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Forest Carbon Sink and Economic Costs of Kyoto Protocol

Background

- The forest carbon (C) sinks were included in the Kyoto Protocol (KP) as a mechanism to mitigate global climate change
- C sinks can be credited and may substitute the reduction of GHG emissions
- KP created need for reliable and transparent estimates of carbon budgets of forests

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Objectives

- Analyse how credited forest C sinks affect the economic costs of the Kyoto Protocol in the economywide and sectoral level
- Evaluate the reliability and comparability of the C sink estimates of the various countries
- **Identify uncertainties related to assessment of forest carbon budget**
- **Develope and improve methods used in forest carbon balance assessment**
- Follow discussions and decisions made on CDMs

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Research plan consists 3 parts

- Implications of Carbon Sinks to Economic Costs of Kyoto Protocol (2000-2002)
- Carbon policy, CDMs and their sosioeconomic consequencies (2001-2003)
- **Integrated method to estimate carbon budgets of forests (2001-2004)**

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Resources

Working months of researchers

	2001	2002	2003 (estimated)	Total
Nat. Sci.	9.2	21.8	40	71
Socio-econ.	19.2	13.8	15	48
Total	**28.2**	**35.6**	**55**	**119**

Total budget

Budget (1000 euros)	**126**	**158**	**216**	**500**
External	**39%**	**44%**	**60%**	**50%**

Integrated method to estimate the carbon budget of forests

- **Joint project with European Forest Institute (EFI)**
- **This presentation focused on work done by research team at Metla**

METLA

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EFI

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Taru Palosuo
Thies Eggers
Ari Pussinen

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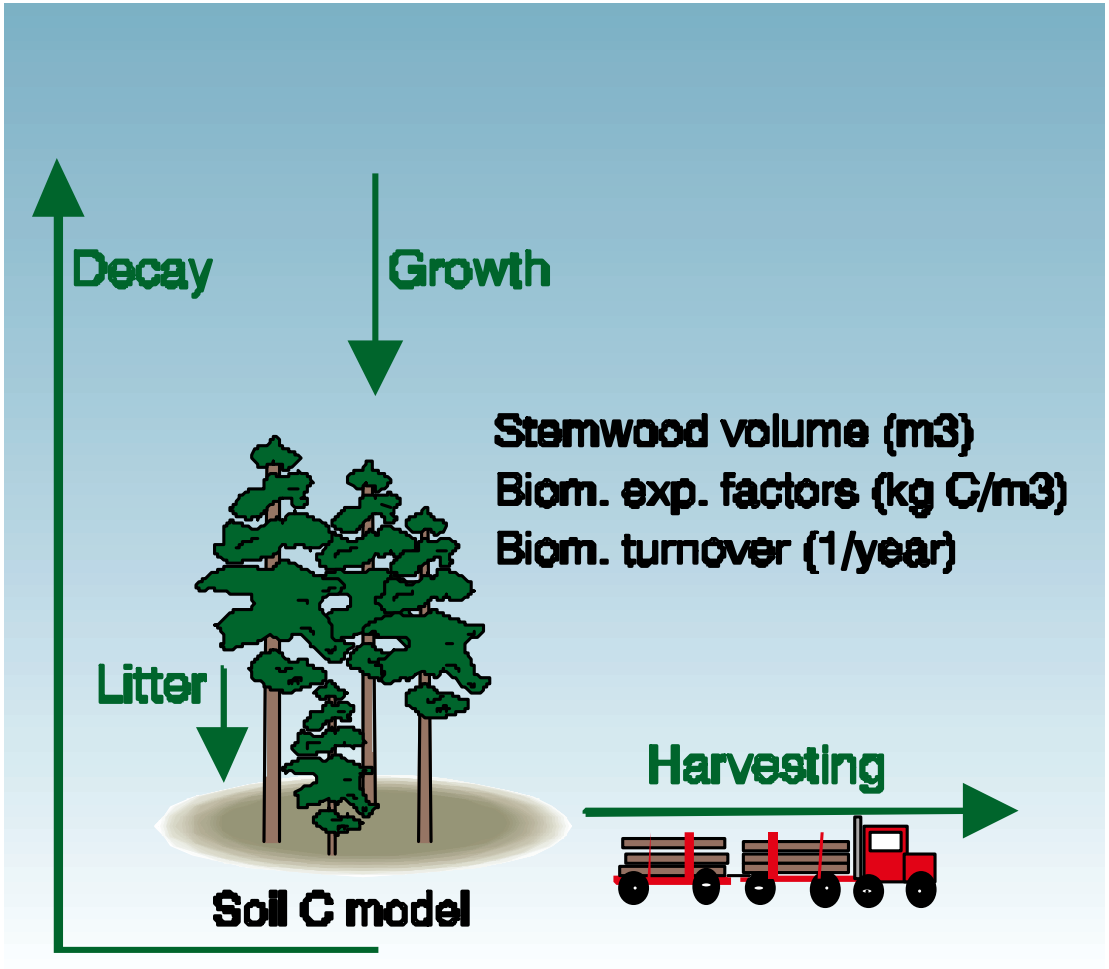
Contents

Metsäntutkimuslaitos
METLA

Integrated method



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Workpackages

Biomass

- Biomass expansion factors (kg biomass/m3 stemwood)
- Biomass models of understorey vegetation

Input to soil C model

- Litter production of trees (branches and needles) and understorey vegetation

Soil C model Yasso

Liski et al. at EFI

Integrated method

Test of validity/applicability

- BEFs - carbon stock of trees in Sweden
- Accumulation of soil C stock according to stand age

Applications

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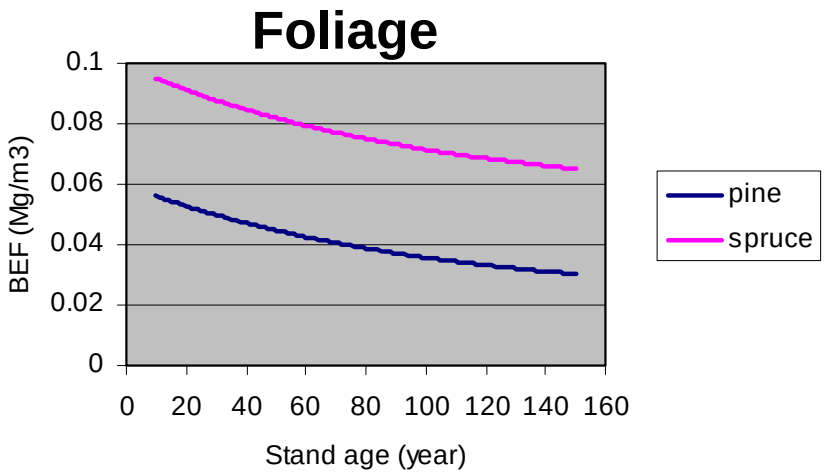
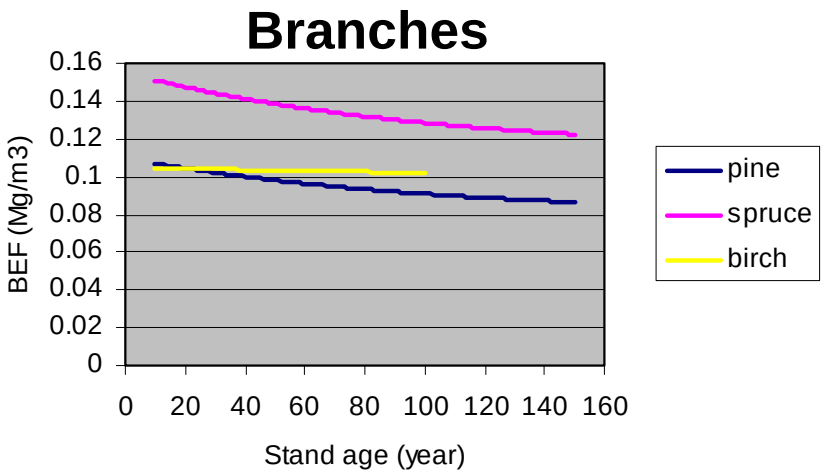
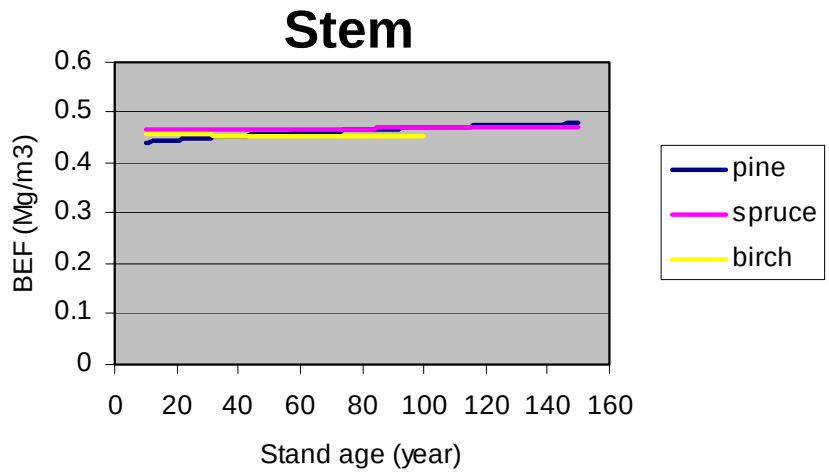
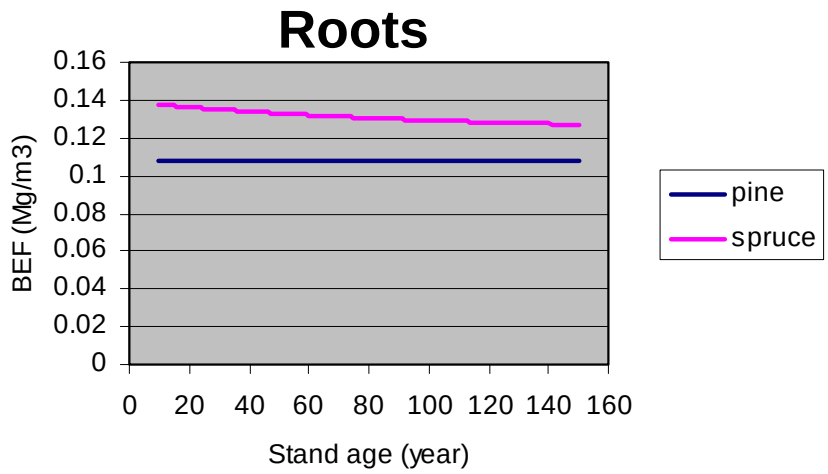
Biomass expansion factors

Lehtonen, A., Mäkipää, R., Heikkinen, J., Sievänen, R., Liski, J. New approach to formulating biomass expansion factors (BEF) for Scots pine, Norway spruce and birch according to stand age. Submitted manuscript.









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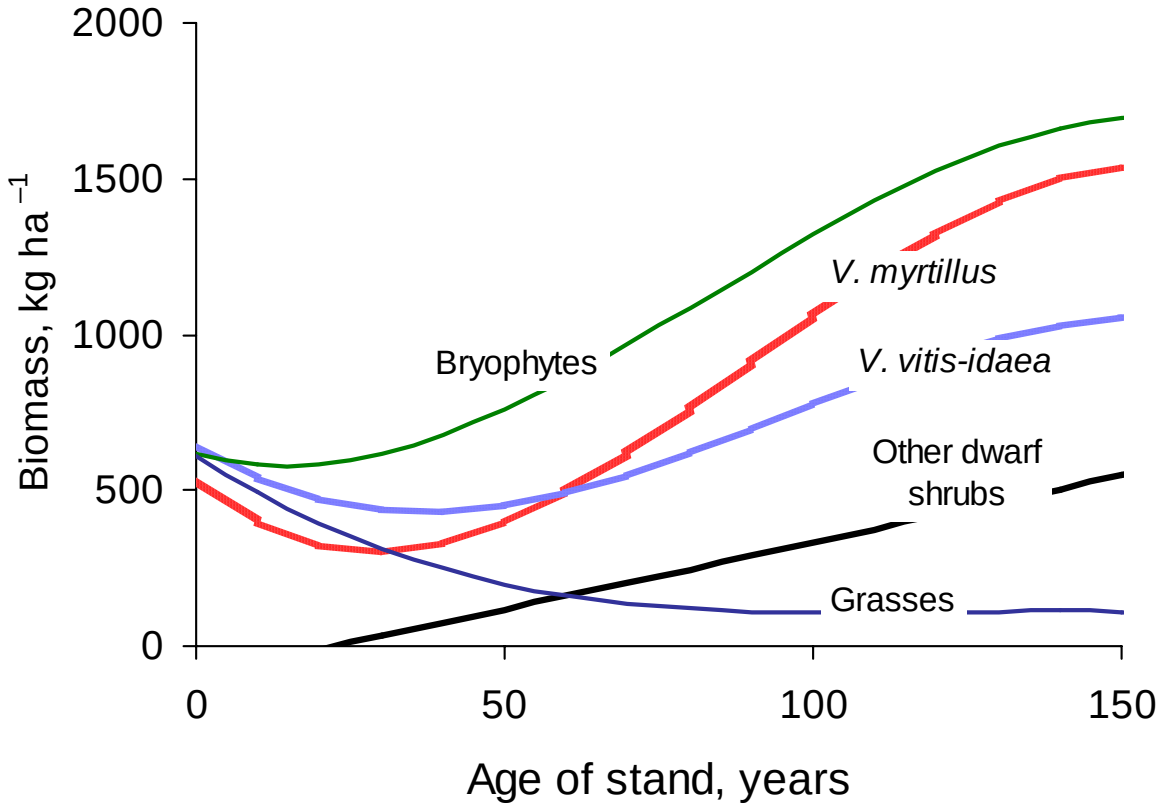
Biomass of understorey vegetation

Muukkonen, P. & Mäkipää, R. Biomass models of understorey vegetation according to stand age and site quality in coniferous forests. Submitted manuscript.



In Norway spruce stands according to stand age

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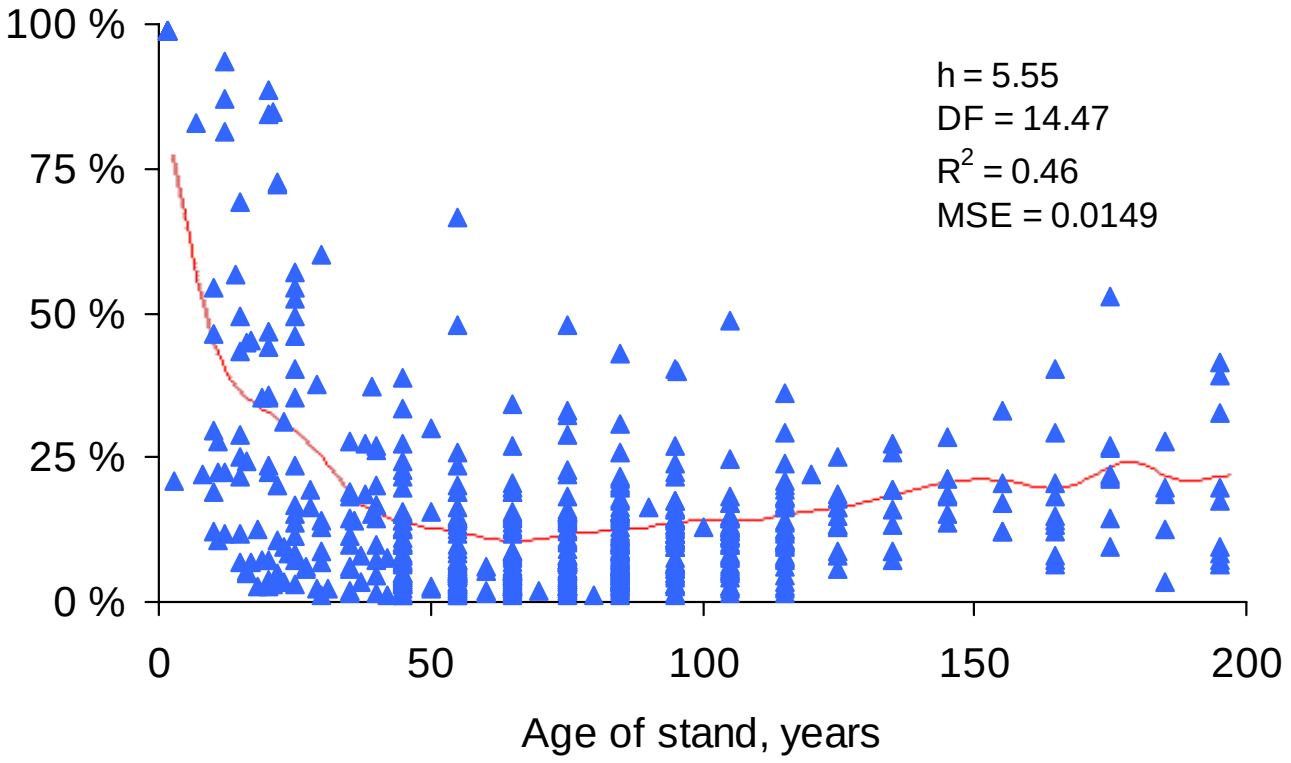
Proportion of litter produced by understorey



In Norway spruce stands according to stand age

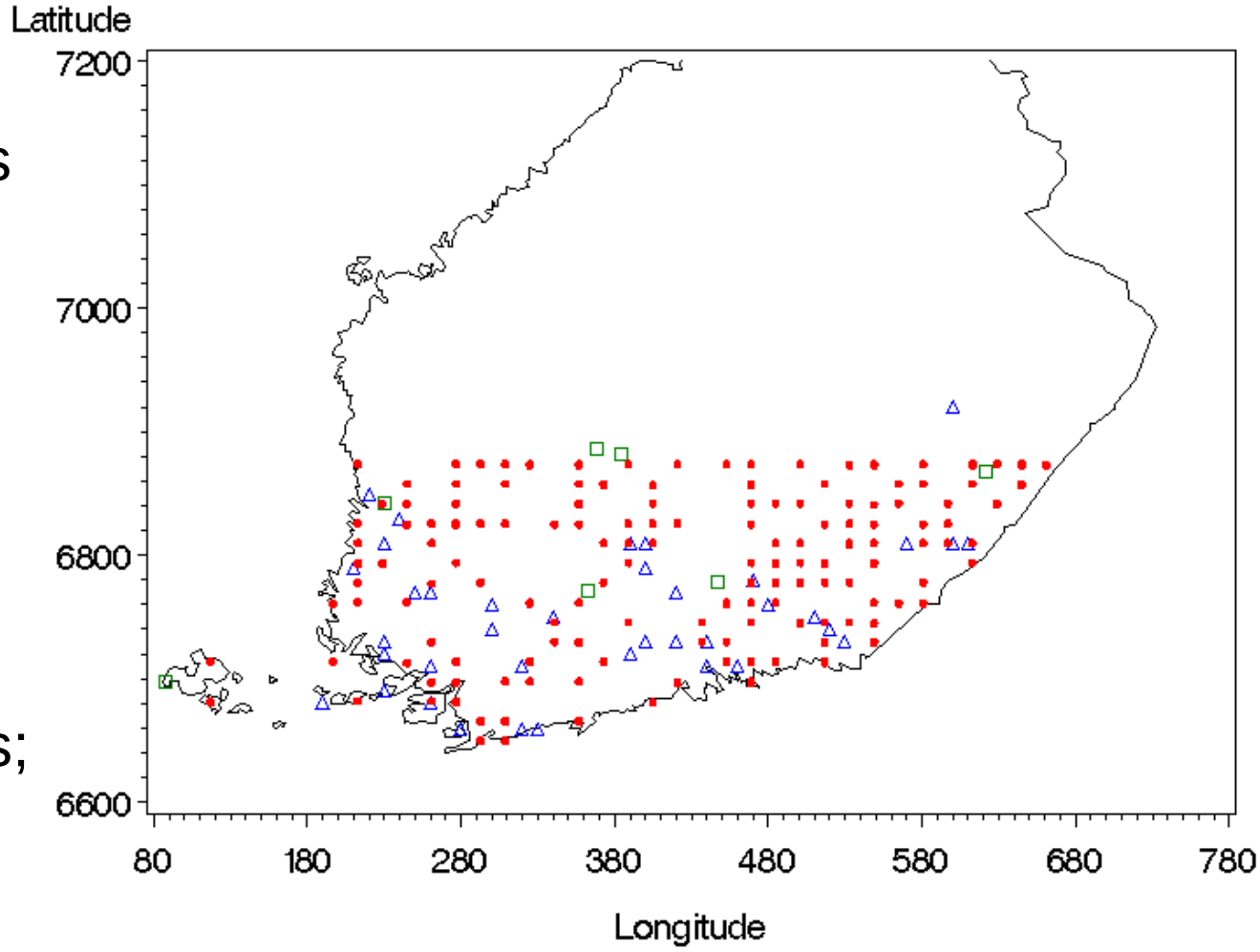
Potential branch litter

Lehtonen, A., Sievänen, R., Mäkelä, A., Mäkipää, R., Korhonen, K and Hokkanen, T.
Potential litterfall of Scots pine branches in southern Finland. Manuscript in preparation.

Material

from Scots pine stands

- sub-sample of permanent sample plots of NFI (1985-86, 1995); (red)
- biomass sampling sites (VAPU); (blue)
- branch litter trap sites; (green)



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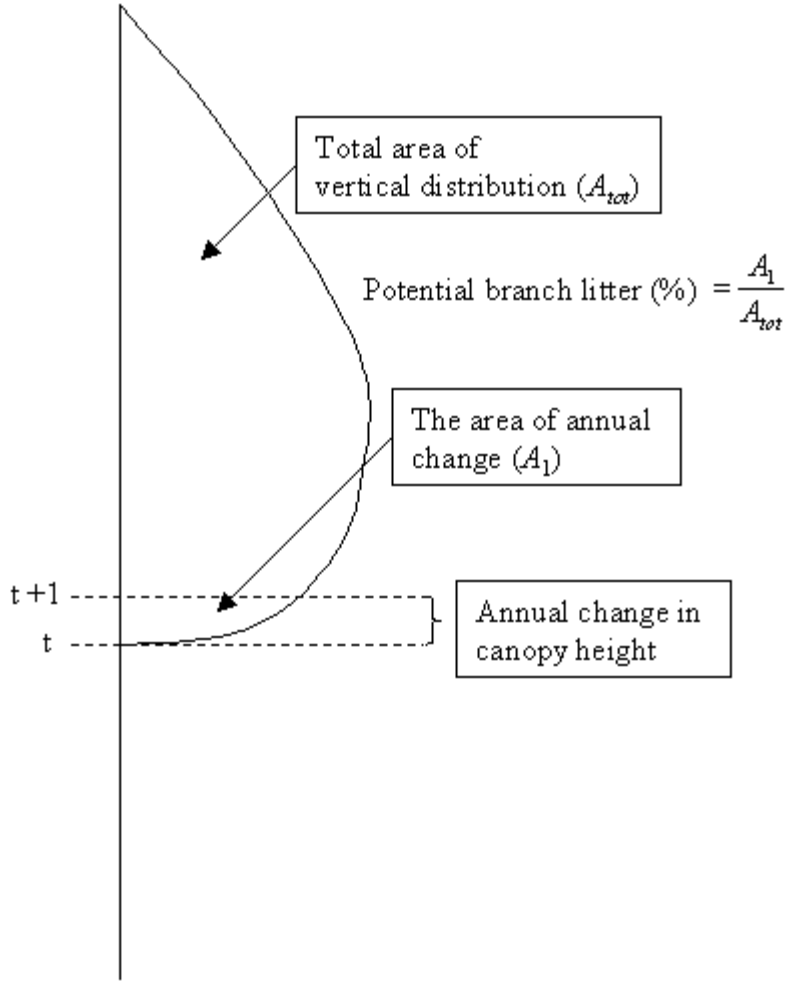
Potential branch litter

Lehtonen, A., Sievänen, R., Mäkelä, A., Mäkipää, R., Korhonen, K and Hokkanen, T.
Potential litterfall of Scots pine branches in southern Finland. Manuscript in preparation.

Potential branch litterfall was modelled based on following information:

- branch biomass > vertical biomass distribution

- canopy height 1985 and 95 > annual change in biomass distribution



Potential branch litter

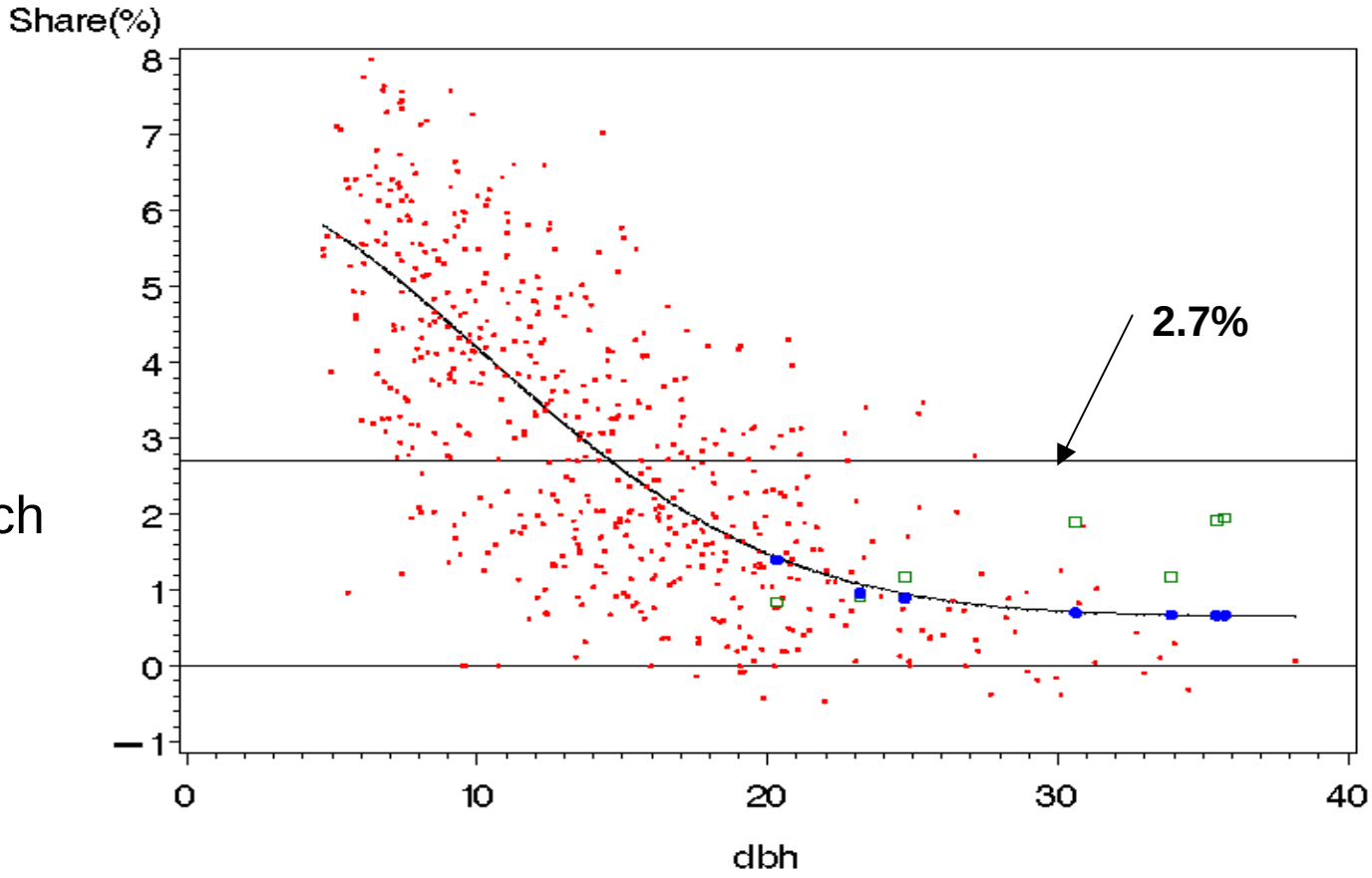
Lehtonen, A., Sievänen, R., Mäkelä, A., Mäkipää, R., Korhonen, K and Hokkanen, T.
Potential litterfall of Scots pine branches in southern Finland. Manuscript in preparation.

Proportion of branch litterfall from branch biomass

- tree observations; (red)

- branch litter measurements at stand level; (green)

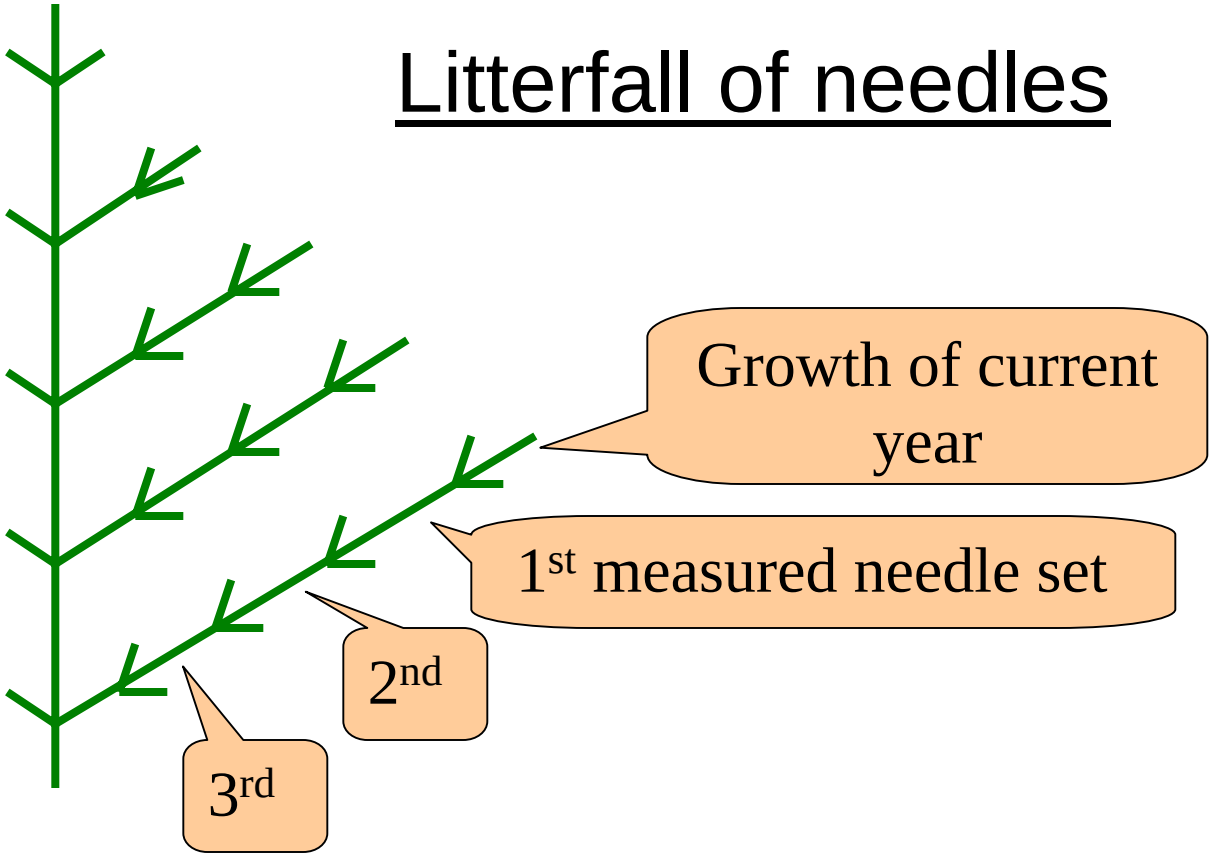
-modelled potential branch litterfall for measured stands (model in figure); (blue)

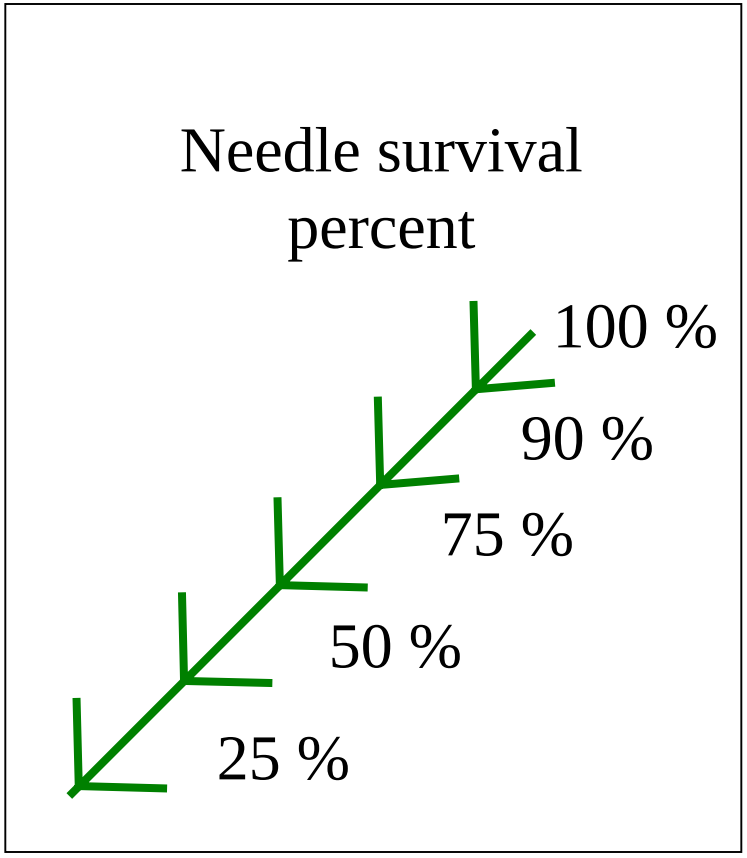


Litter production of Norway spruce

Muukkonen, P. & Lehtonen, A. Needle and branch litter turnover rates of Norway spruce. Manuscript in preparation.

Litterfall of needles





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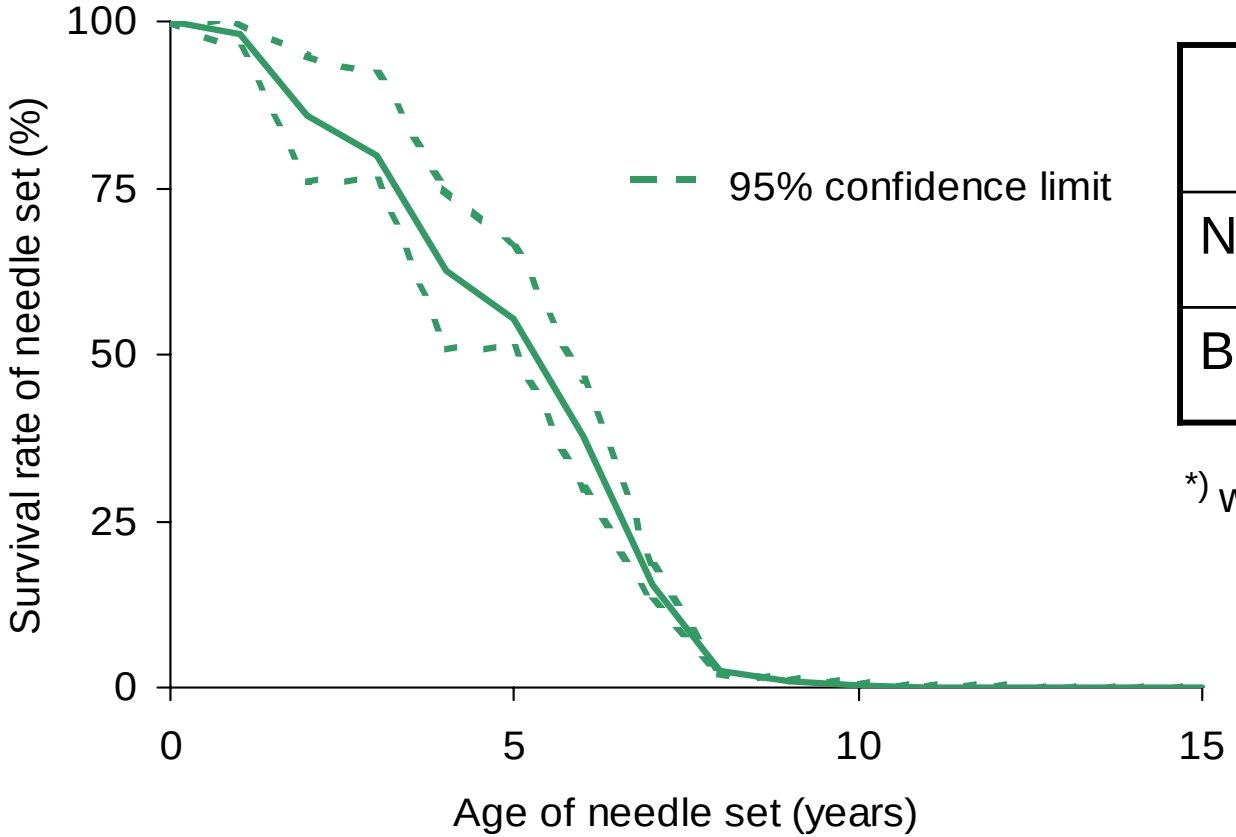
Litter production of Norway spruce

Muukkonen, P. & Lehtonen, A. Needle and branch litter turnover rates of Norway spruce. Manuscript in preparation.

Needle survival percent of Norway spruce



	Biomass turnover rate
Needles *)	0.10
Branches	0.0109

*) weightening and yellowing effect incl.

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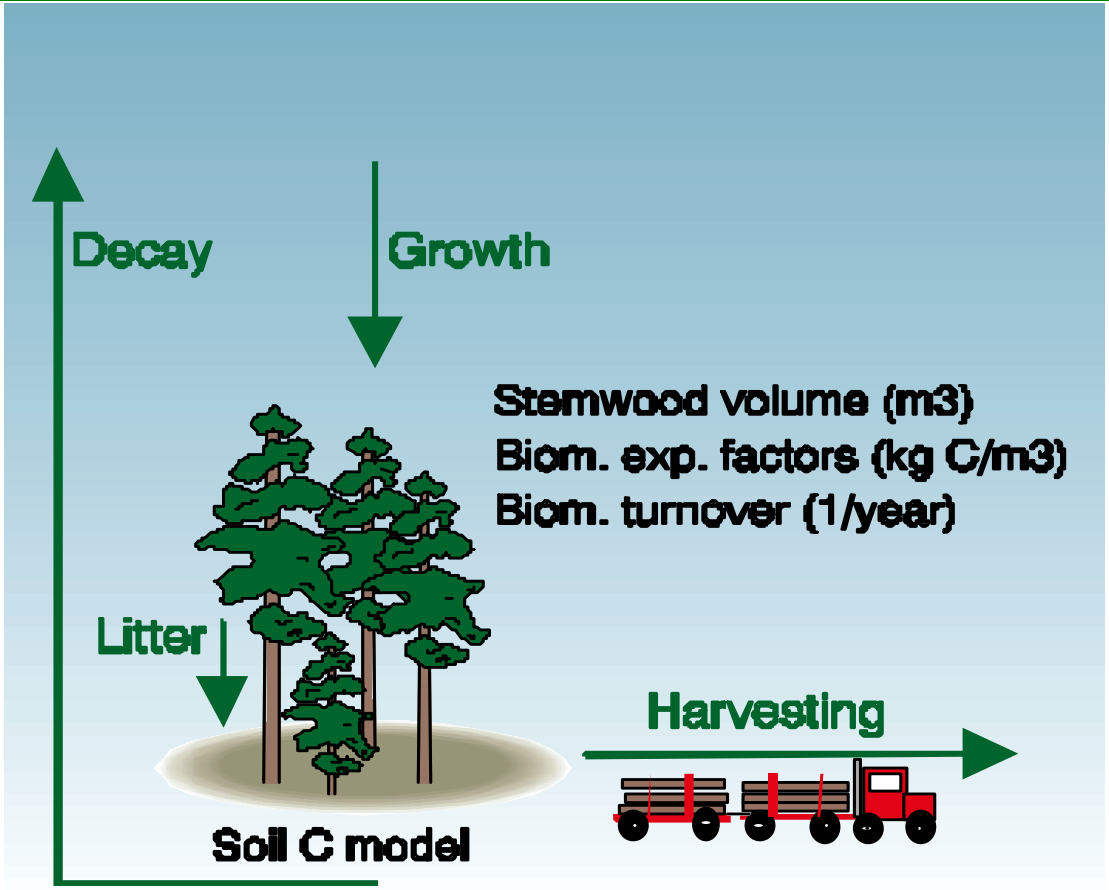
Integrated method

Soil C model YASSO developed and tested at EFI see details



http://www.efi.fi/projects/yasso/

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Testing (1)

Test of applicability of BEFs for estimation of biomass stock of trees in Sweden

- Error budged
- Comparison with calculations that are based on more detailed (tree level) information

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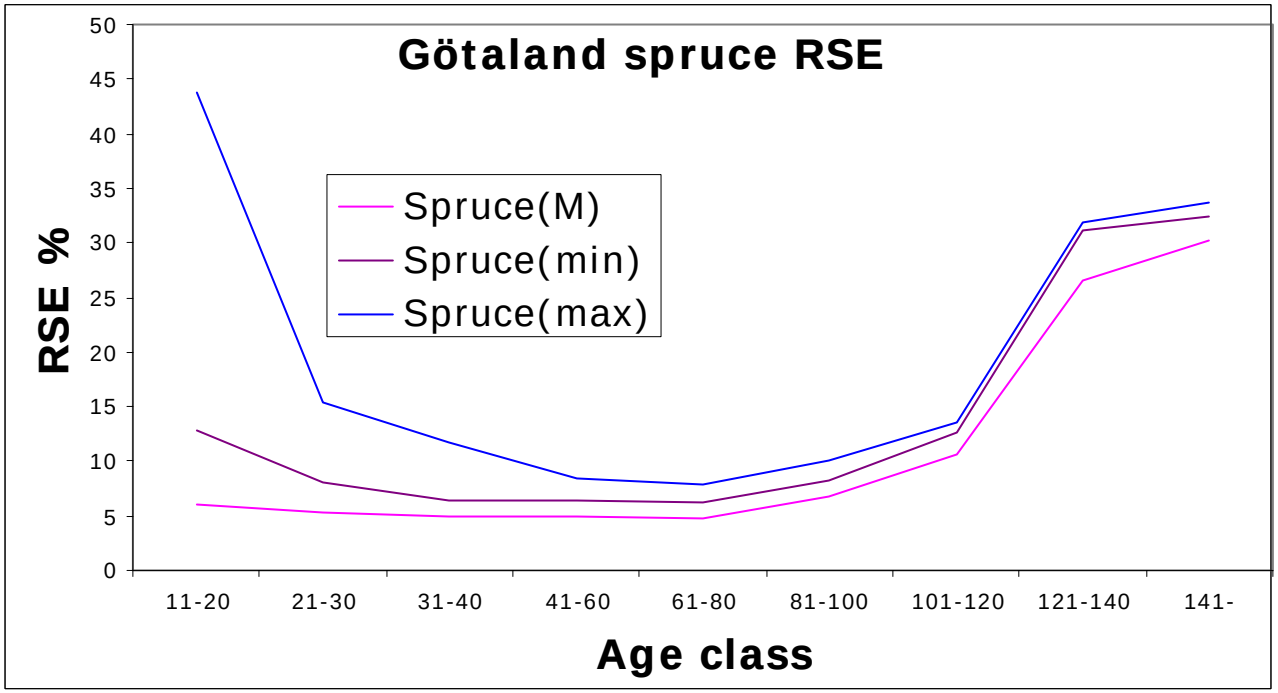
Applicability of BEFs

Jalkanen, A. et al. Estimation of biomass stock of trees in Sweden: comparison of biomass equations and age-dependent biomass expansion factors. Manucsript in prep.

Relative standard error (RSE) of biomass stock of spruce for Götaland - error of volume estimate and error associated with BEF combined



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Applicability of BEFs

Jalkanen, A. et al. Estimation of biomass stock of trees in Sweden: comparison of biomass equations and age-dependent biomass expansion factors. Manucsript in prep.

Biomass estimates (Tg or Mill. tn) of Scots pine and Norway spruce for S Norrland obtained by applying (1) BEFs and, (2) tree level biomass equations (Marklund), and difference (%) between estimates.

	BEF	Marklund	Difference %
Pine	121.3	117.1	3.6
Spruce	177.4	171.1	3.7

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Testing (2)

Test of validity of integrated method – accumulation of soil C according to stand age

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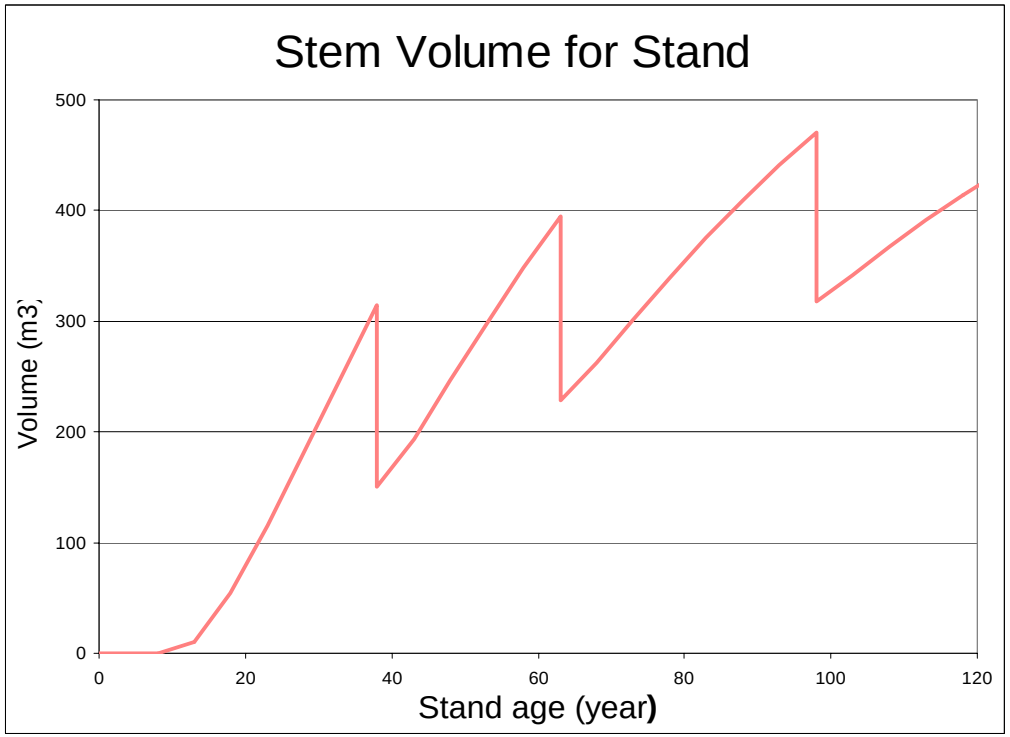
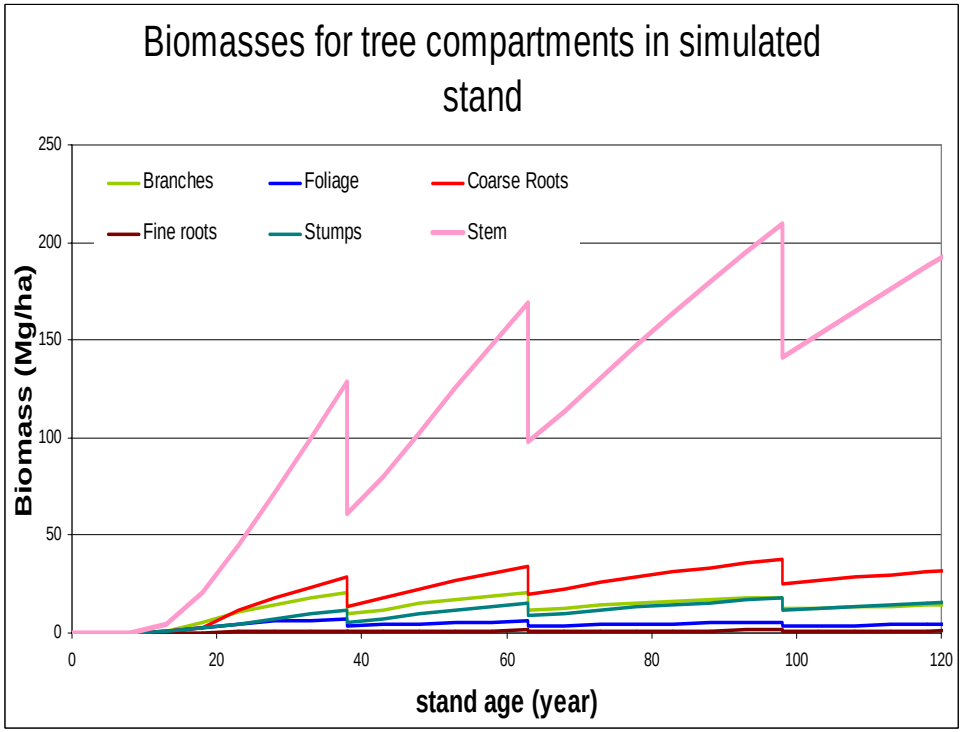
Example Simulation for Stand

Peltoniemi, M., Mäkipää, R., Tamminen, P. et al. Testing of simple soil carbon model (Yasso) validity. Manuscript in preparation.





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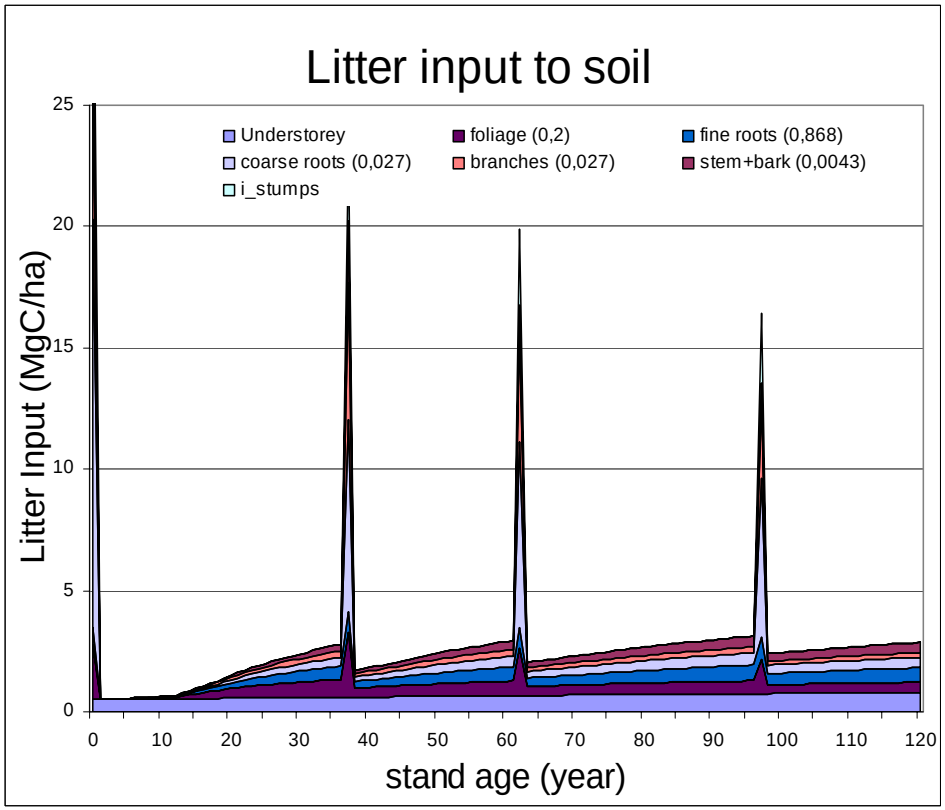
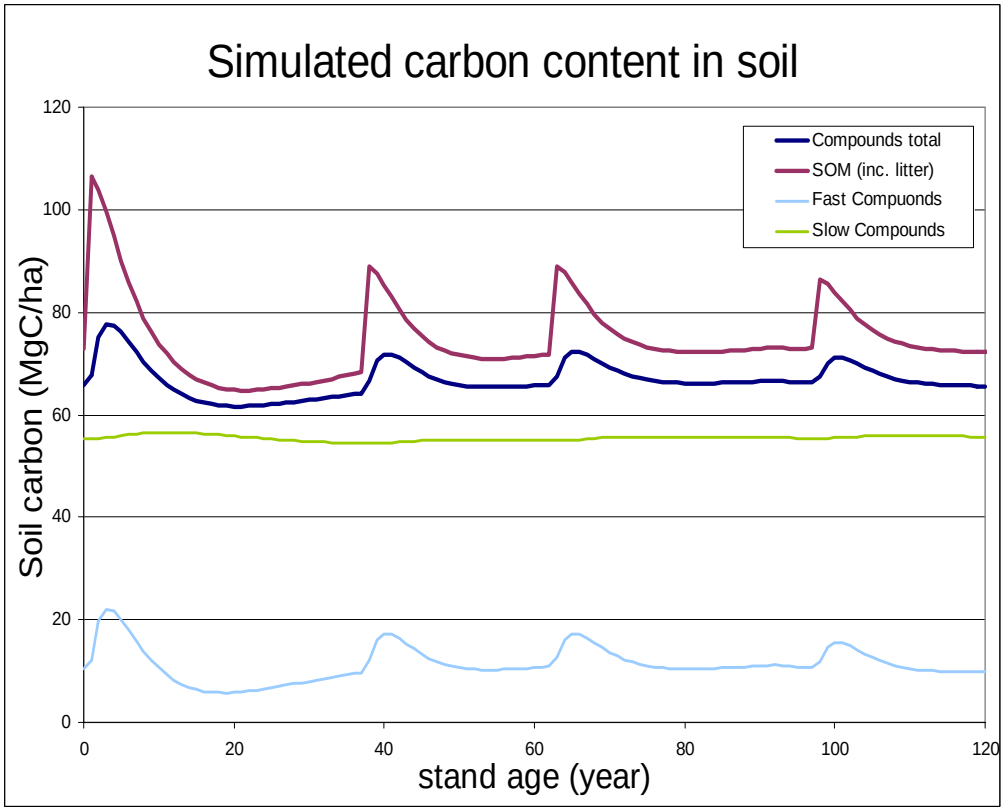
Example Simulation for Stand (cont.)

Peltoniemi, M., Mäkipää, R., Tamminen, P. et al. Testing of simple soil carbon model (Yasso) validity. Manuscript in preparation.





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Measured Values for Soil Carbon

Peltoniemi, M., Mäkipää, R., Tamminen, P. et al. Testing of simple soil carbon model (Yasso) validity. Manuscript in preparation.

Soil measurements reveal a slow increase in C of humus layer over stand age

Legend:

S Spruce, MT

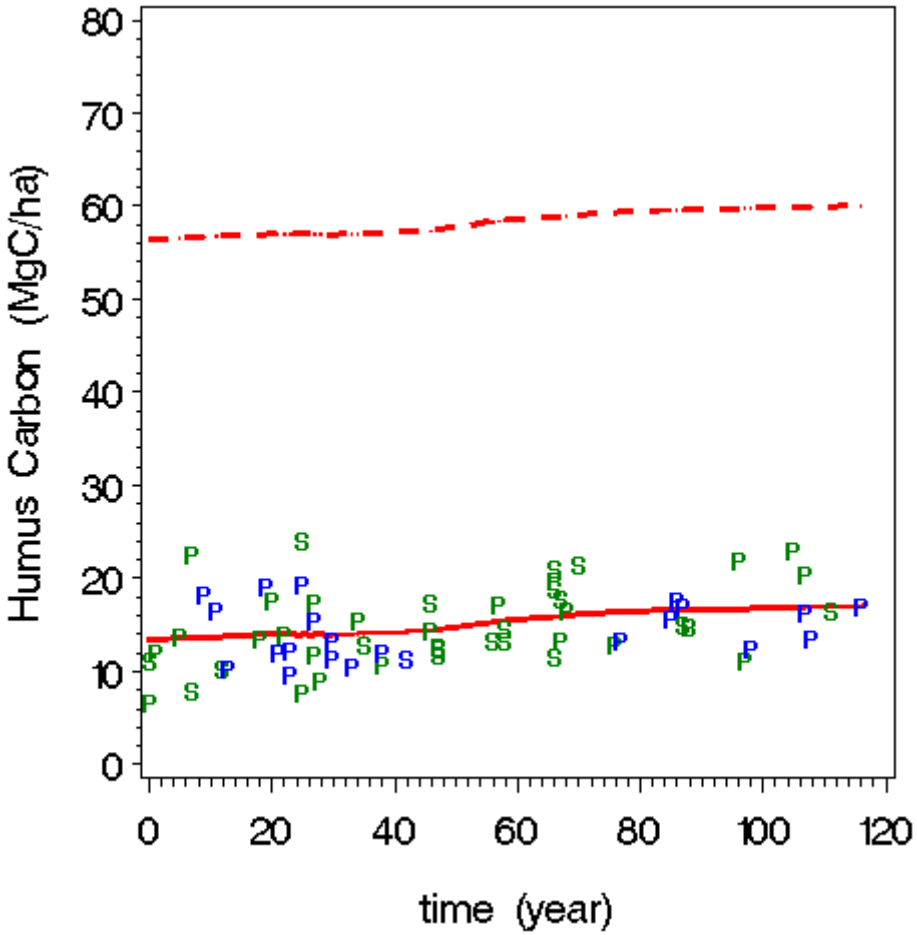
P Pine, MT

S Spruce, VT

P Pine, VT

Spline curve fitted to measured humus values

Estimated total soil carbon to 1 m depth (Humus spline fit + mineral soil mean value (~ 43 MgC/ha) over study area)



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Simulated Values for Soil Carbon

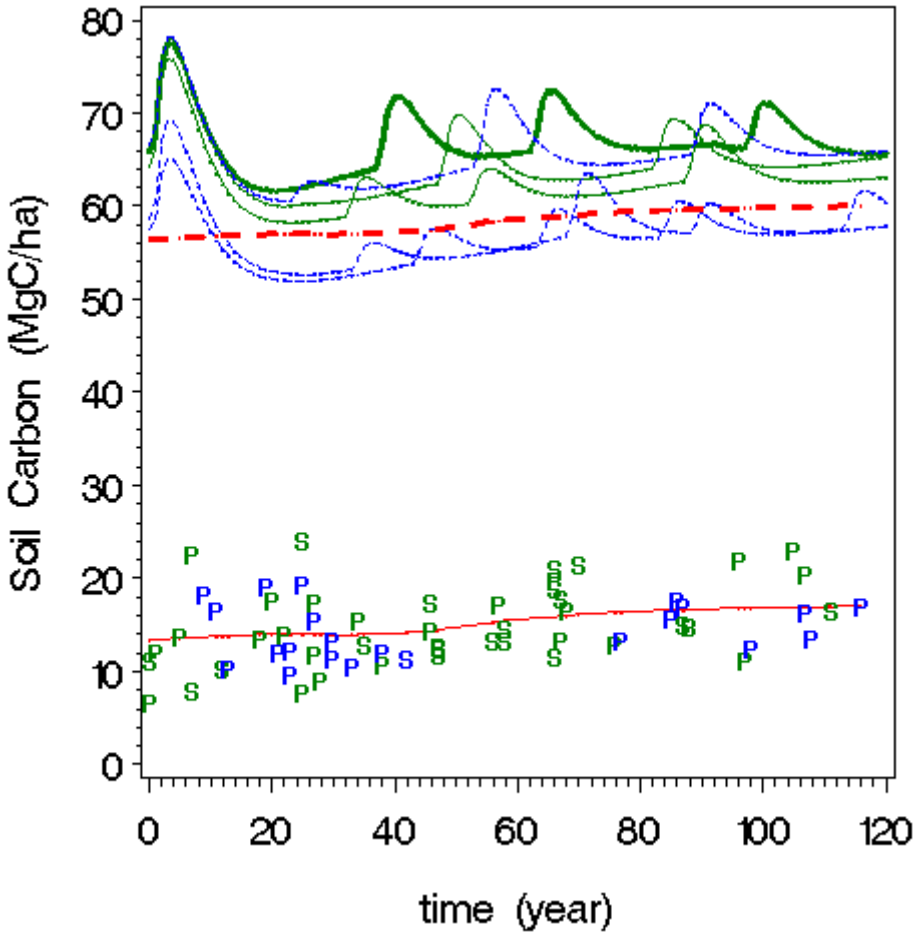
Peltoniemi, M., Mäkipää, R., Tamminen, P. et al. Testing of simple soil carbon model (Yasso) validity. Manuscript in preparation.

Modeled soil carbon for six stands on the study area.

According to simulations with Motti stand simulator and Yasso, carbon content rises over stand age

Estimated/Measured stock is on the same level as in simulations

Carbon storage change rate after clear cut is close to simulated values



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Applications

Applications

- development of BEFs for major tree species in Europe
- Estimation of changes in soil carbon stock

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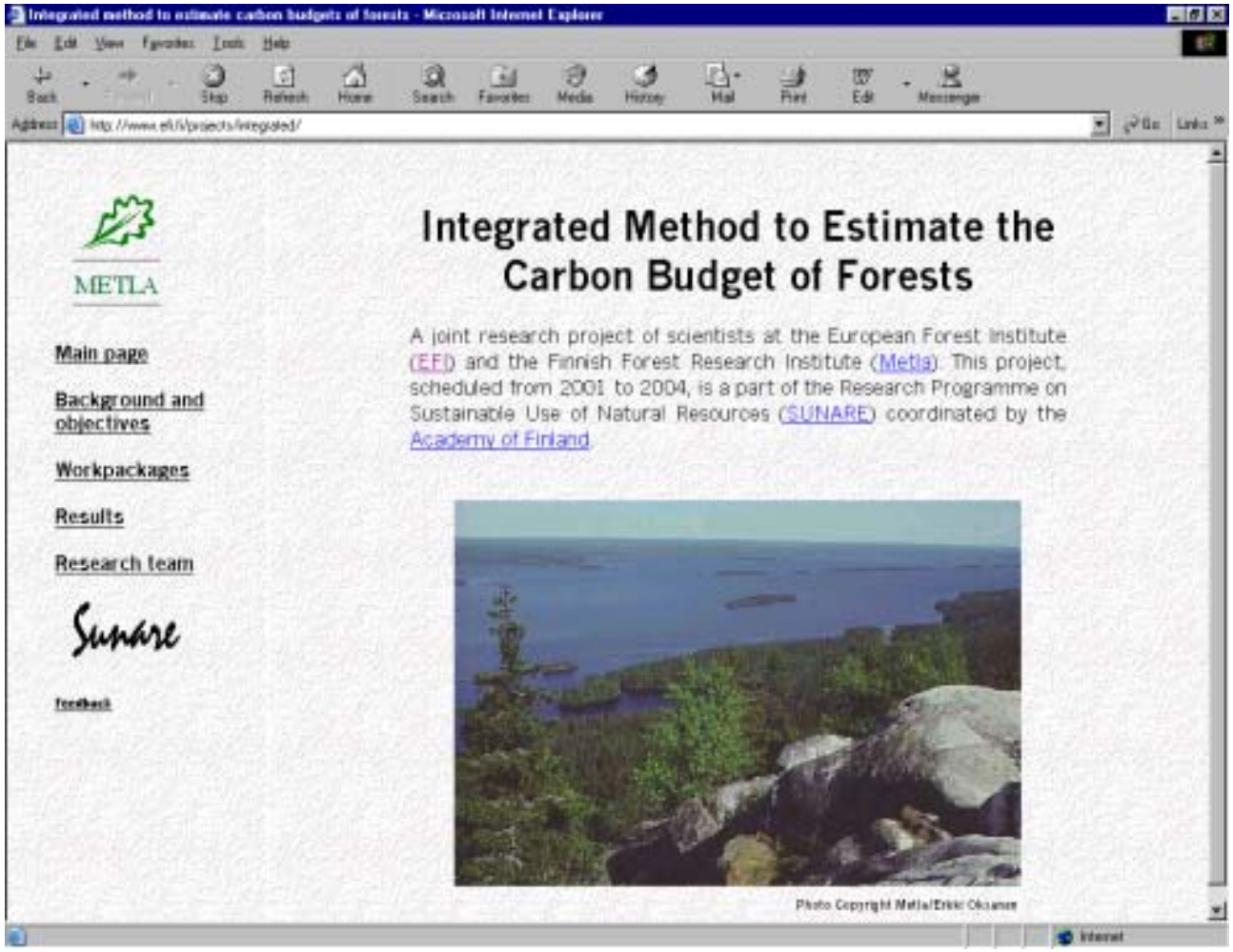
www.metla.fi/hanke/3306/index-en.htm
www.efi.fi/projects/integrated



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Acknowledgements

for cooperation

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