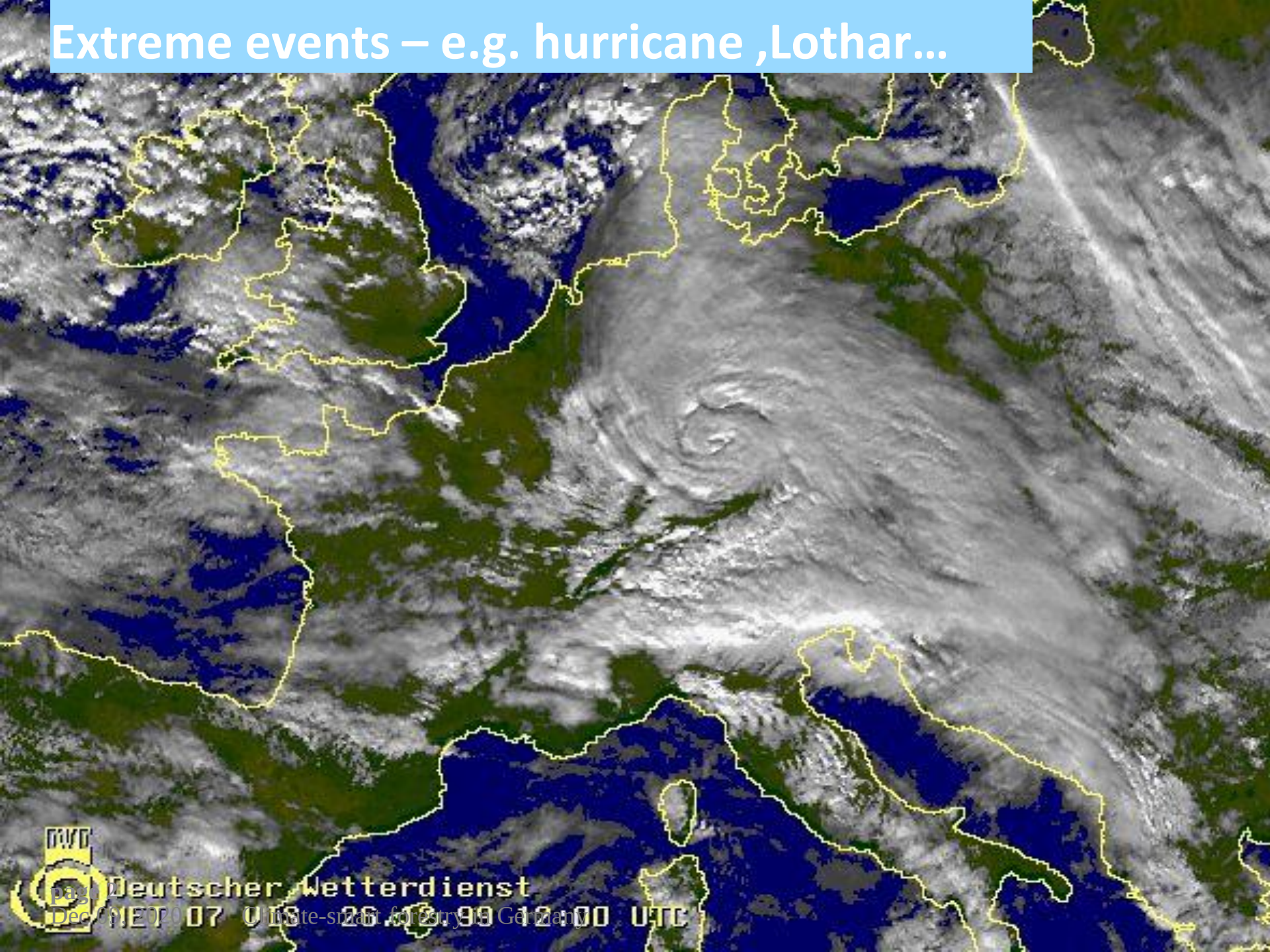
Climate-smart forestry in Germany

Prof. Dr. Peter Spathelf, Eberswalde University for Sustainable Development

Pine forest in Sachsen-Anhalt

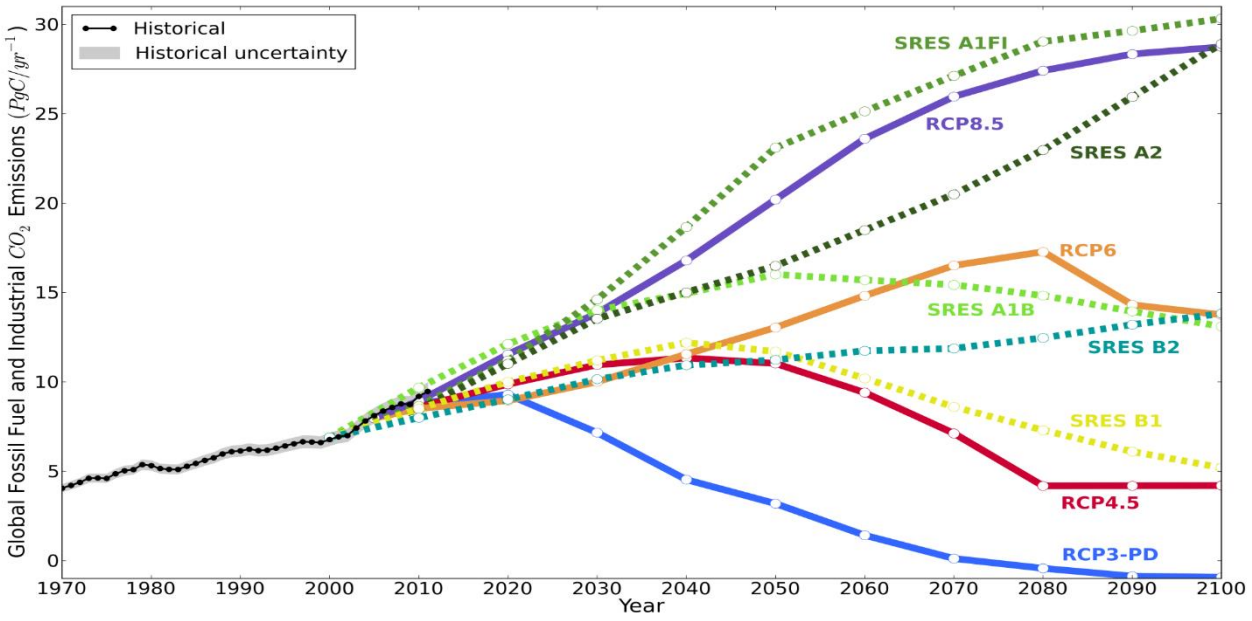
Extreme events – e.g. hurricane ‚Lothar…




… or forest fires (Brandenburg)

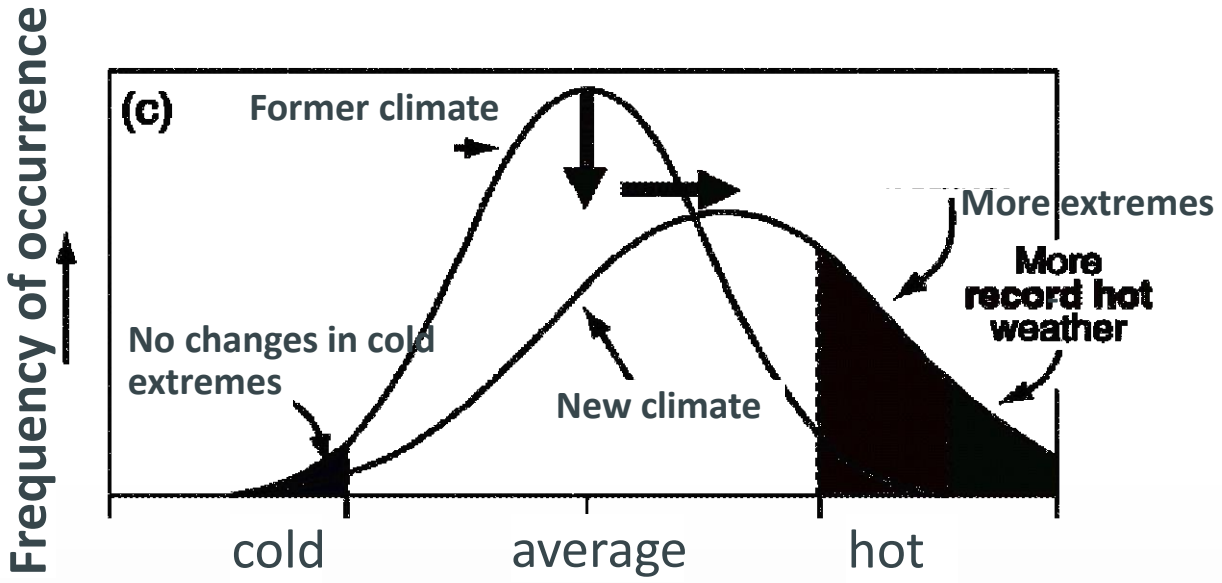
Mortality on oak, near Eberswalde

Climate change / magnitude and impacts



New climate?

Source: IPCC, 2001, changed by A. Bolte, 2020

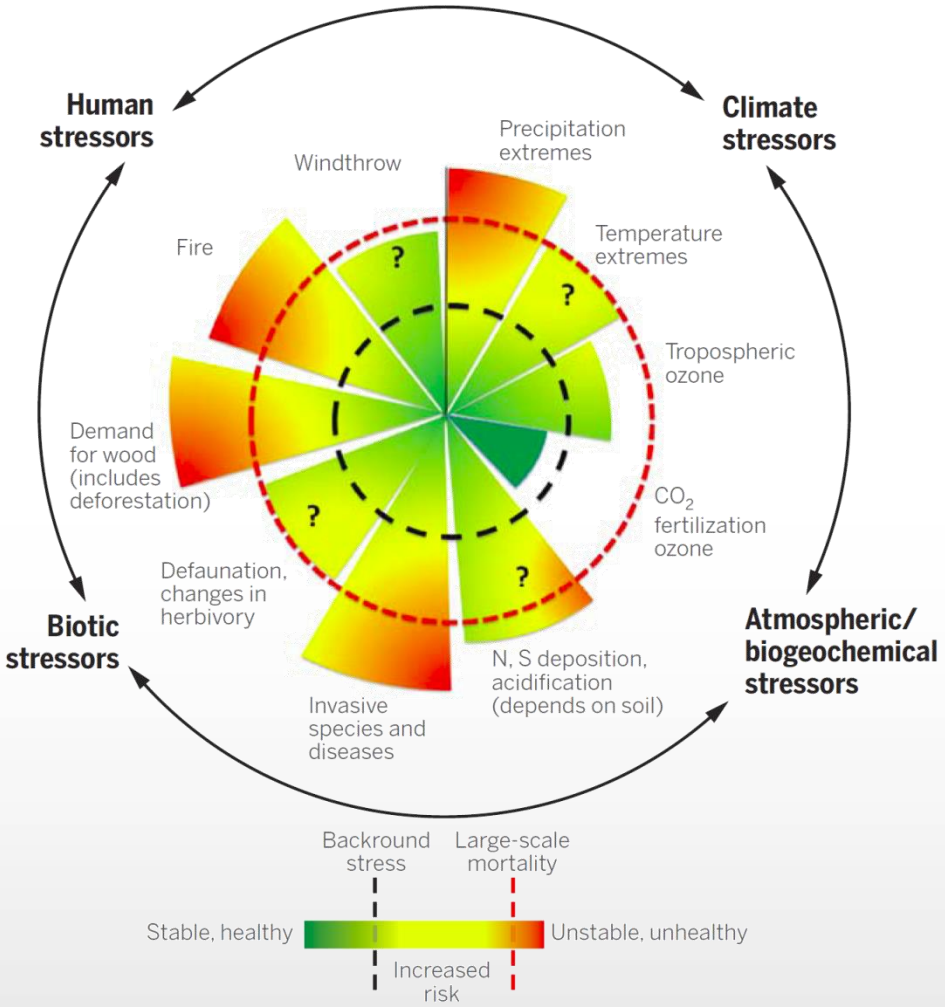


- Changing mean temperatures and extremes (hot droughts, triple drought year)
- Negative climatic water balance in vegetation period, soil water cannot be refilled
- Cold extremes remain

➢ **Subtropical or new climate?**

Expected global increase of stress factors

Planetary boundaries concept or tipping points



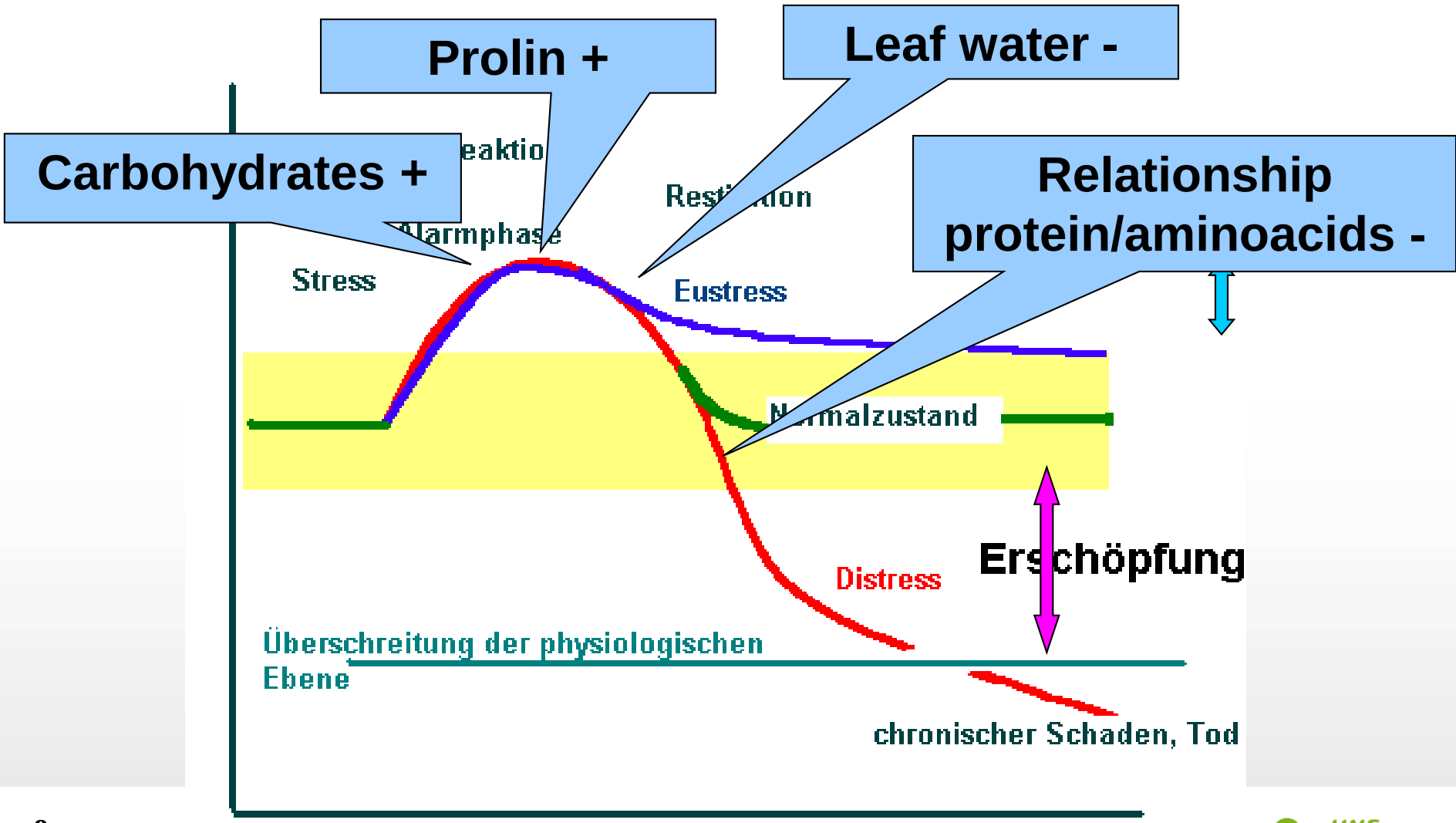
Increasing stressors and disturbances:

- Weather extremes
- Forest fire
- Demand for timber
- Invasive species
- Overuse and deforestation
- Acidification of soils

Source: Trumbore et al., 2015

Drought stress response

acc. to Kätzel, 2015



Carbon starvation or hydraulic failure

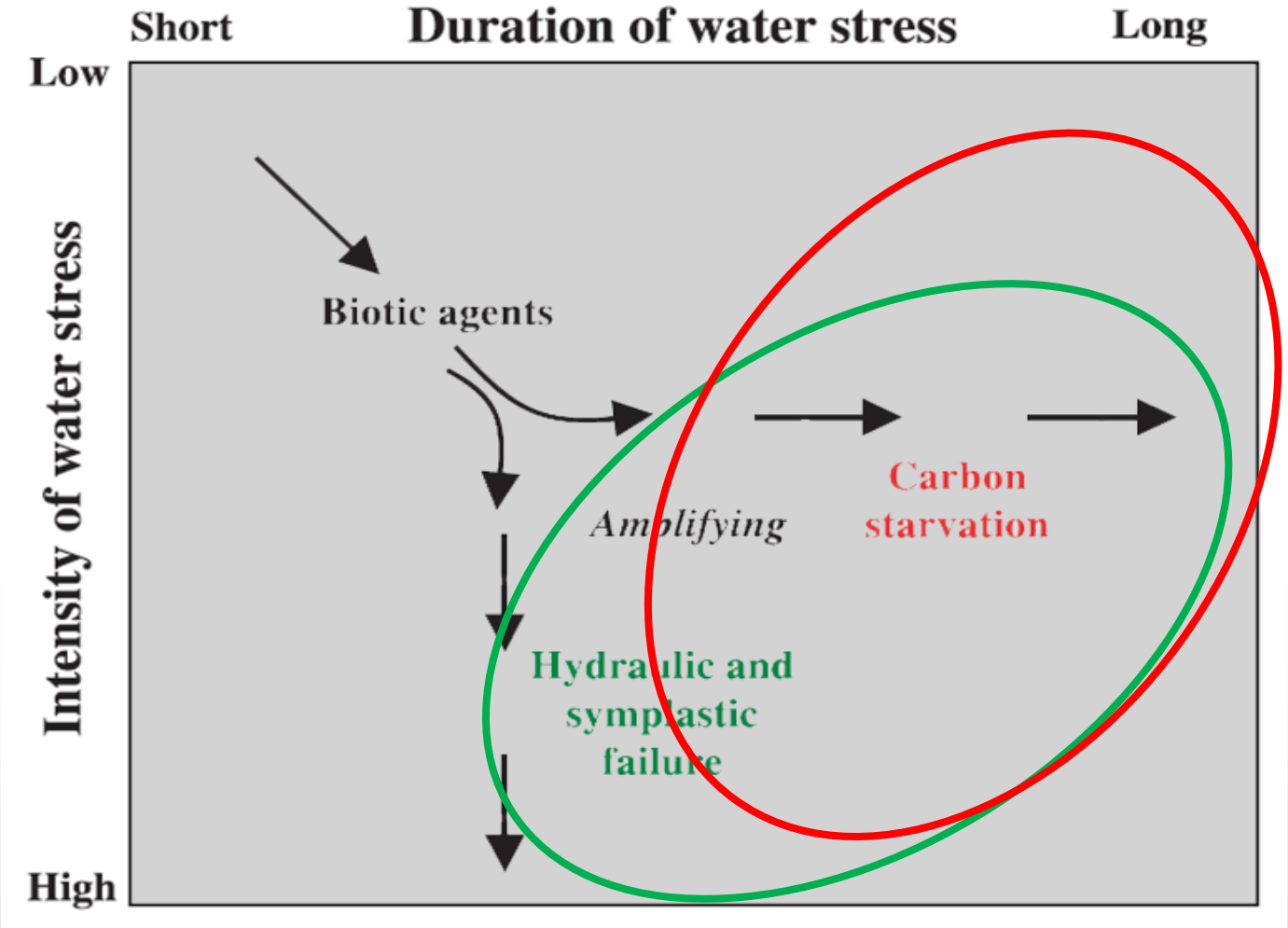
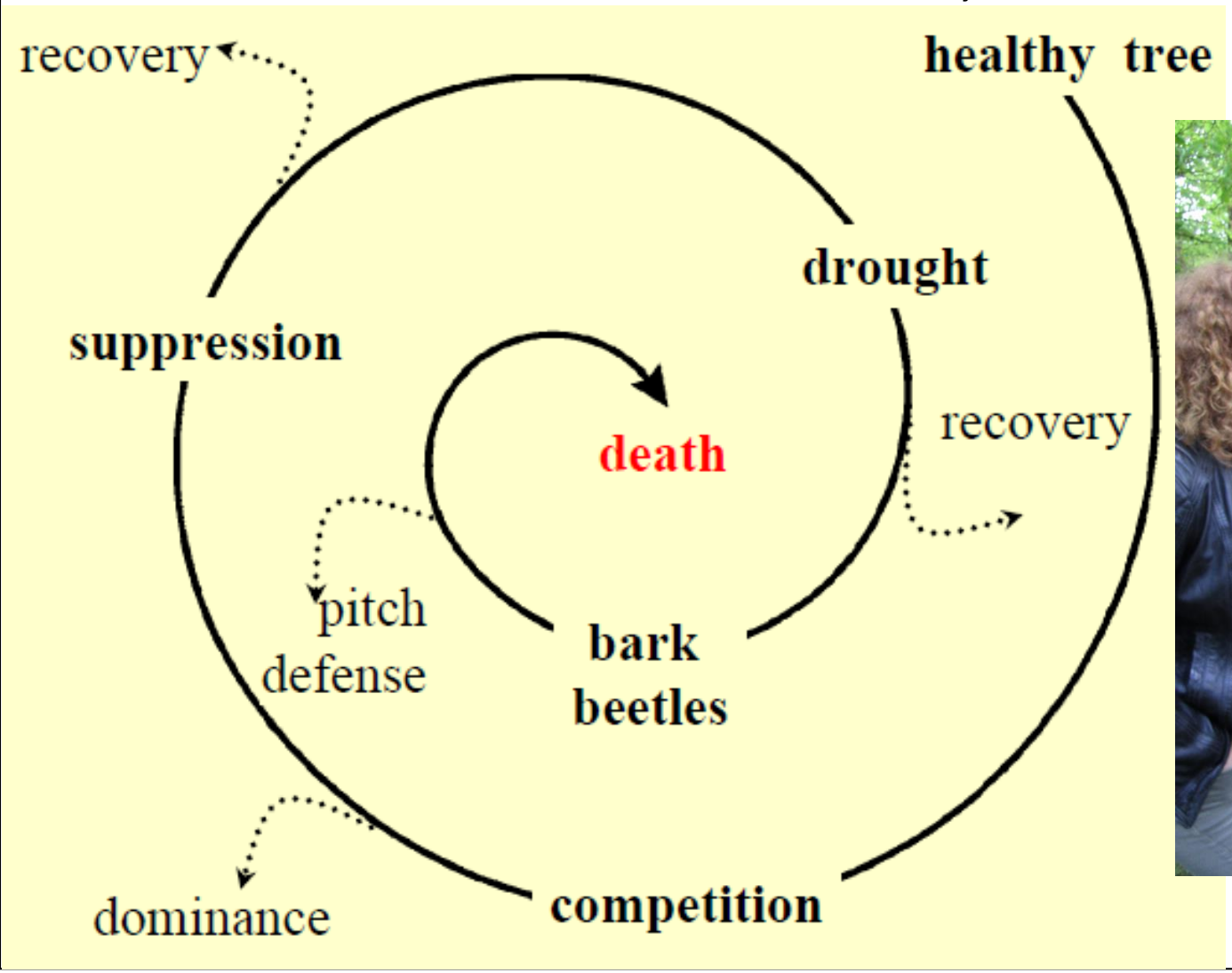


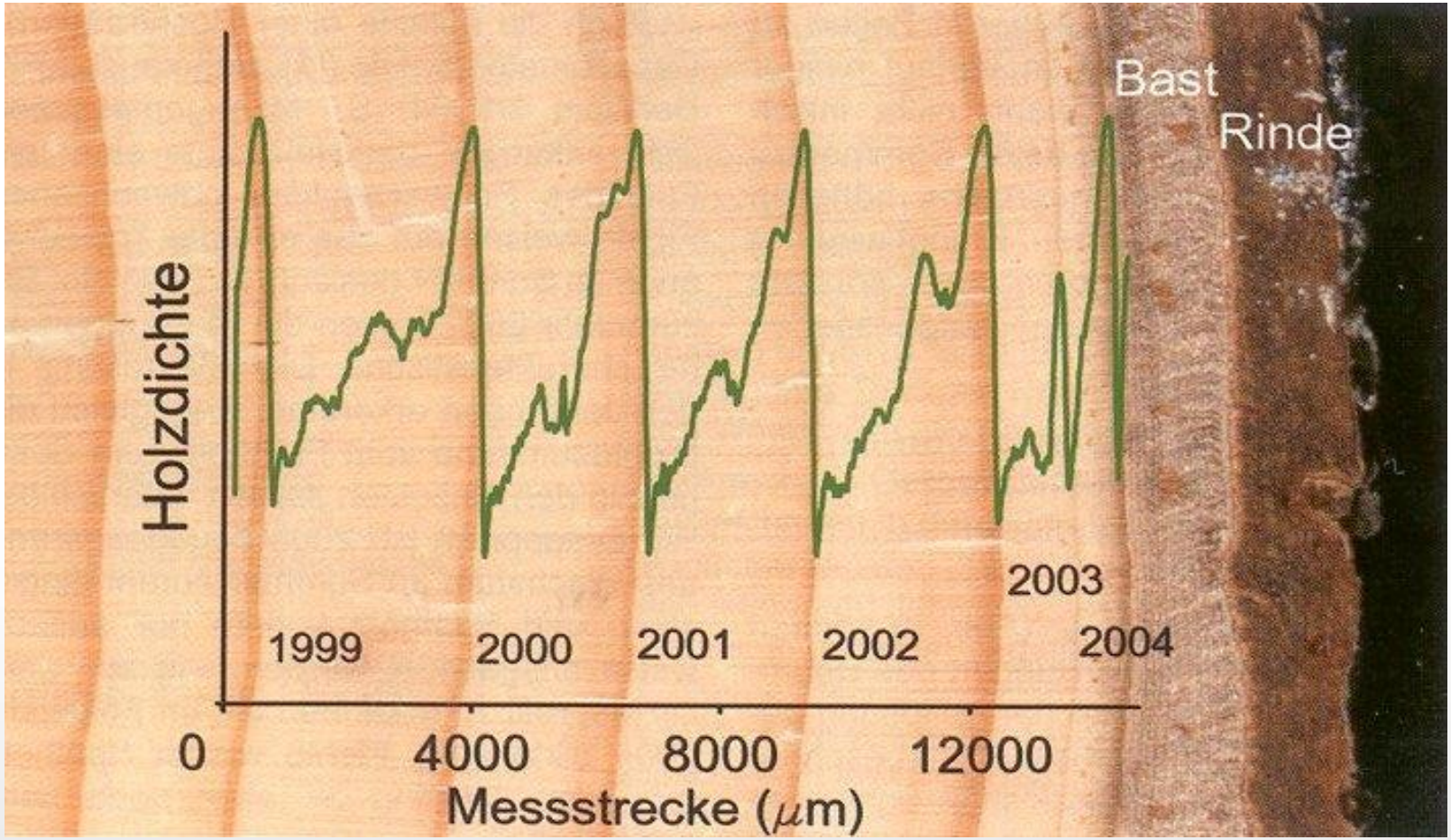
Figure:
Jansen 2013; based on McDowell et al. 2008, New Phytologist

Spiral model of tree decline

acc. to Franklin, 1987

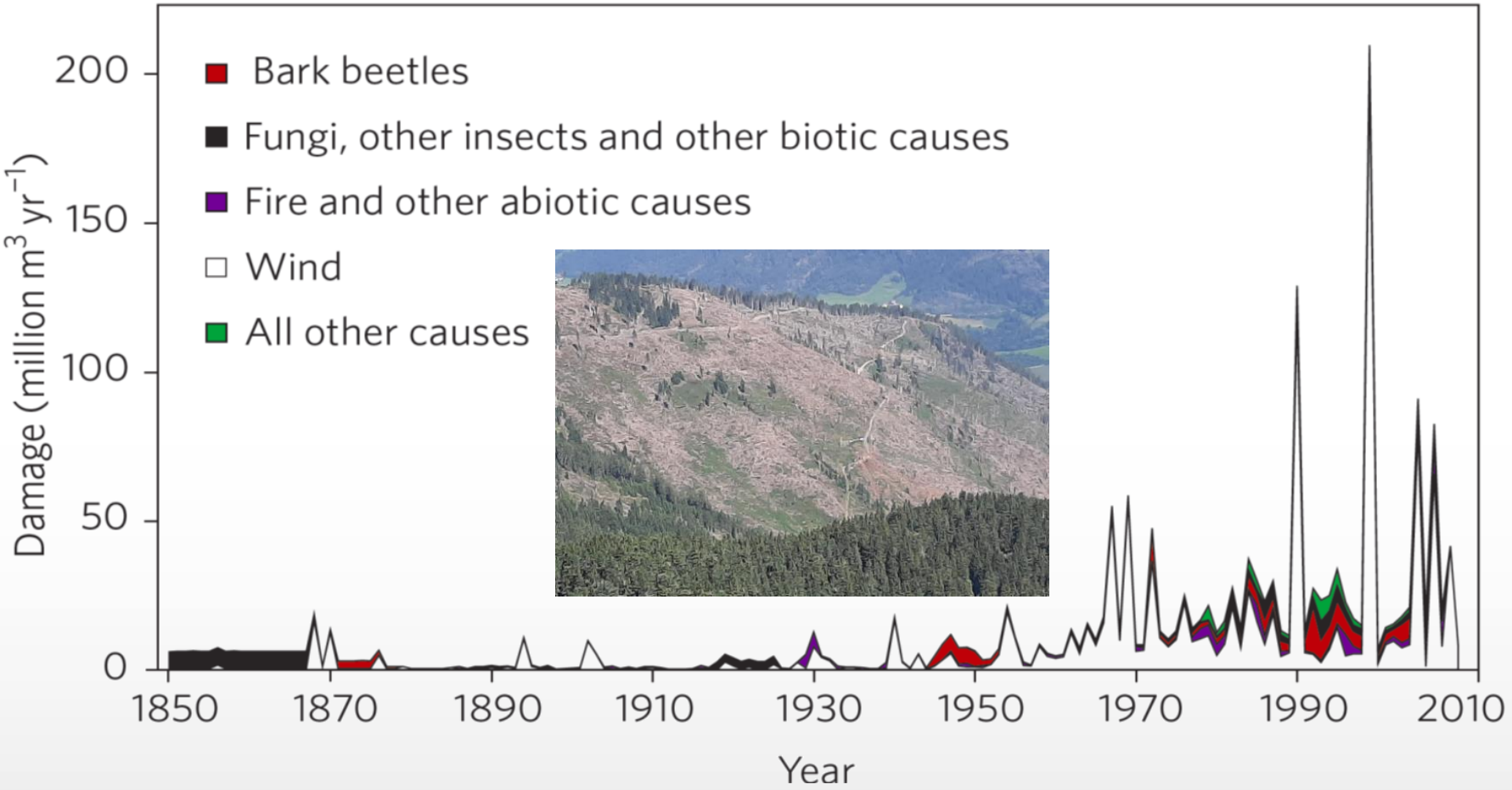


Response: productivity



Source: Spiecker 2005 (measurement with high frequency densitometer)

Response: salvage cutting



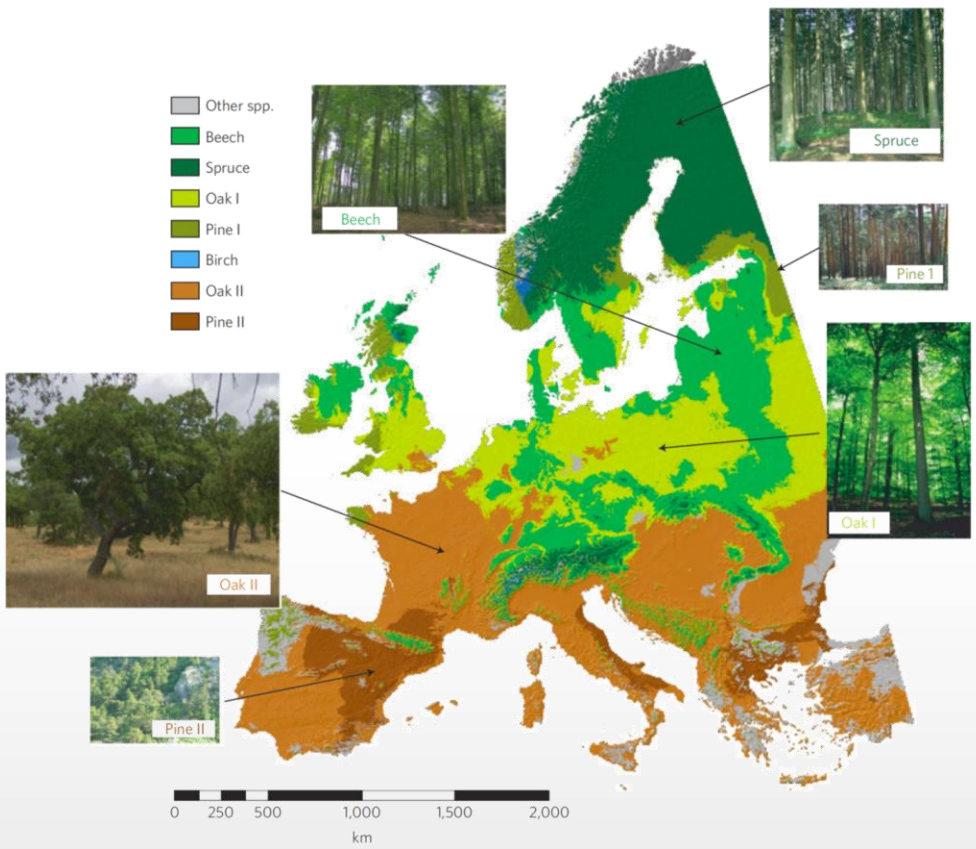
Source: Nabuurs et al. 2013

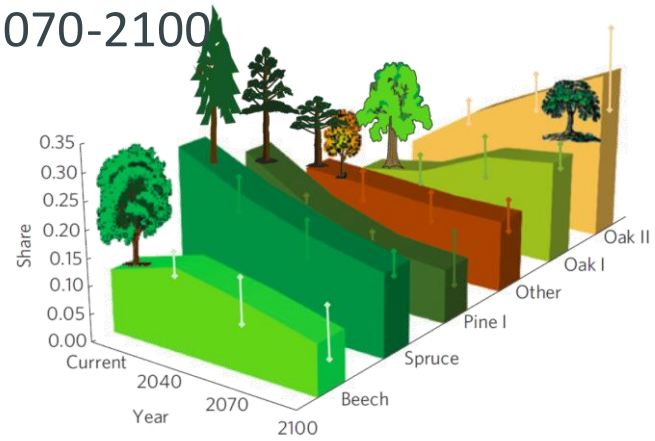
Response: range shift…

Photo: Rigling, WSL

…and economic losses

Projection distribution of forest types in Europe 2070-2100





Projected decline of spruce and pine forests, increase of sub-mediterranean (oak) forest types

Loss of 28% (14 – 50%) of the current forest value in Europe

Source: Hanewinkel et al., 2013

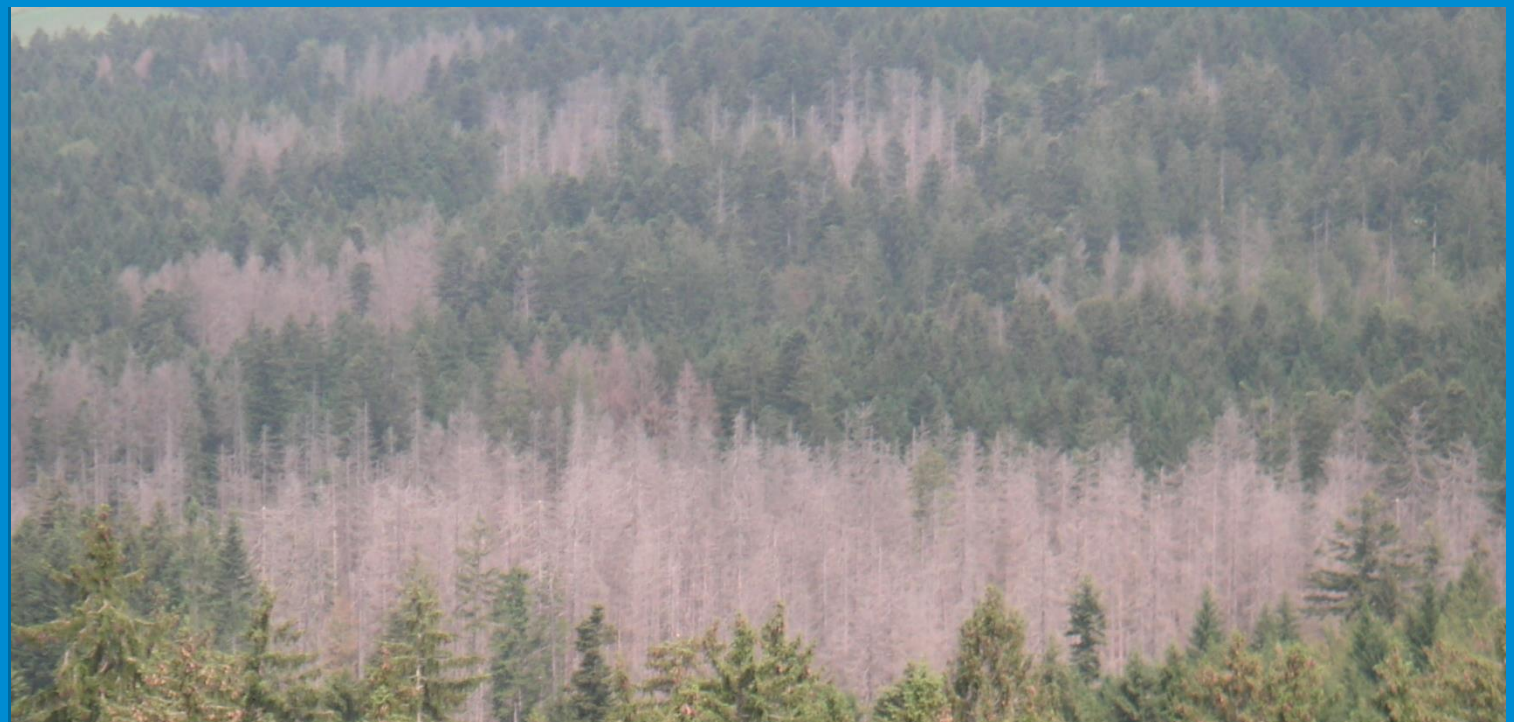
What is climate-smart forestry (CSF)?

CSF has three pillars

- Removing CO2 to mitigate climate change (cc)
- Adapting forest management to enhance resilience, and
- Active forest management aiming to increase productivity and other benefits (ES)

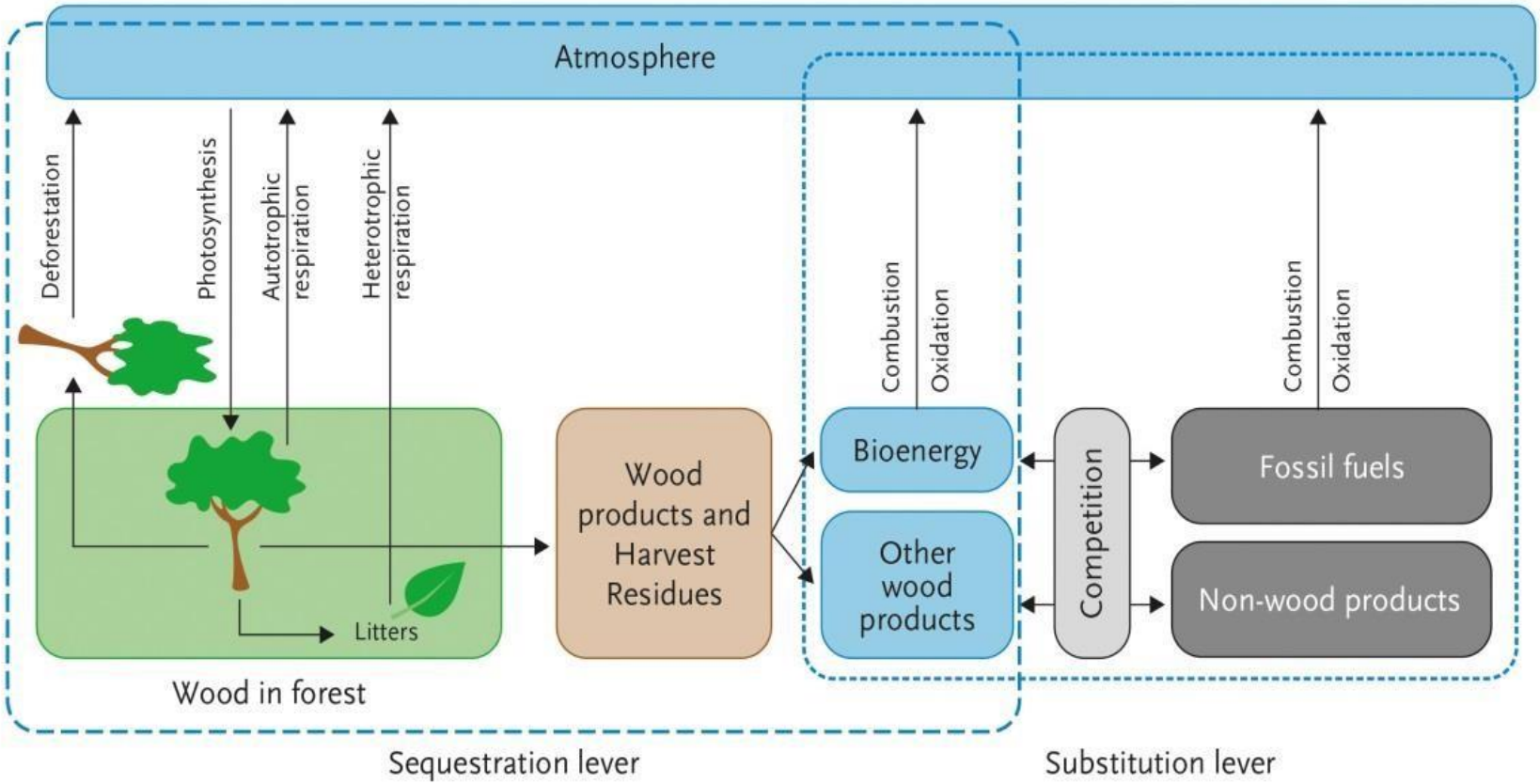
- *CSF is not aiming to substitute SFM, but aims to optimize forest management in response to climate change (acc. to Bowditch et al. 2020, Ecosystem Services)*

Mitigation



Bavarian forest, National ParkP

Forest-related carbon stocksin reservoirs and flows acc. to Nabuurs et al., 2015



Forest landscapes as carbon sinks?

Figure by EFI, 2018

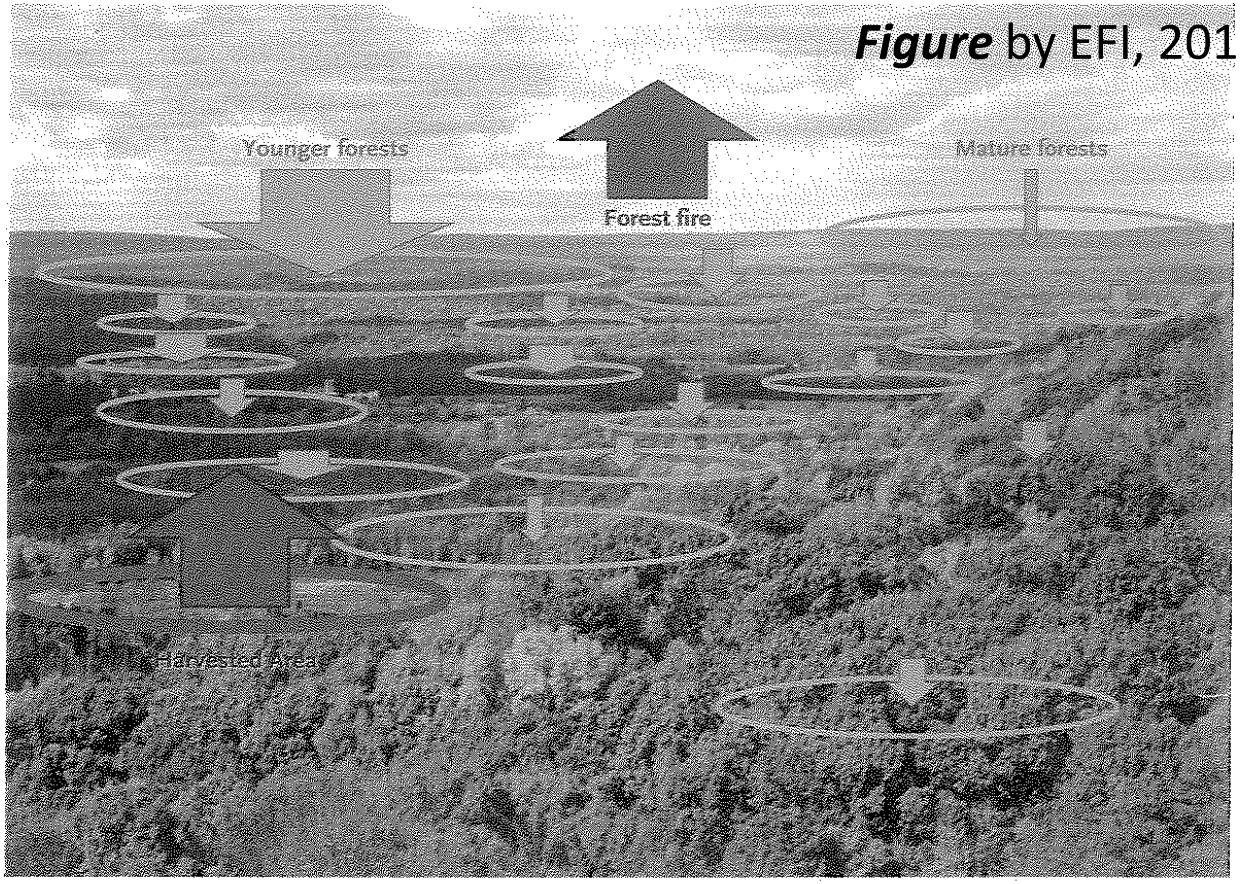


Figure 4. Forest management is planned and coordinated across a mosaic of forest stands to supply a continuous flow of biomass for multiple forest products. The carbon balance switches abruptly from sequestration to emissions when there are fires or stands are harvested (red arrows). But carbon losses in some stands are counteracted by carbon gains in other stands (green arrows, varying size to illustrate variation in sequestration rate), so that across the whole landscape the forest carbon stock fluctuates around a trend line that can be increasing, decreasing or roughly stable. The carbon balance at the landscape level is affected by many factors and taken together, these may have a positive, negative, or neutral influence on the development of forest carbon balances. Figure: National Council for Air and Stream Improvement.

Are the German forests sinks?

YES….

- Carbon storage in forests around 170 t / ha in 2012
- ❖ 60 % aboveground living and dead biomass, 40 % belowground
- +…still positive annual rate of C storage (forest sink)

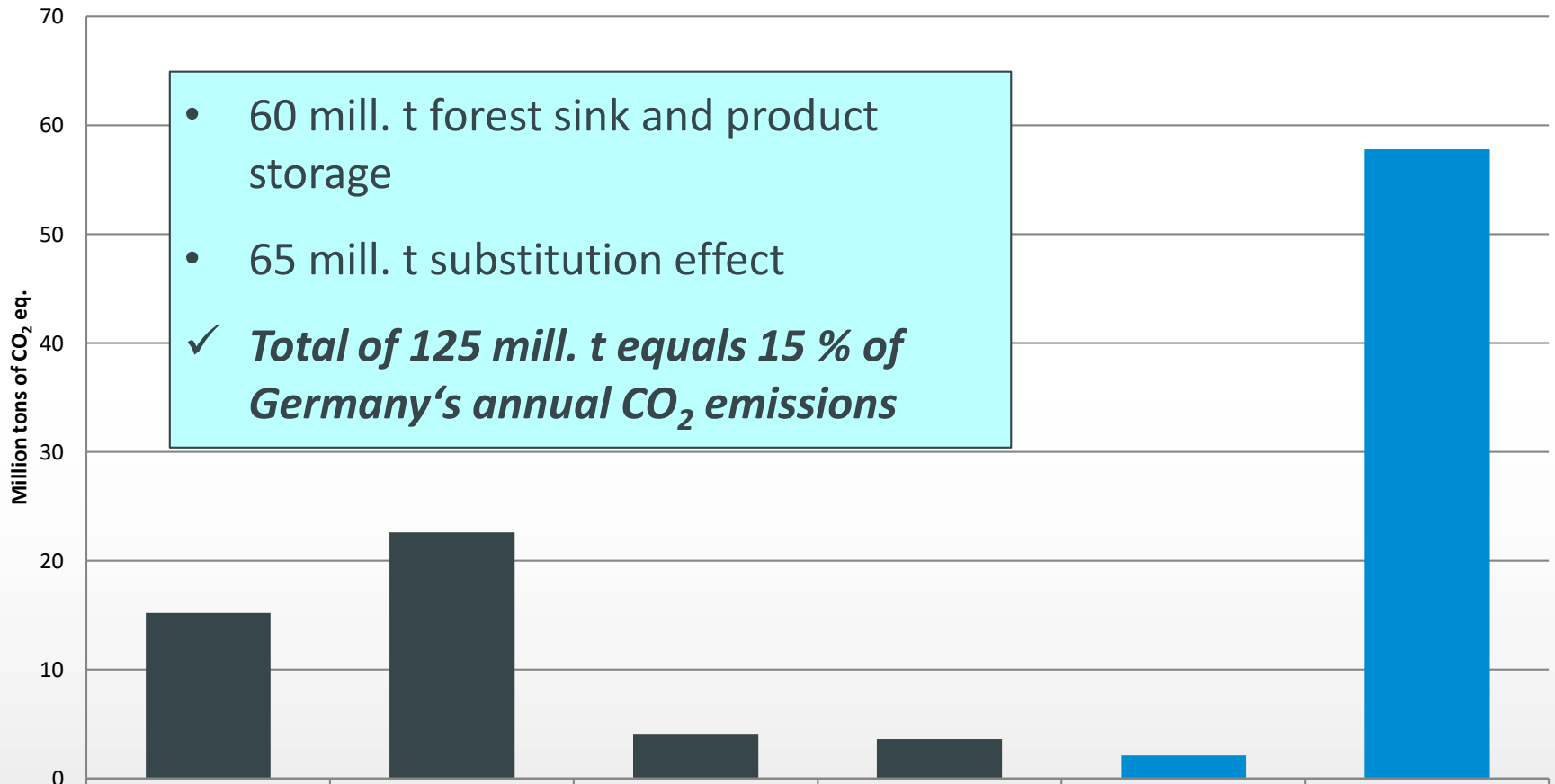
➢ **Forecast:** sink effect of German (and European*) forests will decline in the next years

✓ *…due to species change (mortality), changing age class distribution, downturn of increment trends,…increasing disturbance intensity (salvage)*

* *acc. to Nabuurs et al., 2013 ; Nature Climate Change*

LULUCF sector in Germany

Emissions and sinks in LULUCF 2016



	Arable land	Grassland	Wetlands	Settlements	Timber products	Forests
Sinks 2016					2,1	57,8
Emissions 2016	15,2	22,6	4,1	3,6		

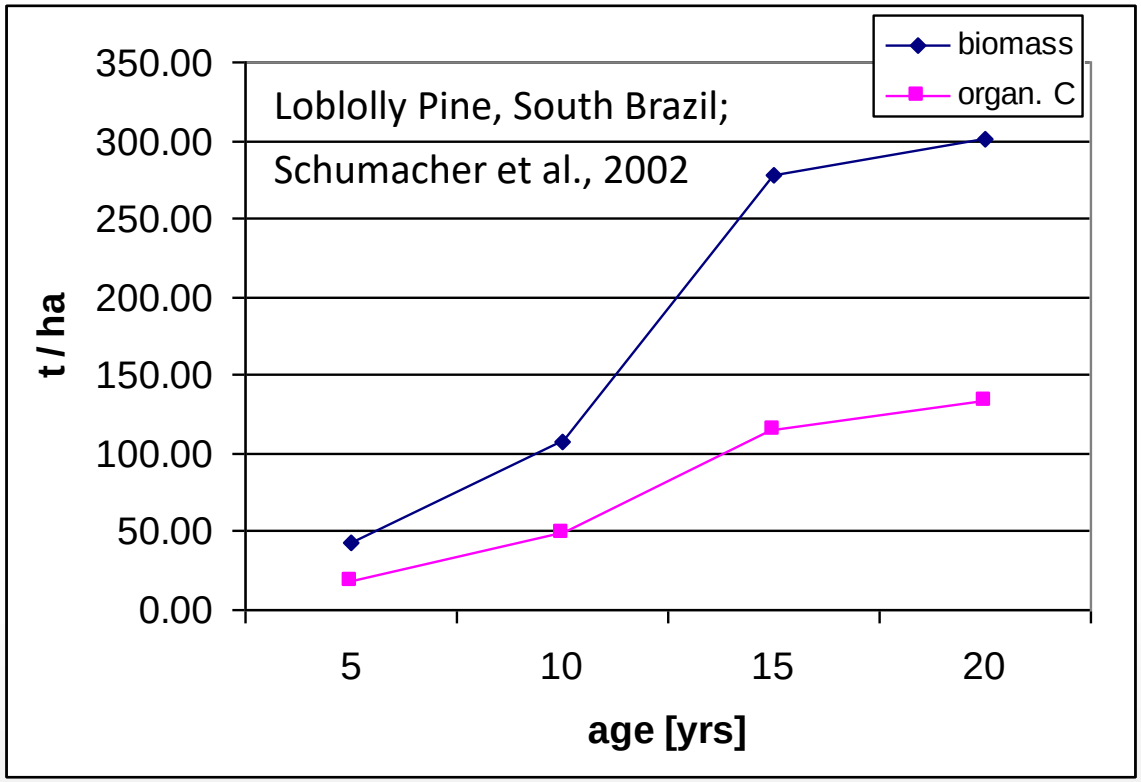
Mitigation

Measures to enhance the forest sink:

- Afforestation on ‘new lands’
- Tree species choice (specific gravity of trees), mixture
- Increase of rotation length, more deadwood
- Optimization of silviculture for carbon-efficient management (thinning intensity, implementation of CCF, …)
- Reduction of disturbance intensity (pest and fire management)
- Conserve high carbon stocks in old forests and in forests on sensitive sites

➢ **Controversy:**
What is better for carbon storage? Set-aside or managed forests?

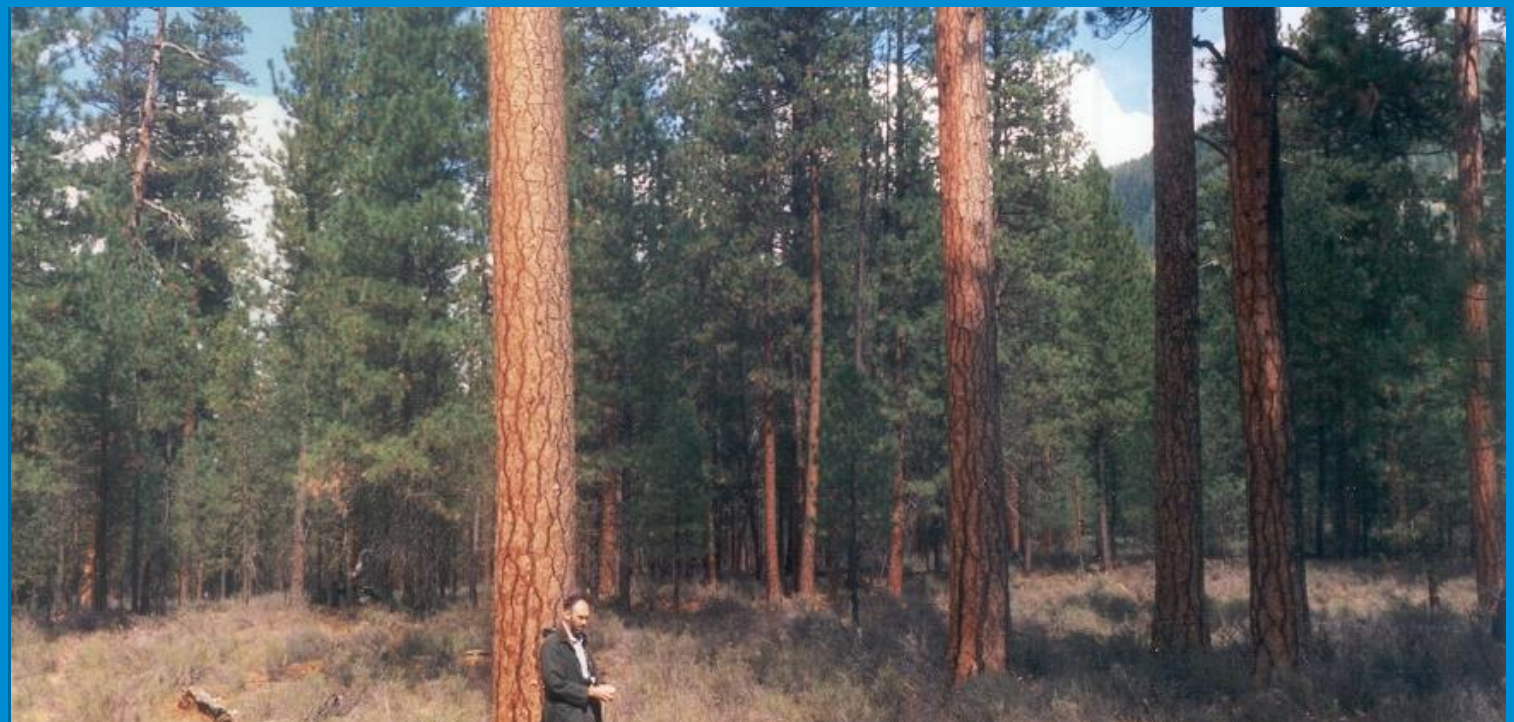
Climate protection through old-growth forests?



Note:

Small carbon stocks in planted forests,
but high sequestration rates, compared to unmanaged forests or selectively managed natural forests

Forest adaptation



Ponderosa pine, USA

Adaptation

(1) Long-term evolutionary adaptation

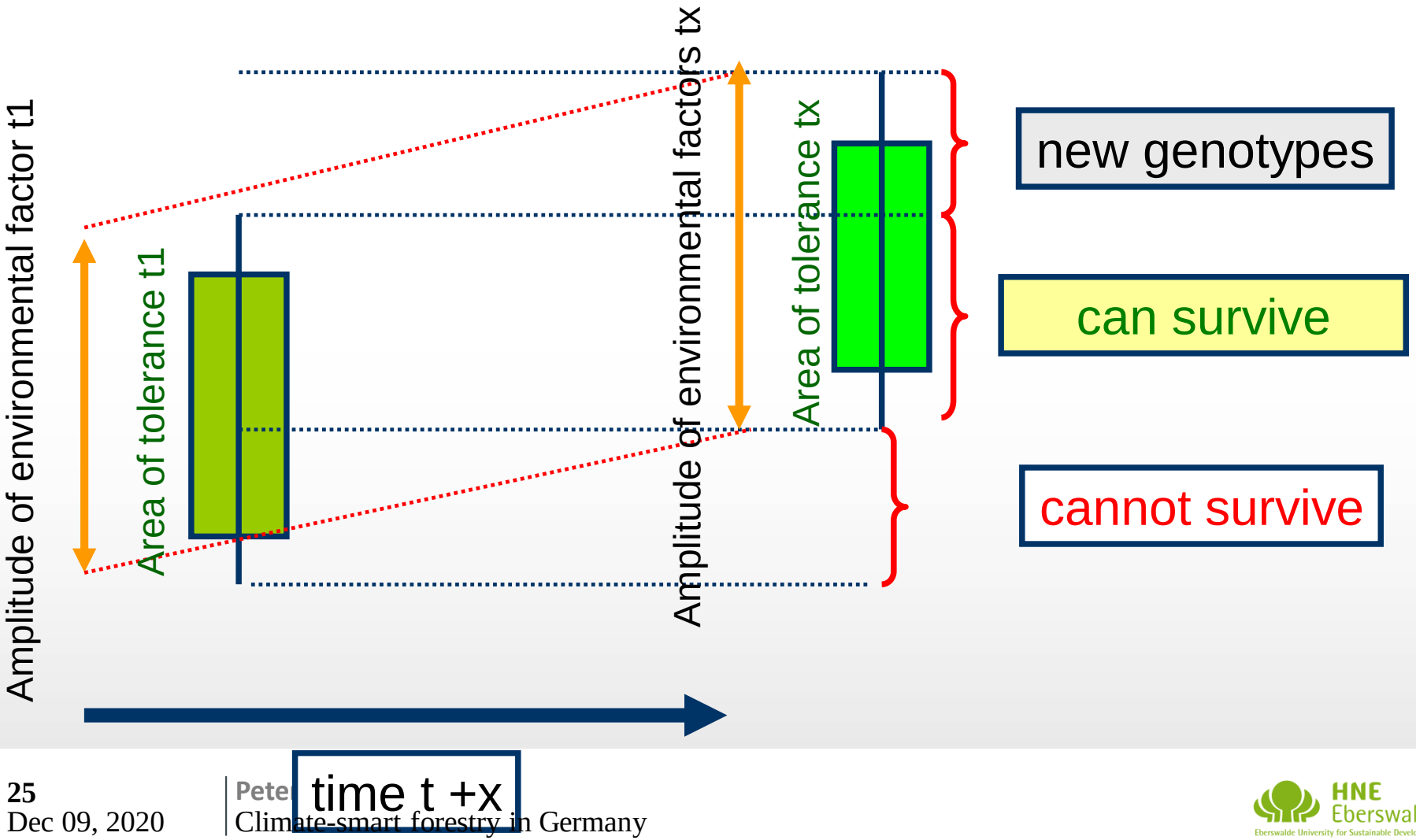
- ability of *<u>populations</u>* to create new genotypes (of special interest: so-called adaptive traits)
- over one or more generations, due to selection processes (--> genetic variability of populations and reproduction strategies of trees)

(2) Short-term phenotypic plasticity

- due to *<u>individual</u>* response of plant morphology and/or physiology

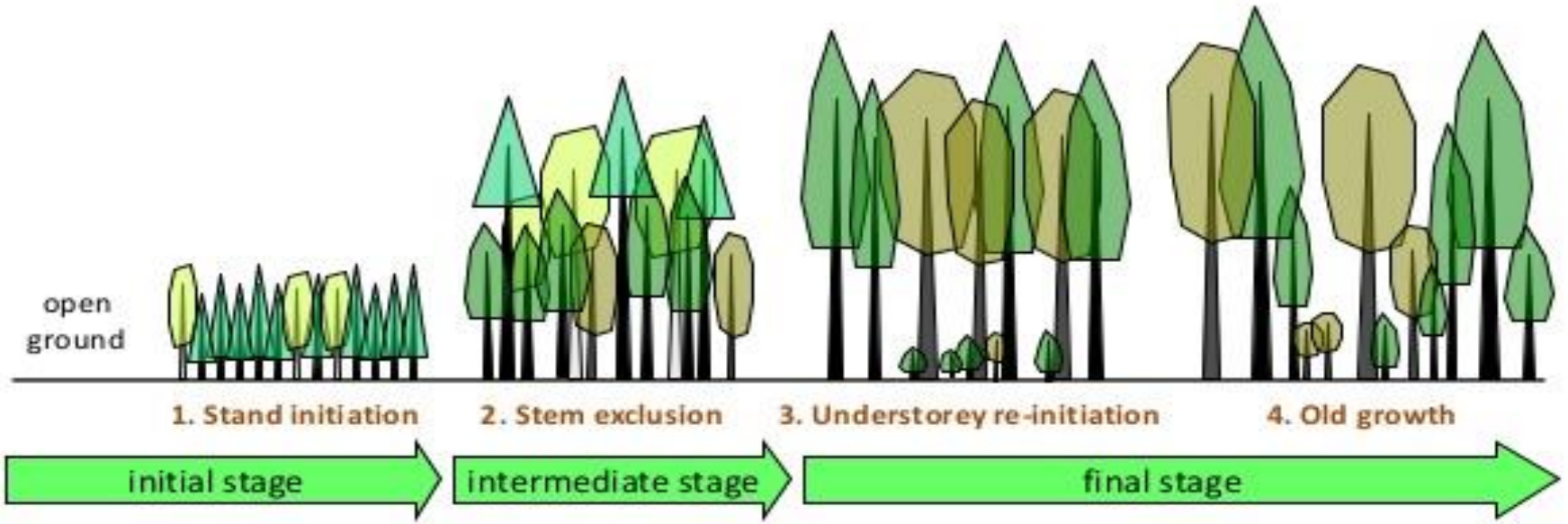
Variability and evolutionary adaptation

acc. to Kätzel, 2015



Strategies for Enhancing Forest Resilience

Development stages in a natural forest



Intervention Options linked to Enhanced Resilience

- Species choice
  - genetics/provenance
- New species introduced
- Wider use of "minor" species
- Mixed species
- Assisted migration of native species

- Modify thinning regimes
- Modify harvesting systems

- Extended "rotations"
- Diversify stand structures (i.e., CCF)

Source: Wilson and Leslie, 2008

Diagram based on Oliver and Larsen 1996
Adapted from graphic by Jens Haufe

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Forestry 2014; **0**, 1–12, doi:10.1093/forestry/cpu018

Suitability of close-to-nature silviculture for adapting temperate European forests to climate change

Peter Brang[1]*, Peter Spathelf[2], J. Bo Larsen[3], Jürgen Bauhus[4], Andrej Bončina[5], Christophe Chauvin[6], Lars Drössler[7], Carlos García-Güemes[8], Caroline Heiri[1], Gar… Urs Mühlethaler[13], Susanr…

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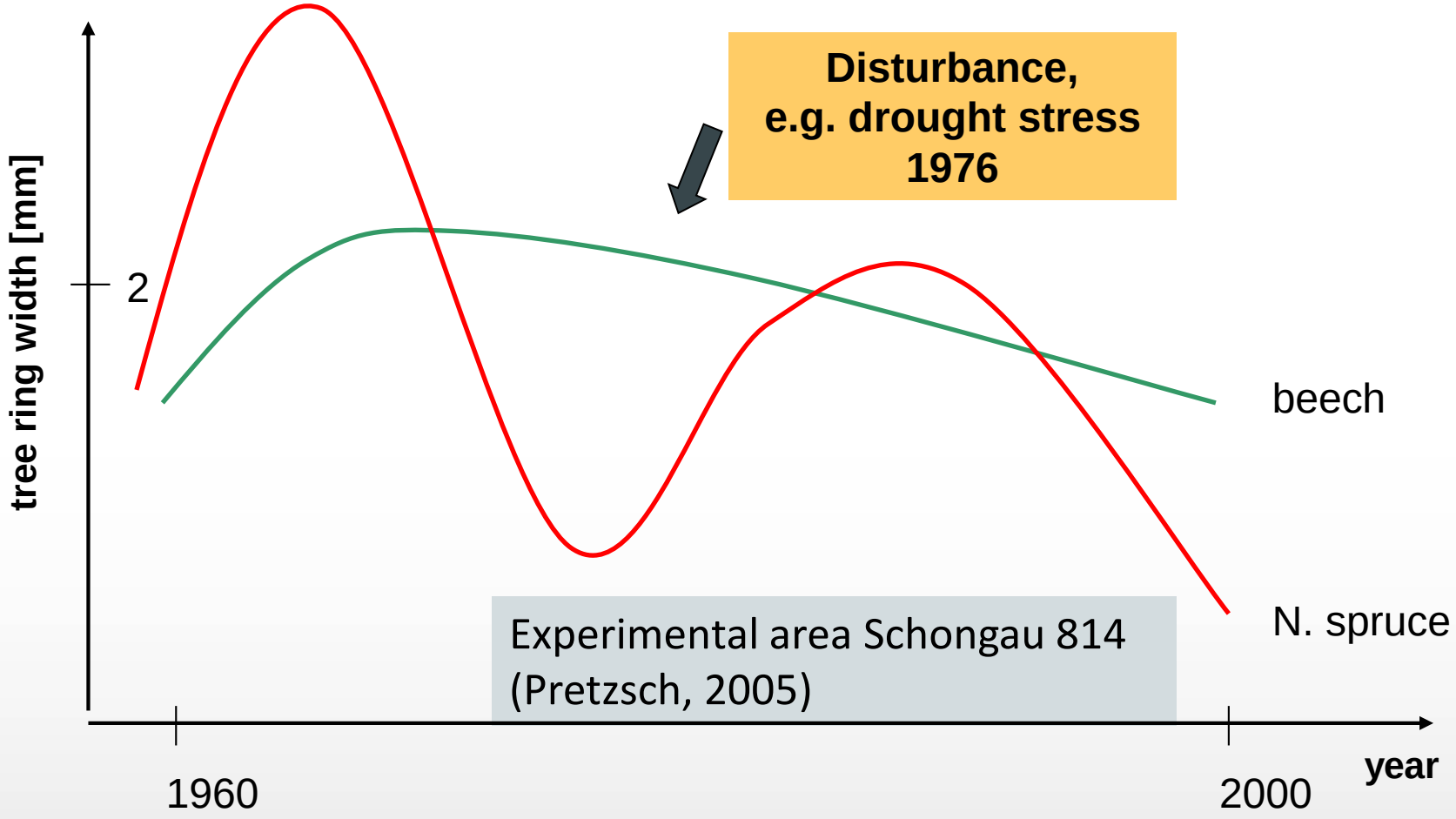
[7]*Southern Swedish Forest Research Centre, Swedish Uni…*
[8]*Servicio Territorial de Medio Ambiente, Junta …*
[9]*Forest Research, Alice Ho…*
[10]*University of Natural Resources and Life Scie…*

- Increase of species richness and structural diversity
- Maintenance of genetic diversity of stands
- Increase of ecological resilience and resistance of tree species
- Reduction of rotation and target diameter, respectively

Species richness and resilience



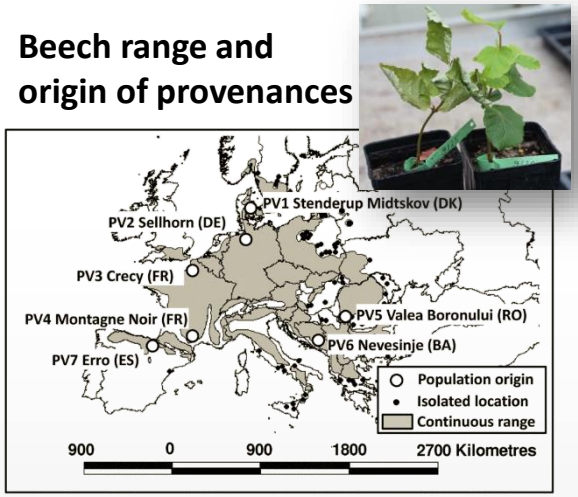
→Principle of *ecological insurance*

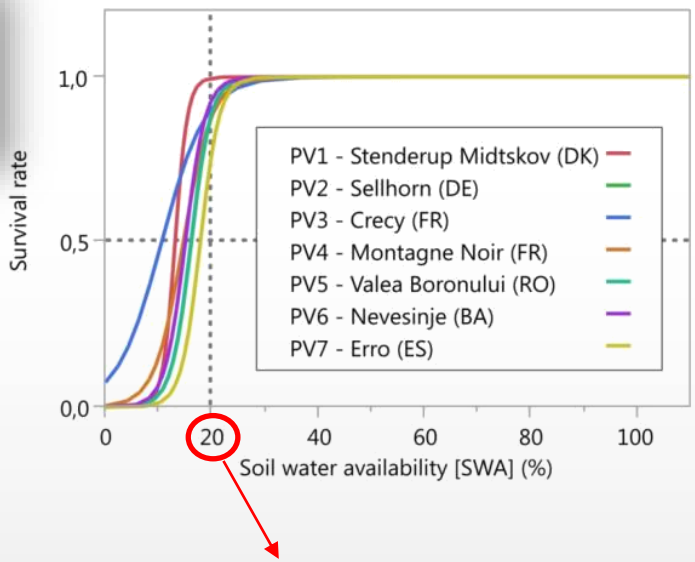
Critical drought threshold, risk modelling

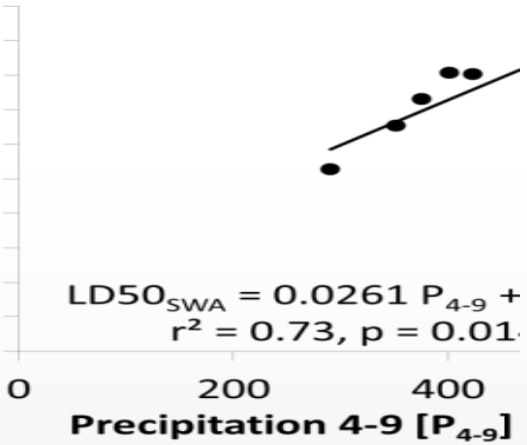
$LD50_{SWA}$: Remaining soil water availability where 50% of tree population survived

Inducing lethal drought → ***Derivation of critical thresholds ($LD50_{SWA}$)*** → ***Correlation to climate at population origin***

Beech range and origin of provenances







Critical threshold $LD50_{SWA}$ ≈ 20% (conservative approach)

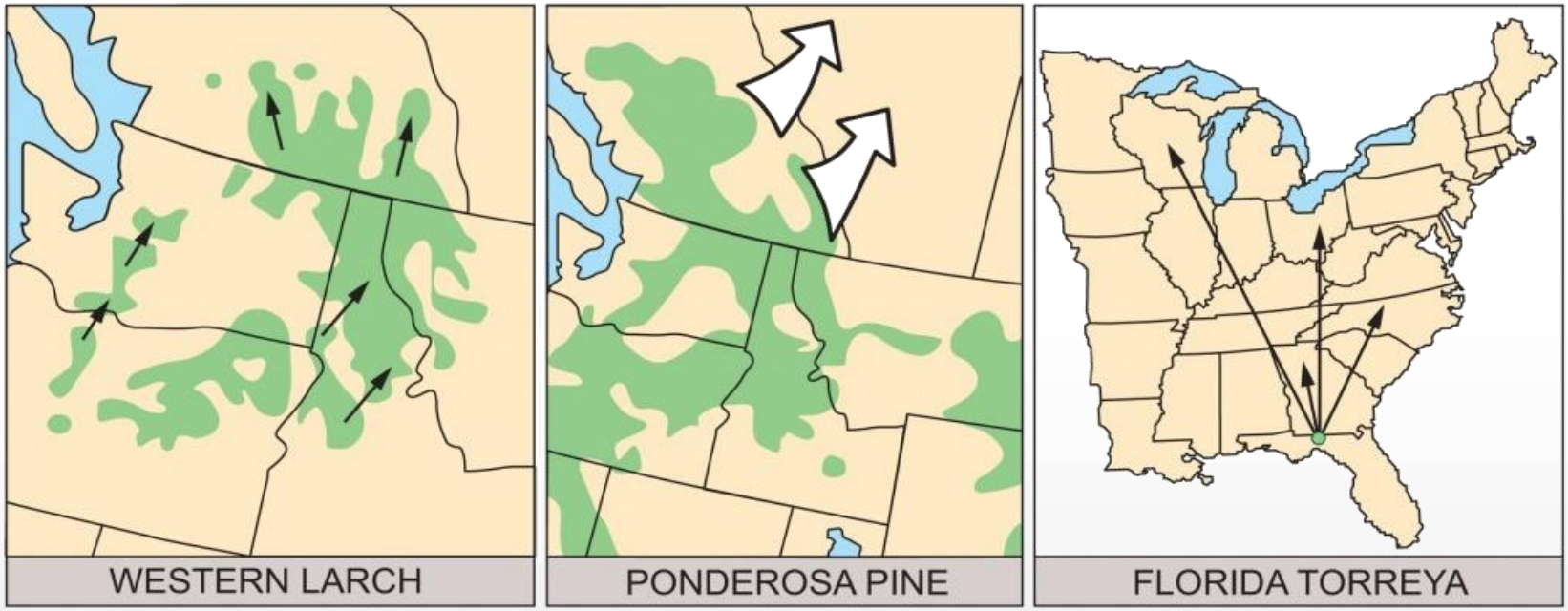
Source: Bolte et al., 2016

Assisted migration

Williams and Dumroese, 2014

- **Assisted migration = planned migration of a species !**

Transfer of provenances within a species range | **Extension of species range** | **Establishment of species**



Slawonic oak | **Downy oak** | **Red oak**

Introduction of non-native tree species - a success story?

Non-native species: Pros and Cons

- ❖ Growth and value performance
- ❖ Risk minimization
- ❖ Adaptation to drought
- ❖ Acceptance in CCF
- \- Decrease in habitat quality
- \- Susceptibility to damages, invasiveness

Potentially suitable non-native tree species in Germany

- Turkish hazel
- Cedar species
- Mediterranean oaks
- …more Asian and North American species such as Hemlock fir and Ponderosa pine

Successfully introduced alien species Brandenburg (Lockow, 2004)

- Douglas fir
- Red oak
- Western red cedar
- Japanese larch
- Grand fir

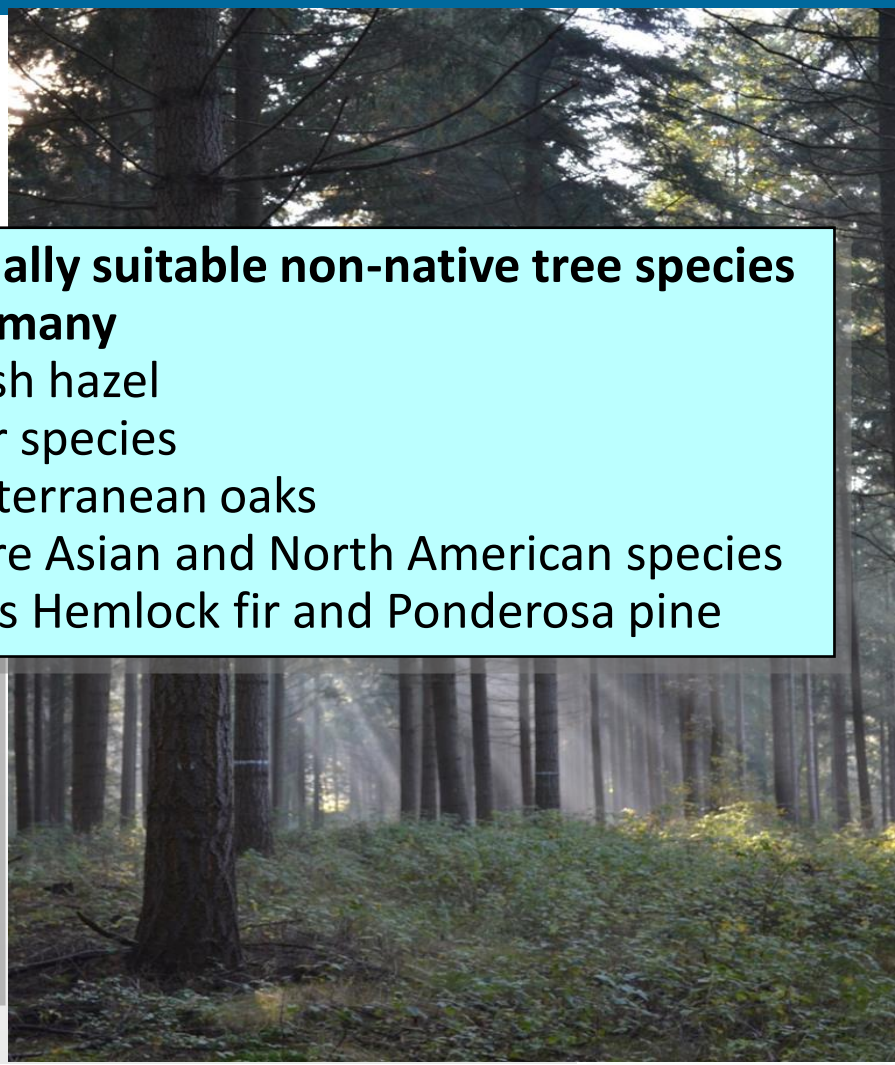


Photo: Douglas fir stand near Eberswalde

Stand legacies and old-growth attributes

Structured forests are more resistant and resilient against disturbances

– Advanced growth increa

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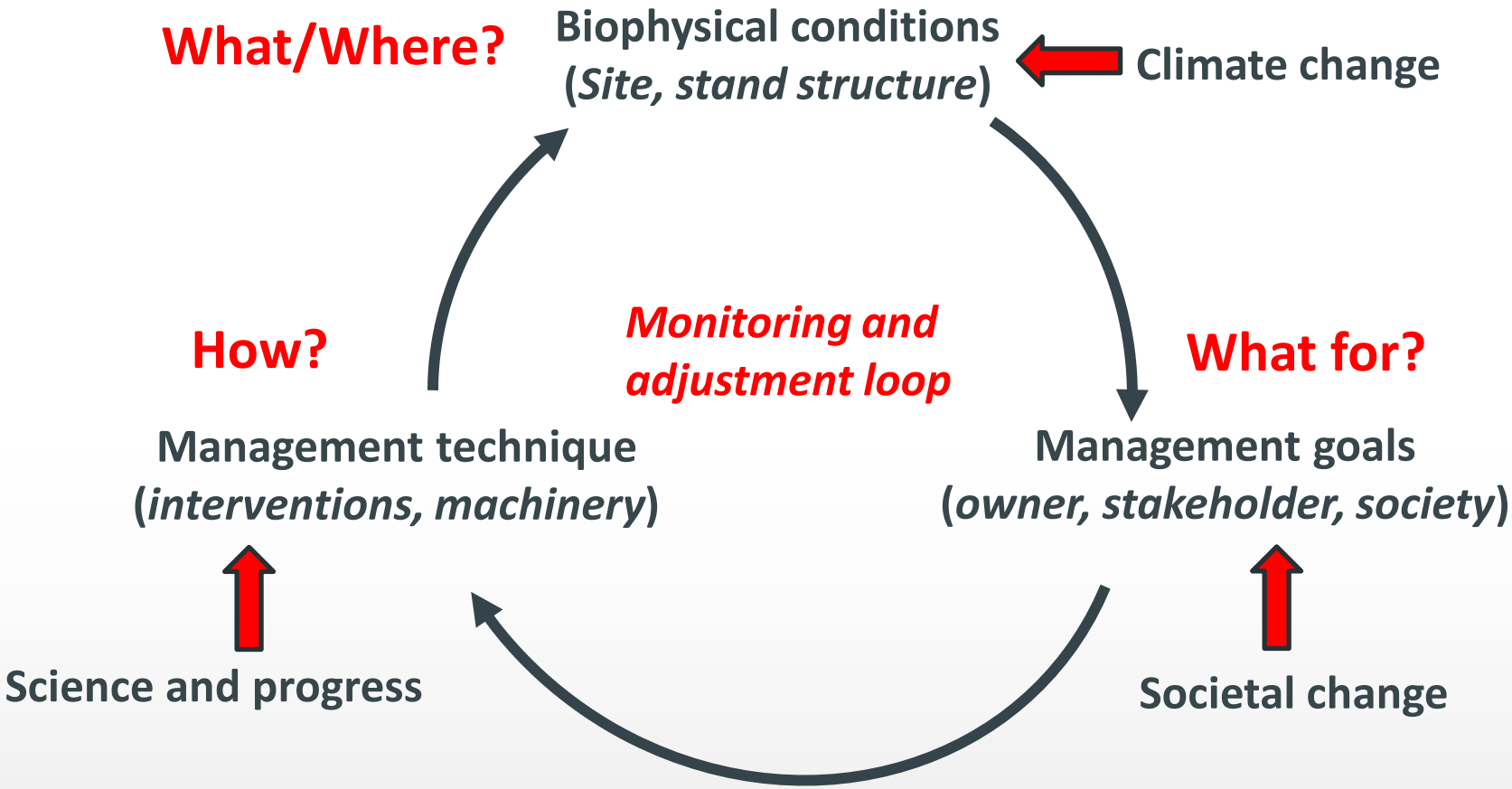
Managing for resilience – The Adaptive Forest Management (AFM) concept



Source: Bolte et al., 2020, in prep.

Do we already practice CSF?

<u>Remember:</u> CSF is not aiming to substitute SFM, but is more targeted to increase the climate benefits from forests (Nabuurs et al., 2018, From science to policy 6, EFI)

- ✓ ***Y E S, but…your opinion???***

Muito Obrigado!

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