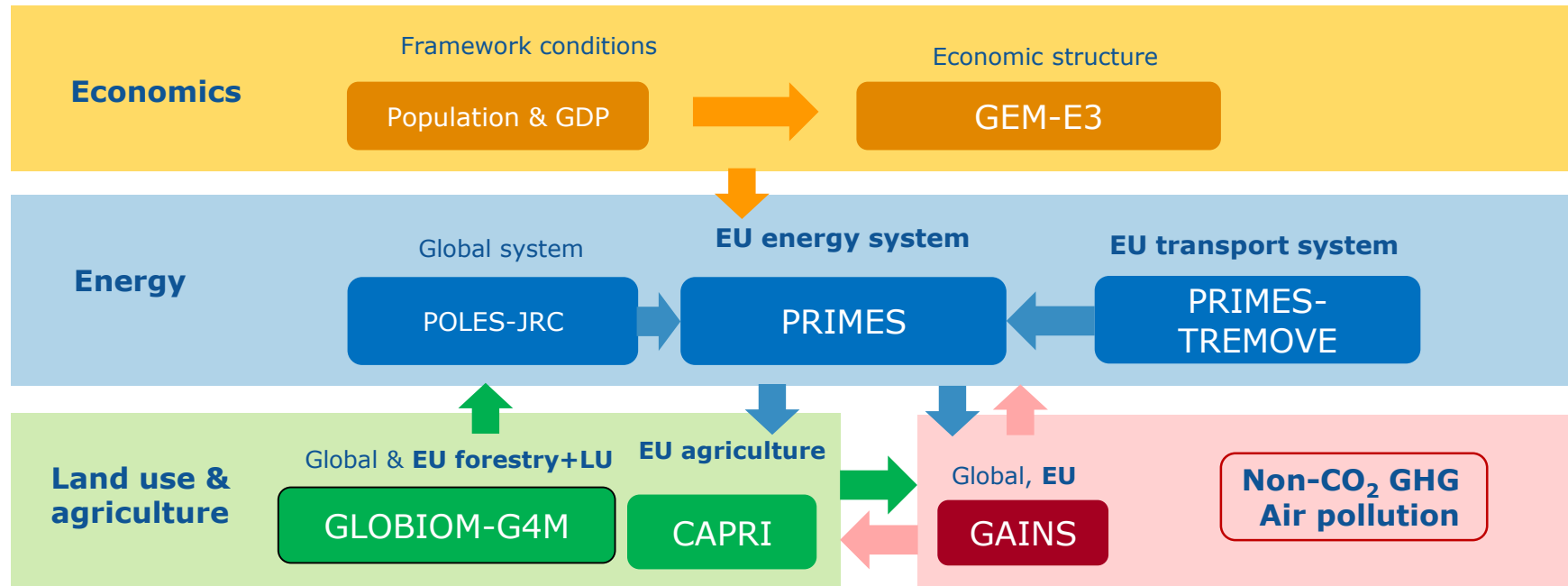# Modelling Energy Community LULUCF emissions/removals with GLOBIOM-G4M

Key assumptions and draft results on land use, land use change, and forestry

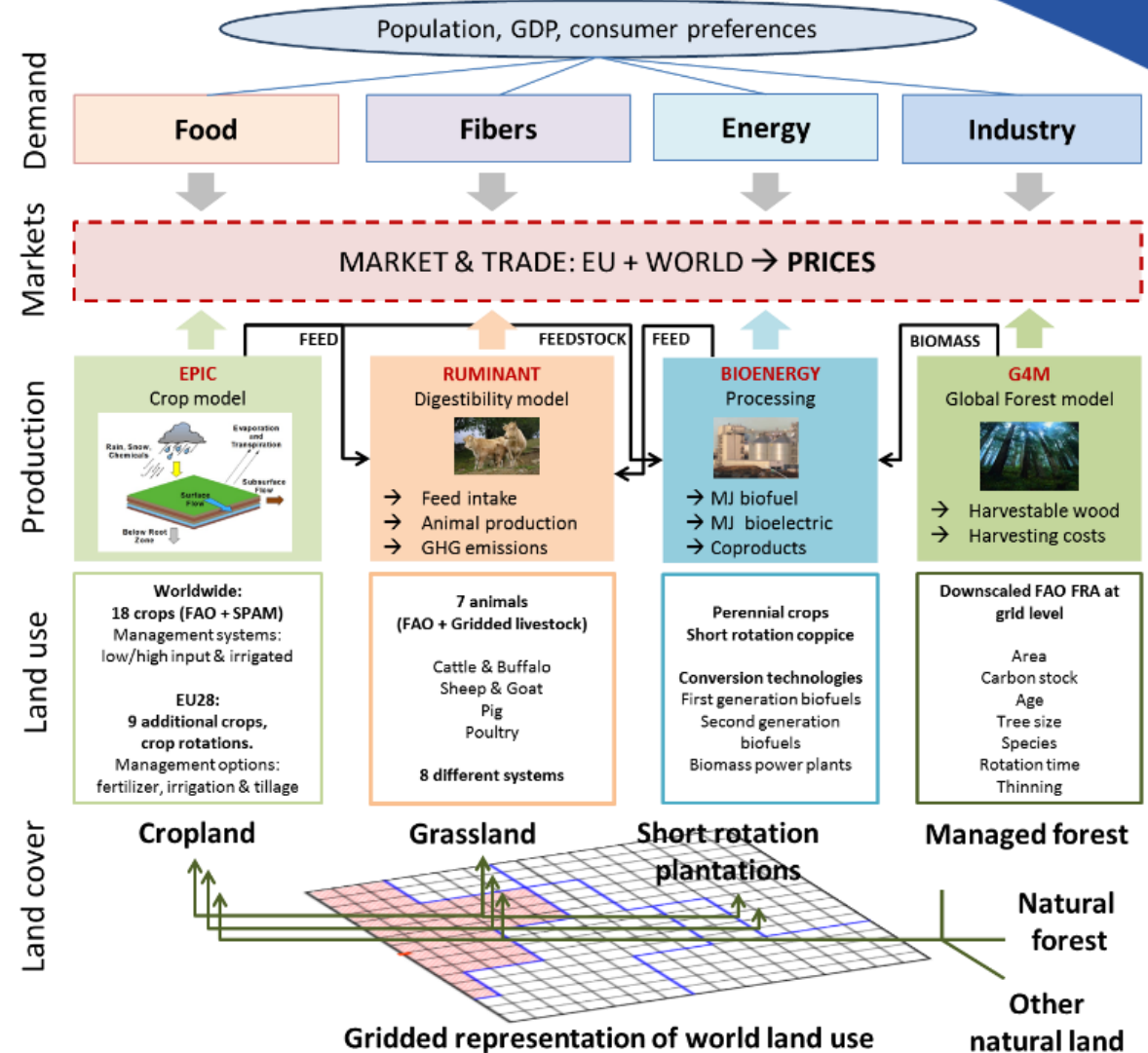Andre Deppermann, Mykola Gusti, Stefan Frank

Integrated Biosphere Futures (IBF) Research Group
Biodiversity and Natural Resources (BNR) Program

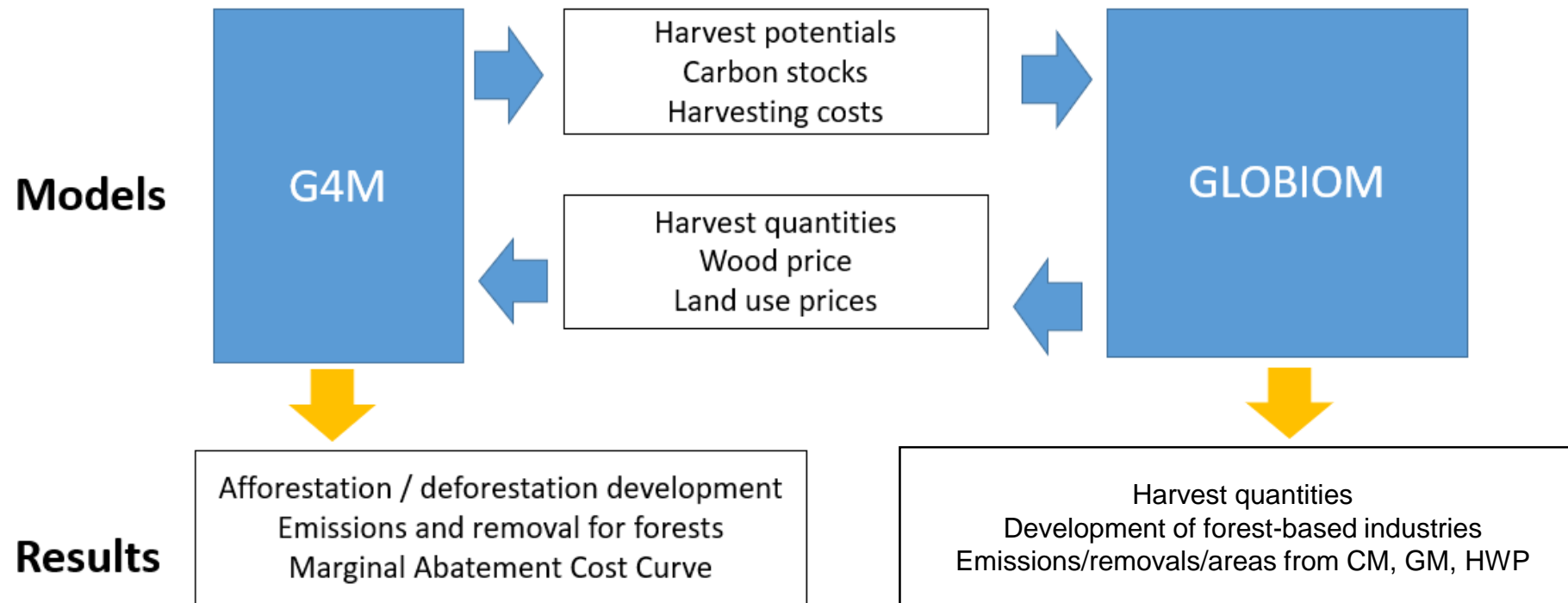# Modelling suite for the draft Reference scenario

GLOBIOM – quick facts

- **Global Biosphere Optimization Model**
  - Developed by IIASAs BNR-Program
- **Partial equilibrium model**
  - Agriculture, forestry, and bioenergy sectors
  - Global coverage, World Regions, EU+Energy Community Countries
  - Bilateral trade flows
- **Bottom-up approach**
  - Detailed spatial resolution
  - Explicit description of production technologies by grid cell
- **Land use and land use change**
  - 6 different land use types
- **Linear programming approach**
  - Maximization of consumer and producer surplus
  - Optimization constraints
- **Base year:** 2000
- **Time step:** 10 years

Linkage between GLOBIOM and G4M

Models

G4M → Harvest potentials / Carbon stocks / Harvesting costs → GLOBIOM

G4M ← Harvest quantities / Wood price / Land use prices ← GLOBIOM

Results

Afforestation / deforestation development
Emissions and removal for forests
Marginal Abatement Cost Curve

Harvest quantities
Development of forest-based industries
Emissions/removals/areas from CM, GM, HWP
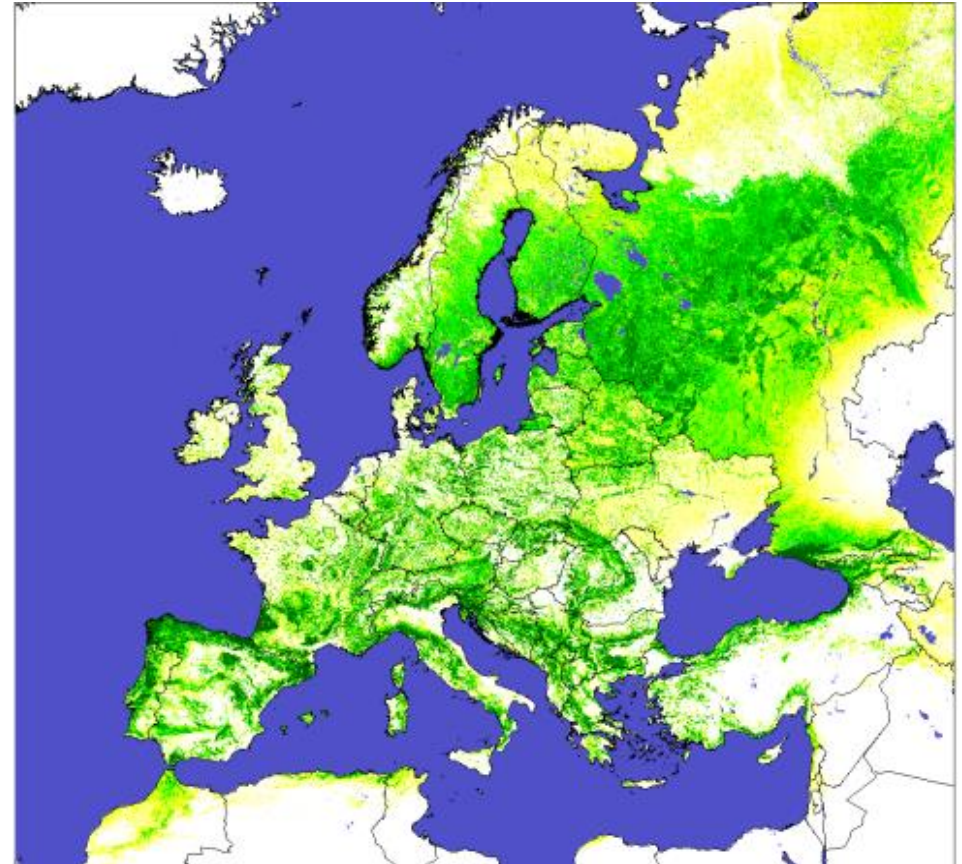
G4M – The Global Forestry Model

- The Global Forestry Model (G4M) is a **geographically explicit economic forest sector model** (full foresight).

- The model provides global coverage and is spatially explicit.

- Estimates the impact of forestry activities (afforestation, deforestation and forest management) on harvestable biomass and forest carbon stocks.

- Historical trends as well as driver developments (wood prices, land productivity & rents, carbon price) are used.
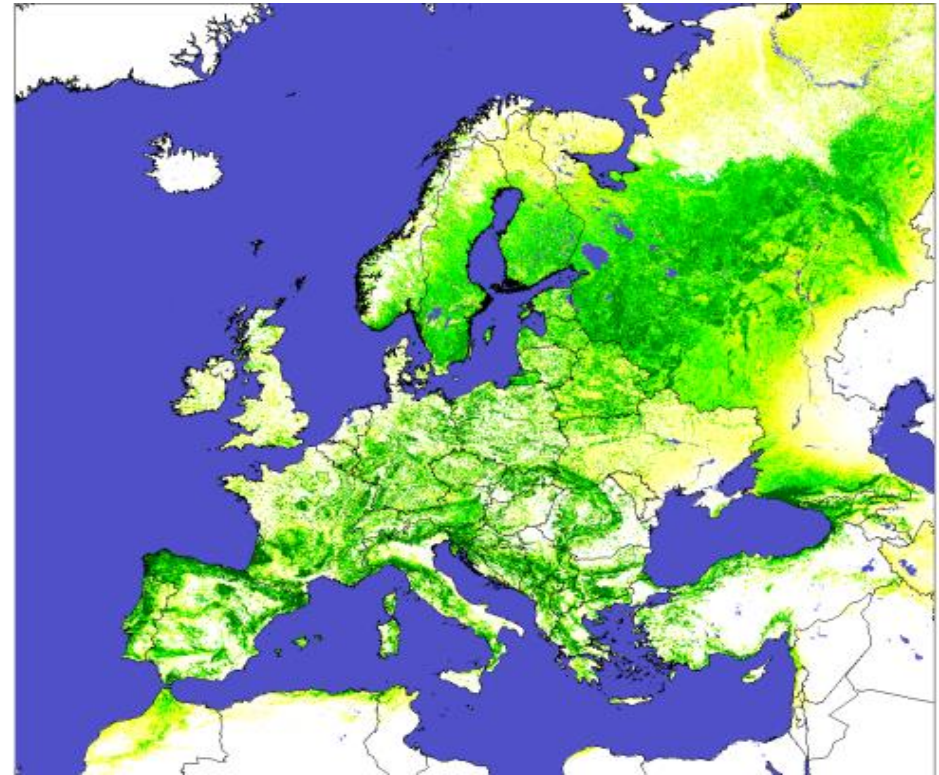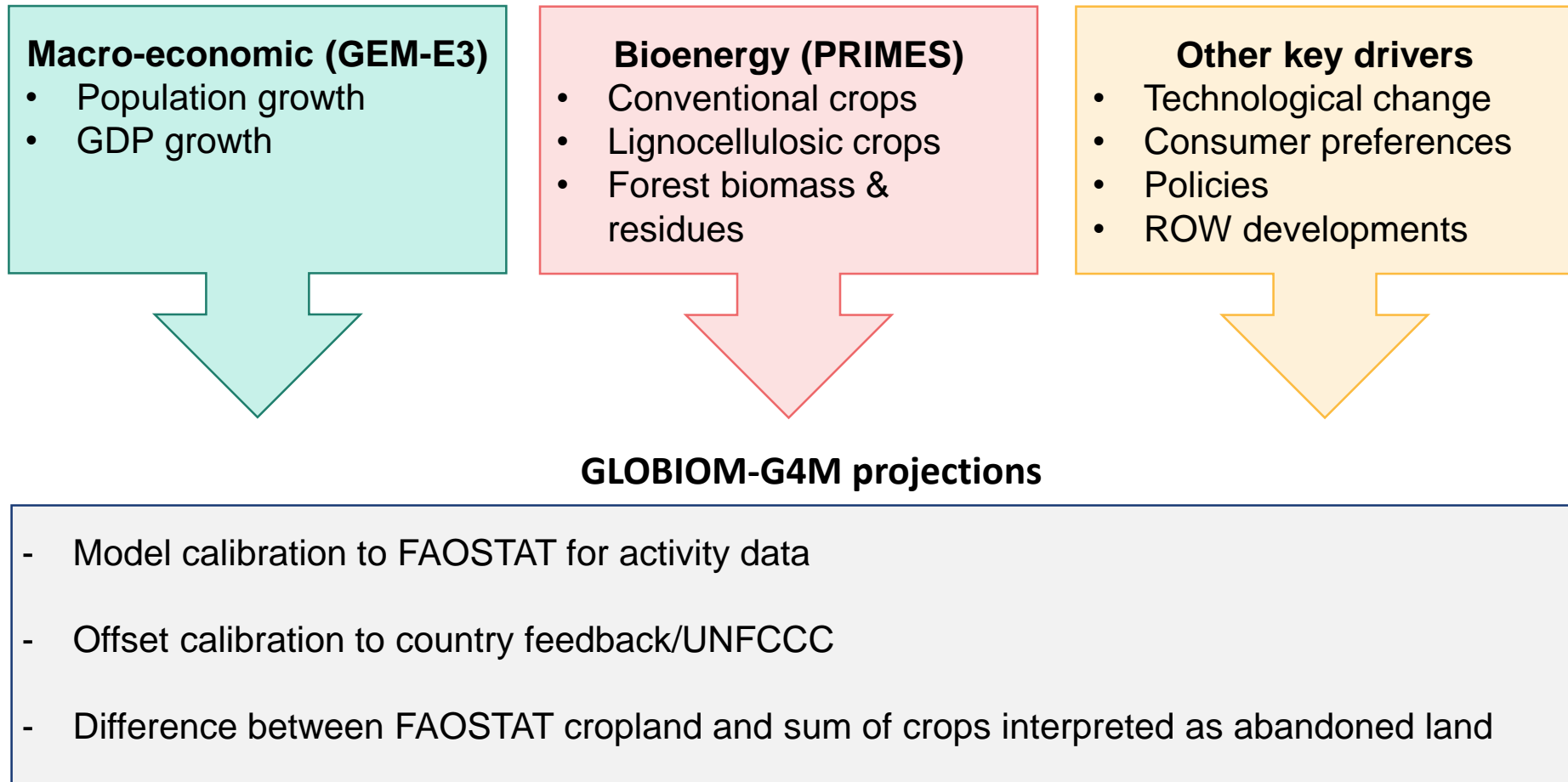
G4M – The Global Forestry Model

The model is linked with GLOBIOM to provide spatial explicit information concerning:

- Change in **forest area** (e.g. afforestation, deforestation) as driven by the value of forest and alternative land use

- Change in **forest management** (e.g. rotation periods, thinning intensity) driven by increasing/decreasing demand of wood (for material and energy purposes)

- The **impact of management activities** on forest carbon stocks, increment, age structure development, harvest assortment, etc.

- **Carbon sequestration** and forest related emissions/removals (e.g. biomass, soil, dead organic matter)

Reference scenario drivers

Macro-economic (GEM-E3)
- Population growth
- GDP growth

Bioenergy (PRIMES)
- Conventional crops
- Lignocellulosic crops
- Forest biomass & residues

Other key drivers
- Technological change
- Consumer preferences
- Policies
- ROW developments

GLOBIOM-G4M projections

- Model calibration to FAOSTAT for activity data

- Offset calibration to country feedback/UNFCCC

- Difference between FAOSTAT cropland and sum of crops interpreted as abandoned land

Data

- UNFCCC data were not available for all countries/categories
- Complemented with country feedback
- If no data available → model results without offset calibration
- Few categories remain empty (e.g. GM can be sink or source in different countries, difficult to assume emission factors)

- Afforestation and deforestation rates*:

  UNFCCC > National data > FAO-FRA > global watch
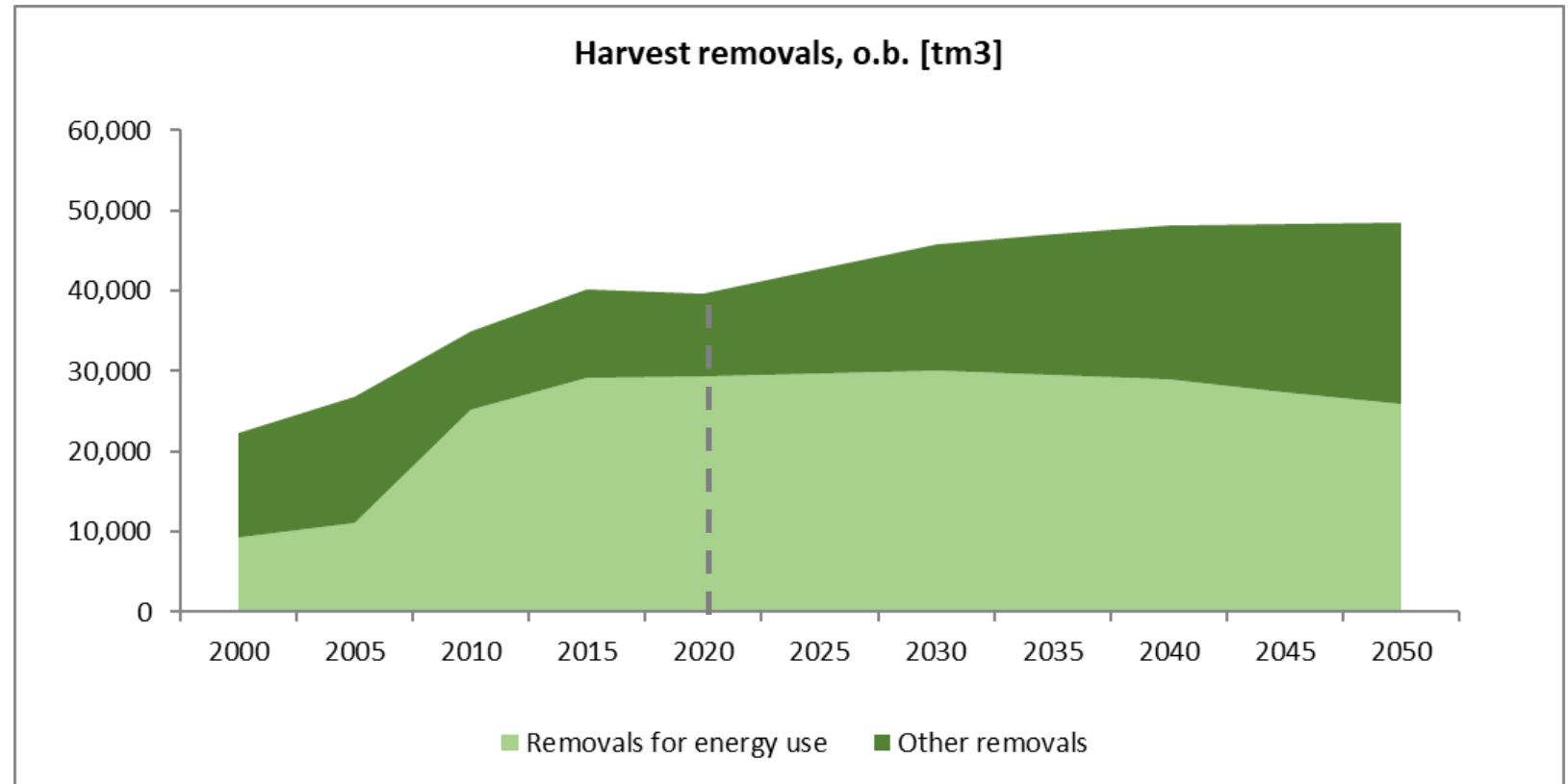- Forest area*: State of Europe's Forest Report > FAO FRA

  * With few deviations
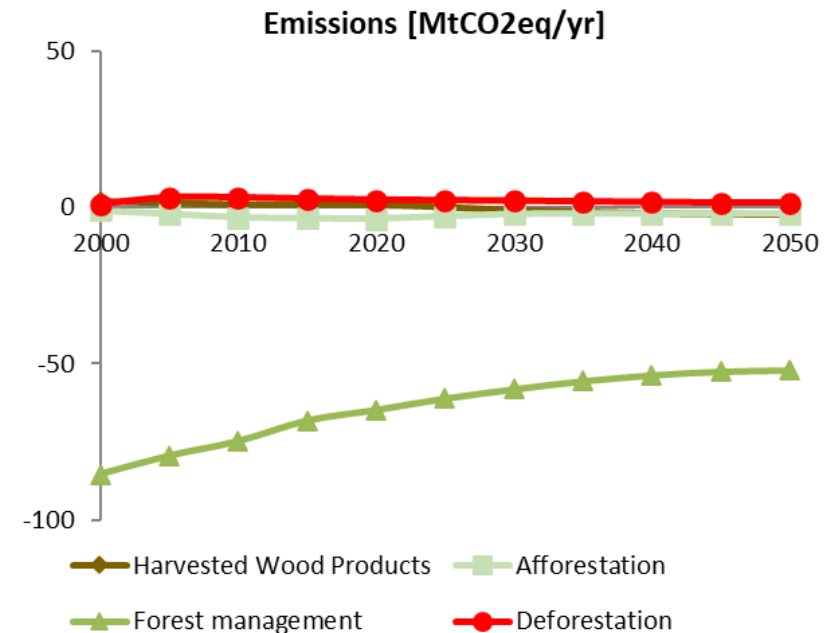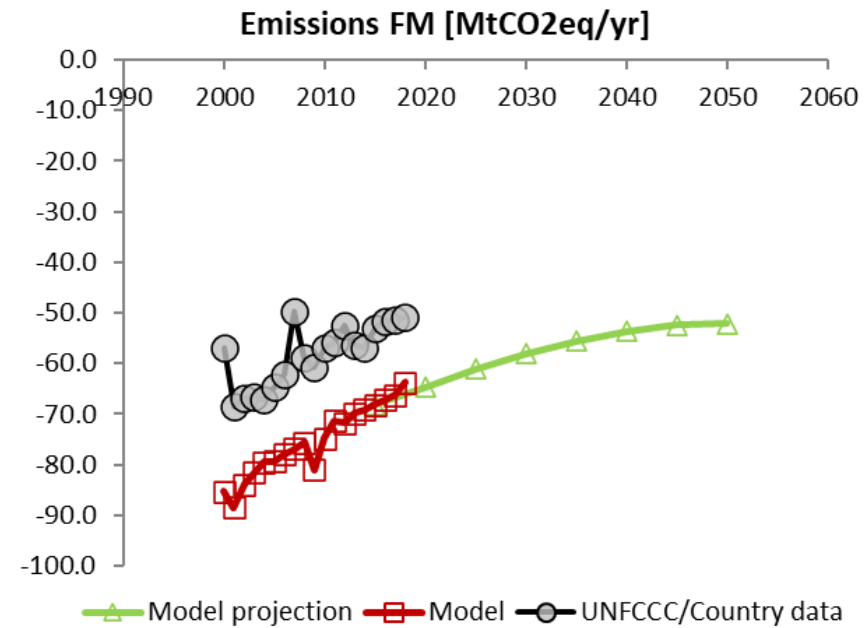
Area developments (EC-9)
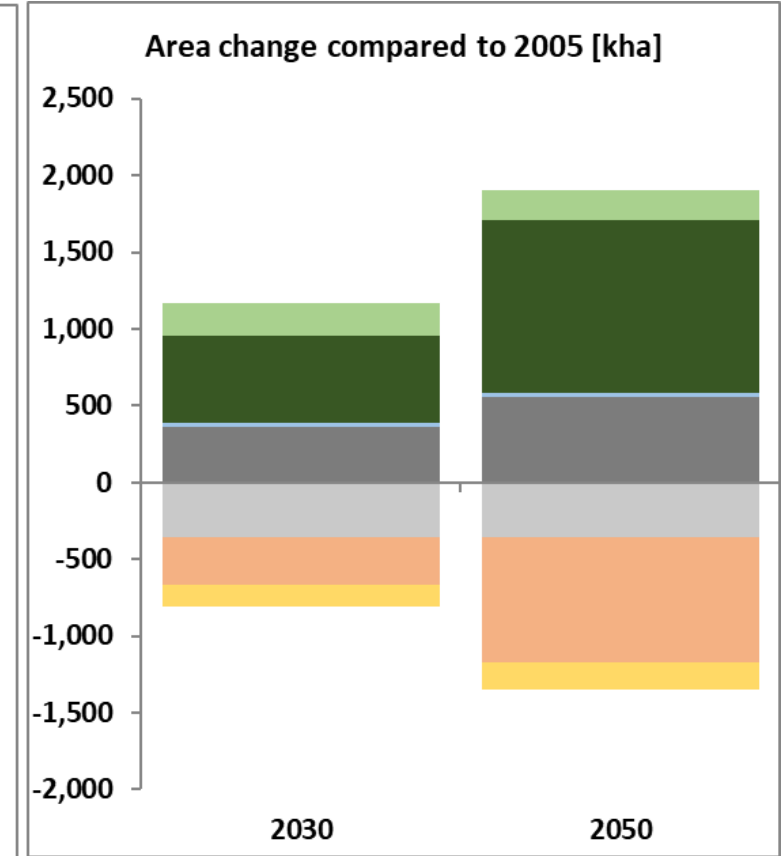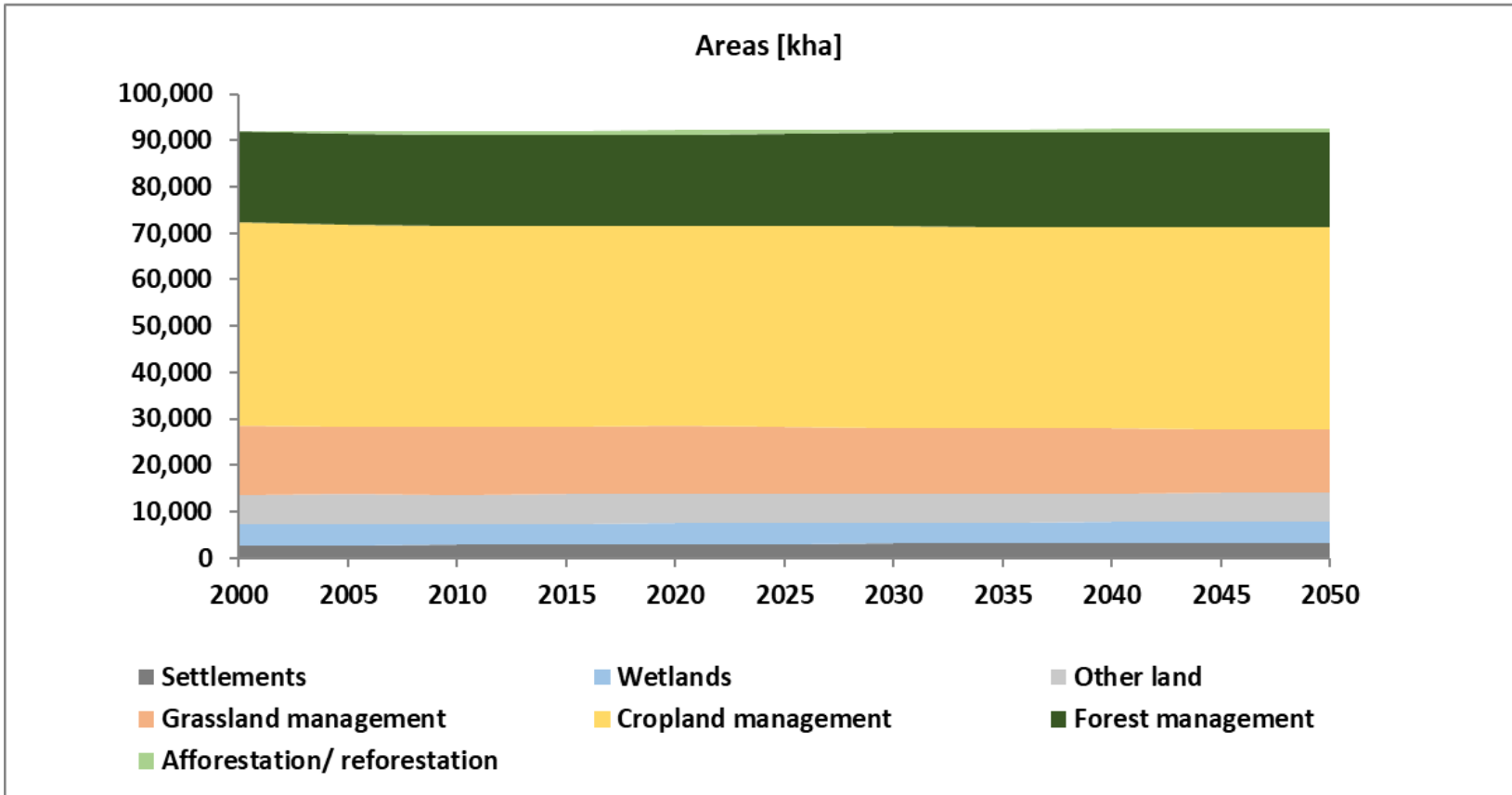
Results – Forest sector removals (EC-9)

- ▸ Historical increase in roundwood harvests continues less strong after 2020

- ▸ Wood use for energy rather stable, material use expanding

Harvest removals, o.b. [tm3]

Legend: ■ Removals for energy use ■ Other removals

Forest sink – EC-9 countries

- Forest management is the main driver of the LULUCF sink

- Difference to UNFCCC/Country data due to missing data for some countries, which have been filled with model results

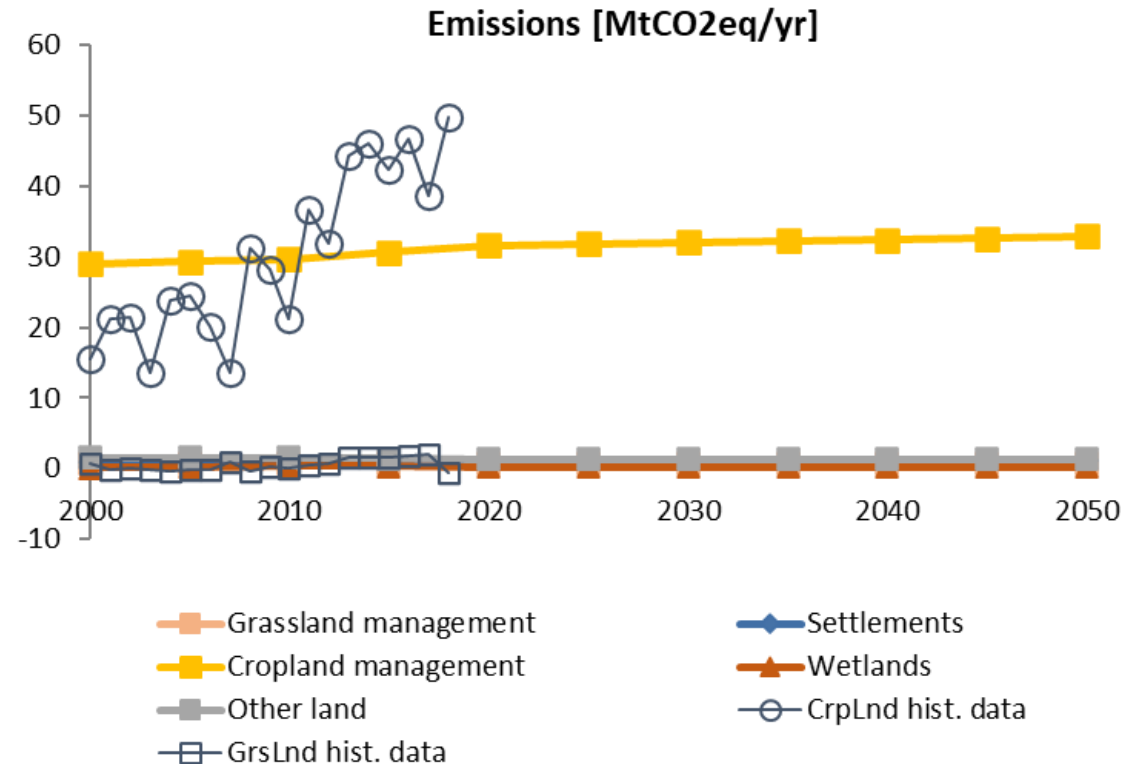- Decreasing sink goes back to higher harvesting of managed forests, only slightly compensated by afforestation

Emissions FM [MtCO2eq/yr]

— Model projection — Model — UNFCCC/Country data

Emissions [MtCO2eq/yr]

— Harvested Wood Products — Afforestation
— Forest management — Deforestation

Results – afforestation and deforestation (EC-9)

▸ Annual afforestation rate declines and stabilizes at lower level after 2015. Slight decline after 2035.

▸ Deforestation rates are low and declining.

▸ Rather stable net forest area growth over time

▸ *Afforestation* category (emissions) covers 20 years according to UNFCCC accounting

▸ *Accumulated Afforestation* shows the trajectory without shifting emissions after 20 years into forest management category
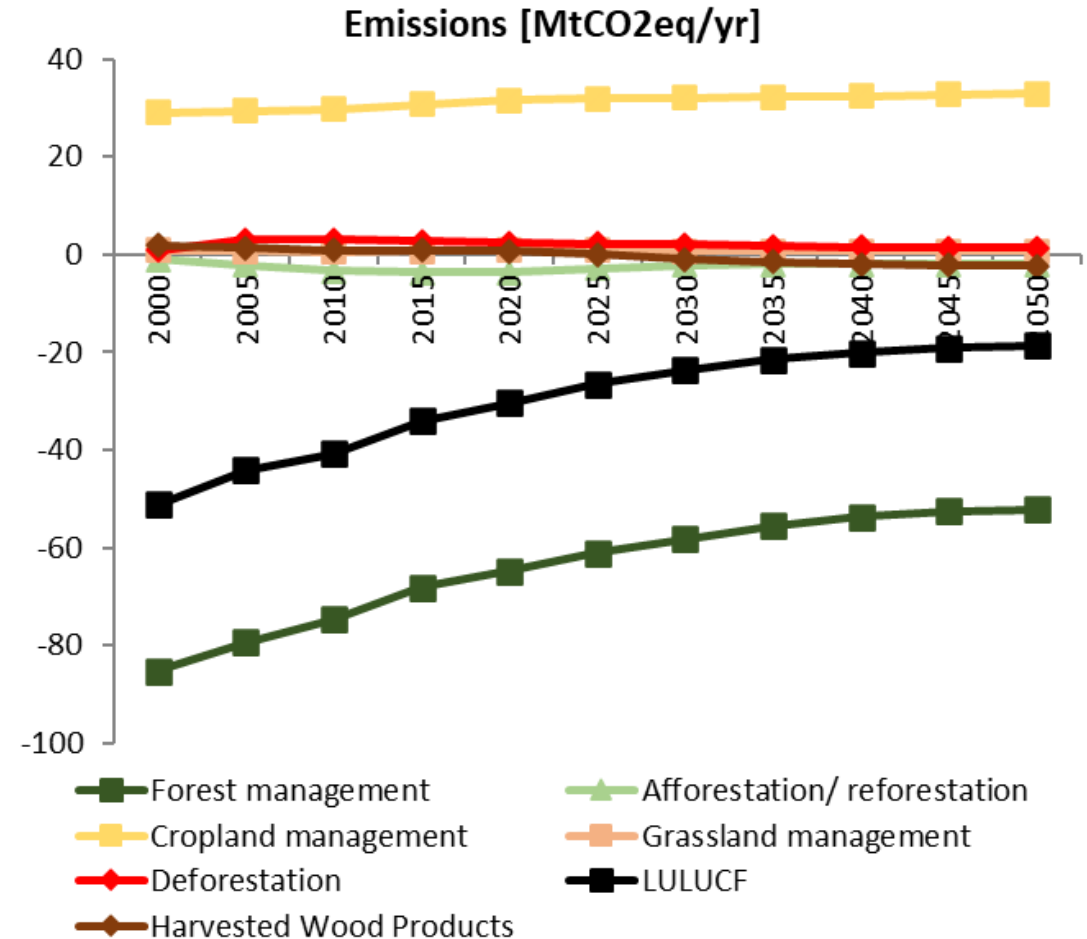

annual afforestation/deforestation [kha]

Emissions afforestation/deforestation [MtCO2eq/yr]
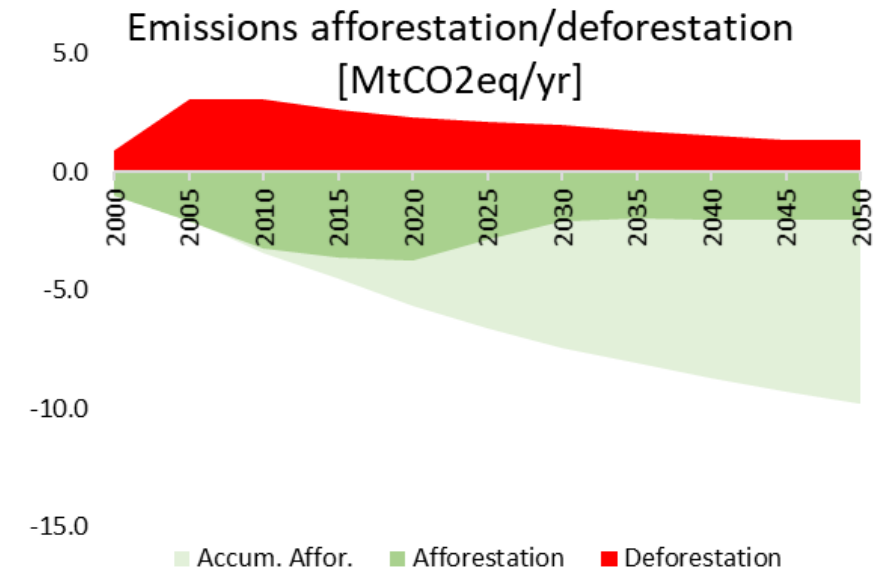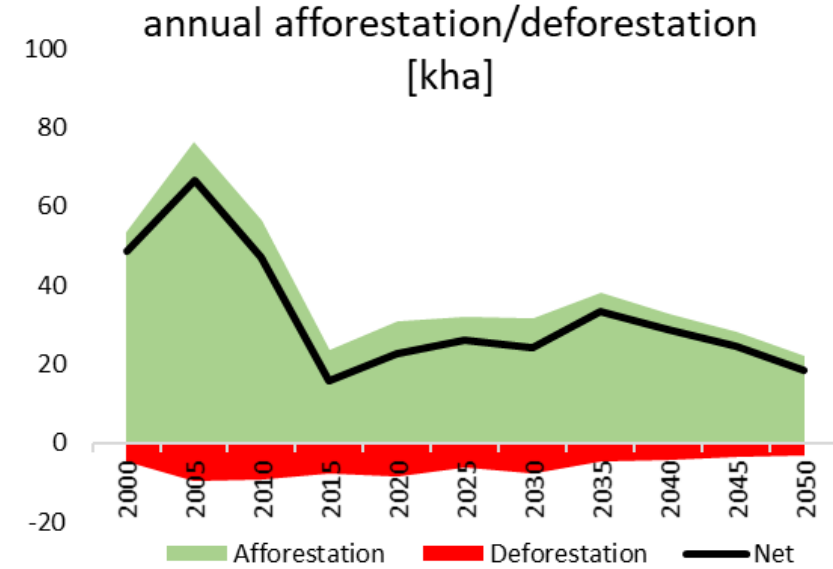
Cropland, Grassland and other (EC-9)

- Projected cropland emissions slightly increase over time

- CM not matching well historical trends

- CM emissions mainly from Ukraine

- No explicit SOC module in the model

- Other categories rather small

Emissions [MtCO2eq/yr]

Legend:
- Grassland management
- Cropland management
- Other land
- GrsLnd hist. data
- Settlements
- Wetlands
- CrpLnd hist. data

Total LULUCF sink (EC-9)

▸ Cropland emissions increase slowly, grasslands remain a small source

▸ LULUCF dominated by forest management sink which is projected to decrease

▸ Net LULUCF sink declines to about 23 $MtCO_2$/y by 2030 (decrease by ~50% compared to 2005), thereafter much less dramatic

▸ Pattern is not the same for all countries

Emissions [MtCO2eq/yr]

Legend:
- Forest management
- Afforestation/ reforestation
- Cropland management
- Grassland management
- Deforestation
- LULUCF
- Harvested Wood Products

Thank you!