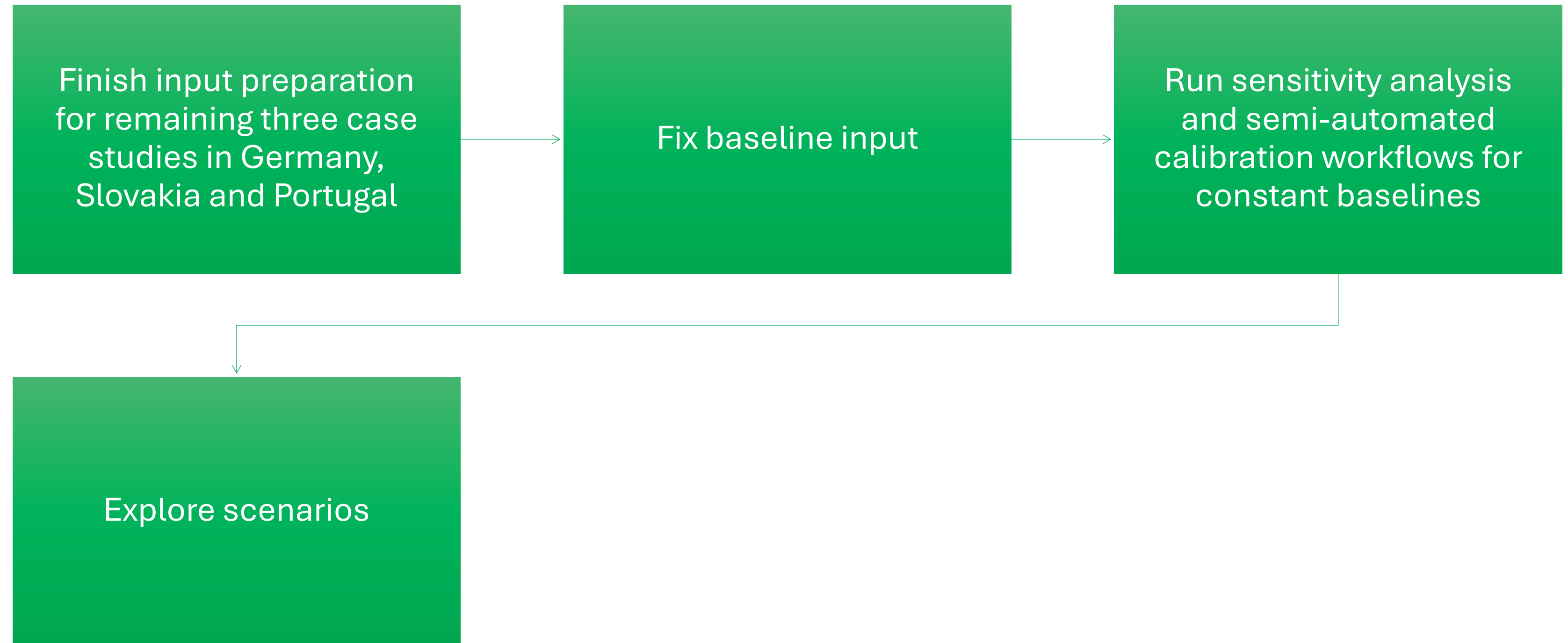


Patch classes



Note: corniferous / forest refers to non-agricultural use

Next steps



Thank you for listening

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[Merci BOKU]