FORMIT management scenarios and EU management types

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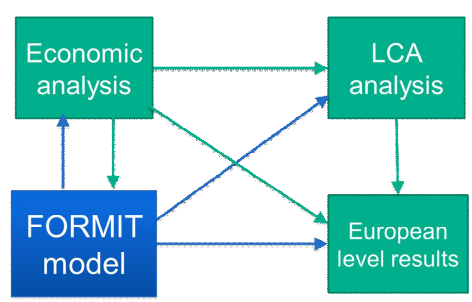
FORMASAM meeting Wageningen 12.11.2018

FORMIT: EU FP7 study on FORest management strategies to enhance the MITigation potential of European forests” (2012-2016)

FORMIT partner countries	
Netherlands	Czech Republic
Austria	Norway
Germany	France
Italy	Romania
Finland	Estonia
Belgium	Poland



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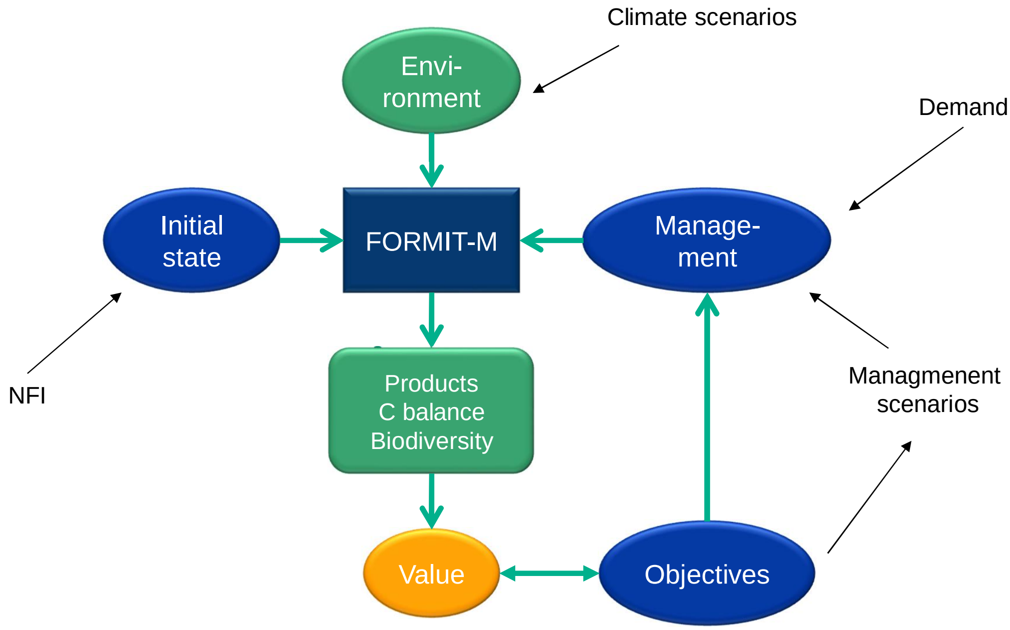
FORMIT: Forest modelling framework



Phase 1: Classification
What determines forest management?

Regions

Species groups

Silvicultural systems

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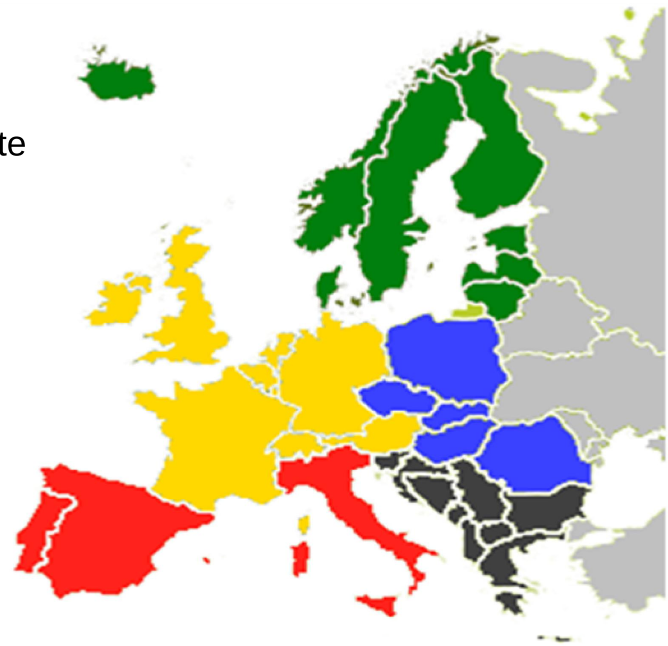
FMU

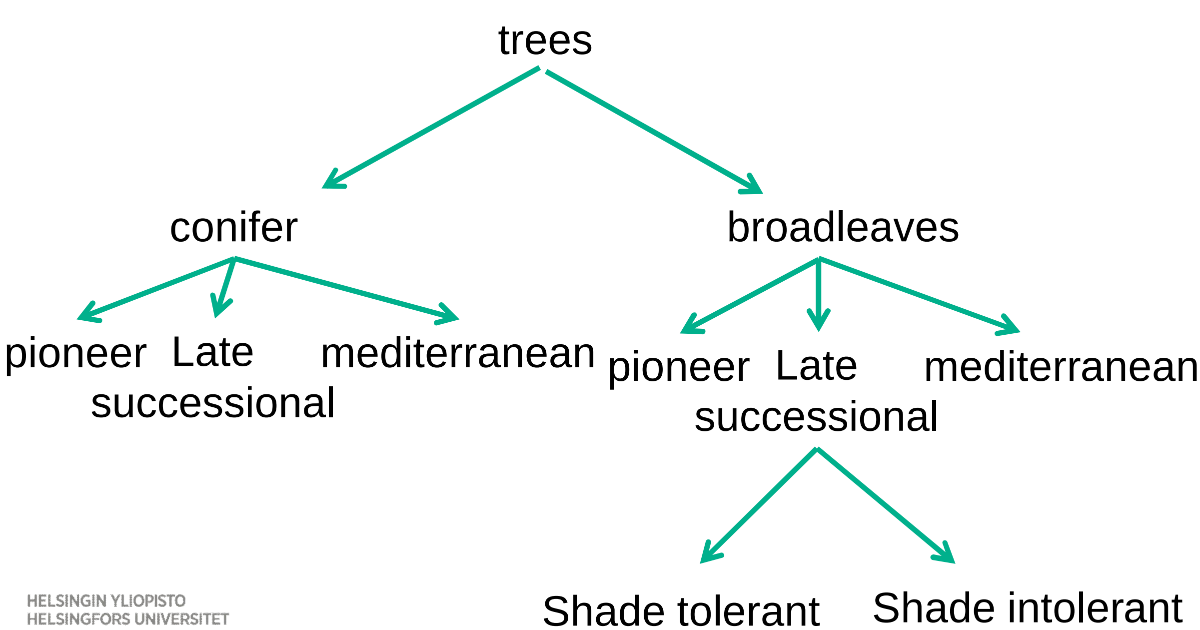
Phase 1: Classification
Regions

Regions based on climate and vegetation:

- North
- West Central
- East central
- West Mediterranean
- East Mediterranean



Phase 1: Classification
Species groups



Phase 1: Classification
Species groups

Species group	Code	Species
Light demanding conifers	SP 1	*Pinus sylvestris, Larix spp., Pinus nigra, Pinus cembra, Pinus heldreichii, Pinus leucodermis, Pinus radiata, Pinus uncinata, Pinus mugo, Pinus contorta, Pinus strobus, Cedrus spp., Juniperus spp.*
Shade tolerant conifers	SP 2	*Picea abies, Abies spp., Pseudotsuga menziesii, Thuja spp., Taxus baccata, Tsuga spp., Chamaecyparis spp.*
Mediterranean conifers	SP 3	*Pinus pinaster, Pinus halepensis, Pinus pinea, Pinus canariensis, Cupressus spp., Pinus brutia*
Fast growing deciduous	SP 4	*Betula spp., Populus spp., Alnus spp., Salix spp., Robinia pseudoacacia, Eucalyptus spp.*
Slow growing light demanding deciduous	SP 5	*Quercus robur, Q. petraea, Q. cerris, Q. pubescens, Q. faginea, Q. frainetto, Q. macrolepis, Q. pyrenaica, Q. rubra, Q. trojana, Q. hartwissiana, Q. vulcanica, Q. macranthera, Q. libani, Q. brantii, Q. ithaburensis, Q. pontica, Fraxinus spp., Castanea sativa, Rosaceae (Malus, Pyrus, Prunus, Sorbus, Crataegus, etc.), Juglans spp., Cercis siliquastrum*
Slow growing shade tolerant deciduous	SP 6	*Fagus spp., Carpinus spp., Tilia spp., Ulmus spp. , Buxus sempervirens, Acer spp. Ilex aquifolium*
Mediterranean evergreen trees	SP 7	*Quercus suber, Quercus ilex, Q. coccifera, Q. lusitanica, Q. rotundifolia, Q. infectoria, Q. aucheri, Tamarix spp. Arbutus spp., Olea europea, Ceratonia siliqua, Erica spp. Laurus spp., Myrtus communis, Phillyrea spp. Pistacia spp. Rhamnus spp. (R. oleoides, R. alaternus), Ilex canariensis, Myrica faya,*

Phase 1: Classification
Silvicultural systems

System	Definition
1. Unmanaged	No management
2. Continuous cover	Continuous cover forest management · Selection cuttings based on diameter
3. Even-aged with shelterwood	Even-aged (2-layer) forest management · Regeneration: natural · Thinnings · Shelterwood cut after certain mean diameter (or age) has been reached
4. Even-aged uniform	Uniform forest management · Regeneration: planting or natural · Thinnings · Clear-cut after certain mean diameter (or age) has been reached
5. Coppice	Woodland which has been regenerated from shoots formed at the stumps of the previous crop trees, root suckers, or both, i.e., by vegetative means.
6. Coppice with standards	Coppice system under low density uneven-aged high forest
7. Short rotation	Plantation forestry including exotic species.

Phase 2: Management rules
How are the different systems managed?

BAU

- Use NFI observed species and silvicultural system

Key management decisions per silvicultural system

- Species
- Planting density
- Harvest frequency
- Harvest intensity
- Rotation length

Phase 2: Management rules
How are the different systems managed?

Procedure

- Questionnaire to partners
- Initial description of actions in all partner countries
- Unification of methods in dedicated workshops

Phase 2: Management rules
Examples of initial descriptions

Broad leaf trees (beech, oak, Acer,..) (Austria)

- 0-2 m treatment of young plants (weeding, stem number reduction,..) 2-10 m precommercial thinning, negative selection
- 2-20 m pruning branches (if high quality wood is the goal)
- 15-30 m thinnings several times, every height increment of 3-5m, or every 5-10 years
- Final cutting when increment culminates, or rotation period is reached (especially for spruce, Douglas fir, pine) or when target diameter is reached (typical for broadleaf trees, beech, oak, but also for spruce, larch)

Coppice forests (Mediterranean)

- In shade intolerant species: clearcut with or without reservoirs (200/ha)
- Rotation:15-30 years
- Reservoirs: 2-3 times the cycle length
- No mechanization

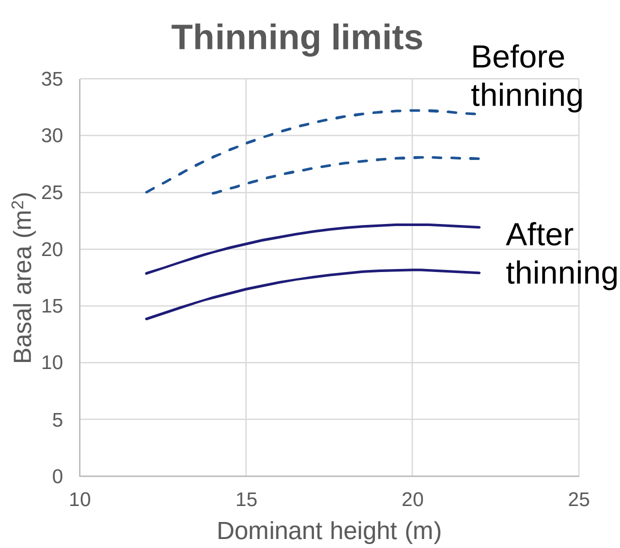
Phase 2: Management rules
Synthesising descriptions to unified regional rules

Objective

- To develop rules applicable as model routines

Method

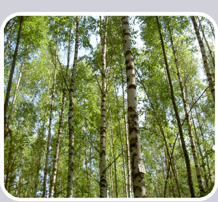
- Use Finnish system as model
  - Harvest is defined on the basis of mean height and basal area
  - Basal area is brought down to a level depending on top height
- Parameterised for all regions by expert analysis of project members

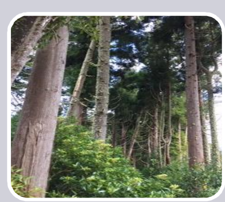


Phase 2 Example: Central Europe Silvic Syst 1-3

<table>
<tr><td></td><td></td><td colspan="7">Species group</td></tr>
<tr><td></td><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Silvicultural system</td><td>1</td><td colspan="7">No management</td></tr>
<tr><td></td><td>2</td><td colspan="7">Each year: average annual values from 100 years of BAU management for that plot</td></tr>
<tr><td></td><td>3</td>
<td><u>Thinnings:</u>
if age>=30: BA = 15.7
if age>=35 | D>11.9: BA = 20
if age>=50 | D>17: BA = 23
if age>=60 | D>19.9: BA = 23
<u>Final cutting:</u>
if age>=85 | D>50: old forest is cut, new trees of age 10 remain</td>
<td><u>Thinnings:</u>
if age>=25: BA = 20.15
if age>=40 | D>23.4: BA = 25
if age>=60 | D>31.6: BA = 30
if age>=80 | D>36.8: BA = 35
<u>Final cutting:</u>
if age>=85 | D>50: old forest is cut, new trees of age 10 remain</td>
<td><u>Final cutting:</u>
if age>=60 | D>50: BA = 0</td>
<td><u>Thinnings:</u>
if age>=30: BA = 12.9
if age>=50 | D>31.6: BA = 20
if age>=70 | D>36.8: BA = 23
<u>Final cutting:</u>
if age>=90 | D>50: old forest is cut, new trees of age 10 remain</td>
<td><u>Thinnings:</u>
if age>=25: BA = 10.02
if age>=35 | D>11.5: BA = 13
if age>=55 | D>19.5: BA = 17
if age>=80 | D>30.3: BA = 19
<u>Final cutting:</u>
if age>=95 | D>50: old forest is cut, new trees of age 10 remain</td>
<td><u>Thinnings:</u>
if age>=30: BA = 12.66
if age>=35 | D>23.4: BA = 16
if age>=60 | D>31.6: BA = 21
if age>=100 | D>36.8: BA = 24
<u>Final cutting:</u>
if age>=105 | D>50: old forest is cut, new trees of age 10 remain</td>
<td><u>Final cutting:</u>
if age>=60 | D>50: BA = 0</td></tr>
</table>

Phase 3: Alternative management strategies How is managment modified under alternative management objectives?




Climate change adap-tation

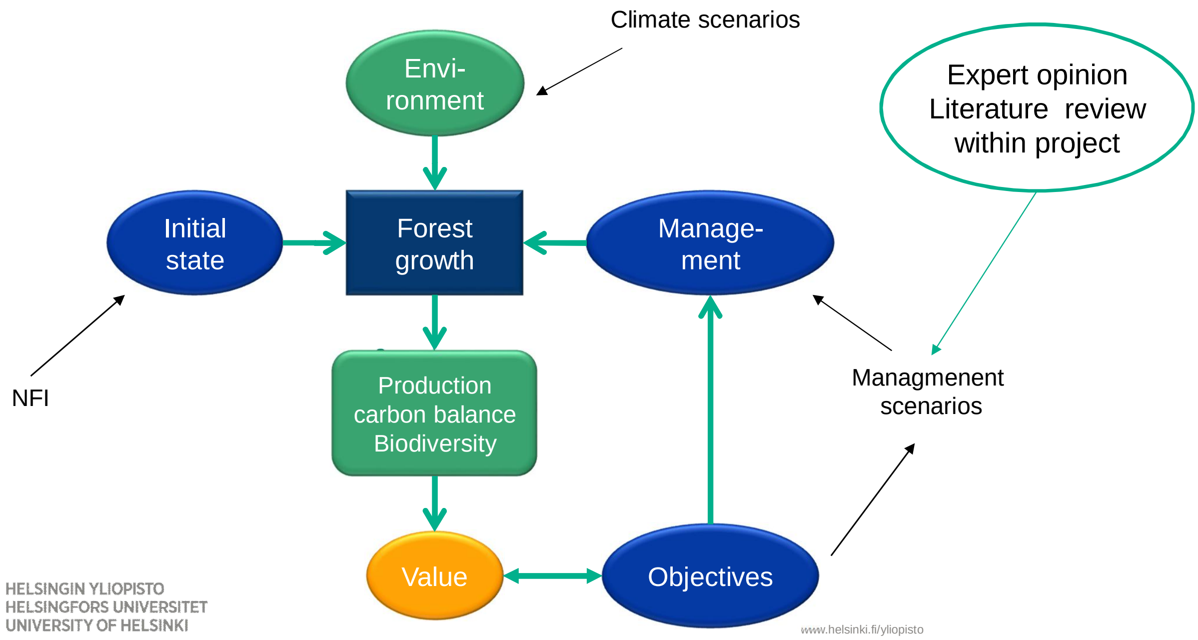
Biodiver-sity and conser-vation

Maximum bioenergy

Maximum material substi-tution

Maximum Carbon offset

FORMIT: Expert-based approach to management methods for alternative objectives



Phase 3: Alternative management strategies How is managment modified under alternative management objectives?

- Questionnaire to partners to collect information from countries on alternative management in relation to the five objectives
- A core team meeting to summarise results
- Key issue:

  How to translate the ideas into rules that can be quantified in model?

Phase 3: Alternative management strategies How is managment modified under alternative management objectives?

Principle

- Define as deviations from BAU
- Define as ”extreme scenarios”
- Combine scenarios later

Deviations to

- Silvicultural system
- Species
- Within SS
  - – planting density
  - – harvest frequency
  - – rotation length
- Harvest assortments

Phase 3: Alternative management strategies Constraints for all scenarios

- No land-use change
- Bioenergy
  - No harvesting of foliage & needles
  - No stump harvesting additional to BAU
- Protection
  - Share of protected forest will not decrease
- No active fertilisation other than to maintain productivity

Climate change adaptation

- the stem number is lowered by 30% of that in the BAU in order to increase the individual crown ratio and stem taper for tree vitality and stability against windthrow
- pure stands should be transferred to mixed stands, at least 30% admixture of other species where possible:
  - northern Europe: coniferous stand to be mixed with broadleaves (birch) except for poor stands
  - Central Europe: see table

current	mixture with
light-demanding conifer	light demanding broadleaf
shade-tolerant conifer	shade-tolerant broadleaf
light-demanding deciduous	light-demanding deciduous
shade-tolerant deciduous	light-demanding deciduous
fast-growing deciduous	fast-growing deciduous

Biodiversity conservation

- +20% of forest land in even proportions of all forest types is added to “unmanaged”
- BAU unmanaged determined by Natura 2000
- the managed area :
  - regeneration with“Potential natural vegetation of Europe”
  - mixed stands are preferred wherever possible
  - deadwood will be retained with a share of 20% of the harvested wood
  - the rotation length will be increased by 25%
  - continuous cover and structure within stands will be fostered by diameter cutting (with exception of light demanding natural systems)
  - harvest residues are retained completely

Maximum Bioenergy

- 66% of harvest residues utilized in energy assortment
- spruce stumps harvested at an increased share from fertile sites in northern Europe
- final harvest at stand's maximum MAI (biomass increment)
- no thinnings
- regeneration:
  - northern Europe: birch or spruce on fertile sites, pine on others
  - central Europe: broadleaved species change to fast-growing broadleaves after final harvest; coniferous stands change to Douglas fir (shade tolerant stands).
  - southern Europe: eucalypt
- fertilization effects may be modelled directly or taken into account afterwards by proxies.

Maximum material substitution

- stocking density increased by +25% (not in central east EUROPE – already high density)
- rotation length increased by 25 %
- even-aged: thinnings from above / selective cuttings
- silvicultural systems:
  - northern Europe: even-aged management of high forests
  - central Europe: BAU (tree species composition, management systems
  - southern Europe remains open
- regeneration for high forest (no coppice)
- species: conifers and slow-growing broadleaves as in NFI, fast-growing broadleaves replaced with slow-growing (light demanding) broadleaves or mixed stands

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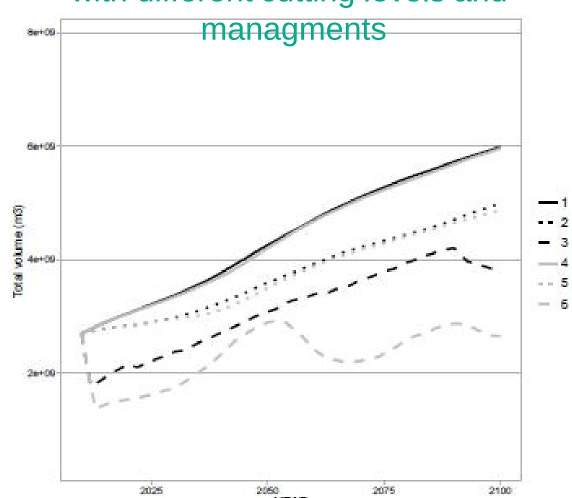
Maximum carbon offset

- As maximum material substitution, IN ADDITION
- Harvest residues for bioenergy (but no stump harvests)
- Poor sites: selection fellings of timber, otherwise maintain as carbon storage
- Old growth stands unmanaged
- Coppice for energy production with focus on carbon neutrality
- Salvage cuttings in all stands

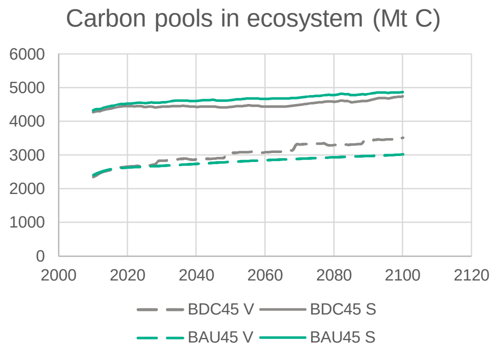
Phase 4: Roundwood demand
How is the intensity of cuttings determined?

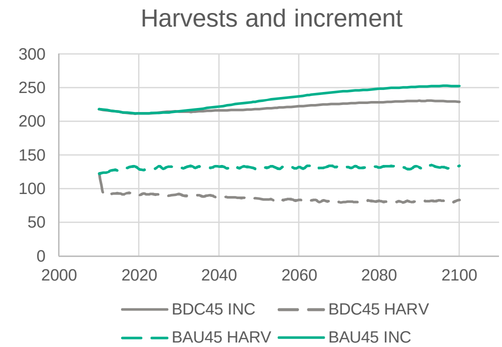
- Cuttings in Europe are currently below maximum annual allowable cut
- => Management rules without roundwood demand will lead to overestimation of cuttings
- In FORMIT demand was based on EFI-GTM, an economic general equilibrium model
- Simulations with fixed demand and supply-driven cuttings were also carried out

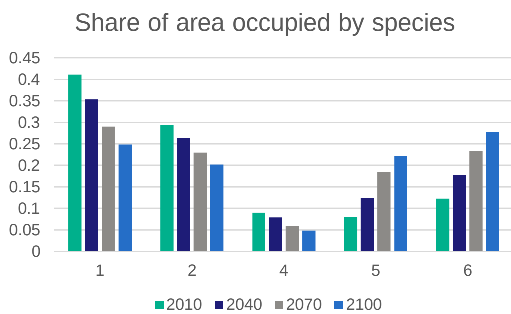
Total growting stock in Finland with different cutting levels and managments



FORMIT-M example results: Central Europe Business as Usual vs Biodiversity scenario

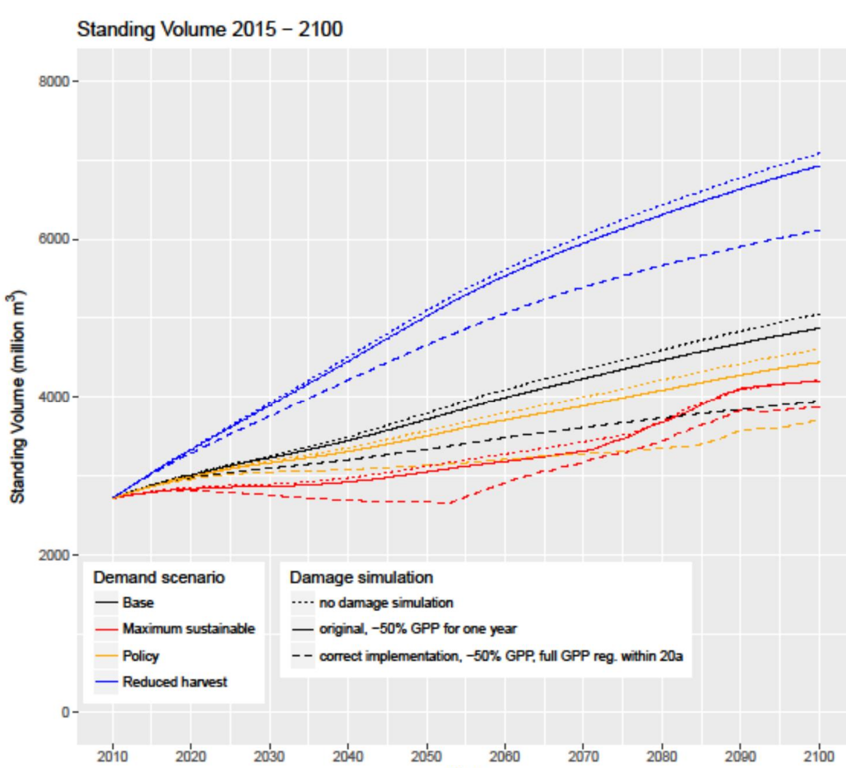






Härkönen et al. under revision

Analysis of damage effects, Finland



Concluding remarks

- Huge effort was required to put together the management scenarios
  - Broad simplification required to cover all European species and management types
  - In practice the most common NFI species of each species group was used
- Harvest level turns out to be the most critical factor (for increment and C balance) in comparison with
  - Management scenario
  - Climate scenario
- Management scenario impacts stronger when interacting with harvest level
  - Bioenergy increases cuttings
  - Conservation and biodiversity decreases cuttings
- More explicit treatment of soil processes & fertilisation might modify the conclusion