Forest production and carbon storage -potentials of European forestry

INTEGRATED SINK ENHANCEMENT ASSESSMENT

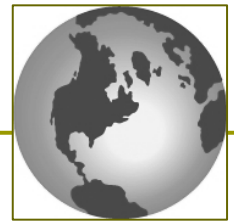
I N S E A
P A R T N E R S

FORESTRY MODELLING

IIASA Forestry Program

Oskar Franklin
Elena Moltchanova
Michael Obersteiner
Florian Kraxner
Rupert Seidl (BOKU, Wien)
Manfred J Lexer (BOKU, Wien)
Dimitry Rokityanskiy
Kentaro Aoki
Ian McCallum
Dagmar Schwab
Glen Armstrong

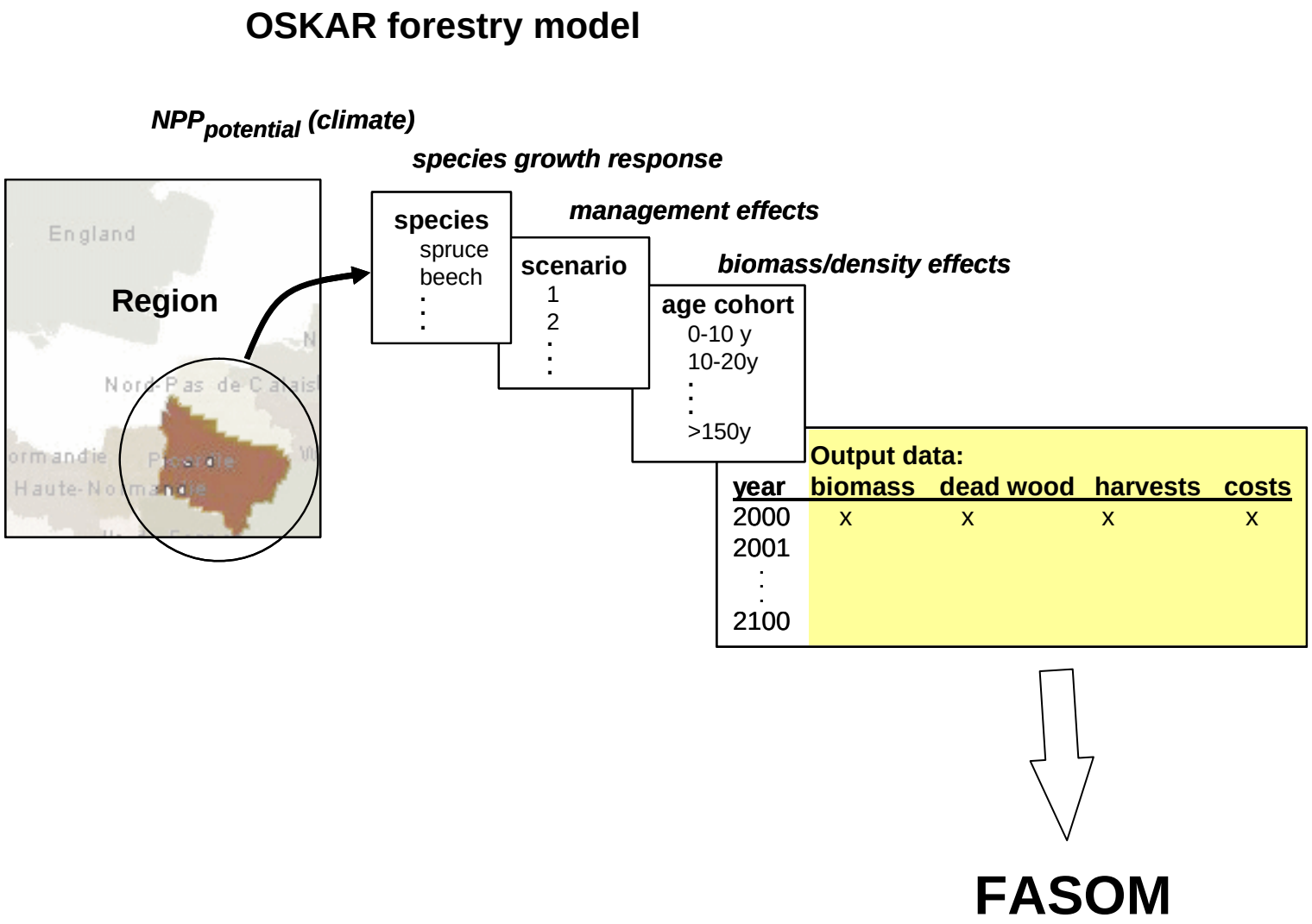
Overview



- Aims and framework
- Forest model (the OSKAR model)
- Results for different scenarios
- Conclusions and implications

Forests and management

the OSKAR Forestry model and data



Forestry modeling framework

FASOM model
-economic optimization of land use

OSKAR model
-forestry scenarios

NPP model

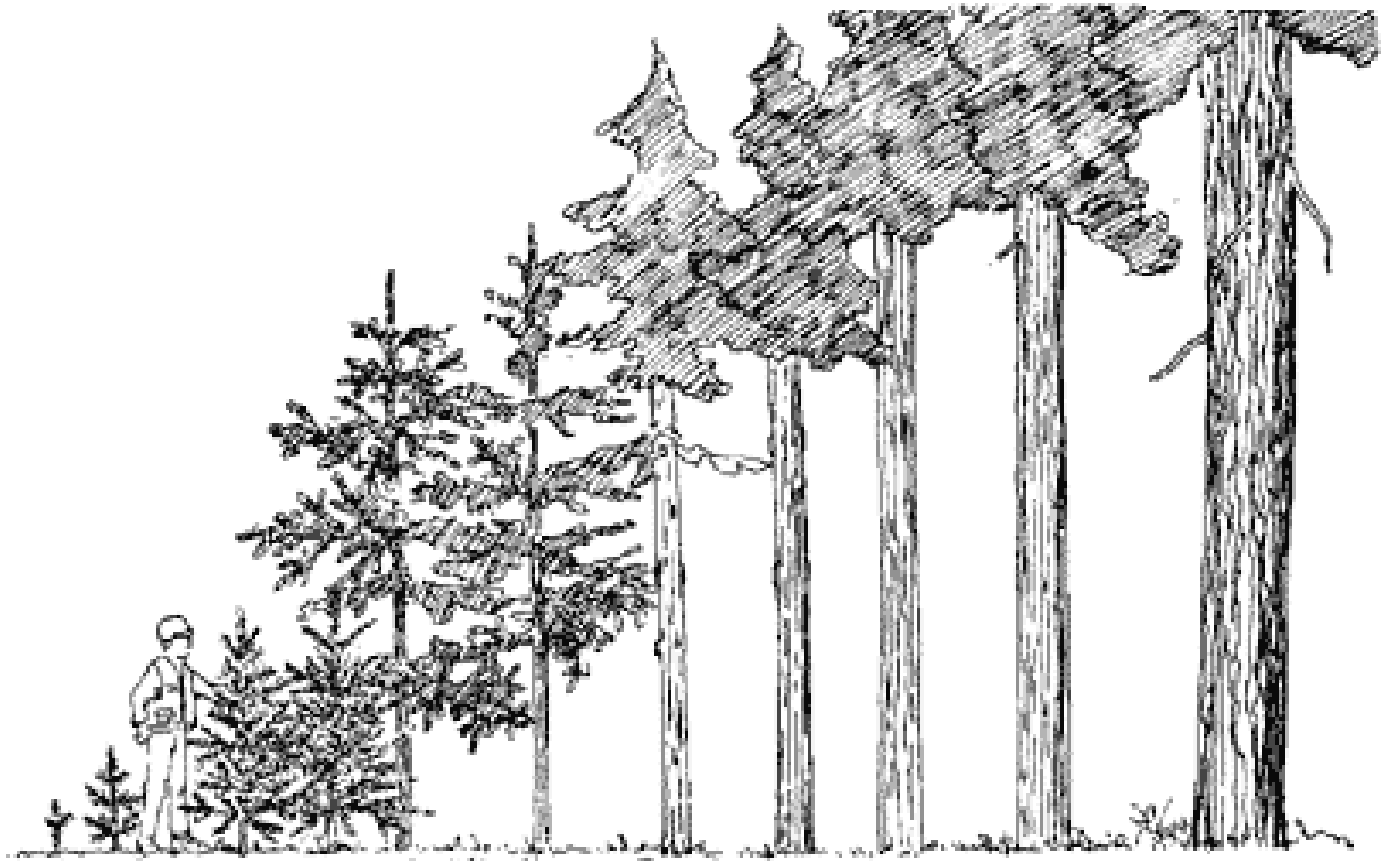
Forestry output:
- C storage (soil, biomass)
- Wood
- Energy biom.
- Forested area

Potentials:
- C storage
- Wood
- Energy biom.
- management costs
- prices
- alternative land uses

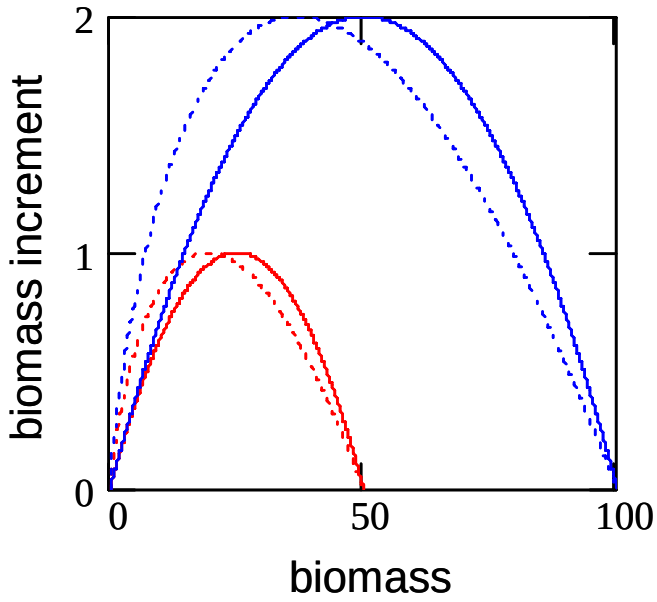
- management scenarios: (harvest, thinning, species)
- climate change effect
- Initial state forest and soil

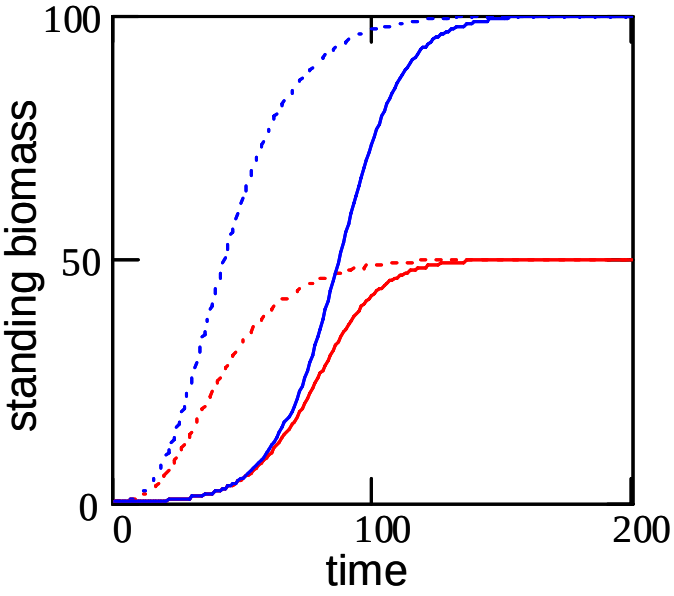
climate

Forest growth modeling



Tree growth

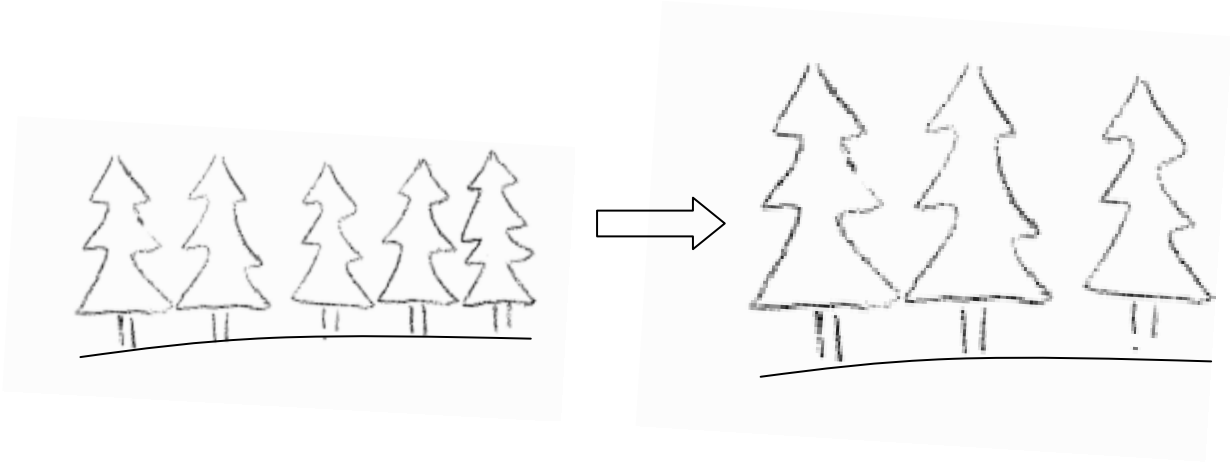


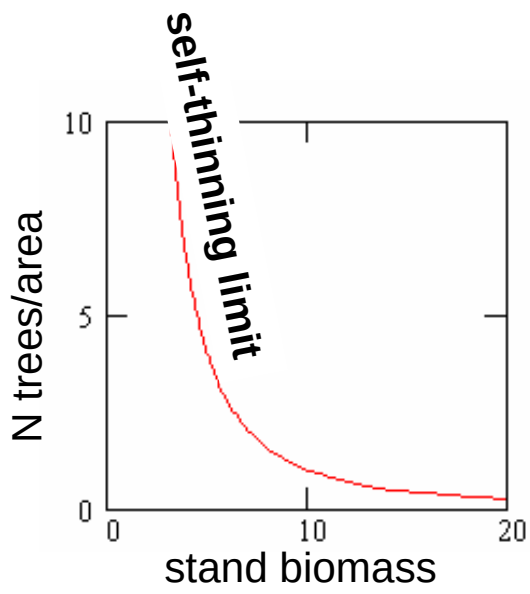


$$\frac{dB}{dt} = k \cdot NPP^{y} \cdot B \left[1 - \left(\frac{B}{B_{max}} \right)^{x} \right] \qquad B_{max} = c \cdot NPP$$

- Productivity of the site (NPP) controls growth rate and equilibrium biomass

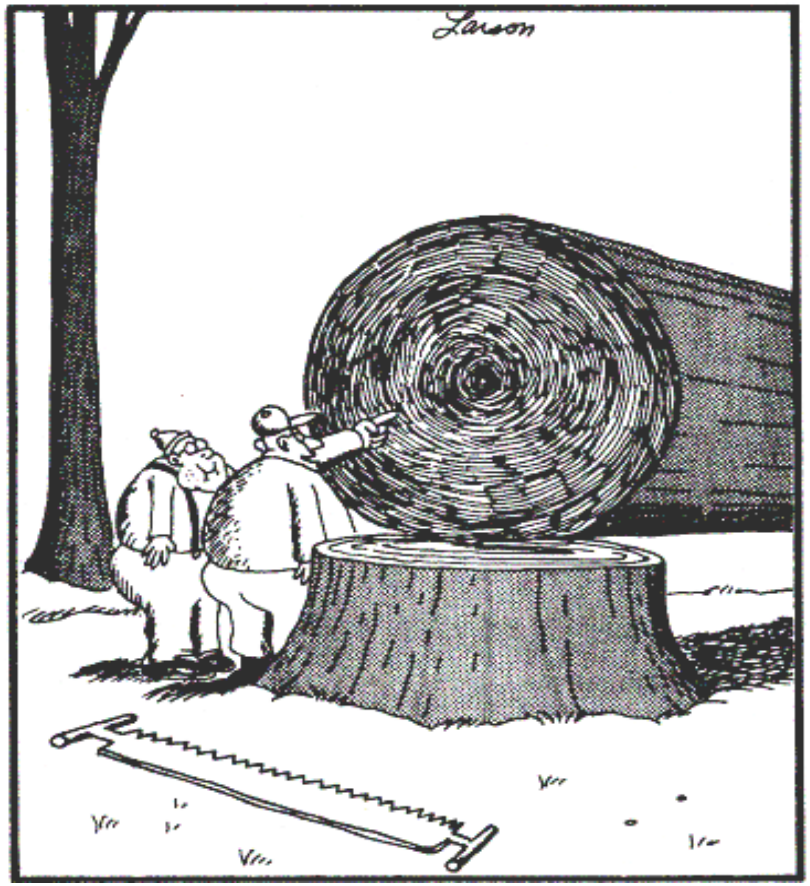
Self-thinning and mortality





- Growth and competition causes self-thinning
- The number of trees per are is limited by the self thinning line. This number decreases with increasing tree size

Forest management

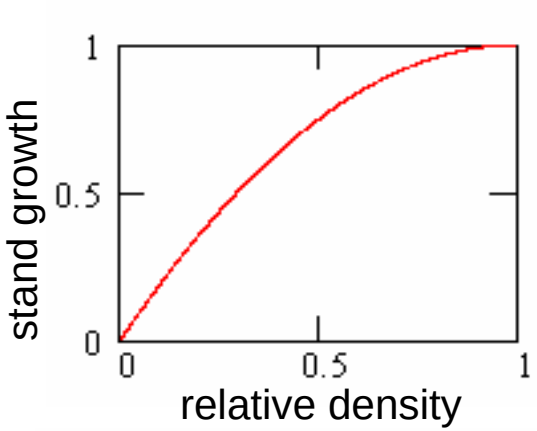


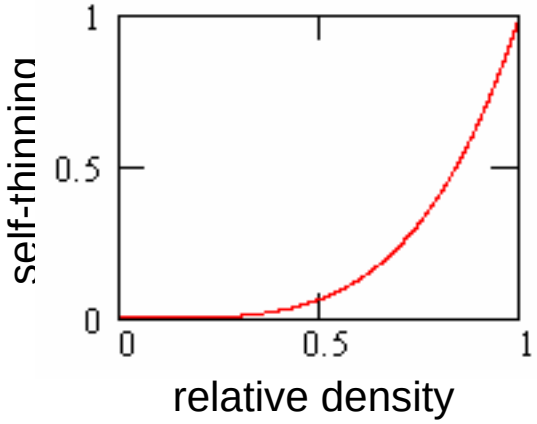
“And see this ring right here, Jimmy? . . . That’s another time the old fellow miraculously survived some big forest fire.”

Thinning management

- Thinning purposes:
  - get larger trees (but fewer)
  - harvest more
  - take out bad trees
  - facilitate regeneration

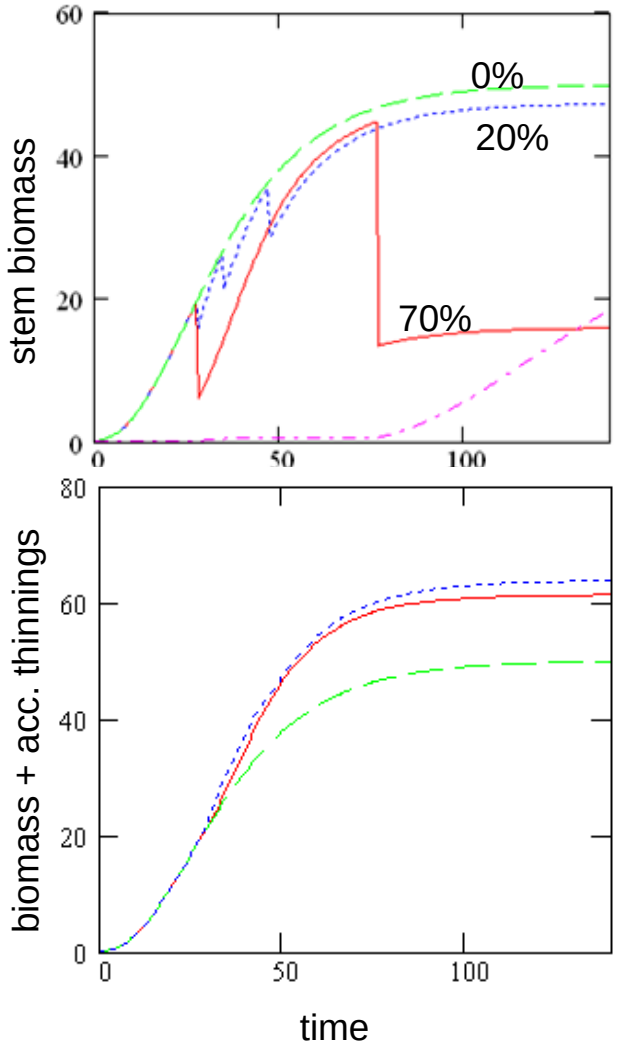
- Growth effect: reduced density but more resources available per tree
- Mortality effect: reduced self-thinning mortality





Thinning scenarios

- Thinning at an early stage have a small effect on final biomass
- After thinning at a late stage, the old trees does fill up the space
- Large thinnings leaves space and resources (light) for new generation
- Thinnings can result in larger total harvests (thinnings + final harvest)

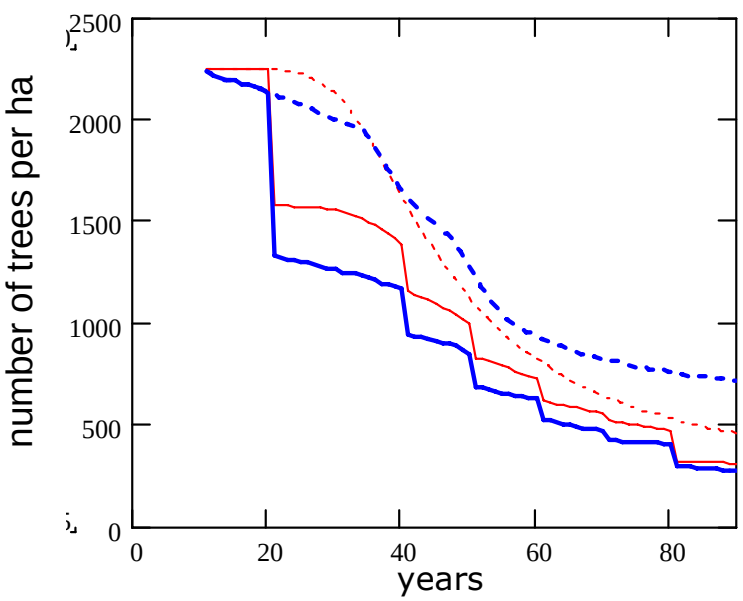


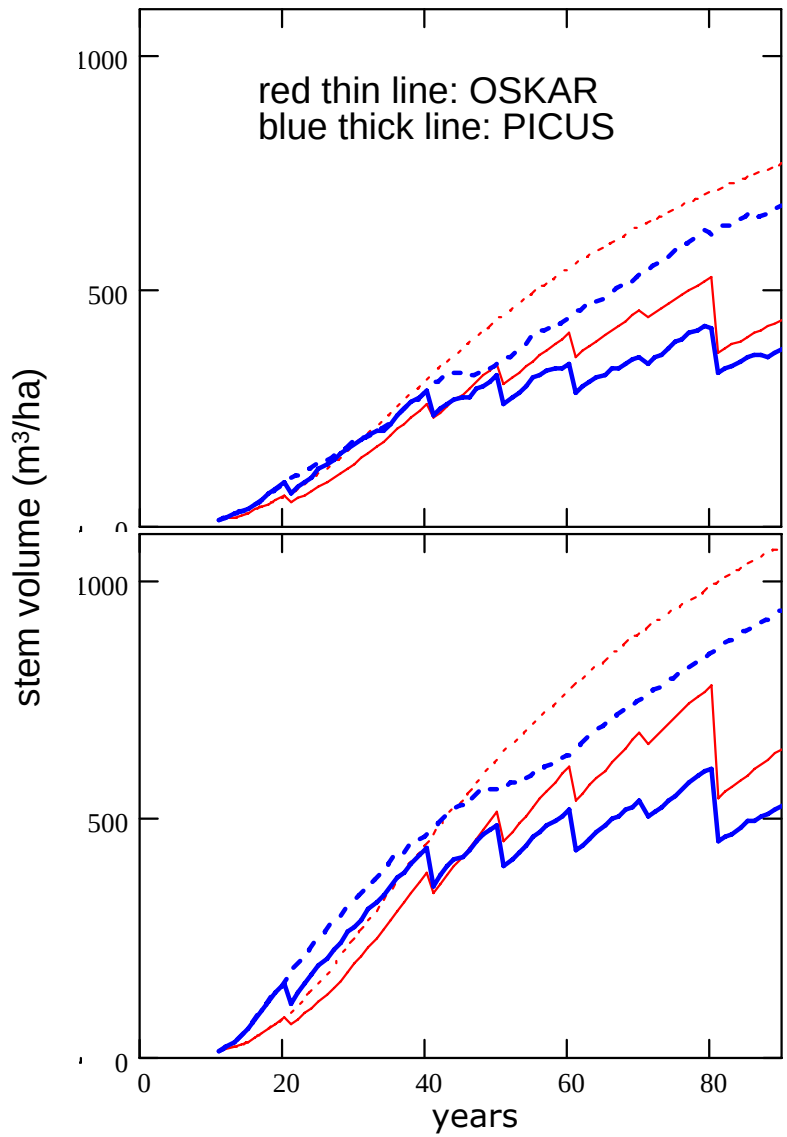
Other management options

- Rotation length
- Species selection
- Fertilization

Validation of the model

- Production estimate agrees well with a detailed tree level physiological model PICUS (hybrid –patch model)
- Thinning effect is almost identical in both models

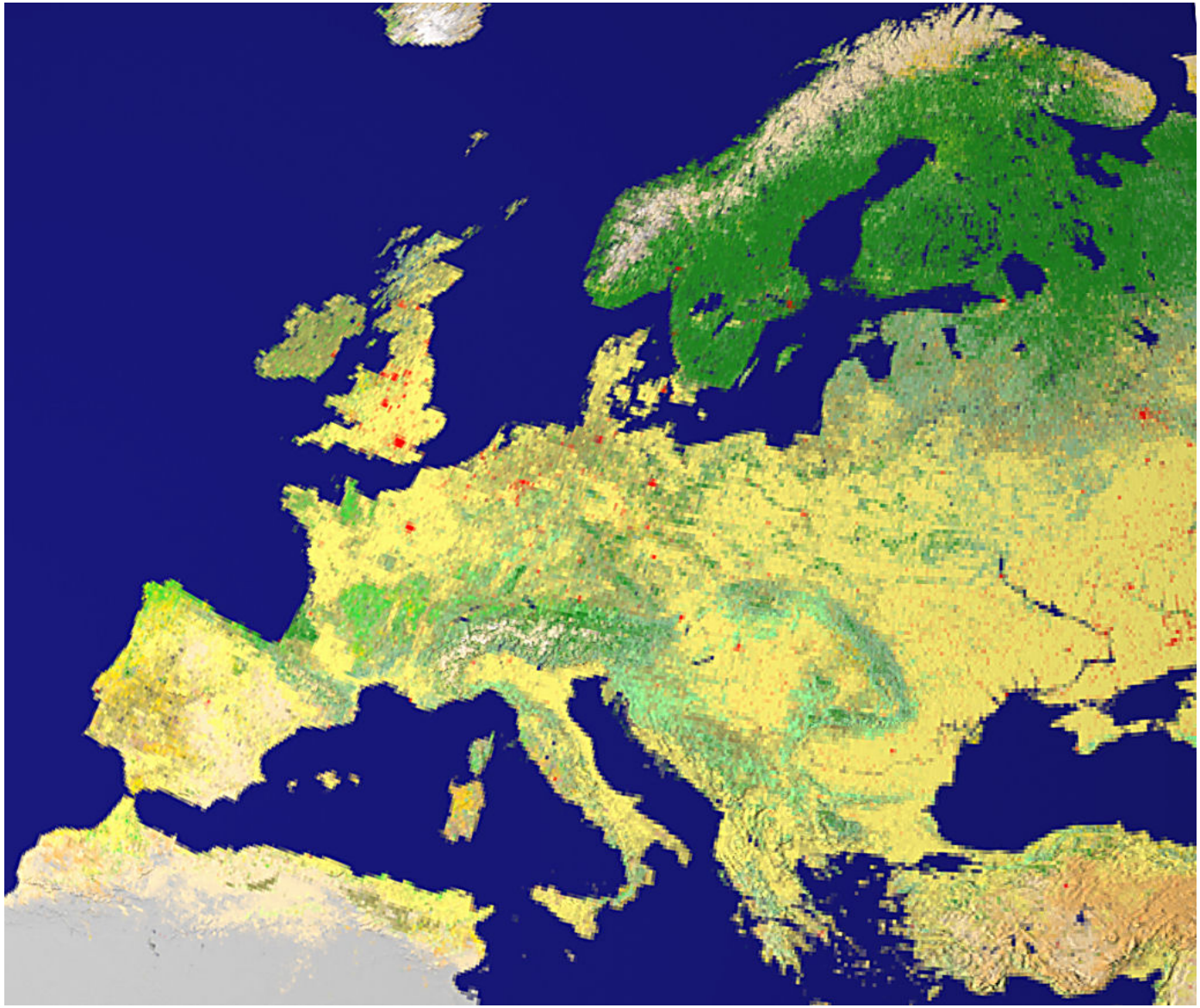




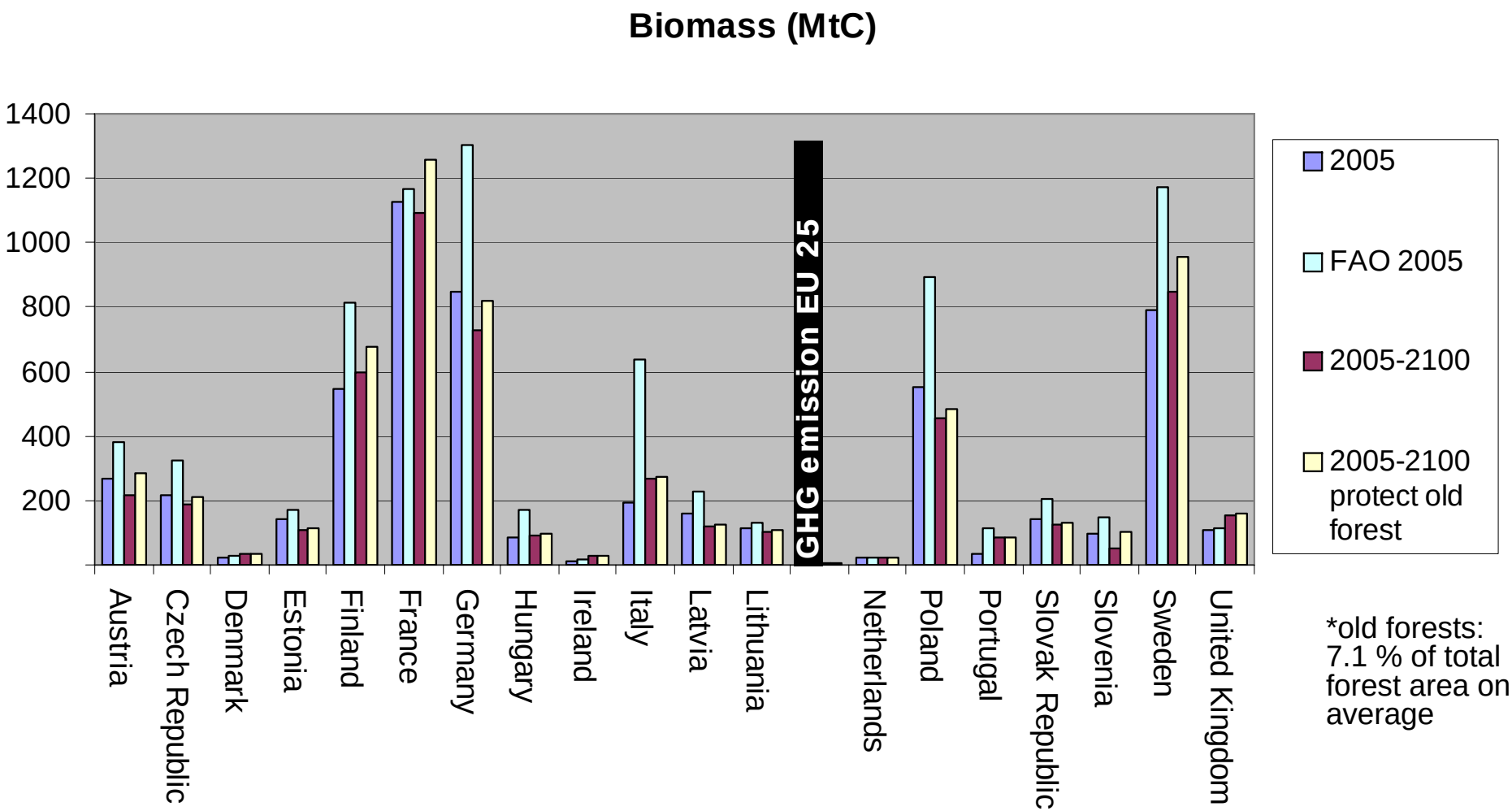
Model summary

- Predicts carbon accumulation, forestry production and management costs in response to management (thinning, species selection, rotation) and climate change
- In contrast to most existing management models, it does not rely on local empirical relations and local site indexes, but is based on globally applicable biophysical principles and species characteristics.
- it can be run for any region and time period and is easily integrated with global models of climate change effects (LPJ) and land use economic optimization models (FASOM model), which is done in the European carbon sink project INSEA.

Reality and results

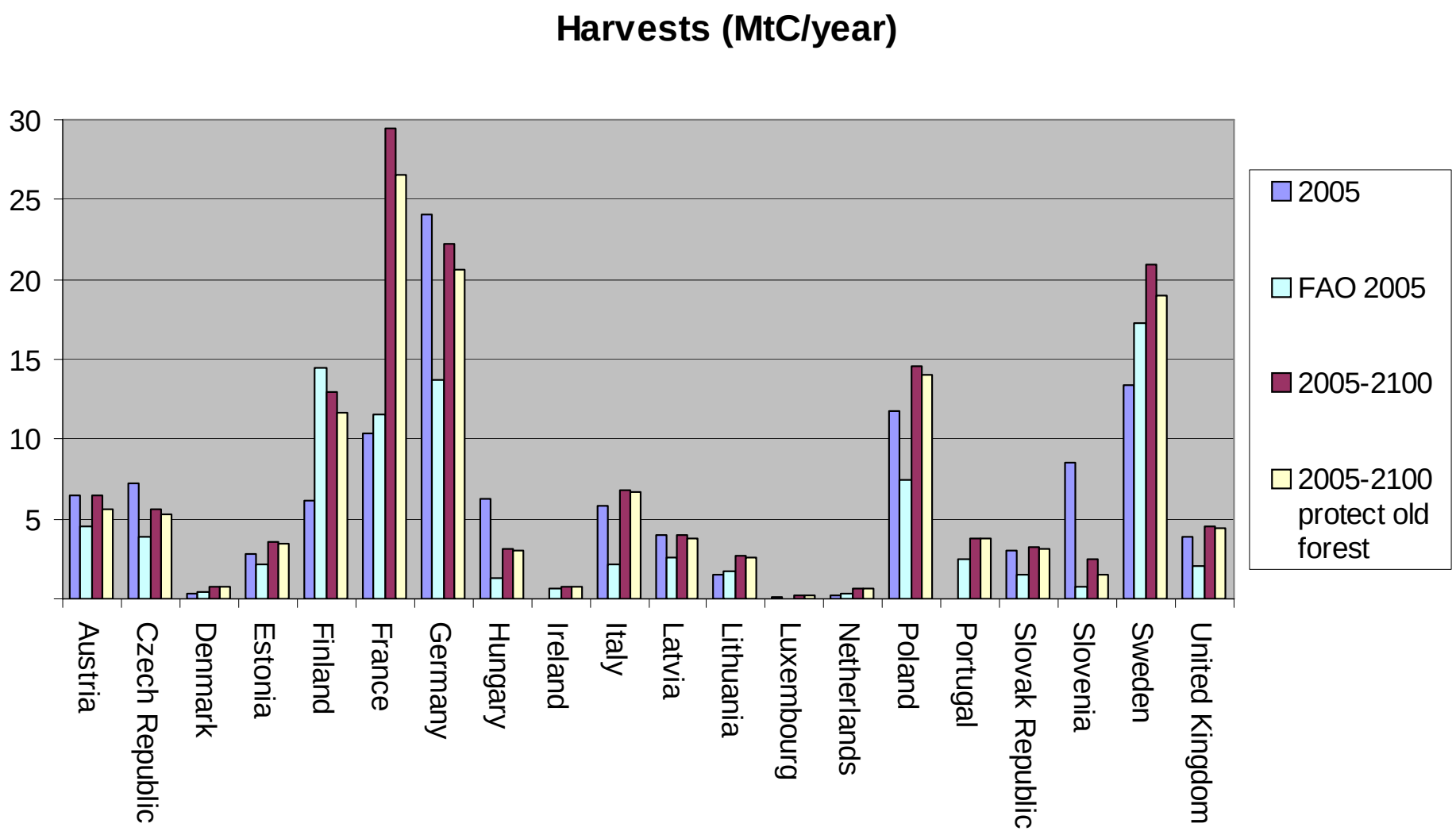


Current and future forests



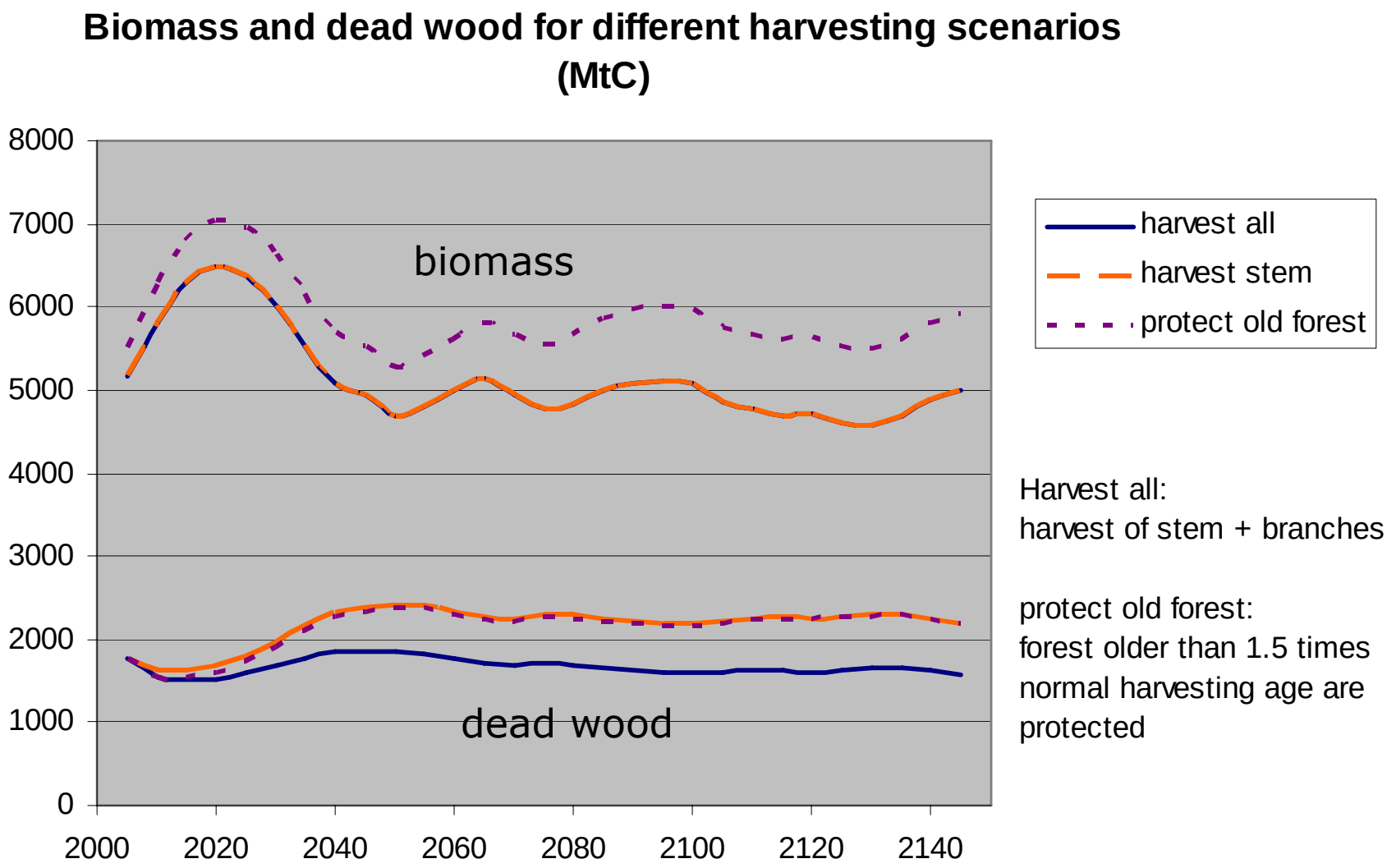
modeled biomass and estimated by FAO for EU countries, for 2005 and mean of 2005-2100 for two scenarios: 1) all managed, 2) old forest protected

Current and future forests



Total maximum sustainable harvests in EU ≈ 200 MtC/year (2005-2100)

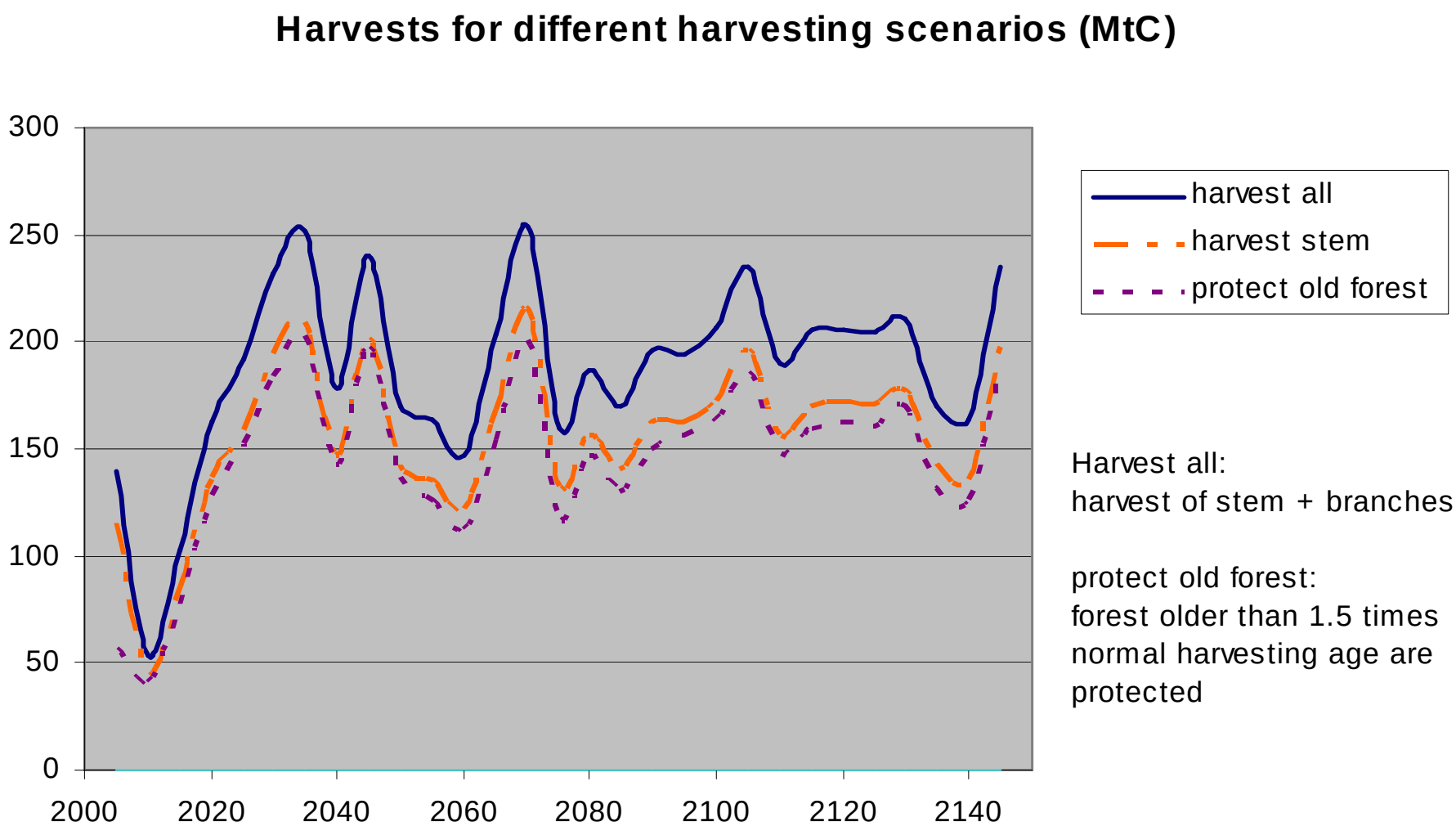
Forest development scenarios



Harvest all:
harvest of stem + branches

protect old forest:
forest older than 1.5 times normal harvesting age are protected

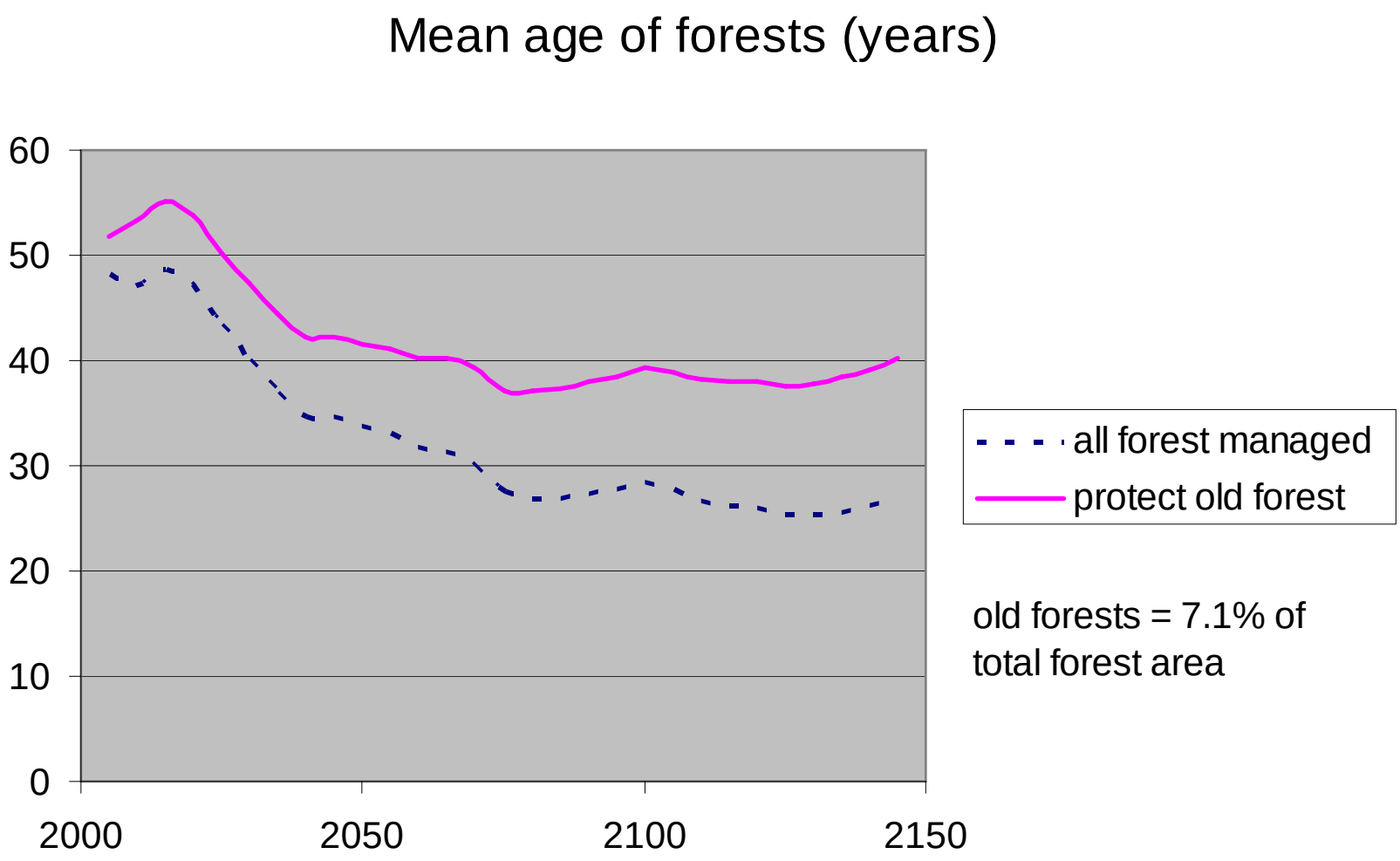
Forest development scenarios



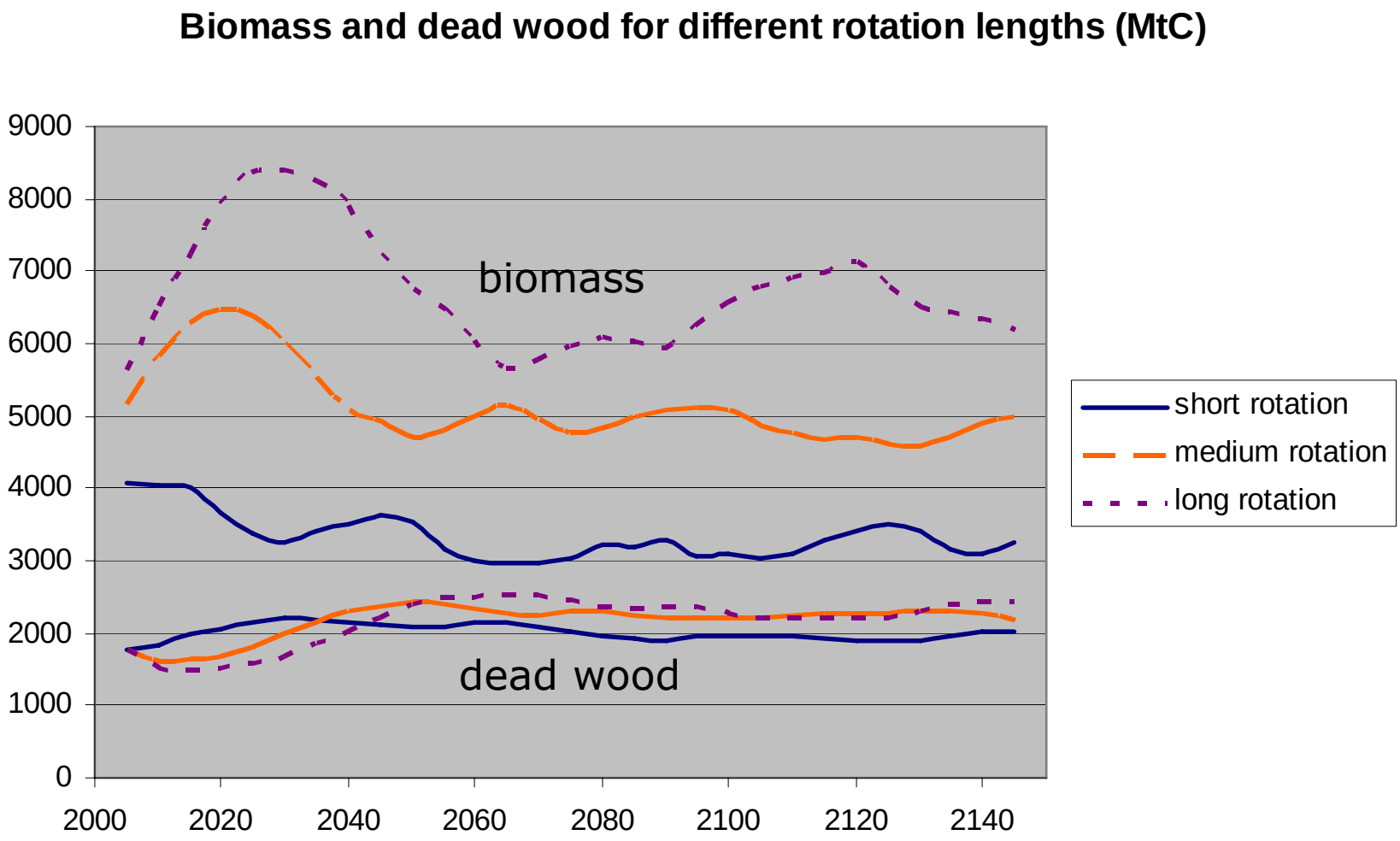
Harvest all:
harvest of stem + branches

protect old forest:
forest older than 1.5 times normal harvesting age are protected

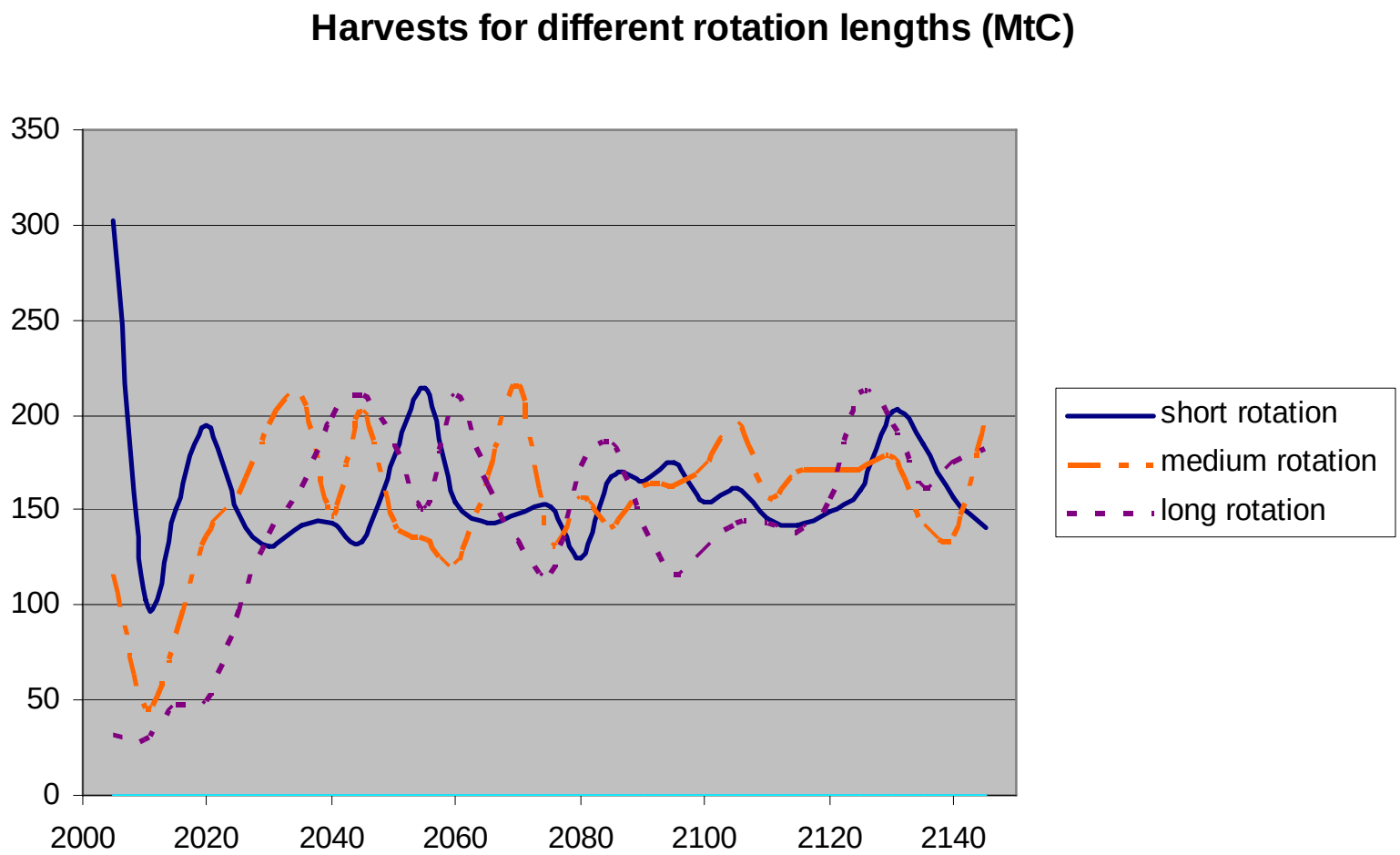
Forest development scenarios



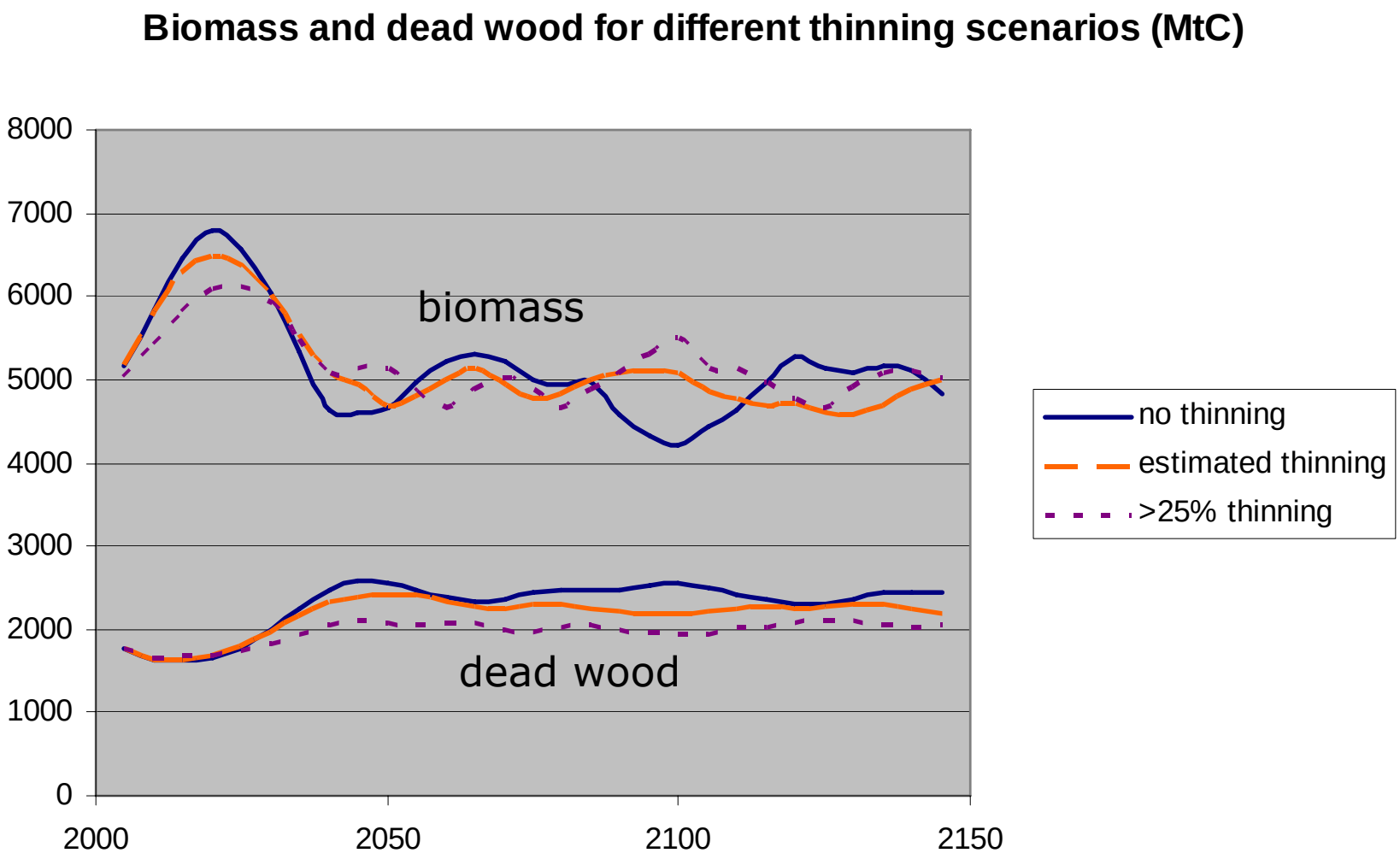
Forest development scenarios



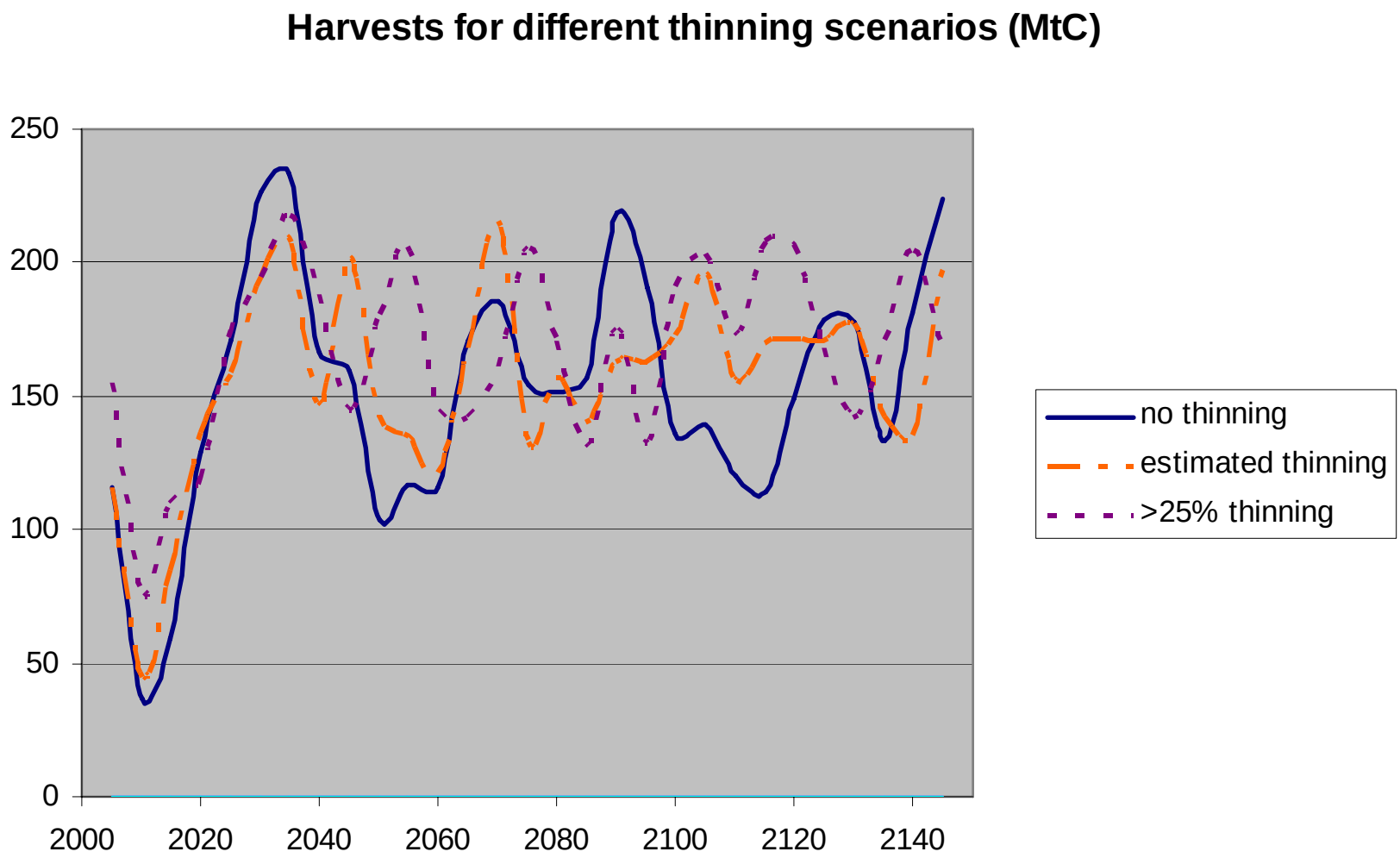
Forest development scenarios



Forest development scenarios



Forest development scenarios



Conclusions

- Future forest prediction strongly depends on estimates of current forests.
- There is a potential to increase harvests substantially in about 20 years from now
- Increasing the rotation time/age at harvest is a way to increase the carbon storage in the forest, but initially reduces harvest.
- By protecting old forests, carbon storage can be increase about 20% almost without reduction in harvests