

Adaptive forest management in Central Europe - options and limitations

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Outline

- **Impacts of CC in Central Europe**
- **Tree and population adaptation**
- **Adaptive forest management – theory and practise**
- **Conclusions – ‘state of play’**

Impacts of CC in Central Europe

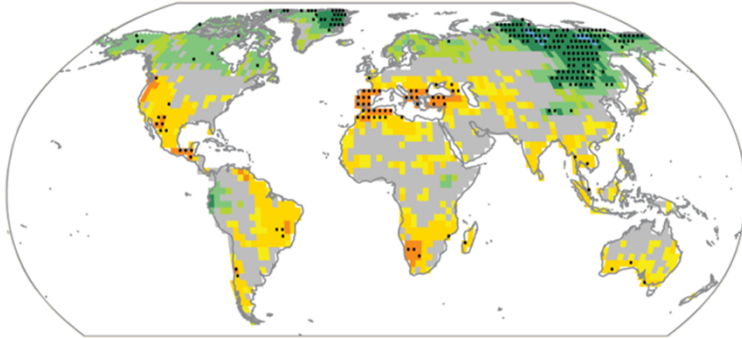


Foto: M. Löf

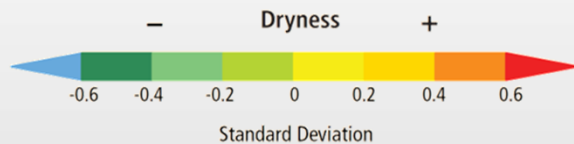
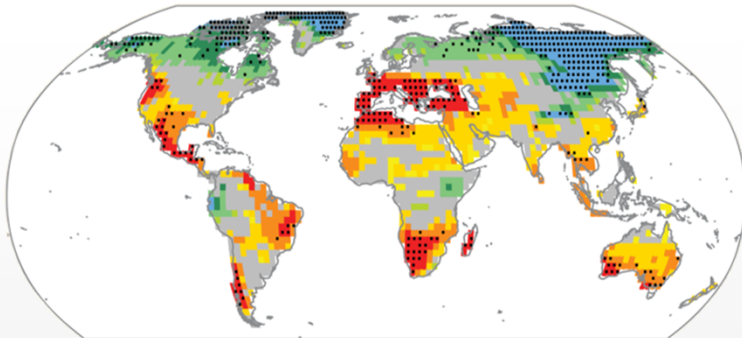
Drought: Projected changes in dryness

Change in consecutive dry days (CDD)

2046 - 2065

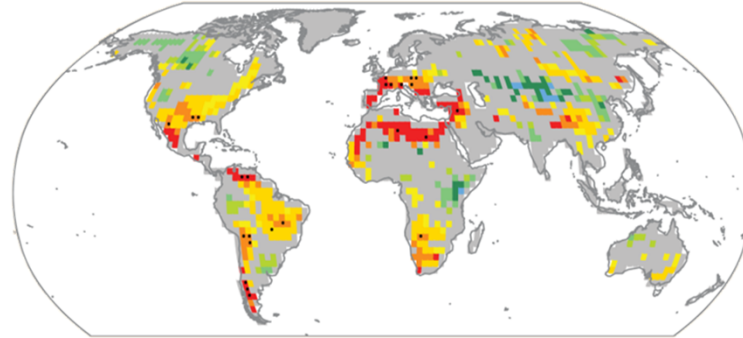


2081 - 2100

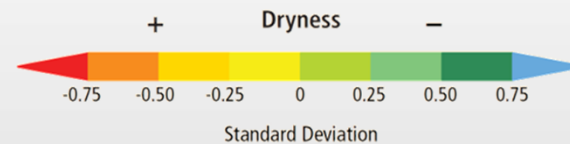
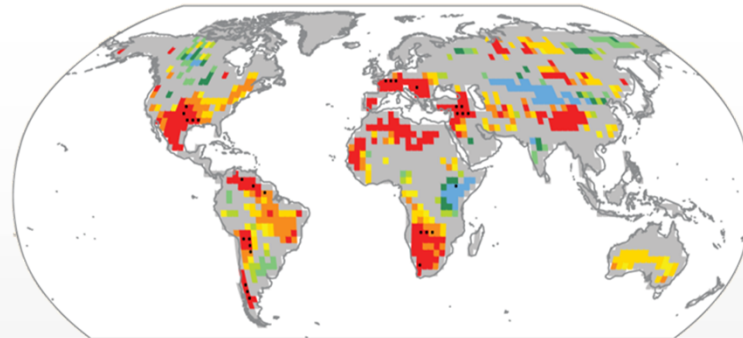


Soil moisture anomalies (SMA)

2046 - 2065

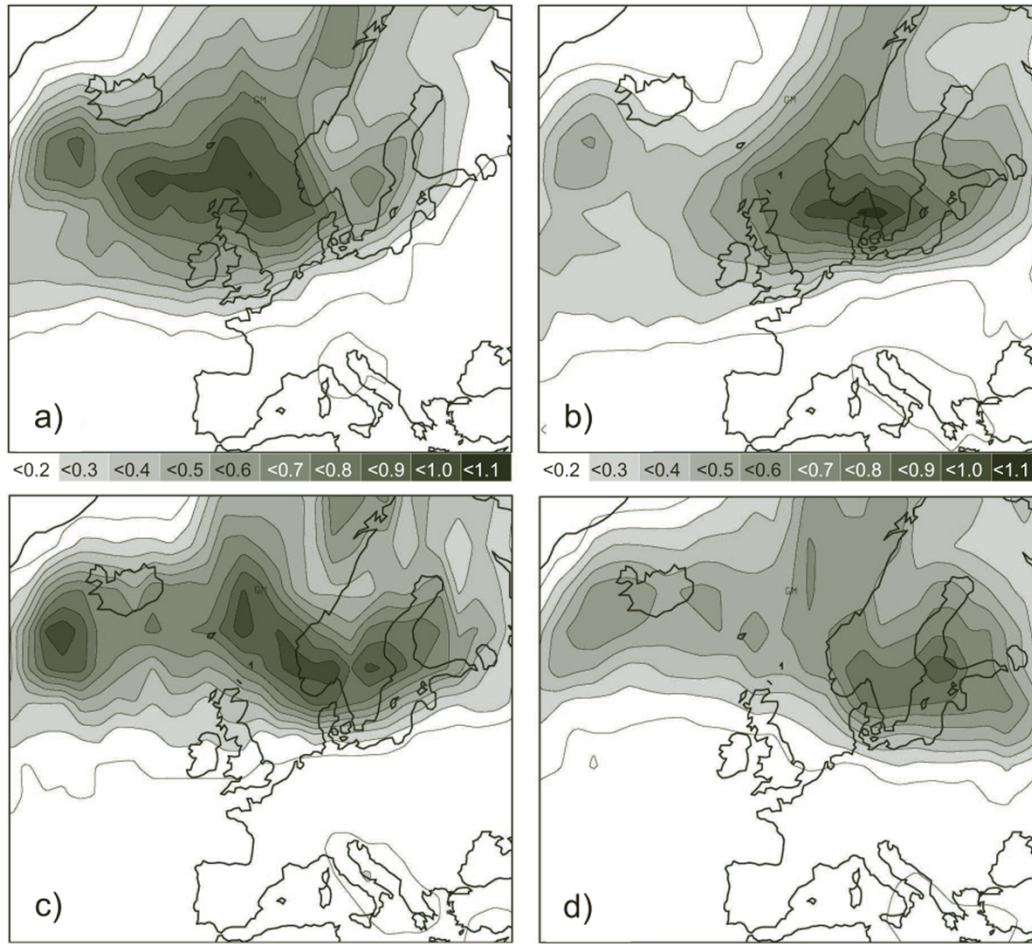


2081 - 2100



Source: IPCC, 2012

Storm: Standardized cyclone track density

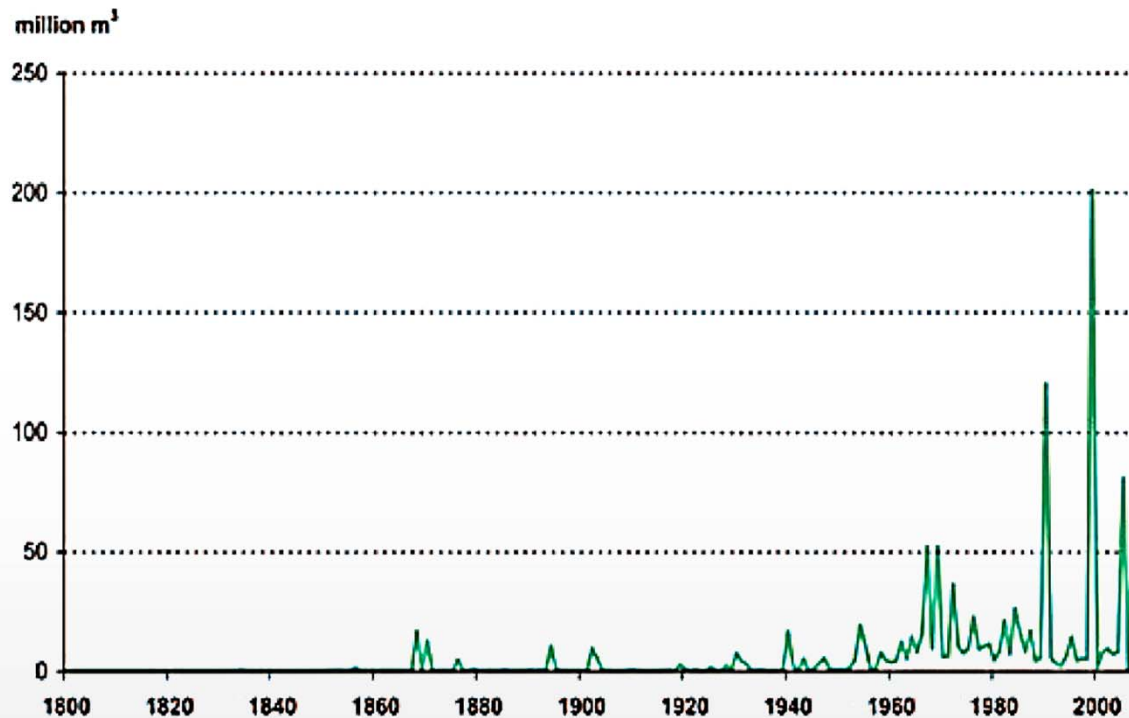


Northern central Europe is often affected by storm.

An increase in extreme wind intensity for this region is projected (*Leckebusch et al., 2006*).

Source: Leckebusch et al., 2008 (p 76)

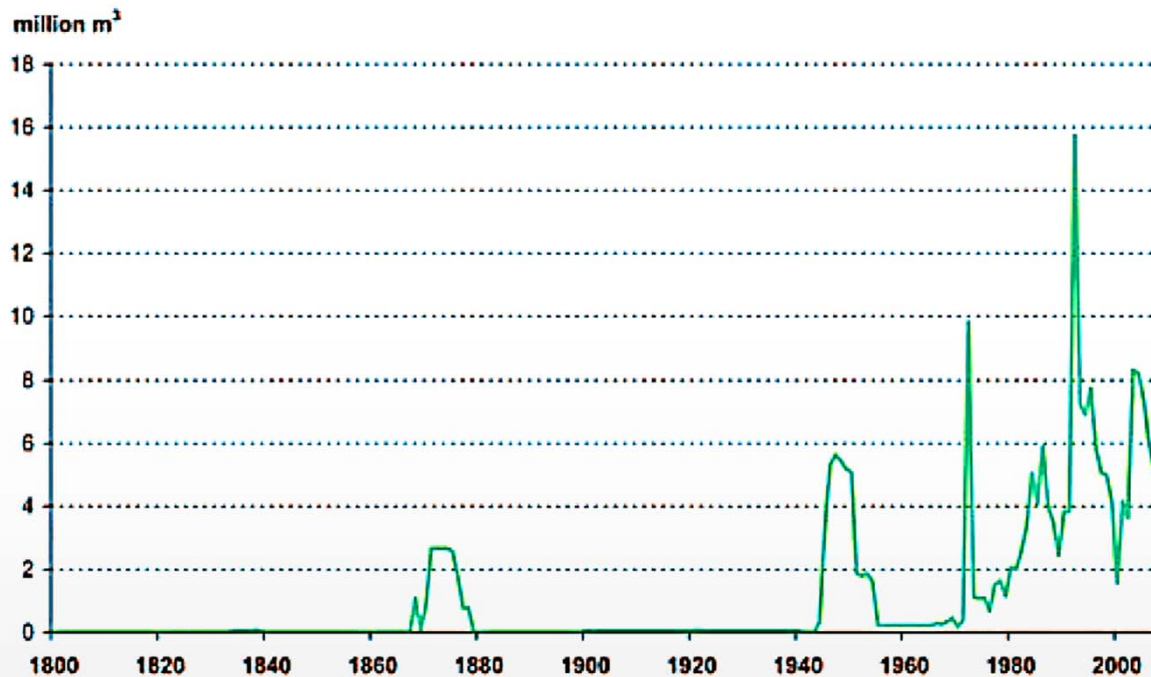
Wood volume loss due to storm damages (Europe)



Increasing wood volume losses biased by record high standing volume in European forests? (*cf. Bolte et al. 2009*)

Source: Dobbertin & DeVries, 2008
(based on Schellhas et al., 2003)

Biotic threads: Losses by bark beetle attacks

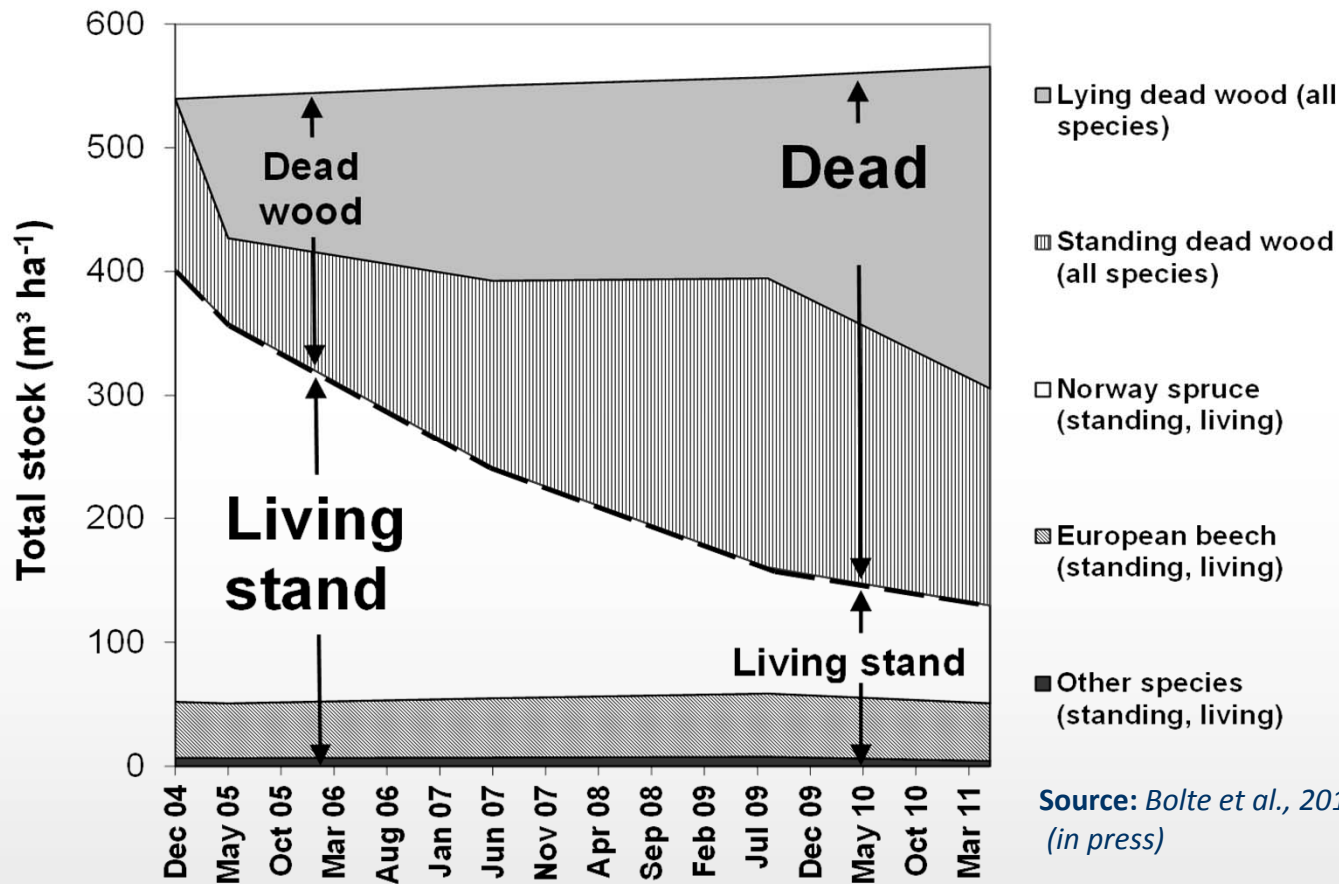


Biotic attacks following storm and drought events are important drivers for tree and stand mortality.

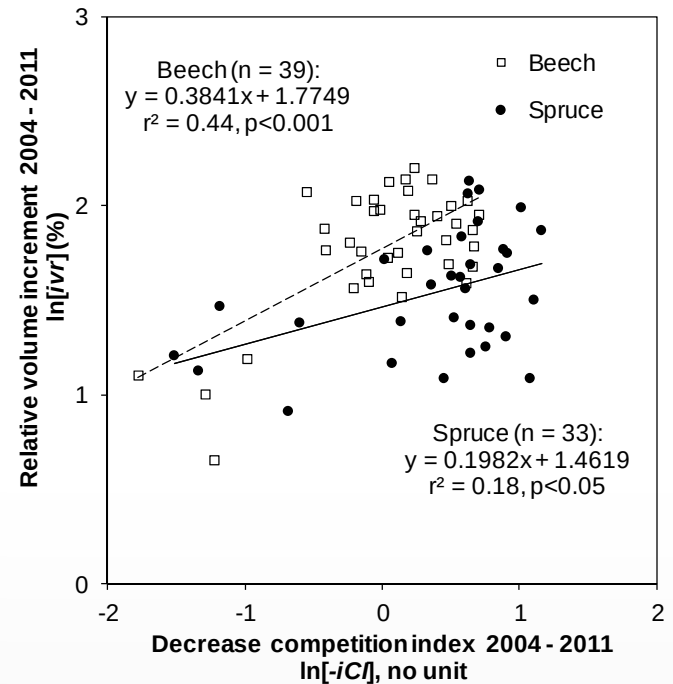
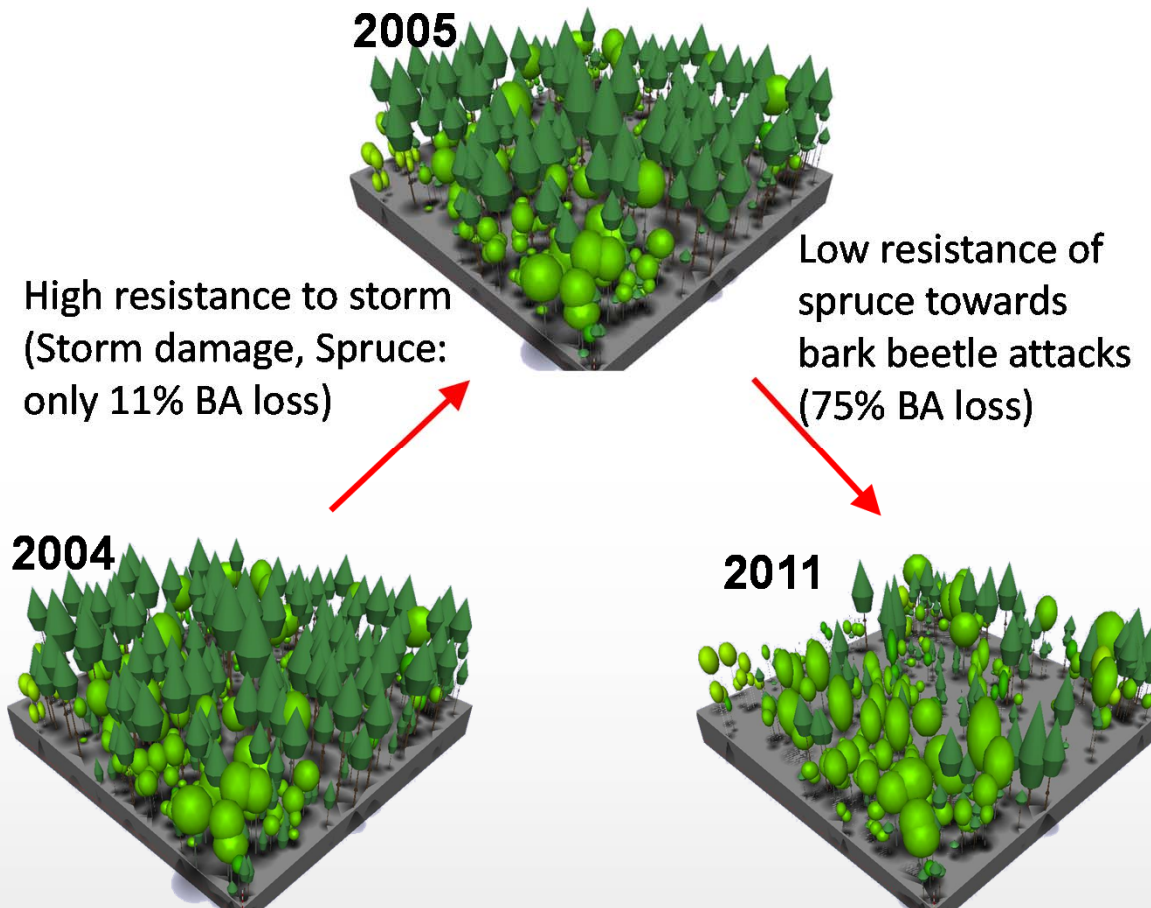
Source: Dobbertin & DeVries, 2008
(based on Schellhas et al., 2003)

Combined impacts (storm/drought) – the Siggaboda case study

Total stock dynamics at Siggaboda nature reserve 2004 to 2011

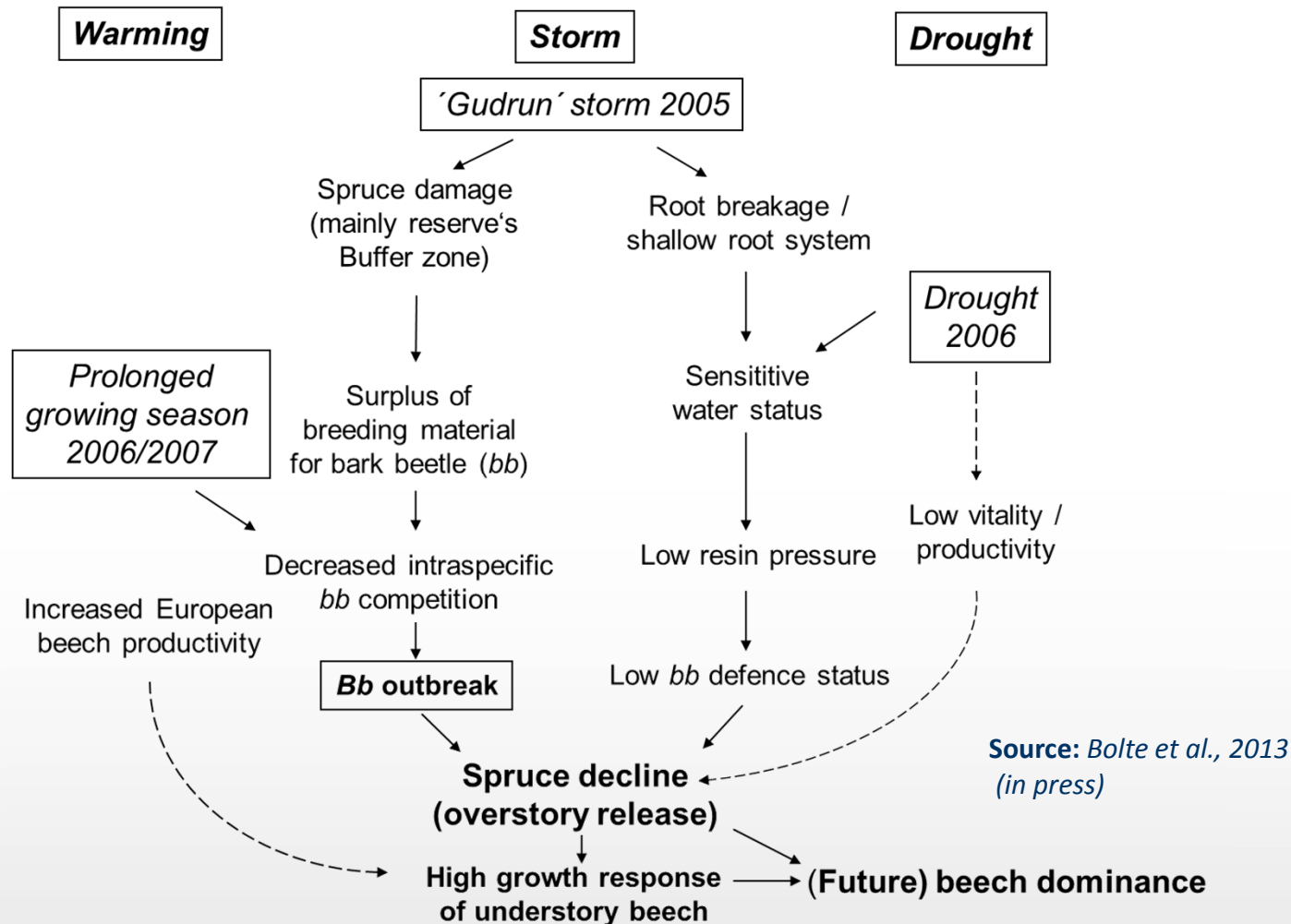


Spruce overstory decline and beech understorey vitalization



Source: Bolte et al., 2010, 2013
(in press)

Conceptual scheme of CC supported forest succession



Some interim conclusions/hypotheses

- Storm, heat/drought and accompanied biotic impacts are probably the most important CC impacts on forests in central Europe.
- Several impacts interact among each other (e.g. storm damages, drought/heat waves and bark beetle infestations).
- CC impacts modify the competitive interactions between the major tree species.
- Disturbances play a major role for CC-supported forest succession (e.g. from Norway spruce to European beech in mountainous and sub-boreal regions)

Tree and population adaptation



Foto: J. Müller

Adaptive processes

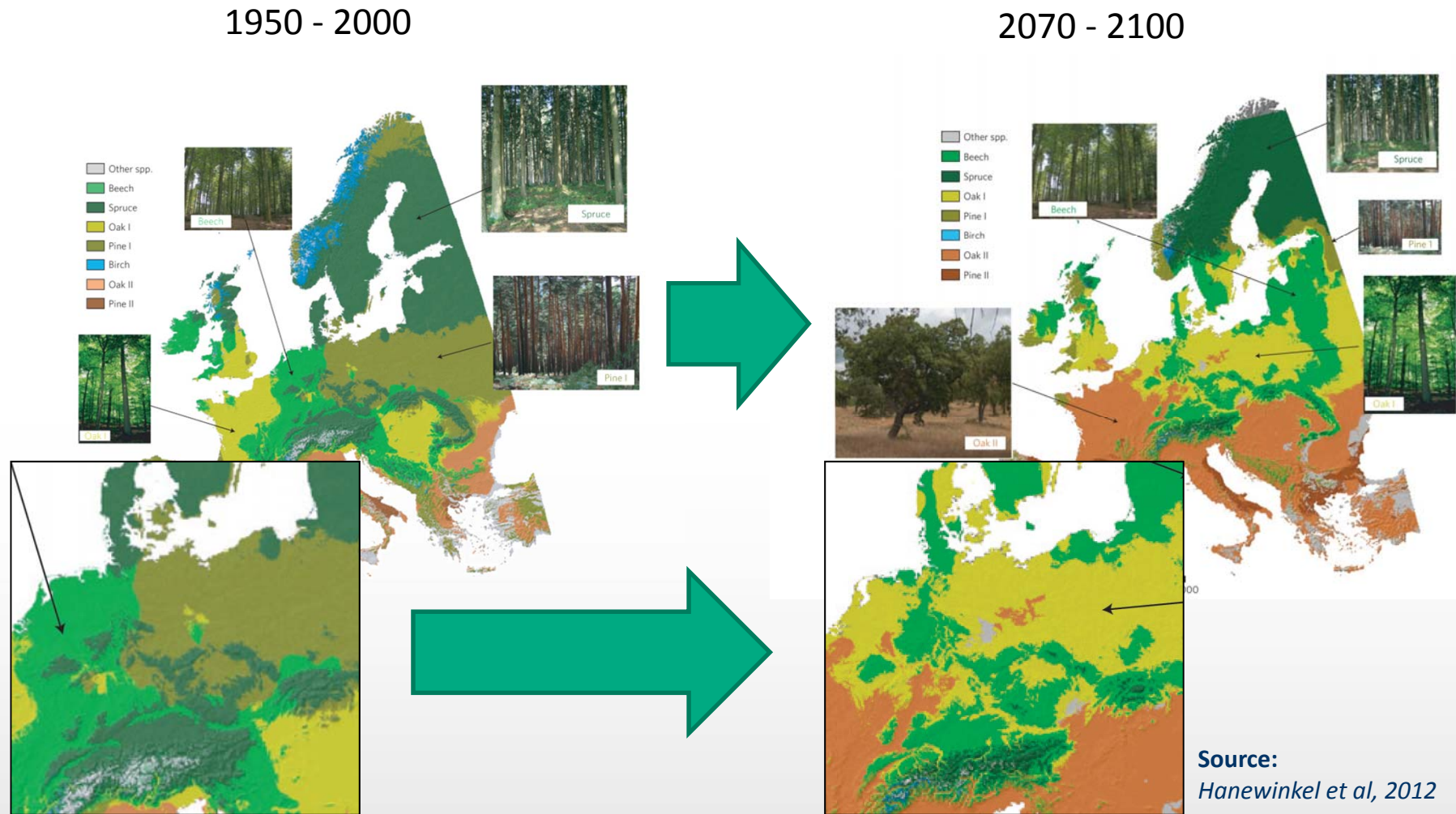
(1) Long-term evolutionary adaptation

- over one or more generations**
- due to selection processes**

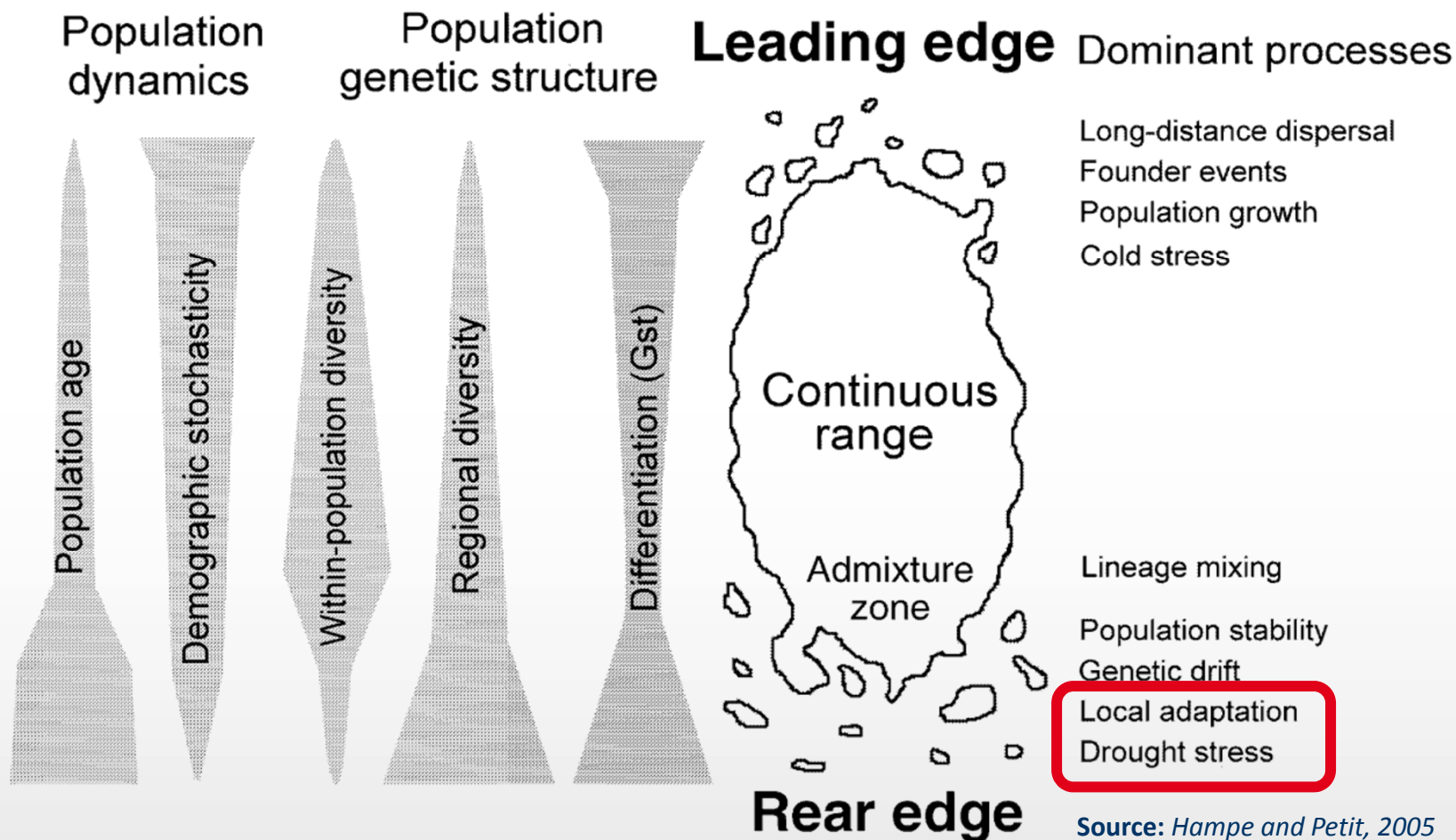
(2) Phenotypic plasticity

- ensuring short-term persistence of several years or a decade**
- due to individual alternation of plant morphology and/or physiology**

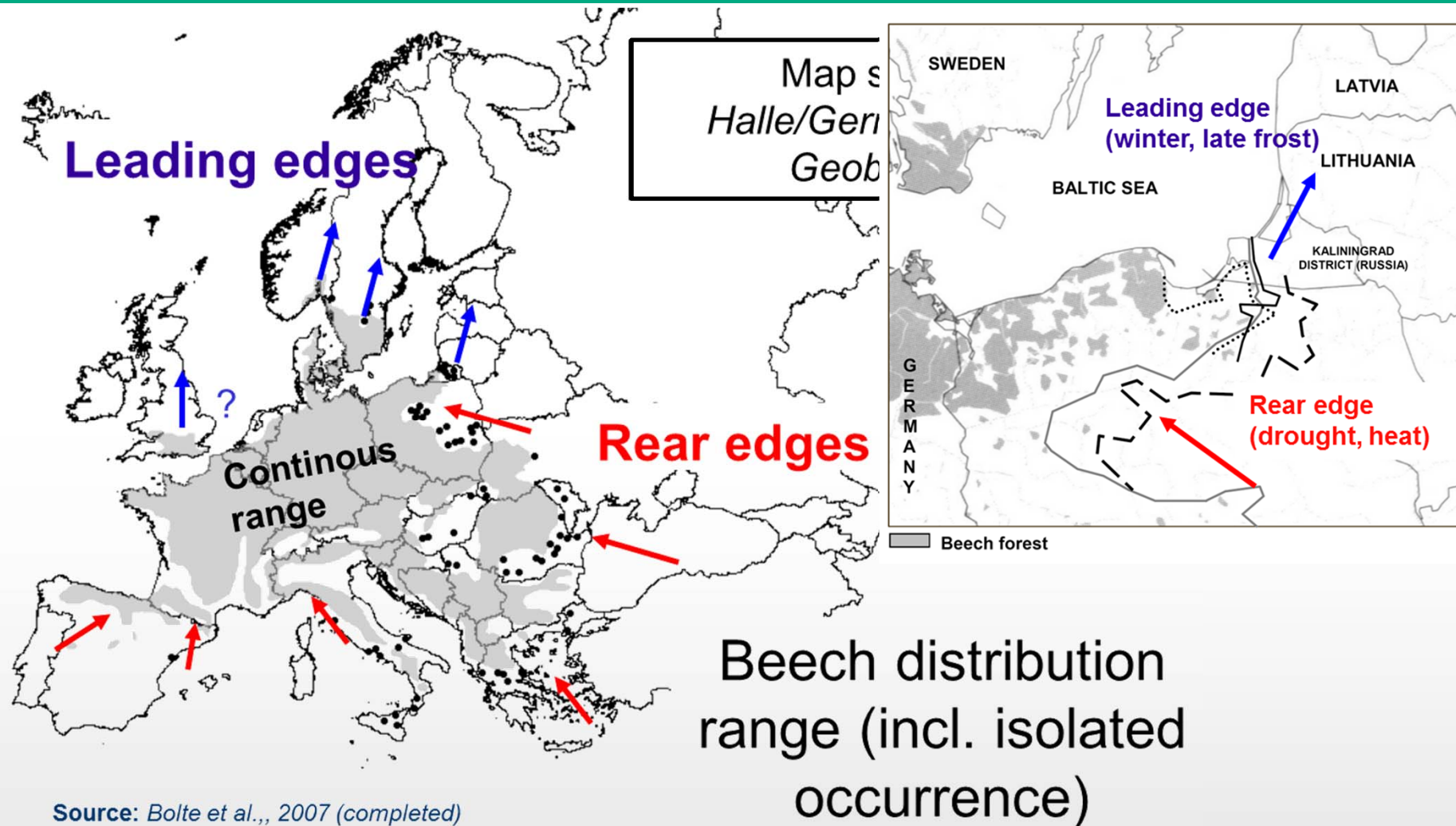
Tree species range shifts due to CC



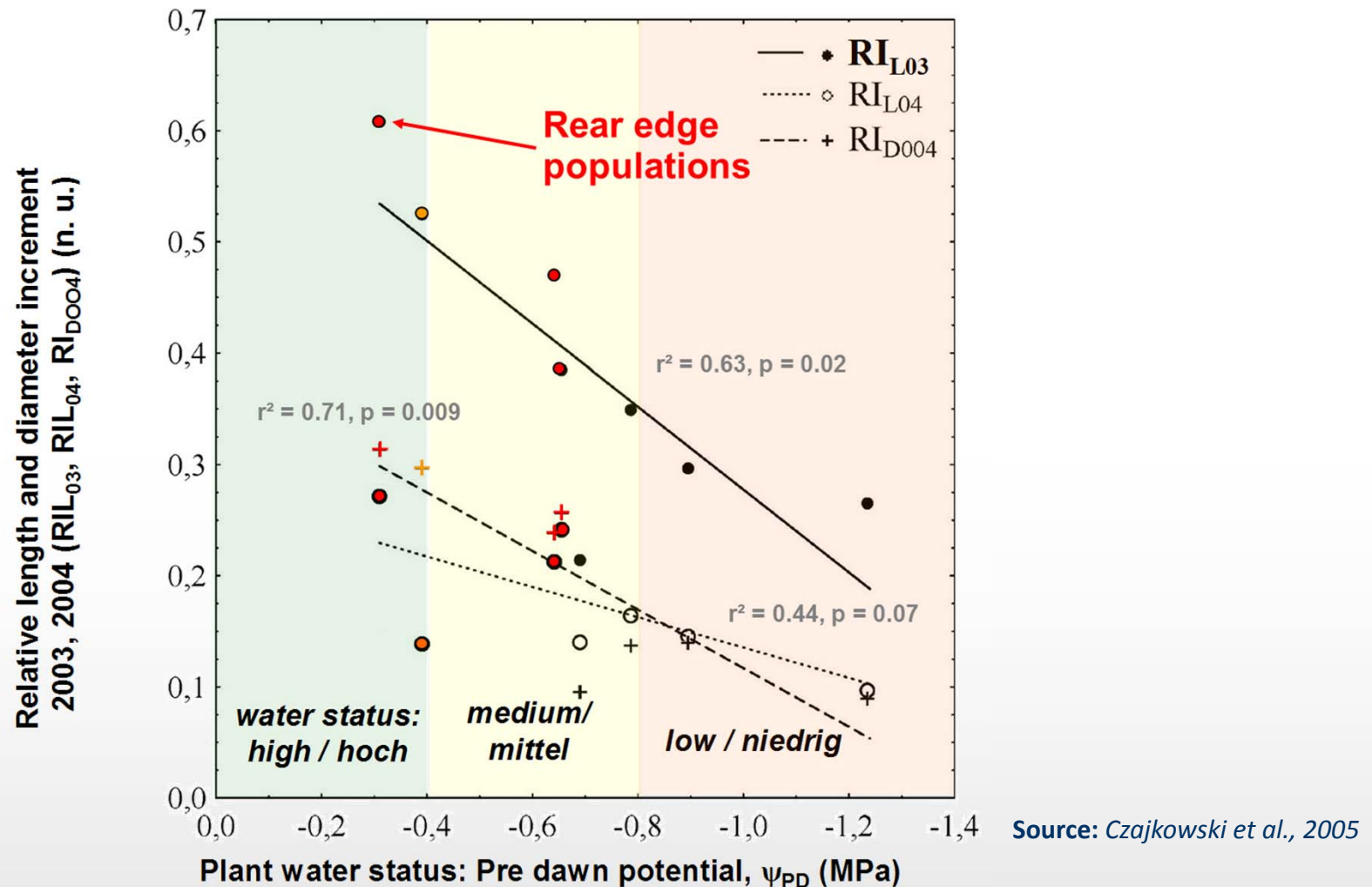
Species range shifts and local adaptation ('rear edge')



Beech distribution margins (North-eastern C-E)



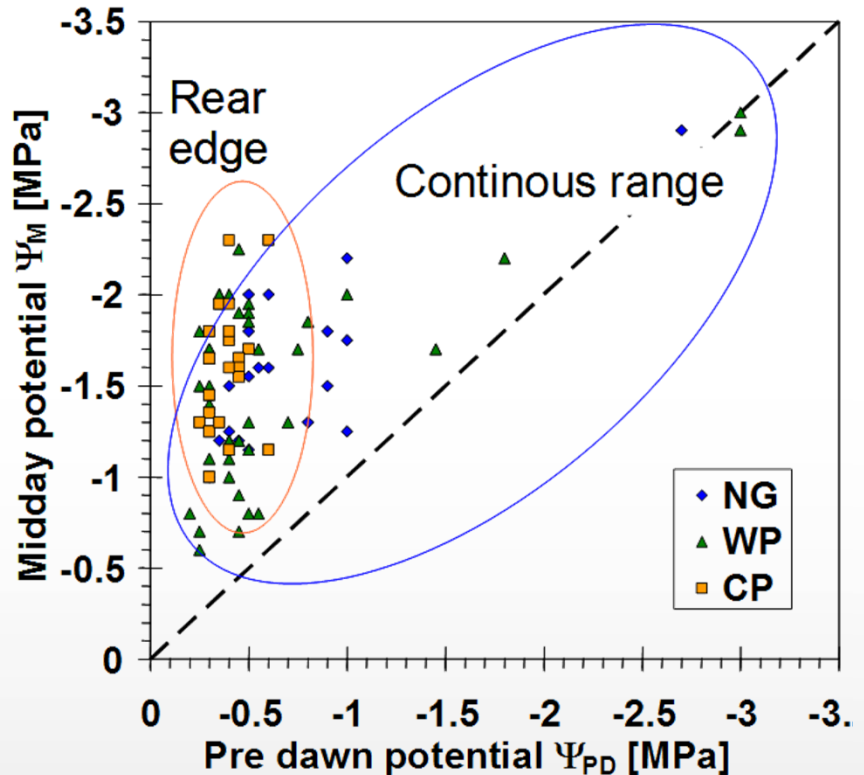
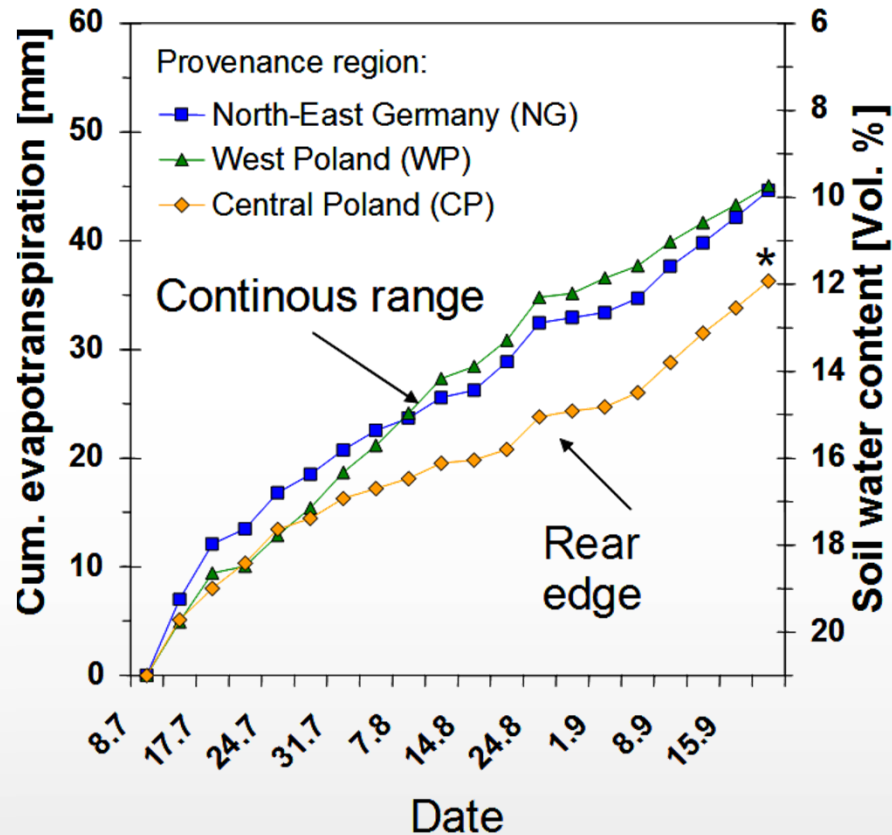
Growth performance of rear edge populations



Source: Czajkowski et al., 2005

Evolutionary adaptation of rear edge-populations

Pre-info: No significant differences in diameter/length increment!

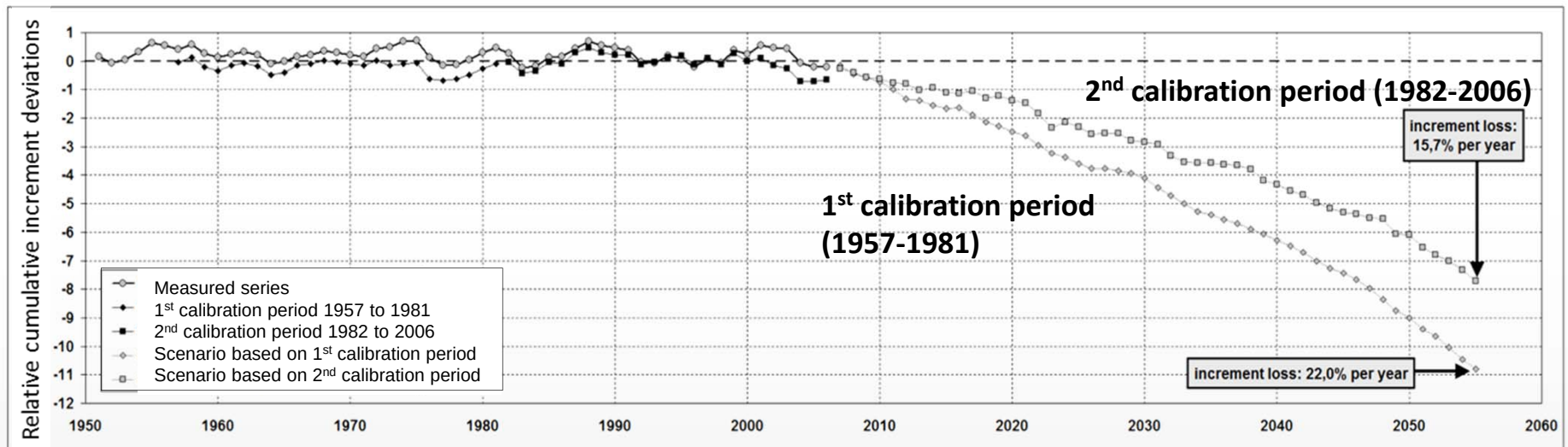


Source: Czajkowski and Bolte, 2006

Phenotypic plasticity of European beech

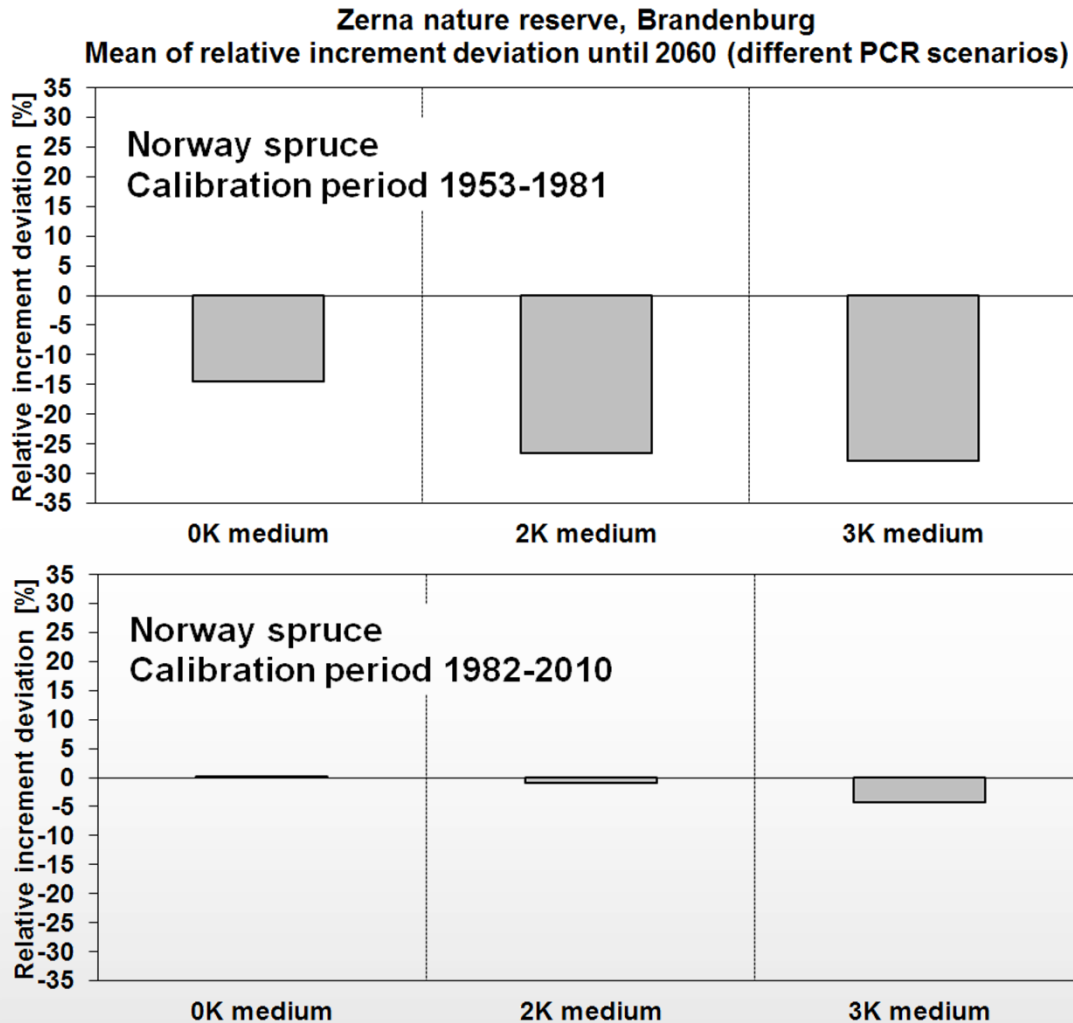
Projected cumulative increment deviations

(PCR scenarios, model CLIMTREG), European beech (Hainich National Park)



Source: Beck et al., 2013 (in press)

Phenotypic plasticity of Norway spruce



Source: Beck, 2013 (not published)

Some interim conclusions/hypotheses

- Both evolutionary adaptation and phenotypic plasticity are important elements of tree/population adaptation and future tree/population performance.
- It is important to consider adaptive potential of trees beyond the species level (provenances; ‘beech is not beech’).
- The use of retrospective information of tree performance for future projections underestimates the adaptive potentials of trees (by neglecting phenotypic plasticity).

Adaptive forest management



Theory: Strategies of Adaptive Forest Measures (CC)

- **Conservation of forest structures**

- Maintenance of forest structures against successional pressure
- Increasing risk of catastrophic loss
- Chance of achieving original management targets

- **Active adaptation**

- Usage of silvicultural methods to change stand structure/composition
- Chance to increase stress tolerance and adaptive potential of stands (less susceptible species/provenances, stand structures)
- High costs and efforts

- **Passive adaptation**

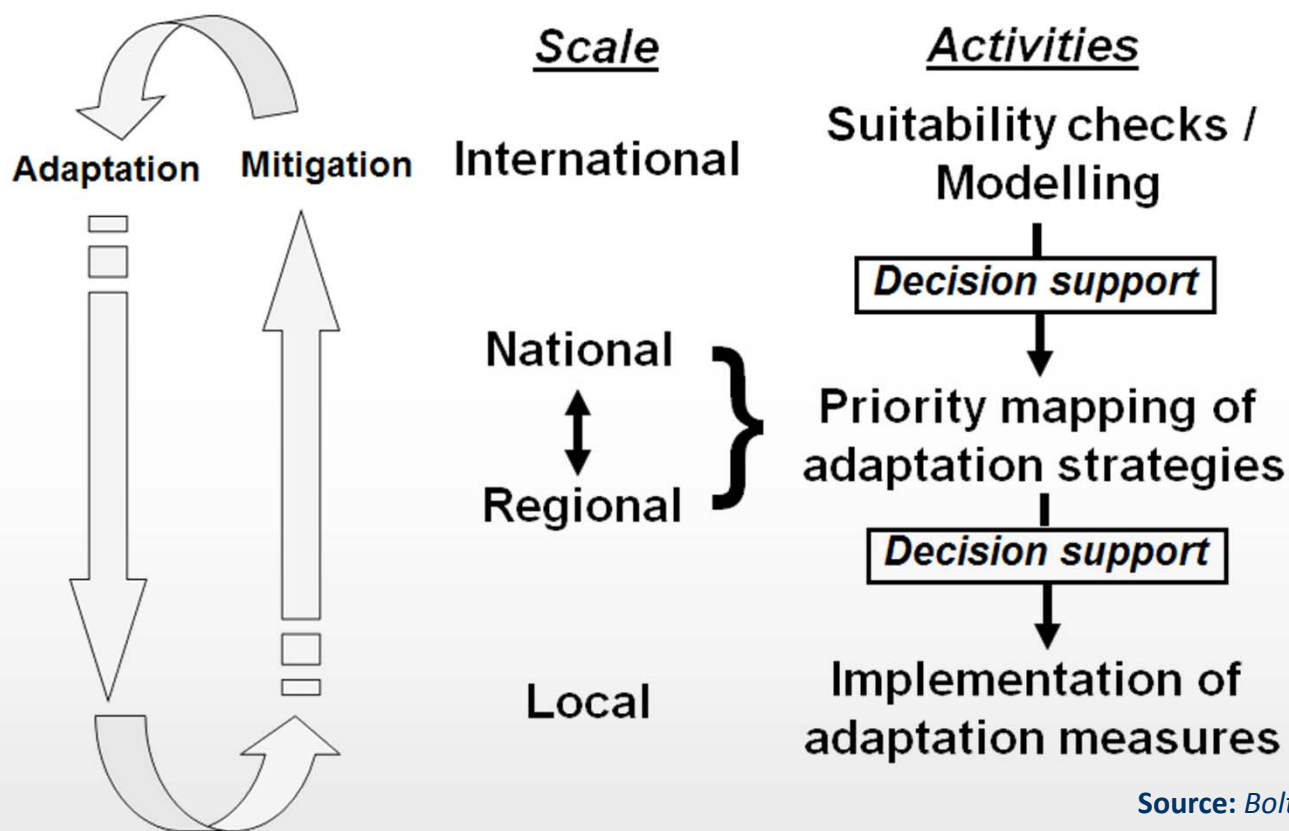
- Active decision to stop measure to maintain forest structures
- Use of spontaneous adaptation processes (forest succession)
- Low control of future forest composition and structure

➤ **Problem:** Lack of knowledge on future local climate and tree adaptation

Source: Bolte et al., 2009

Therory: Concept of Adaptive Forest Manegment

Suggestion for an integrative concept of adaptive forest management



Source: Bolte et al., 2009

Practise: Close-to-nature silviculture (CNS)

Principles of CNS (Central European perspective)

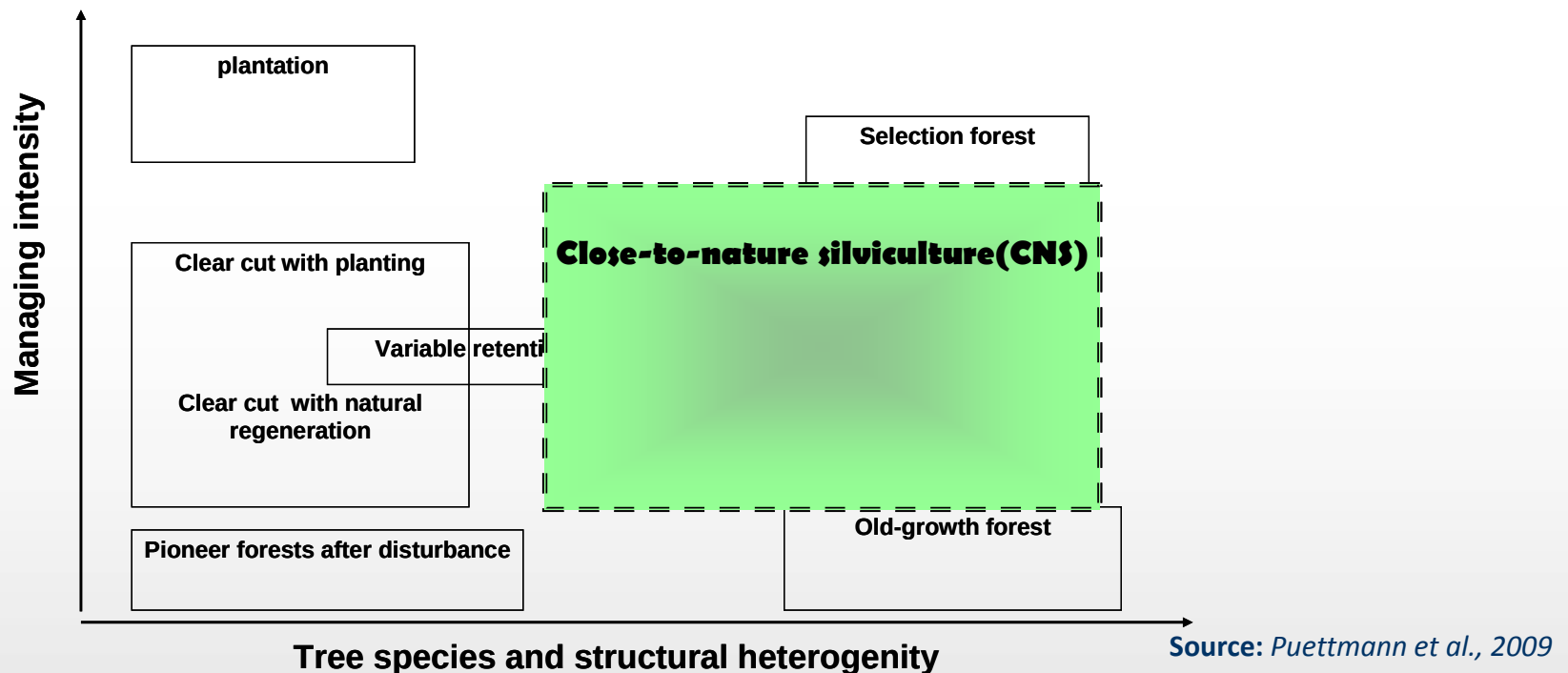
- Avoidance of clear-cuts
- Single-tree oriented interventions
- Promotion of the natural and/or site-adapted tree species composition
- Promotion of mixed and 'structured' forests
- Promotion of natural regeneration
- Integration of forest ecosystem services (e.g. water, recreation) at small spatial scales

Source: Spathelf and Bolte, in review

Practise: CNS and forest adaptation to CC

Criteria for increased unspecific adaptive potential of forests:

- High species richness and structural diversity
- High genetic variation within tree populations and individuals



Practise: CNS and forest adaptation to CC

CNS fulfills the criteria of high structural diversity well but tree species richness is restricted due to:

- the avoidance to introduce non-native tree species and provenances
- the promotion of mid- and late-successional species that limits the occurrence of stress-tolerant pioneer tree species.

Thus, 'active adaptation' measures and 'human-induced' assistance are restricted.

Conclusions and ‘state of play’



Conclusions

- Interactions of CC impacts and distinct disturbance events will probably play a major role for CC-induced forest succession and species migration.
- Species-oriented and retrospective analyses of tree performance under CC may not provide a proper basis for projections on future tree performance. Evolutionary adaptation and phenotypic plasticity should be included.
- Theoretical concepts of adaptive forest management (AFM) lack of basis information on local CC and adaptive potential of trees for their implementation. CNS as an unspecific adaptation program has some critical restrictions.

'State of play'

- There are many useful 'bits and pieces' in modelling, forest ecology and silviculture that are waiting for being combined in an integrative, pan-European or global initiatives.
- There is an upcoming activity of IUFRO members (in Europe, America and Asia) to establish a world-wide network on research plots (testing tree species, provenances and interventions).
- The collaboration between 'Science' and 'Policy' as well as on different political/spatial scales (international-regional/national-local) is difficult. We need a few 'key activities' to show the benefits of such co-operations.

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