LIST OF SESSIONS

FORESTS & SOCIETY TOWARDS 2050

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26th WORLD CONGRESS IUFRO
FORESTS & SOCIETY TOWARDS 2050

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Technical Theme 1
Strengthening forest resilience and adaptation to stress

Climate-smart pine forest management

The global change crisis is happening in front of our eyes. Climate-driven changes affect strongly tree growth, survival and disturbance dynamics in pine forests, similar to other forest ecosystems. The realised positive effects of climate change, such as higher growth rates and extended vegetation periods in boreal forests, are totally overshadowed even there by associated negative phenomena: warming, changing precipitation, an altered pattern of extreme weather events, forest fires and insects herbivores outbreaks. In temperate, Mediterranean and subtropical pine forest ecosystems, even climate and pest-prone decline events are reported, and major shifts in species composition of forests and woodlands are expected.

Many of these adverse consequences of climate change can be avoided, mitigated or at least delayed by implementation of adaptive forest management. Pine and mixed pine-broadleaves forests have a significant potential to become a vital part of these efforts. On the other hand, the role of pines for plantation forestry is paramount worldwide, providing essential ecosystems services such as timber, biomass and NWFPs provisioning for a bio-based economy.

This session intends to address the issue of forest management adaptation to climate changes, with the focus on pine forests. Both adaptation and mitigation efforts are of interest. The most important questions are: how to incorporate mitigation of the negative impacts of climate change into forest management and how to combine it with other ecological, social and economic goals? In this session we would welcome contributions that (i) implement adaptive concepts into forest management (ii) change stand structures and tree species composition in ways that make the resulting forest better adapted to the climate and maintain/increase genetic diversity (iii) use natural forest dynamics for optimizing stand development (iv) predicts, quantify and explore impacts of climate change on pine forests.

The objectives of the technical session are (i) to create space for presentation of current results of scientific work in the field of forest management and climate change adaptation, (ii) facilitate information and knowledge exchange and (iii) finally encourage discussions and collaborations between researchers from different disciplines.

Mikolaj Lula[1] , Emma Holmström[1], Teresa F. Fonseca[2], Santiago C. González-Martínez[3], Miren del Río[4], Sven Mutke[5]

[1] Southern Swedish Forest Research Centre

[2] Coordinator WP1.01.10 Ecology and Silviculture of Pine

[3] Coordinator Division 2 Physiology and Genetics

[4] Deputy RG1.09.00 Ecology and silviculture of mixed forests

[5] Coordinator RG1.08.00 Silviculture for edible NWFP

Climate-adapted silvicultural strategies for harvest cuts of Scots pine (*Pinus sylvestris* L.) stands in Northern Germany

Hergen Christian Knocke[1, 2, 3], Jan Hendrik Hansen[1], Ralf-Volker Nagel[1], Matthias Albert[1, 2]

[1]Northwest German Forest Research Institute, Department of Forest Growth, Göttingen, Germany [2]Georg-August-University, Faculty of Forest Sciences & Forest Ecology, Göttingen

[3]Ministry for Climate Protection, Agriculture, Rural Areas & Environment Mecklenburg-Western Pomerania, Department of Climate Protection, Nature Conservation & Forests, Schwerin

Quo vadis Scots pine? – Let´s simulate!

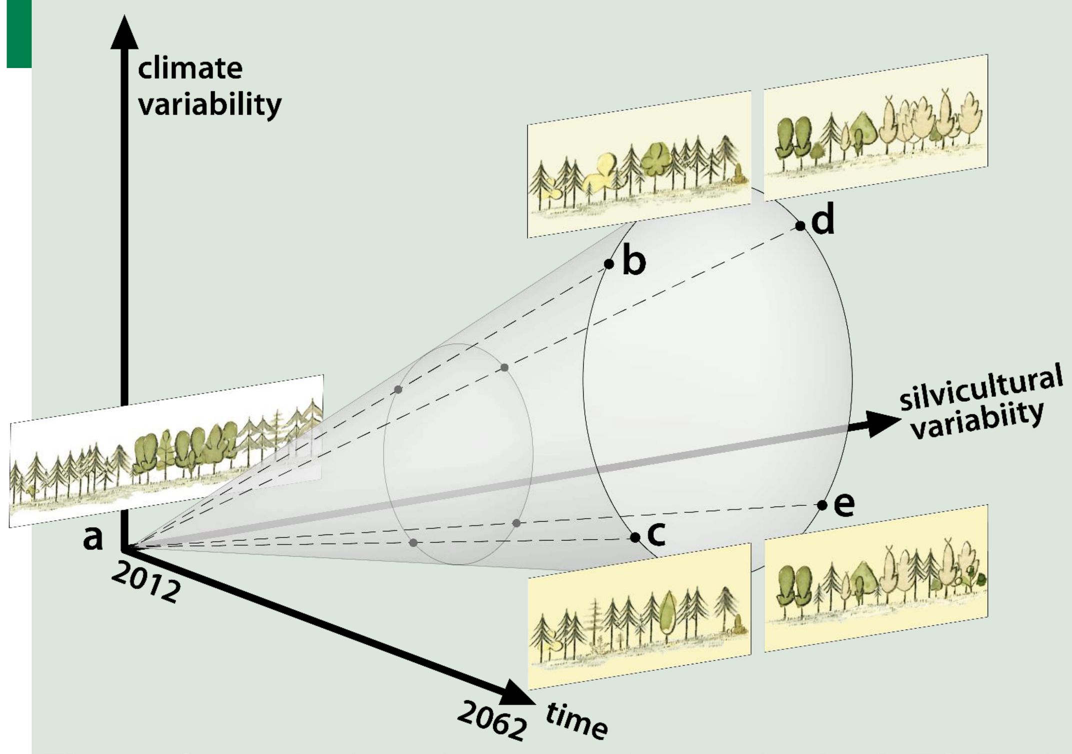

Fig. 1 Scenario funnel: **a** Today's stands, **b+d** EC-Earth (RACMO) & **c+e** HadGEM2 (WettReg13) with **b+c** maximum & **d+e** minimum pine share for forest restoration

- Scots pine is of greatest importance in Northern Germany: It has the biggest cultivation area and high capability to perform in climate change
- pine mainly occurs in monocultures which have to be restored to mixed stands – yet, future development of pine remains uncertain due to leeway in silvicultural guidelines and future climate
- what is the range of uncertainty in forest landscape restoration (FLR)?

→ **in 2062 the predicted FLR ranges only from 50-72%: Under the given management concepts restoration is alarmingly slow.**

→ **amid the rapidly changing climate, the management guidelines must be adjusted**

Material & Methods

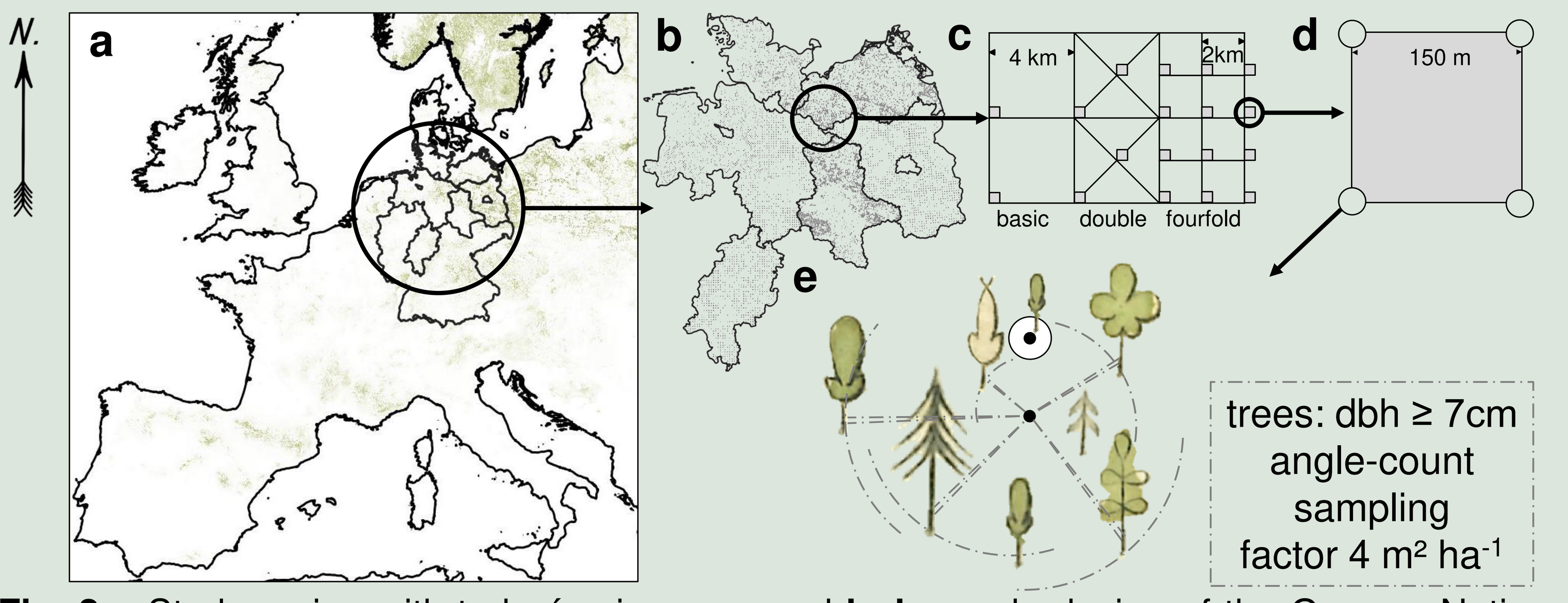

Fig. 2 a Study region with today´s pine area and **b-d** sample design of the German National Forest Inventory, **e** whose trees are the starting point for our simulations

1. regionalizing RCP 8.5 climate models (EC-Earth & HadGEM2)
2. algorithm-based selection of climate- and site-sensitive Forest Development Types (FDT, maximizing or minimizing pine´s share) for six German federal states → Fig. 1+2
3. generating virtual forest stands and updating climate-sensitive growth
4. quantifying silvicultural guidelines & simulation in steps of 5 years using the single-tree growth simulator *WaldPlaner* with...

... Our silvicultural strategies

- tree species selection and stand treatment based on FDT by future climatic water balances
- shelterwood cuts/ seed tree systems within close-to-nature/ continuous cover forestry
- target diameter pine: 45cm dbh unpruned, 55cm dbh pruned
- maturity definition (harvest start): 25 or 50% stand basal area (BA) above target dbh
- thinning intensities according to yield tables → Fig. 3

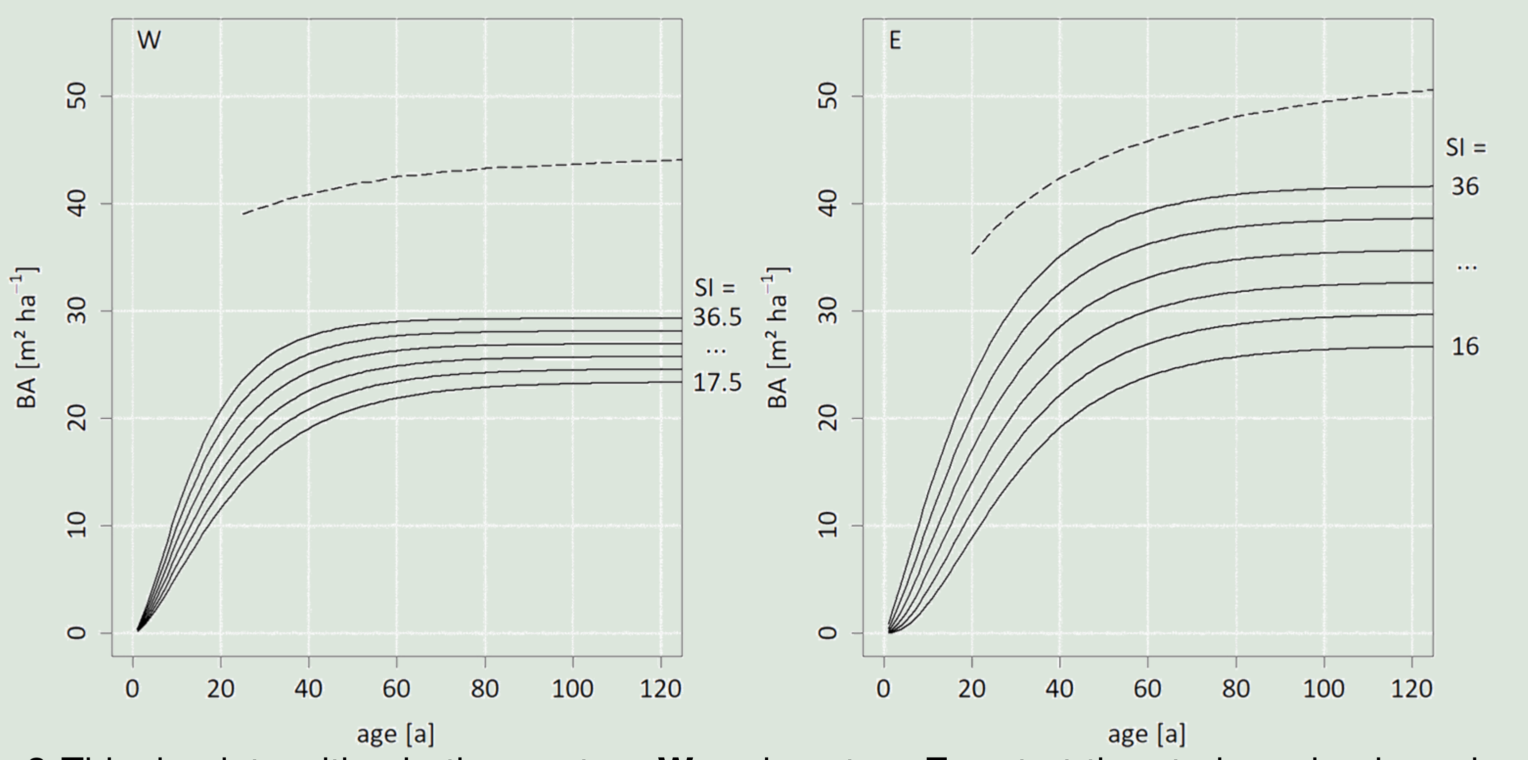

Fig. 3 Thinning intensities in the western **W** and eastern **E** part ot the study region based on silvicultural guidelines and yield tables for different site indices (SI). Dashed line represent maximum denisty

Results

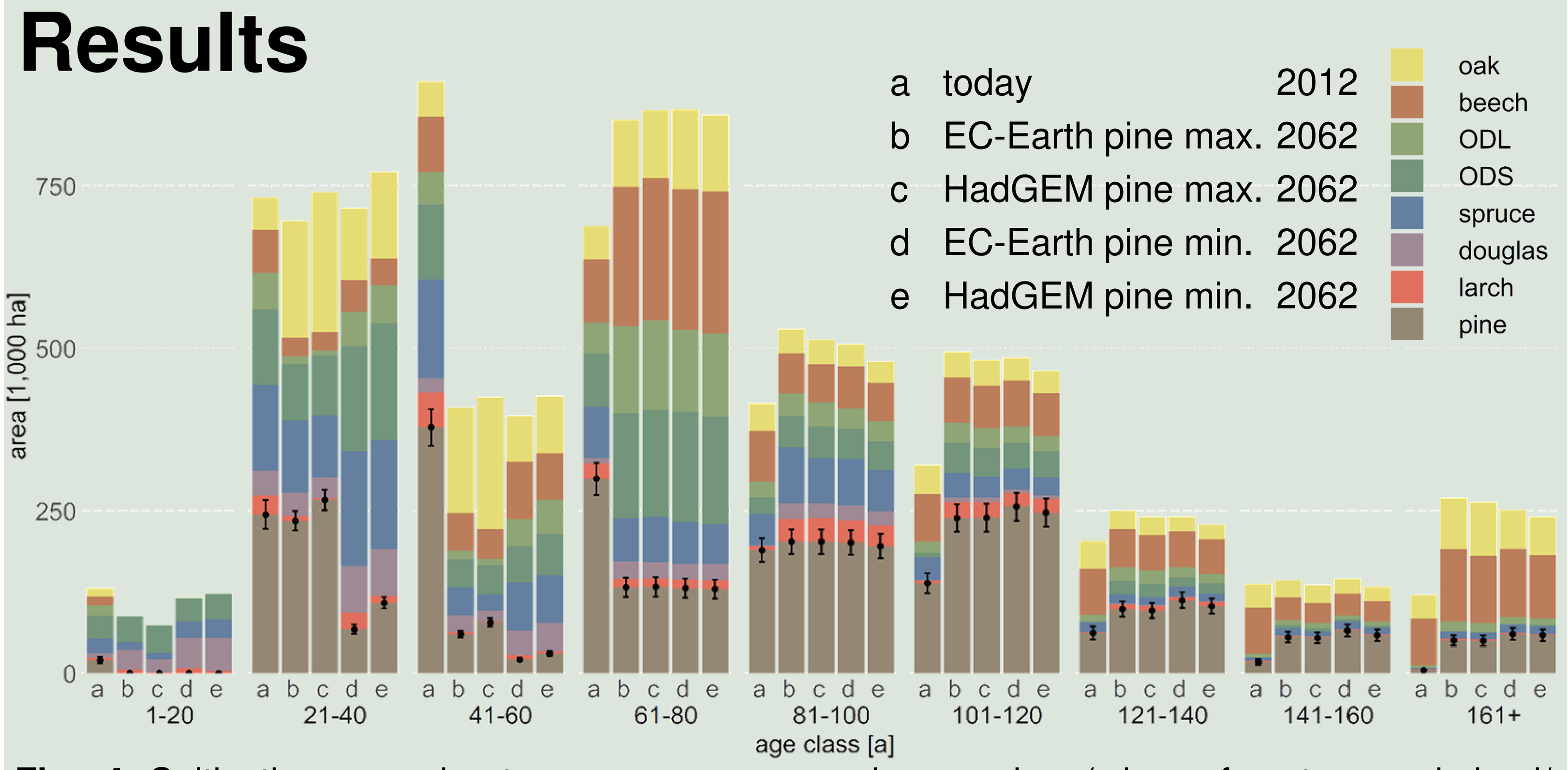

Fig. 4 Cultivation area by tree spp. groups and scenarios (where forestry maximized/ minimized pine's share in FLR; ODL/ ODS: Other deciduous with long/ short life expectancy)

- age-class distribution remains uneven → Fig. 4
- pine's extent is decreasing from (a) 1.358 million hectares towards a minimum of 68% (d) and 83% at maximum (c) – even if pine is promoted (b+c)
- old stands > 101 years age increase strikingly

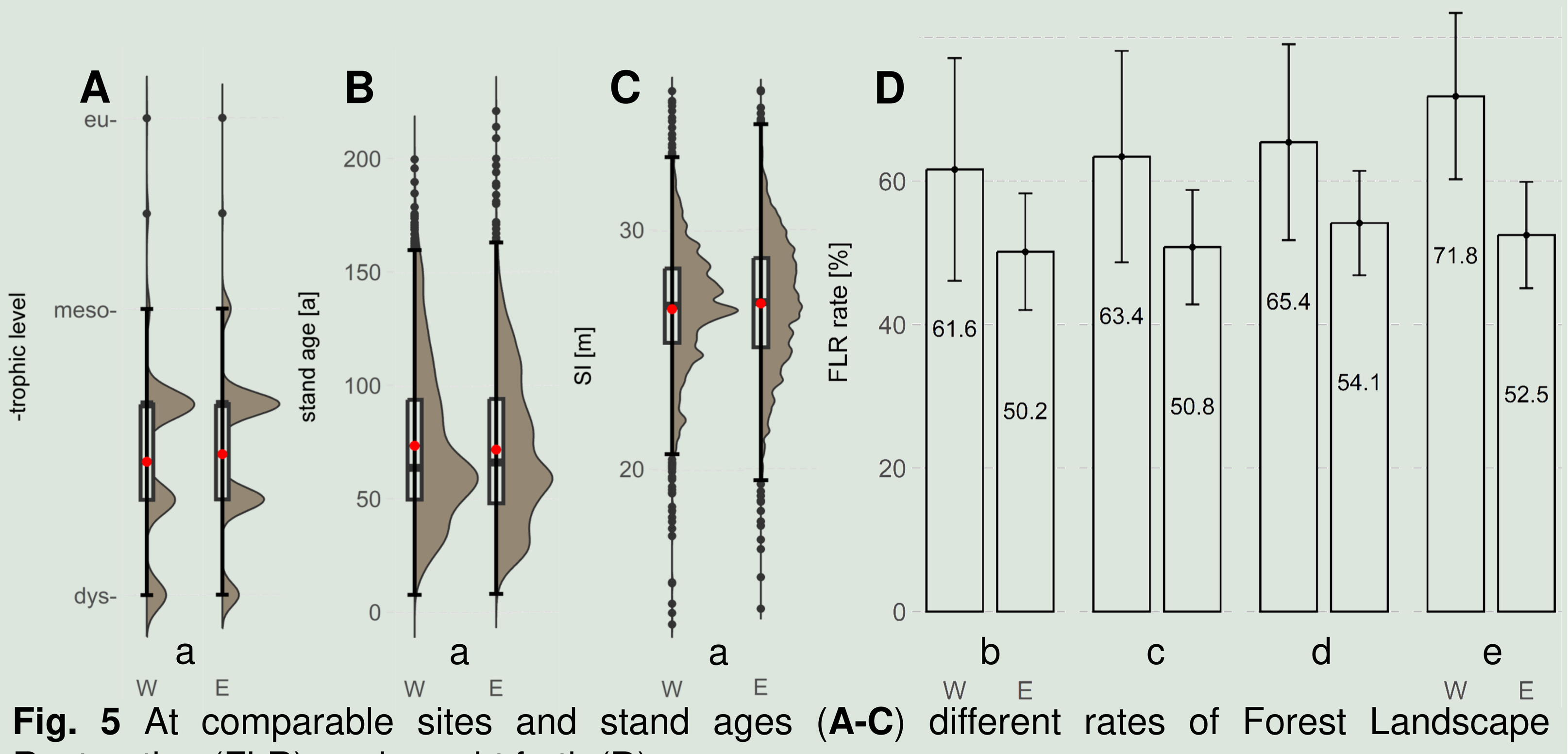

Fig. 5 At comparable sites and stand ages (**A-C**) different rates of Forest Landscape Restoration (FLR) are brought forth (**D**)

- if only pure stands (>90% monospecific basal area) on the plot level are examined, the ratio of FLR can be stated → Fig. 5
- the share of pure stands in 2062 related to 2012 differs significantly between the eastern and the western region:

→ more FLR when shade-tolerant species (minimizing pine) are promoted

→ highest FLR if thinning intensity is more intense

Outlook

→ how much do disturbances accelerate FLR? (inclusion of survival probabilities & empirical mortality patterns)

→ simulations based on modified target diameters (dbh range 40-60cm)

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E-mail: hergen.knocke@nw-fva.de
Phone: +49 0551 69401 107
Web: *www.nw-fva.de*

Northwest German Forest Research Institute
Hergen Christian Knocke
Department of Forest Growth
Grätzelstraße 2 • 37079 Göttingen • Germany

Climate-adapted silvicultural strategies for harvest cuts of Scots pine (Pinus sylvestris L.) stands in Northern Germany

T1.5 Climate-smart pine forest management

Hergen Christian Knocke[1, 2] , *Jan Hansen*[1], *Ralf-Volker Nagel*[1], *Matthias Albert*[1]

[1] Northwest German Forest Research Institute, Department of Forest Growth, Göttingen, Germany

[2] Ministry for Climate Protection, Agriculture, Rural Areas and the Environment Mecklenburg-Vorpommern, Department of Climate Protection, Nature Conservation and Forests, Schwerin, Germany

Abstract

Pine stands dominate the landscape in Northern Germany. They are subject to forest conversion towards mixed stands, because of increasing risk resulting from often insufficient mixture and structure. In the six northern federal states the silvicultural guidelines are expert-based adapted towards climate change and schedule pine cultivation even on poorest and driest sites. However, evidence-based studies indicate pines' increasing vulnerability especially in warm-dry weather. The unbalanced age class structure and increasing proportions of strong dimensioned wood also pose challenges for harvest cuts and associated climate adaptation. We question how cultivation area, standing and harvested volume and increment of pine develops by climate-sensitive simulations.

To analyze stand development, the plots of the third German NFI are simulated until the year 2062 using the single-tree growth simulator WaldPlaner. We account for climate change effects using climate projections of the moderate global model EC-EARTH12 in combination with the regional model RACMO and the extreme global model HadGEM2 with the regional model WettReg2013 under RCP8.5. For current stands site index shifts are predicted applying site-sensitive height-age curves. For future stands species suitability strongly depends on site water supply, which is dynamized considering the climate projections.

The simulation further considers two target diameters for pruned and unpruned pine stands. The silvicultural concepts of the investigated federal states are implemented in the growth simulations using targeted basal areas and crop tree numbers. Besides the projection of current stands, two contrasting scenarios concerning the next forest generation are simulated. Based on the catalog of suitable tree species derived from the site water budget corresponding to the respective climate projection, the first scenario maximizes the proportion of future pine by selecting light-demanding species from the said catalog. The second scenario minimizes the proportion of pine by preferring shade-tolerant species. This requires different harvest courses of the current stands by means of shelterwood cutting.

Afterwards, the simulation results are evaluated looking at abiotic and biotic risks. Within the guardrails outlined in this variant study, pine area consolidates after decades of decline, whereas the uneven age-class structure leads to bugwave effects regarding timber usage.