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High mitigation pathways with low biomass use for energy

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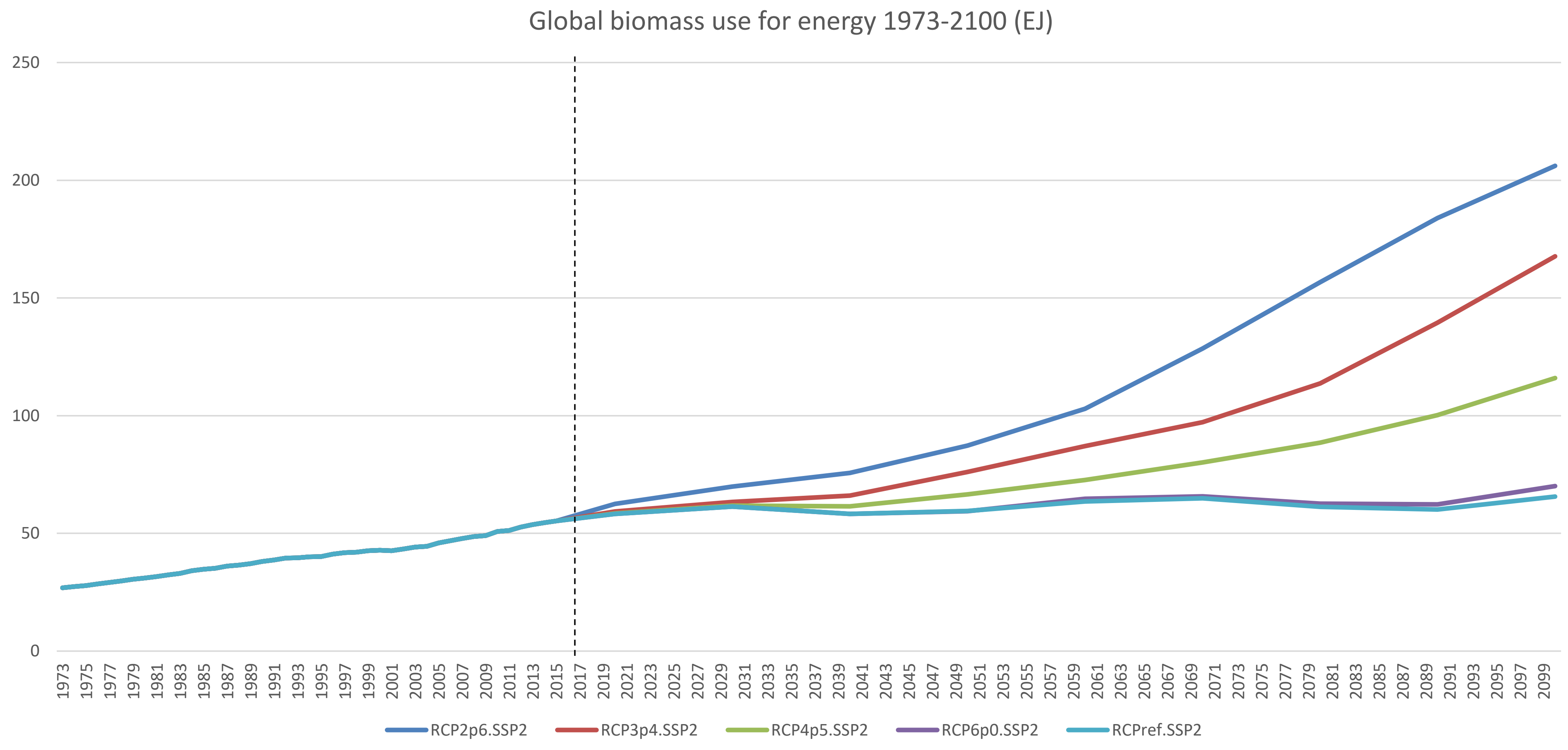
- Purpose: Consider possibility to decrease biomass use for energy in high mitigation scenarios by replacing BECCS by afforestation uptake and by changing mitigation timing.

- Method: Extend GLOBIOM model to include three negative emissions technologies: afforestation uptake (AFFOR), short rotation plantations uptake (SRP) and bioenergy and carbon capture and storage (BECCS). Consider trade-off between these technologies for given carbon budget (RCP2.6 SSP2).

- Results: 1) Globally biomass use for energy can be decreased 30-50% relative to baseline RCP2.6 SSP2.
  2) In the regional level biomass use for energy can be decreased more (40-60%) in tropical zone than in boreal and temperate zones (20-40%).

Global biomass use for energy 1973-2100



Why bioenergy demand is increasing in the RCP-SSP scenarios ?

-Climate change mitigation (RCP2p6 > RCP3p4>RCP4p5>RCPref)

-Mitigation by substituting fossil fuels carbon emissions by bioenergy ?

=> fossil fuels carbon neutral with CCS

=> no need to substitute fossil fuels by bioenergy (at least in next 100 years..)

-Mitigation by negative emissions ?

=> zero emissions are not sufficient for the 2°C target due to “overshooting” of carbon budget

=> we need negative emissions and BECCS is the only way to provide them sufficiently

=> RCP-SSP scenarios: max feasible AFFOR 1000 Mha (≈250 $GtC0_2$), but 700 $GtC0_2$ is needed for the 2°C target

Modelling negative emissions supply and demand

-negative emissions supply based on BECCS, SRP and AFFOR technologies

-negative emissions demand based on carbon budget (RCP2p6)

BECCS &SRP: 1) Biophysical biomass potential and costs: G4M, EPIC, own estimates for SRP

2) Bioenergy and CCS technologies and costs: IPCC (2014), Rubin (2015)

AFFOR: 1) Forest cover potential + max biophysical uptake: G4M

2) Afforestation uptake over time: biomass growth curves (Chapman-Richards volume growth model), only living biomass considered

3) Costs: planting + land conversion, no management costs after planting

Scenarios

1) Baseline

   -carbon budget: RCP2p6 SSP2

   -timing of emissions: RCP2p6 SSP2

   -amount of BECCS, SRP and AFFOR: forced to RCP2p6 SSP2

2) Late

   -carbon budget: RCP2p6 SSP2

   -timing of emissions: RCP2p6 SSP2

   -amount of BECCS,SRP and AFFOR: free based on economic trade-off

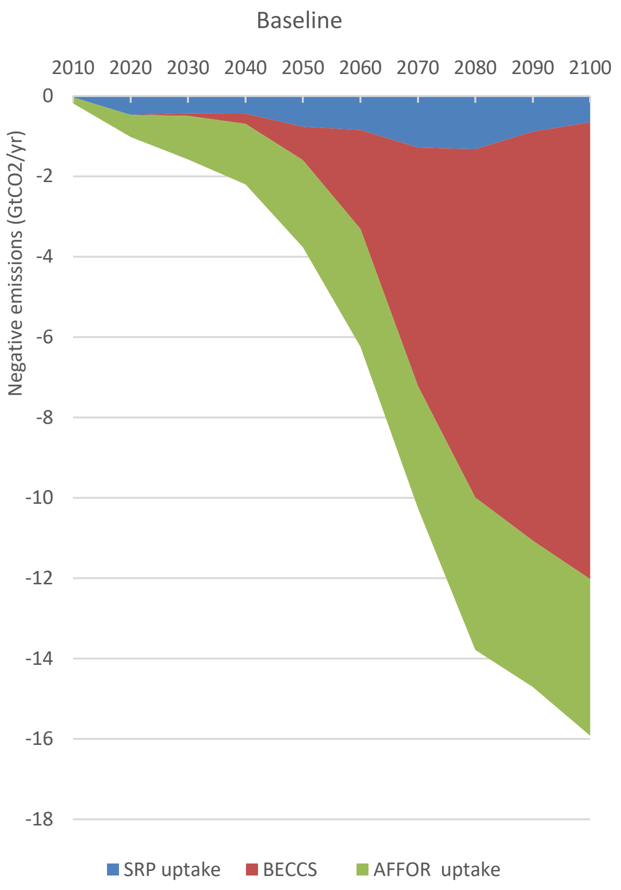
3) Early

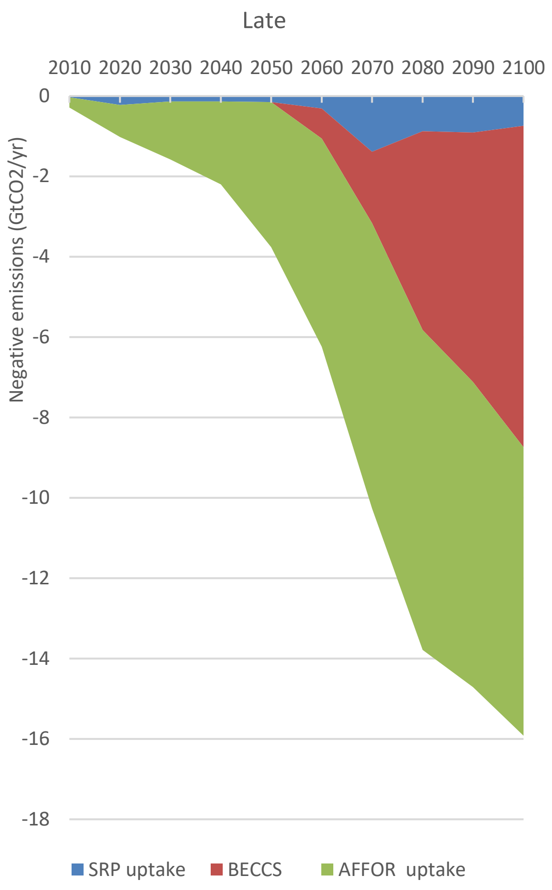
   -carbon budget: RCP2p6 SSP2

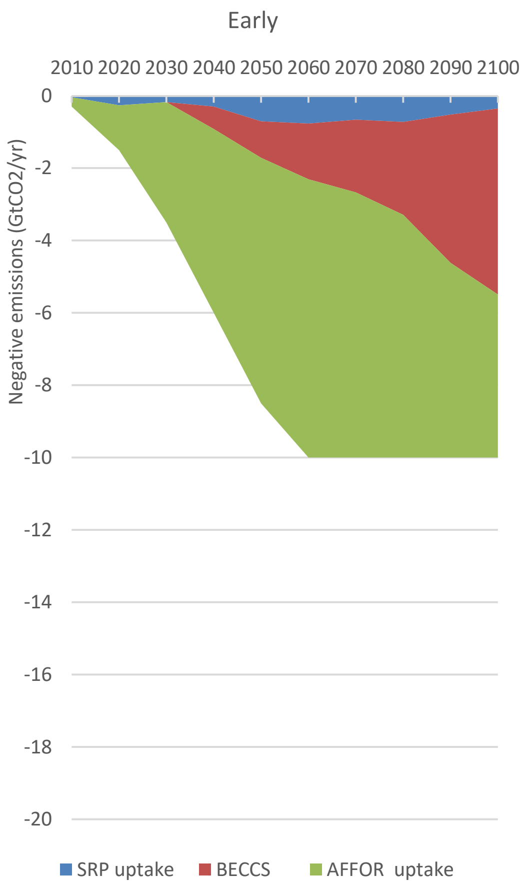
   -timing of emissions: min negative emissions capacity

   -amount of BECCS,SRP and AFFOR: free based on economic trade-off

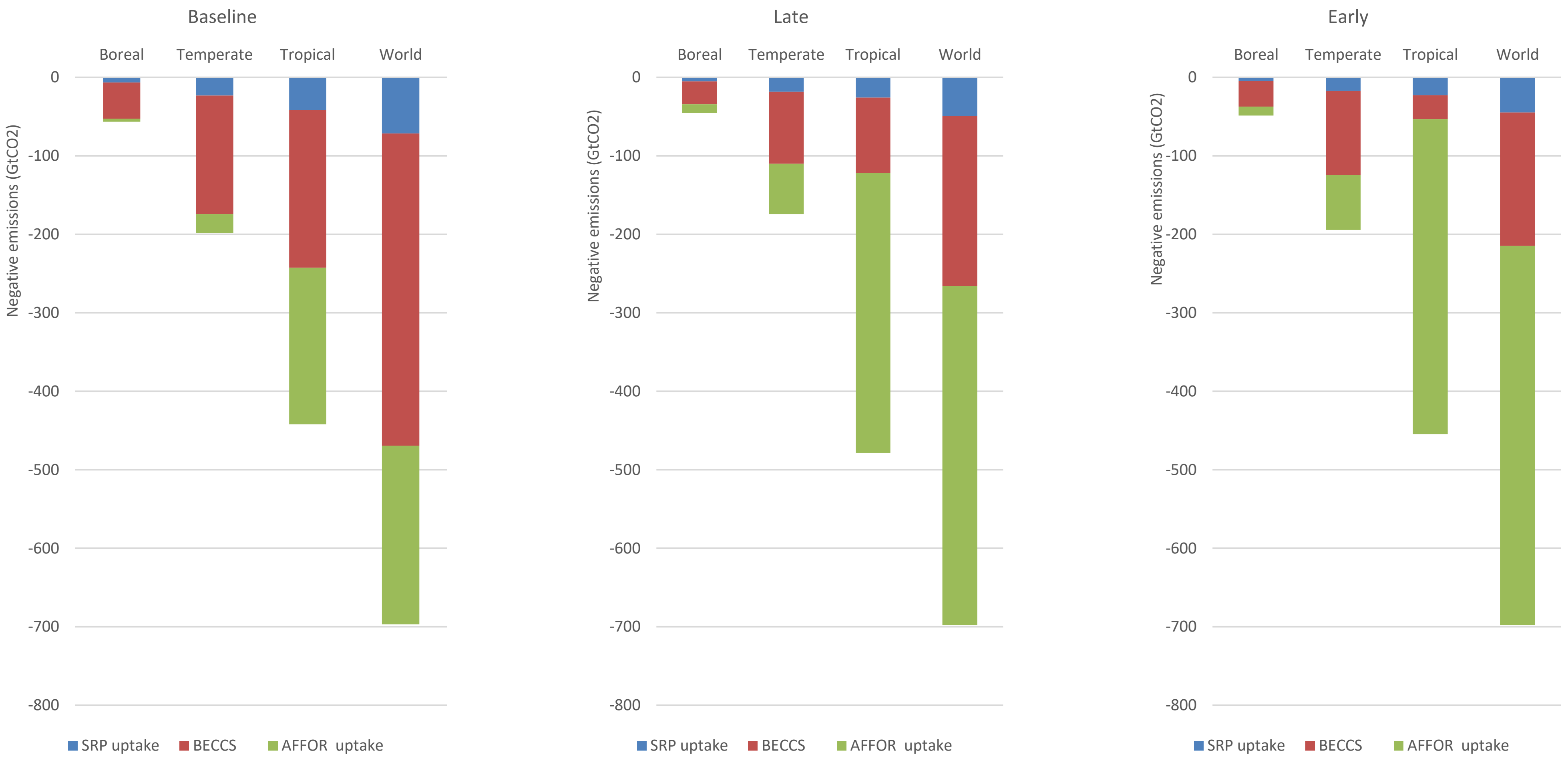
Negative emissions time paths 2010-2100







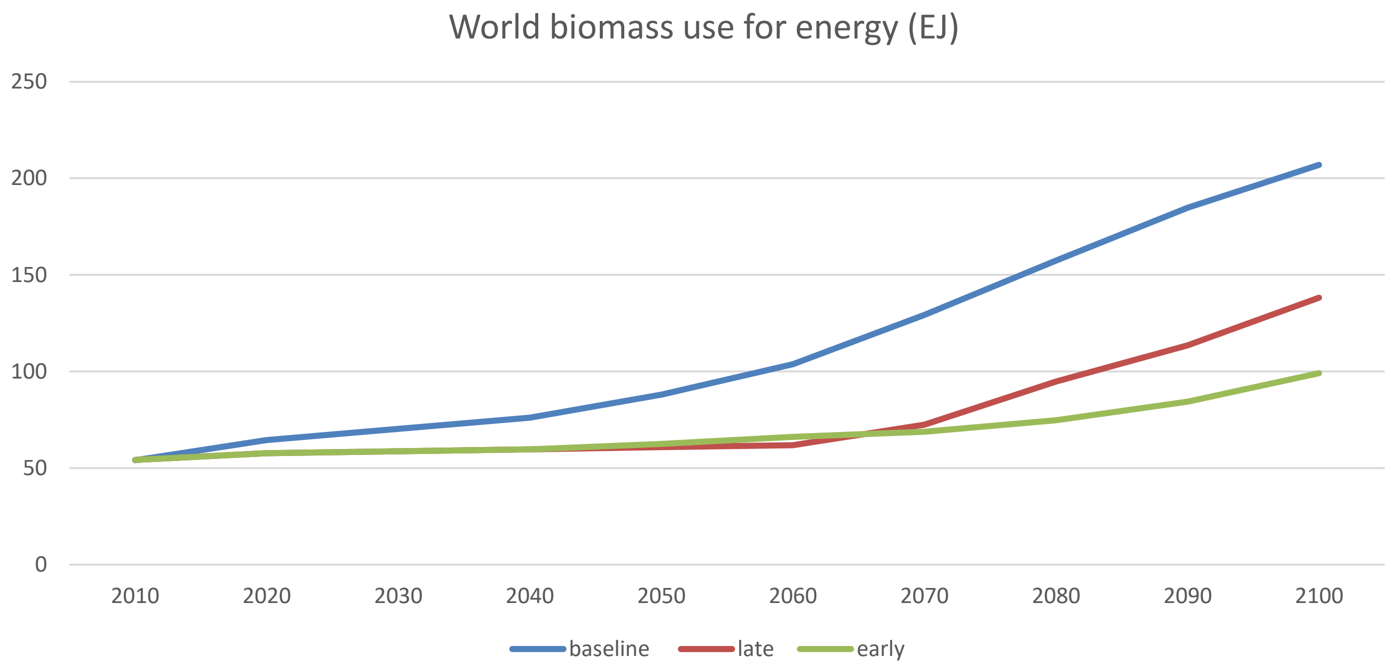
Regional division of cumulative negative emissions 2010-2100



Global biomass use for energy in 2010-2100

-"late" scenario -30 % relative to baseline

-"early" scenario -50 % relative to baseline

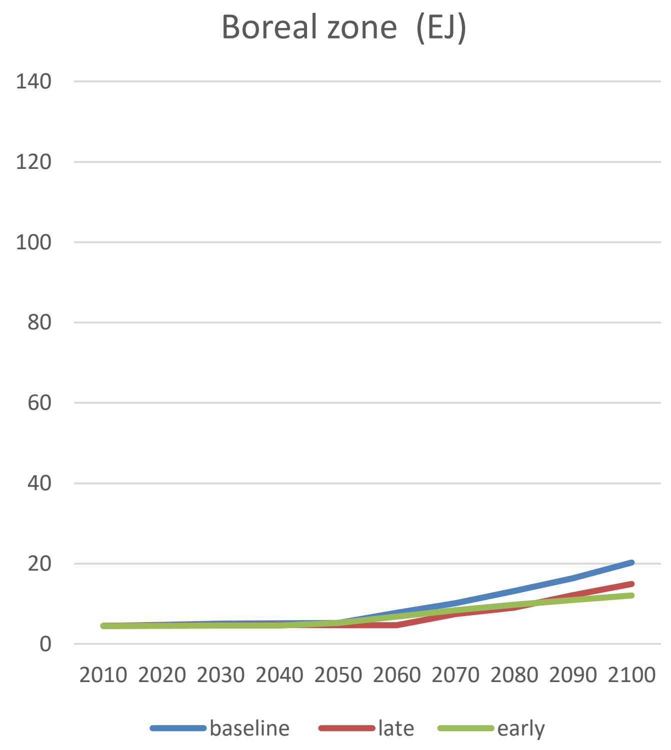


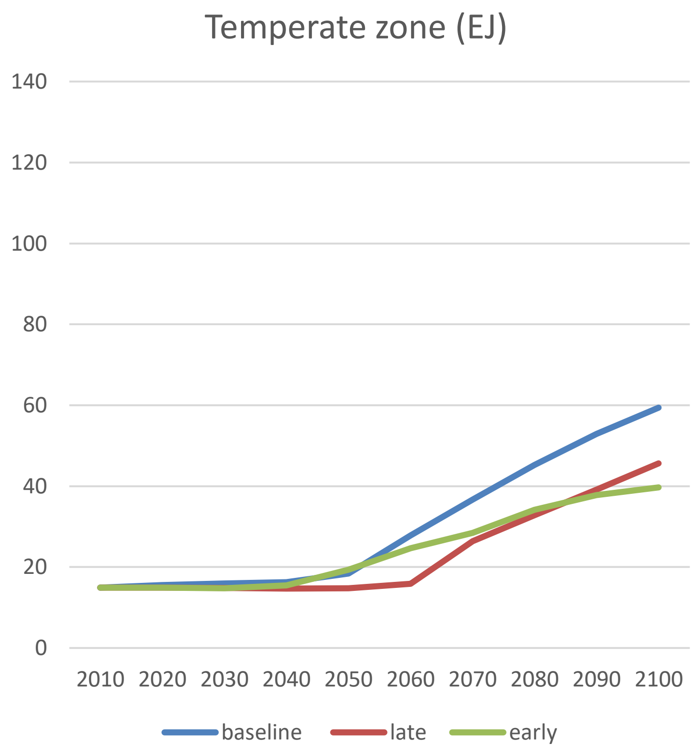
Regional biomass use for energy in 2010-2100

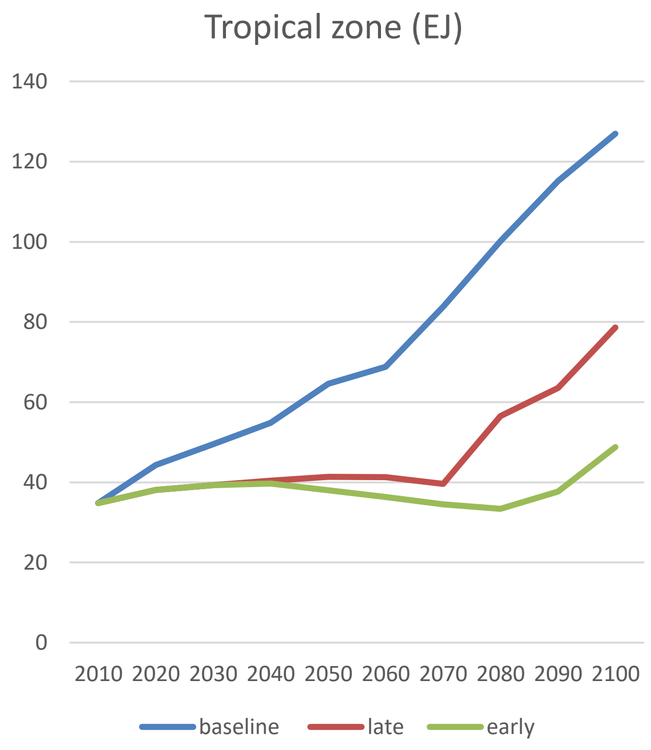
-tropical zone: ”late” scenario -40 % relative to baseline, ”early” scenario -60 % relative to baseline

-temperate zone: ”late” scenario -20 % relative to baseline, ”early” scenario -35 % relative to baseline

-boreal zone: ”late” scenario -25 % relative to baseline, ”early” scenario -40 % relative to baseline







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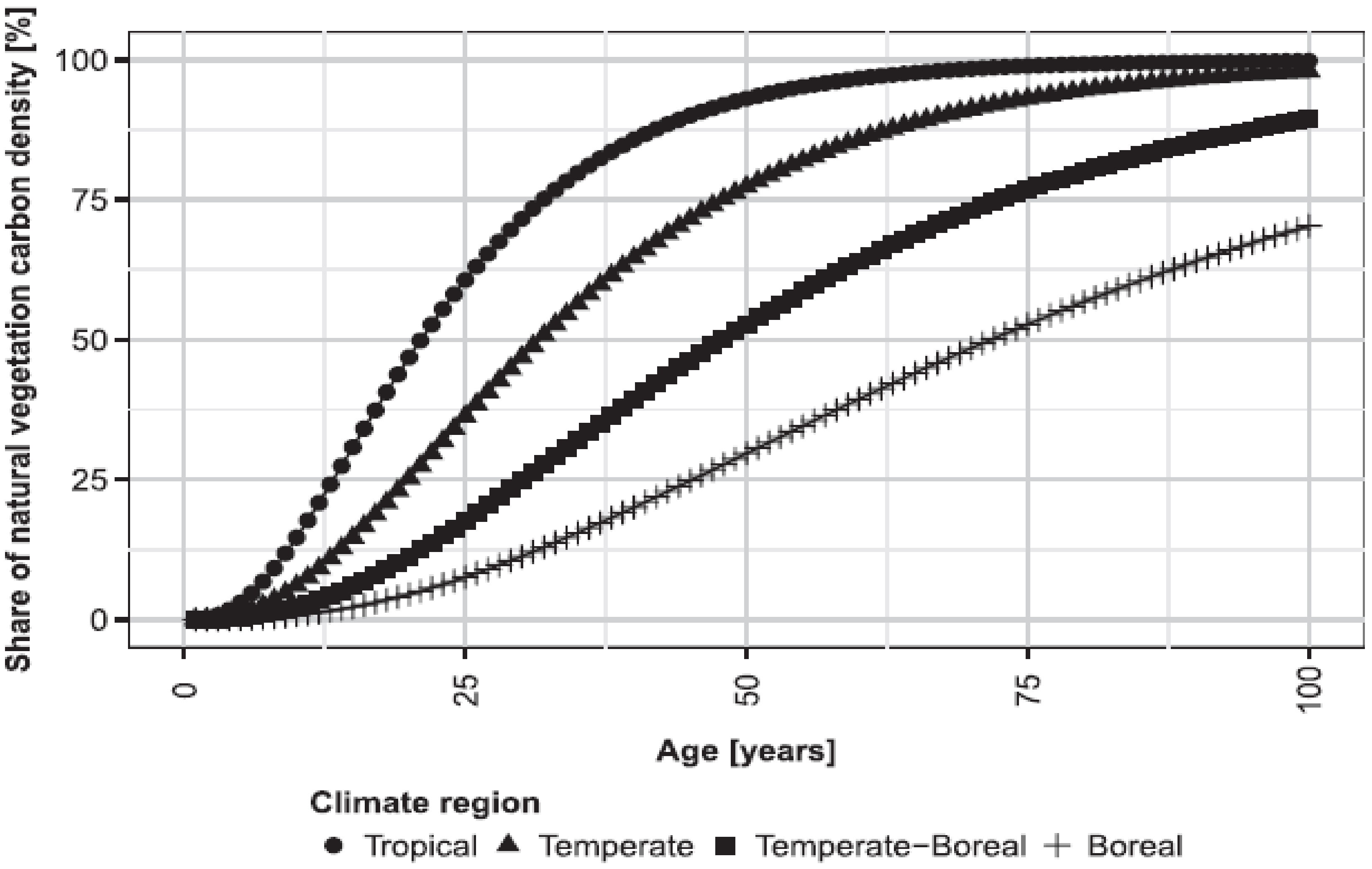
Conclusions

1) Globally biomass use for energy can be decreased 30-50% relative to baseline RCP2.6 SSP2.

2) In the regional level biomass use for energy can be decreased more (40-60%) in tropical zone than in boreal and temperate zones (20-40%). Main reason for this are slow increase of vegetation carbon in the boreal and temperate zones, which makes AFFOR less competitive negative emission technology there.

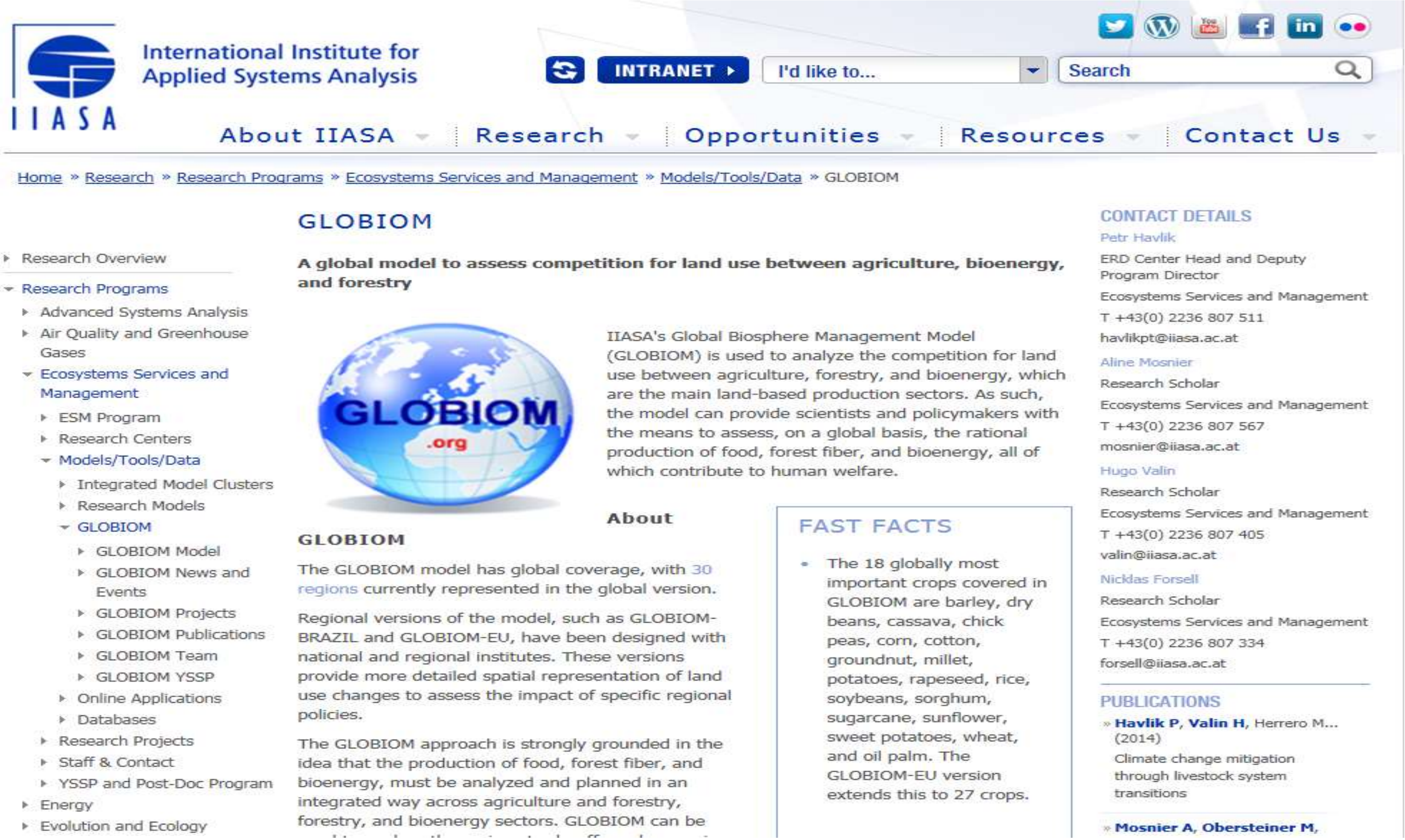
3) AFFOR area increases from 846 to 1741-1872 Mha in 2010-2100. This increases food prices about 10% if calories consumption is kept in the RCP2p6 SSP2 level. Main reason for the small food security effect is that land quality requirements for AFFOR are lower than for energy and food crops (feasible area for AFFOR 6000 Mha while for energy and wood crops 2000 Mha if no deforestation allowed).

Chapman-Richards volume growth model



GLOBIOM model

http://www.globiom.org/



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GLOBIOM

A global model to assess competition for land use between agriculture, bioenergy, and forestry

GLOBIOM .org

IIASA's Global Biosphere Management Model (GLOBIOM) is used to analyze the competition for land use between agriculture, forestry, and bioenergy, which are the main land-based production sectors. As such, the model can provide scientists and policymakers with the means to assess, on a global basis, the rational production of food, forest fiber, and bioenergy, all of which contribute to human welfare.

About GLOBIOM

The GLOBIOM model has global coverage, with 30 regions currently represented in the global version.

Regional versions of the model, such as GLOBIOM-BRAZIL and GLOBIOM-EU, have been designed with national and regional institutes. These versions provide more detailed spatial representation of land use changes to assess the impact of specific regional policies.

The GLOBIOM approach is strongly grounded in the idea that the production of food, forest fiber, and bioenergy, must be analyzed and planned in an integrated way across agriculture and forestry, forestry, and bioenergy sectors. GLOBIOM can be

FAST FACTS

- The 18 globally most important crops covered in GLOBIOM are barley, dry beans, cassava, chick peas, corn, cotton, groundnut, millet, potatoes, rapeseed, rice, soybeans, sorghum, sugarcane, sunflower, sweet potatoes, wheat, and oil palm. The GLOBIOM-EU version extends this to 27 crops.

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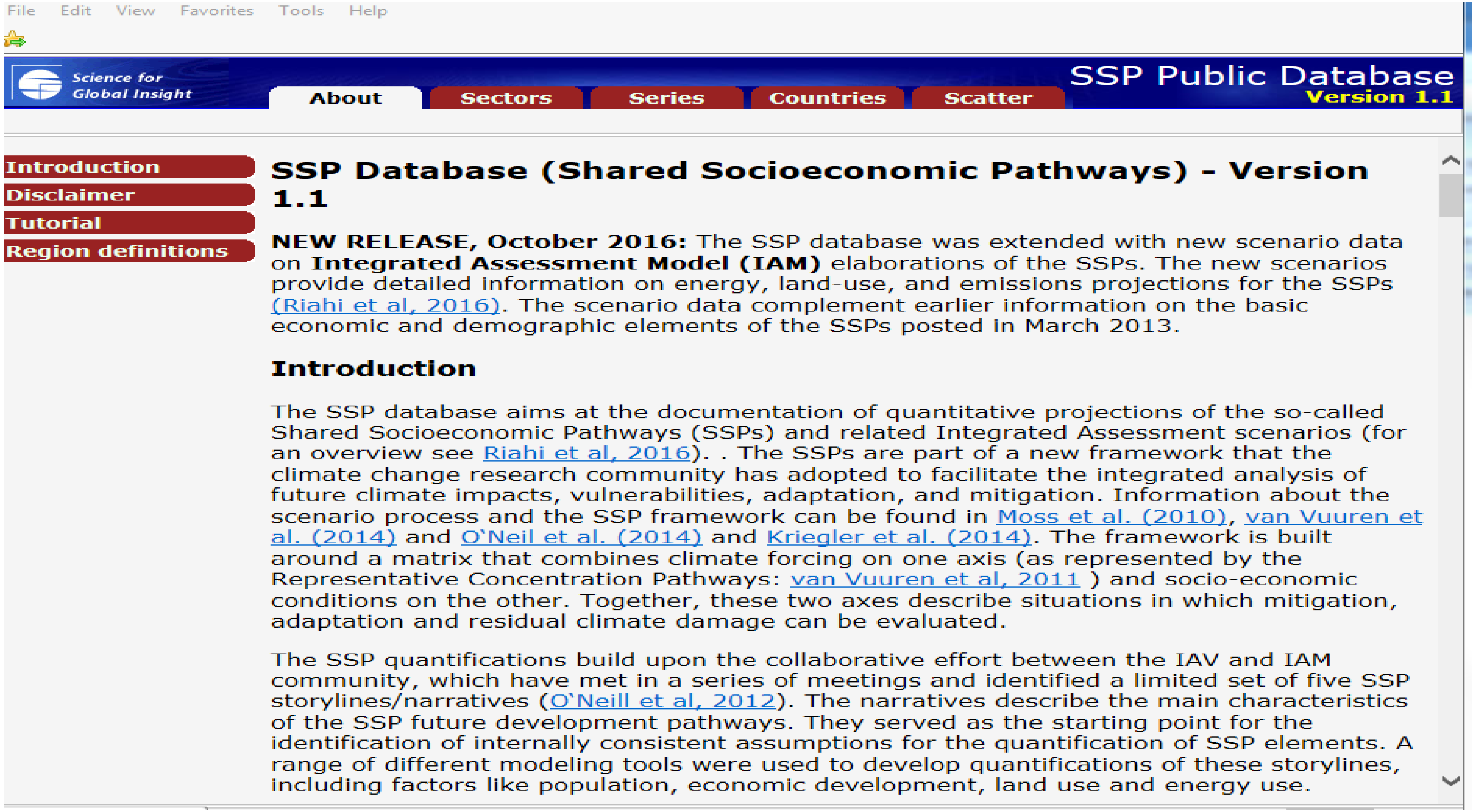
PUBLICATIONS

» **Havlik P, Valin H**, Herrero M... (2014)
Climate change mitigation through livestock system transitions

» **Mosnier A, Obersteiner M,**

SSP-RCP scenario data

SSP database: https://tntcat.iiasa.ac.at/SspDb/



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SSP Public Database
Version 1.1

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Tutorial
Region definitions

SSP Database (Shared Socioeconomic Pathways) - Version 1.1

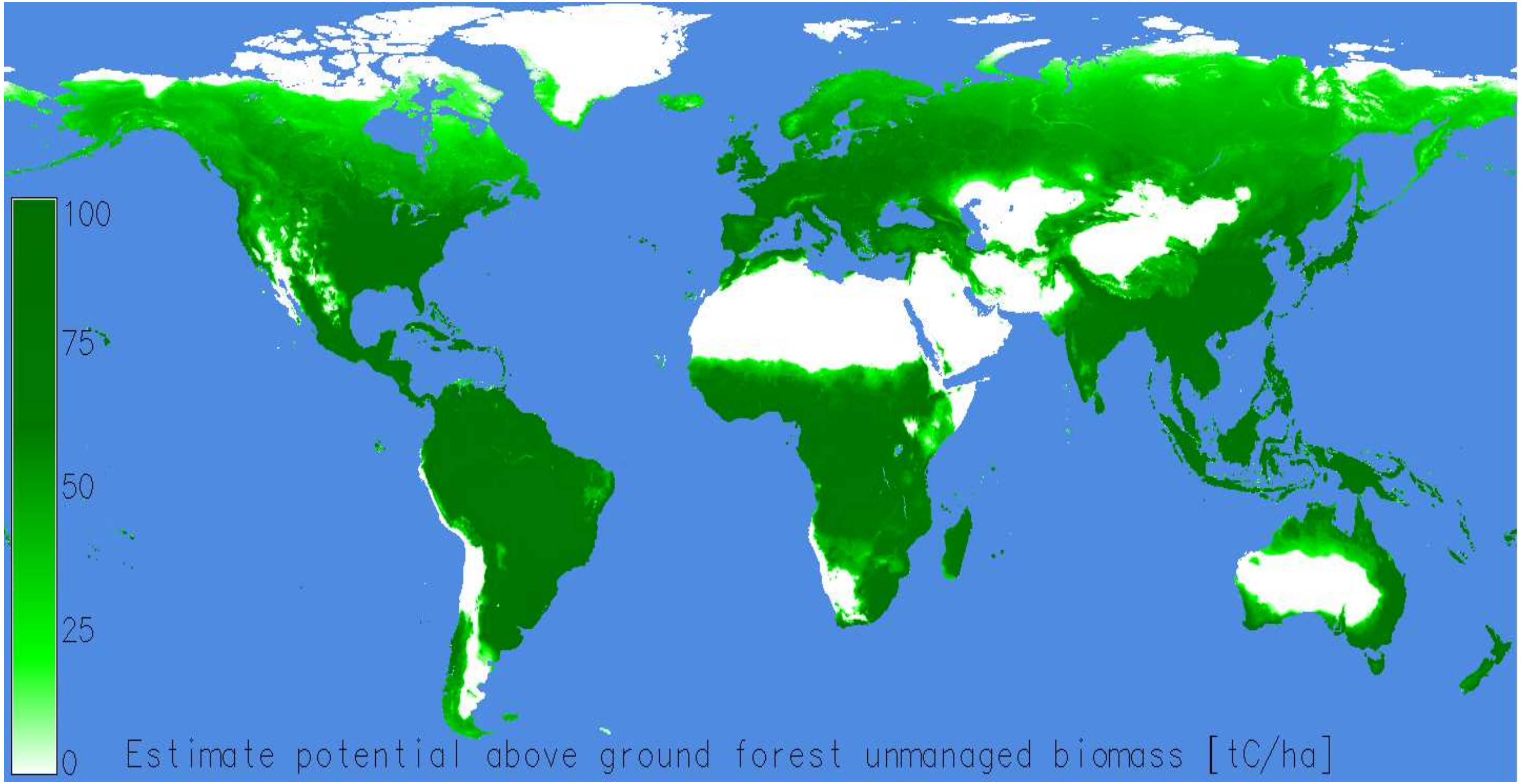
NEW RELEASE, October 2016: The SSP database was extended with new scenario data on **Integrated Assessment Model (IAM)** elaborations of the SSPs. The new scenarios provide detailed information on energy, land-use, and emissions projections for the SSPs (Riahi et al, 2016). The scenario data complement earlier information on the basic economic and demographic elements of the SSPs posted in March 2013.

Introduction

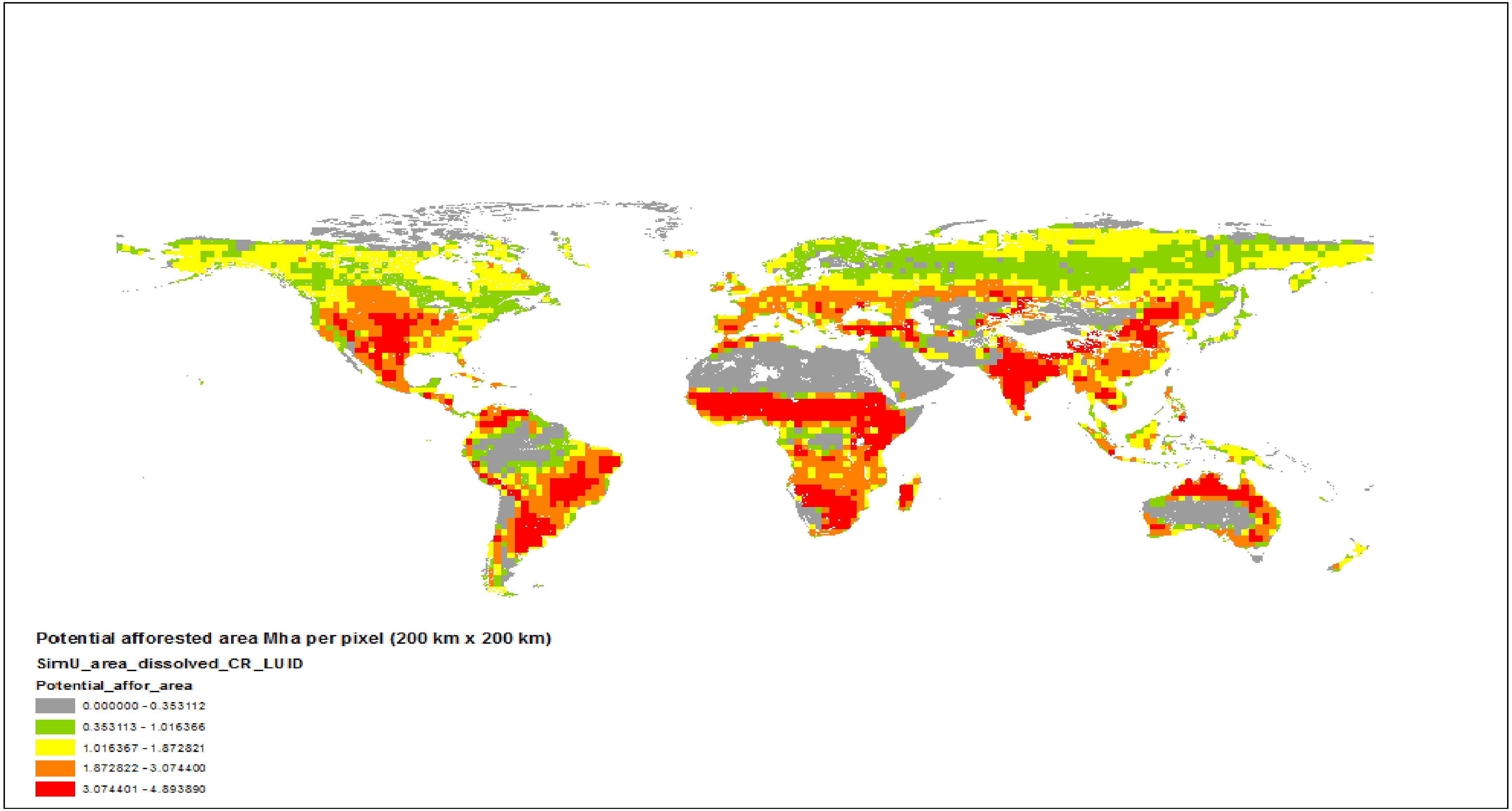
The SSP database aims at the documentation of quantitative projections of the so-called Shared Socioeconomic Pathways (SSPs) and related Integrated Assessment scenarios (for an overview see Riahi et al, 2016). . The SSPs are part of a new framework that the climate change research community has adopted to facilitate the integrated analysis of future climate impacts, vulnerabilities, adaptation, and mitigation. Information about the scenario process and the SSP framework can be found in Moss et al. (2010), van Vuuren et al. (2014) and O'Neil et al. (2014) and Kriegler et al. (2014). The framework is built around a matrix that combines climate forcing on one axis (as represented by the Representative Concentration Pathways: van Vuuren et al, 2011) and socio-economic conditions on the other. Together, these two axes describe situations in which mitigation, adaptation and residual climate damage can be evaluated.

The SSP quantifications build upon the collaborative effort between the IAV and IAM community, which have met in a series of meetings and identified a limited set of five SSP storylines/narratives (O'Neill et al, 2012). The narratives describe the main characteristics of the SSP future development pathways. They served as the starting point for the identification of internally consistent assumptions for the quantification of SSP elements. A range of different modeling tools were used to develop quantifications of these storylines, including factors like population, economic development, land use and energy use.

G4M forest cover potential (9948 Mha)



Technical afforestation potential (5948 Mha)



Realized afforestation in 2100 (1872 Mha)