

Sustainable forest management under climate change: Adaptation strategies based on a comprehensive vulnerability assessment



**University of Natural Resources
and Applied Life Sciences, Vienna**
Department of Forest and Soil
Sciences

Rupert Seidl, Werner Rammer, Manfred J. Lexer
Institute of Silviculture, BOKU Vienna, Austria

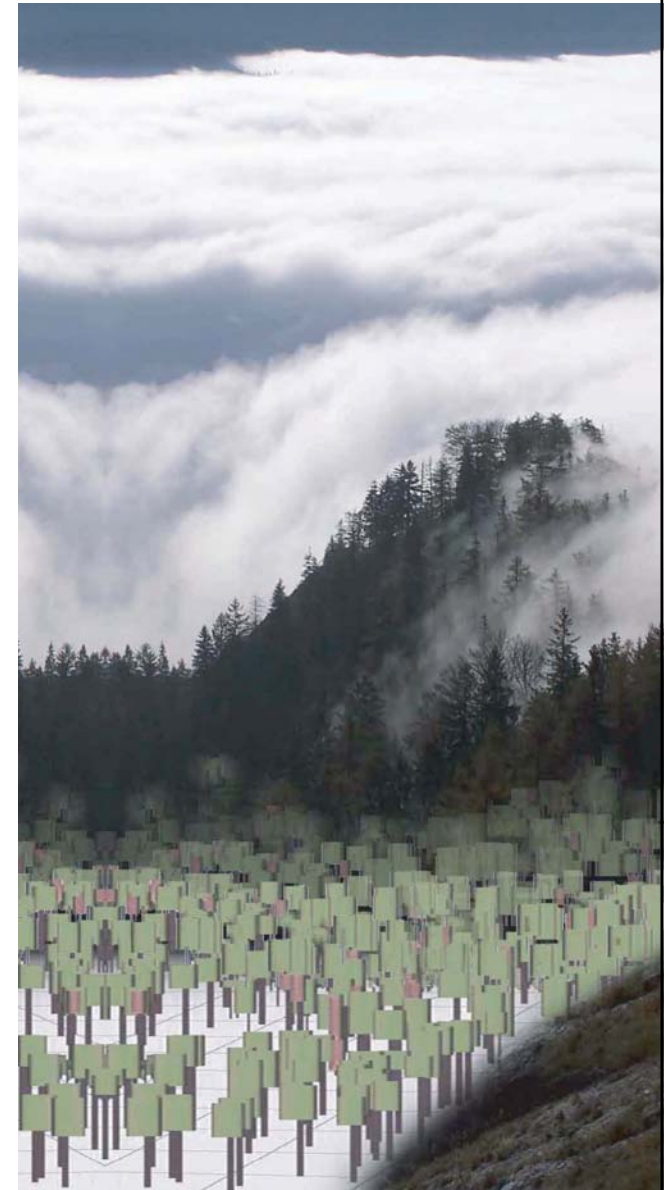
2008-10-16

CFS Climate Change Seminar Series



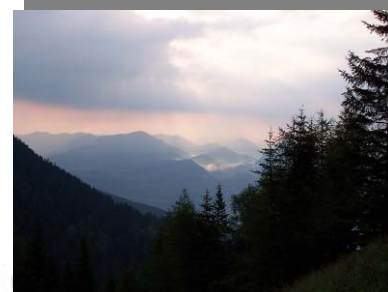
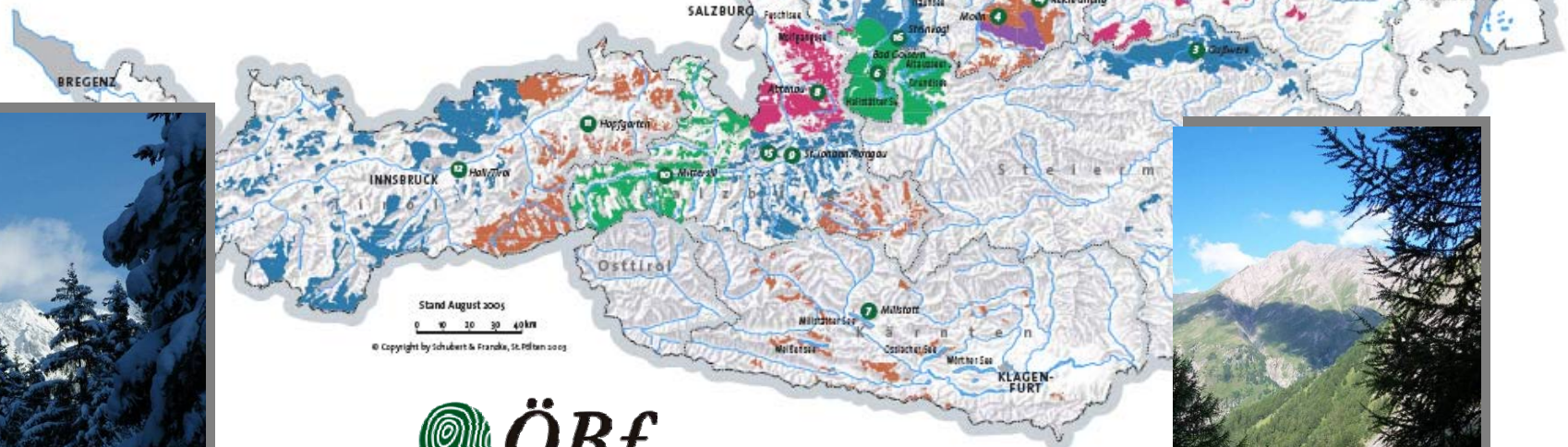
outline

- background, motivation
- vulnerability assessment
 - concept
 - material
 - results under business as usual management
- adaptive management
 - design
 - evaluation
- discussion / outlook



background

- Austrian Federal Forests ÖBf
 - ca. 590,000 ha
 - ~15% of Austrias forest area
 - predominantly mountain forests
 - timber production main mgmt objective on ~368,000 ha



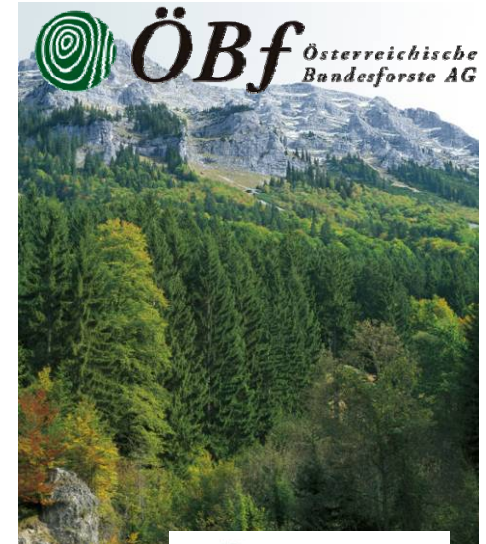
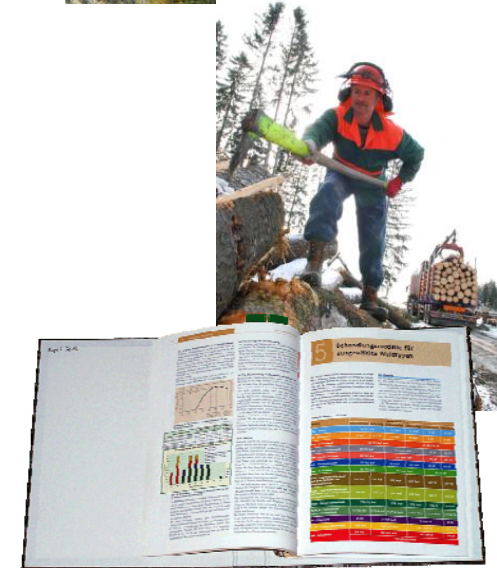
 **ÖBf**



motivation

- objectives
 - *HOW* vulnerable?
 - *WHERE* are hotspots?
 - *WHEN* will impacts exceed thresholds?
 - *WHAT* to do about it? → adaptation

- assessment framework fundamentals
 - science-based
 - context: sustainable forest management (SFM)
 - stakeholder involvement
 - imperative: decision support for operational management



climate change vulnerability

- „vulnerability: what's in a word?“ (O'Brien et al. 2004)

four stages of climate change vulnerability assessment (Füssel and Klein 2006)

impact assessment

1st generation vulnerability

2nd generation vulnerability

adaptation policy framework

role of adaptation

bottom line: no generally agreed on and operational definition

vulnerability indicators – a stakeholder process

methods (1)



sustainability indicators

the MCPFE

Ministerial Conference on the Protection of Forests in Europe

The MCPFE is a high level political initiative towards the protection and sustainable management of forests throughout the region.



Nachhaltige Waldwirtschaft in Österreich

Österreichischer Waldbericht 2004



cc-sensitivity

stakeholder

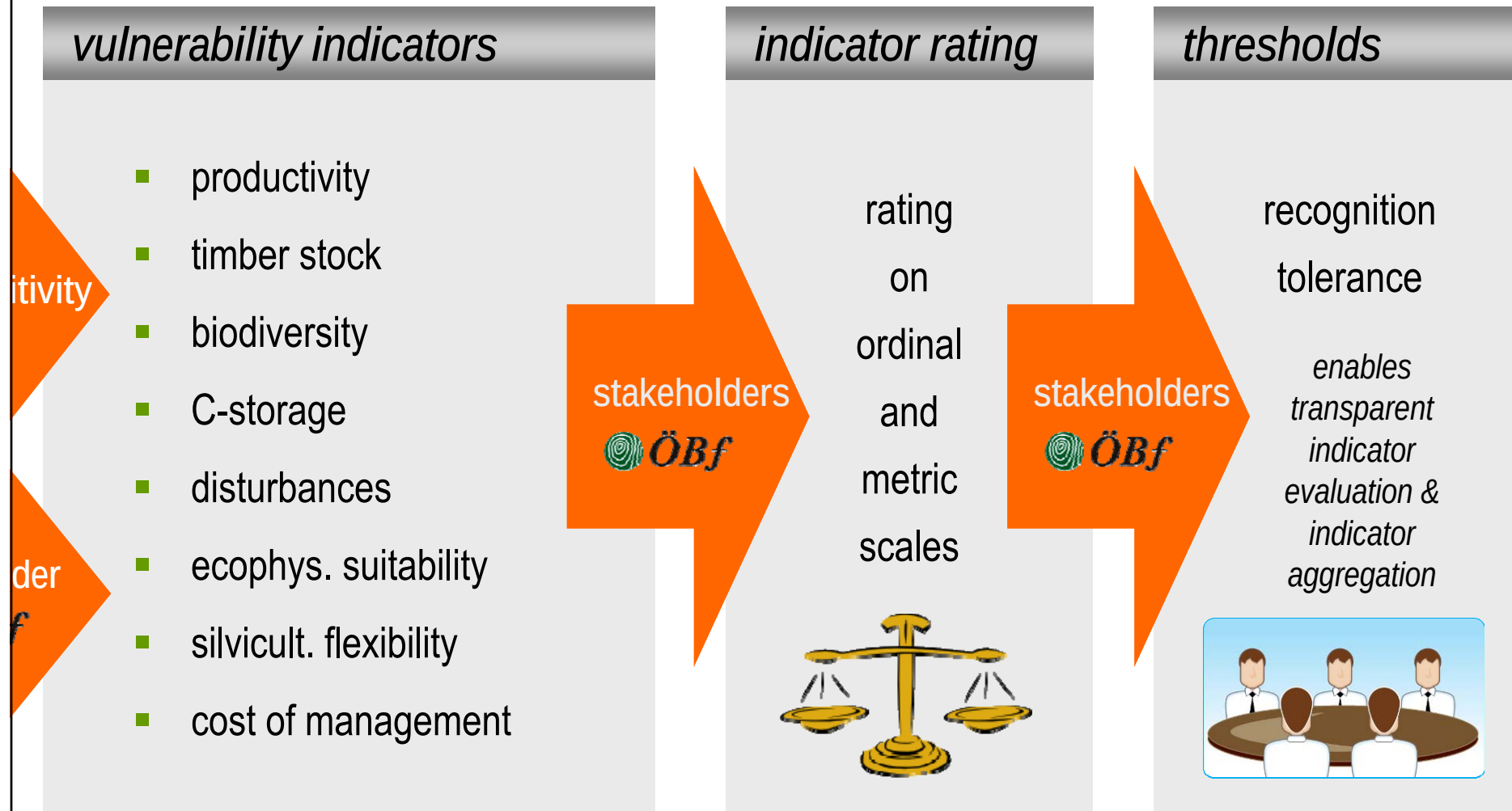


vulnerability indicators

- productivity
- timber stock
- biodiversity
- C-storage
- disturbances
- ecophysiological suitability
- silvicultural flexibility
- management cost

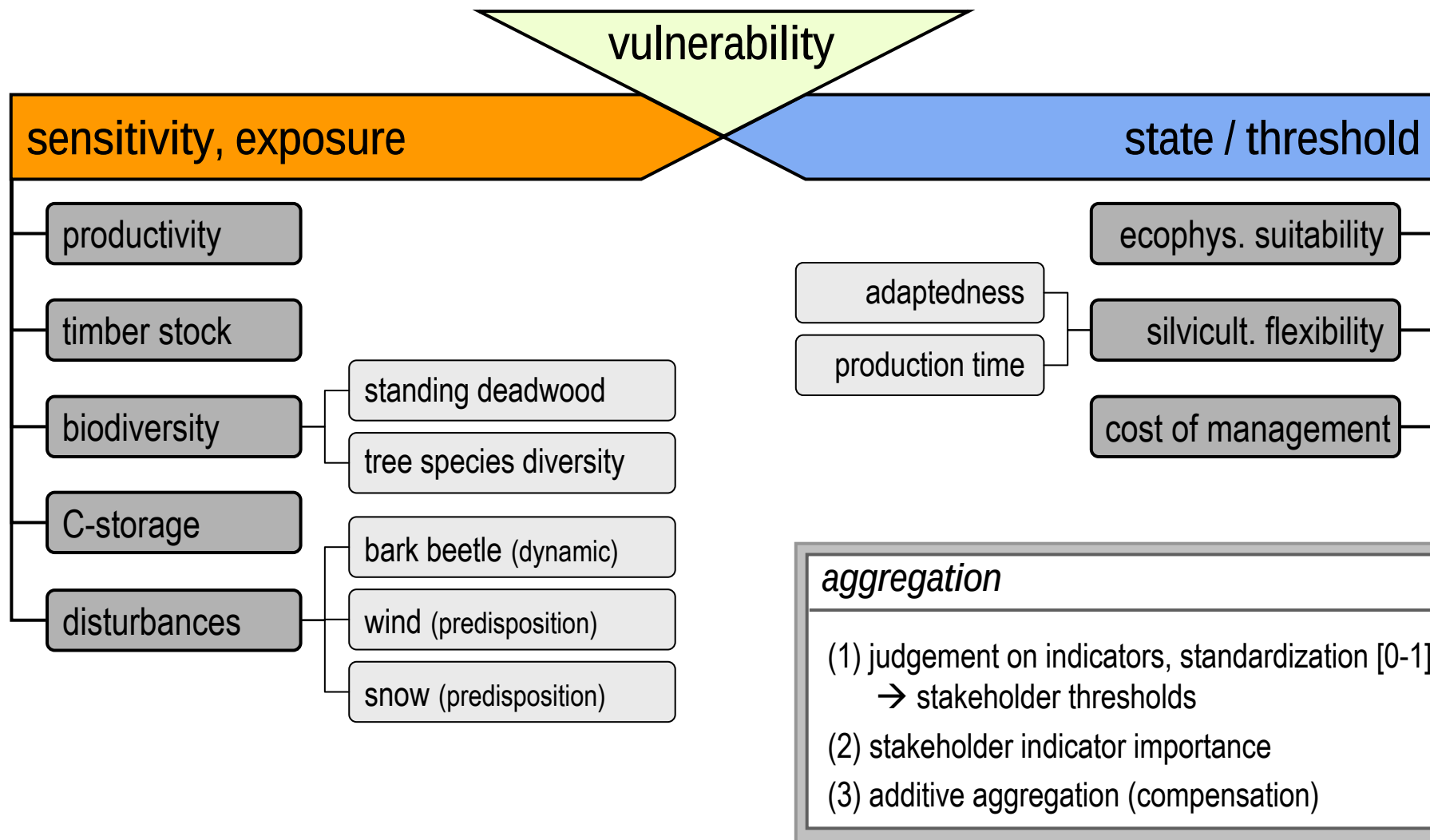
vulnerability indicators – a stakeholder process

methods (2)



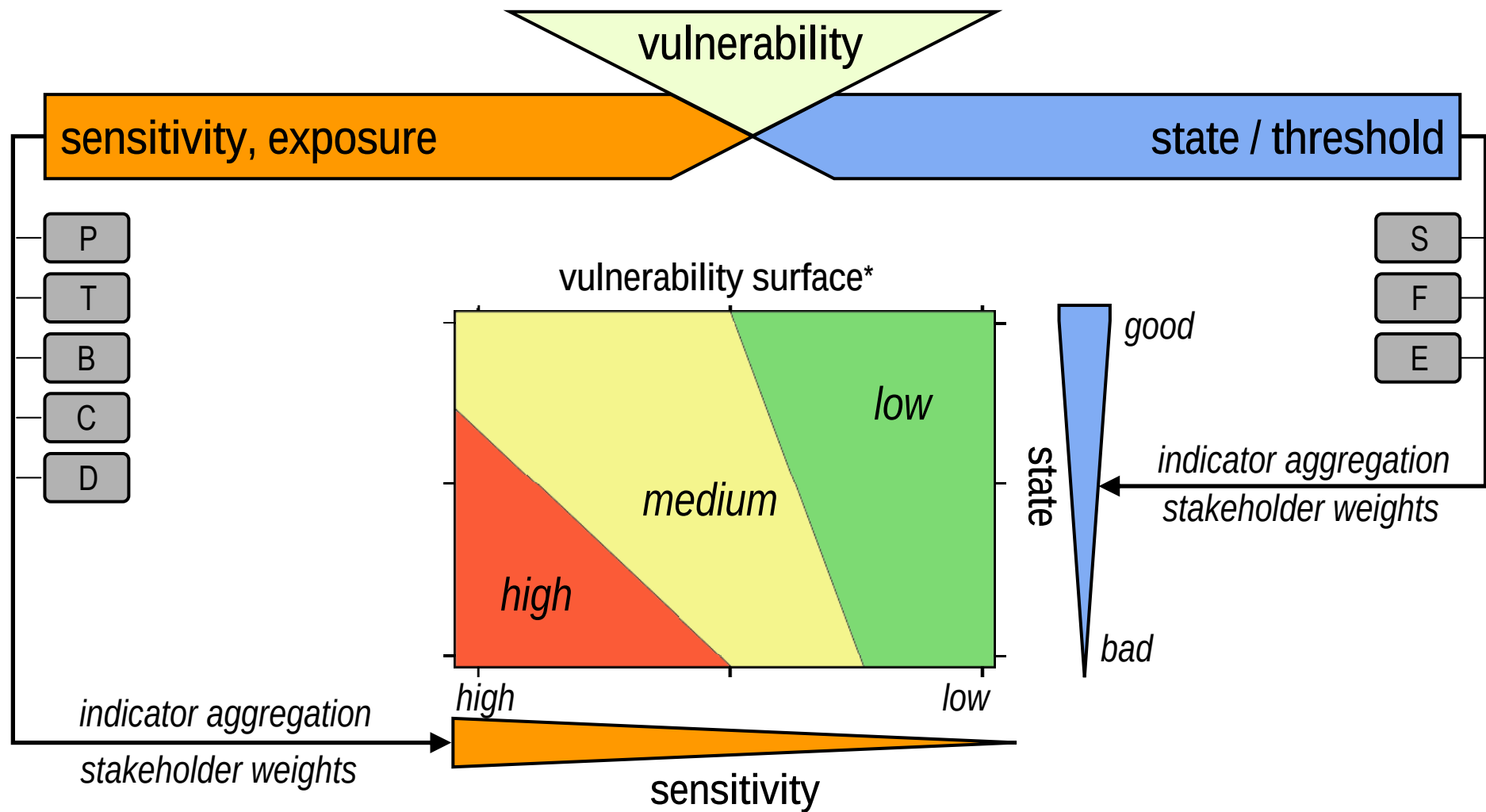
dimensions of vulnerability

methods (3)



vulnerability assessment scheme

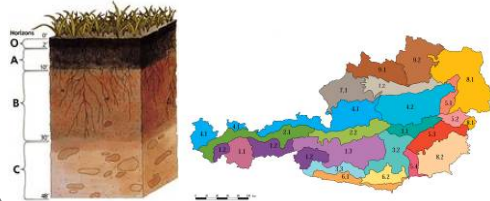
methods (4)



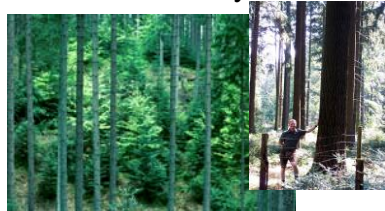
* cf. Luers (2005)

study design

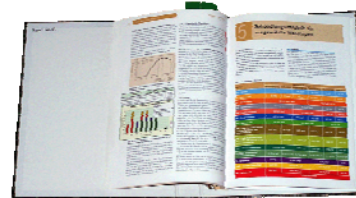
site and climate conditions



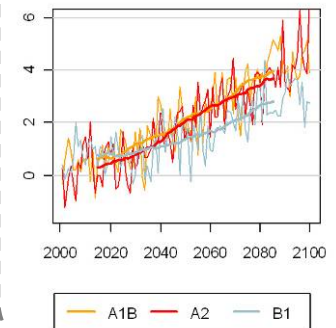
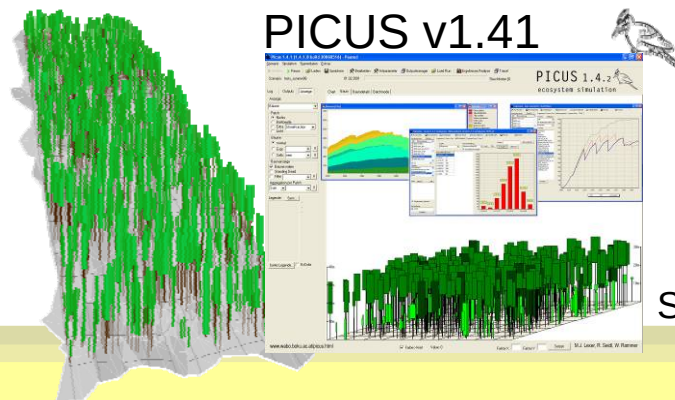
forest inventory



management



climate scenarios



Seidl et al. (2005, 2007)

sensitivity, exposure



state / threshold

VULNERABILITY

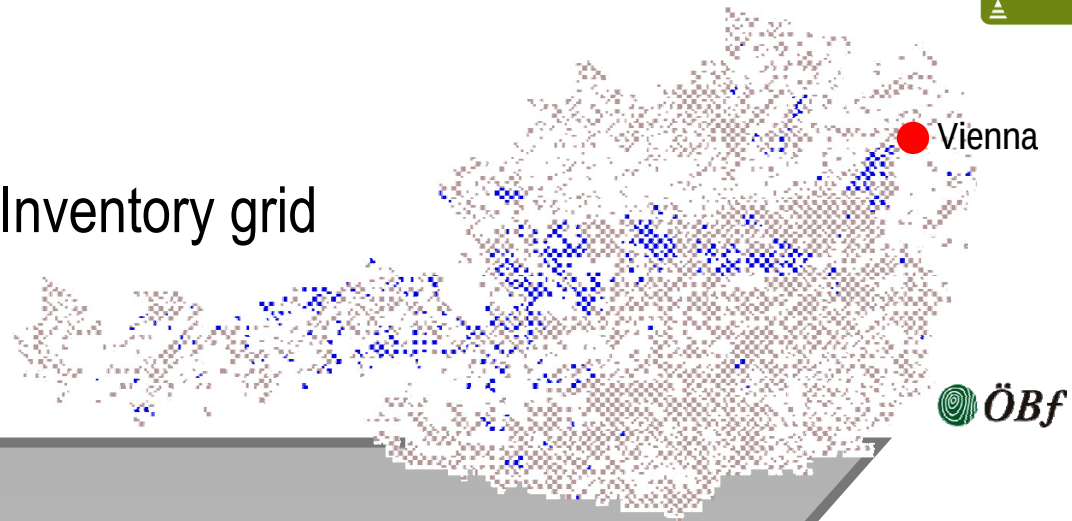
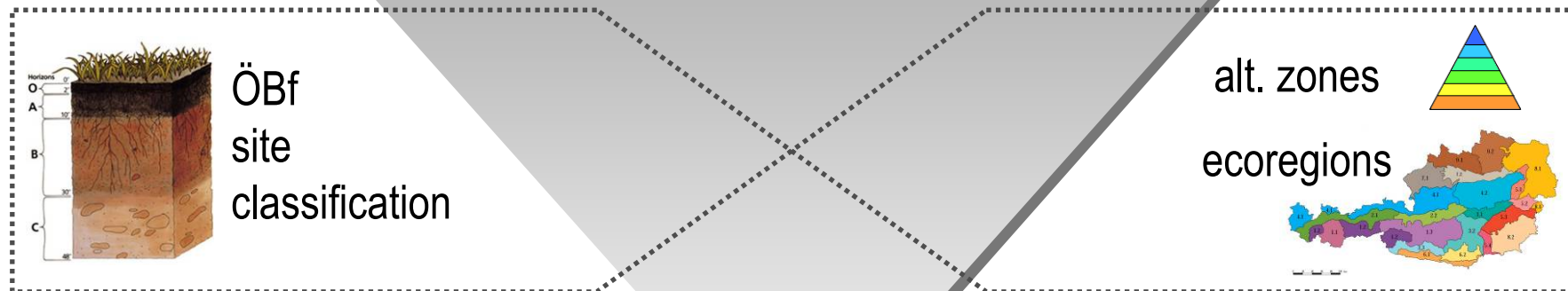
database

material (1)



National Forest Inventory grid

- climate data
- soil data



52 representative study sites

initialization & scenarios

material (2)



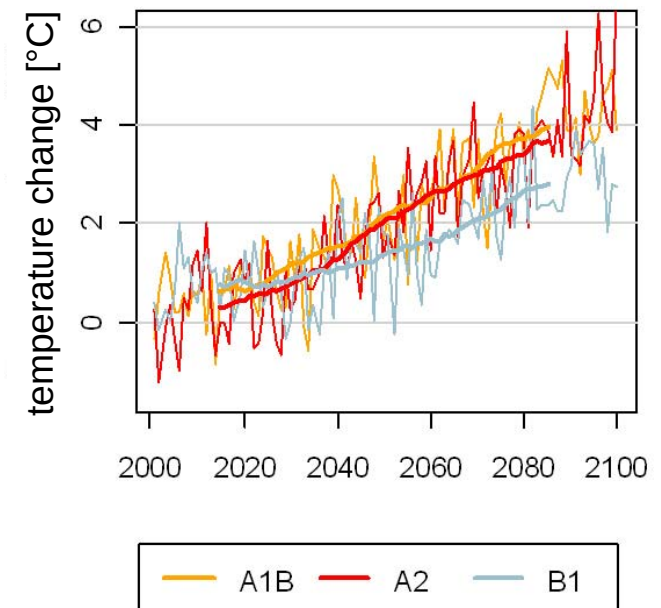
■ initial stand conditions

- ÖBf forest inventory (stand level)
- most abundant tree species mixture types per site
- two development stages per site and mixture
- current management (business as usual)



■ climate scenarios

- scope: 21st century
- baseline: de-trended, 1961-1990
- three climate change scenarios (ECHAM 5 AR4)
- statistically downscaled to NFI-plots
- SRES scenarios A1B, A2, B1

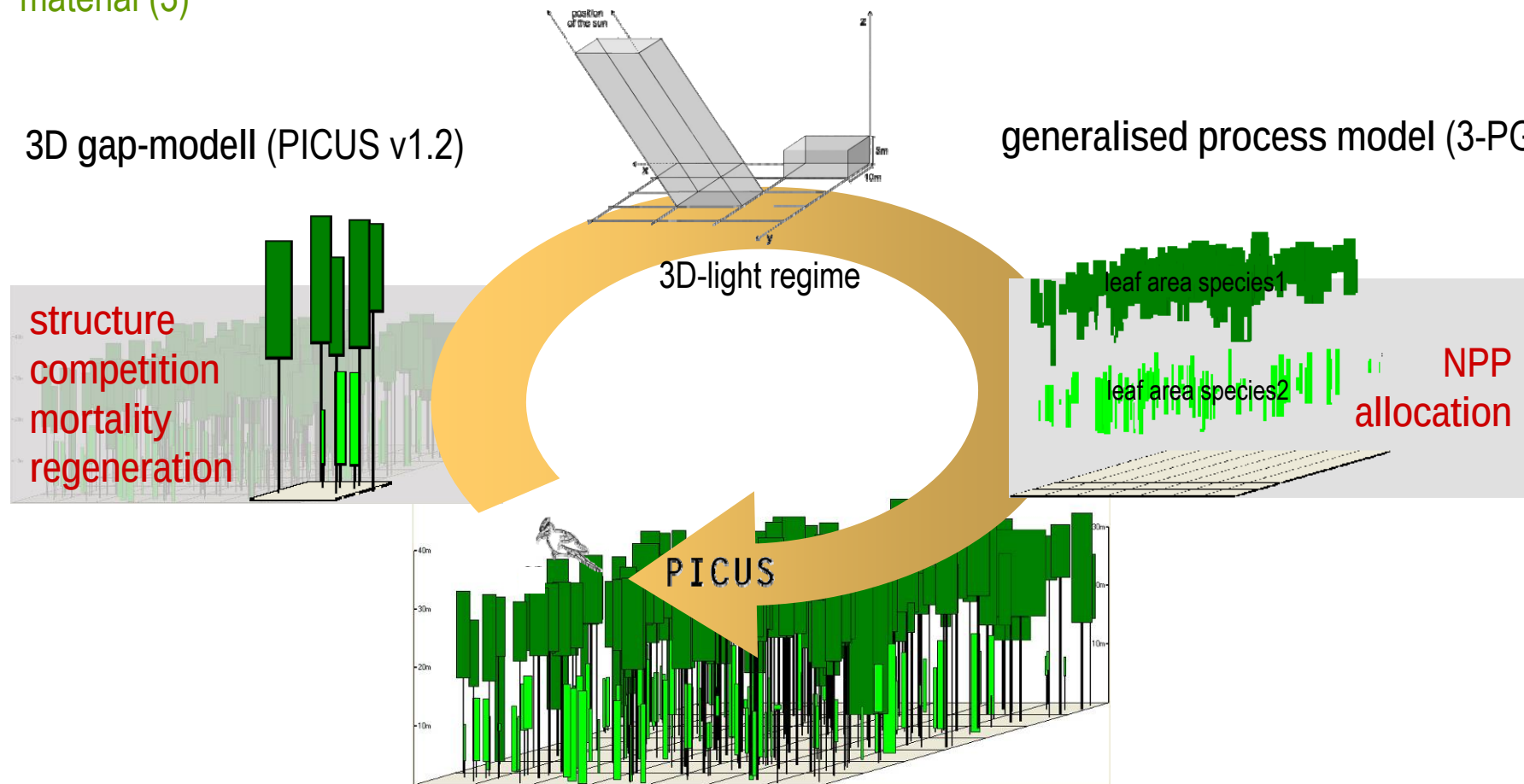


the hybrid model PICUS v1.4

material (3)

3D gap-modell (PICUS v1.2)

generalised process model (3-PG)

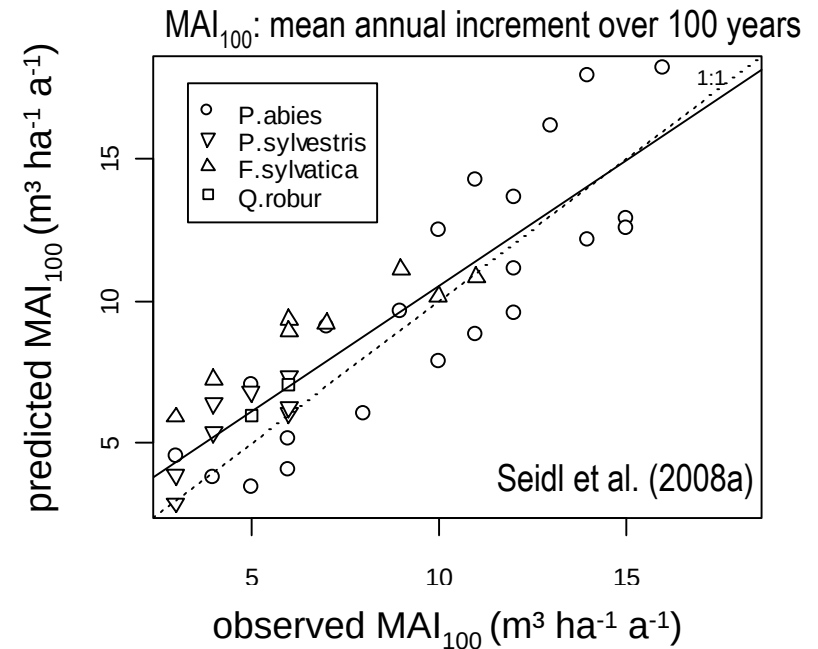
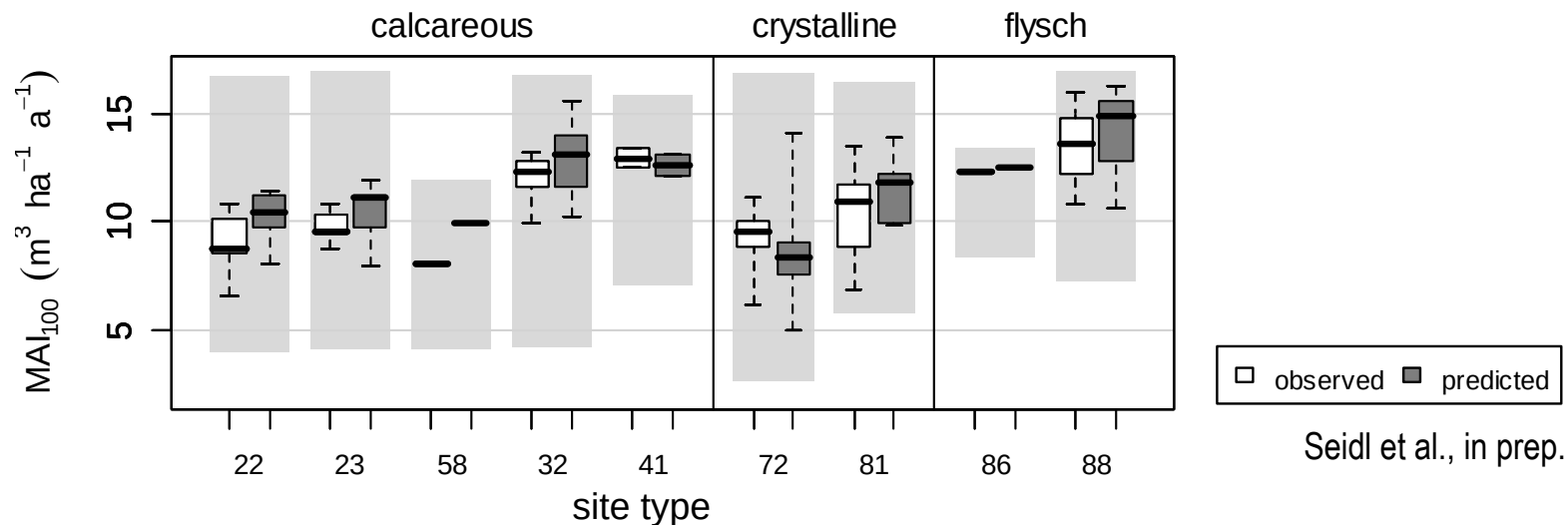


- thoroughly evaluated for the study region (e.g., Seidl et al. 2005, 2007, 2008a)
- applied in climate change impact assessments (e.g., Lexer et al. 2002, Seidl et al. 2008b)

model evaluation

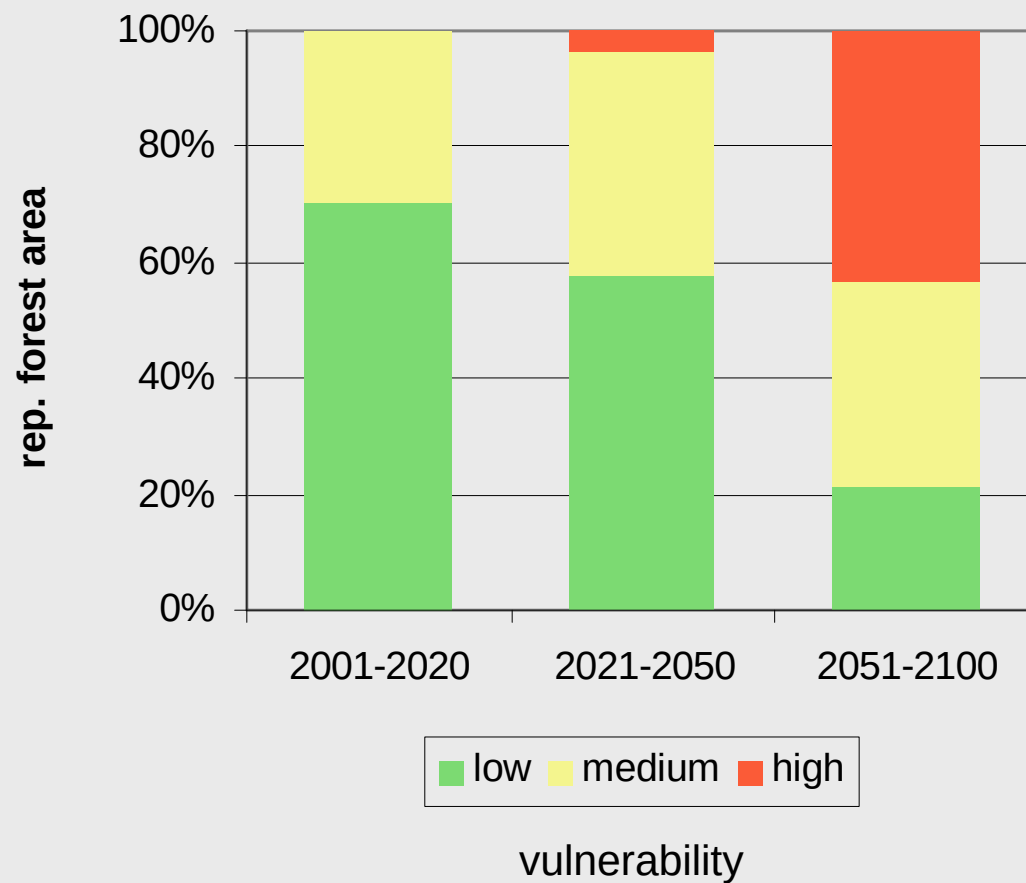
material (4)

- against independent data
 - selected forest inventory plots
- do simulations represent site types?
 - shown here for Norway spruce



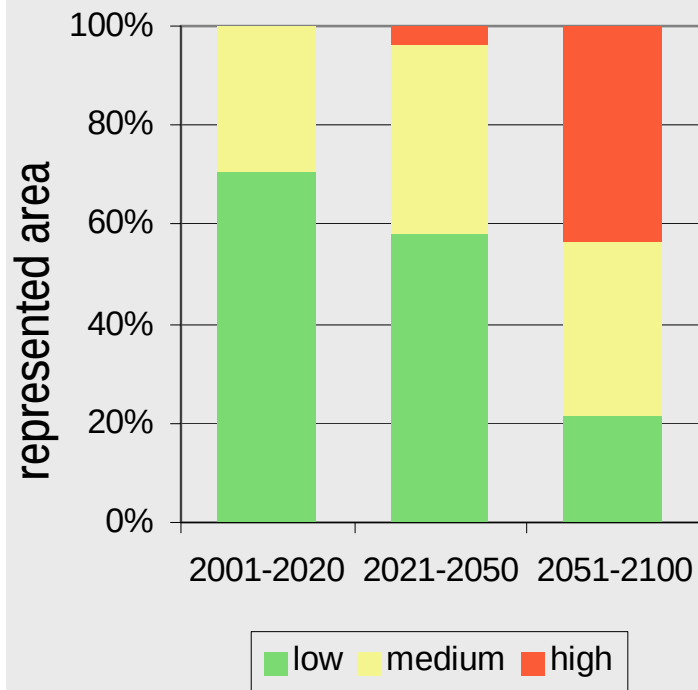
vulnerability under current management

business as usual management

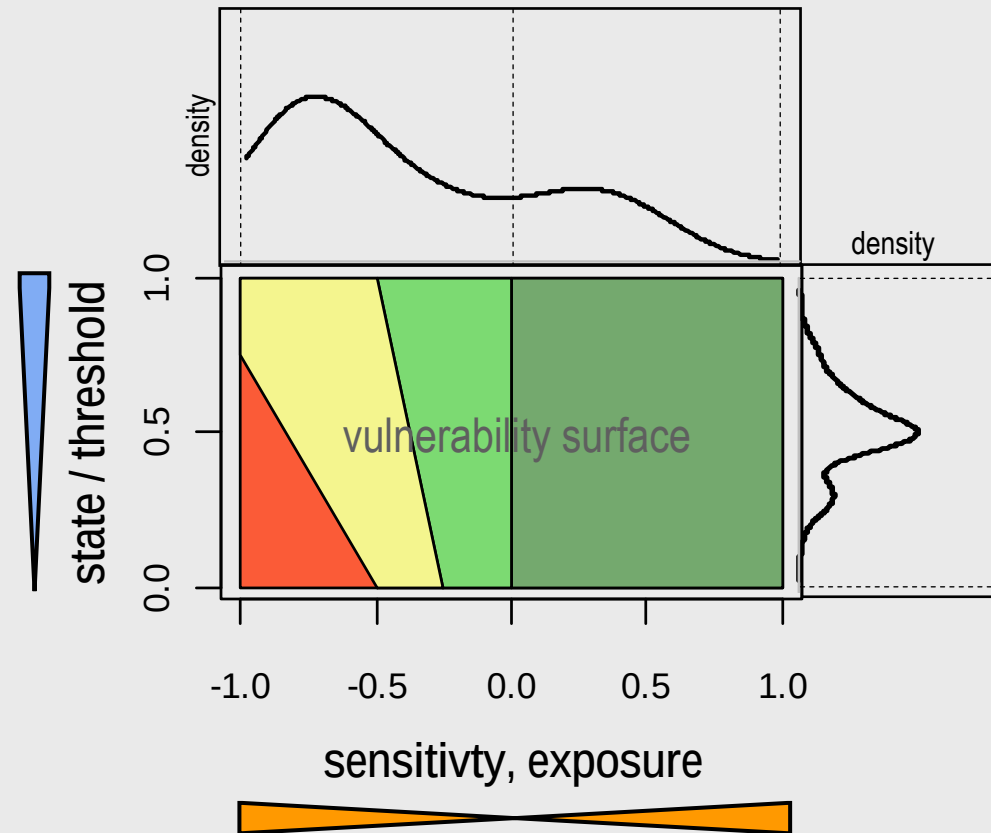


vulnerability under current management

over time



distribution in dimensions (2051-2100)



vulnerability – lowland spruce

example 1

site description

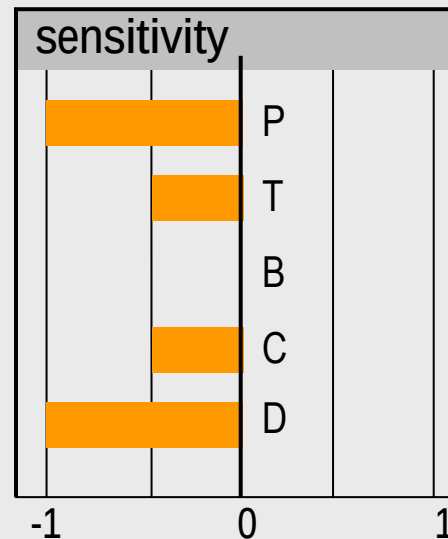
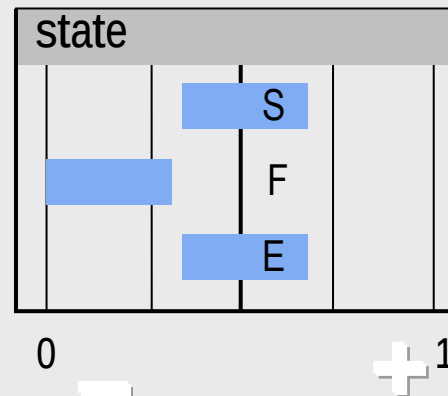
- pre-alpine foothills
- submontane
- Norway spruce forest



P ... productivity
T ... timber stock
B ... biodiversity
C ... C-stock
D ... disturbances

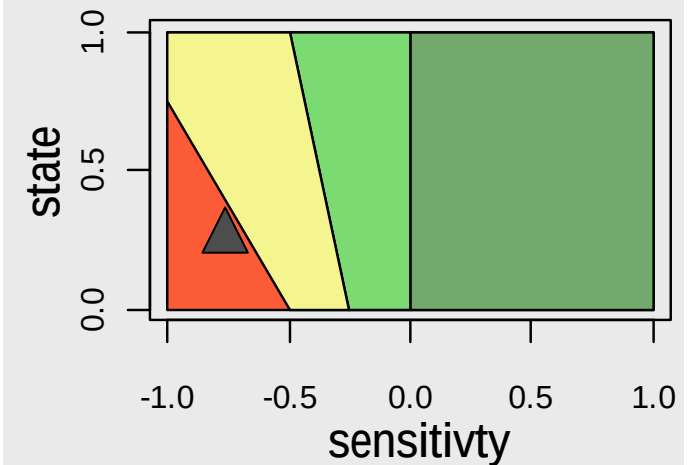
S ... suitability
F ... flexibility
E ... cost

vulnerability profile



vulnerability

period: 2051-2100



vulnerability – montane spruce

example 2

site description

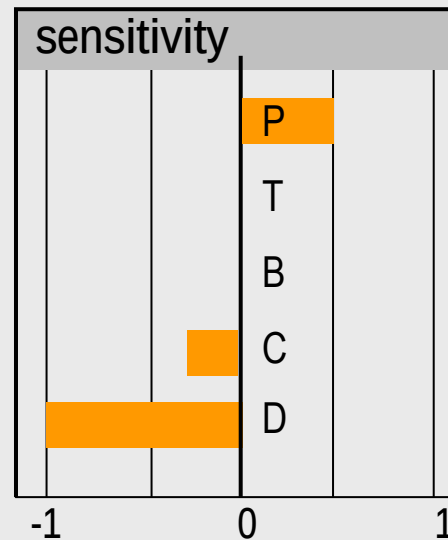
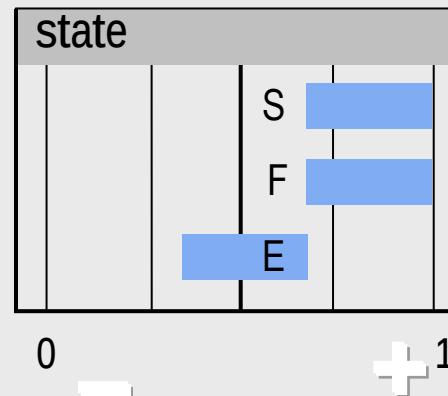
- inner Alps
- high montane
- Norway spruce forest



P ... productivity
T ... timber stock
B ... biodiversity
C ... C-stock
D ... disturbances

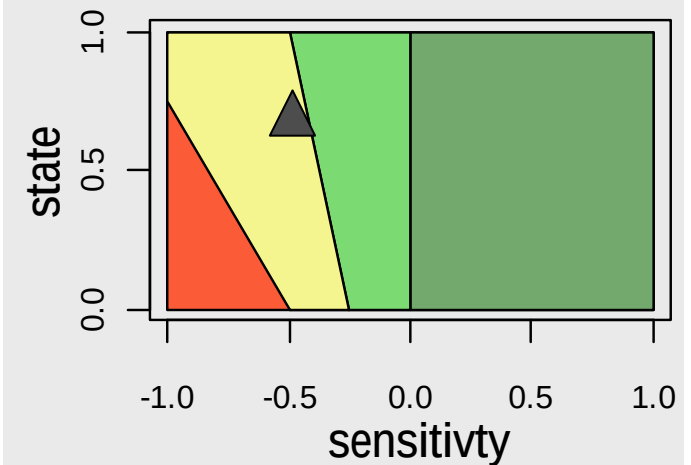
S ... suitability
F ... flexibility
E ... cost

vulnerability profile



vulnerability

period: 2051-2100



vulnerability patterns

	V		
	sensitivity	state	temporal pattern
acute cluster 1 (36%)	--	-	> 2010
severe cluster 2 (36%)	-	- / ~	> 2050
mixed cluster 3 (6%)	- (dist.) ~ / +	~	> 2050
none cluster 4 (22%)	~ / +	~ / +	

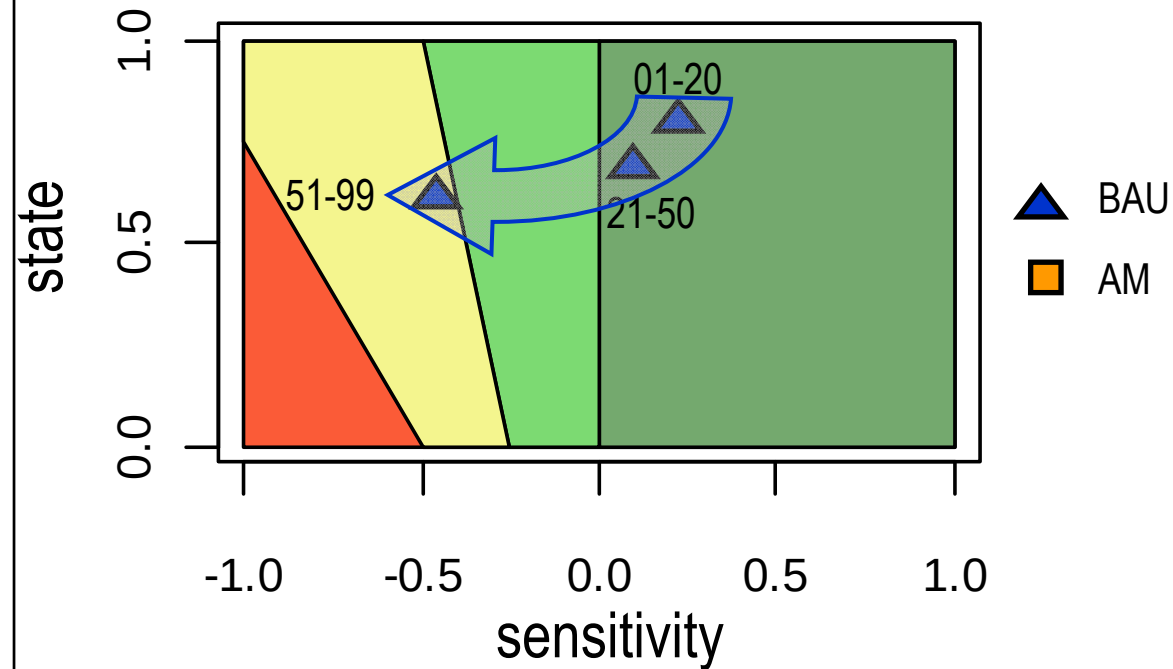
adaptation

	species	silviculture	mgmt intensity
acute cluster 1 (36%)	X	X	X
severe cluster 2 (36%)	X	X	
mixed cluster 3 (6%)		X	X

- two alternative tree species compositions per entity
- strategies simulated in PICUS v1.4 and evaluated in assessment framework

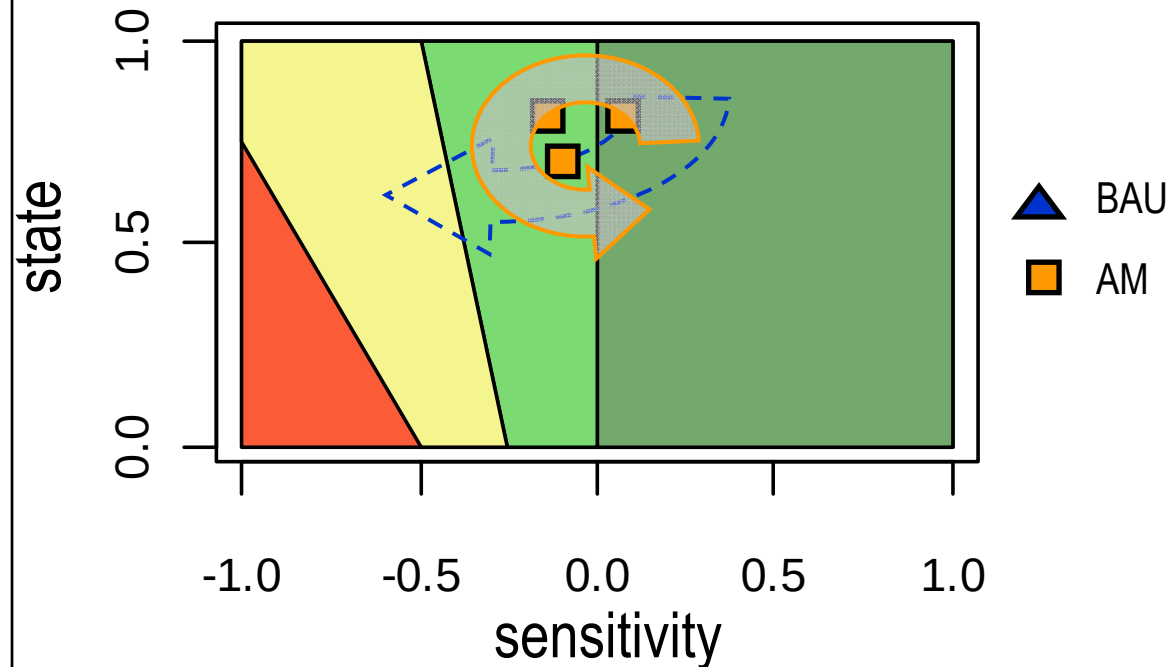
adaptation effect

montane spruce („mixed“ cluster)



adaptation effect

montane spruce („mixed“ cluster)



adaptation
(AM)

species

silviculture

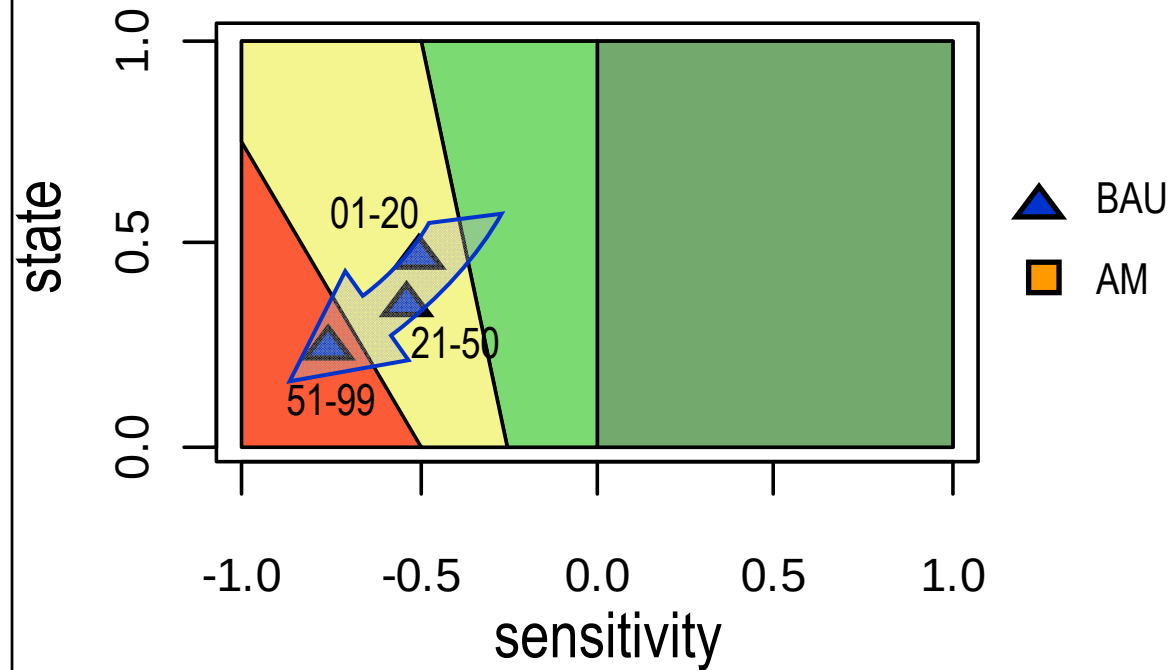
— 3 small stripcuts

mgmt intensity

— rotation period ↓
— thinning intensity ↑

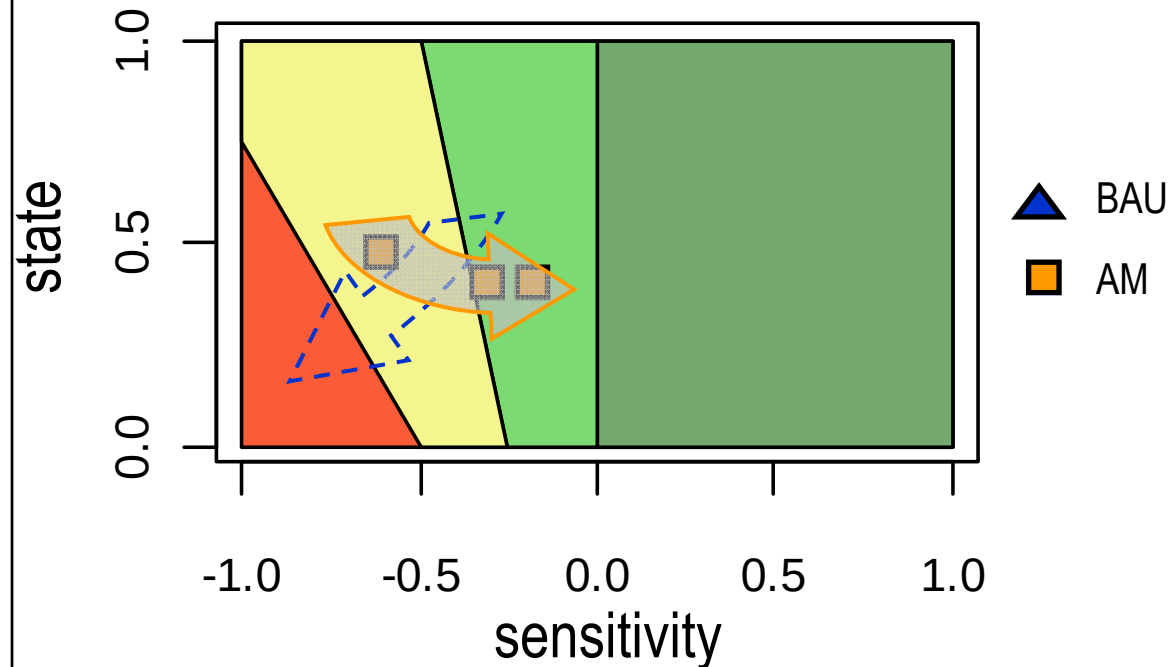
adaptation effect

lowland spruce („acute“ cluster)



adaptation effect

lowland spruce („acute“ cluster)



adaptation
(AM)

species

- change to oak - hornbeam

silviculture

- clearcut
- oak mgmt

mgmt intensity

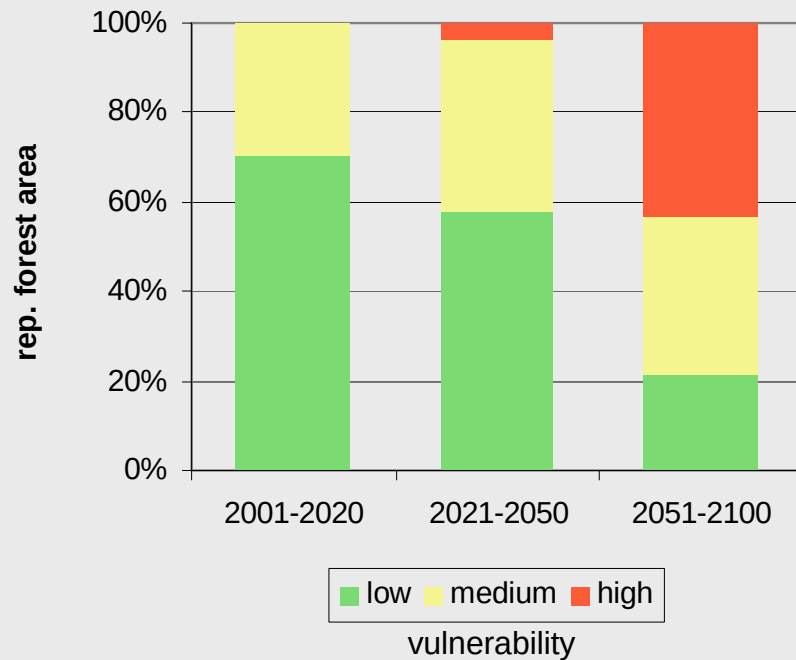
- rotation period ↓

adaptation success & residual vulnerability

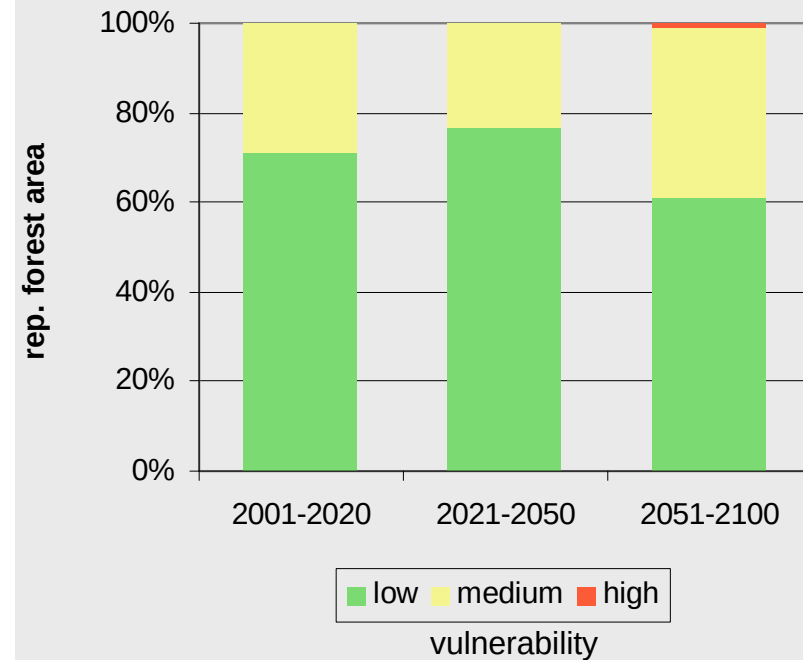
results (6)



business as usual management

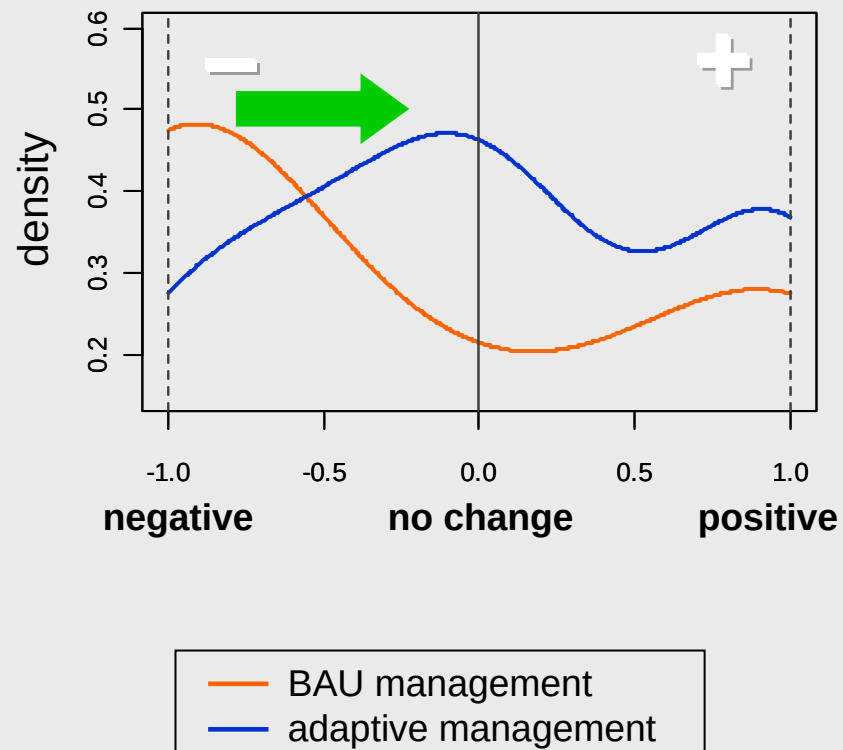


adaptive management

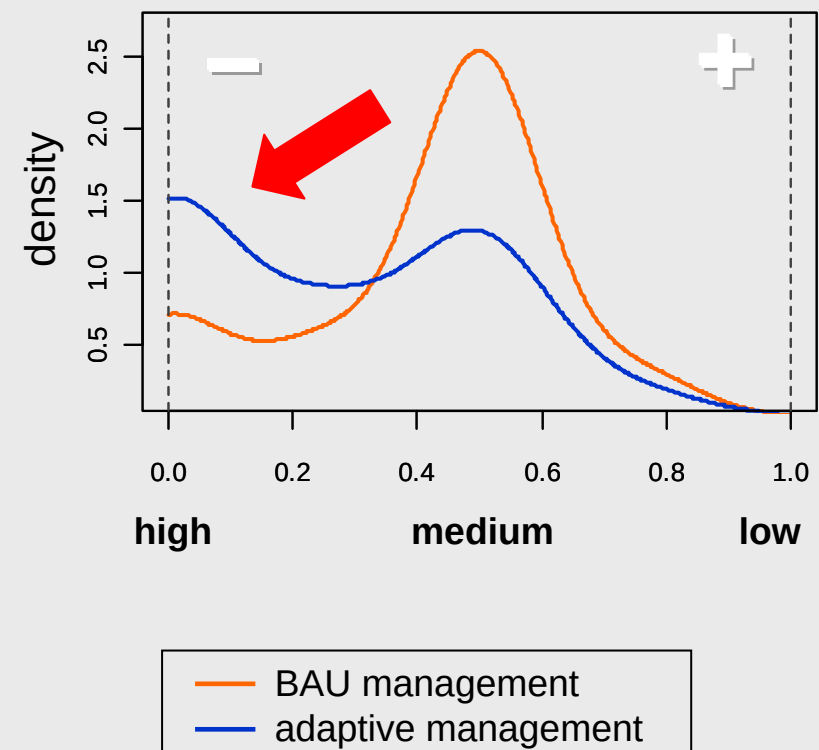


the effects of adaptive management on...

productivity (2051-2100)



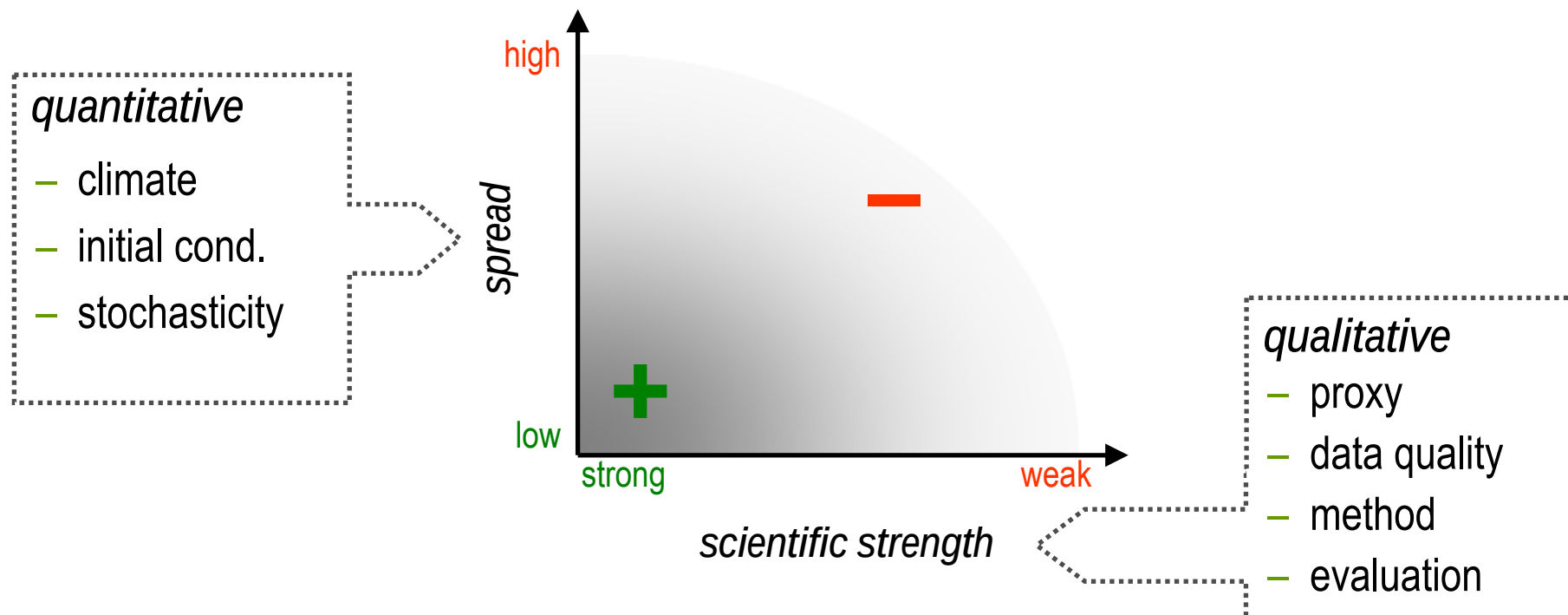
management costs (2051-2100)



uncertainty assessment

discussion (1)

- NUSAP Numeral Unit Spread Assessment Pedigree
 - quantitative and qualitative dimensions of uncertainty
 - NUSAP diagnostic diagram: coherent communication of uncertainties

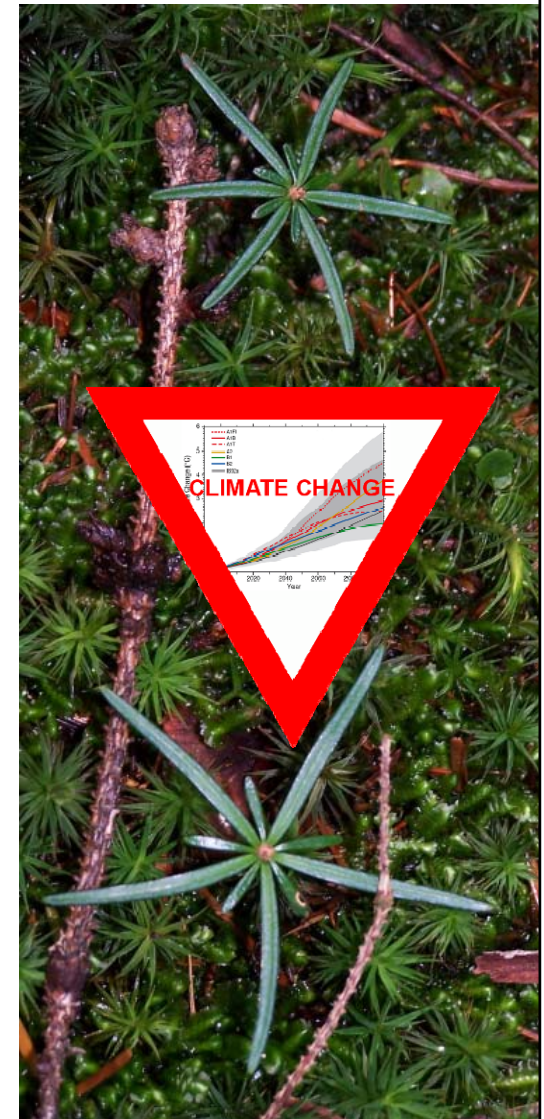


Funtowicz and Ravetz 1990, van der Sluijs et al. 2005, <http://www.nusap.net>

methodological issues

discussion (2)

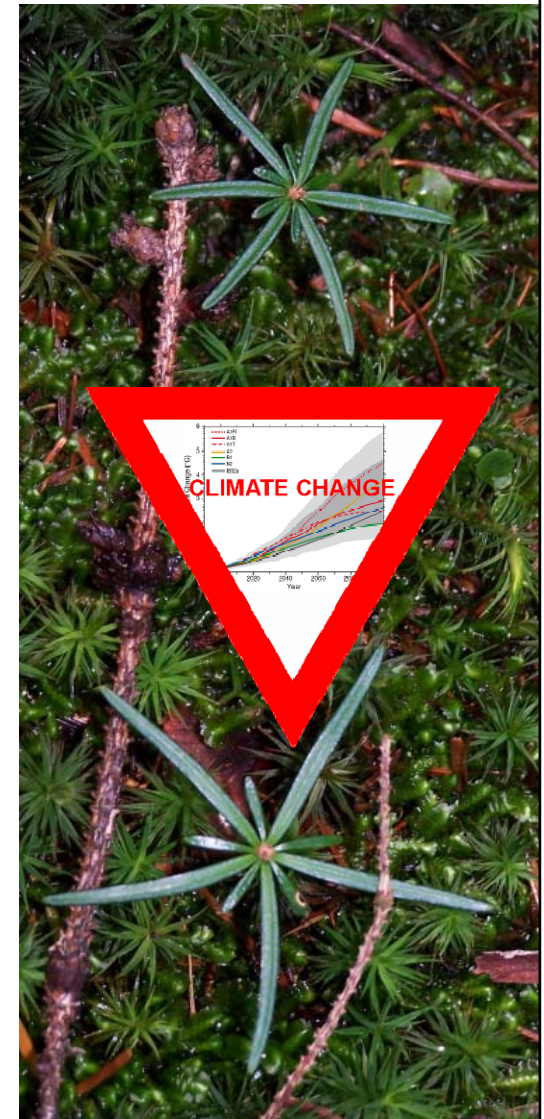
- tools & concepts
 - towards an integrated analysis
 - full disturbance regime needs to be considered (now only bark beetle dynamically simulated)
 - spatial, landscape scale effects neglected
- vulnerability assessment & SFM
 - consistent & transparent evaluation framework
 - how to deal with multiple objectives?
- stakeholder preferences and interests
 - results for a particular set of preferences



findings and implications

discussion (3)

- vulnerability under BAU management
 - considerable beyond 2050
 - particularly affected:
 - low to mid altituded
 - shallow calcareous sites
 - mixed effects in mountain areas
 - increased productivity
 - high susceptibility to disturbances
- adaptation
 - increasing diversity & complexity reduced vulnerability
 - considerable time lag of effects
 - residual vulnerability
- implementation
 - challenging (communication, knowledge transfer,...)



rupert.seidl@boku.ac.at

<http://www.wabo.boku.ac.at/seidl.html>

<http://www.wabo.boku.ac.at/picus.html>

The presented work is currently being prepared for publication. For the time being, please refer to it as Seidl et al., in prep.

this project was financially supported by:



lebensministerium.at

