International Institute for Applied Systems Analysis
www.iiasa.ac.at

science for global insight

Linking global development goals and forest management alternatives: The GLOBIOM approach

Fulvio Di Fulvio
Ecosystems Services and Management Program
International Institute for Applied System Analysis

Our forest modeling team at IIASA

Nicklas Forsell

Anu Korosuo

Pekka Lauri

Mykola Gusti

Fulvio Di Fulvio

Summary

- Climate policies and development pathways
- The GLOBIOM model for Impact Assessment
- The impact of different climate targets on the forest sector
- Another dimension of impacts: Biodiversity
- Looking into future applications

nature climate change

ARTICLES

https://doi.org/10.1038/s41558-018-0091-3

Scenarios towards limiting global mean temperature increase below 1.5 °C

Joeri Rogelj[1,2*], Alexander Popp[3], Katherine V. Calvin[4], Gunnar Luderer[3], Johannes Emmerling[5,6], David Gernaat[7,8], Shinichiro Fujimori[1,9], Jessica Strefler[3], Tomoko Hasegawa[1,9], Giacomo Marangoni[5,6], Volker Krey[1], Elmar Kriegler[3], Keywan Riahi[1], Detlef P. van Vuuren[7,8], Jonathan Doelman[7], Laurent Drouet[5,6], Jae Edmonds[4], Oliver Fricko[1], Mathijs Harmsen[7,8], Petr Havlík[1], Florian Humpenöder[3], Elke Stehfest[7] and Massimo Tavoni[5,6,10]

Contents lists available at ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

Impact of the 2 °C target on global woody biomass use

Pekka Lauri[a,*], Nicklas Forsell[a], Anu Korosuo[a], Petr Havlík[a], Michael Obersteiner[a], Annika Nordin[b]

[a] International Institute for Applied Systems Analysis (IIASA), Schlossplatz 1, A-2361 Laxenburg, Austria
[b] Swedish University of Agricultural (SLU), Umeå, Sweden

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

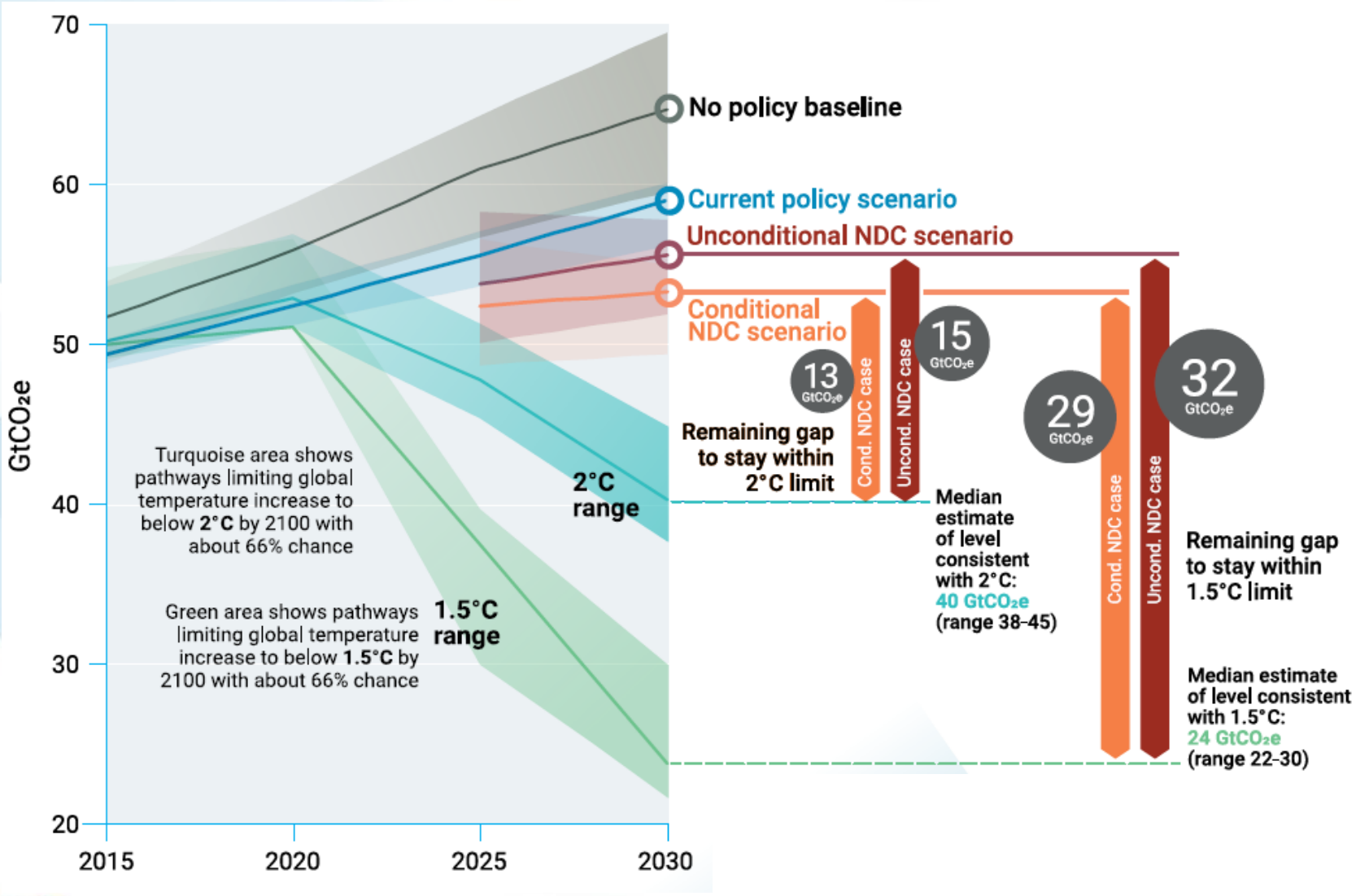
Spatially explicit LCA analysis of biodiversity losses due to different bioenergy policies in the European Union

Fulvio Di Fulvio [a,*], Nicklas Forsell [a], Anu Korosuo [a], Michael Obersteiner [a], Stefanie Hellweg [b]

[a] Ecosystems Services and Management Program (ESM), International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria
[b] Ecological Systems Design, Institute of Environmental Engineering (IfU), ETH, Zurich, Switzerland

Climate policies and development pathways

Paris Agreement and the NDC's

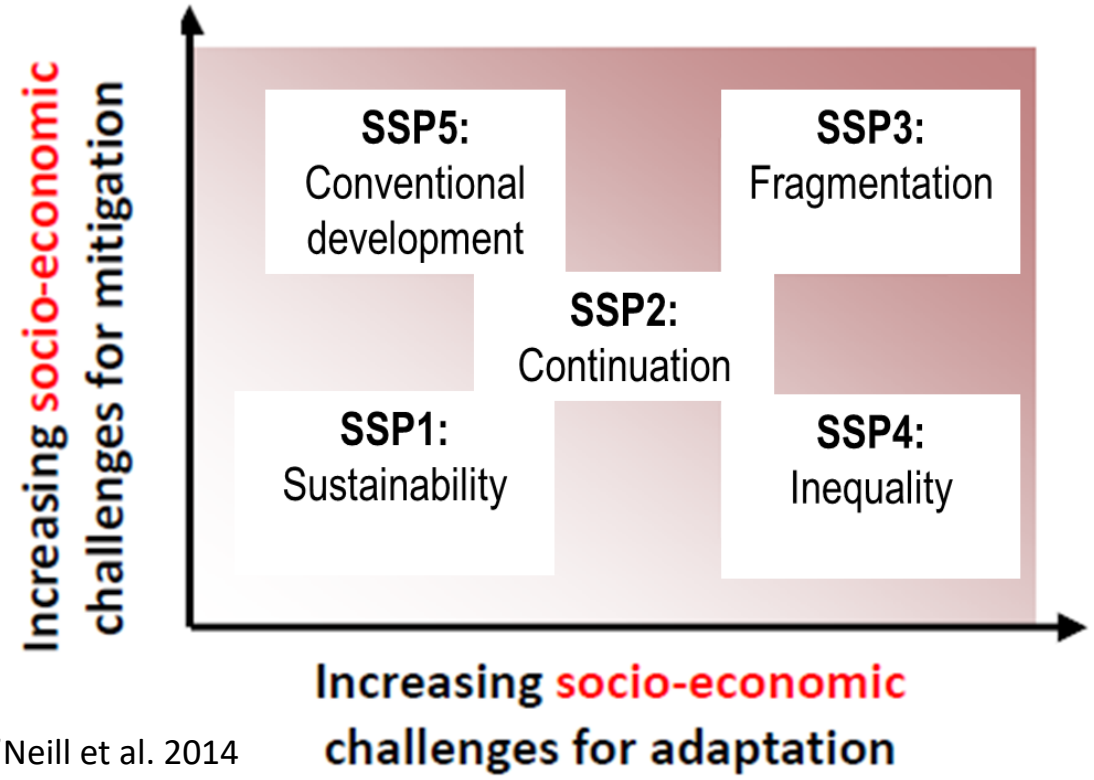


Nationally Determined Contributions (NDCs)

- 196 Parties aiming at limiting global warming to 1.5 to 2 °C above pre-industrial levels

Source: UNEP (2018)

The SSPs and the forest sector



O'Neill et al. 2014

Shared Socioeconomic Pathways (SSPs)

- Population
- Urbanization
- GDP

Developed by the climate change research community

O'Neil et al. (2014)

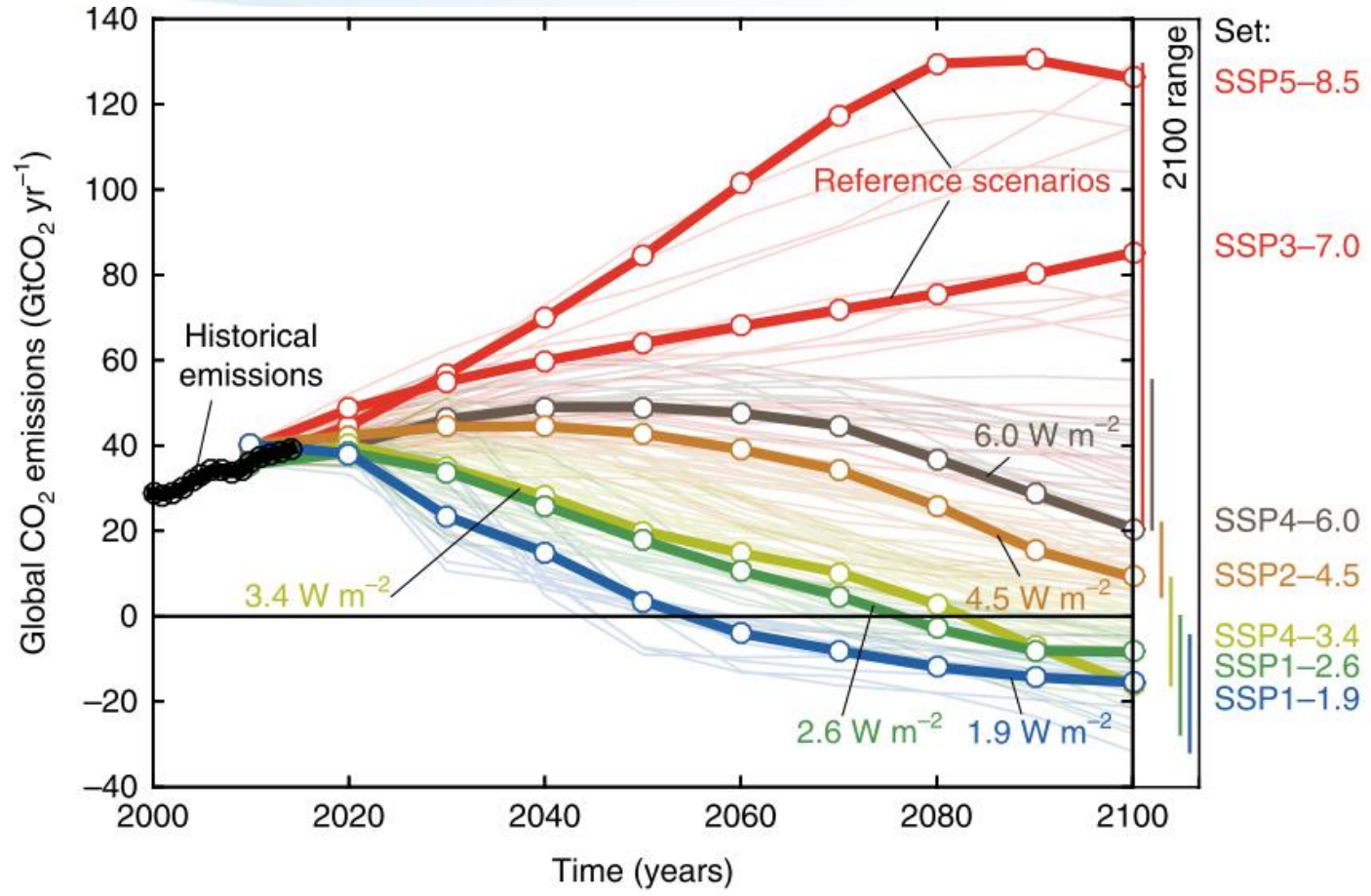
Forest Sector Pathways (FSPs)

drives for the forest sector:

- Land-use change regulation
- Forest productivity growth
- Environmental impact of forestry activities
- International trade
- Globalization
- Land-based mitigation policies
- Efficiency of timber processing and wood use
- Consumption of primary and secondary forest products

According to: Daigneault et al. forthcoming in the IJFE

RCPs and Carbon Neutrality in MIP



Representative Concentration Pathways (RCPs)

- Input for climate and atmospheric chemistry modeling as part of 5th Assessment Report IPCC

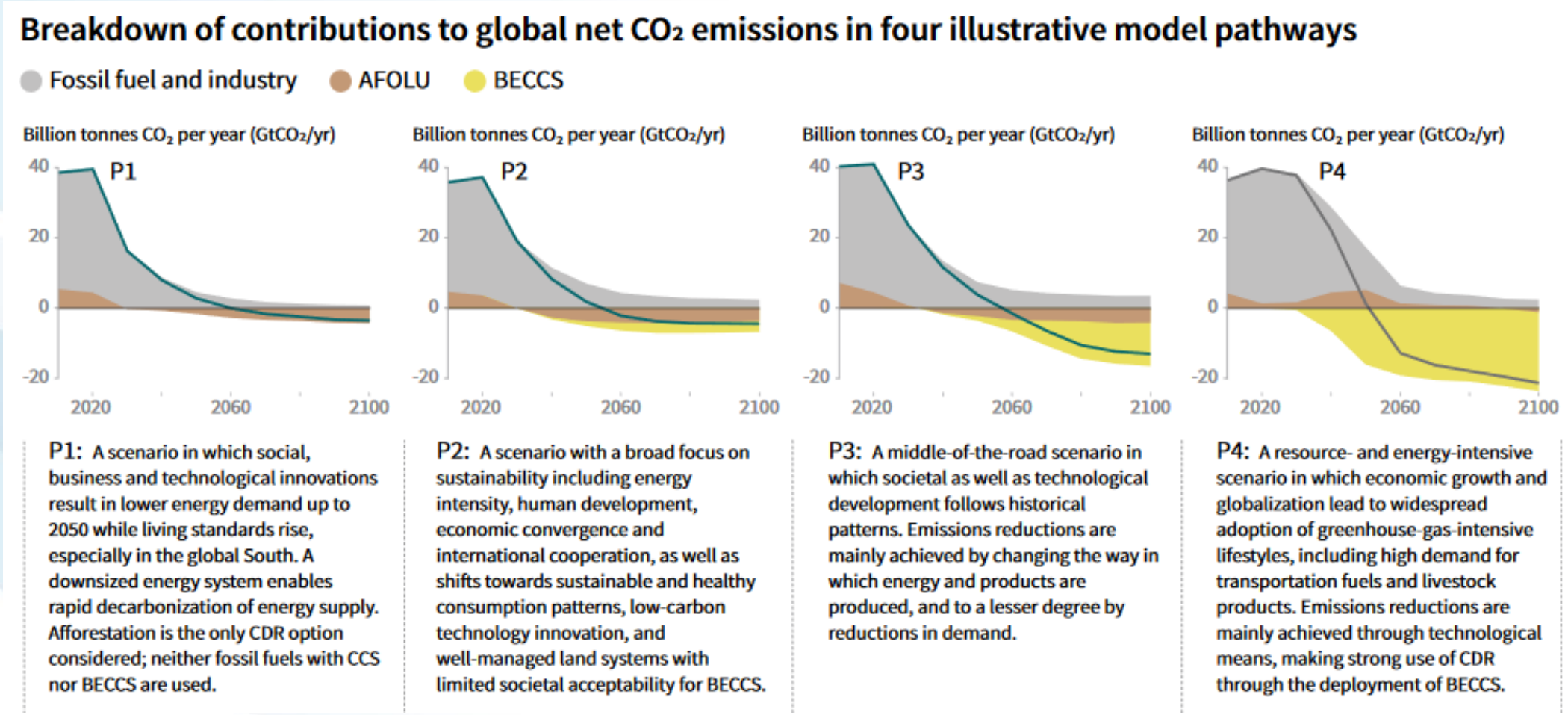
Carbon neutrality compatible with

- 2°C (RCP 2.6): 2055 – 2080
- 1.5°C (RCP 1.9): 2045 - 2070

Source: Rogelj et al. 2018

Scenarios for climate stabilization

The same climate target could be achieved through different strategies!



Source: IPCC (2018)

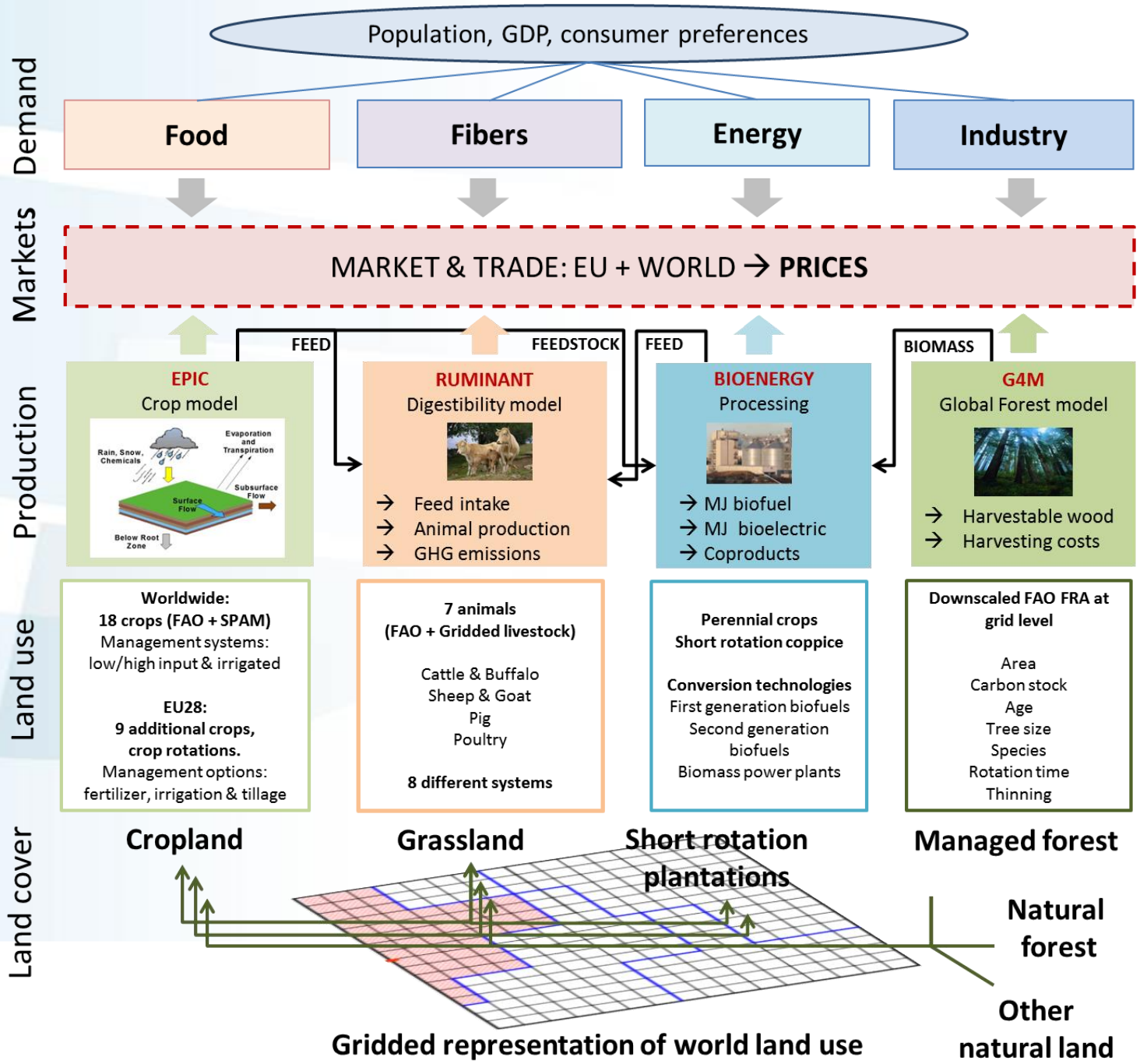
The GLOBIOM model for Impact Assessment

The GLOBIOM

Global Biosphere Management Model

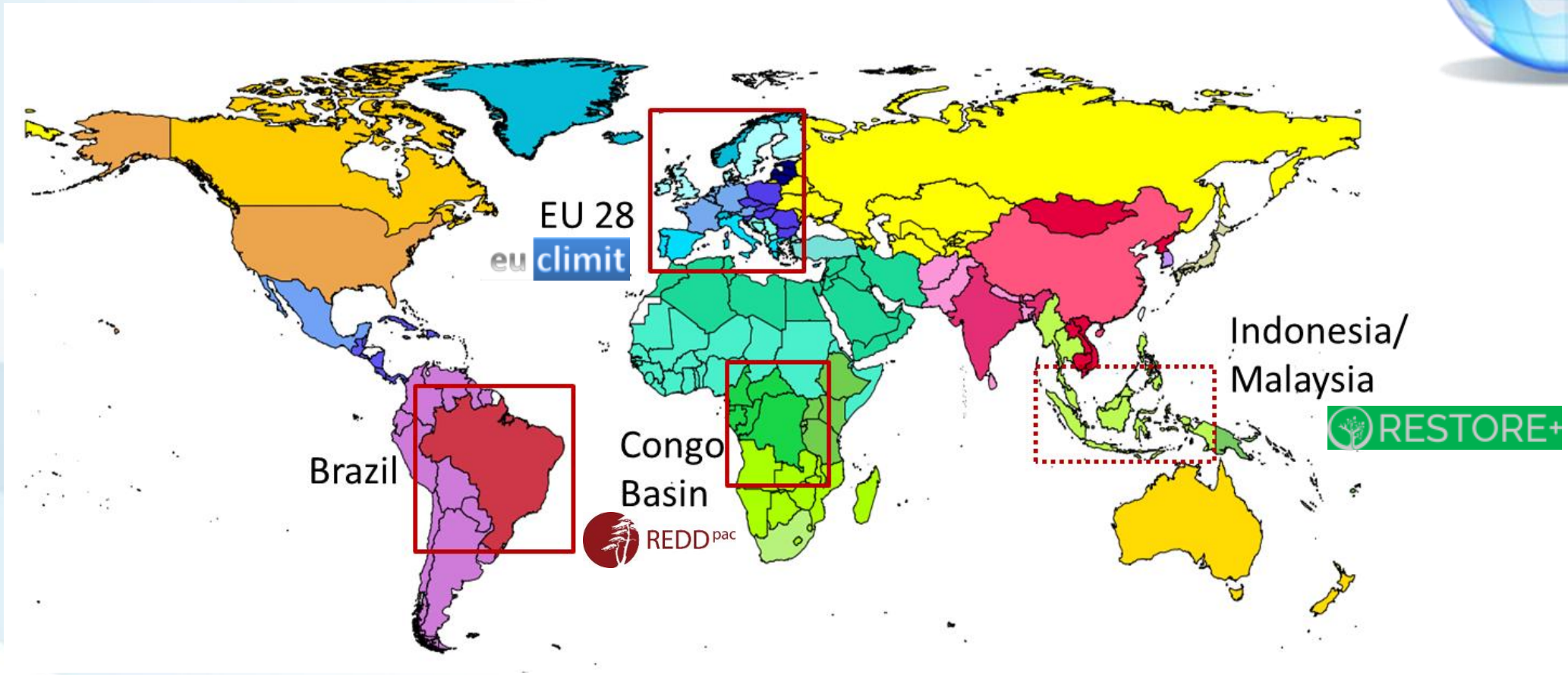
- Developed by IIASAs ESM-Program
- **Partial equilibrium model**
  - Agriculture, forestry, and bioenergy sectors
  - Global coverage, 57 world regions
- **Bilateral trade flows**
  - Spatial equilibrium approach
- **Bottom-up approach**
  - Detailed spatial resolution (>200k cells)
  - Explicit description of production technologies a la Leontief
  - Technologies specified by production system and grid cell (process-based models)
- **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. **Time horizon:** 2070/2100

Source: http://www.globiom.org



Source: http://www.globiom.org

Global and Regional assessments



Source: http://www.globiom.org

Scenario input/output parameters

- Common scenario input parameters
  - Social-economic drivers (GDP, population, consumption, etc.)
  - Bioenergy demand & Carbon prices
  - Policies related to cascade use of wood and resource efficiency
  - Changes in future consumption of goods or intermediate commodities
  - Changes in availability and/or recovery of woody materials
  - Protection of land areas or land-conversions

- Common scenario output parameters
  - Future forest harvest levels and use of woody and agricultural commodities
  - Future consumption of commodities and market developments
  - LULUCF emissions and removals at national, regional, and global level
    - Afforestation, deforestation, forest management
    - Harvested Wood Products pool
  - Changes in trade patterns
  - Interconnectivities between consumption of commodities

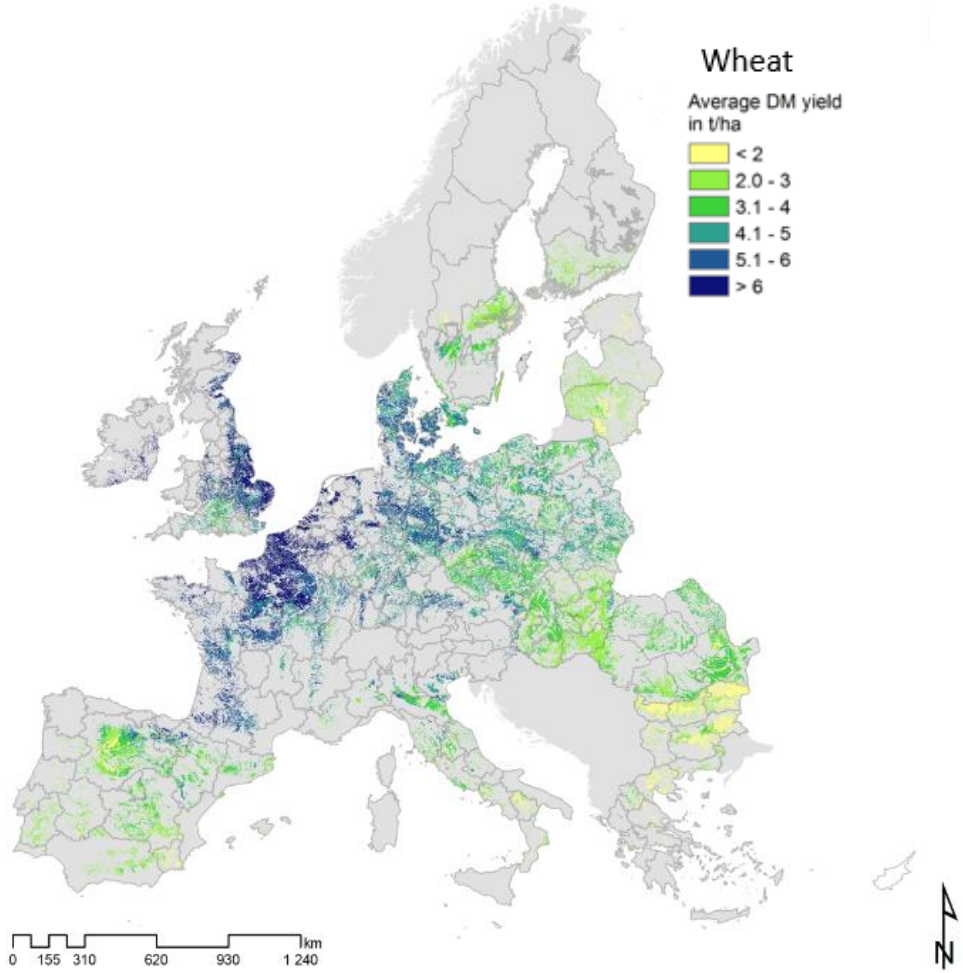
EU detailed modeling in GLOBIOM

Good data availability in Europe

→ More detailed representation of EU AFOLU sector

Enhanced details:

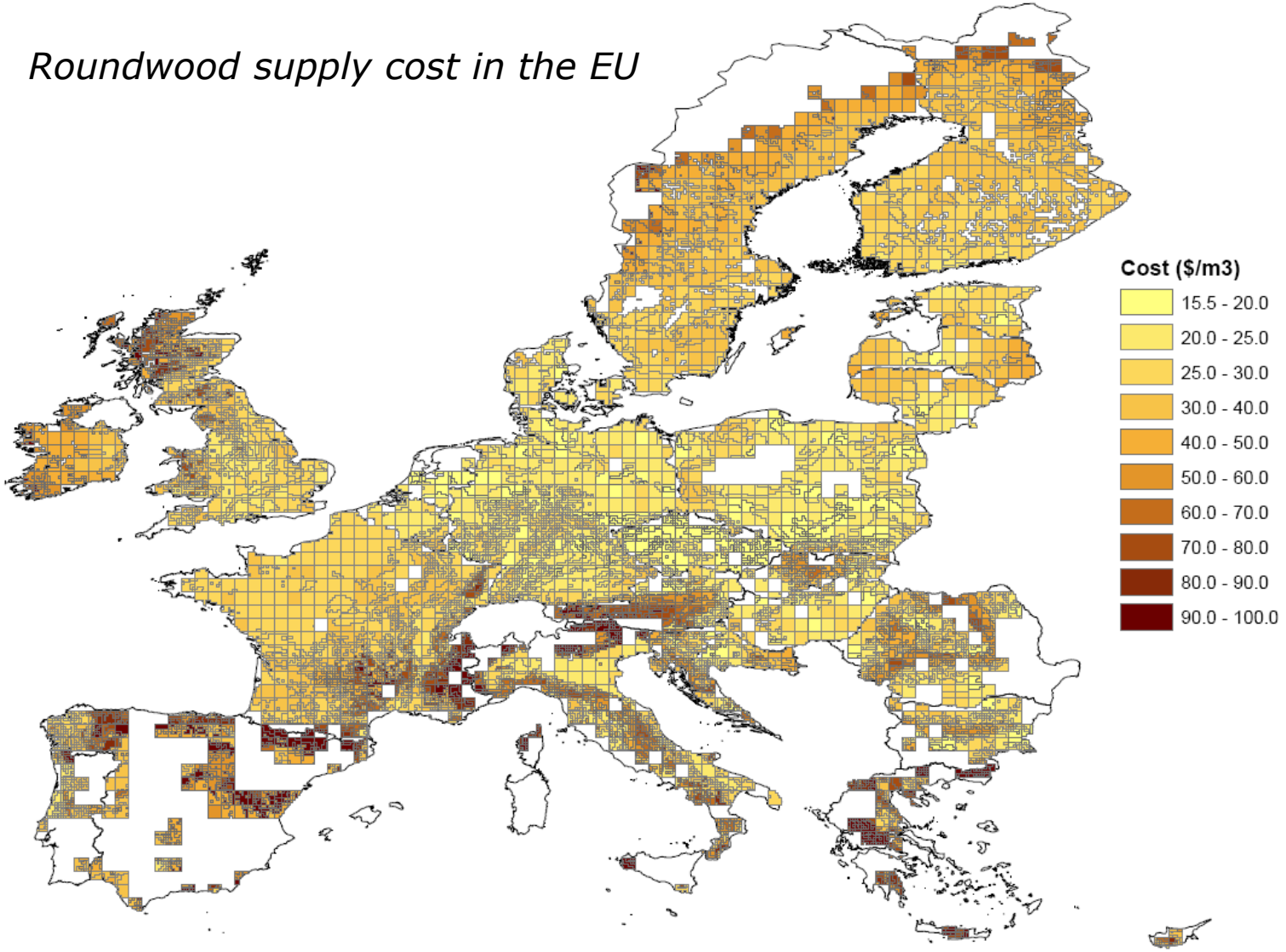
- Biophysical soil characteristics
- Datasets updated with EU information on management systems
- Additional crops i.e. sugar beet, oats, rye, silage, maize…
- Production, demand, areas… based on EUROSTAT
- EU common markets
- Basic resolution 1x1 km
- ~370.000 SimUs



Cost accounting module in GLOBIOM

COST INDUSTRY GATE

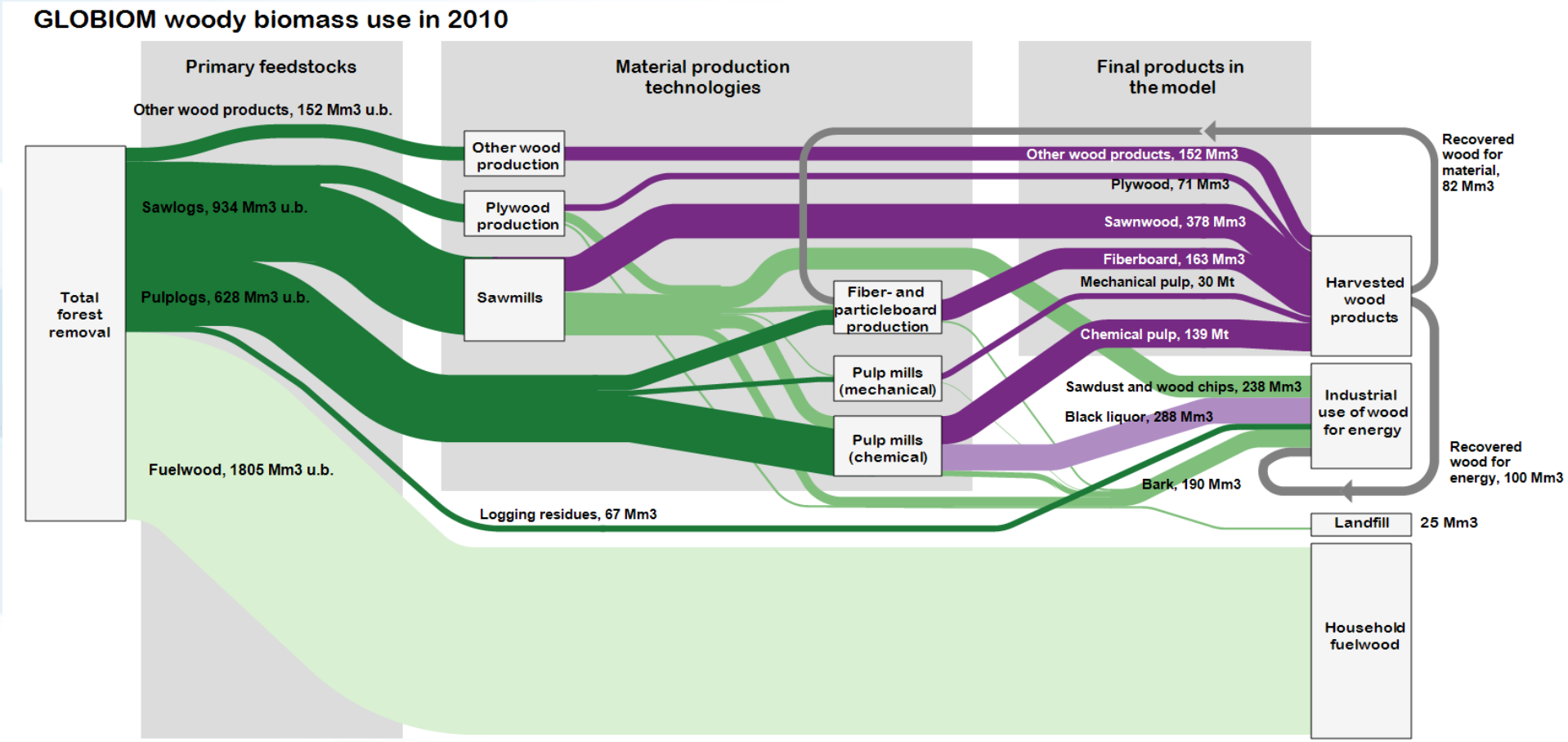
Roundwood supply cost in the EU



Source: Di Fulvio et al. 2016

Representation of wood flows in GLOBIOM

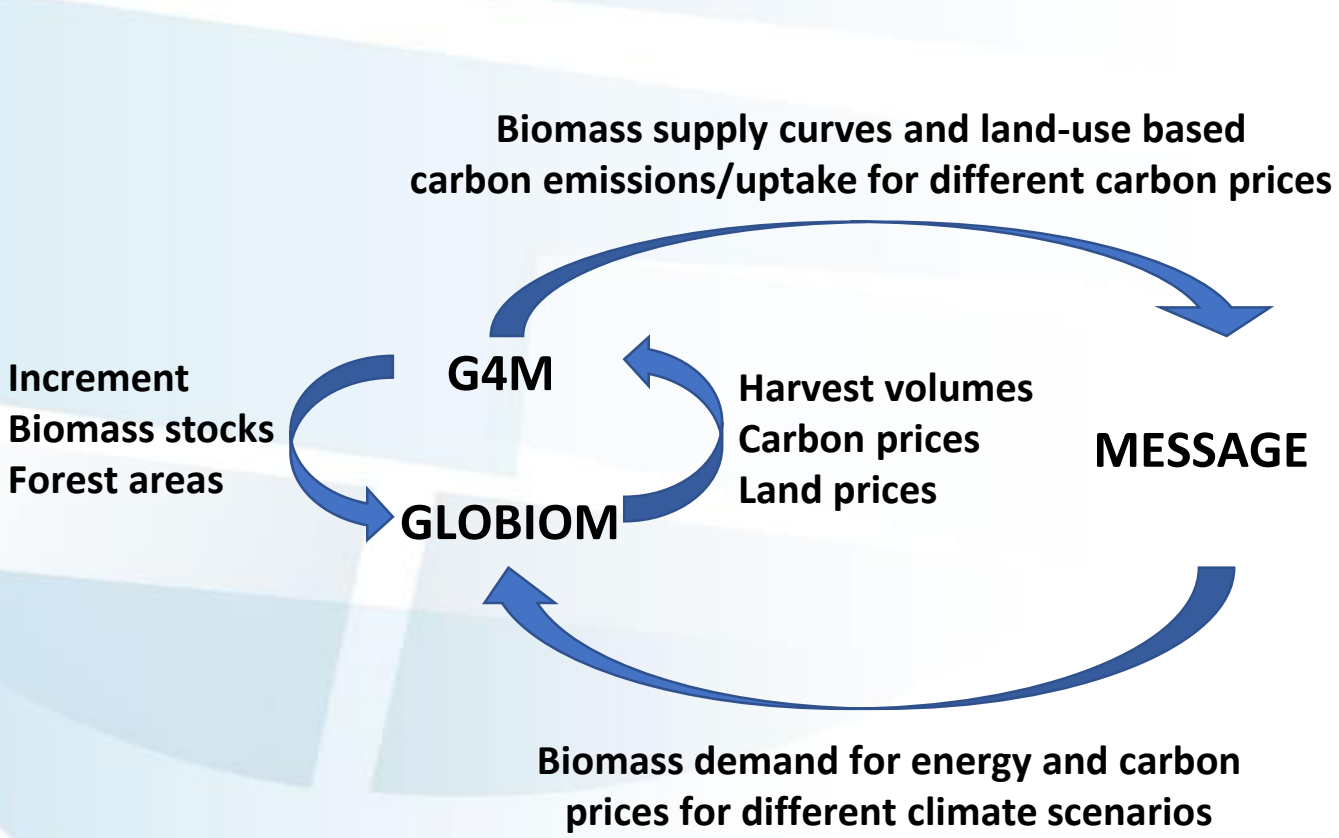
- GLOBIOM covers the main primary feedstocks, by-products, and semi-finished HWP products
- Wood flows calibrated according to FAOSTAT

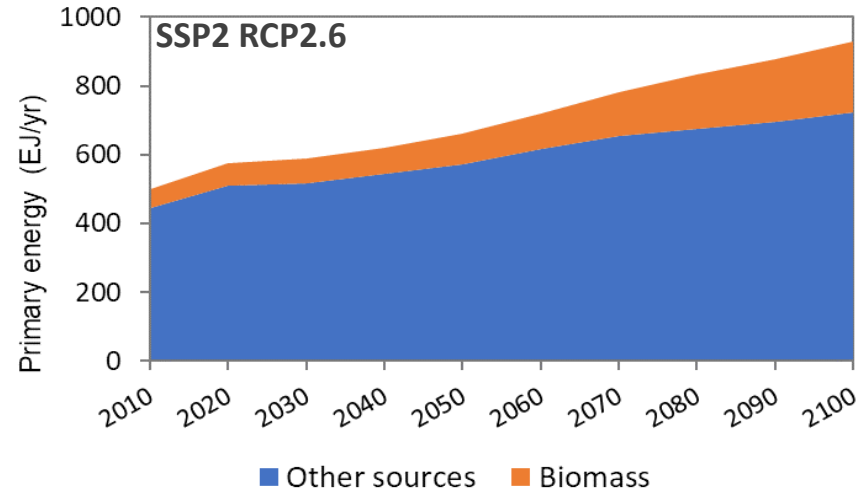


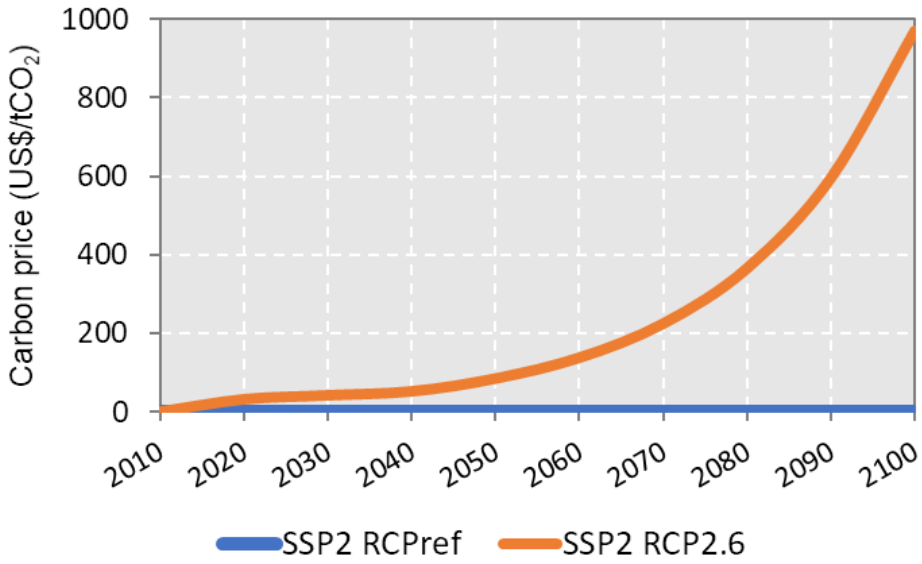
Source: Lauri et al. 2017

The impact of different climate targets on the forest sector

Linkage of GLOBIOM to the other IIASA's models

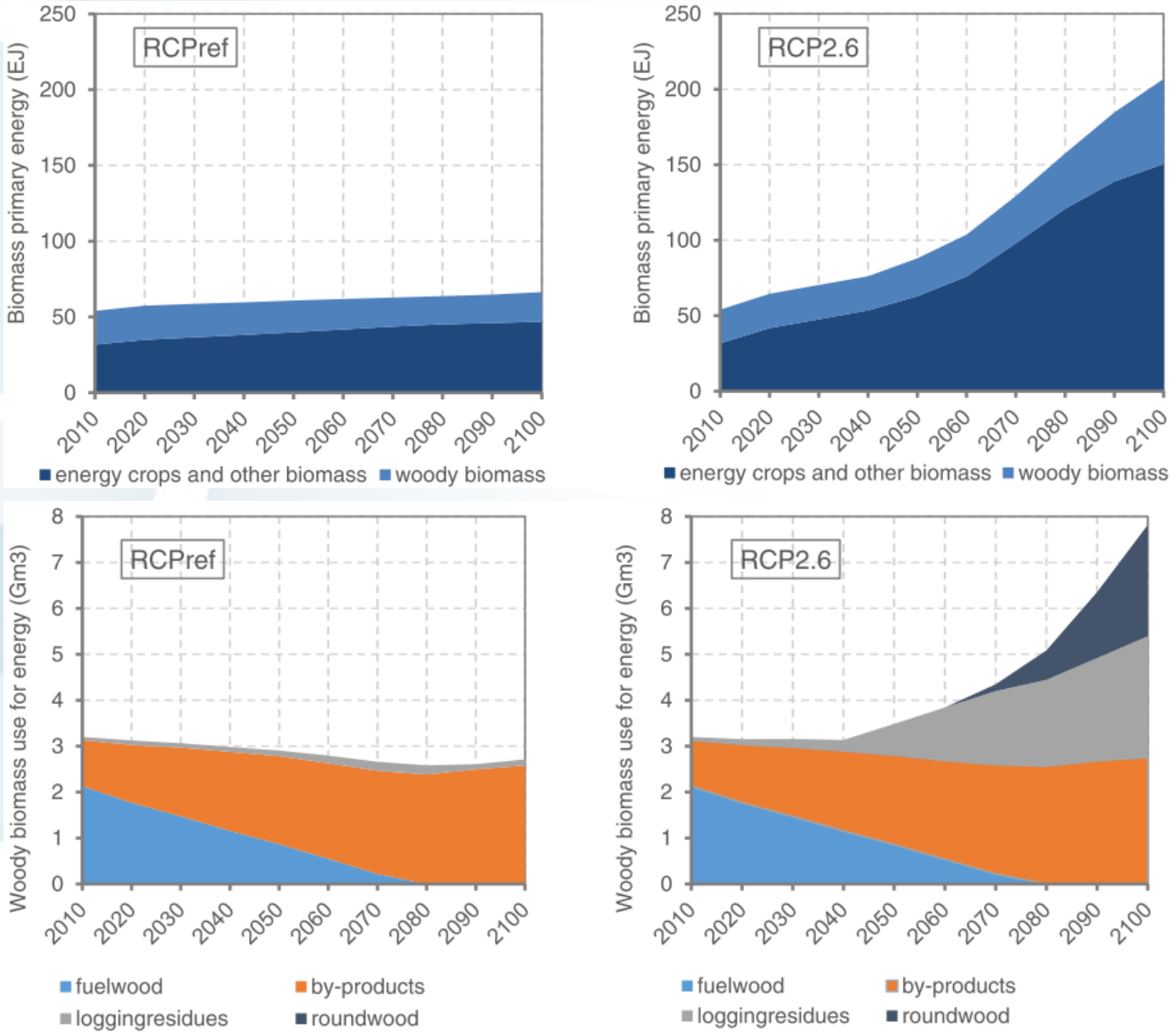






Source: IIASA SSPs and RCPs Public database
Lauri et al. 2017

Forest sector contribution to bioenergy demand

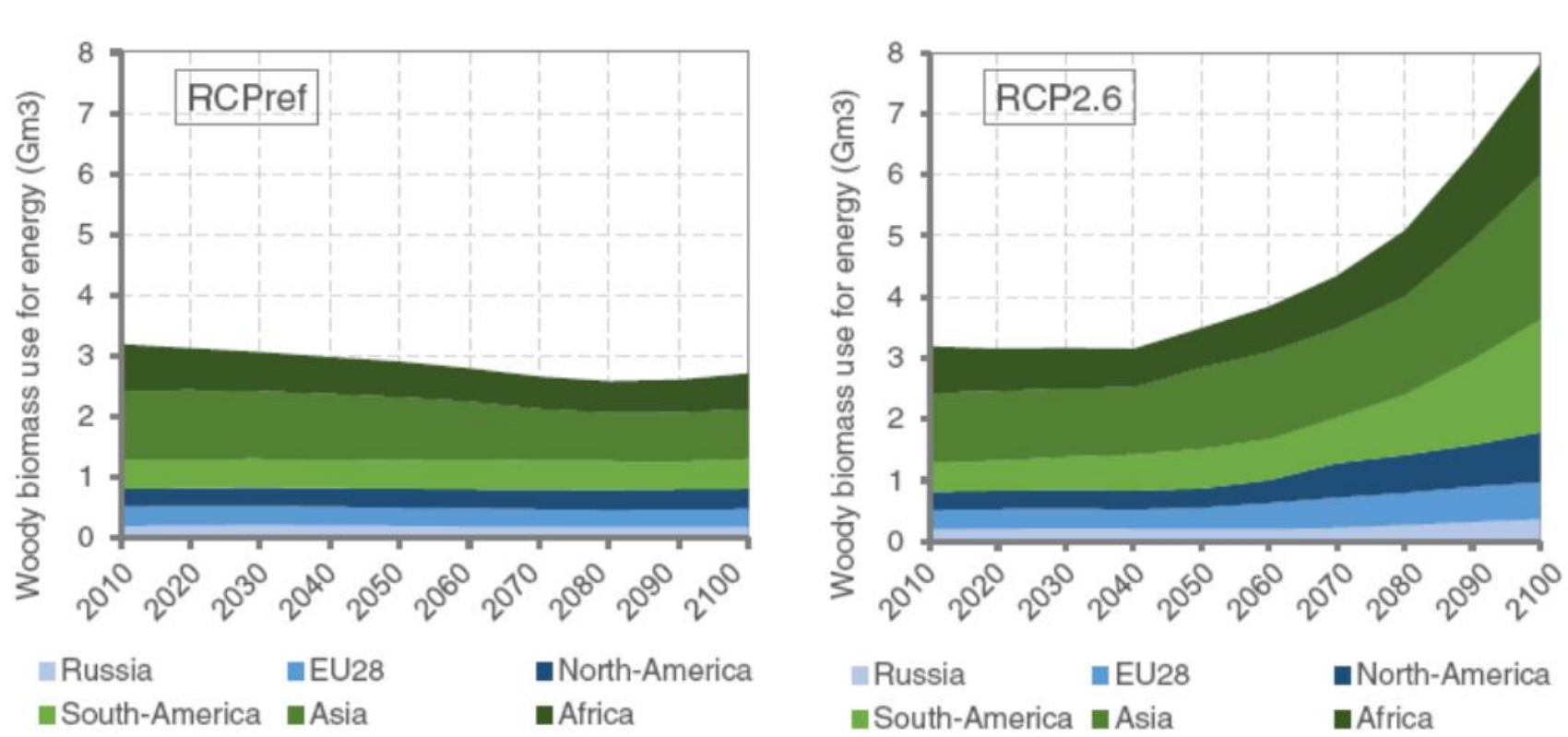


Important increase of woody biomass use for energy in case of mitigation:

- SSP2
- BECCS
- Increase of by-products
- Increase of logging residues and roundwood use for energy
- Reduction of traditional fuelwood

Source: Lauri et al. 2017

Increase of woody biomass energy use in the different Regions

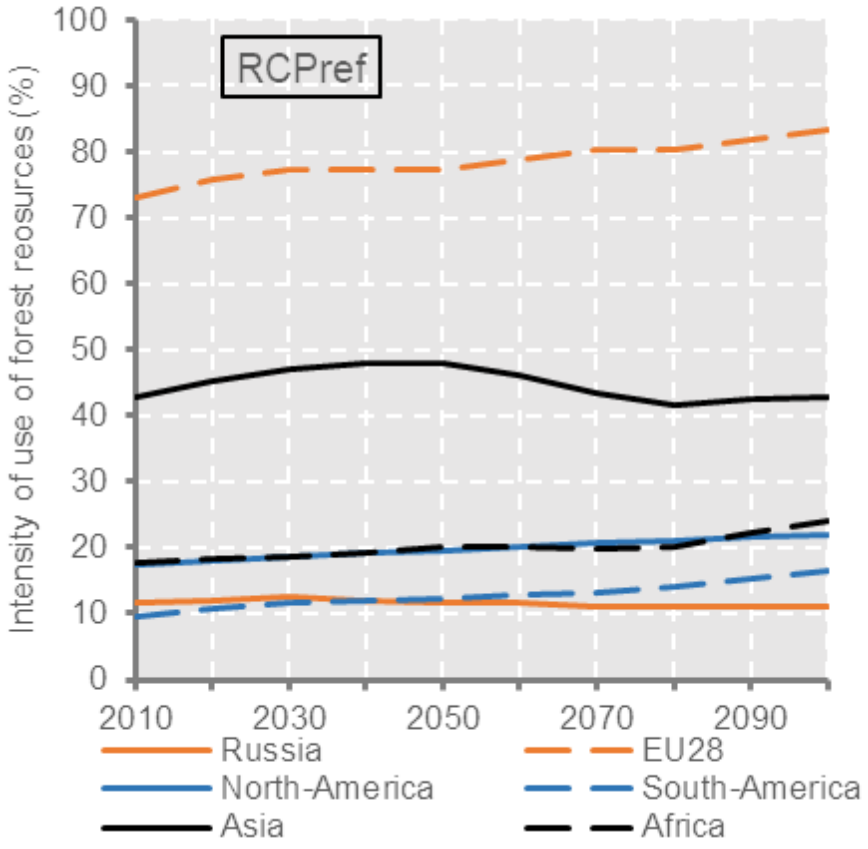


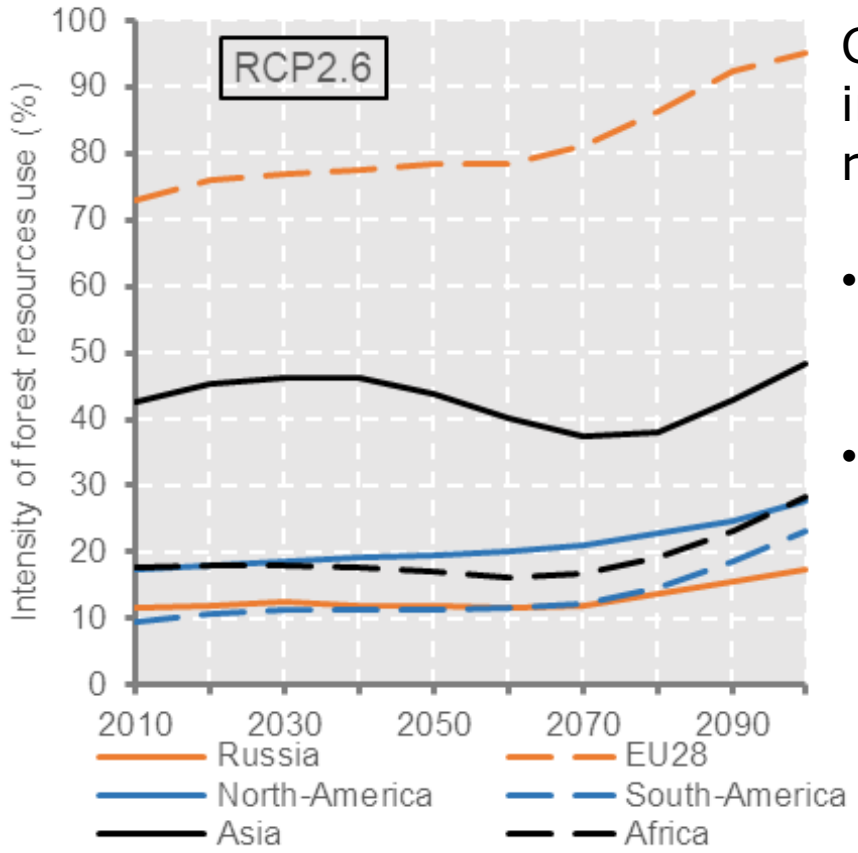
Larger effects in tropical region:

- larger forest resources
- lower production costs
- faster socioeconomic development
- Effects of trade

Source: Lauri et al. 2017

Impacts on the intensity of use of forest resources



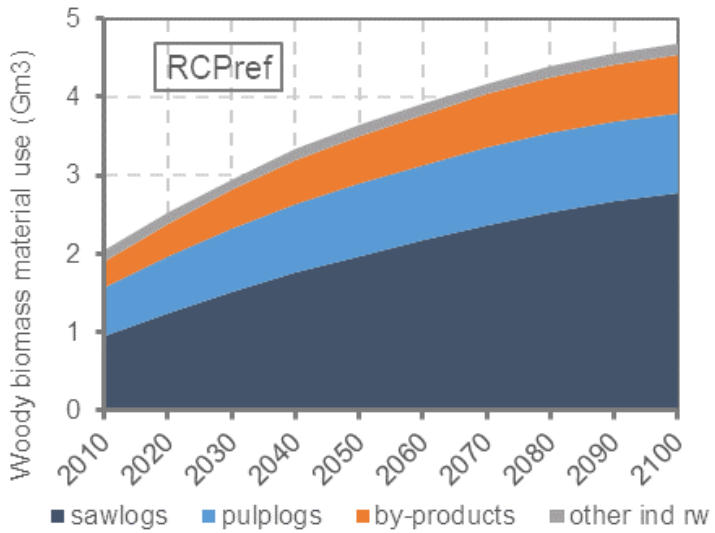


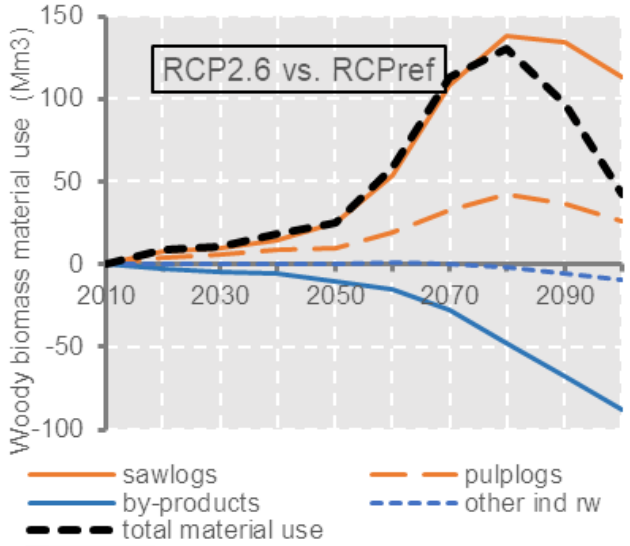
General increase of intensity of use of forest resources:

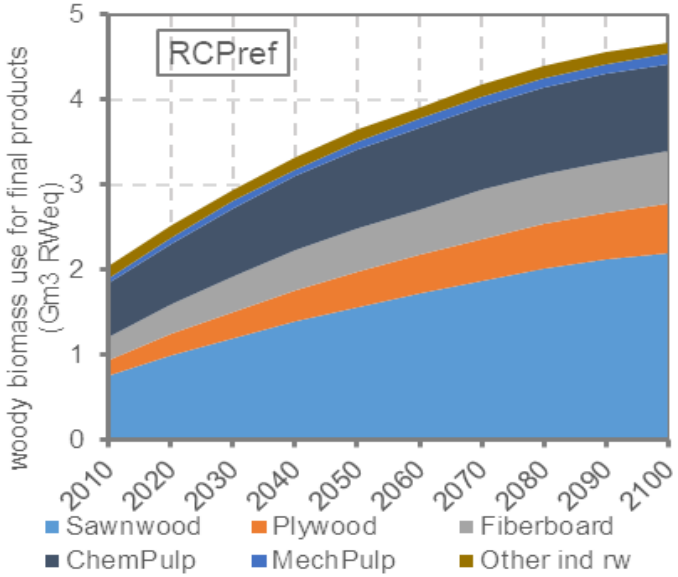
- Strongest effect in the EU
- Tropical countries are delayed by the reduction of traditional fuelwood use

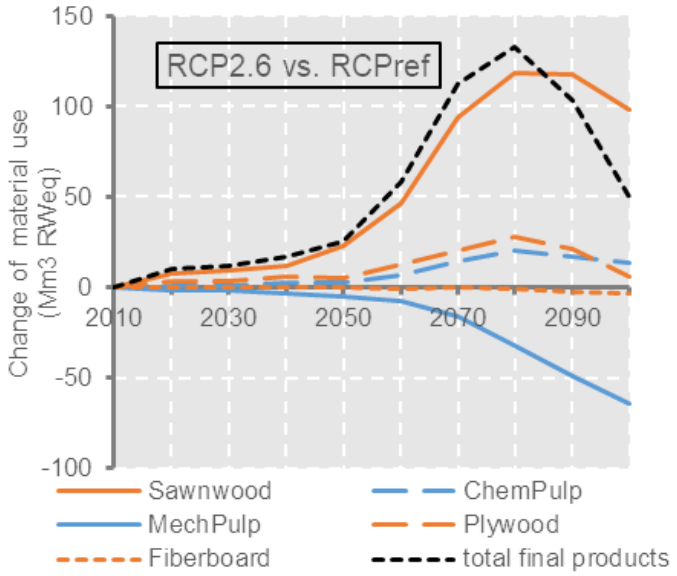
Source: Lauri et al. 2017

Impact of increasing bioenergy demand on the material use









Reverse U shaped trajectories:

- Firstly increase of by-products
- After 2080 strong direct competition of roundwood use for energy

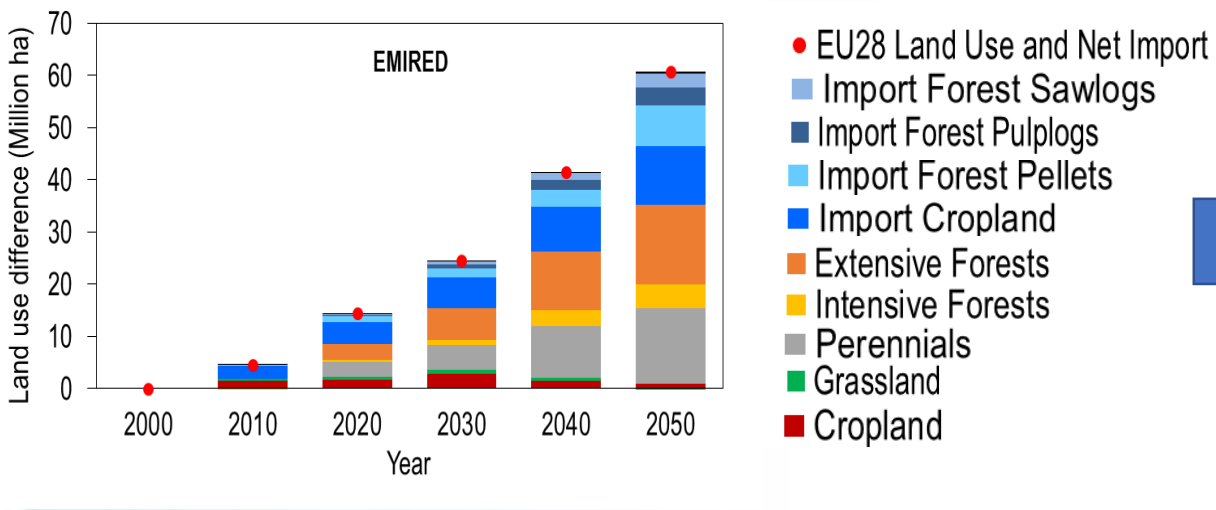
Source: Lauri et al. 2017

Another dimension of impacts: Biodiversity

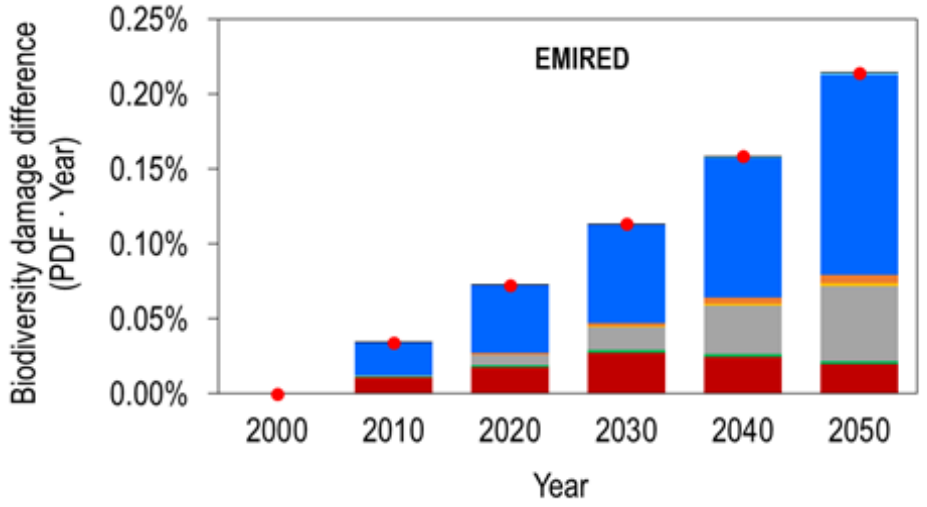
Quantification of the EU28 biodiversity footprint

- **Quantify spatially explicit LULUCF driven biodiversity loss from different EU28 policies in the bioenergy sector**
- **Investigate the potential global loss of species directly associated to land use in the EU and due to trade with other regions over time (EU footprint)**

Land use + trade



Global species loss



- **ILUCs effects due to expansion of energy crops in the EU**
- **Import of pellets**
- **Biodiversity trade offs between internal expansion of energy crops and import of cropland**

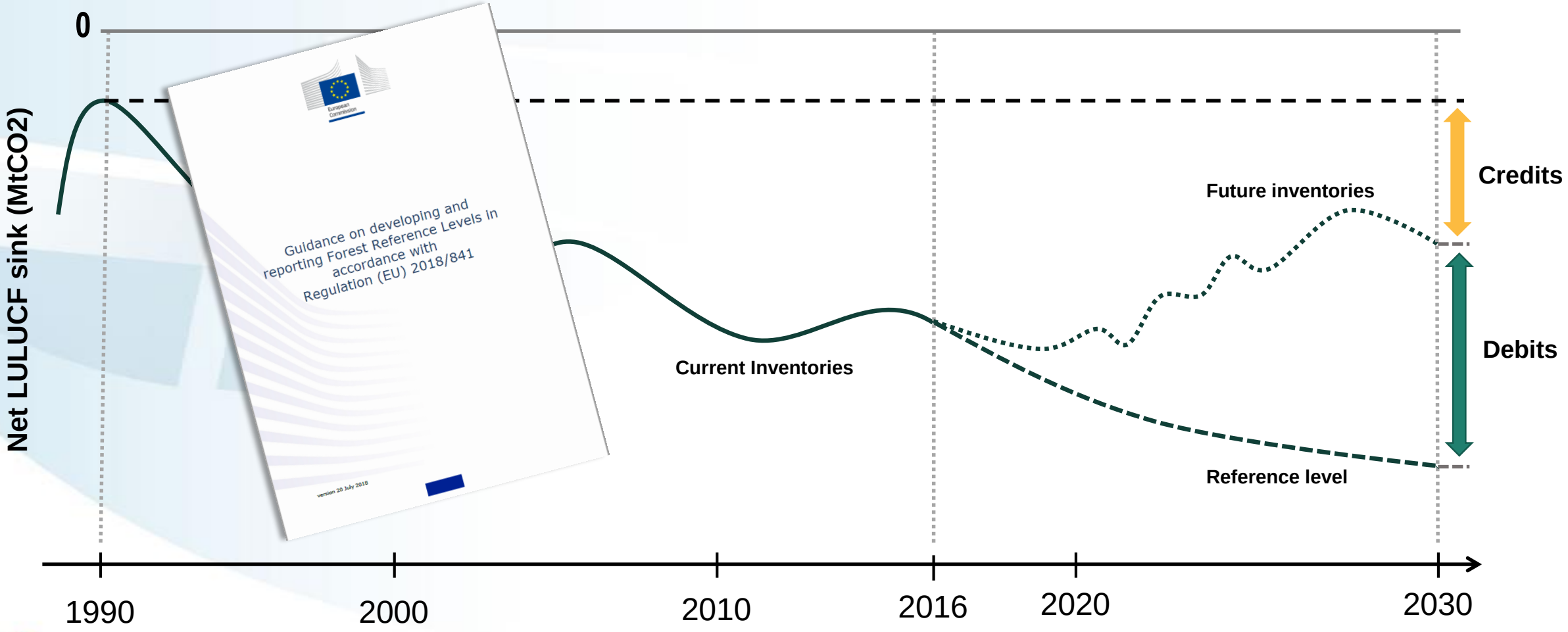
Source: Di Fulvio et al. 2018

Looking into future applications

Importance of forest management in the EU political discussion

LULUCF EU Regulation 2018/841

- Forest management on a net-net basis against a **reference level**, where the reference level defines what the emissions would have been without changes to management of a reference period 2000-2009



Source: Forsell 2018

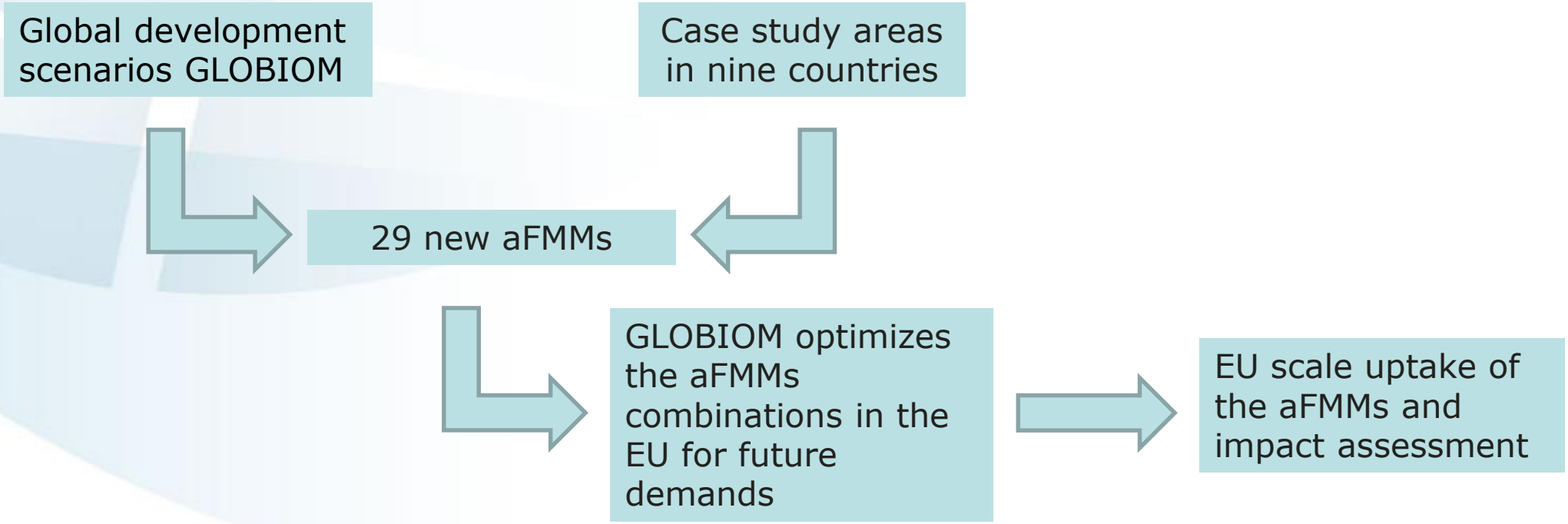
Adaptation of forest management alternatives to future demands

The ALTERFOR project examines
alternative Forest Management Models (aFMMs)
to optimize them for use in different European countries

ALTERFOR

Horizon 2020

- How the aFMMs will affect provision of Ecosystem Services at EU scale?



https://www.alterfor-project.eu

Improve global mapping of forest management

Illustration: S.Harris

"Nature Map Earth" project launched in the spring 2019 at IIASA

https://naturemap.earth

International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at
UN environment WCMC 40 years
SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK
A GLOBAL INITIATIVE FOR THE UNITED NATIONS

Summary and Conclusion

- Large structural changes are required to reach international climate targets.
- A lot of different pathways exist to reach climate targets, not just one solution that will fit all countries and all sectors.
- More and more information about the potential impacts on the forest sector for reaching a climate target is becoming available.
- Integrated markets require to consider the interactions between different global regions.
- Including the trade-offs between different ecosystem services has become essential.

Thanks for your attention

difulvi@iiasa.ac.at