FOREXCLIM: Forests and extreme weather events: Solutions for risk resilient management in a changing climate

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FOREXCLIM: Research Partners

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FOREXCLIM: Main questions and hypotheses

(1) What is the risk of extreme weather event-induced forest damage in Europe and what ecological and financial impacts will extreme weather events have on major European tree species and forest types in the coming decades?

\( H(1): \text{The risk of extreme events-induced impacts on forests will increase in the future.} \)
FOREXCLIM: Main questions and hypotheses

(1) What is the risk of extreme weather event-induced forest damage in Europe and what ecological and financial impacts will extreme weather events have on major European tree species and forest types in the coming decades?

(2) How should current forest management regimes in Europe be adapted to make stand structures and tree species composition portfolios robust to the impacts of extreme weather events?

H(2): Close to nature forestry is an advantageous strategy to balance financial return and ES from European forests while reducing risk associated with increased extremes under future climate.
FOREXCLIM: Main questions and hypotheses

(1) What is the risk of extreme weather event-induced forest damage in Europe and what ecological and financial impacts will extreme weather events have on major European tree species and forest types in the coming decades?

(2) How should current forest management regimes in Europe be adapted to make stand structures and tree species composition portfolios robust to the impacts of extreme weather events?

(3) How does uncertainty about future climate, timber market prices and forest ecosystem functioning under changed climate influence optimal forest management regimes?

H(3): Both management objectives, multifunctionality and reducing adverse effects of increasing uncertainty due to climate change require diversifying management alternatives.
FOREXCLIM: Approach

Risk-resilient multifunctional European forest landscapes in the future.

- Changing climate
- Changing forest dynamics
- Changing timber markets
- Different forest management strategies
- Different weights of social/economic/ecologic aspects (ecosystem services)
FOREXCLIM: Approach

Model-based analysis

- **Climate**
  - Trend
  - Weather extremes (heat wave, drought, storm)

- **Response**
  - Forest susceptibility to extreme events (fire, pathogens)
  - Ecosystem dynamics
  - Species composition
  - Forest productivity

- **Management**
  - Species composition
  - Species selection
  - Rotation period
  - Management strategy (e.g. close to nature forestry)

- **Economy**
  - Economic value
  - Market development
  - Ecosystem service provision

**Feedback** and **Optimization** arrows connect the stages.
FOREXCLIM: Workpackages

WP0: Management & coordination (TUM-LSAI)
Goal: Ensure management and coordination of project workflow, support communication among project partners

WP1: Expert dialogue (ULjub/TUM-LSAI)
Goal: Co-develop optimal management strategies.

WP2: Extreme events in European forest ecosystems (ULund/TUM-LSAI)
Goals: Quantify impacts, estimate damage risk and simulate adaptation strategies.

WP3: Coupled climate, ecosystem & economic analysis (TUM-IFM/ULund)
Goals: Provide alternative strategies for climate-resilient multifunctional forest management.
Current work: Get models running...
The dynamic vegetation model LPJ-GUESS*: 

- CO₂
- N-deposition
- climate land use

- primary production & growth
- plant biogeography
- soil biogeochemistry
- population dynamics & disturbance

Soil organic matter

Vegetation

*LPJ-GUESS – a global ecosystem model
Smith et al. 2001, 2014
www.nateko.lu.se/lpj-guess
The dynamic vegetation model LPJ-GUESS*:

An example simulation of succession of boreal forest in Canada

Forest types
- Boreal needleleaved evergreen (early successional)
- Boreal needleleaved evergreen (late successional)
- C3-Grasses
- Broadleaved summmergreen

*LPJ-GUESS – a global ecosystem model
Smith et al. 2001, 2014
www.nateko.lu.se/lpj-guess

Figures from Steinkamp et al. 2018
Setting up forest management in LPJ-GUESS*:

**Detailed forestry:**
- Stand types/management types with:
- Planting systems (PFT selections)
- Establishment rules (e.g. all natural PFTs)
- Harvest systems (clearcut, continuous)
- N fertilisation

**Simple forestry used with LUH2:**
- Clearcut + creation of new stand

**Impacts of extreme events:**
- Drought mortality
- Wind disturbance
- Pathogens

*LPJ-GUESS – a global ecosystem model
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www.nateko.lu.se/lpj-guess
Setting up management decisions in YAFO 4.0*

YAFO is a planning-support tool for the development of management plans under uncertainty focusing on the forest enterprise level.

Coupling with LPJ-GUESS:
- Provide input data for calculation of management scenarios (felling plans) to be optimized with respect to financial considerations and ecological constraints.
- Determine objective function to consider risks and uncertainties due to natural calamities and timber price fluctuations.

*Yafo – Yet another forest optimizer
Härtl et al. 2013
Expected outcome...

Härtl et al. 2016

Present-day
NCAR-PCM
HadCM3

Hickler et al. 2012