Scots pine decline in inner-Alpine valleys - system analysis and management options

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Content of the presentation

1. Scots pine decline - System analysis

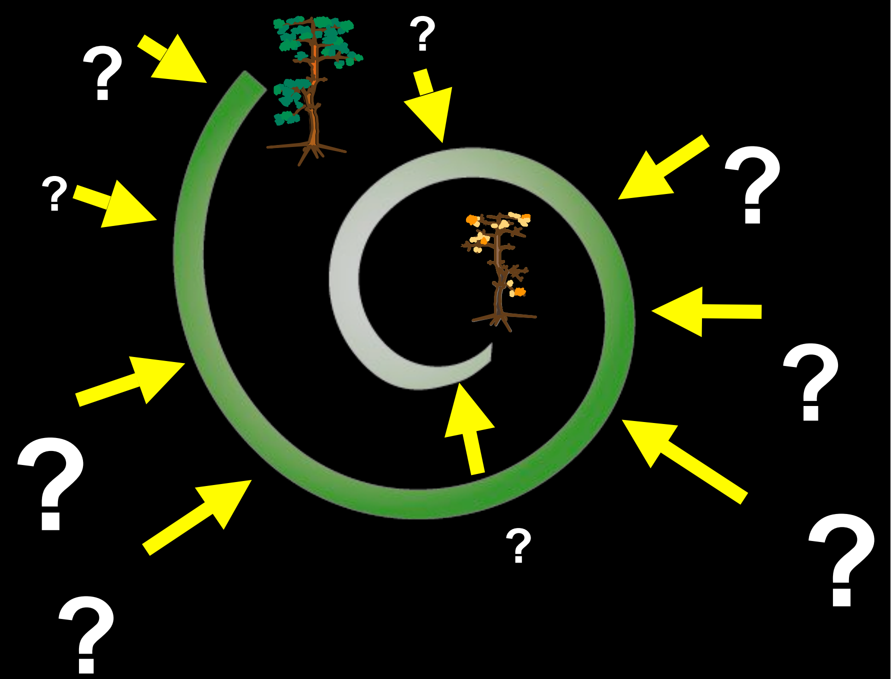
Scots pine decline in the Swiss Rhone valley

20. century - increased since 1990ties

Pines with varying crown transparencies

Why do the pines die?

Forest ecosystems are complex and not static: consist of a high variety of biotic and abiotic components, with a high variability of combinations in space and time.

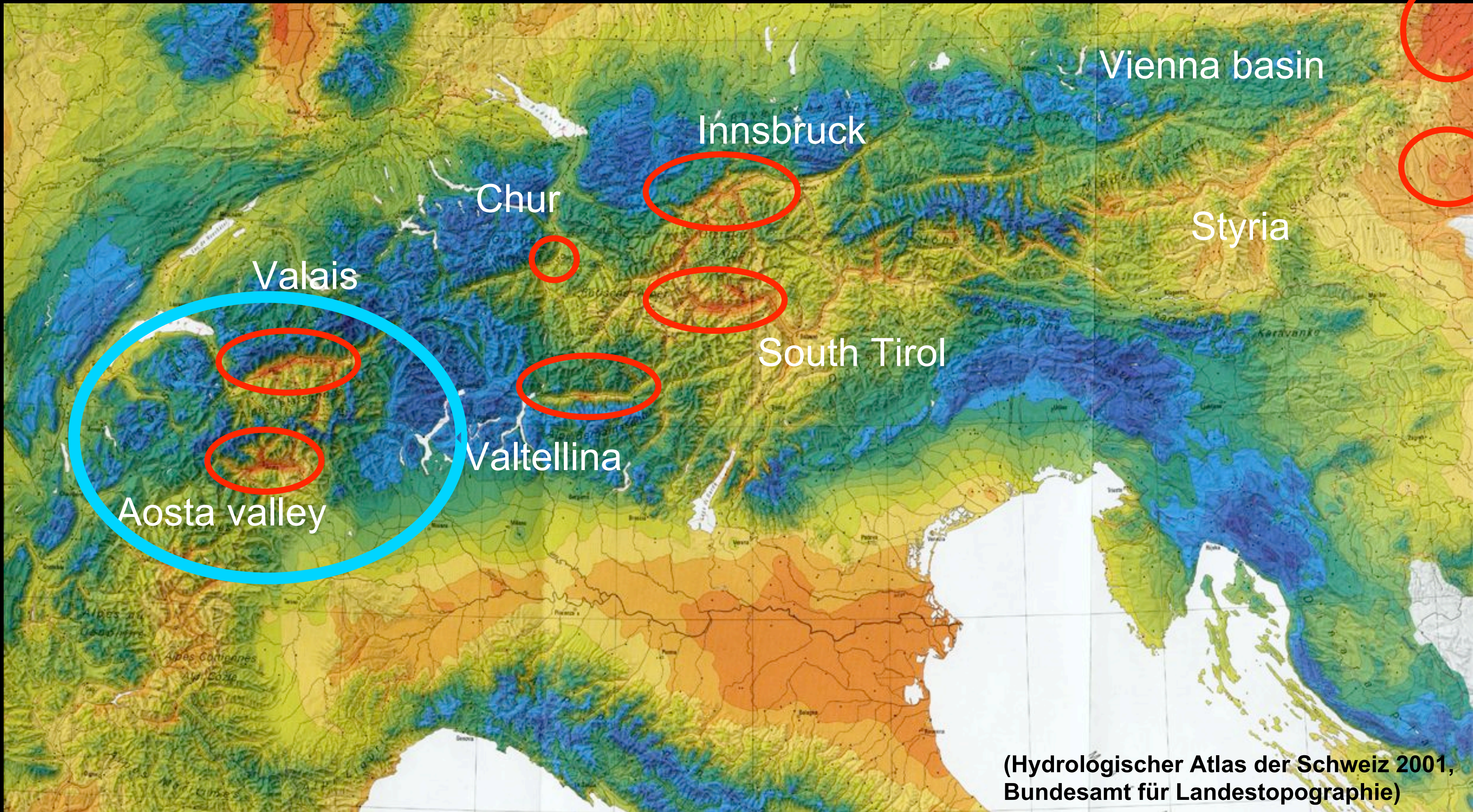


Forest decline processes are mostly multi-causal (only at very extremes (e.g. mountain pine beetle, pollution, fire, storm) single factors might become dominant):

- Site factors are heterogenous in space and time
- Tree species (mixture, structure, age , growth strategy, sensitivity, ...)
- Multiple, often species-specific stressors (e.g. climate, pests, competition, ...)
- Systems with individual histories (forest management, succession)

Alpine dry regions

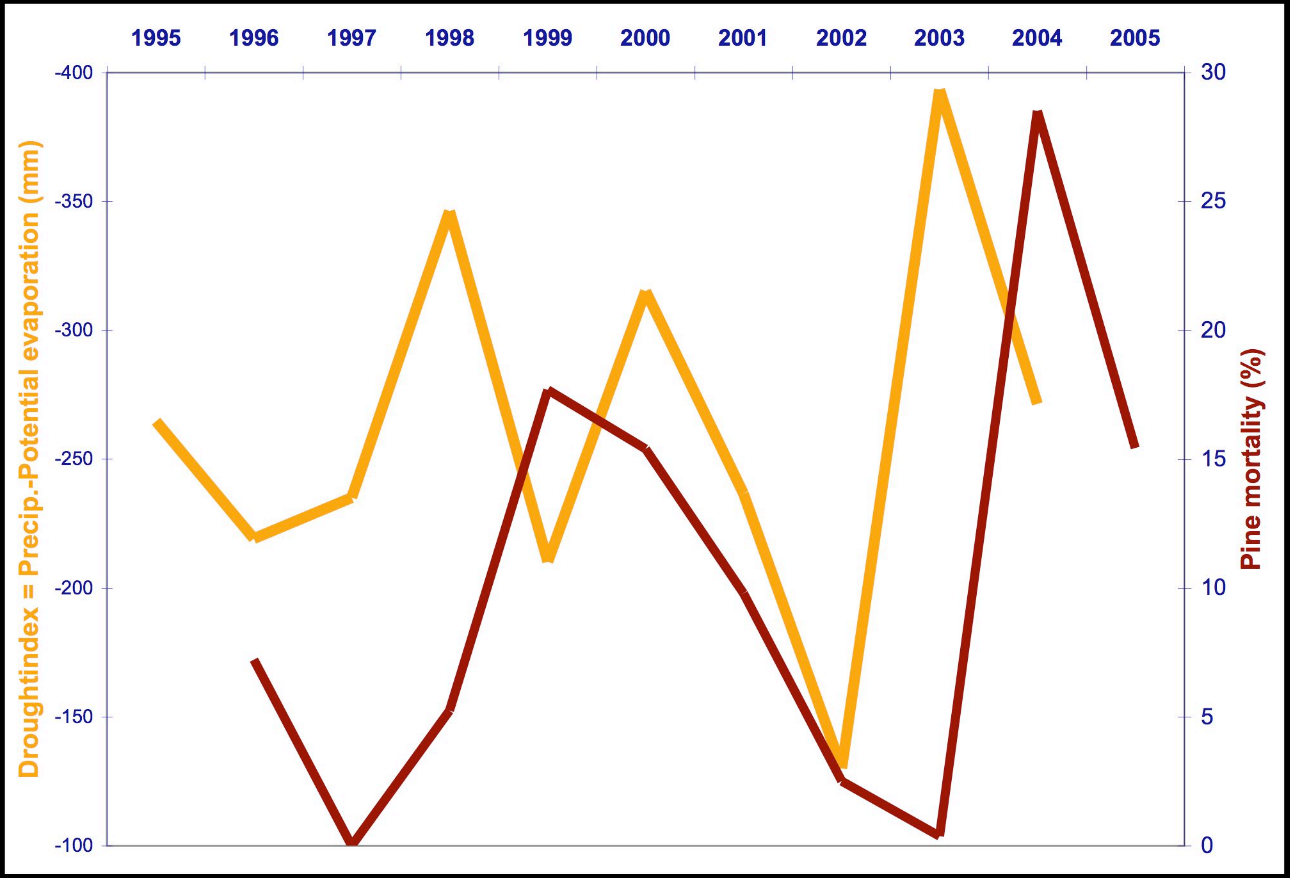
Annual precipitation in the Alps



Mortality and summer drought

Monitoring plot Visp:

1995-2005:
60% pines but only 15% broadleaves died



- **Pine mortality increased in the year following hot-dry summers**
- **Multiple drought years significantly increase the probability of pine death**
- **Mortality was highest on dry sites (Monitoring 1983/85 - 2002/03)**

(Bigler, Braeker, Bugmann, Dobbertin, Rigling 2006: Ecosystems) *(Rigling et al. 2006: FORUM F. WISSEN)*

Irrigation experiment Pfynwald

C	W	W	C	C	W	W	C
+8.1*	-8.6*	-3.9*	+12.8*	+9.0*	-7.0*	-2.8	+9.9*

Wasser Kanal

8 plots (each 40x25 m) in

4 blocks each 1x watered and control (60-100 trees)

Irrigation Apr-Oct, during the night

June 2003 - October 2009

Transparency change 2003-07

Control: + 9.8 %

Irrigated: - 6.1 %

Mortality (March 03 - March 07)

Control: 18 trees 6.08 %

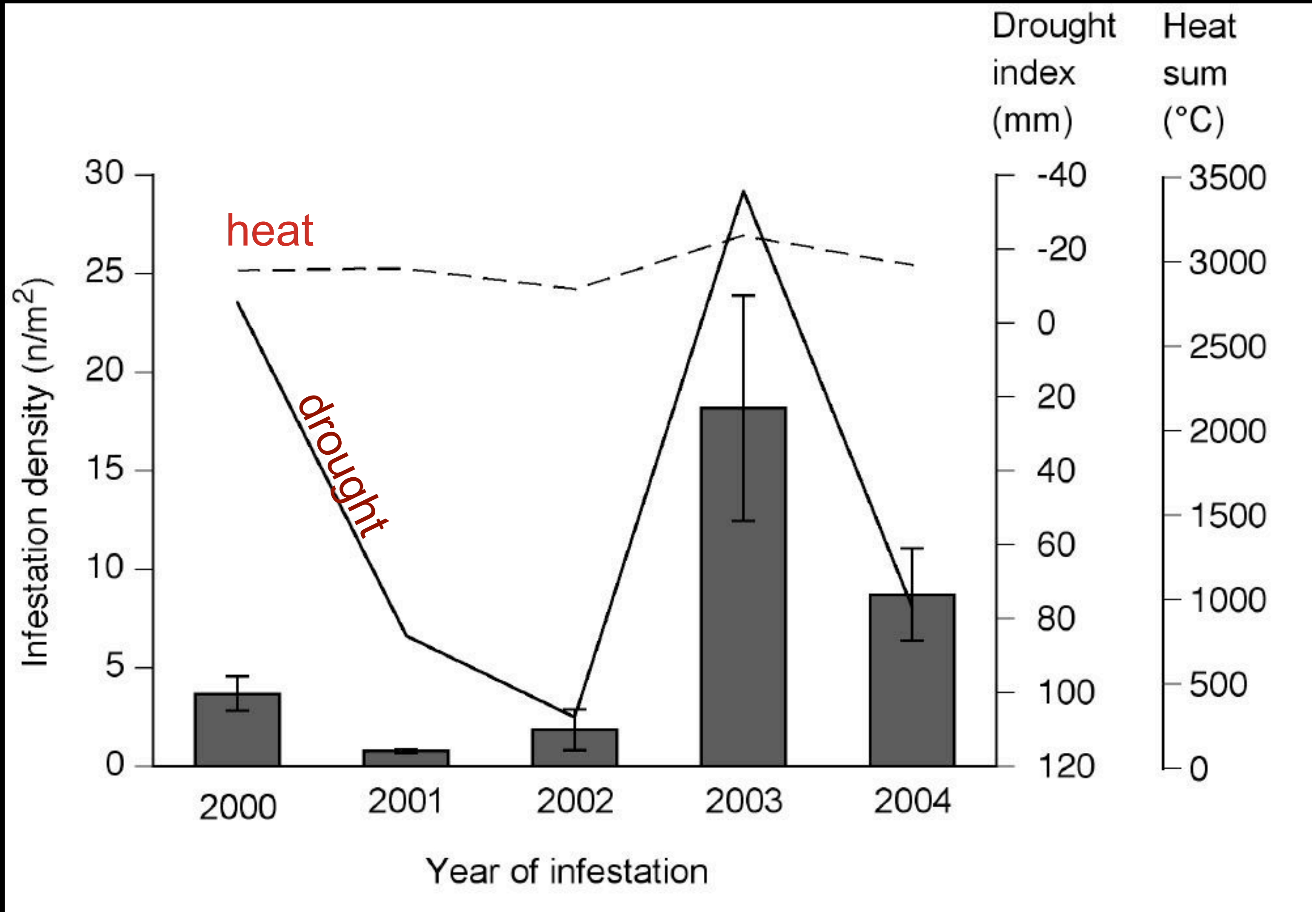
Irrigated: 7 trees 2.45 %

Irrigation had a positive effect on foliage mass and reduced tree mortality

(Dobbertin, Landolt, Pannatier,Rigling: data unpublished)

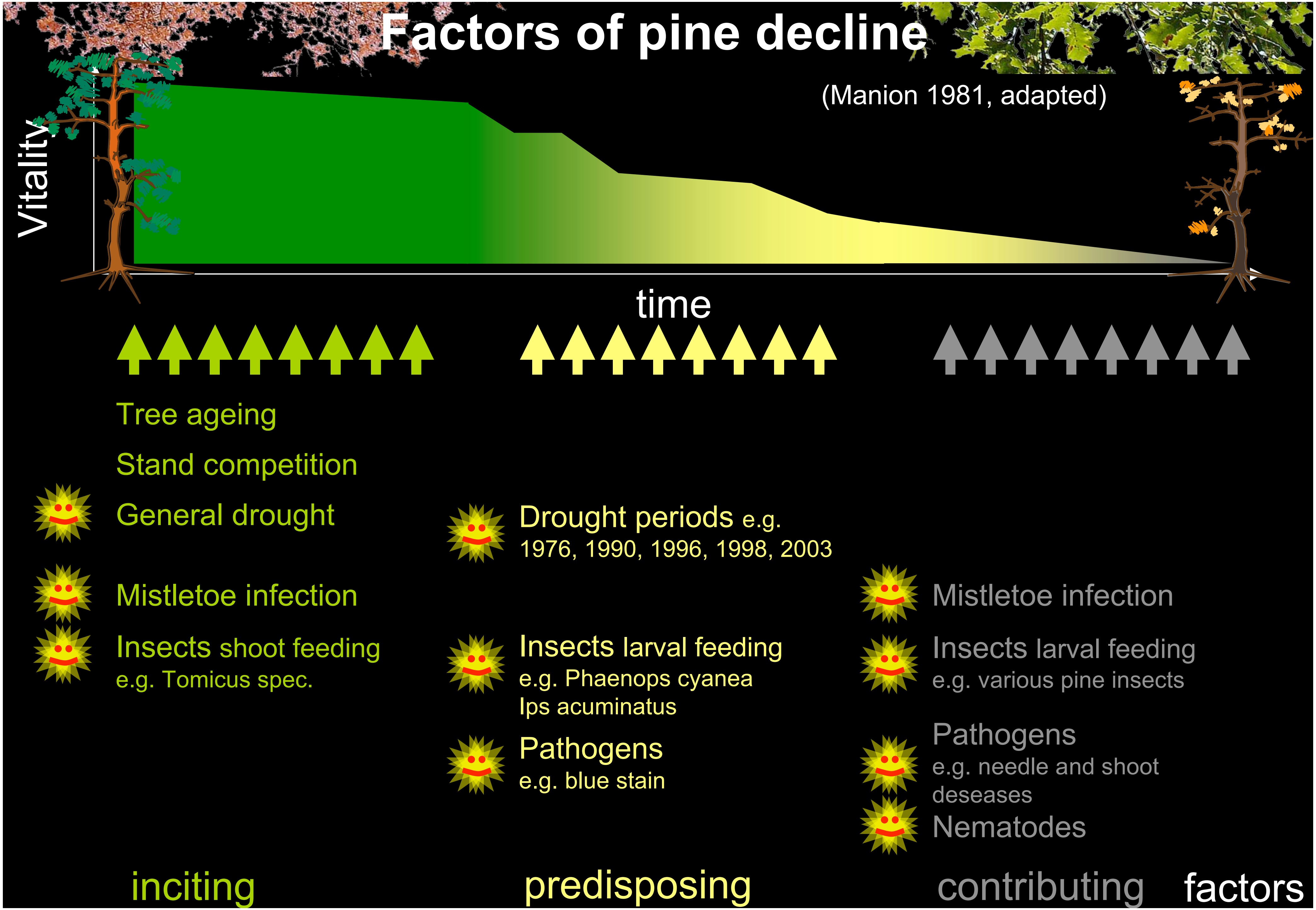
Drought and insect infestations

2000-2005 in total 200 trees were cut, put into breeding chambers with insect-traps.



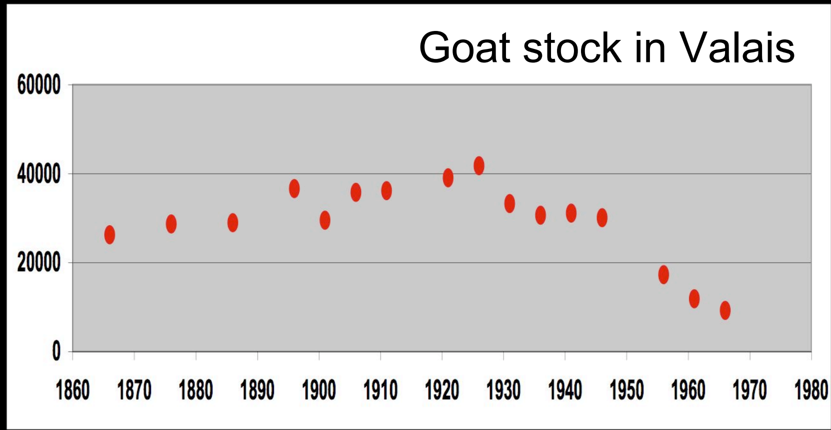
- Hot - dry summers boost the development- and investation rate of insects (indirect effect)

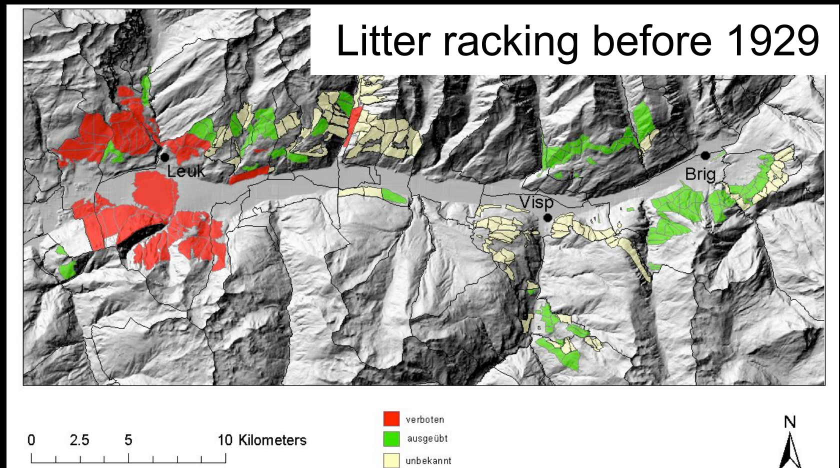
(Wermelinger, Rigling, Dobbertin: in review; Ecol. Entomol.)


Factors of pine decline
(Manion 1981, adapted)
Vitality
time
Tree ageing
Stand competition
General drought
Mistletoe infection
Insects shoot feeding
e.g. Tomicus spec.
Drought periods e.g.
1976, 1990, 1996, 1998, 2003
Insects larval feeding
e.g. Phaenops cyanea
Ips acuminatus
Pathogens
e.g. blue stain
Mistletoe infection
Insects larval feeding
e.g. various pine insects
Pathogens
e.g. needle and shoot
deseases
Nematodes
inciting
predisposing
contributing
factors

Pine decline and spreading of broadleaves

Historic forest use





1 Selective cuttings & plantations

2 Forest grazing

- Goats and sheeps
- Selective browsing (neg. for broadleaves)
- Seed bed pos. for pine

3 Litter racking

- Negative impact on seed bank (oak) and nutrients
- Seed bed pos. for pine

In areas where neither forest grazing nor litter racking was practised in the past, the change from pine to oak is today significantly more advanced!

(Gimmi & Bürgi; Env. History, accepted)

Summary pine decline

- Pine decline as a result of the direct (drought) and indirect effects (pests) of climate change.

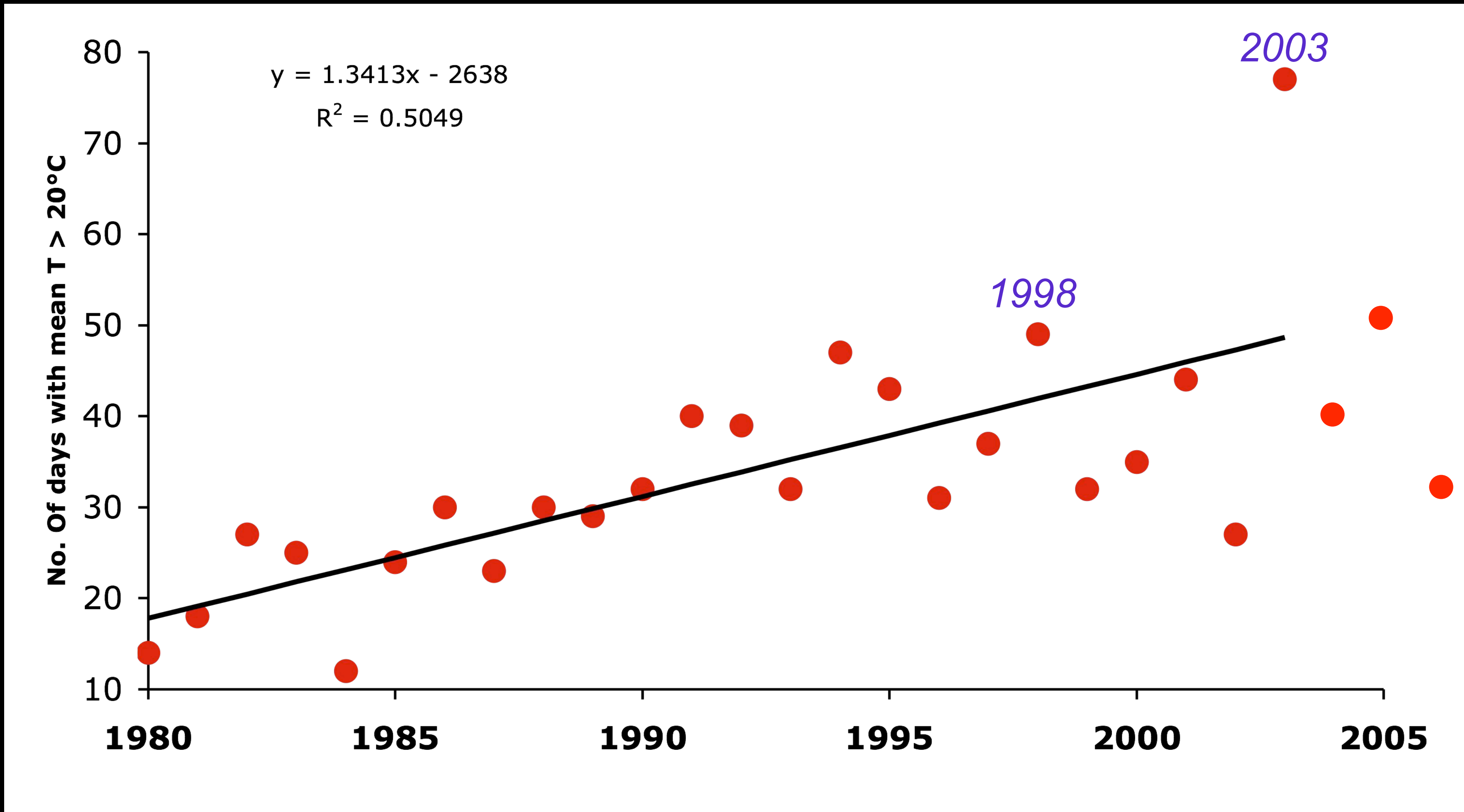
- Shift in tree species composition (from pine to oak) as a result of past forest use (grazing, litter racking, & locally selective cuttings, plantations).

Content of the presentation

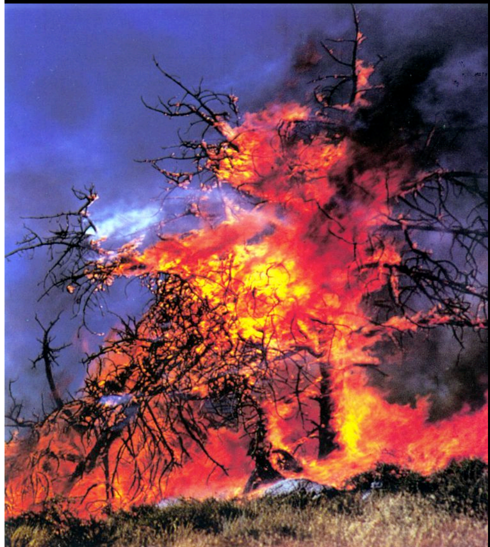
2. Prognoses on future development

It is getting hotter

Number of days with mean temperature > 20°C in Visp



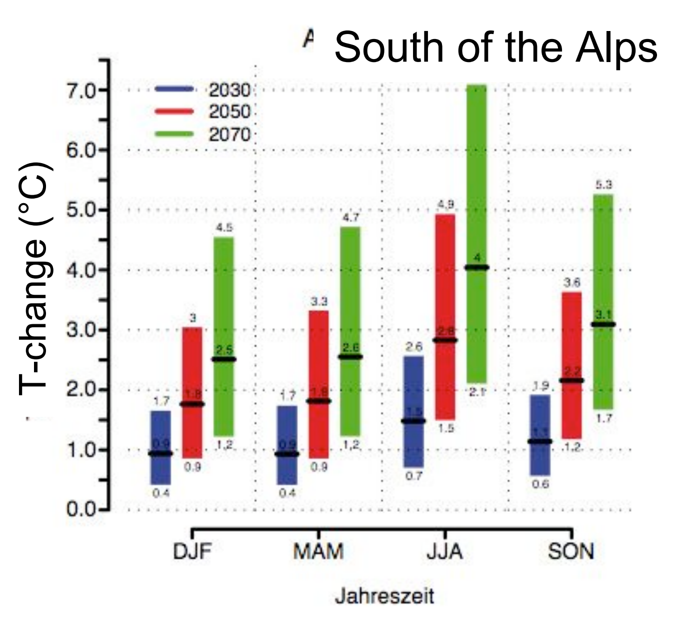
Summer hot spell 2003

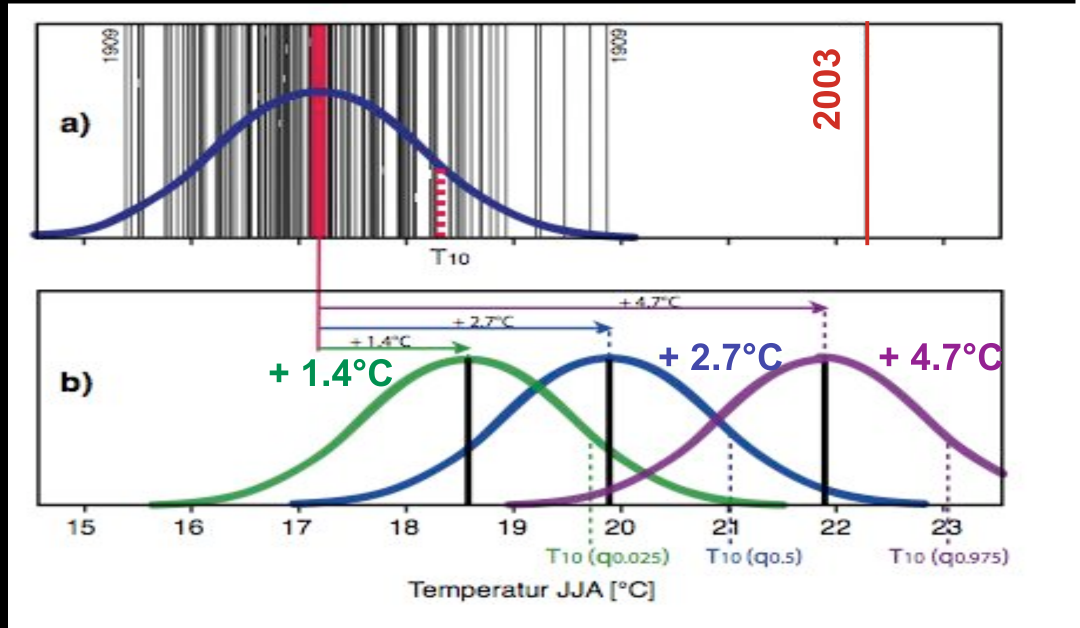


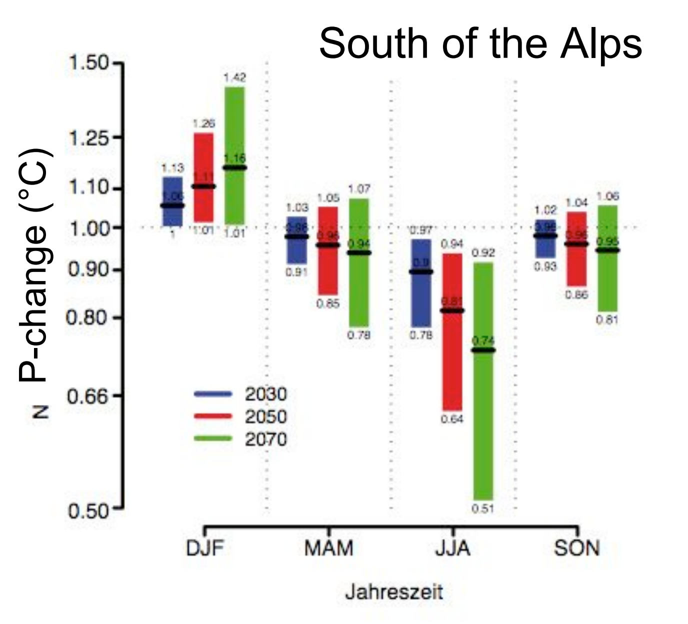

Hot spell 2003 had significant consequences on the forests:

- Water shortage
- Forest fires (e.g. Leuk 300 ha protection forests destroyed)
- Trees almost stopped their growth, increased mortality and early leaf-shedding was frequent, also for oak!

Future climate szenarios







- Hot spell 2003 will become average

- Winters will become warmer and more moist
- Summers will become hotter and drier

(OcCC 2007)

Content of the presentation

3. Management options

Szenario 1: moderate warming

Inner-Alpine pine forests

High altitude
> 1200 m asl

Low altitude
< 1200 m asl

Target forest:
Mixed broadleaved forest (dominated by oak and with pine mixed in)

Phytosanitary measures:
large area, different pests,
difficult to access, difficult to control - not efficient

Measures to increase tree vitality:
Reduction of the competition for water by
- thinnings
- removal of the understorey (e.g. goats)
- removal of mistletoes

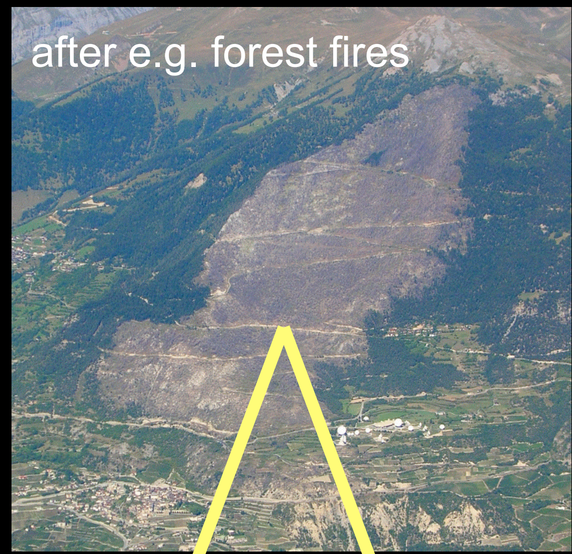
Measures to reduces the risks of pests:
- avoid monocultures
- promote tree species diversity
- increase horizontal, vertical and age structure

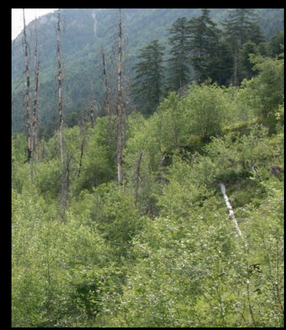
Regeneration strategies:
- increase species diversity
- avoid big openings (drought)
- regeneration under shelter
- timing of seeding and planting
- promote broadleave seed trees

Szenario 2: hot spell 2003 as future average?

Too dry for native forest vegetation

Recruitment as bottleneck





Forest ?

Steppe ?

There is a need for experiments ...

- Experiments with alternative tree species
- Irrigation (vss control)
- Rain shelters (simulate drought)
- Altitudinal gradients and top-down transplantations (simulate warming)
- Warming experiments

... to adapt forest management concepts

Thank you for your attention

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