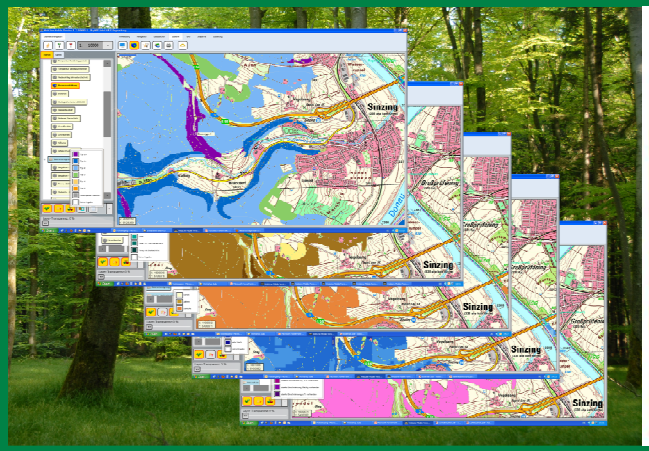


Adaptation of forests to climate change

An innovative digital tool for Bavaria (Germany)

Steffen Taeger
Wolfgang Falk, Karl H. Mellert, Josefine Beck, Elke Dietz, Christian Kölling

Bayerische Landesanstalt
für Wald und Forstwirtschaft

BAYERISCHE FORSTVERWALTUNG

ZENTRUM WALD FORST HOLZ
WEIHENSTEPHAN

Adaptation of forests to climate change
An innovative digital tool for Bavaria (Germany)

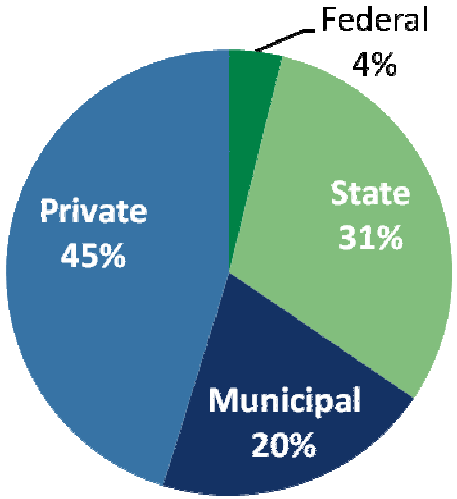
1. Forests and forest adaptation in Germany
2. The Bavarian way
3. Development of a cultivation risk model
4. Implementation of a cultivation risk model
   → Forest GIS

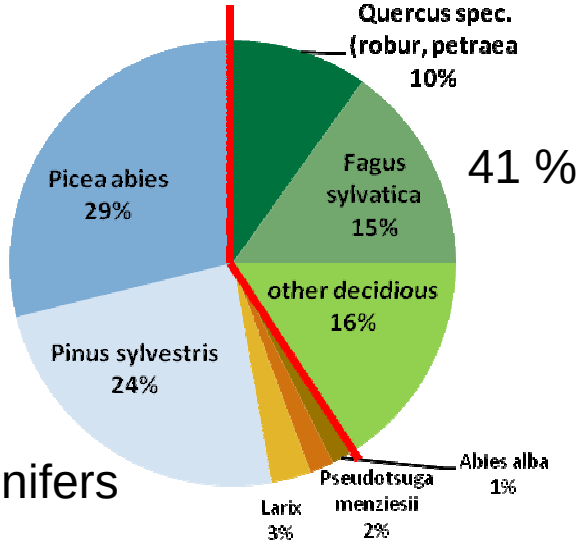
German forests

(data: NFI 2001/2002)

- Germany: 11.1 Mio ha forest land (31%)

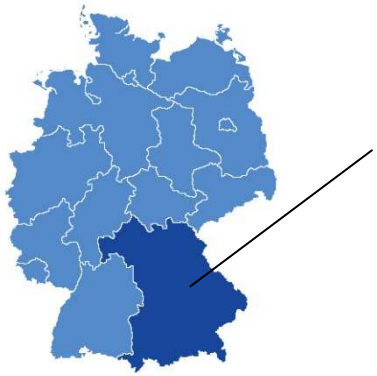
2 Million private forest owners





41 % Decidous

59 % Conifers



Bavaria: 2.6 Mio ha forest land
69 % Conifers (45% Picea abies!)

average size of private forest property: 2 ha

Forest adaptation in Germany

National level: providing a framework –general recommendations

- „DAS“ - German adaptation strategy 2008 / 2011 (BMUB 2012)
- Forest strategy 2020 (BMELV 2011)
  - Forests will be negatively affected by dry periods, warmer temperatures, pest infestations
  - Adaptation measures should be taken:
    Mixed forests with Site-adapted tree species

Federal structure:
Federal states responsible!

Forest adaptation in Germany

Federal states

- Assessment of threats due to climate change and possible adaptation responses similar, but
- Diverse strategies of adaptation measures are implemented

Two groups:

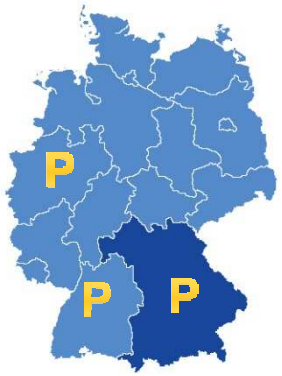
P Proactive substitution

Forest transformation / conversion

by replacing sensitive tree species

Stabilization

Risk minimizing by management close to nature / mixed forests



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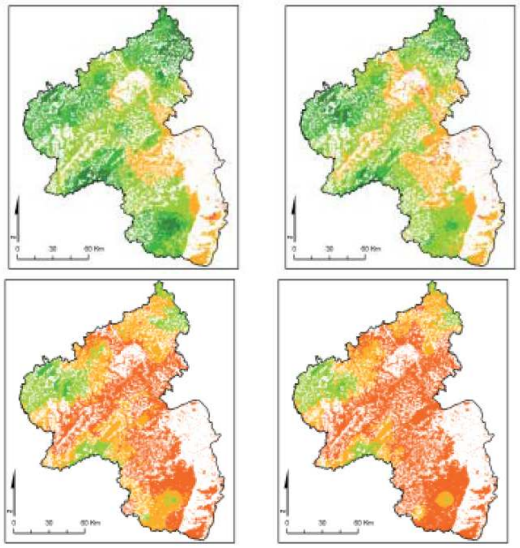
Forest adaptation in Germany

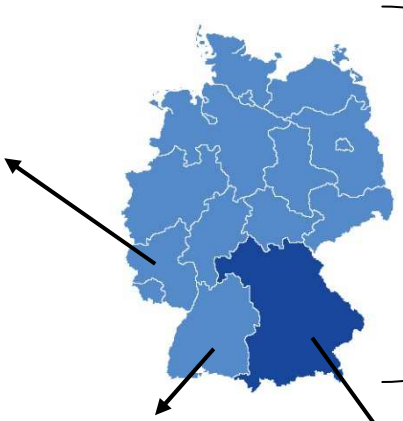
- Several approaches to assess species risk, e.g. :

Rhineland-Palatinate

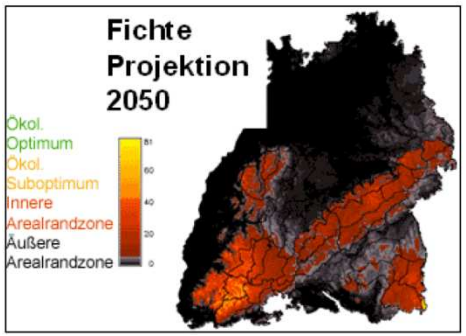
Fichte



Germany - National



Baden-Württemberg



Bavaria

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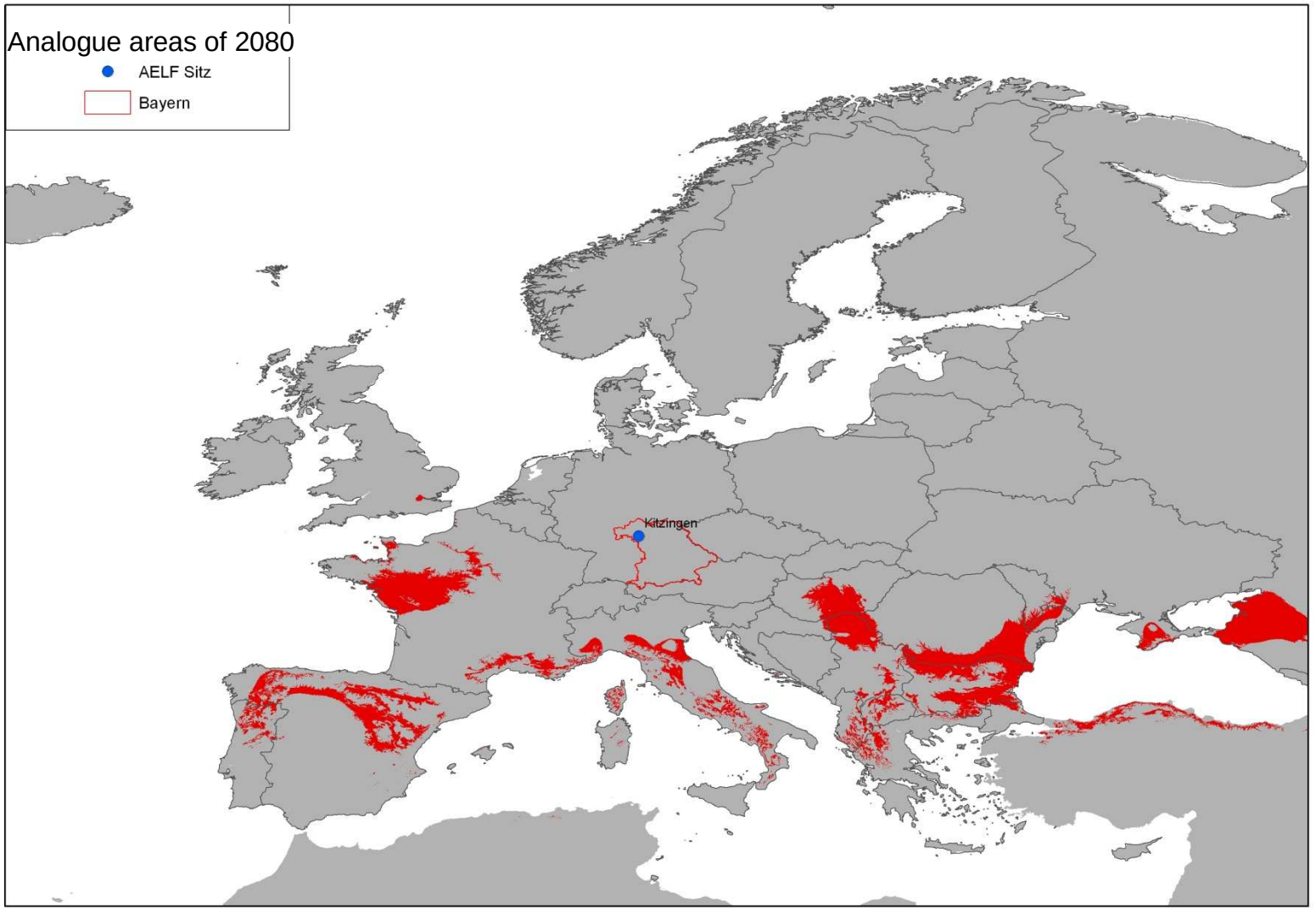
Bavarian climate of the future analogue to …



Possible impacts

- Tolerance level of species is / could be exceeded

Spruce in Bavaria

Ammer et al. (2006) LWF Wissen 54

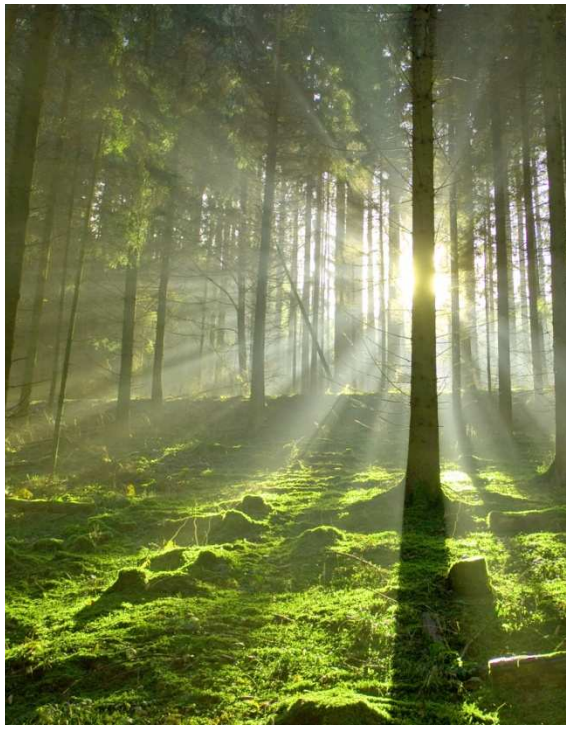
Pine in Valais (Switzerland)

Rigling et al. (2006) WSL-Merkblatt

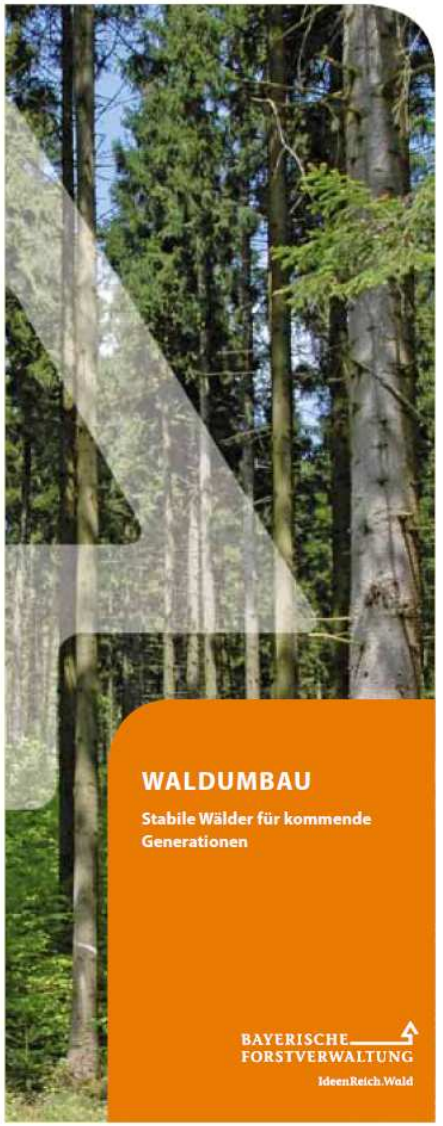
Beech in Spain

Peñuelas, J., Boada, M. (2003)
Global Change Biology 9 (2), 131-140

Adaptation - Forest Conversion



Funding by the Bavarian State



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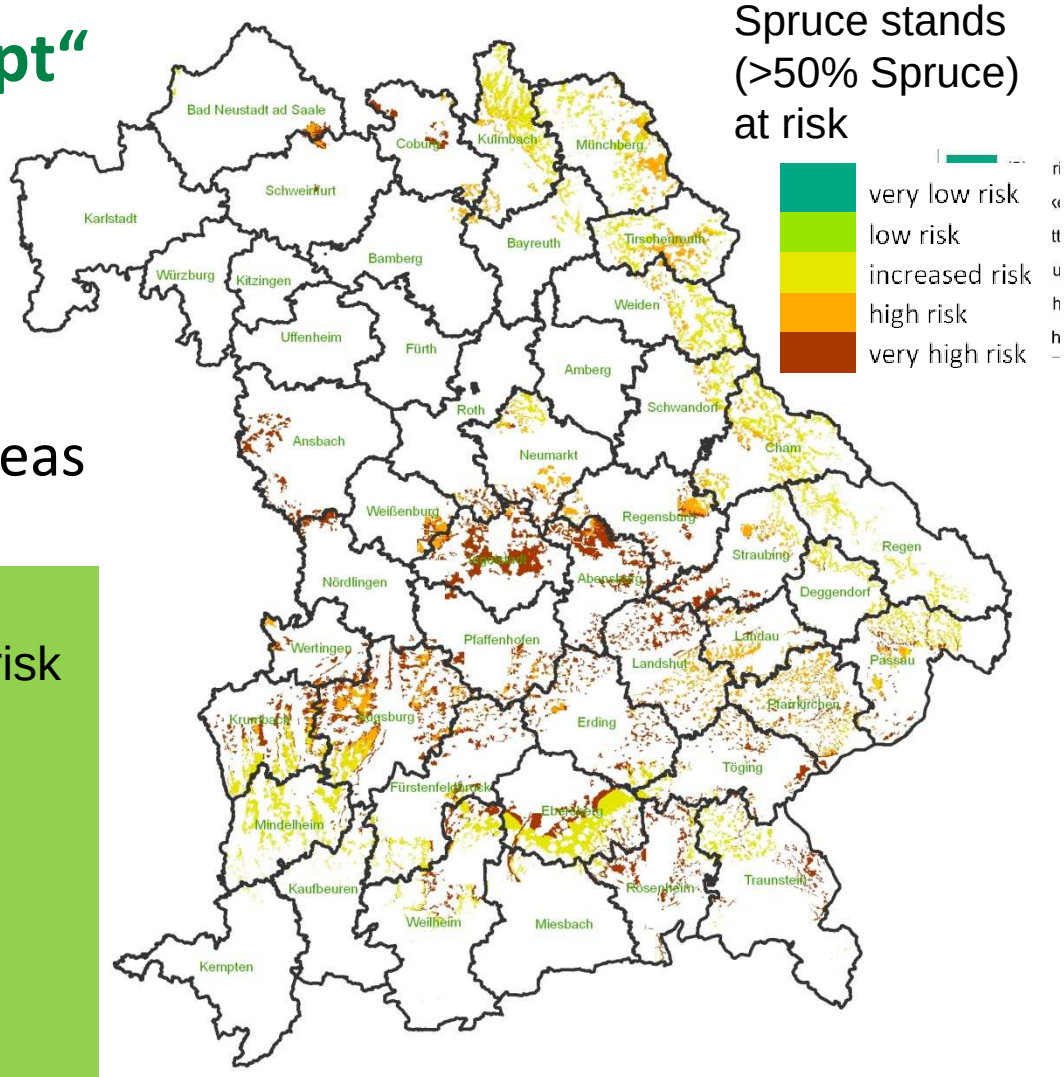
Focus of adaptation measures

„Bavarian climate concept“

- **Research**
- **Forest adaptation**
  - Conversion
  - Focus areas → project areas



Private / municipal forests:
260.000 ha Spruce stands at urgent risk

Adaptation:
Transformation of
100.000 ha until 2020
→adapted mixed forests

Annually granted funding: 7 Mio. €

1. Forests and forest adaptation in Germany
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3. **Development of a cultivation risk model**
4. Implementation of a cultivation risk model
   → Forest GIS

Development of GIS tool for Bavaria

1. Cultivation risk model
   - Data:
     - European Level I data (ICP Forests), Bavarian NFI data (BWI²)
     - Climate data for Europe (WorldClim, Hijmans et al. 2005)
     - Climate, terrain and soil data for Bavaria
   - Methods: **Species distribution models**
     (relationship between species distribution and environmental parameters)
   - Modelling technique: Generalized Additive Models

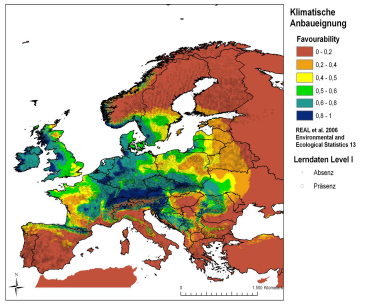
Development of cultivation risk model

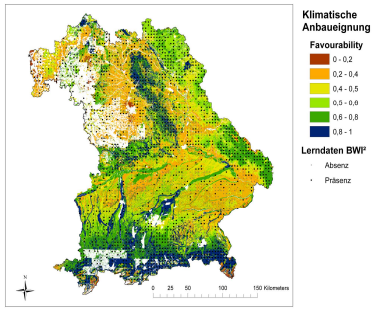
Species distribution models

European model
(distribution incl. margins)

Bavarian model
including soil information

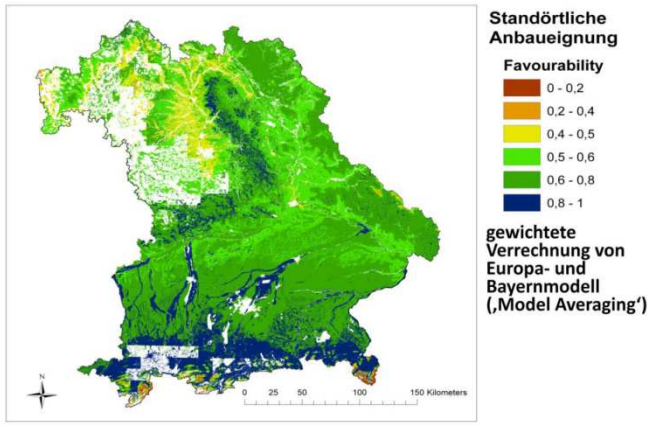
T May-Aug
T Jan
PPT





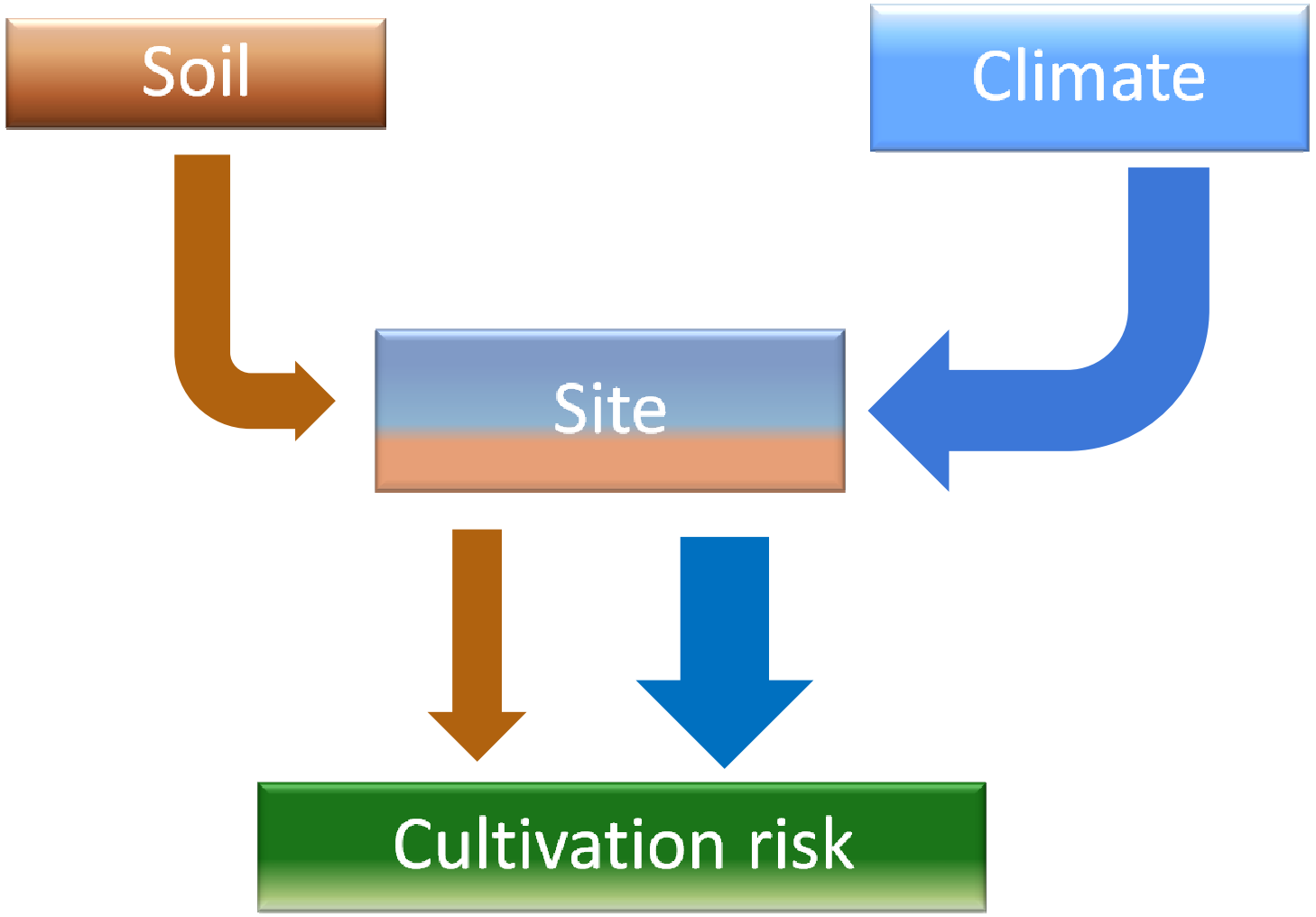
including:
Soil information

intersection



Patches of special local soil conditions

Development of cultivation risk model

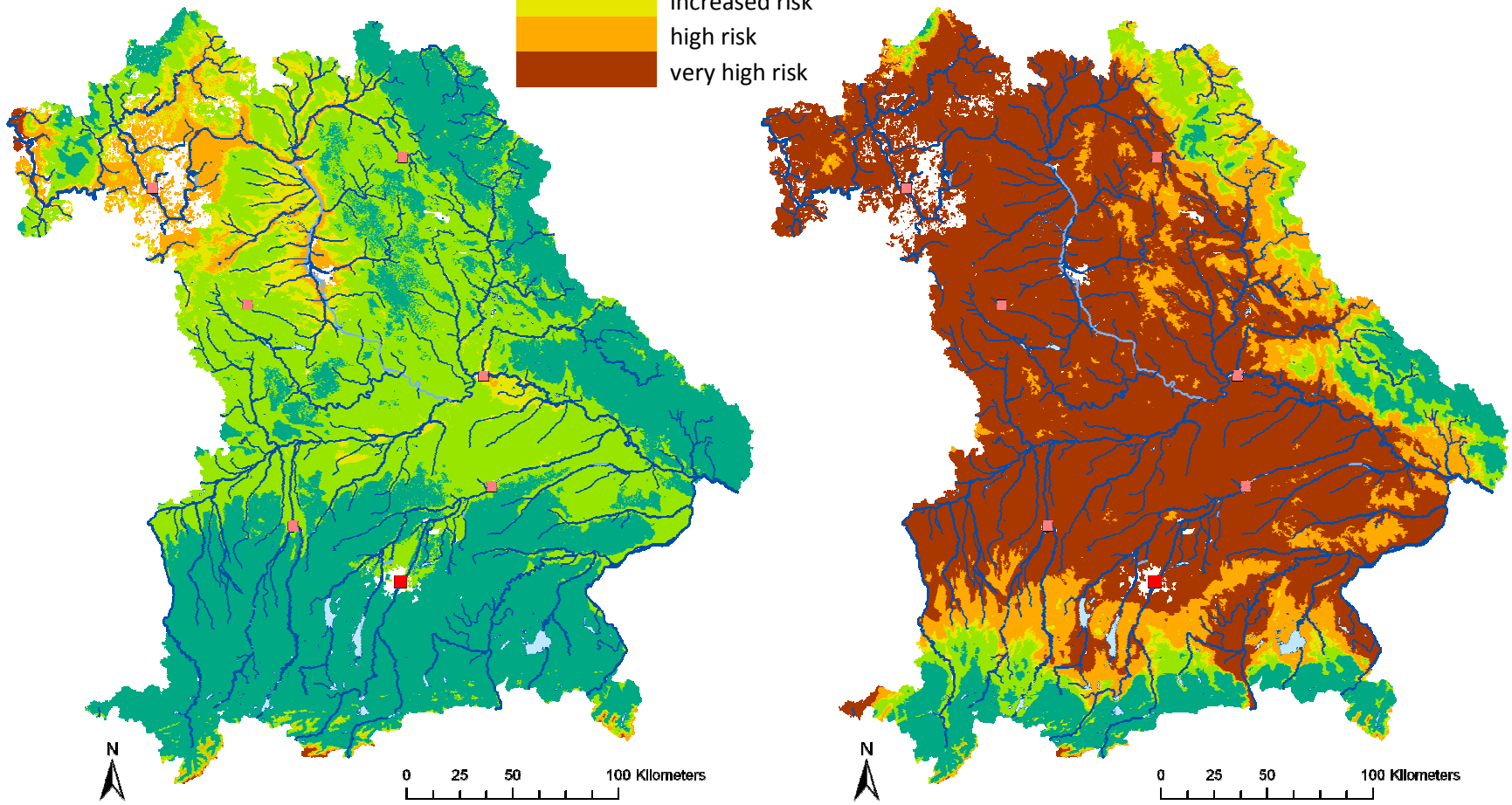


Forest GIS - BaSIS

Spruce 1951-2000

very low risk
low risk
increased risk
high risk
very high risk

2071-2100 WETTREG SRES B1



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   - Methods: **Species distribution models**
     (relationship between species distribution and environmental parameters)

2. Digital site-information system (soil, climate, terrain) covering all forest areas in Bavaria
3. Forest GIS for the forestry administration: “BaSIS”
   → integration of all forestry data (e.g. ownership, protected areas…)

1. Forests and forest adaptation in Germany
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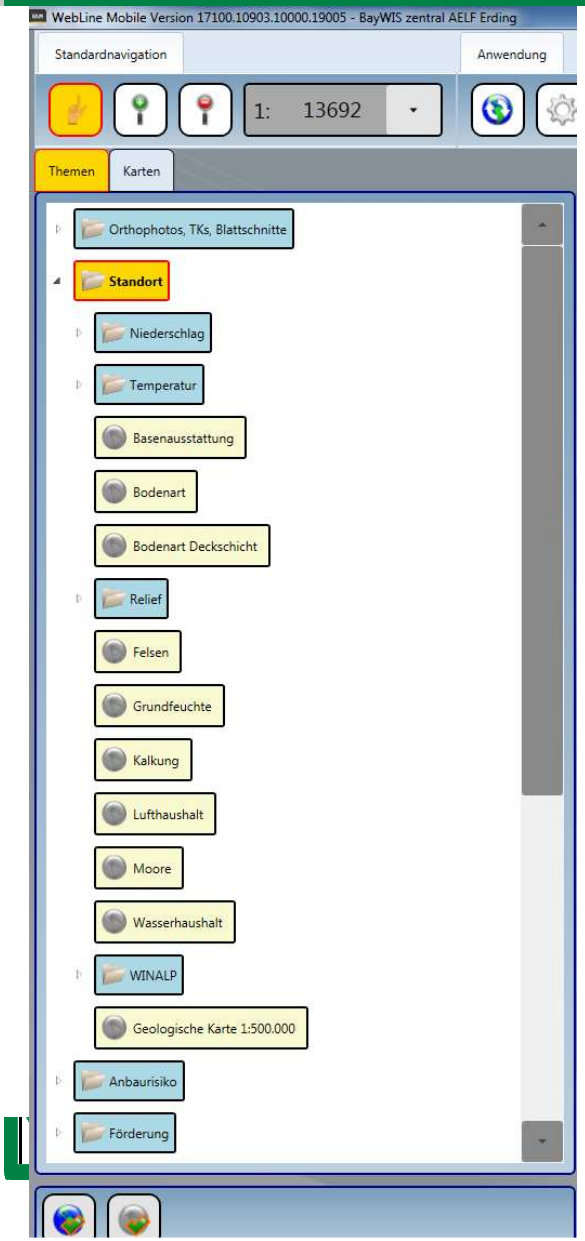
   → Forest GIS

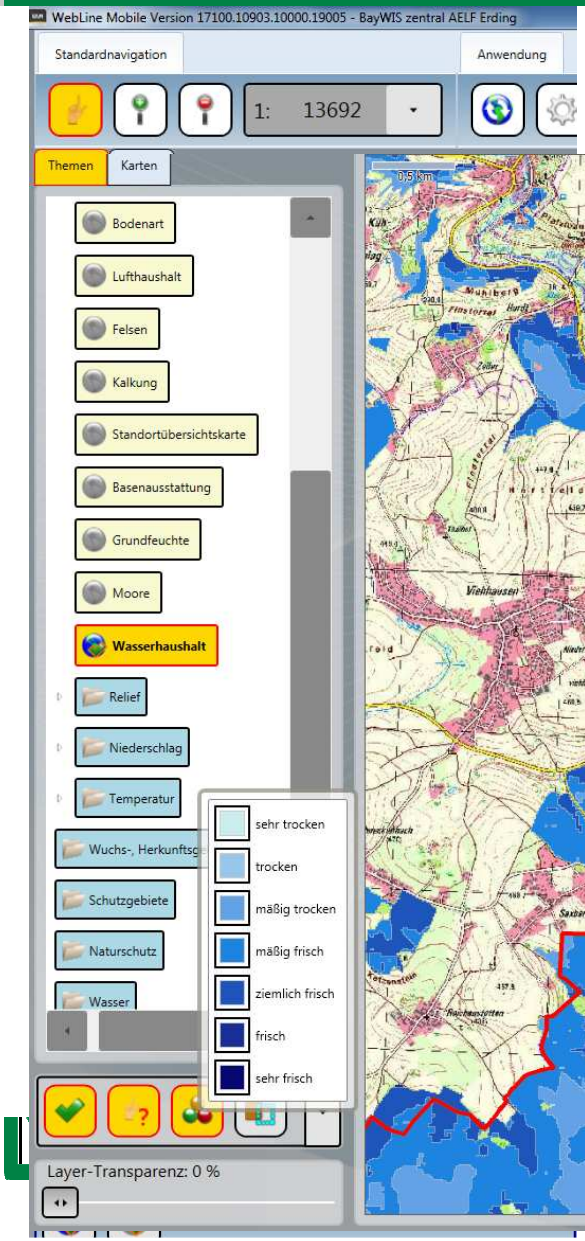
Forest GIS: BaSIS – site information



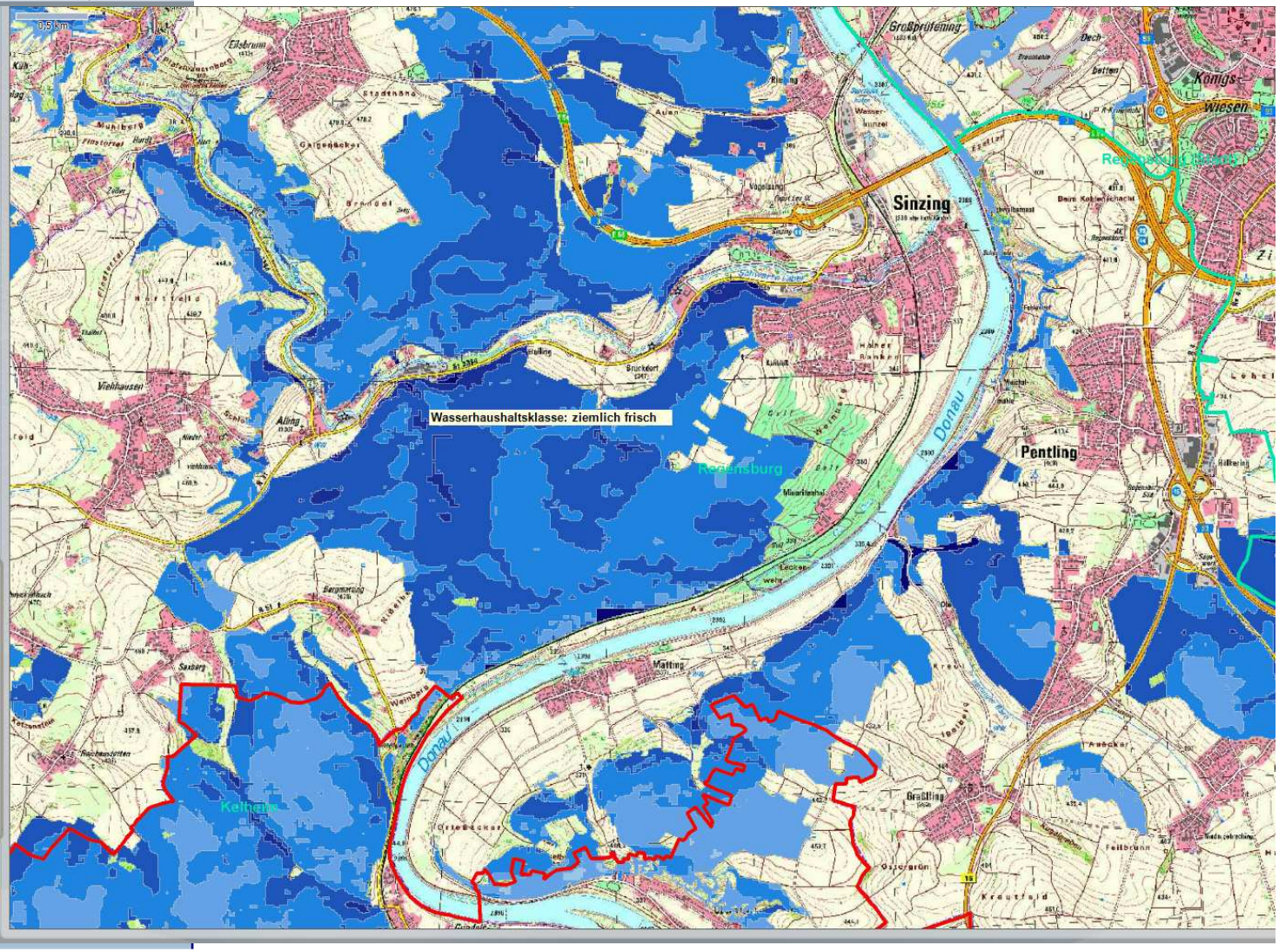
■ Site information – thematic maps

- Temperature
- Precipitation
- Rocks
- Soil type, soil texture
- Soil chemistry
- Water balance
- Aeration of soil (gley, pseudogley)

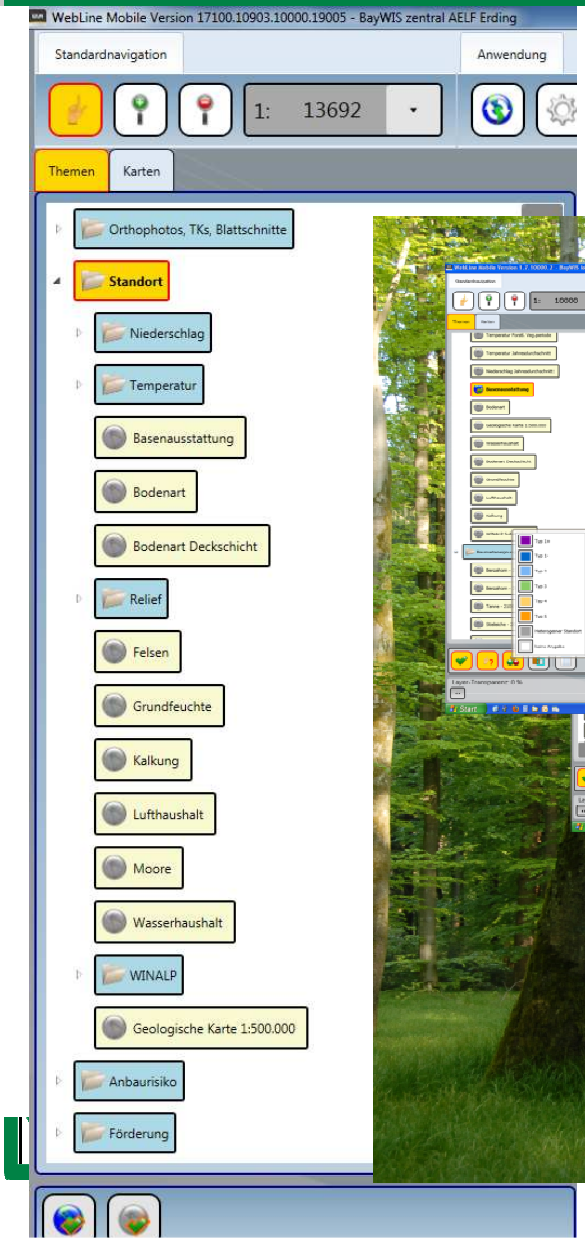
Forest GIS: BaSIS – site information



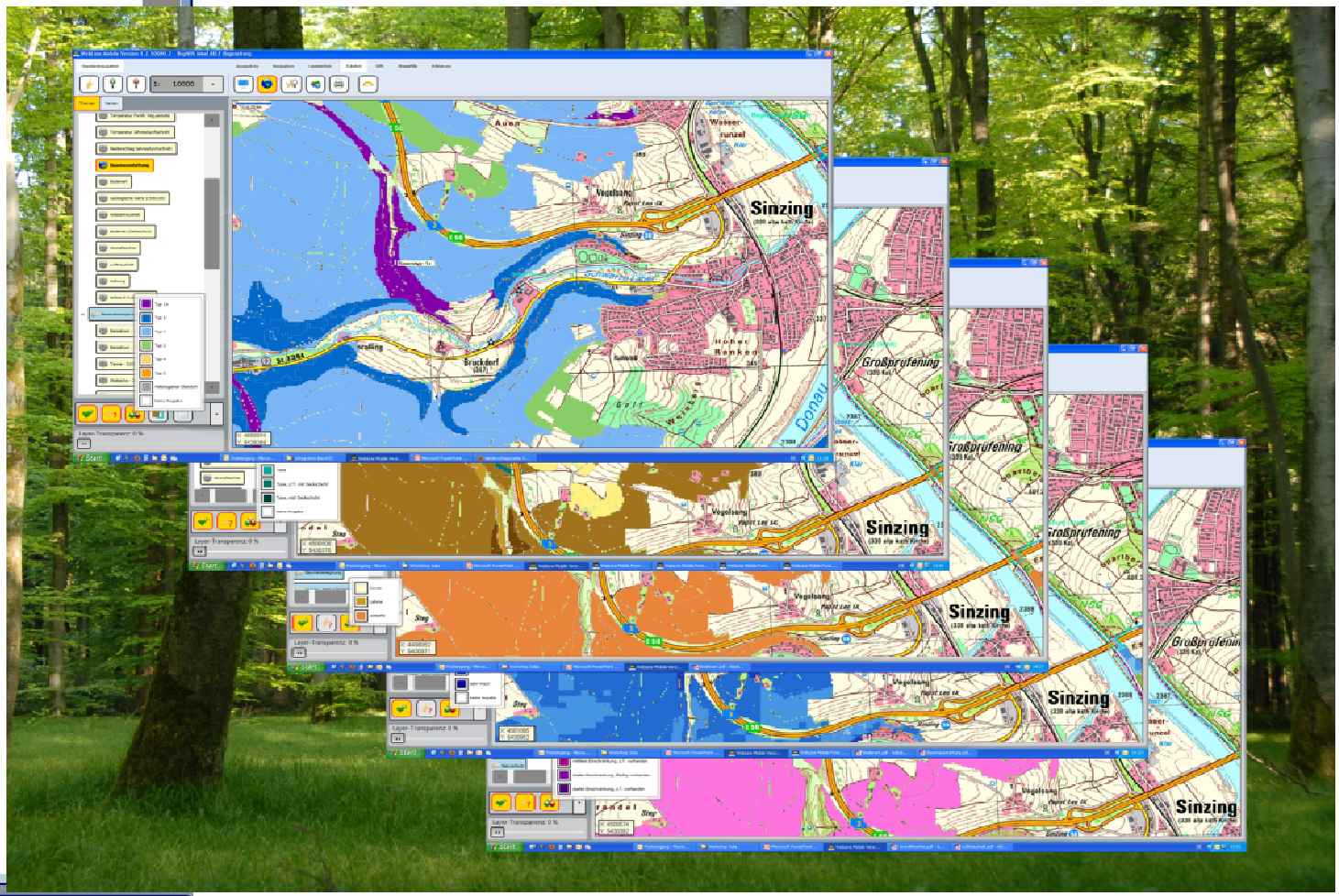
■ Site information – thematic maps



Forest GIS: BaSIS – site information



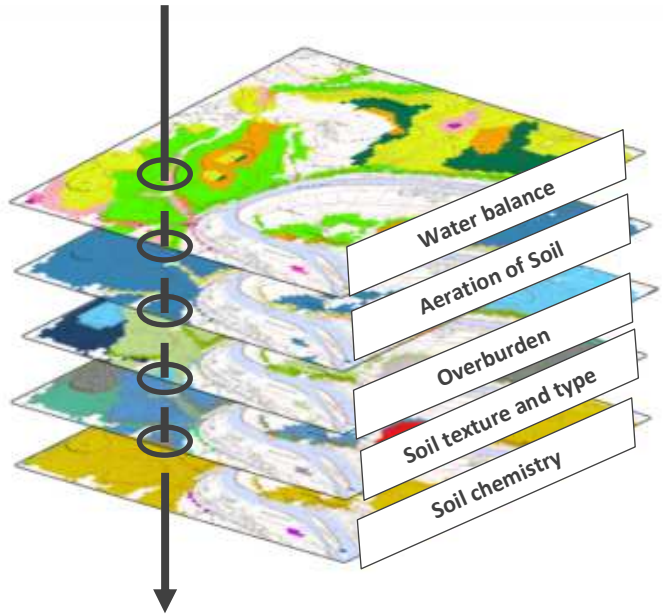
- **Site information – thematic maps**



Forest GIS: BaSIS – site information

Point information

Soil properties
Soil chemistry
Water balance

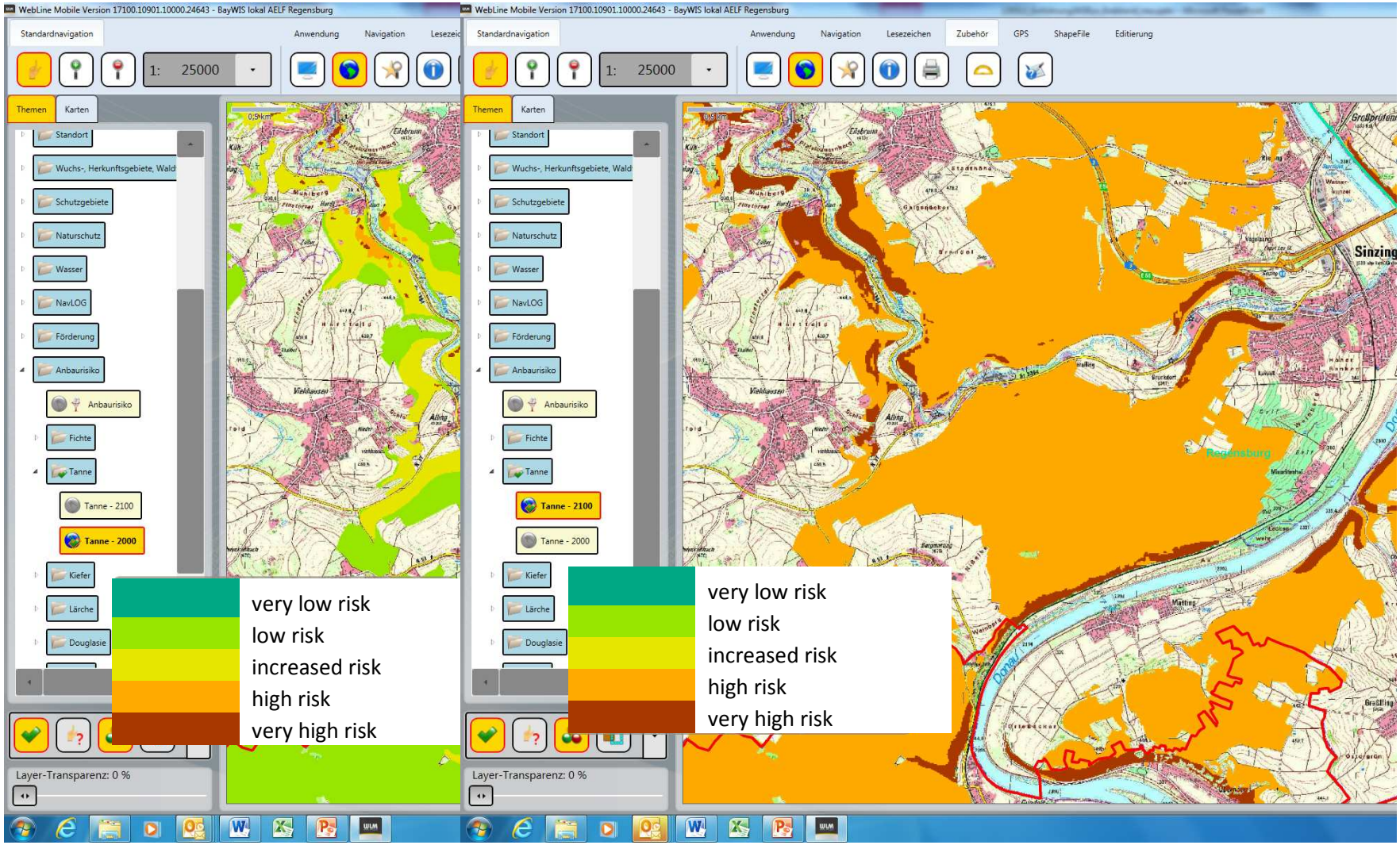


Gemeinde	Sinzing		
Gemarkung	Sinzing	**Rechtswert**	4499538
Flurstück	469/0	**Hochwert**	5426505

Bodenart: Schluffe

Bodenklasse	Stauwasserböden		
Ausgangssubstrat	Löss und Lösslehm (mit Fremdmaterial)		
Besonderheiten	-		
Ohne Deckschicht	Sand [%]	Schluff [%]	Ton [%]
	Skelettgehalt [%]	0 / 50 / 100 (skelettarm, mittel, skelettreich)	
	Grobbodenart	-	
	Mächtigkeit der Deckschicht	-	
	Flächenanteil der Deckschicht	-	
Schluffe	**Sand** [%]	**Silt** [%]	**Clay** [%]
	Skelettgehalt [%]	0 / 50 / 100 (skelettarm, mittel, skelettreich)	
	Grobbodenart	-	
Qualität	Anzahl Bodenprofile	33	
	Qualitätsstufe	2 - gut (Laboranalysen und Geländeansprachen)	
	Datenherkunft	Geländekartierung LfU	

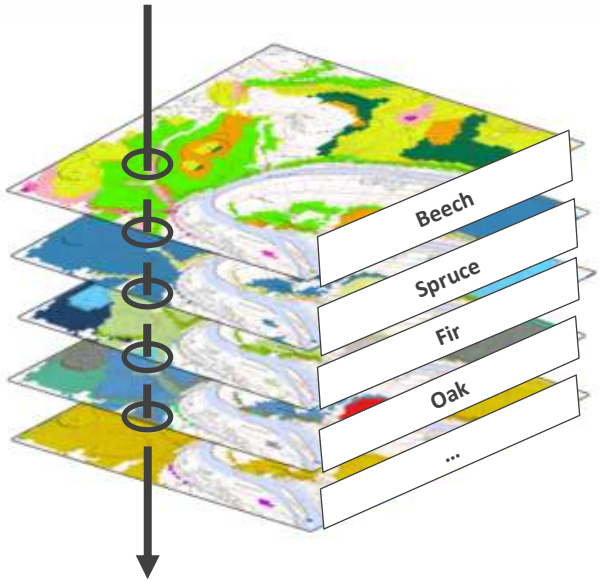
Forest GIS: BaSIS – cultivation risk



Forest GIS: BaSIS – cultivation risk

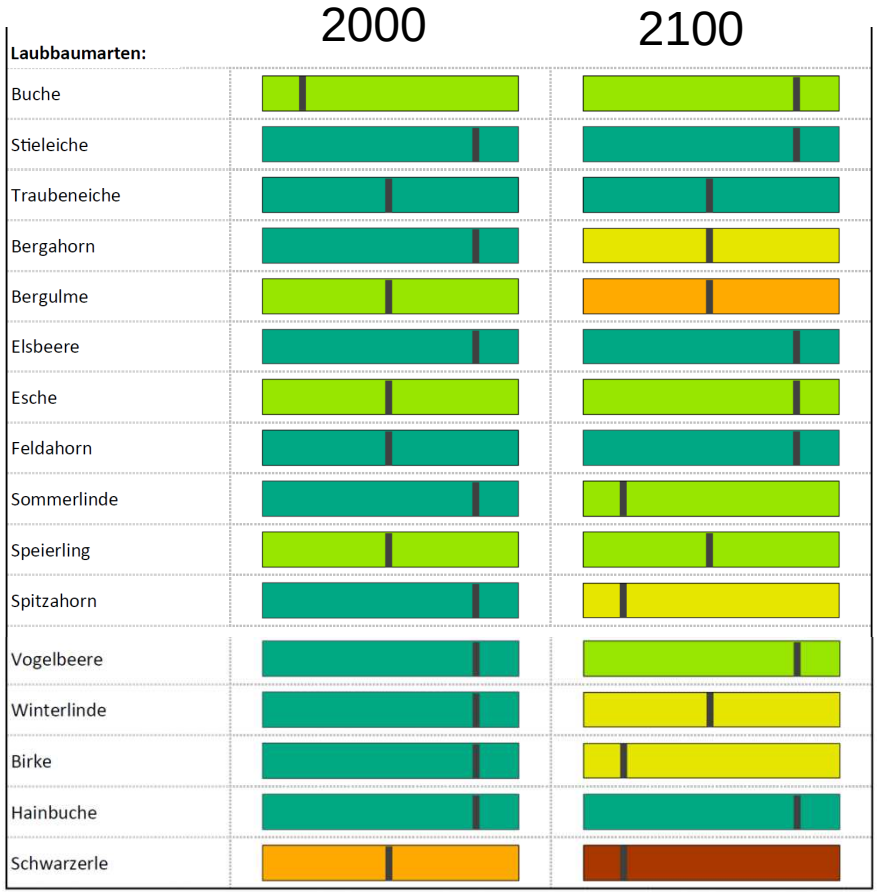
Point information

- Condensed point information: overview over the risk assessment of 21 tree species within the system



Forest GIS: BaSIS – cultivation risk

- Condensed point information: overview over the risk assessment of 21 tree species within the system



Forest GIS: BaSIS

- Complex system for forest experts
- Incorporated scientific knowledge - state of the art
- Dynamic, learning system → updates
- Transparent rules
- **Basis of forest consulting**

Forest GIS - BaSIS

All problems solved?

Implementation and adaptation – a fast selling item?

- Level of acceptance?
  - Climate scenarios
  - Consequences for tree species
  - Own experience – will become void / outdated
  - new tools – traditional forestry

We have to reduce uncertainties

scientific basis → foresters, forest owners

LWF

Conclusions and outlook

- Global warming impacts German / Bavarian forest ecosystems
  → tolerance levels of tree species may be exceeded
- Bavaria, as several other federal states started adaptation measures and promotes the conversion of single species stands at high risk
- Tool - based on SDM to support the choice of tree species
- Our tool will be developed further
  - integration of climate data ensembles
  - Improvement of tolerance levels of species (MARGINS-project)
  - Integrate growth potential and combine it with cultivation risk
- But: decision is up to the forest owner

LWF

Thank you!