



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

Simulation-based decision support for forest management under climate change.

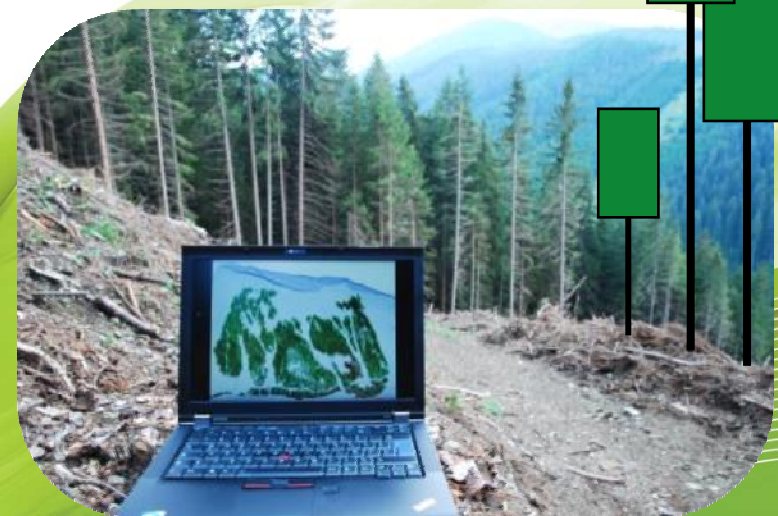
An example from Austrian mountain forests

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AFORCE

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content

- background & expectations
- a forest simulation model
 - creating initial forest conditions
 - visualizing model output
- example: applying a forest simulation model
- decision support: fact or fiction?

background

- growing demands towards forest ecosystems & forest management
 - interest in various ecosystem services
 - by a variety of stakeholders
 - credible proof of sustainable forest management needed
 - uncertainties due to climate change
 - need for cost-efficient management (hesitant payments for ecosystem services)

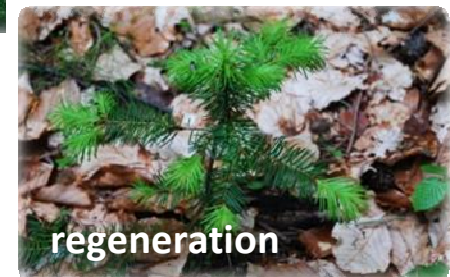
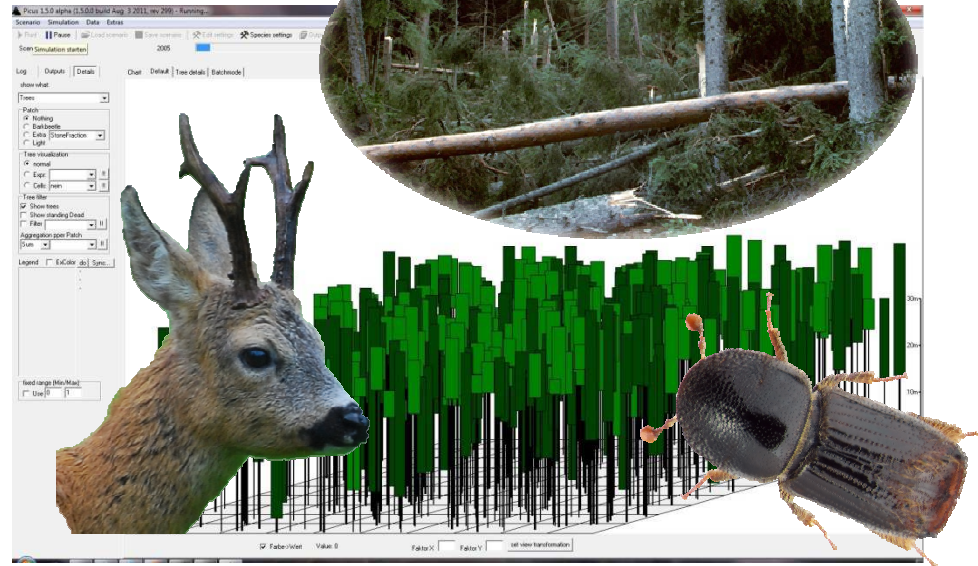
- technological progress
 - computing power
 - remote sensing (air- & spaceborn) based inventories

Expectations towards forest simulation models as decision support tools ...

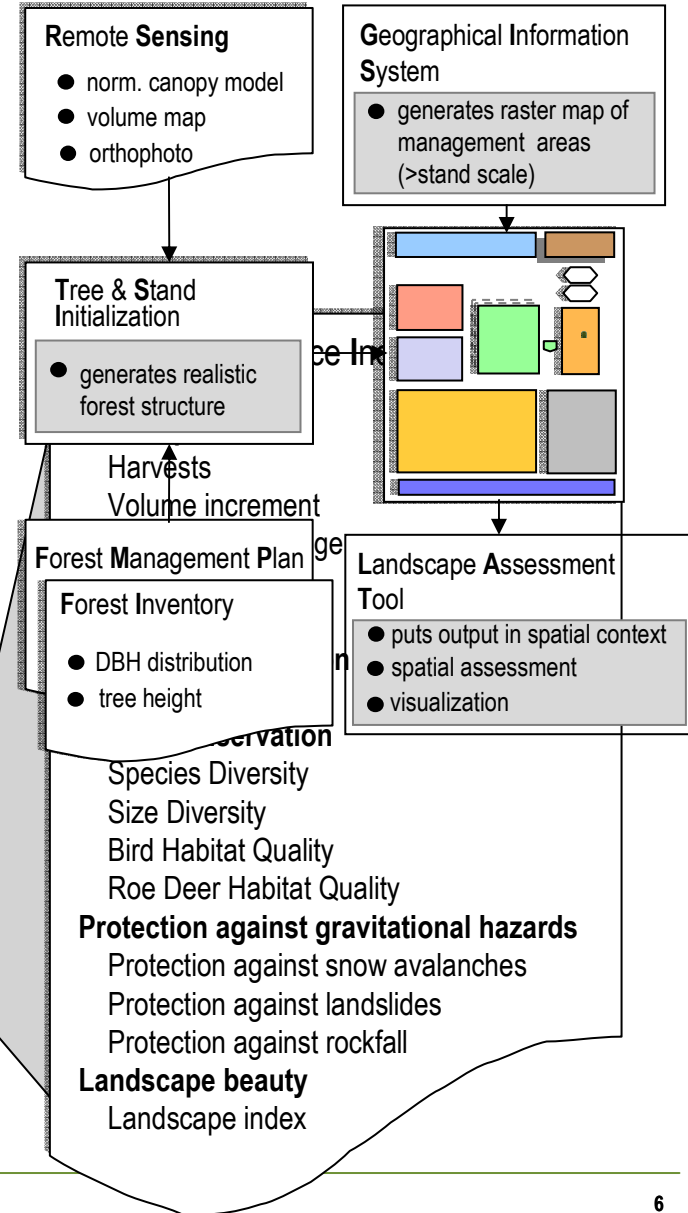
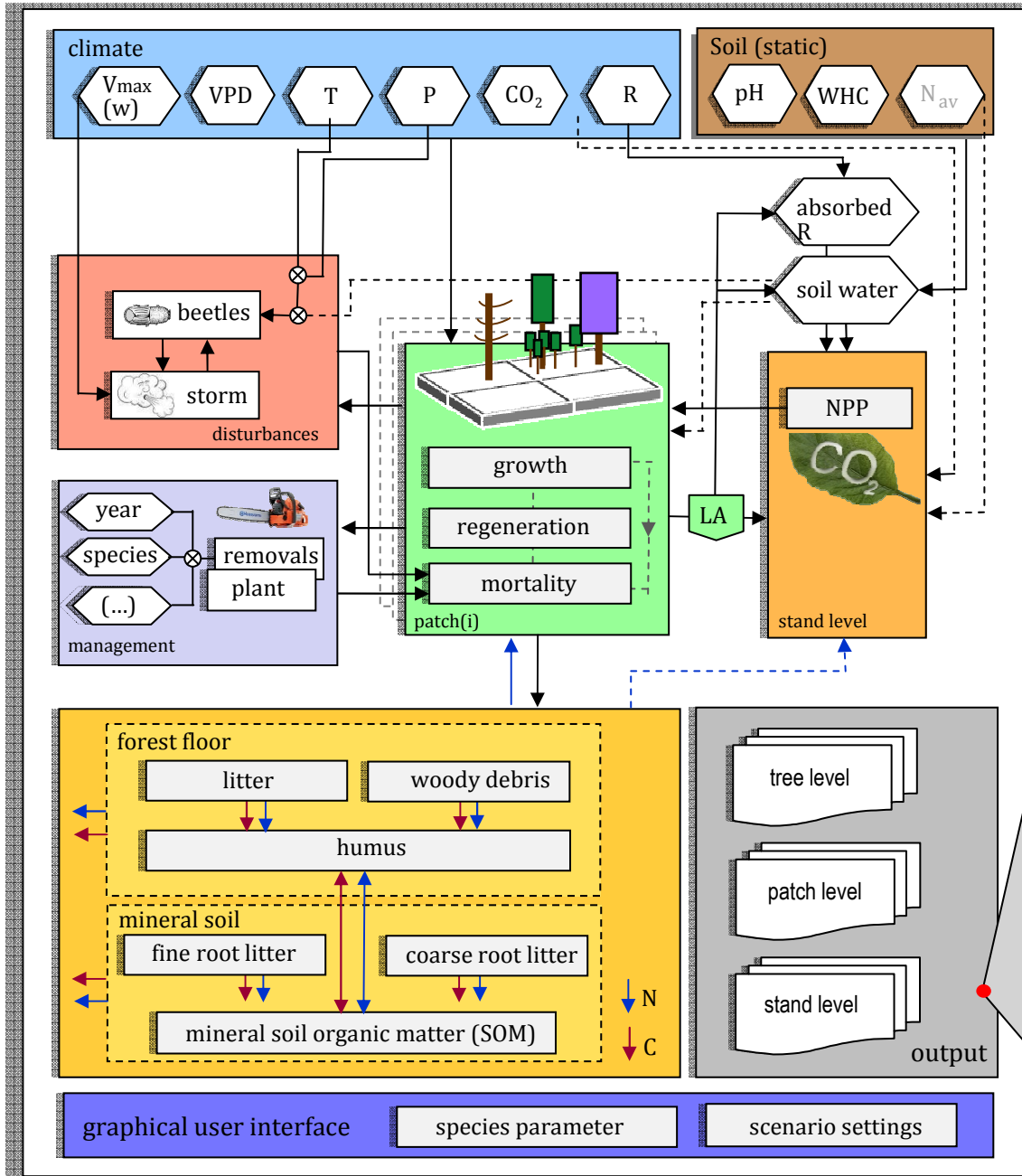
- projection of mid-/longterm forest development **AND** related ecosystem service provisioning
- virtual experiments to explore the interrelated effects of
 - management
 - climate change
 - disturbances
- virtual try-out of options without risk of failure
- accurate predictions of future forest values
- transparency and reproducibility of management planning

forest ecosystem model PICUS v1.51

- hybrid approach
 - patch x ITG x phys.prod. model
 - processes at tree & stand level
 - sensitive to climate
- spatial resolution 10 x 10 m
- tree population dynamics
 - growth
 - mortality
 - regeneration
- disturbance regimes
 - bark beetles
 - storm
 - browsing by ungulates
- can simulate up to 25ha forest area simultaneously
- output in annual time steps
- simulation period >100s years



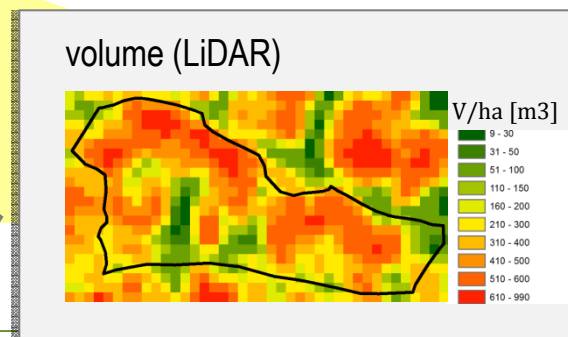
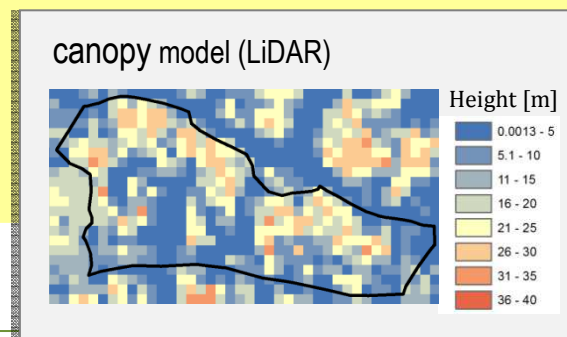
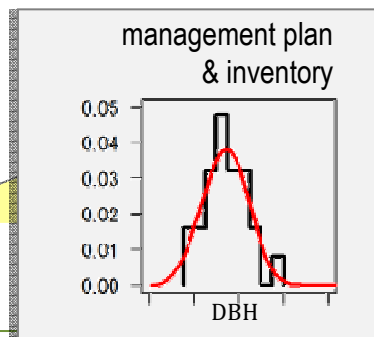
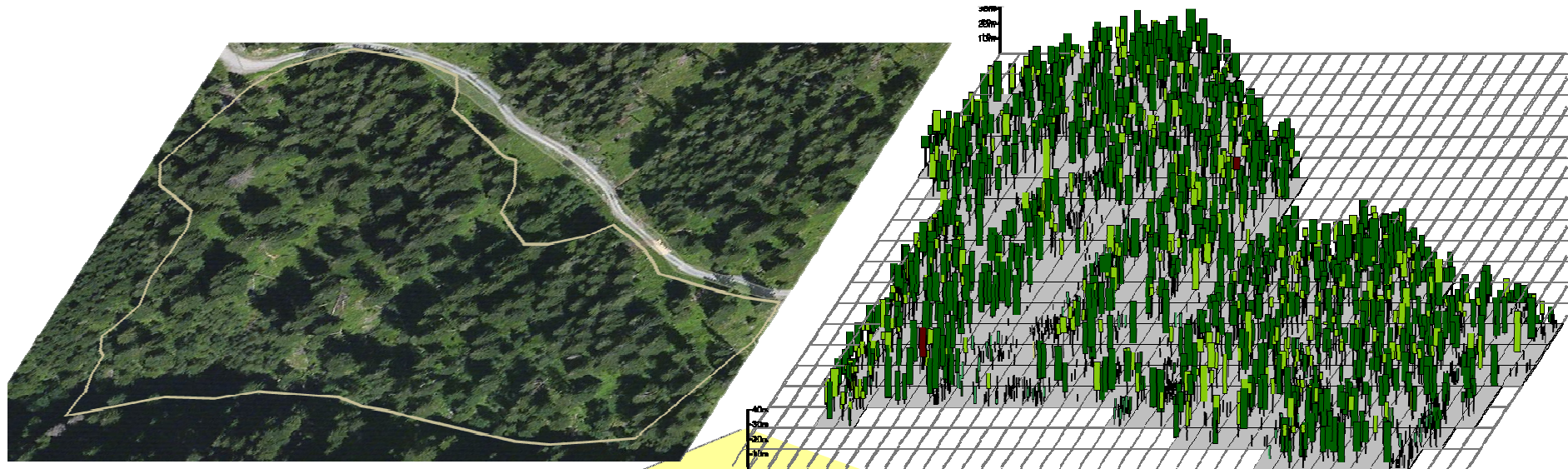
model components



Initial state of a forest simulation

Combining management plan, forest inventory data & remote sensing

real forest  virtual (random)



... loading output files into „Landscape Assessment Tool“

The diagram illustrates the data flow: **RS** and **GIS** feed into **Initial stand**, which then feeds into **LAT**. The screenshot shows the **Landscape Assessment Tool** interface with a 3D terrain model overlaid with green vegetation. The interface includes a control panel on the left and a console window at the bottom.

Assessment tool

sonstiges/dem_rell.txt

Select year of vegetation: 2100

Ecosystem service script: services.js

Indicator	Type	Description
AV 30	ternary	Avalanche rating for inclinations 30-35°
AV 35	ternary	Avalanche rating for inclinations 35-40°
AV 40	ternary	Avalanche rating for inclinations 40-45°
AV 45	ternary	Avalanche rating for inclinations >45°
Landslide	ternary	Risk rating for landslide, erosion, and debris flow
Infiltration	ternary	landslide infiltration zone
Rockfall 005	ternary	Rockfall protection for rocks <0.05m ³

Analysis

Visualization options

show status

Data export

save current result (av_30) as ASCII grid:

Overlay intensity:

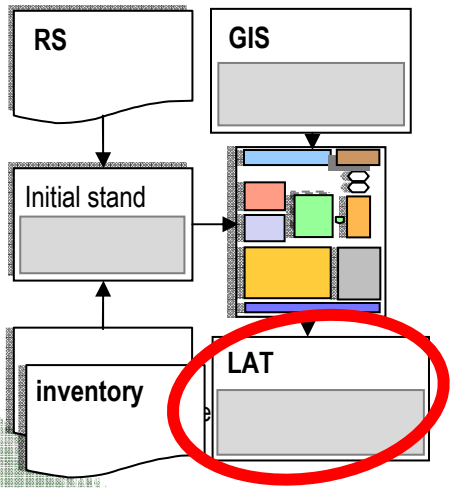
Show grid: Z factor: 1.0

Common: setup of cell formulas complete.
Common: setup of cell formulas complete.
Common: setup of cell formulas complete.
Common: setup of cell formulas complete.
Common: setup of cell formulas complete.
Common: Loaded project file "E:/Daten/BOKU/ARANGE/toolbox/lat_data/rellstal_c5.ini"
Common: 'setting up space from file E:/Daten/BOKU/ARANGE/toolbox/lat_data/rellstal_c5.ini'

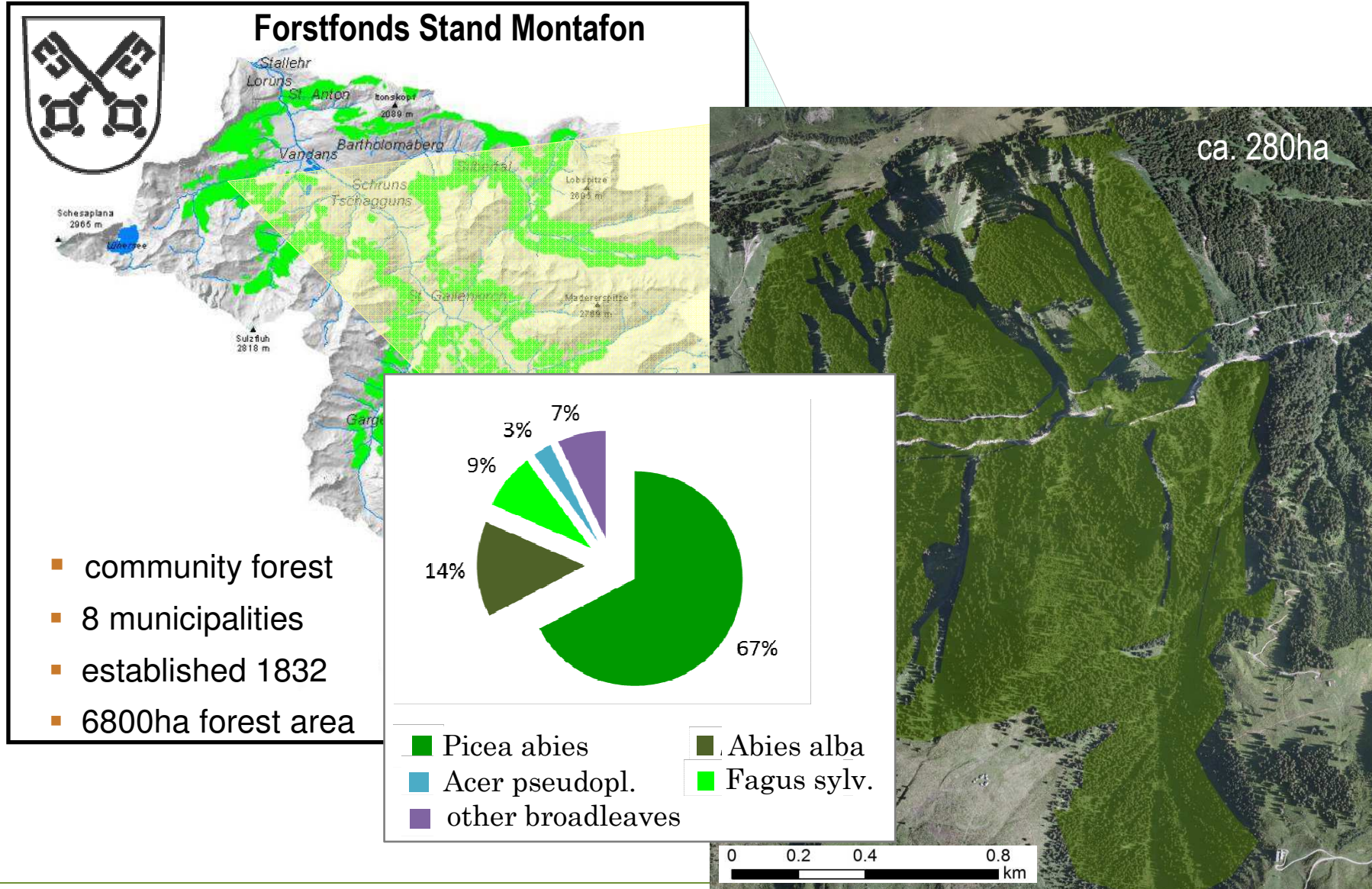
■ **calculation of spatial indicators**

(e.g., gap detection for protection against gravitative hazards, habitat, ...)

■ **visualization & communication**
(management options, ecosystem services)

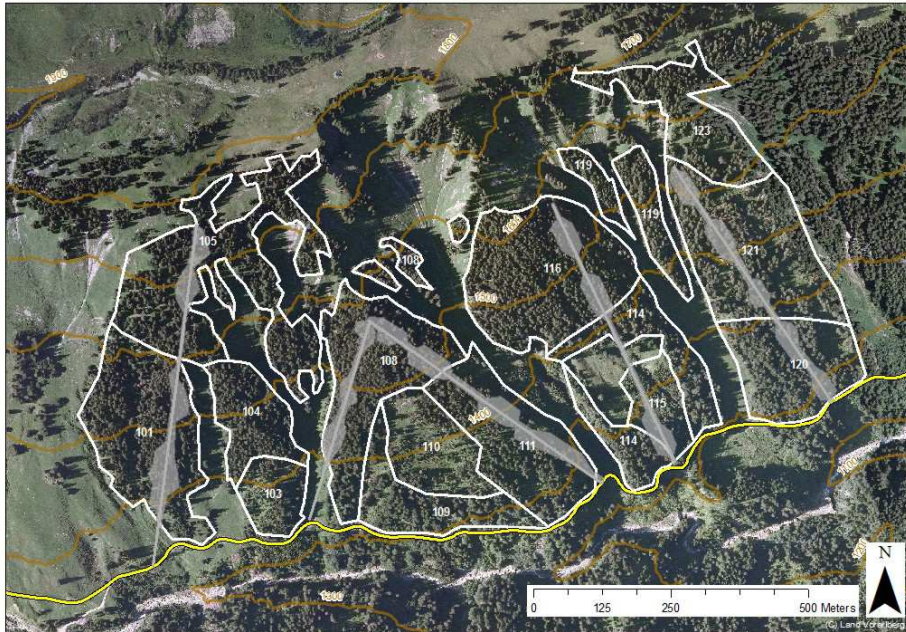


model application – example a catchment in the Eastern Alps in Austria



forest management

Business As Usual & alternatives



patches

natural regeneration

- skylines of 800-1200m length across slope (skyline yarding)
- current practice (BAU): patch cuts along skyline, natural regeneration
- **What happens to ecosystem service provisioning on the long run?**
 - Continuing with current management?
 - What are effects of climate change?

strip cut

natural regeneration / planting

slit cut

natural regeneration

sanitary management

natural forest dynamics (& planting BL)

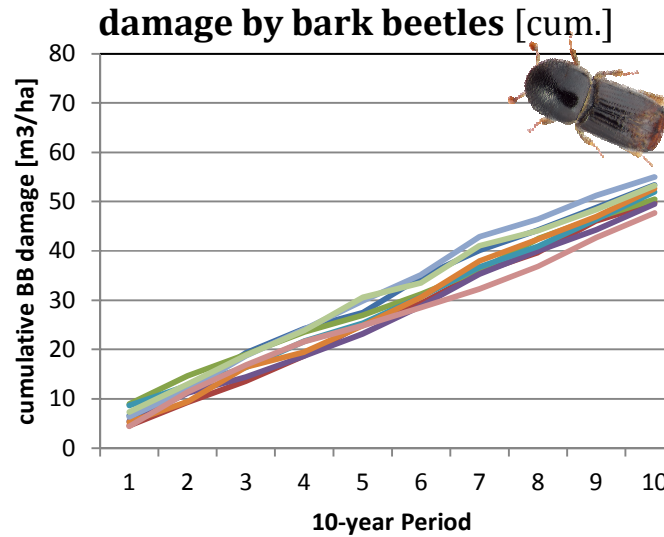
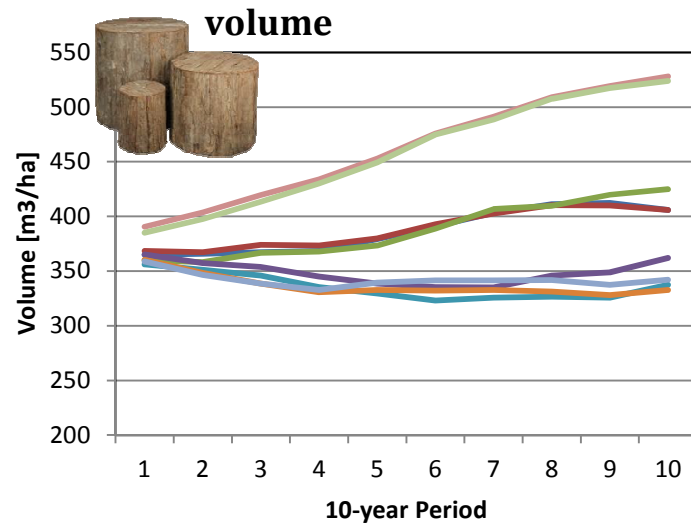
no management

natural forest dynamics

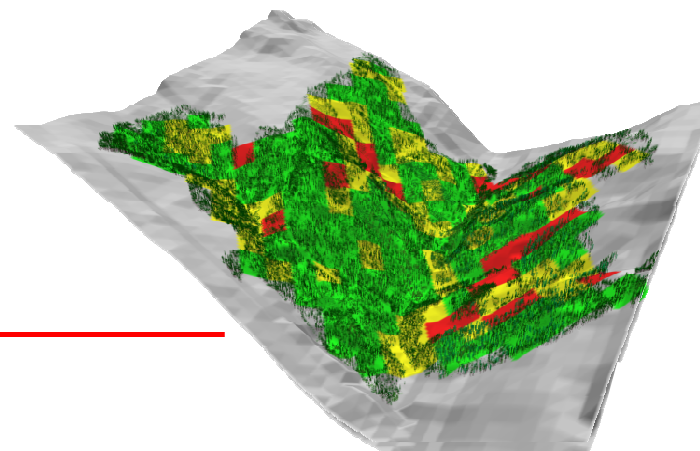
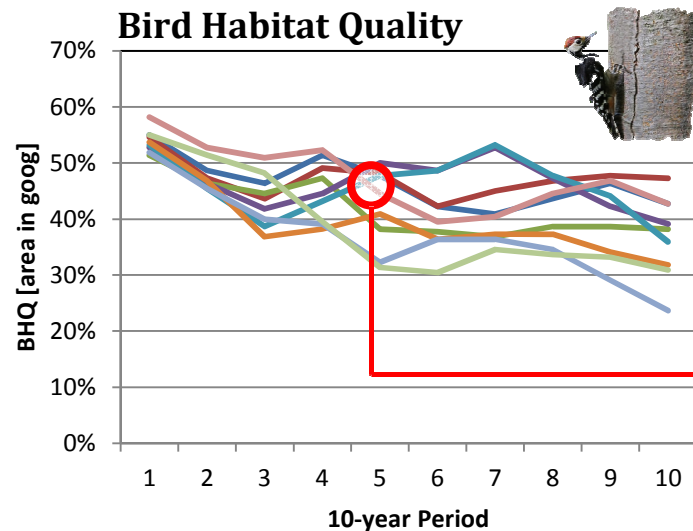
aggregating model output for interpretation effects of management



[historic climate]



- SLIT-LO
- PATCH-LO
- STRIP-LO
- SLIT-HI
- PATCH-HI
- STRIP-HI
- STRIP-HI-P
- NOM
- SAN

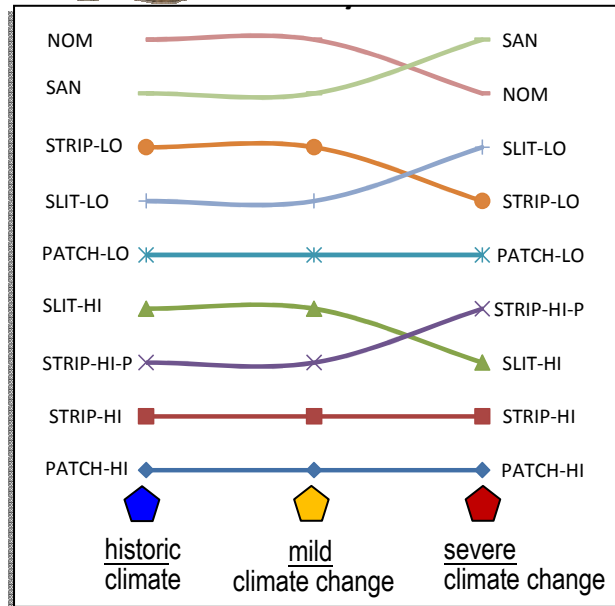


aggregating model output

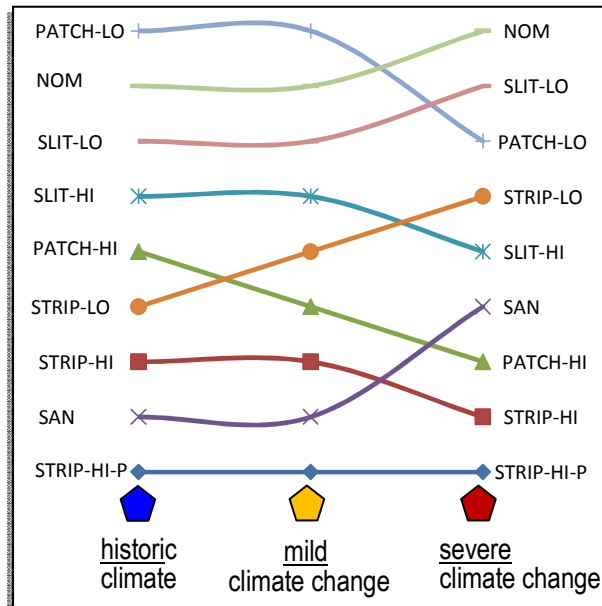
Effects of climate change



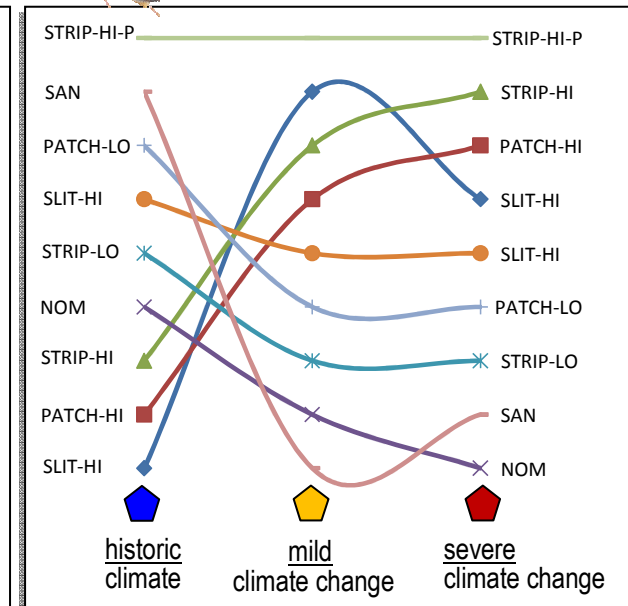
volume



Bird Habitat Quality



damage by bark beetles



Conclusions from model application:

- *disturbances drive development of forest structure and related ES provisioning*
- *partly huge trade-offs between ES (timber vs habitat & protection)*
- *partly synergies (habitat, protection)*
- *planting may be required to manage with shorter turn-over times*



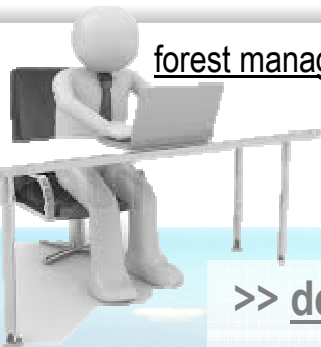
„Which tree species are suitable in the future?“

>> need for operational guidance



small-scale owner

>> simulation & analysis >> guidelines >> advice by extension services



forest manager

„How can I meet the demand of my stakeholders for ES?“

„What is the best plan for my unit?“

>> designing a strategy

>> optimizing a management plan



■ demonstration cases by scientists

>> simulation & optimization & visualization

■ manager hires a consultant



>> interpretation



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thank you!

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