Institute of Forest Management
TUM School of Life Sciences Weihenstephan
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Deriving risk reducing management strategies with the forest economic optimization model YAFO 4

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Project ForExClim

Ljubljana, April 25th 2018

With support from

Federal Ministry of Food and Agriculture

by decision of the German Bundestag

Overview

1. Research interests

2. YAFO 4

3. Current (preliminary) results
   - Settings
   - LPJ-GUESS Growth Data
   - YAFO Optimization Results

4. Information needed for close-to-reality-optimization

Research interests

1. Forest management faced with extreme weather event

2. Advantageous management strategies with respect to risk related returns

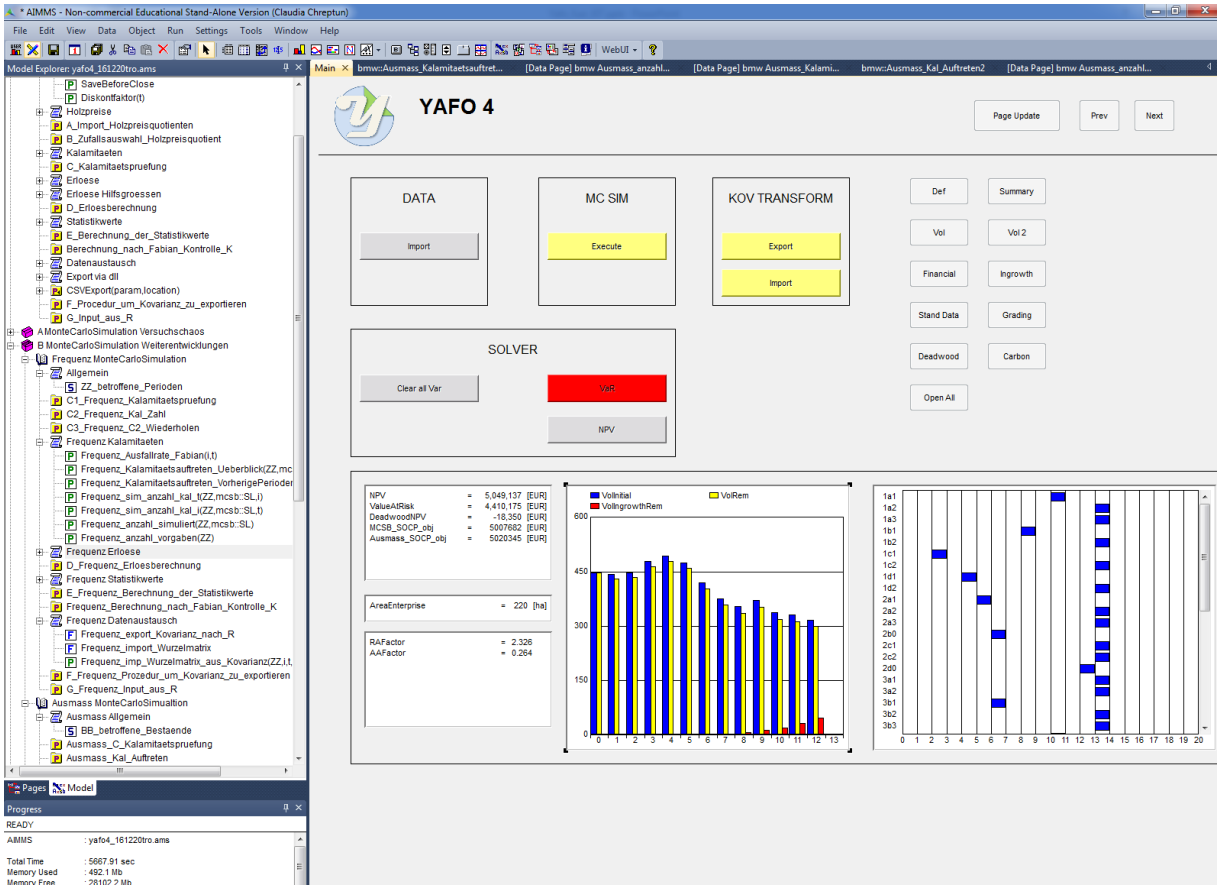
3. Integration of other ecosystem services into the optimization

AIMMS

https://aimms.com/

YAFO 4

Quadratic constraint programming



Härtl, F., Hahn, A., Knoke, T. (2013): Risk-sensitive planning support for forest enterprises: The YAFO model. Computers and Electronics in Agriculture: 94, 58–70
Härtl et al. (2016): Multifunctionality in European mountain forests — an optimization under changing climatic conditions. In: Can. J. For. Res. 46 (2), 163–171.

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Yafo 4 – Optimization

1. Objective function: Net present value (NPV)

$$\max_{f} Z = \sum_{i} \sum_{t} \sum_{s} \left(d_{its} f^{d}_{its} + a_{its} f^{a}_{its} + z_{its} f^{z}_{its} \right) (1+r)^{-t}$$

Sum of discounted financial returns (Thinnings, Harvest, Salvage) over stand(i), time(t) and option(s)

1.1 Restrictions:

$$\sum_{s} f^{d}_{it's} + \sum_{t=0}^{t'} \sum_{s} (f^{a}_{its} + f^{z}_{its}) = f_i \quad \forall i, t'$$

Choice between thinning or final harvest

$$\sum_{s} f^{z}_{its} = f^{z}_{it} \quad \forall i, t$$

Salvage areas can´t be harvested or thinned

$$f^{(d,a,z)}_{its} \geqslant 0 \quad \forall i, t, s$$

Areas can´t be negative

2. Objective function: Value at Risk (VAR)

$$\max_{f} VAR = E(NPV) - \sigma_{NPV} * m$$

NPV reduced by product of the total standard deviation (σ_{NPV}) and factor (m) for the x% quantile of the E(NPV) distribution

Härtl, F. (2015): Der Einfluss des Holzpreises auf die Konkurrenz zwischen stofflicher und thermischer Holzverwertung.
Hahn et al. (2014): Financially optimized management planning under risk aversion results in even-flow sustained timber yield. In: Forest Policy and Economics 42.

Current results (preliminary) - Settings

1. Input data created with LPJ-GUESS

Simulation of a small forest enterprise in South Germany in LPJ-GUESS

Forest inventory data of 2014
42 stands
200 ha

Thinning: „Take every 5 years 10 % of biomass, after Age 70 no thinning“

2. Optimization with YAFO 4

Rate 1.3%/year
Value-at-risk at 99%

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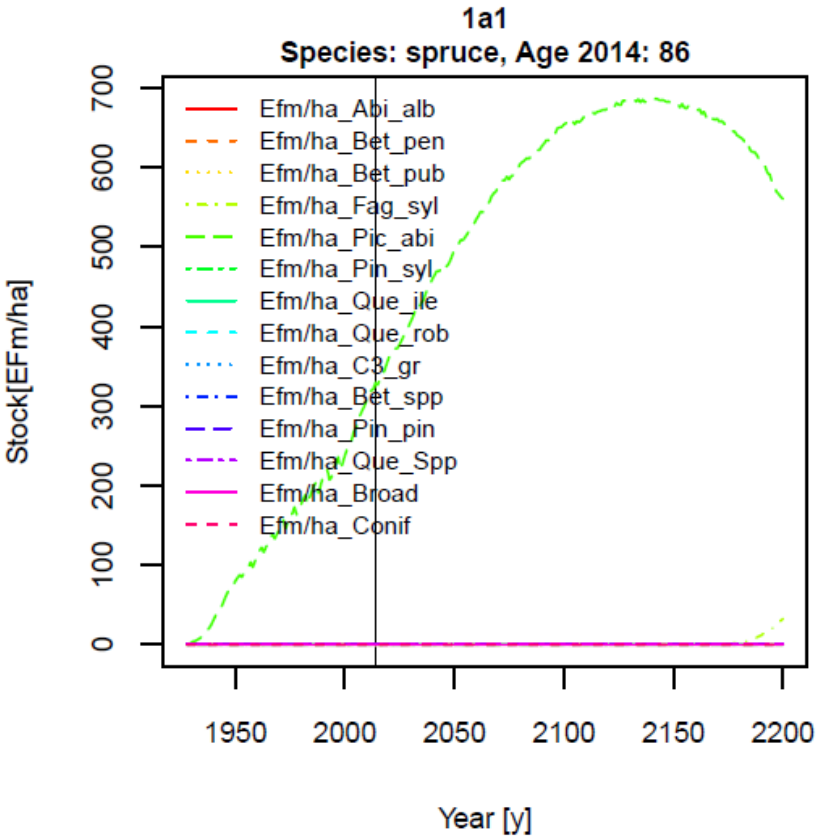
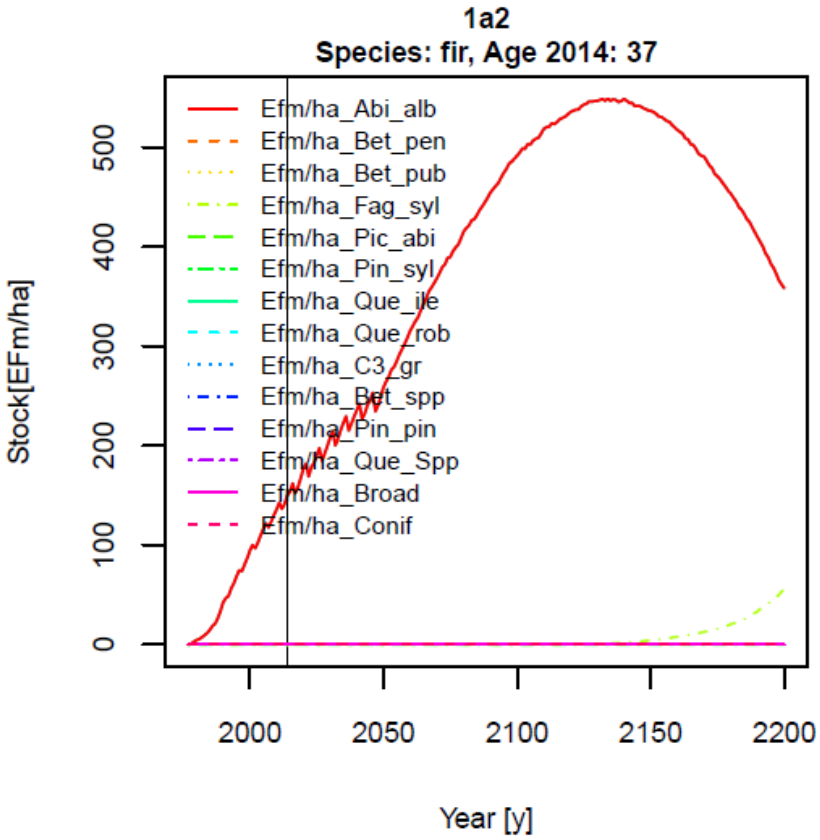
Current results - LPJ-GUESS Growth data





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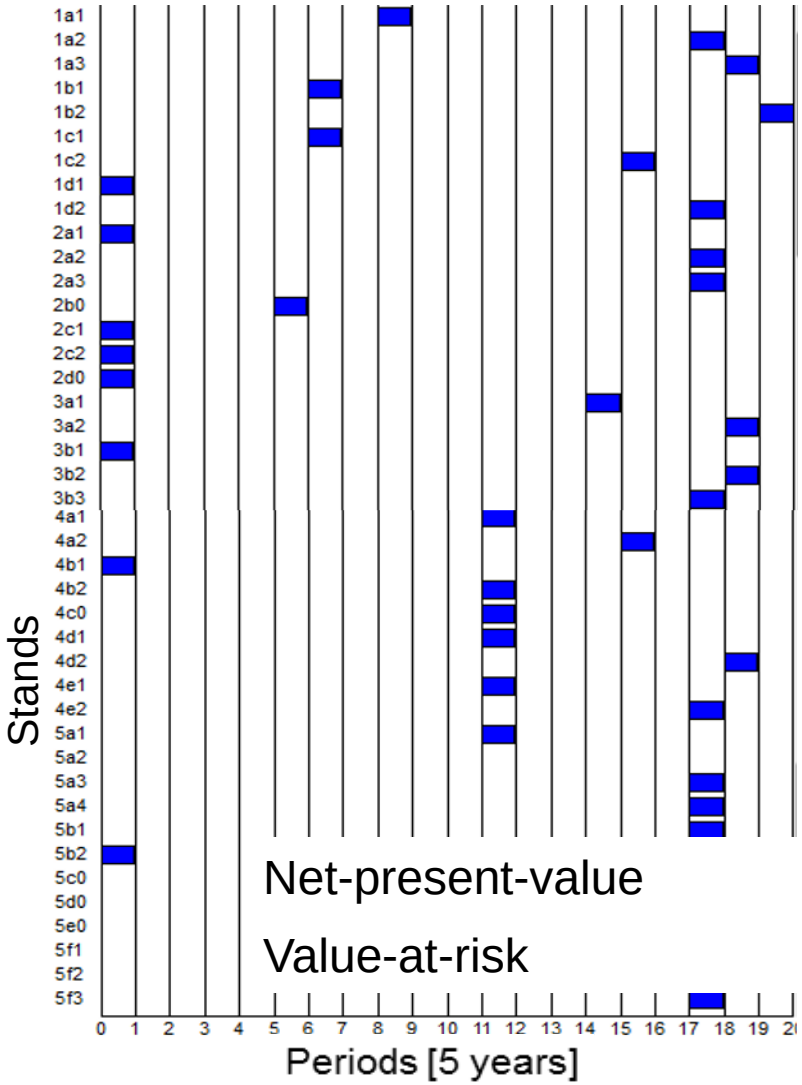
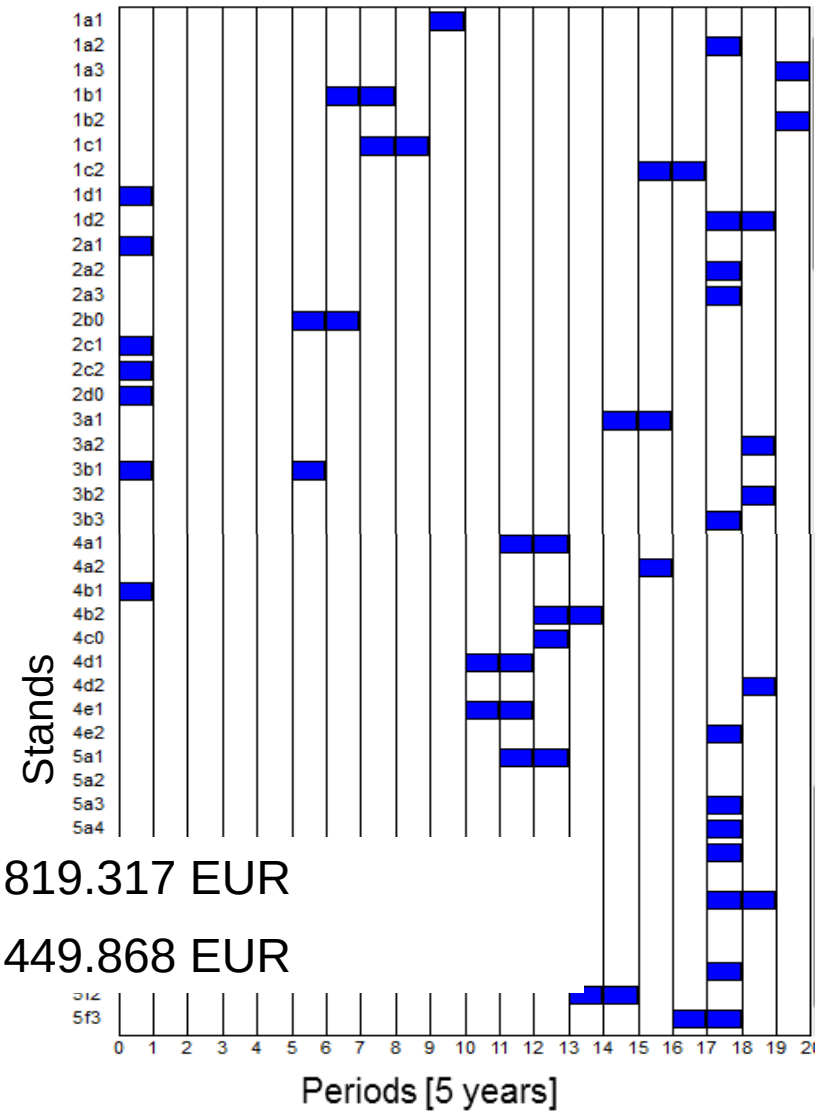
Net present value



Net-present-value 2.819.317 EUR

Value-at-risk 2.449.868 EUR

Value at Risk



Information needed for close-to-reality-optimization

1. Restrictions:

Minimum volume in the stands/ whole forest?

Maximum area/volume for one thinning/final cut?

2. Important ecosystem services?

- Erosion protection
- Recreation zones
- Habitat structures
- C-Sequestration

3. Discount rate → expectation of return?

4. Risk avoidance → willingness to pay for security of outcome?