Professur für Forstökonomie
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Economic Impacts of Climate Change on European forests

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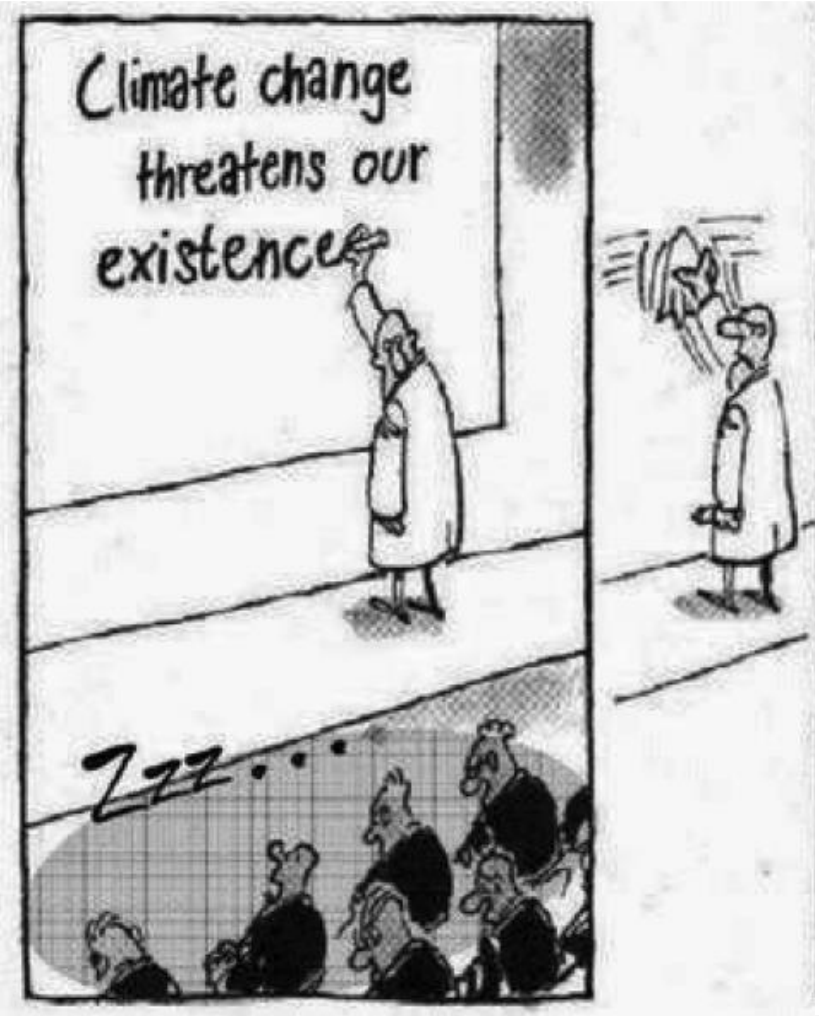
Why economy matters

Why economy matters



Why economy matters

Structure

- Introduction
- Data & Methods
- Results
- Pitfalls – uncertainties
- Research Challenges

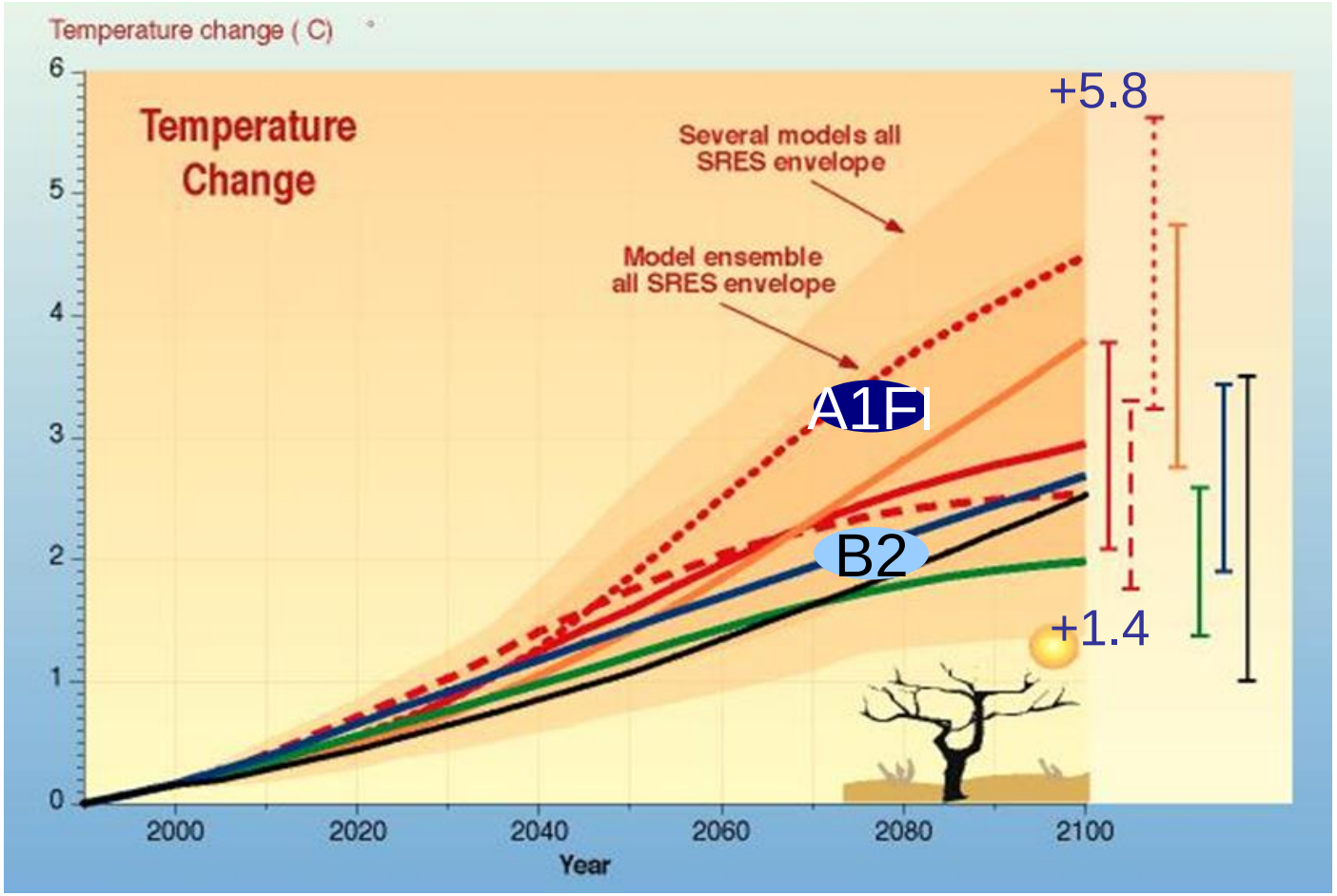
– Climate is a major driver of vegetation distribution and plant growth / survival / mortality.

- Main questions:
- What are potential future ranges of trees?
- Economic impacts of range shifts?
- Impact on overall value of forestland?

Hanewinkel, M., Cullmann, D.A., Schelhaas, M.J., Nabuurs, G.-J. Zimmermann, N.E. (2013) Climate change may cause severe loss in the economic value of European forest land. Nature Climate Change,3:204-207. DOI: 10.1038/NCLIMATE1687

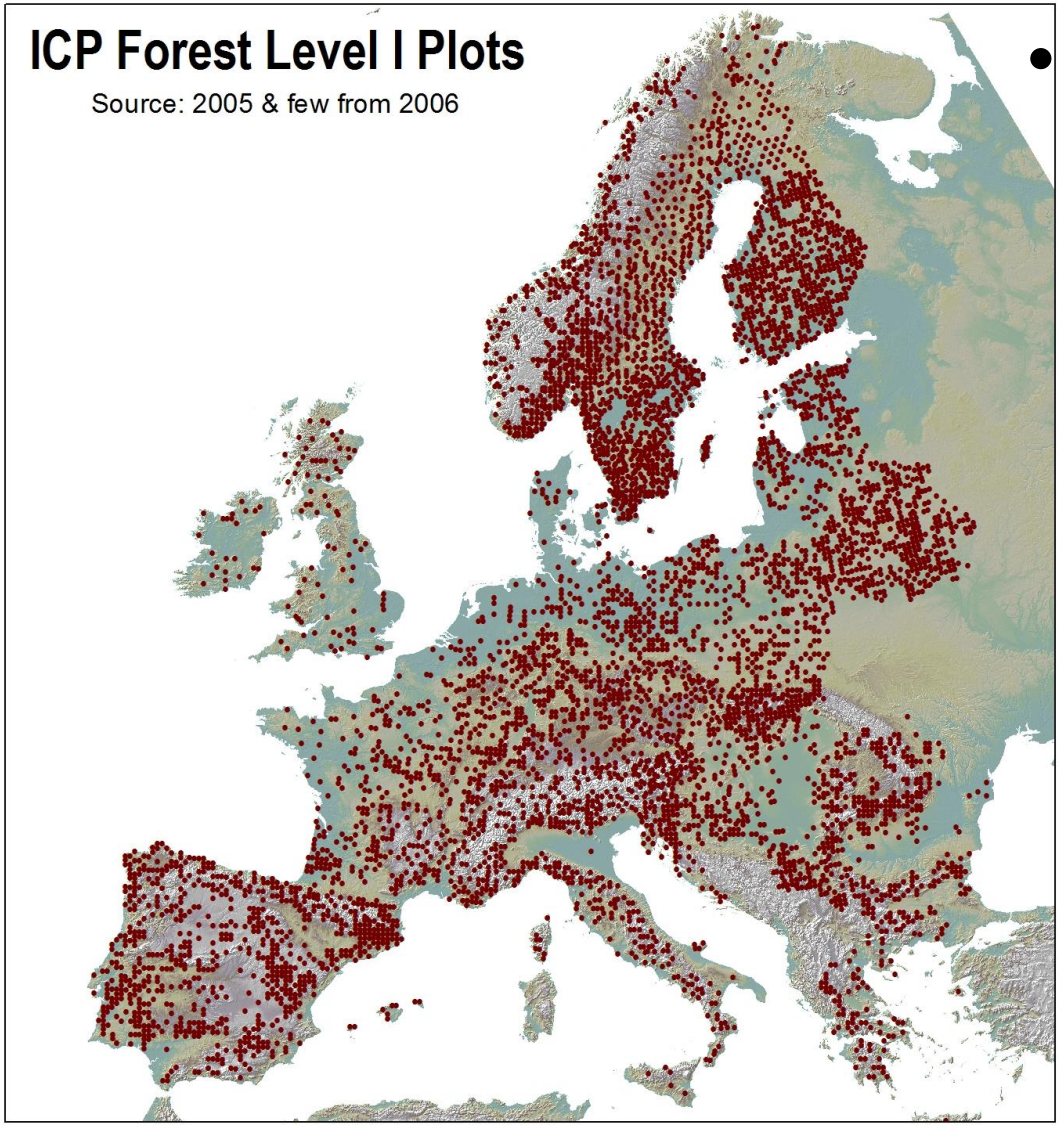
- The climate – today and tomorrow

SRES – IPCC Scenarios of global change

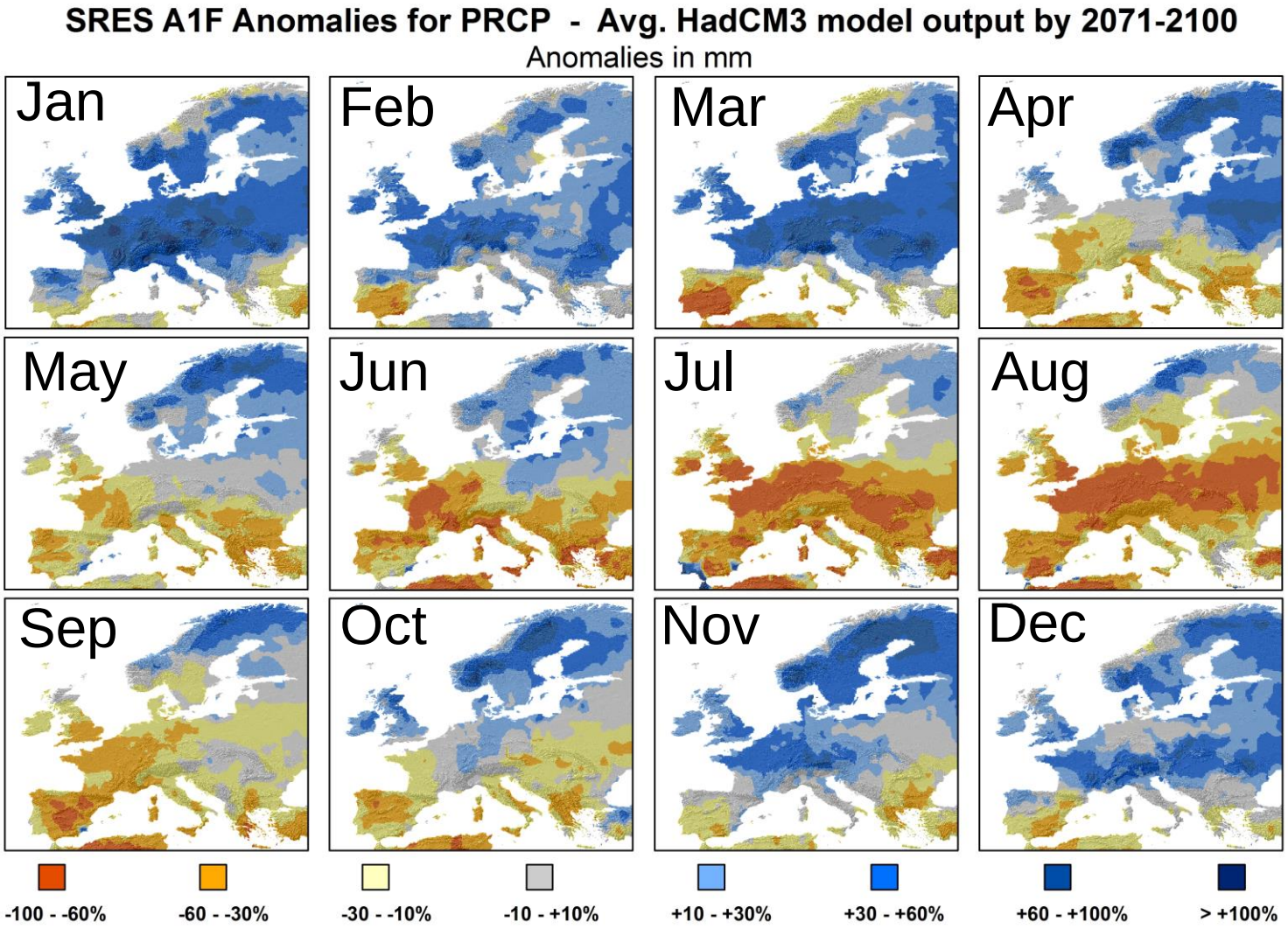


Data & Methods

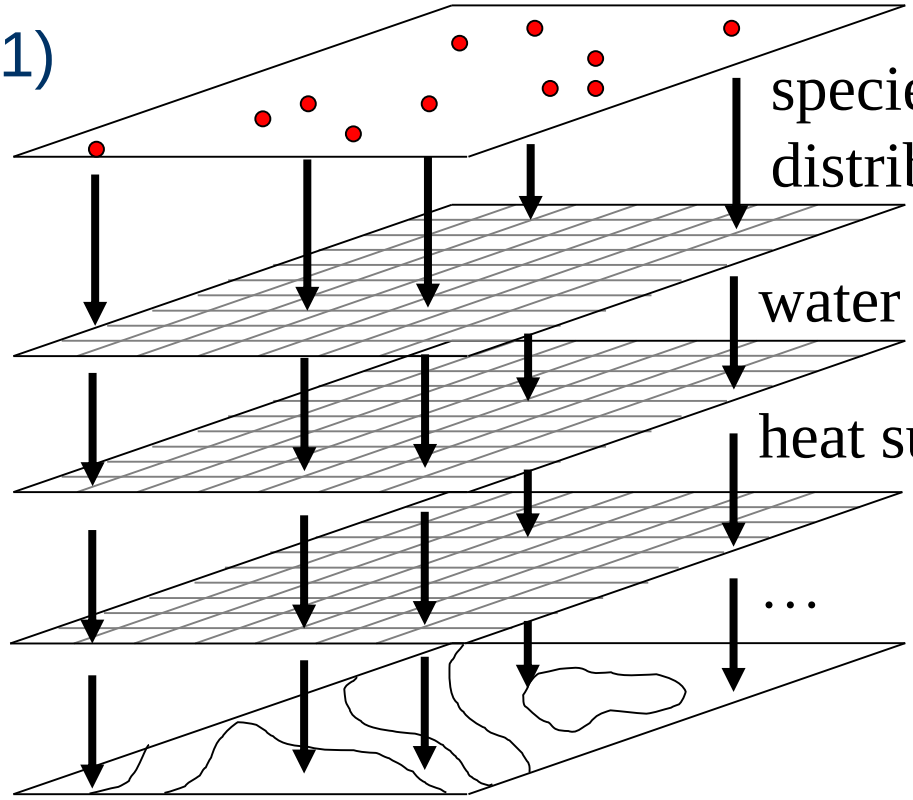
- Requirements
  - Pan-European tree distribution data
  - Sound design
  - High-resolution climate data (<1km)
  - Climate Projections into future



- Nature of data
  - 6129 plots
  - ~16km grid
  - 139 tree spp.


SRES A1F Anomalies for PRCP - Avg. HadCM3 model output by 2071-2100
Anomalies in mm
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
-100 - -60%
-60 - -30%
-30 - -10%
-10 - +10%
+10 - +30%
+30 - +60%
+60 - +100%
> +100%

(1)



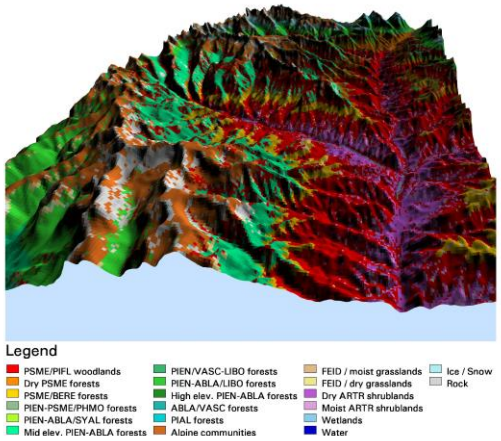
(2) *Concept and theory-based variable selection*

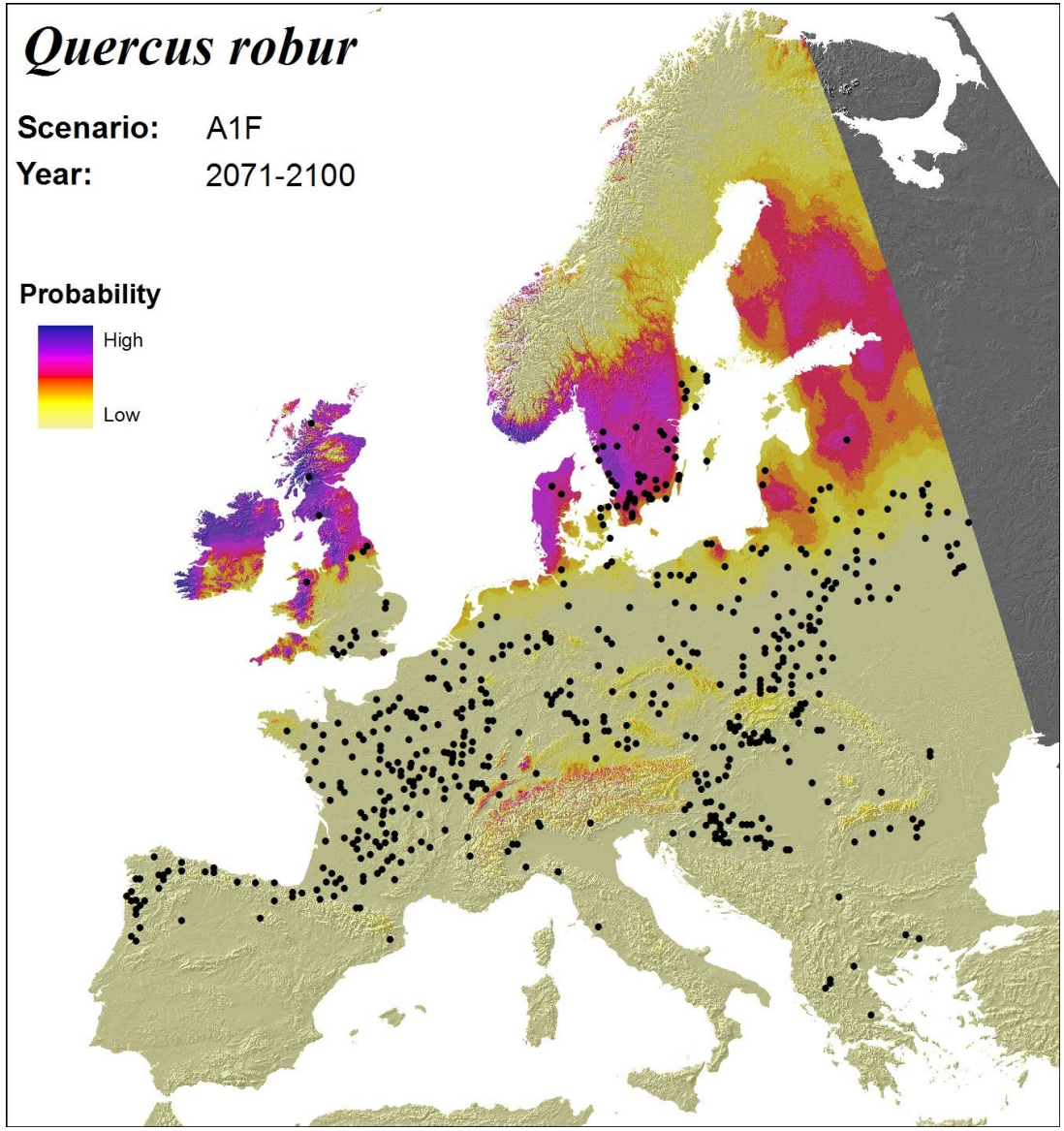
(3)

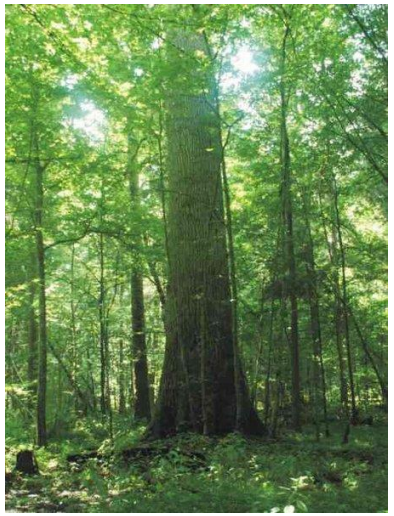
ID	Sp1	Tave	Prcp	Geol	...
1	0	3.25	1390	X	...
2	1	5.57	1840	b	...
3	1	7.21	2130	a	...
4	0	2.94	1420	Y	...
5	1	8.43	1789	a	...
...	...	...	...	...	...

(4) $P(\text{Sp1}) = f(\text{Tave,Prcp,Geol,...})$

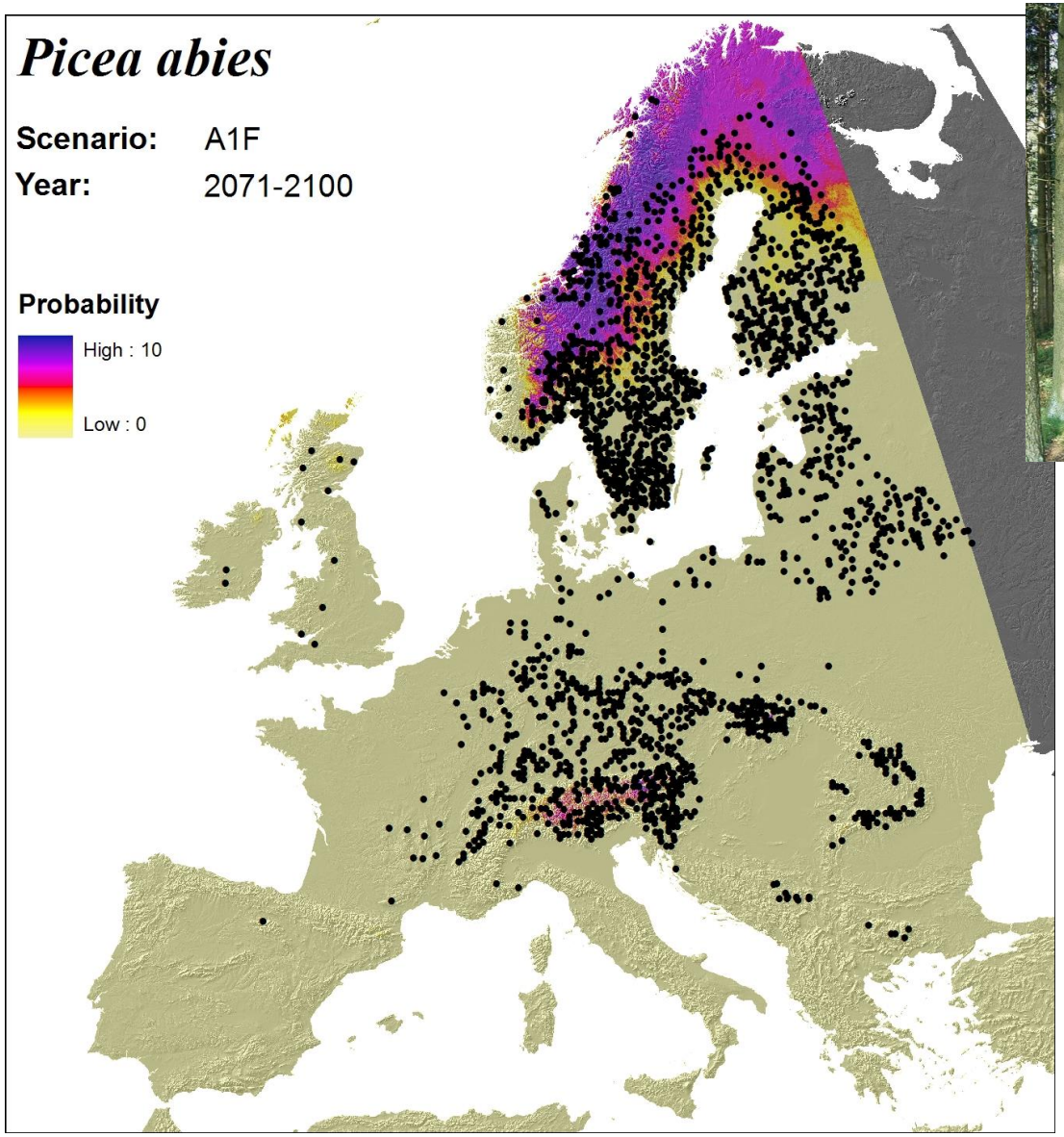
(5)

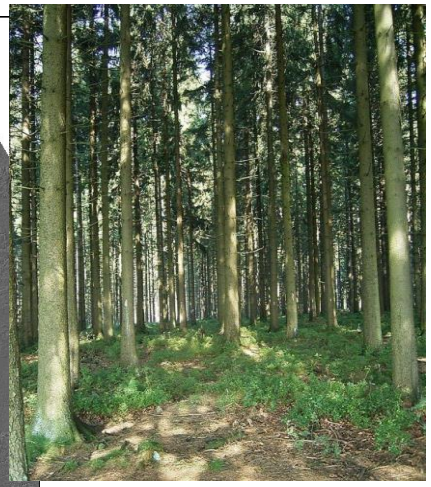




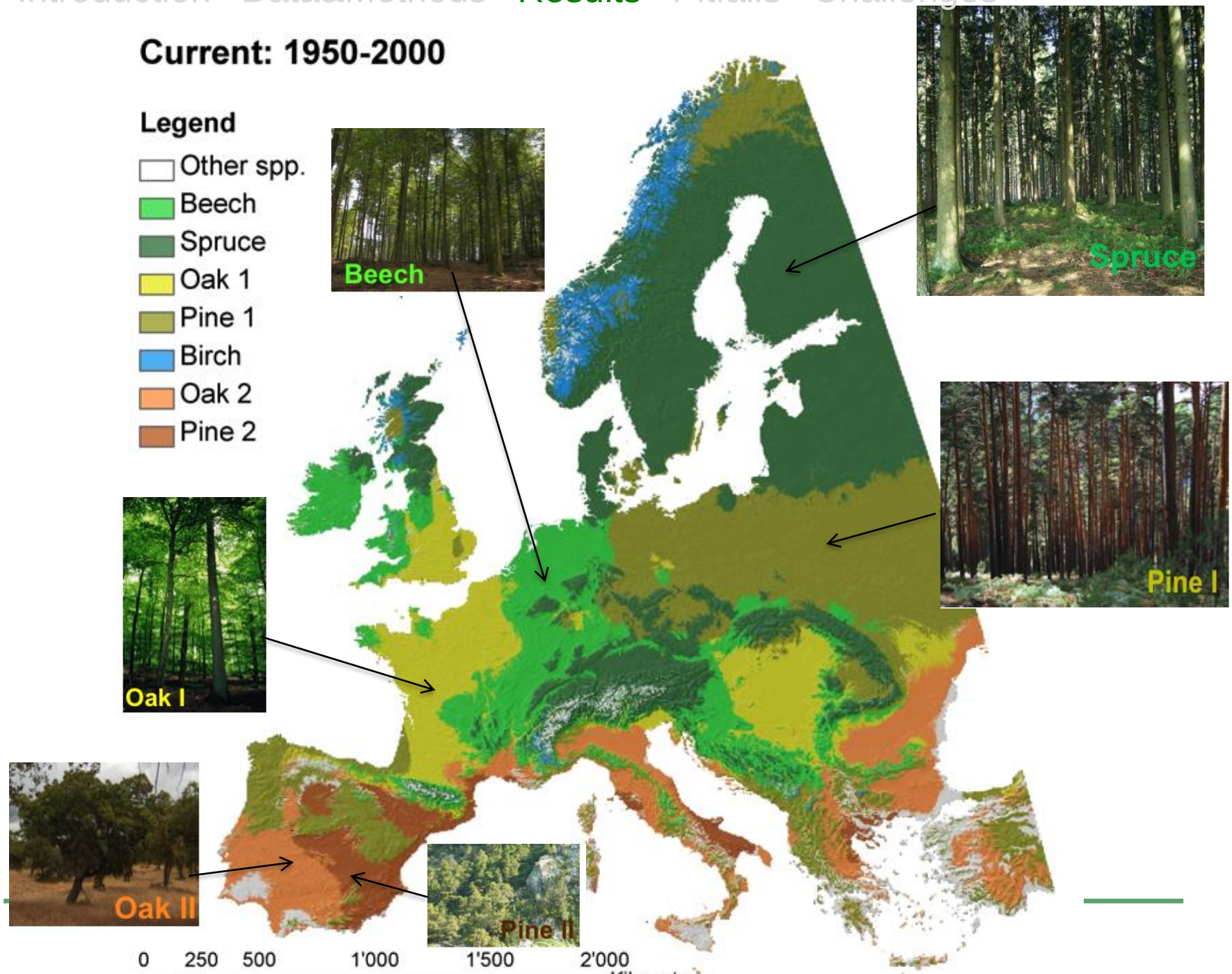


Potential future ranges



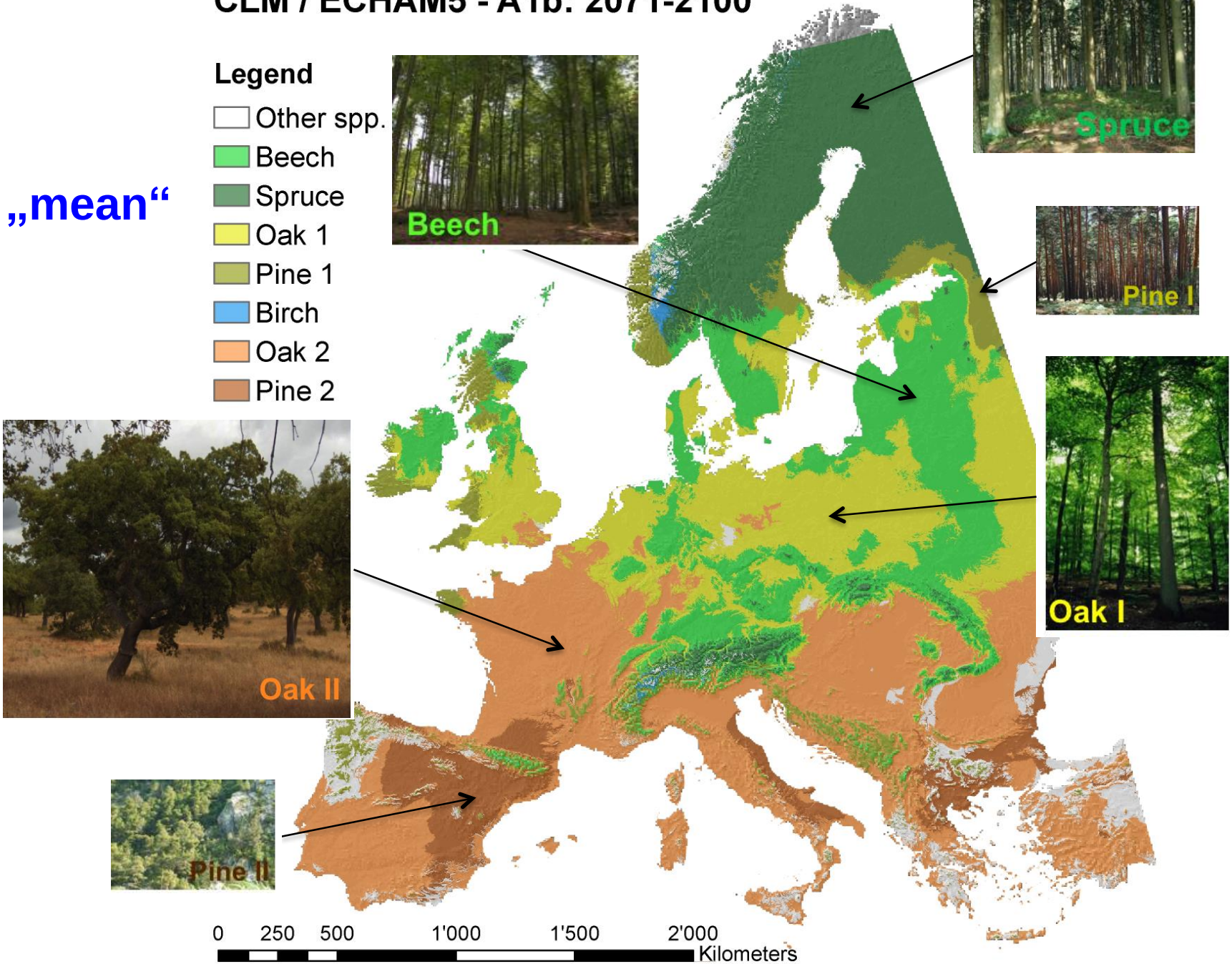


Potential future ranges


Current: 1950-2000
Legend
Other spp.
Beech
Spruce
Oak 1
Pine 1
Birch
Oak 2
Pine 2
Beech
Spruce
Pine I
Oak I
Oak II
Pine II
0 250 500 1'000 1'500 2'000

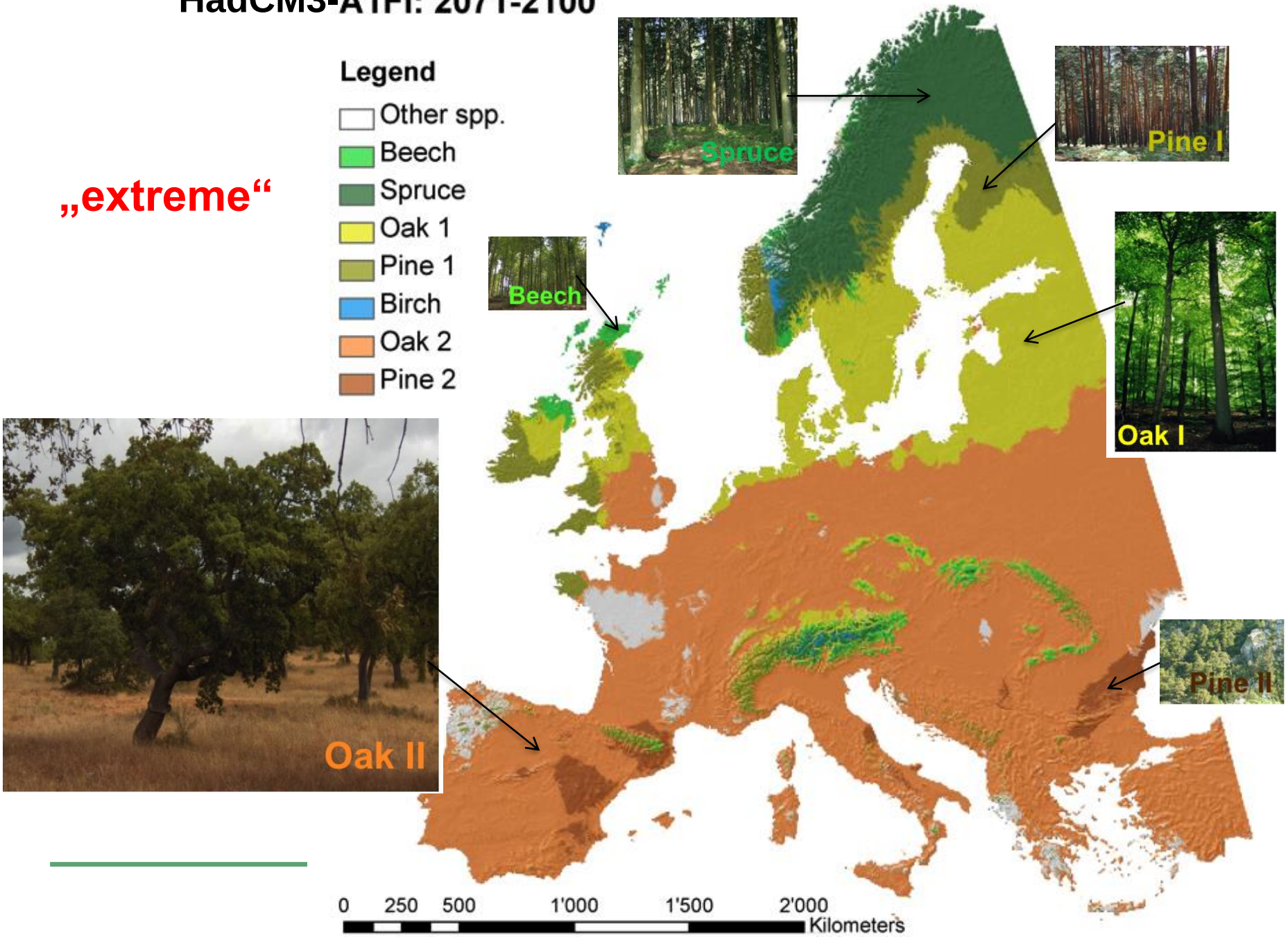
CLM / ECHAM5 - A1b: 2071-2100

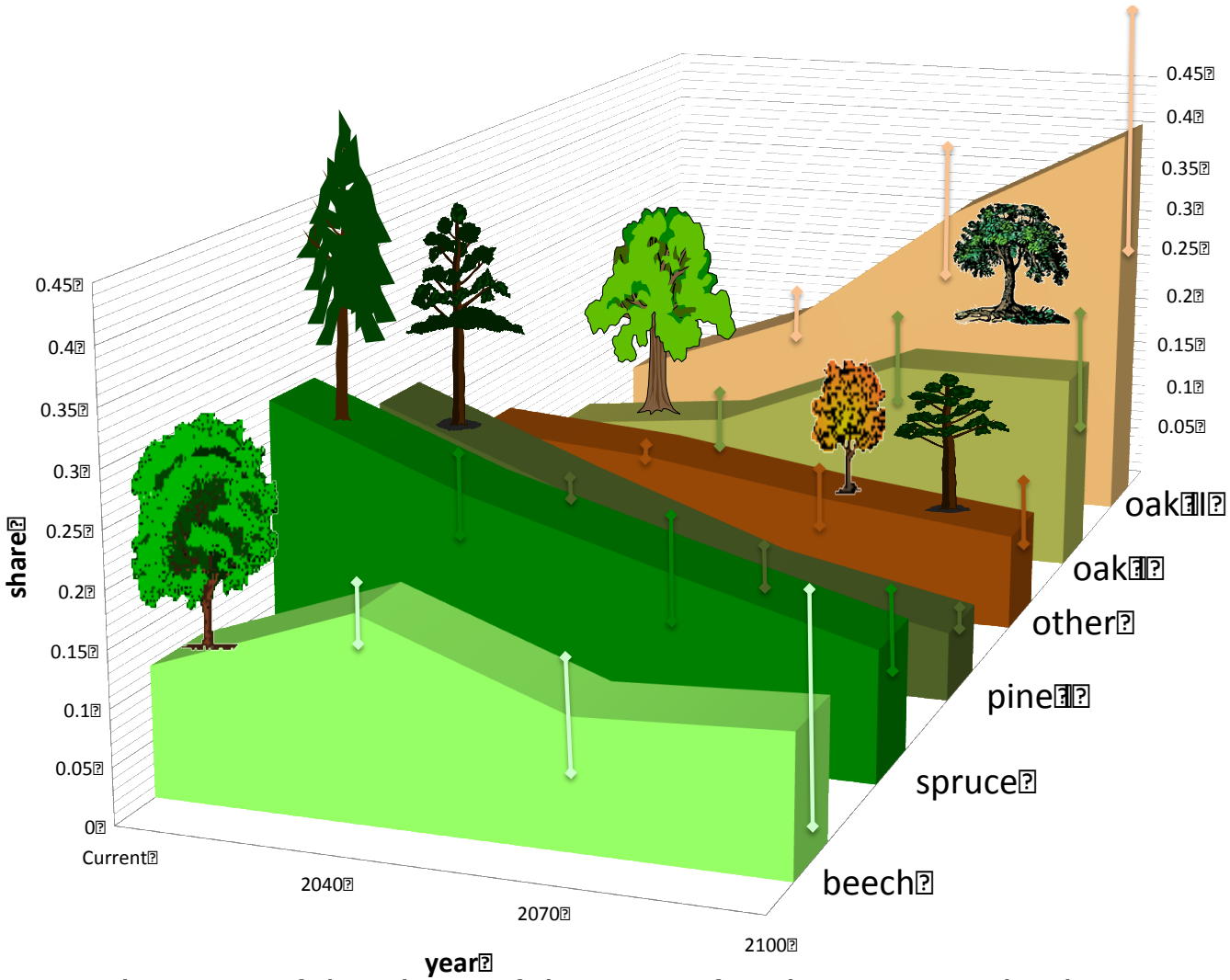
„mean“



HadCM3-A1FI: 2071-2100

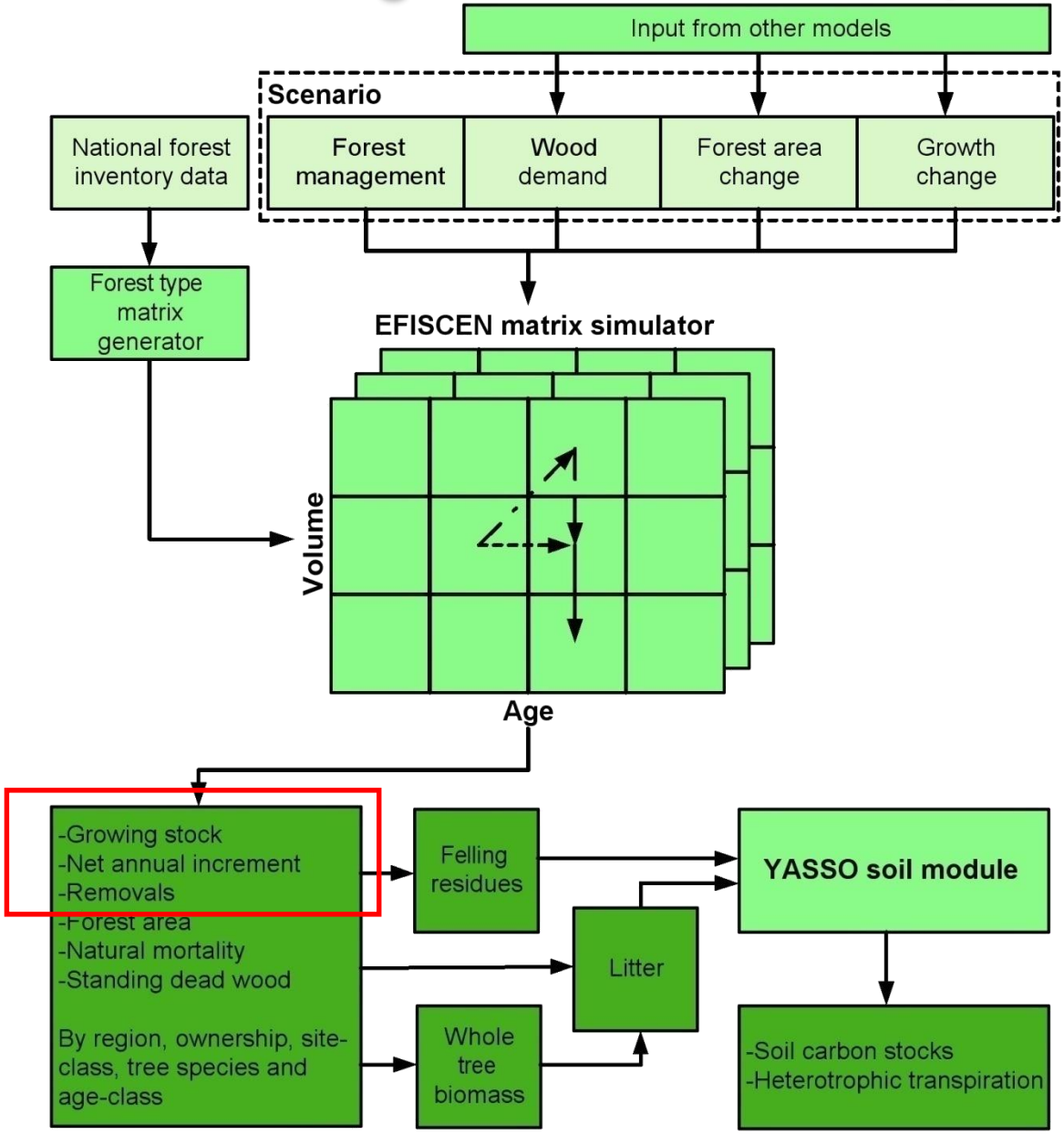
„extreme“





Development of the share of the area of major tree species in Europe under scenario A1Fi until 2100

EFISCEN modelling framework Alterra, EFI

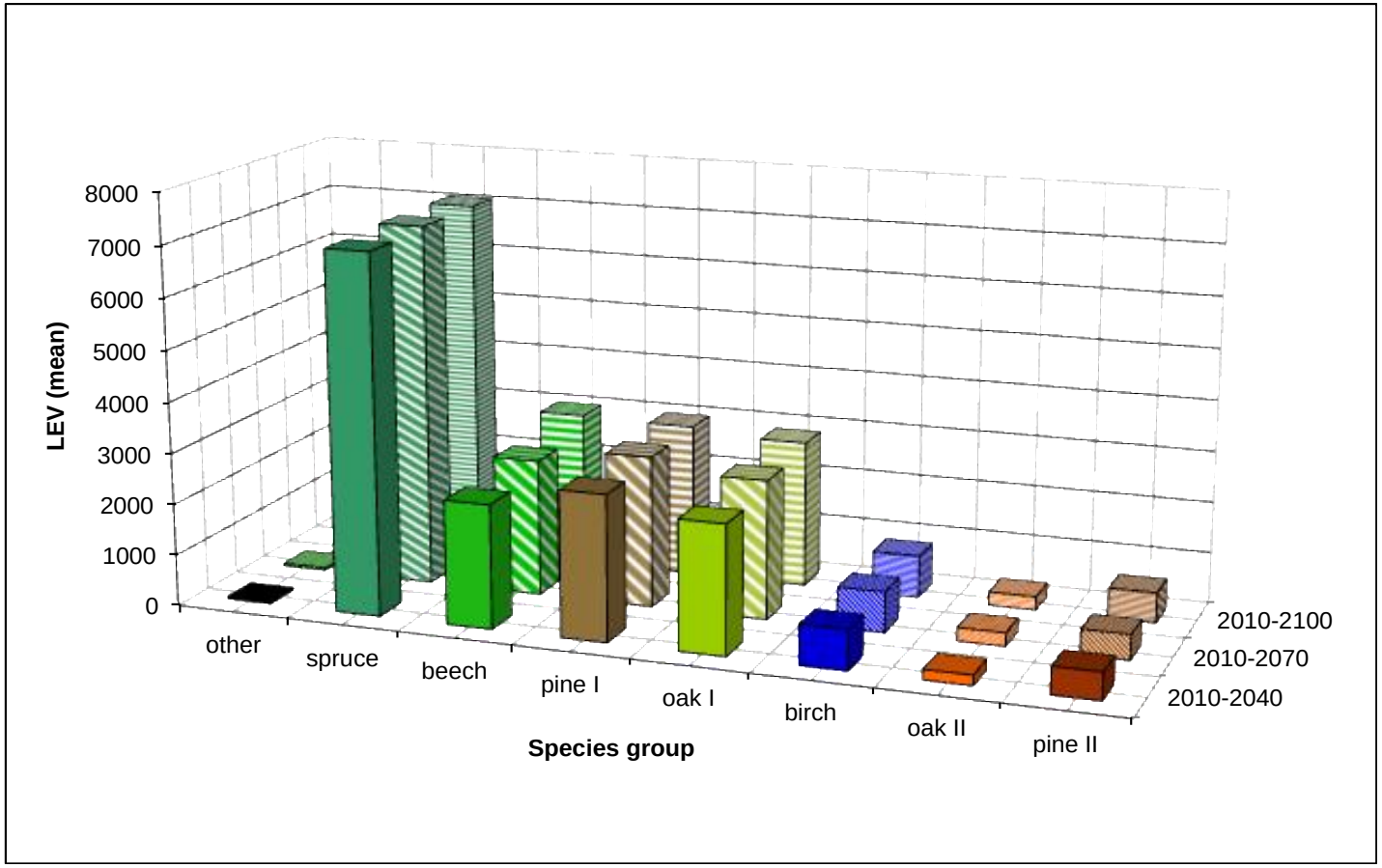


Land Expectation Value (Faustmann 1849)

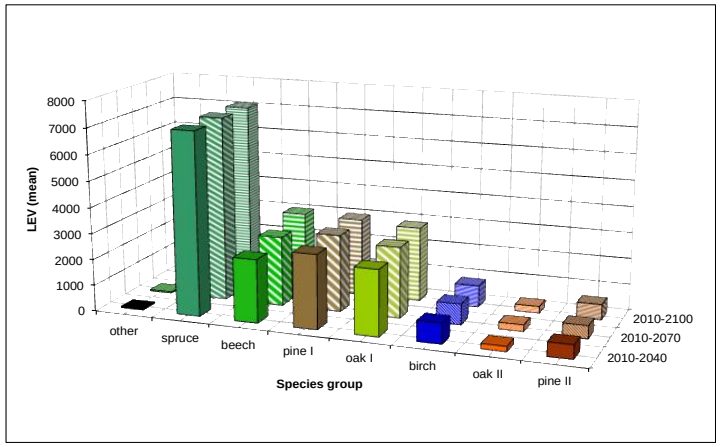
$$LEV = \frac{Fh_t + \sum_{a=1}^{t} Th_a \cdot (1+i)^{t-a} - c \cdot (1+i)^t}{(1+i)^t - 1}$$

EFISCEN

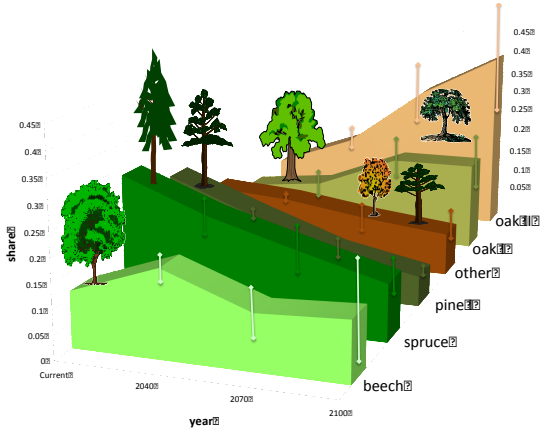
Beech AGE (t) (years)	DISCOUNT FACTORS(t)	COSTS(t) (€ * ha-1)	STUMPAGE VALUES ST(t) (€ * ha-1)	THINNINGS TH(t) (€ * ha-1)	LAND EXPECTATION VALUE LEV(t) (€ * ha-1)
0	1	1500	0,00	0,00	
10	0,90573081	550	0,00	0,00	-21196
20	0,74301473	0	-11,83	0,00	-7810
30	0,60953087	0	-66,21	-66,67	-5325
40	0,50002761	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



Land Expectation Value per ha of species area for 7 species groups calculated as moving mean for 2010 to 2100 (scenario A1FI, ir = 2%)

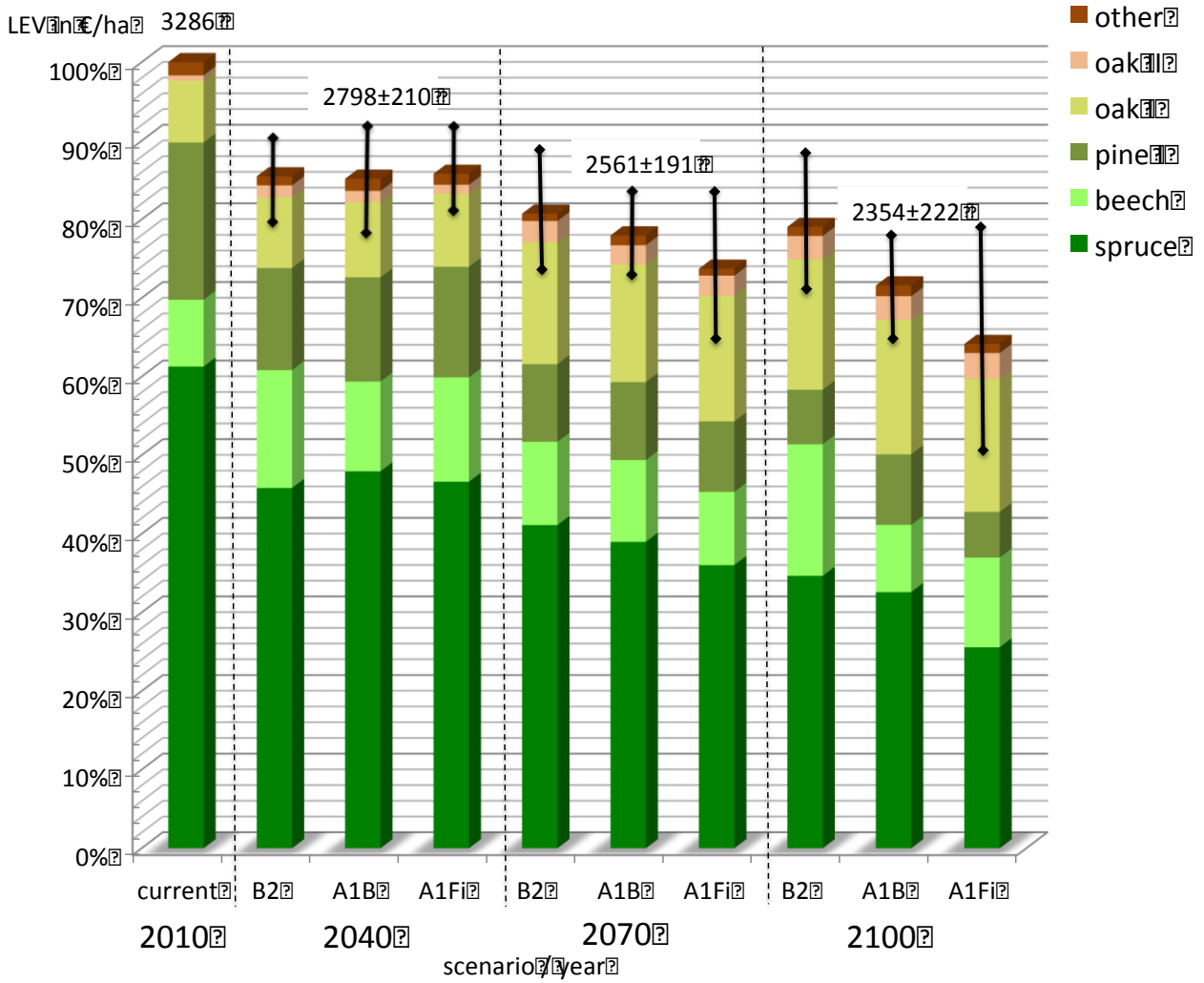

LEV (mean)
8000
7000
6000
5000
4000
3000
2000
1000
0
other
spruce
beech
pine I
oak I
birch
oak II
pine II
Species group
2010-2100
2010-2070
2010-2040

X


share
year
Current
2040
2070
2100
oak
other
pine
spruce
beech

= Loss of LEV

Land expectation values of European forest land in €/ha 2010 - 2100



2010-2100 i=0.02, price/costs - 2010

Pitfalls - uncertainties

I.

– Adaptive capacity of species – underestimated

– Speed of migration overestimated

– Change of productivity under CC

- CO2- fertilization effect
- Increase of vegetation period

II.

– Socio-economic adaptive capacities

– Dynamic market reactions

– Adaptation strategies of landowners

- Who adapts? (Blennow, Persson, Tomé, Hanewinkel (2012) Climate Change: Believing and Seeing Implies Adapting PLoS ONE 7(11)
- Change of species, management

Uncertainties

III.

– Economic background (Faustmann model): interest rate, price-cost level, cash flows, risks, …

IV.

– Modeling: Combination of biome shift, large scale scenario and economic model – assumptions, error propagation !
– Additional effects: Carbon sequestration, biodiversity, other forest goods and services!

Challenges - research questions

I. Effects of disturbances

– Large scale (pan-European –including Russia !!) risk modeling

– Increased productivity vs. increase of disturbances

– The role of extreme events

II. New economic models

– Modeling of market reactions

– Integration with dynamic vegetation models

– Include/reveal uncertainties (Bayesian calibration)