

# Modelling the impacts of intensifying forest management on carbon budget across a long latitudinal gradient in Europe

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# Introduction

- EU is committed to at least 40% reduction in greenhouse gas emissions by 2030 compared to 1990 (INDCs 2015)
- Forest use is projected to intensify in Europe due to increasing bioenergy demand (Forsell et al. 2016)



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Forsell, N. et al. (2016): Study on impacts on resource efficiency of future EU demand for bioenergy (ReceBio). Final report.

## Forest management intensification

- Removal of harvest residues
- Shortened rotation lengths
  - Baseline 90 years



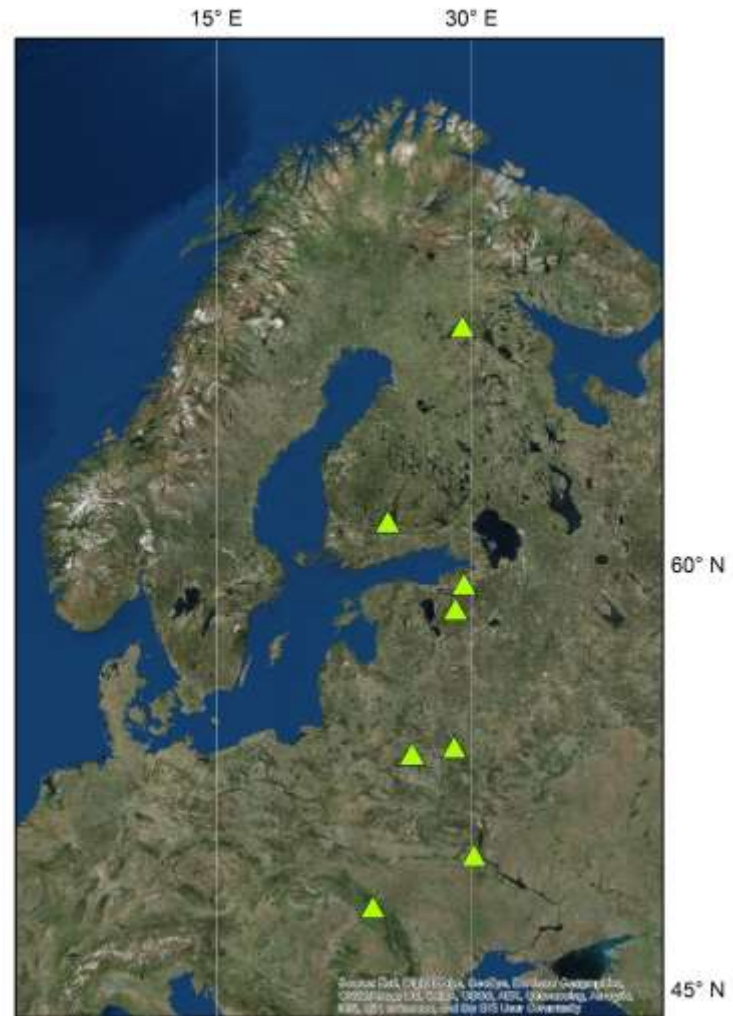
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## Are productivity and carbon sink capacity at risk?

- Soil carbon and nutrient losses due to reduced litter input to soil
- Feedbacks to forest growth can be studied by process-based modeling
- Evaluating the climate change mitigation potential of forest management systems

# Modelling across a latitudinal gradient

- Selected typical boreal and temperate coniferous forest sites
- BioGeoChemistry management model BGC-MAN
- Litter and soil carbon model Yasso



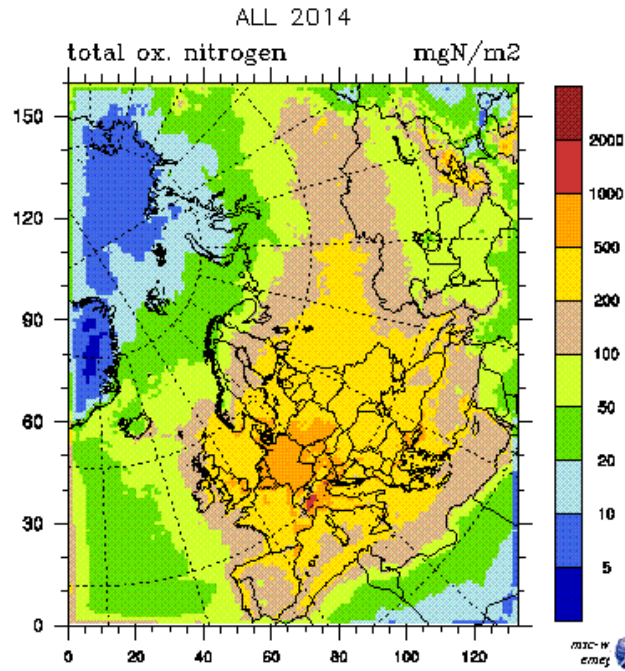
BGC-MAN model at IIASA website: <http://bit.ly/2bATrj3>

Information on Yasso: <https://en.ilmatieteenlaitos.fi/yasso>

# Model input data



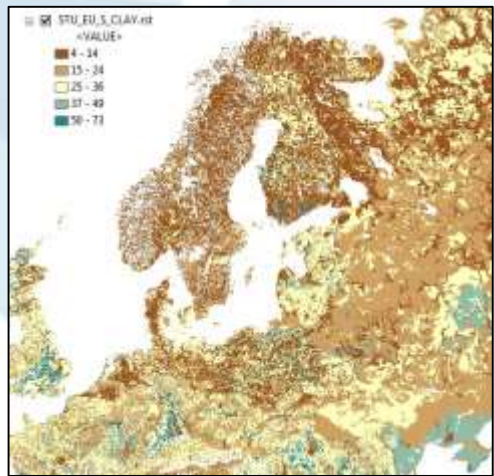
DAILY WEATHER DATA  
Periods 1915-2005, 2006-2095



NITROGEN  
DEPOSITION



ECOPHYSIOLOGICAL  
PARAMETERS

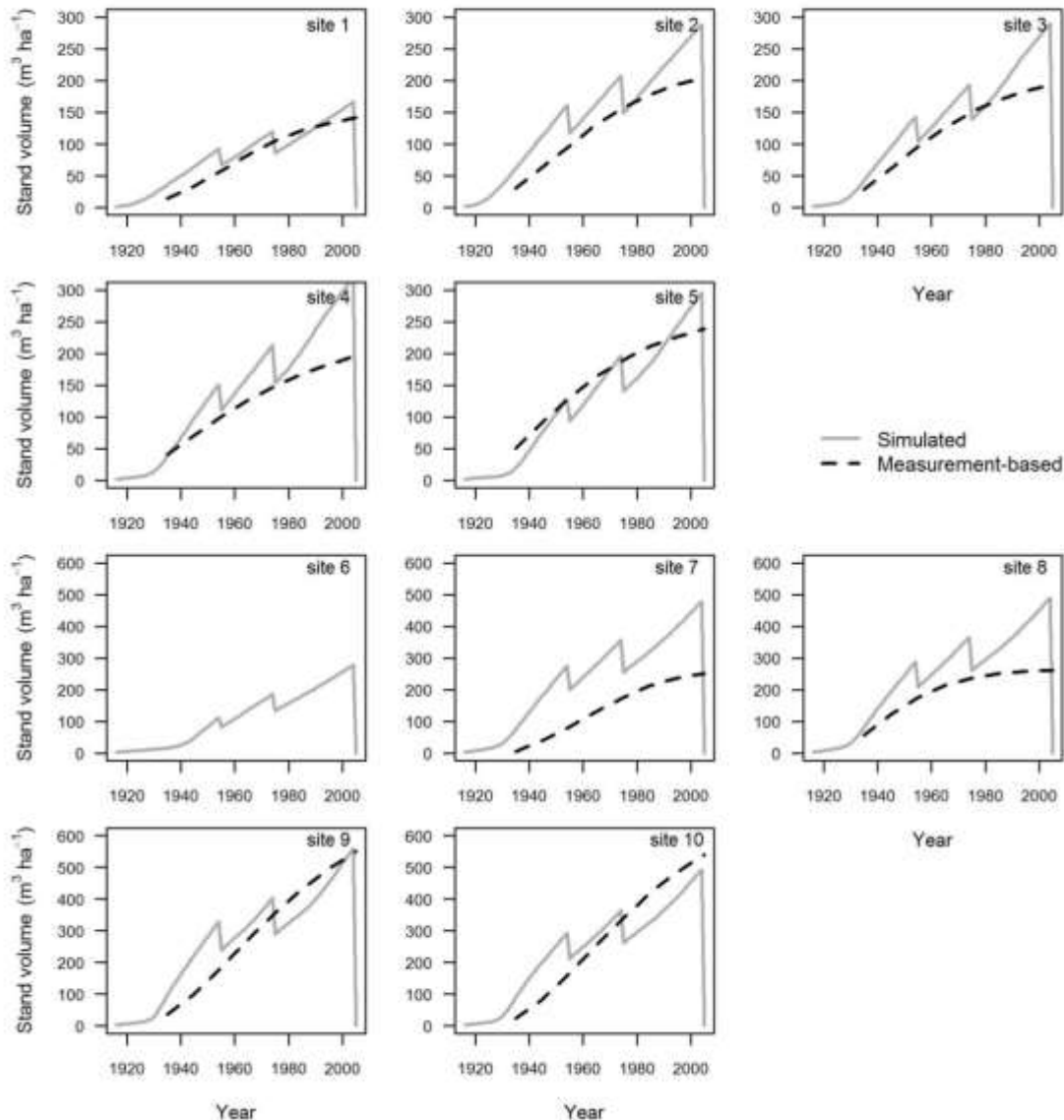


SOIL DEPTH AND  
TEXTURE



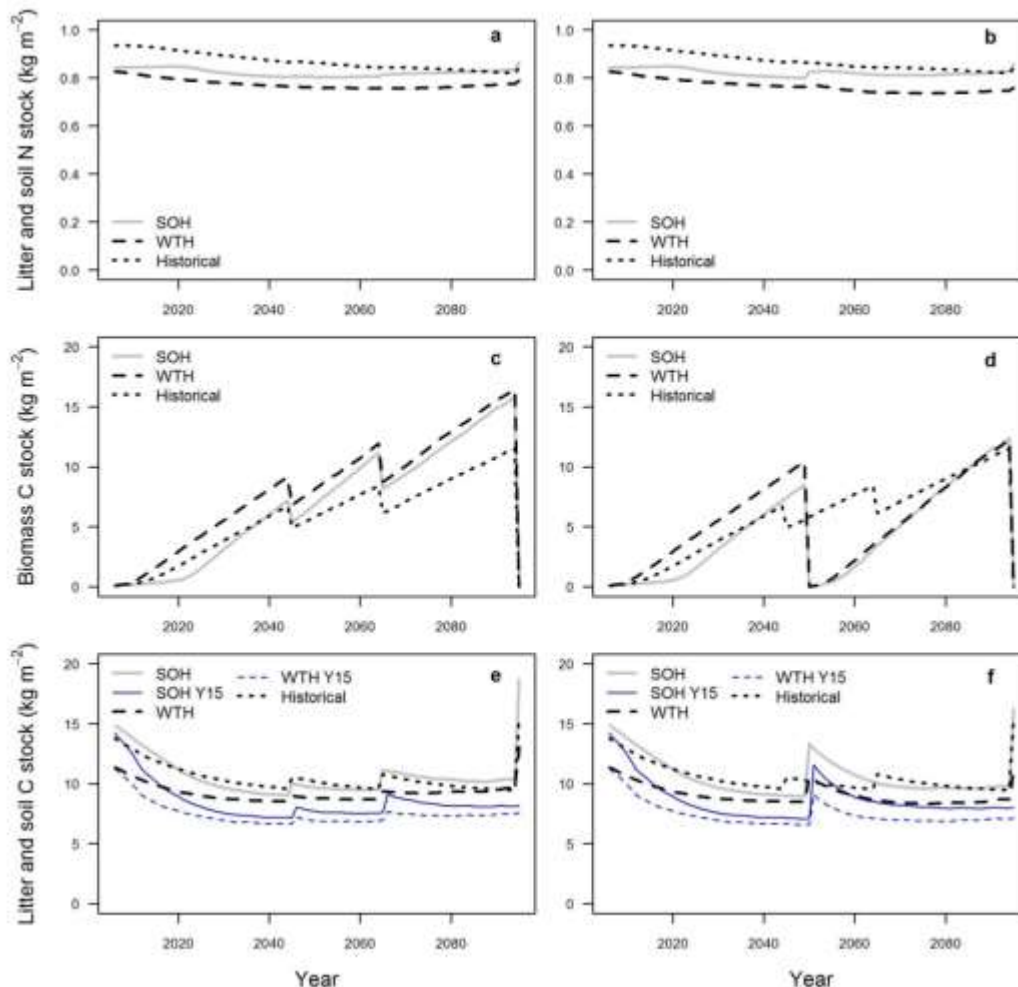
ELEVATION,  
SLOPE, ASPECT

# Historical simulation 1915-2005



- The simulated stand volume was higher than growth and yield tables
- Management history had a large effect on stand growth

# Scenarios for 2006-2095 (site 2)



- Biomass C stock increased due to climate change
- WTH produced higher biomass than SOH
- WTH decreased litter and soil N and C contents

# Climate change impacts

- Climate change increased the biomass C stock by 19-55% between 2005 and 2095 depending on the site
- The changes in the litter and soil C stock were less clear



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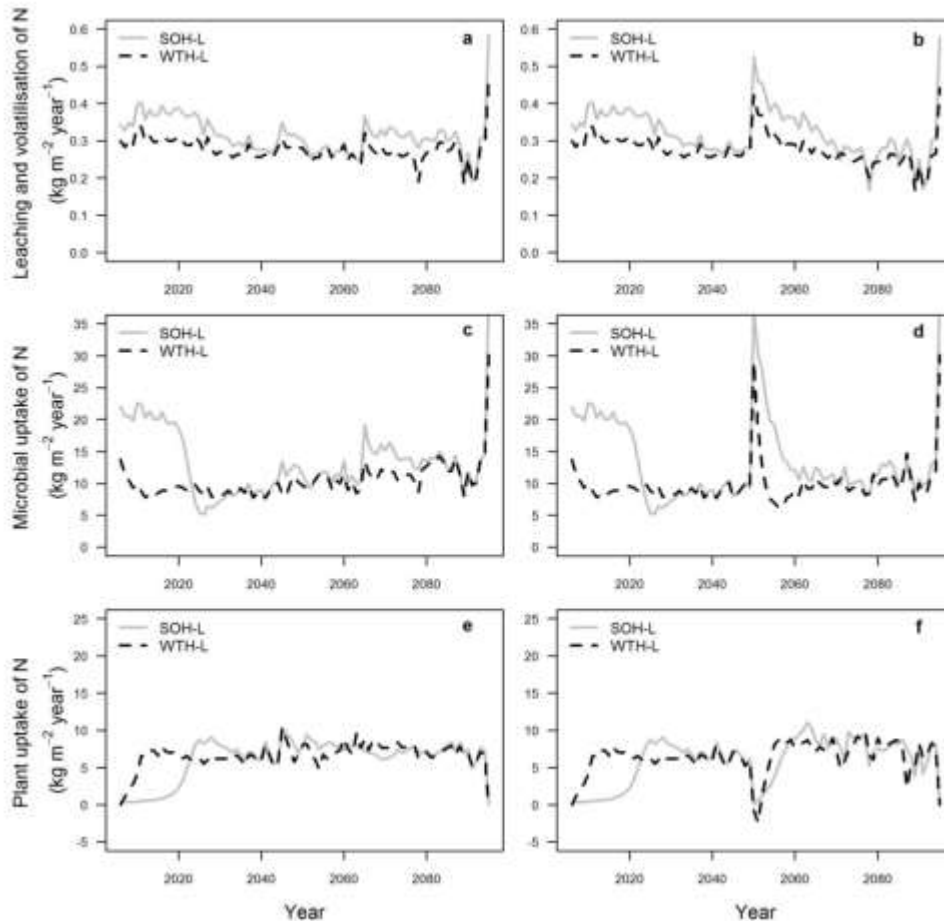
# Forest management impacts

- With **WTH**, the biomass C stock was **1-23% higher** and the litter and soil C stock **1-9% lower** compared with SOH in 2095 depending on the site
- **Shortened rotation length** decreased the total forest C stock by **12-49%** compared with SOH depending on the site and the level of harvest residue removal

# Harvest residues are substrates for soil microbes

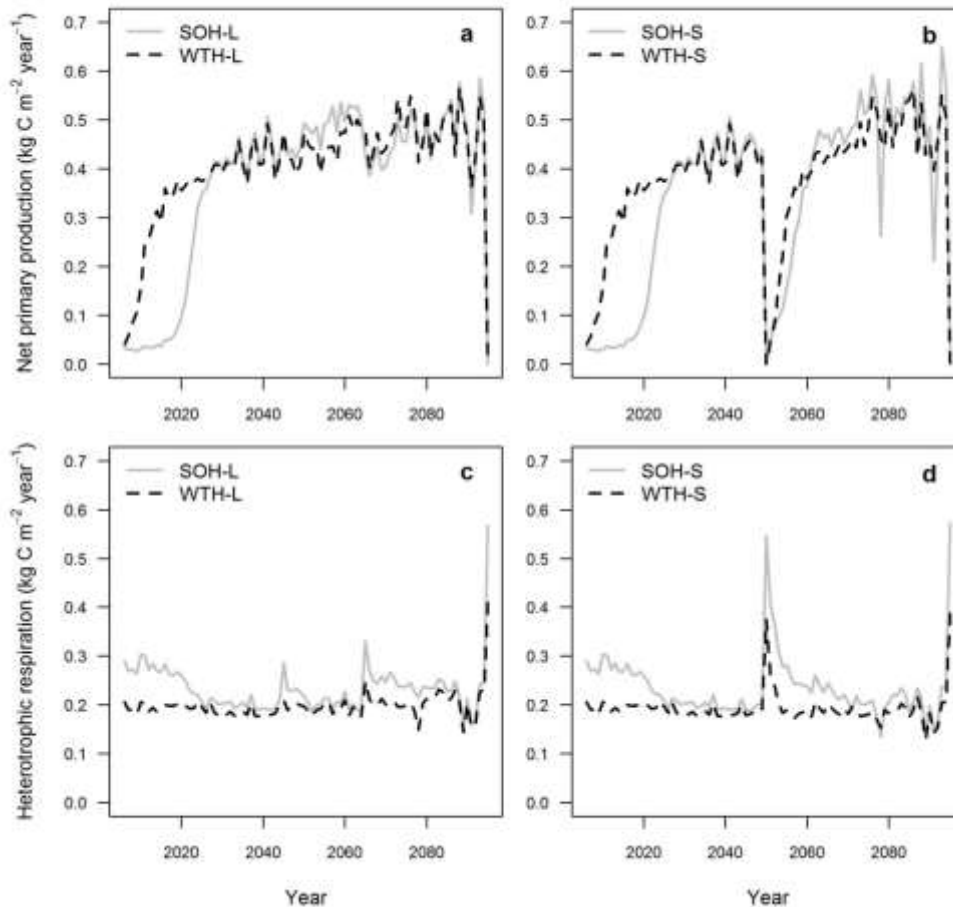


# Nitrogen dynamics regulates tree growth in the model (site 2)



- WTH reduced leaching and volatilisation of N
- Immobilisation of N peaked after SOH leading to lower plant uptake of N

# High microbial activity after harvest



- Net primary production increased temporarily after WTH
- SOH caused higher respiration rates due to better substrate availability

# Topics for discussion

- Empirical results of the impacts of WTH on stand growth are contrasting
- Field measurements are needed to
  - Improve process understanding
  - Enable model development
- Knowledge gaps at the process level
  - How fast do microbes colonise dead wood after harvest?
  - Soil acidification due to repeated residue removal might reduce stand growth in the long run

# Acknowledgements

- IIASA YSSP 2016
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