FOREST BIOMASS FOR ENERGY PRODUCTION –
POTENTIALS, MANAGEMENT AND RISKS UNDER CLIMATE CHANGE

Ashraful Alam, Antti Kilpeläinen, Seppo Kellomäki

School of Forest Sciences,
University of Eastern Finland, Joensuu

Future Climate and Renewable Energy – Impacts, Risks and Adaptation
Oslo, Norway

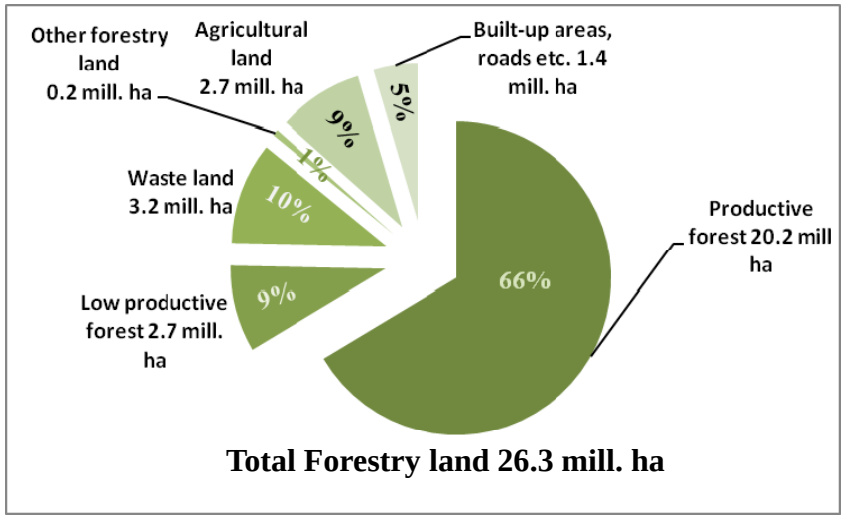
2 June, 2010

Contents

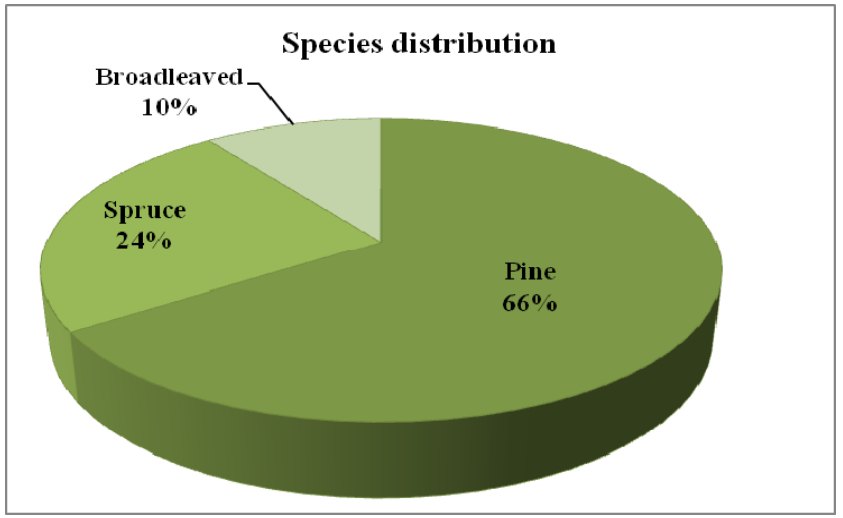
- Forestry in Finland
- Challenges
- Objectives
- Methodology
- Key findings
- Conclusions

Forestry in Finland

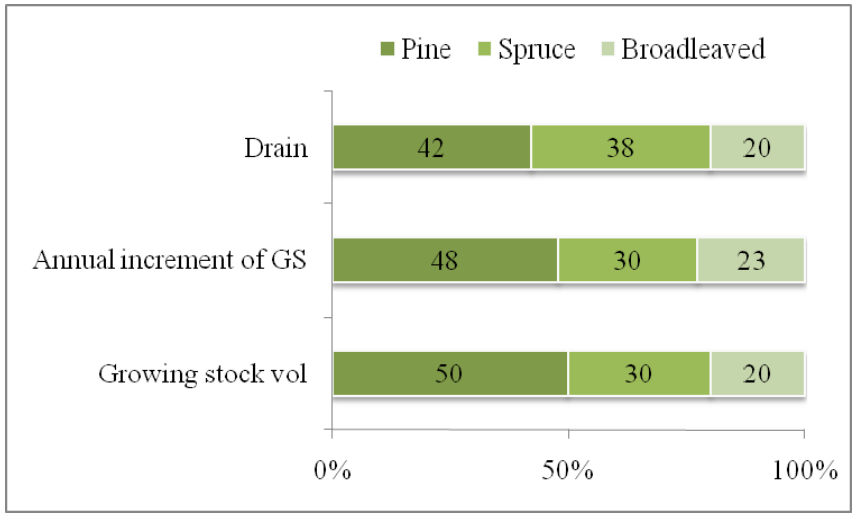
1. Land area distribution



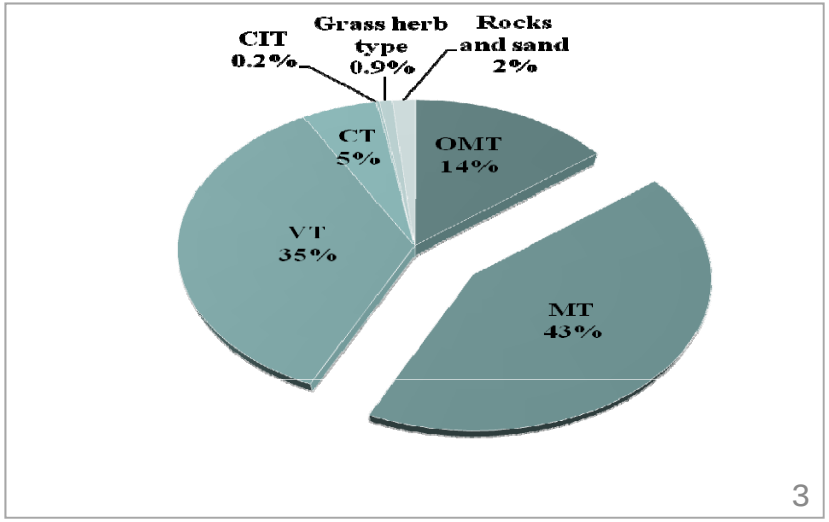
2. Species distribution



3. Growing stocks, increment and drain

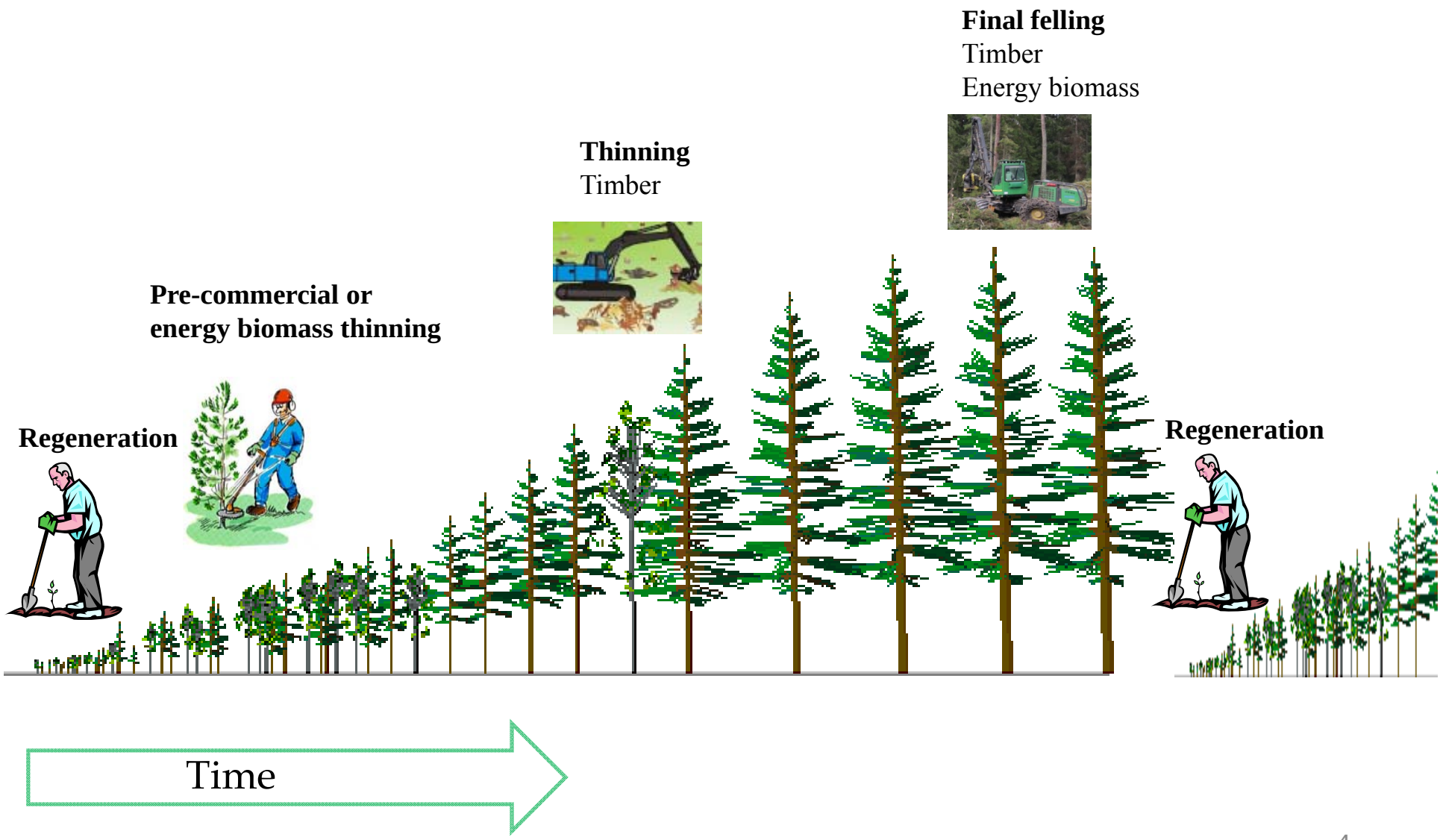


4. Site type distribution

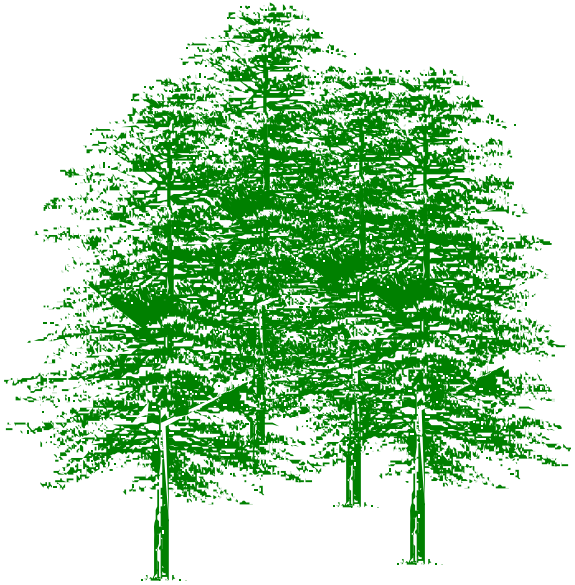


Source: Finnish Forest Research Institute, 2008

Forest management



Main assortments



Saw logs

Pulpwood

Energy biomass

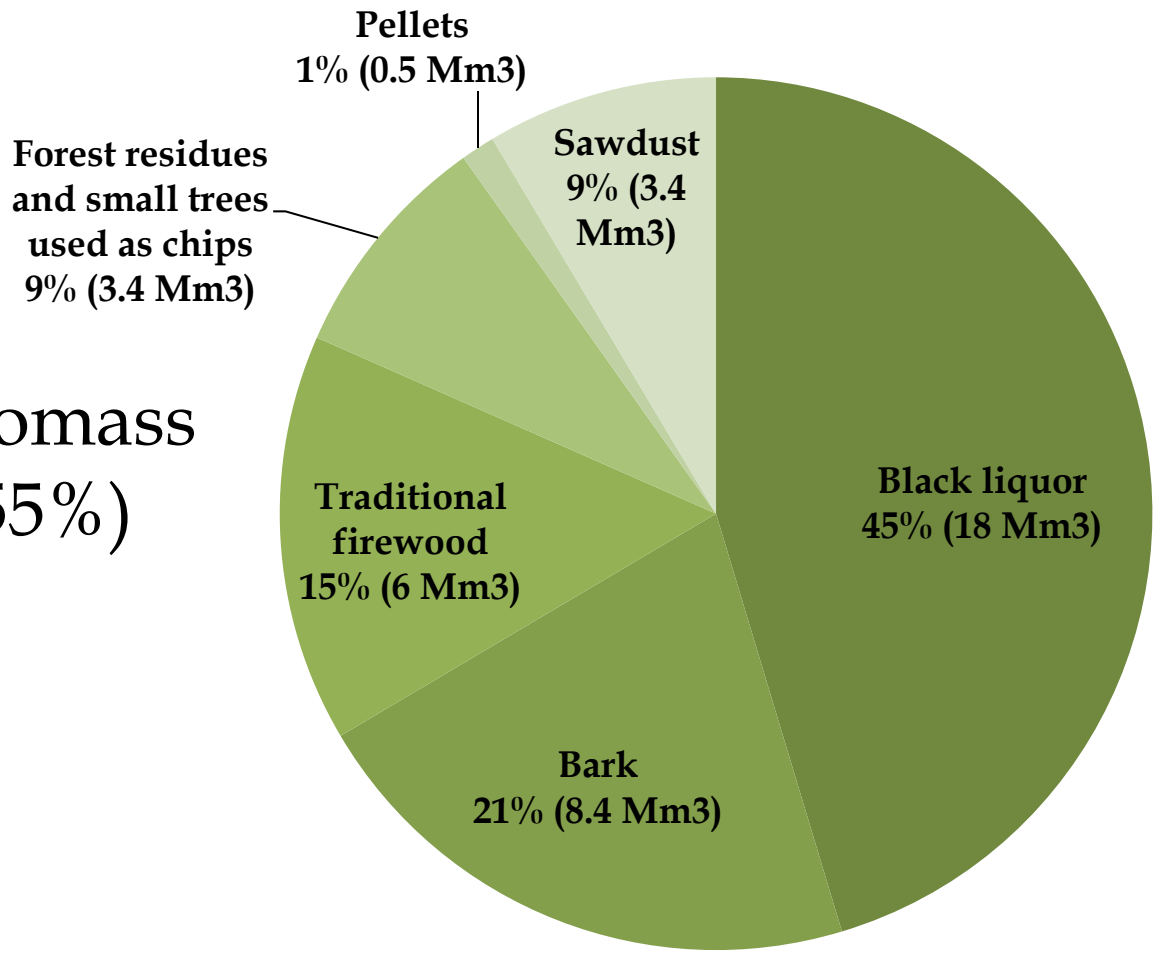
Small trees

Residues

Stumps

Use of biomass based energy in Finland

Energy biomass
46 TWh (55%)



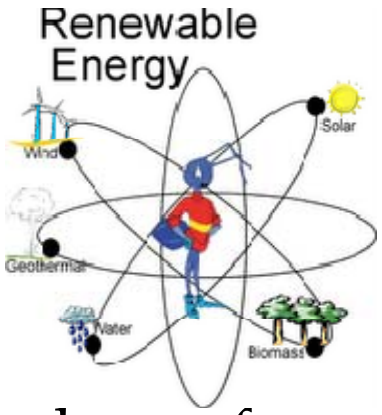
Energy biomass: 20% of the primary energy production

Source: Finnish Forest Research Institute, 2007

Interactions: forests, climate, management &production

- **Boreal forests**: growth is mainly limited by low temperature, short growing season
- **Climate change effect**: defined by increase in temperature, precipitation and CO_2, may provide favourable condition to boreal forests to grow forest faster
- **Management**: expected climate change may bring a new dimension to current mgt. as it utilises the opportunity provided by the surrounding environment
- **Energy biomass production**

What are the challenges?



- EU is committed to raise the share of renewable energy to 20% by 2020
- This target for Finland is 38% by 2020
- The production of energy biomass to substitute fossil fuels
- In 2006, 21 mil. m^3 (46 TWh) of energy biomass was used in Finland, of which only 9% was from forest residues and small-sized trees

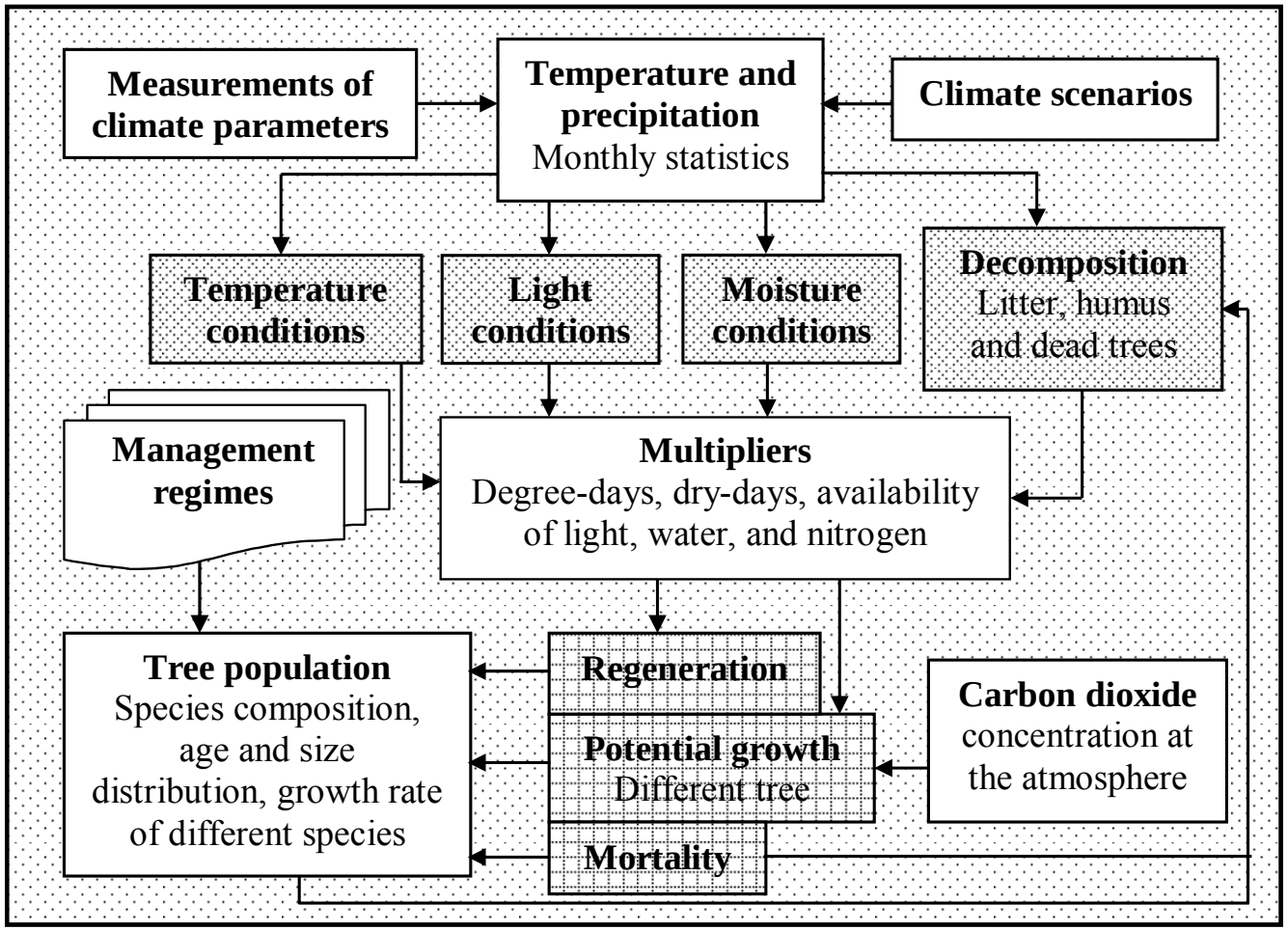
Objectives

- Effect of climate on the potential production of energy biomass at different scales in space and time

- Effect of forest management on energy biomass production along with timber and carbon stocks in the forest ecosystem

- To assess the ecological risks to produce energy biomass

Ecosystem model

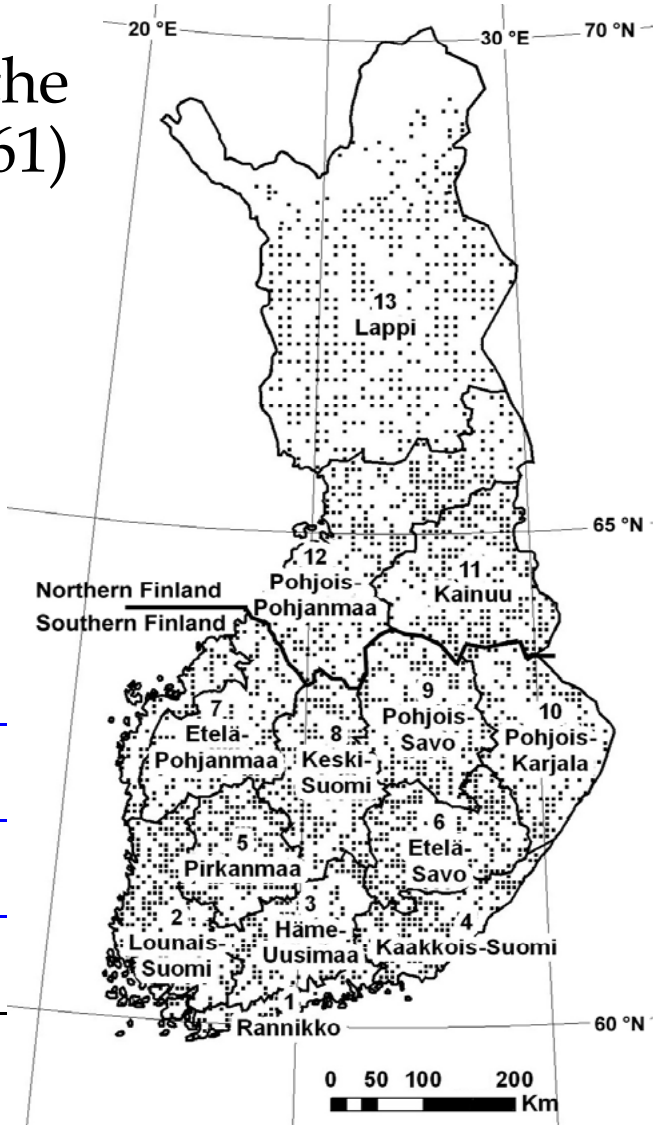


Input data

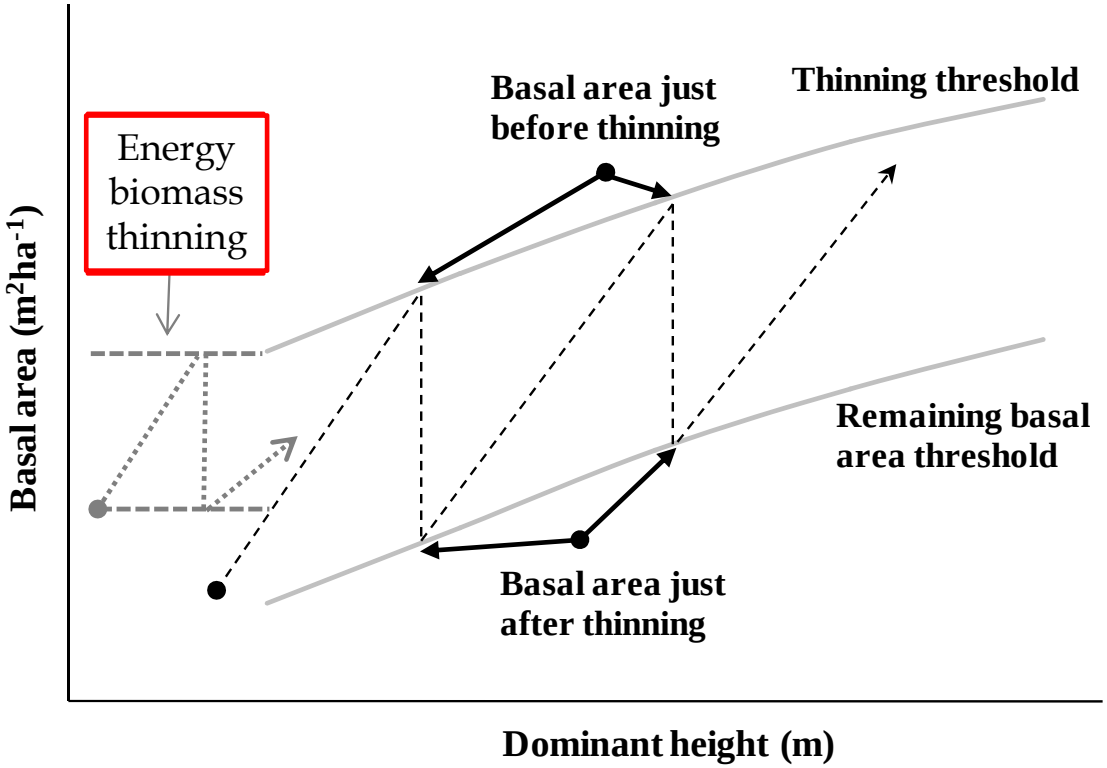
- Finnish NFI data
- total 2816 permanent sample plots for the whole of Finland (south: 1855; north: 961)

- FMI - Climatic data
- Current climate (1971-2000)
- Changing climate during 2010-2099 (2010-2039; 2040-2069; 2070-2099)

A2 scenario	Summer	Winter
Temp.	▲6˚c	▲7˚c
Precip.	+10%	+30%
CO_2	Nearly double	

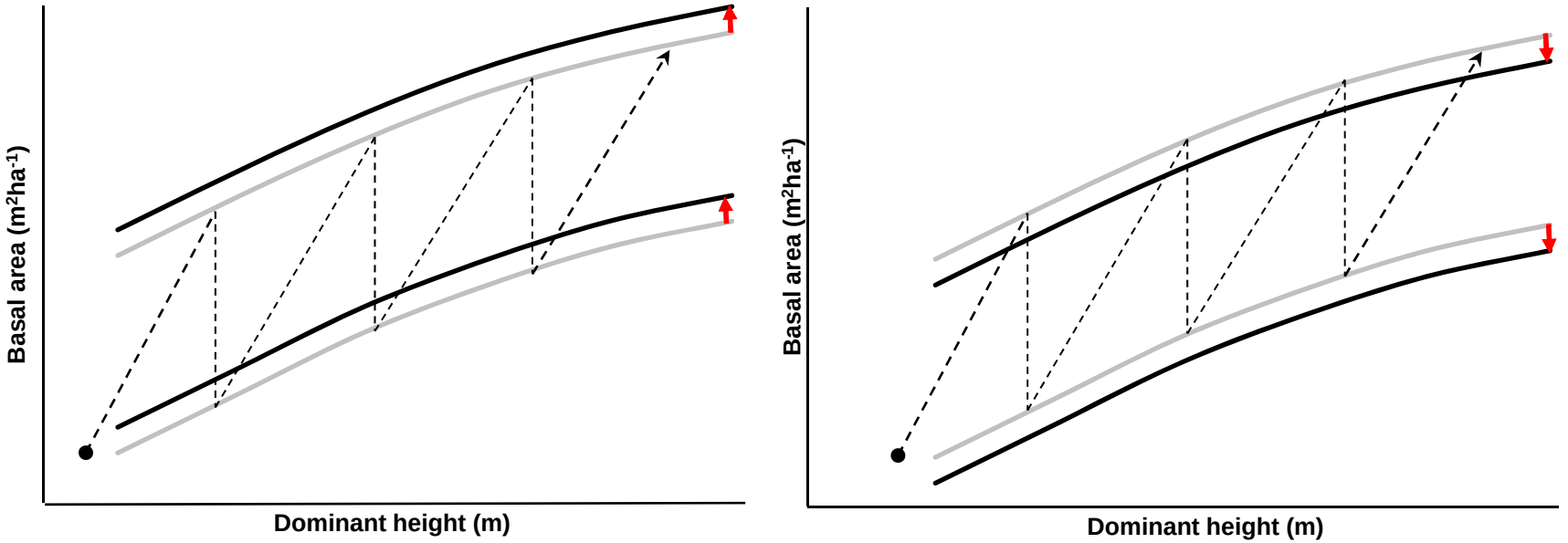


Forest management principles



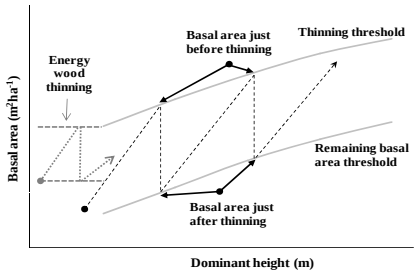
Management regimes

Changes in basal area thinning thresholds in %

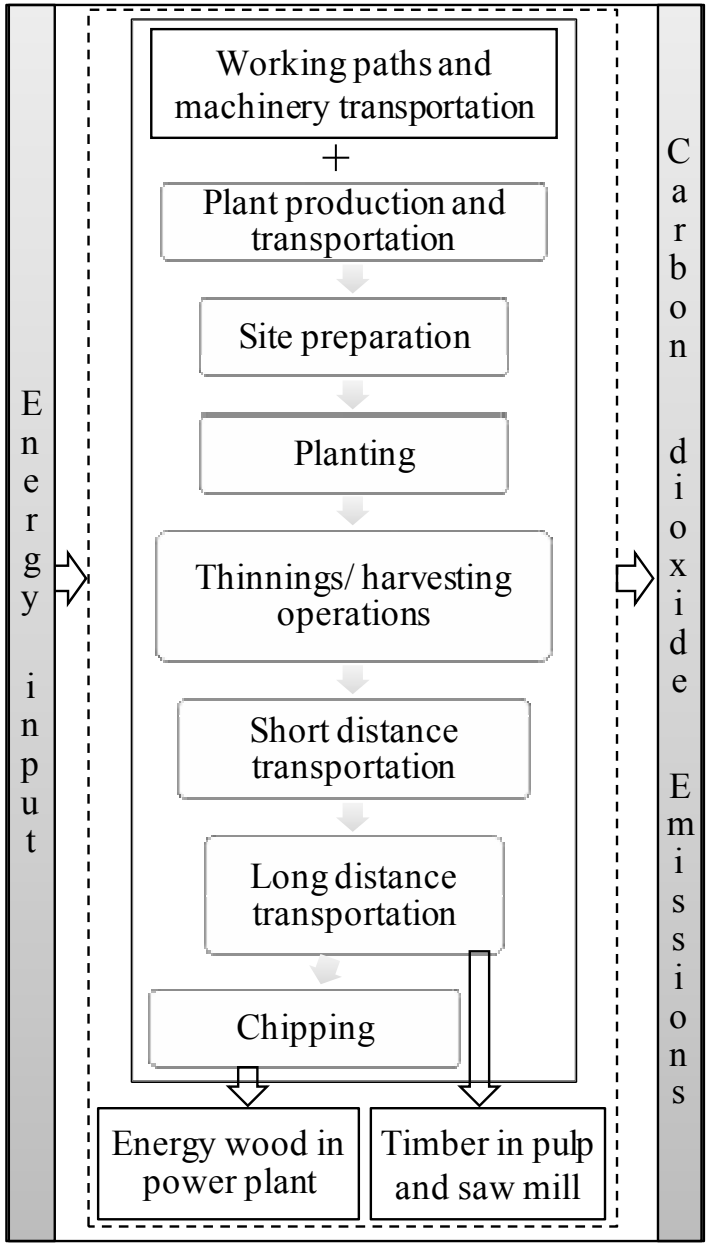


- Changes in initial stand density

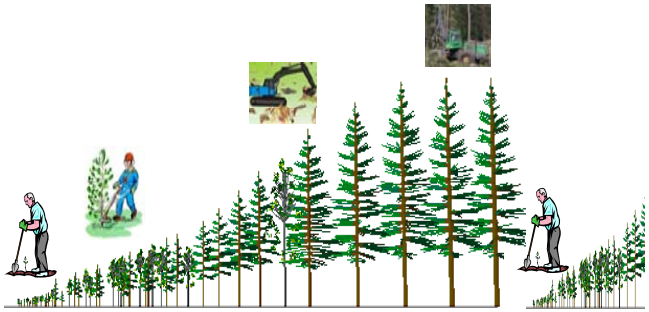
2000 – 4000 stems /ha

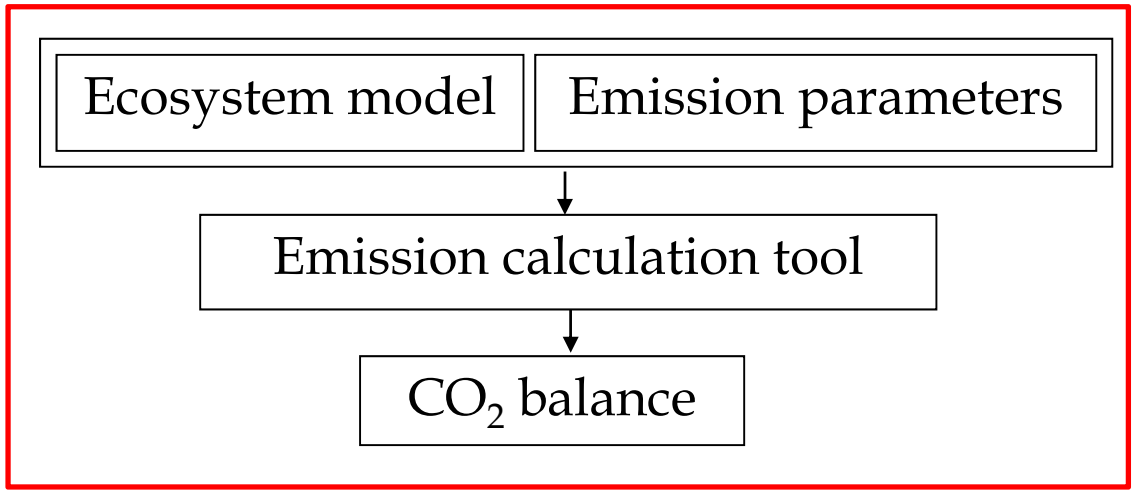


Emission calculation tool (ECT)



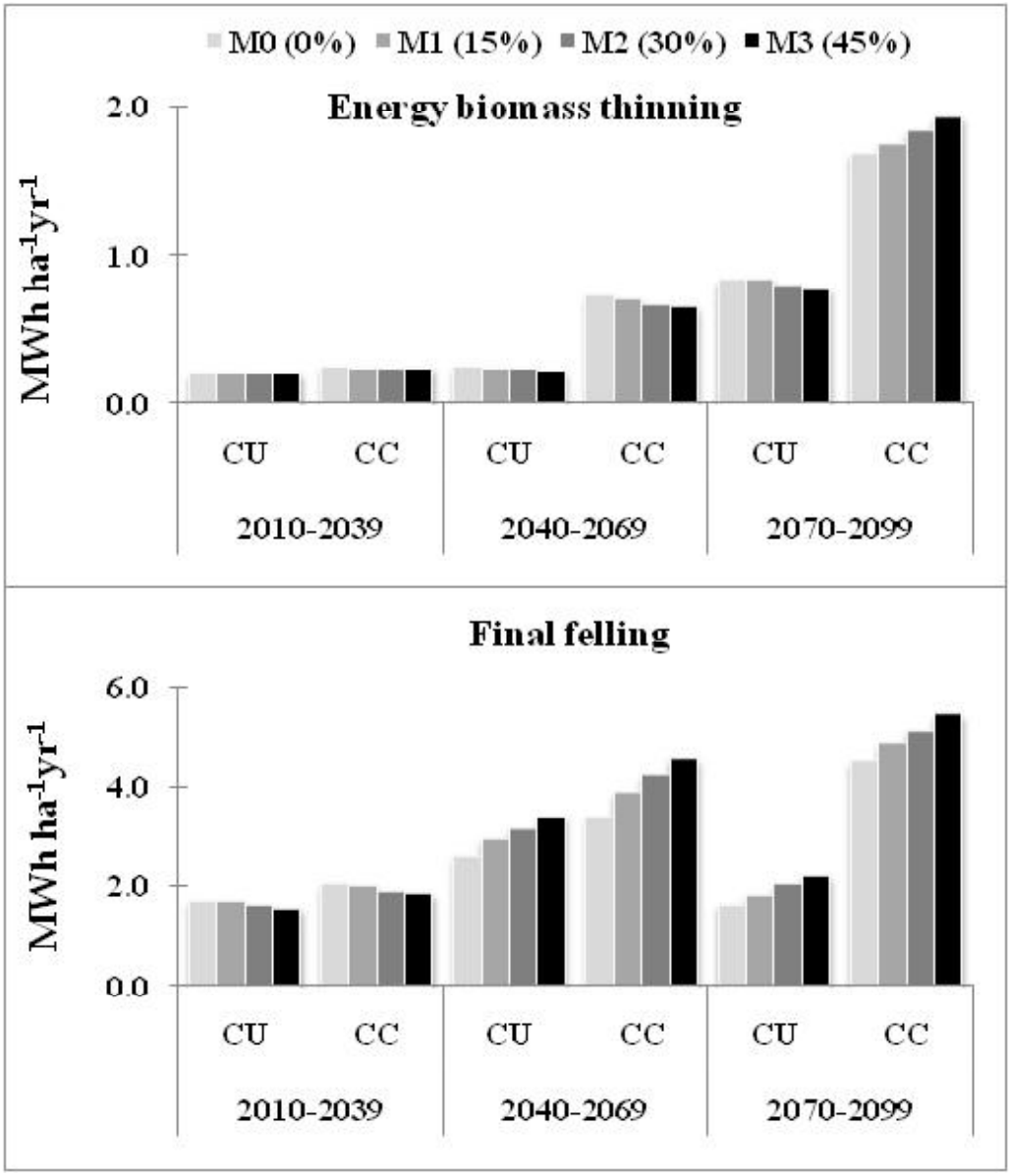
Rotation period

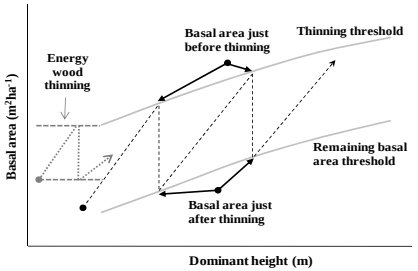




Findings

Effect of climate and management on energy biomass production

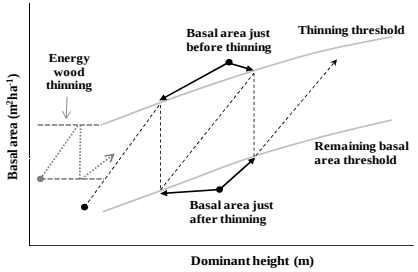




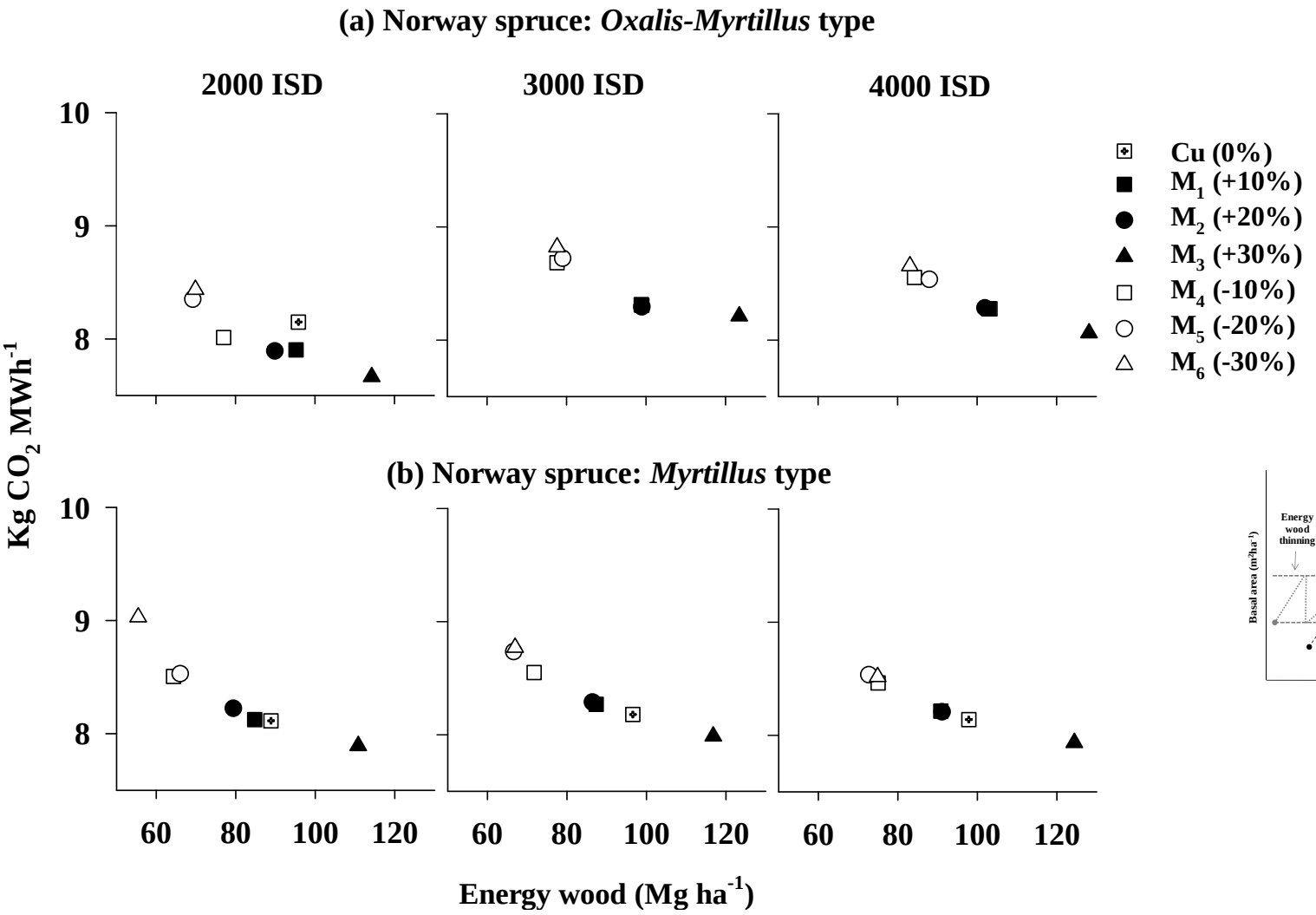
Findings: production and substitution potential (2010-2099)

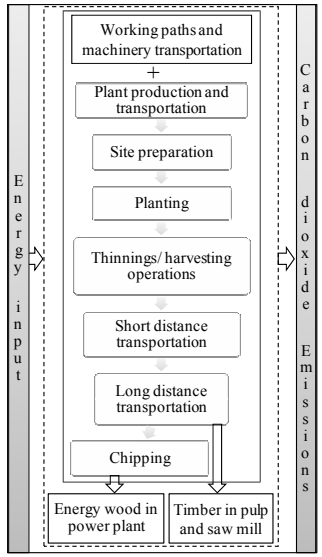
Total energy biomass at EBT and FF in Finland

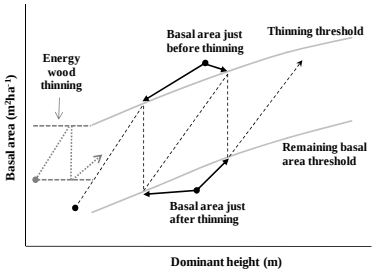
Management regimes	Current climate				Climate change			
	EBT	FF	**Total**		EBT	FF	**Total**	
	TWh yr^{-1}			%	TWh yr^{-1}			%
M0 (0%)	8.7	40.4	**49.1**	*--*	17.8	67.5	**85.4**	*--*
M1 (+15%)	8.7	43.9	**52.6**	*7*	18.1	72.8	**90.9**	*7*
M2 (+30%)	8.4	46.4	**54.8**	*12*	18.4	76.4	**94.8**	*11*
M3 (+45%)	8.1	48.7	**56.8**	*16*	19.0	80.3	**99.3**	*16*



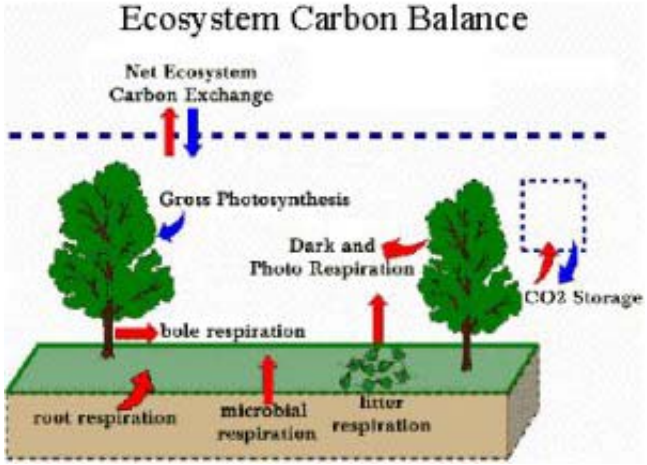
Findings

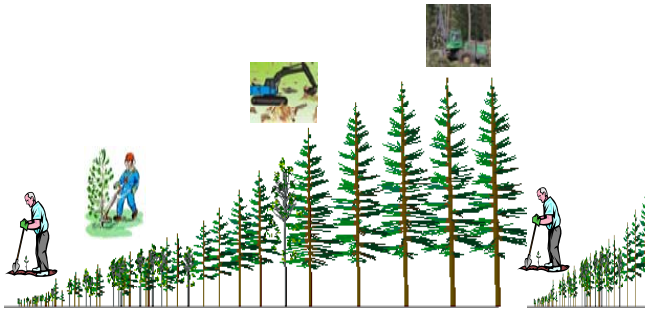

(a) Norway spruce: *Oxalis-Myrtillus* type
2000 ISD
3000 ISD
4000 ISD
10
9
8
Kg CO_2 MWh^{-1}
Cu (0%)
M_1 (+10%)
M_2 (+20%)
M_3 (+30%)
M_4 (-10%)
M_5 (-20%)
M_6 (-30%)
(b) Norway spruce: *Myrtillus* type
60
80
100
120
Energy wood (Mg ha^{-1})

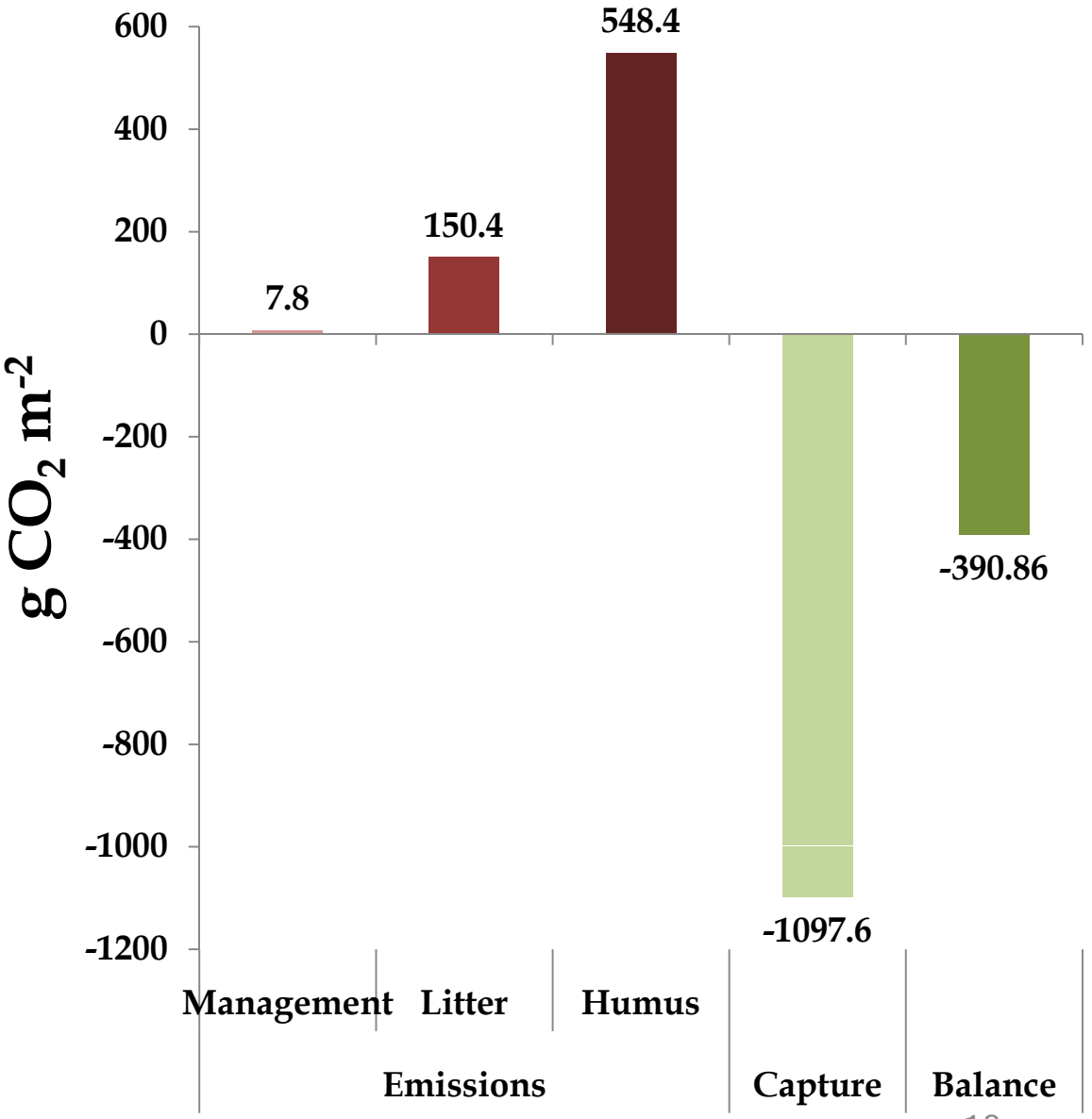

Working paths and machinery transportation
+
Plant production and transportation
Site preparation
Planting
Thinnings/ harvesting operations
Short distance transportation
Long distance transportation
Chipping
Energy wood in power plant
Timber in pulp and saw mill
Energy input
Carbon dioxide Emissions


Energy wood thinning
Basal area just before thinning
Thinning threshold
Remaining basal area threshold
Basal area just after thinning
Basal area (m^2ha^{-1})
Dominant height (m)

Findings: ecosystem CO_2 balance







Conclusions

- Large amount of unutilised energy biomass are available in Finland
- Climate change increased energy biomass production
- Higher production can be gained with changed forest management
- Energy biomass production are associated with timber production
- Forest biomass energy is competitive compared with other fuels (coal and peat) in respect of carbon benefits

Moving! Green Energy HuH…