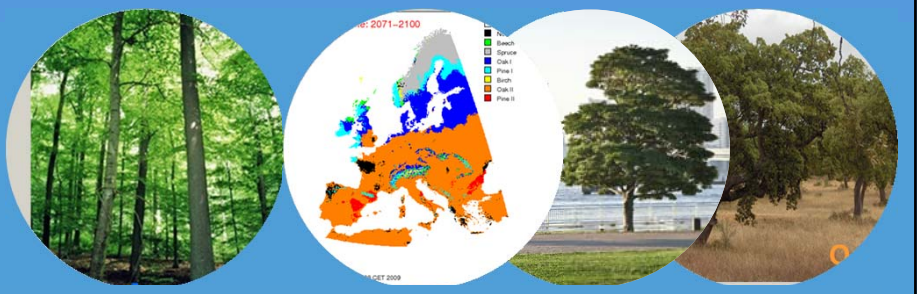
Economic impacts of climate change on European forests

Hanewinkel, Zimmermann, Cullmann, Nabuurs

Mart-Jan Schelhaas, 3 November 2014



Hanewinkel, M., D.A. Cullmann, M.J. Schelhaas, G.J. Nabuurs, N.E. Zimmermann. 2012. Climate change may cause severe loss in economic value of European forestland. Nature Climate Change 3: 203-207. DOI: 10.1038/NCLIMATE1687

Data & Methods

- Pan-European tree distribution data
- High-resolution climate data (<1km)
- Climate Projections into future

- Forest resource model EFISCEN
- Economic calculations (NPV per type)

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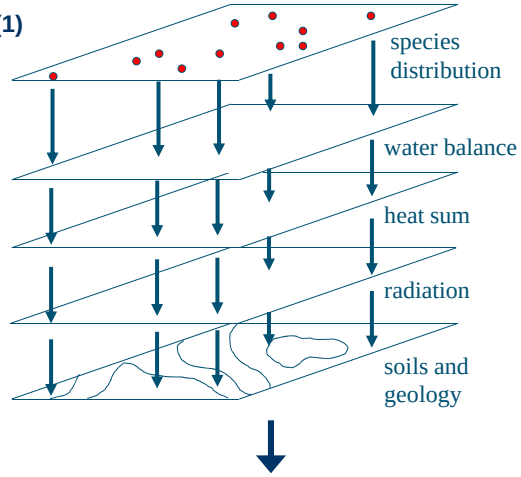
Species preference

(1)



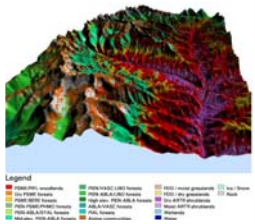
(2) *Concept and theory-based variable selection*

(3)

ID	Sp1	Tave	Prcp	Geol	...
1	0	3.25	1390	X	...
2	1	5.57	1840	b	...
3	1	7.21	2130	a	...
4	0	2.94	1420	Y	...
5	1	8.43	1789	a	...
...	...	...	...	...	...

(4) $P(Sp1) = f(Tave,Prcp,Geol,...)$

(5)



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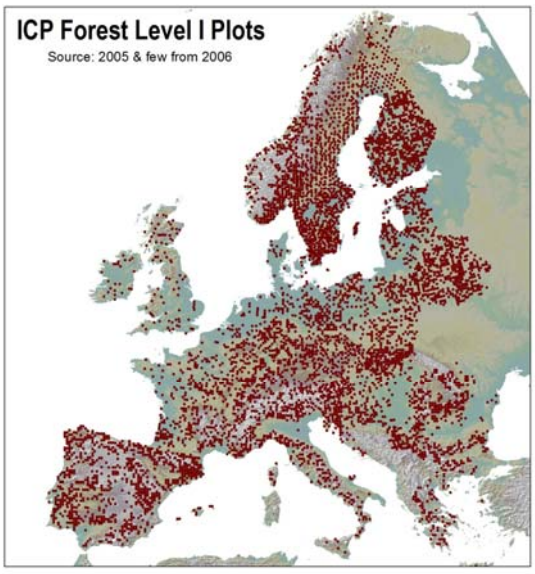
Species occurrence data



6129 plots
~16km grid
139 tree spp.

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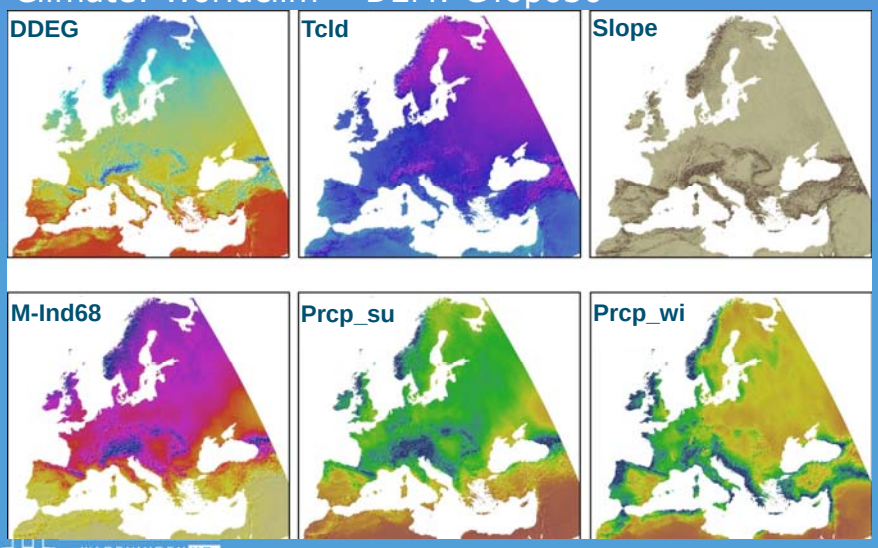
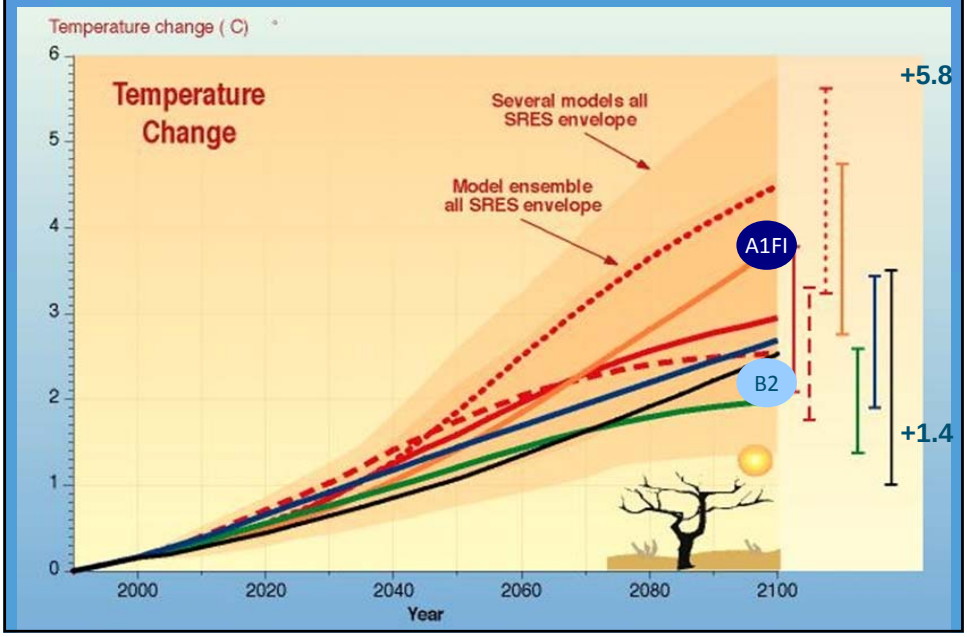
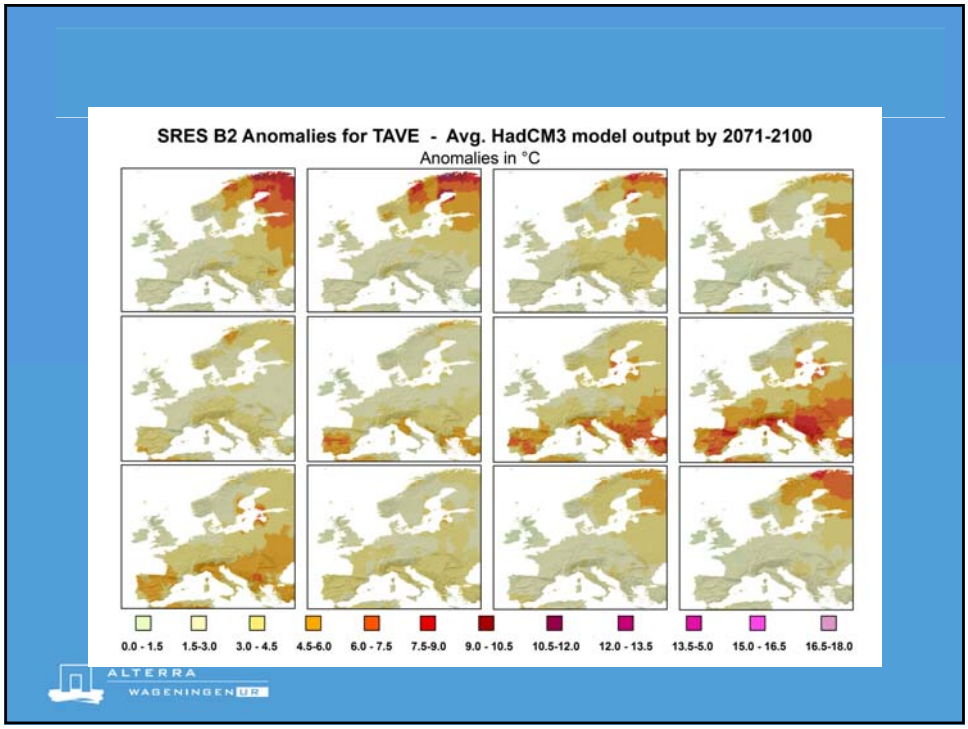
Current climate & DEM

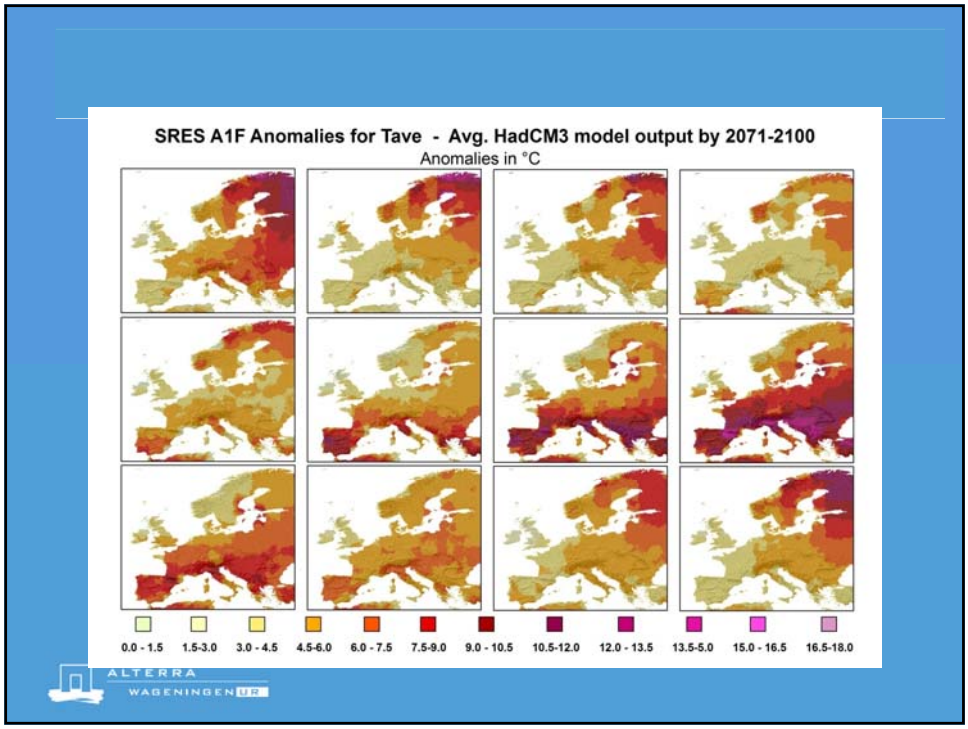
Climate: Worldclim DEM: GTopo30

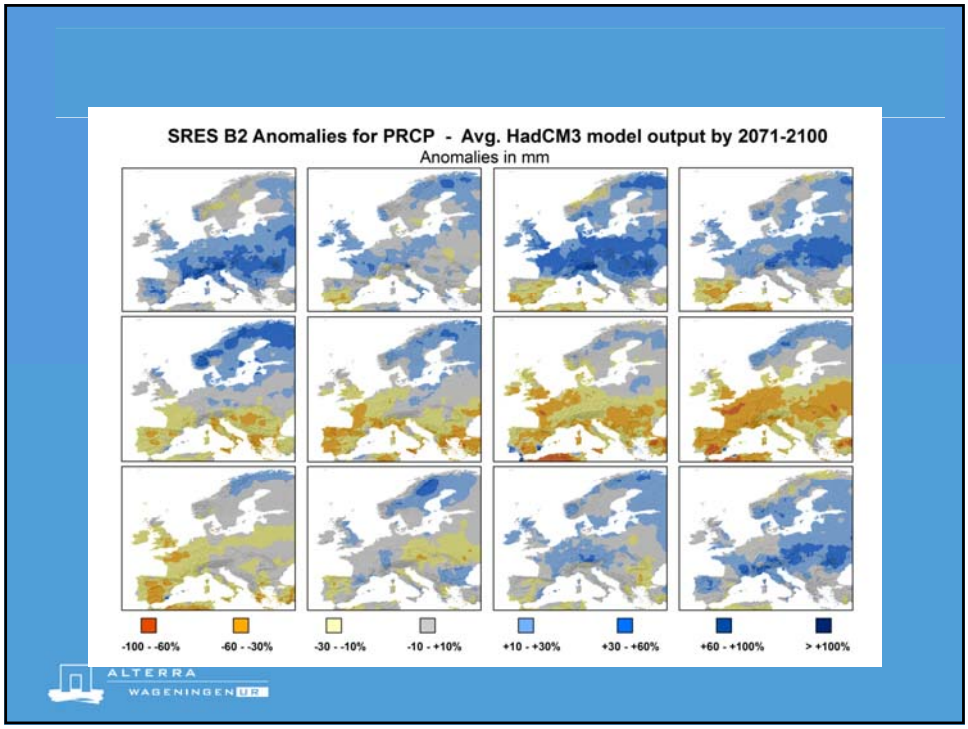


Climate scenarios

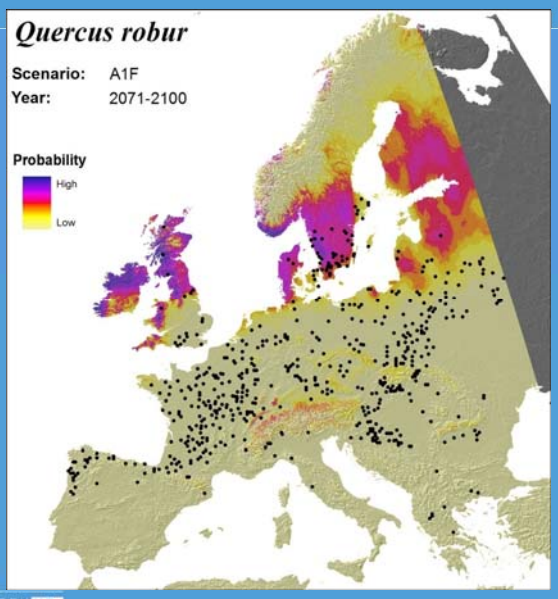



SRES B2 Anomalies for TAVE - Avg. HadCM3 model output by 2071-2100
Anomalies in °C
0.0 - 1.5
1.5-3.0
3.0 - 4.5
4.5-6.0
6.0 - 7.5
7.5-9.0
9.0 - 10.5
10.5-12.0
12.0 - 13.5
13.5-5.0
15.0 - 16.5
16.5-18.0
ALTERRA
WAGENINGEN UR

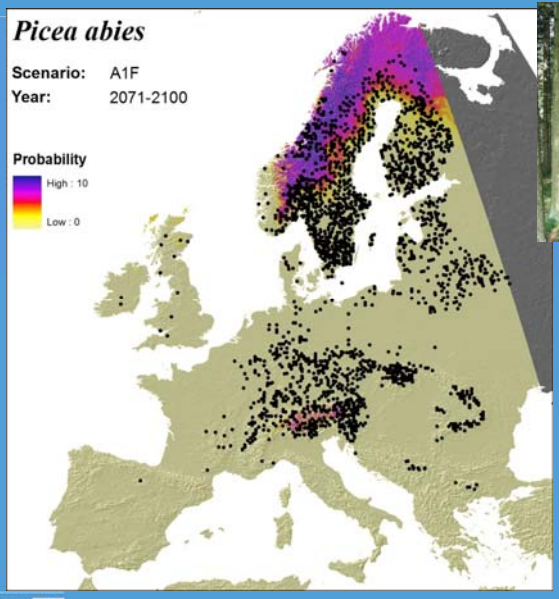

SRES A1F Anomalies for Tave - Avg. HadCM3 model output by 2071-2100
Anomalies in °C
0.0 - 1.5
1.5-3.0
3.0 - 4.5
4.5-6.0
6.0 - 7.5
7.5-9.0
9.0 - 10.5
10.5-12.0
12.0 - 13.5
13.5-5.0
15.0 - 16.5
16.5-18.0
ALTERRA
WAGENINGEN UR

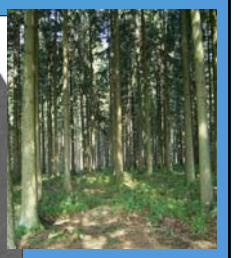


Results: Potential future ranges



Results: Potential future ranges





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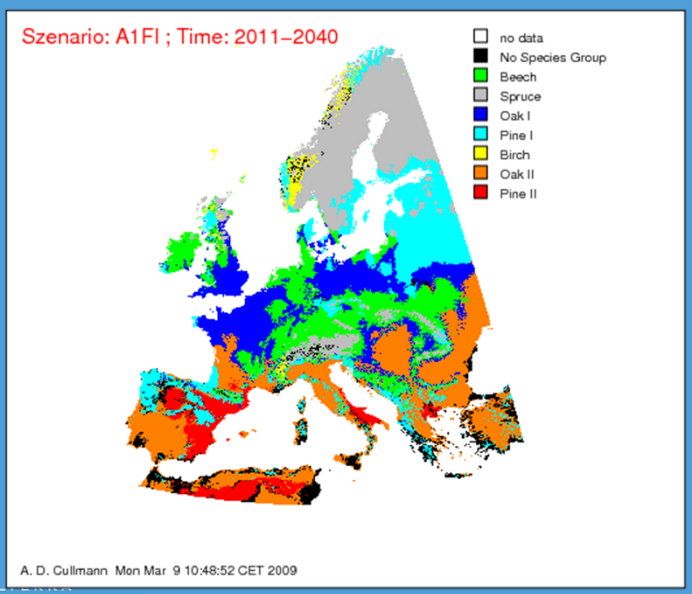

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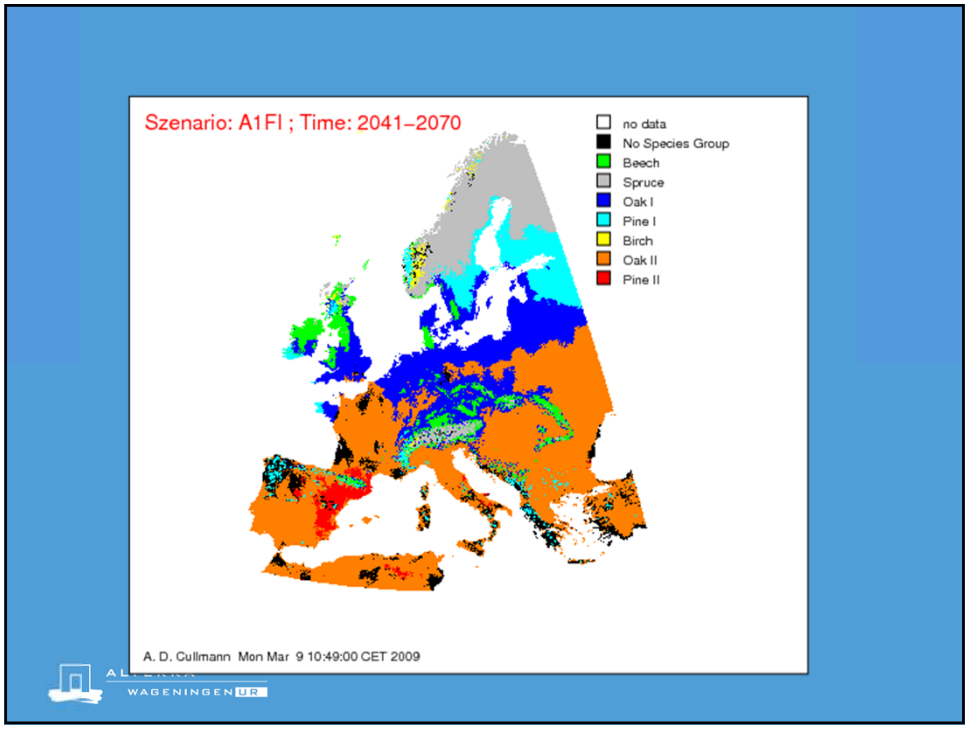
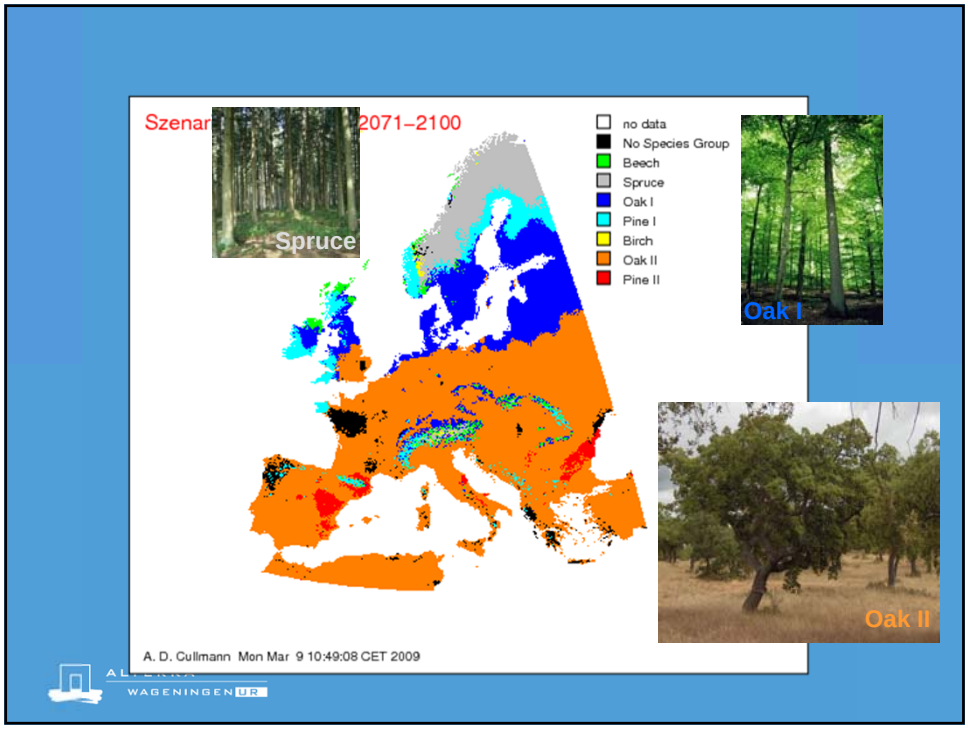

Szenario: A1FI ; Time: 2041–2070
no data
No Species Group
Beech
Spruce
Oak I
Pine I
Birch
Oak II
Pine II
A. D. Cullmann Mon Mar 9 10:49:00 CET 2009
WAGENINGEN UR


Szenar 2071–2100
no data
No Species Group
Beech
Spruce
Oak I
Pine I
Birch
Oak II
Pine II
Spruce
Oak I
Oak II
A. D. Cullmann Mon Mar 9 10:49:08 CET 2009
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Land Expectation Value (Faustmann 1849)

$$LEV = \frac{Fh_t + \sum_{a=1}^{t} Th_a \cdot (1+i)^{t-a} - c \cdot (1+i)^t}{(1+i)^t - 1}$$

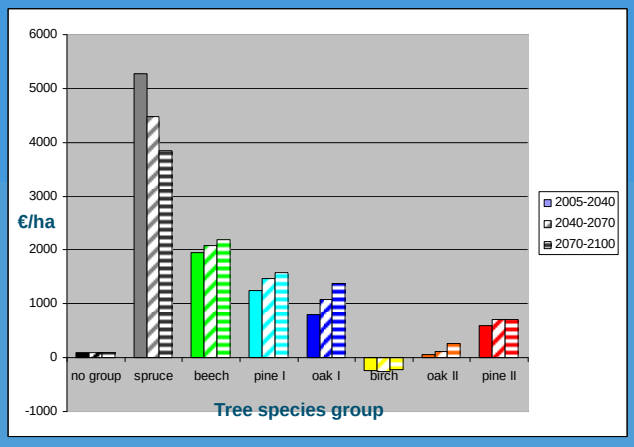
EFISCEN

Beech AGE (t) (years)	DISCOUNT FACTORS(t)	COSTS(t) (€ * ha-1)	STUMPAGE VALUES ST(t) (€ * ha-1)	THINNINGS TH(t) (€ * ha-1)	LAND EXPECTATION VALUE LEV(t) (€ * ha-1)
0	1	1500	0,00	0,00	
10	0,90573081	550	0,00	0,00	-21196
20	0,74301473	0	-11,83	0,00	-7810
30	0,60953087	0	-66,21	-66,67	-5325
40	0,50002761	0	-143,64	-120,64	-4342
50	0,4101968	0	-188,60	-108,20	-3765
60	0,33650425	0	576,21	-79,39	-2979
70	0,27605069	0	1359,12	7,77	-2477
80	0,22645771	0	1800,86	206,62	-2215
90	0,1857742	0	3389,31	1003,80	-1603
100	0,15239955	0	4928,99	2903,30	-874
110	0,12502071	0	6678,56	4565,65	-99
120	0,10256053	0	7144,10	4406,22	293
130	0,08413535	0	9596,76	5967,89	917
140	0,0690203	0	10111,49	6034,54	1232

(Samuelson 1976)

Land expectation values of different European tree species 2005 - 2100

$$LEV = \frac{Fh_t + \sum_{a=1}^{t} Th_a \cdot (1+i)^{t-a} - c \cdot (1+i)^t}{(1+i)^t - 1}$$



LEVs, A1FI, 2005-2100 i=0.02, price/costs - 2005

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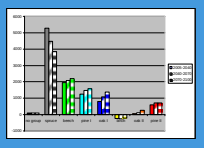
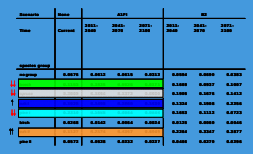
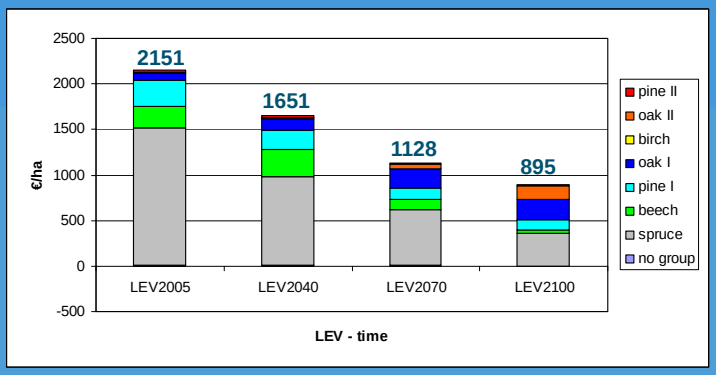
Land expectation values of European forestland in €/ha 2005 - 2100



X





Scen. A1FI, 2005-2100 i=0.02, price/costs - 2005

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The cost of not mitigating climate change

Per ha European forestland (€/ha)

		2040	2070	2100
i=1%	A1FI	1549	3874	5314
	B2	1791	2961	3275
i=2%	A1FI	500	1023	1256
	B2	578	895	1024
i=3%	A1FI	279	549	684
	B2	323	486	604

Overall – MCPFE – forest area

	incl. RUS	without RUS
km2	10 million	1,6 million
ha	1 billion	160 million

~ 800 billion €

~ 200 billion €

~ 100 billion €

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Scen. A1FI,B2 2005-2100 i=0.01-0.03, price/costs - 2005

Thanks for your attention!

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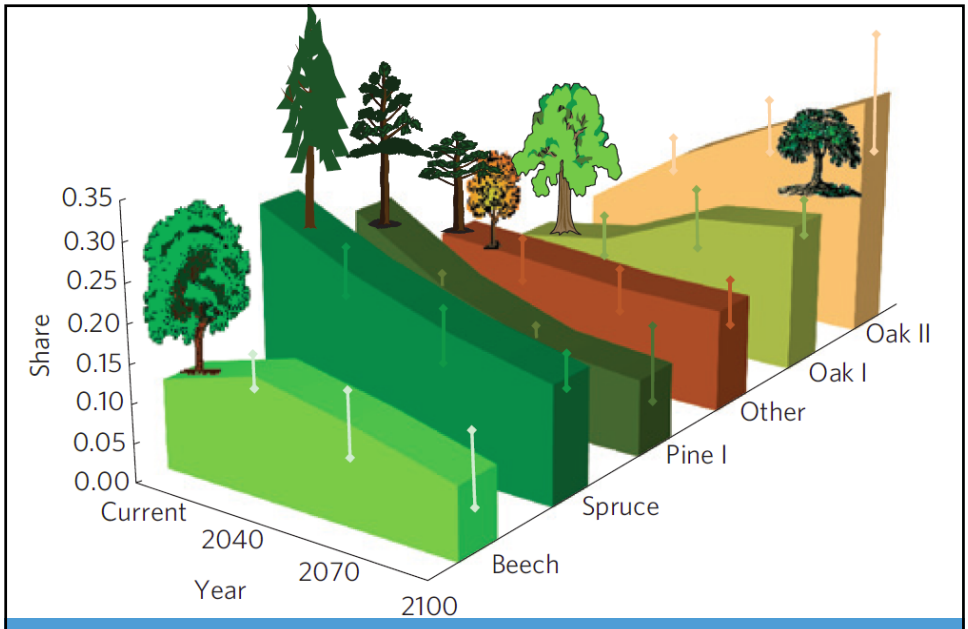

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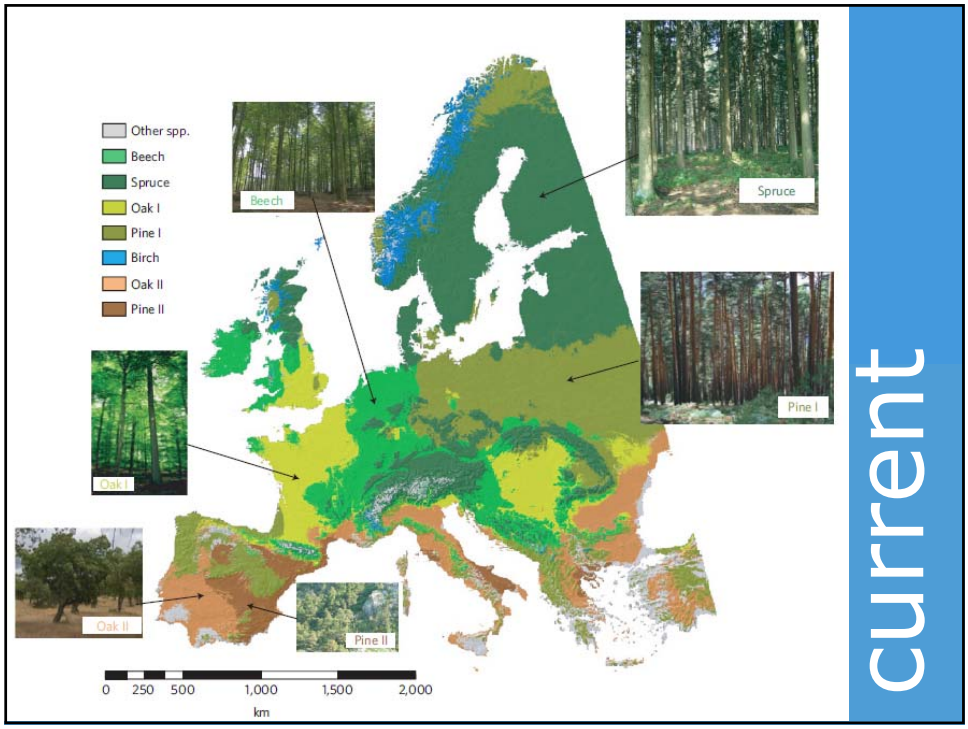
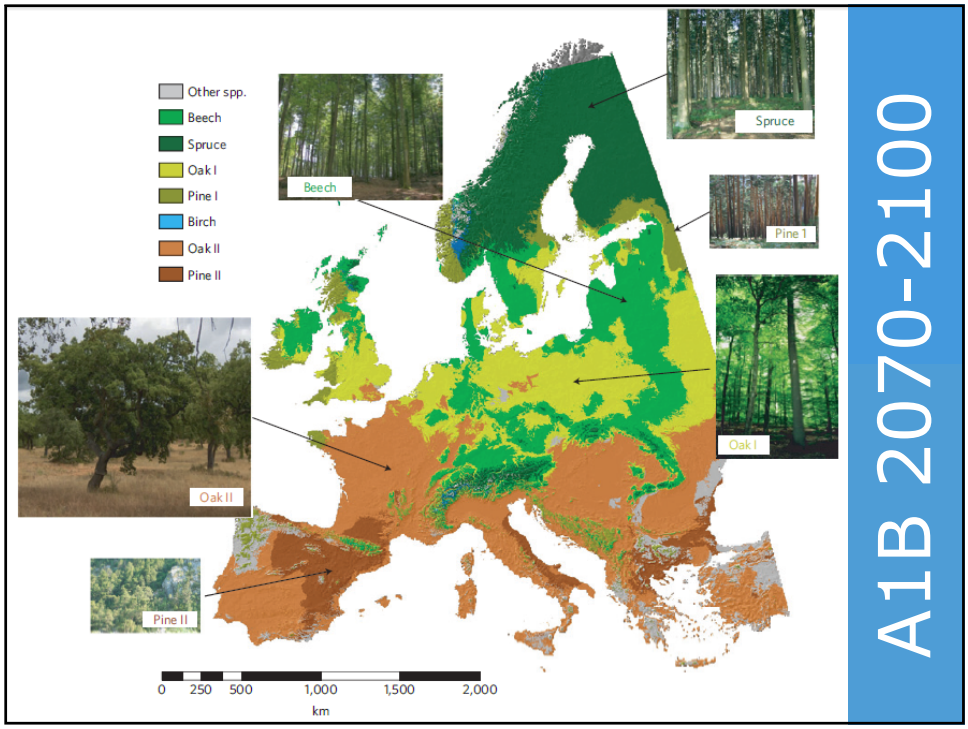
A1B


Other spp.
Beech
Spruce
Oak I
Pine I
Birch
Oak II
Pine II
Beech
Spruce
Pine I
Oak I
Oak II
Pine II
0 250 500 1,000 1,500 2,000
km
current


Other spp.
Beech
Spruce
Oak I
Pine I
Birch
Oak II
Pine II
Spruce
Beech
Pine I
Oak I
Oak II
Pine II
0 250 500 1,000 1,500 2,000
km
A1B 2070-2100