SPATIO-TEMPORAL PATTERN OF DECLINE IN SCOTS PINE VITALITY

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Study areas in the Italian and Swiss Alps

A multidisciplinary, trans-national research effort has been undertaken in the last 4 years to understand the causes of an ongoing dieback wave in Scots pine (*Pinus sylvestris* L.) forests across the Alps. The rationale of this process has been sought in the decline-disease theory framework that invokes the interaction of long-term, **predisposing** stress factors such as competition and generalized drought, and **contributing** and **inciting** factors acting on a shorter time frame, e.g., repeated drought years or severe insect or pathogenic infestations.

Disentangling these factors and their impact on tree vigor or survival is a daunting task, since the parameters commonly used as indicators of individual vitality are highly unspecific. The scope of this research is to test the hypothesis that **different stress factors result in specific spatial and temporal patterns of tree vitality**, as reflected by overstory crown transparency, radial growth and tree survival.

Study area and Methods

Aim: Finding out the **spatial signature** left by different stress agents on stand structure.

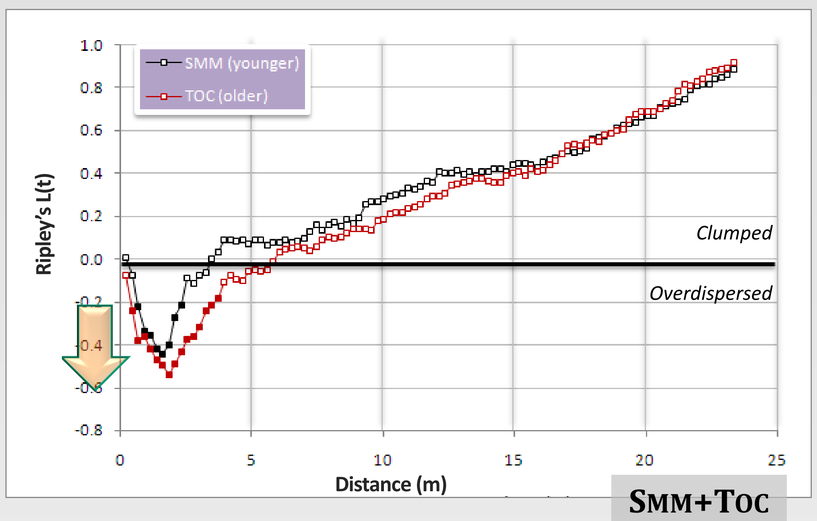
Study areas: permanent monitoring plots on the northern and southern sides of the Alps, in pure Scots pine forests affected by a range of stress factors and intensities. Each area was chosen among an existing monitoring network in order to scrutinize stand dynamics related to a single, dominant stress agent.

Methods:

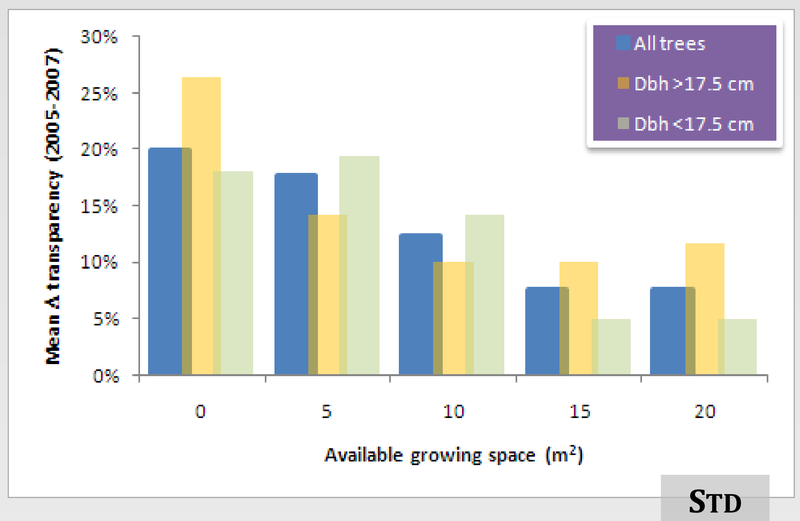
1. Reconstruction of past and current growth rates by means of dendrochronological sampling (MOR; *n*= 100 trees). Radial growth was preliminarily detrended with a site-based age filter.
2. Spatial point pattern analysis (Ripley's *L*) to reveal the degree of tree clumping based on a simulated (SMM+TOC) or real (SNP) chronosequence of pine stands.
3. Yearly assessments of crown transparency within an irrigation experiment (randomized block sampling design, PFY) and at a dry site as a function of available growing space (STD).
4. Geostatistic tools (Moran's *I*) to assess spatial autocorrelation of size- and growth- related variables (MOR, SNP). The noise induced by age and tree location was filtered by analyzing spatial residuals.

Preliminary results

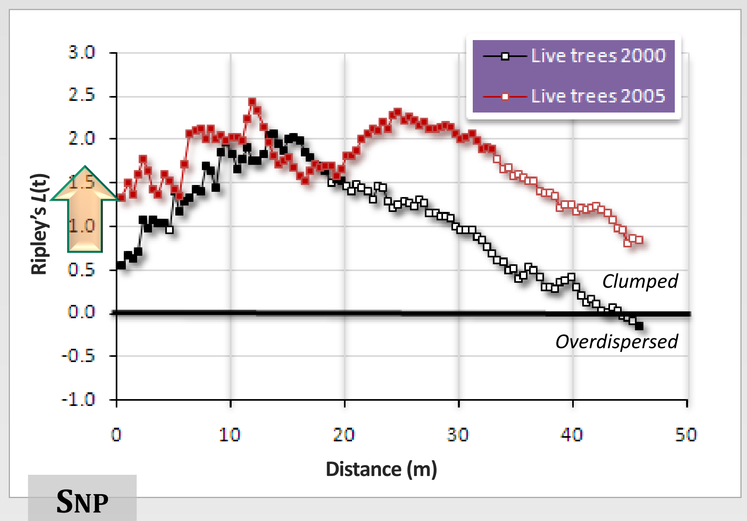
Dark squares mean significant values ($p < 0.05$).



SMM+TOC

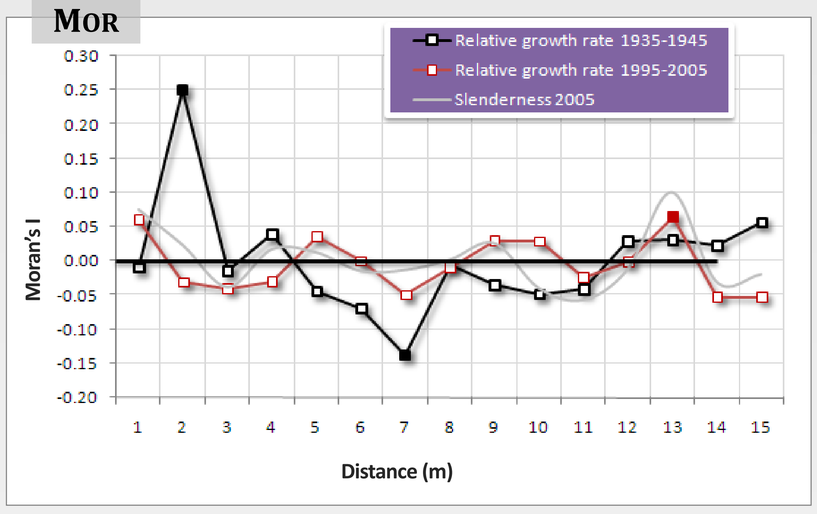


STD

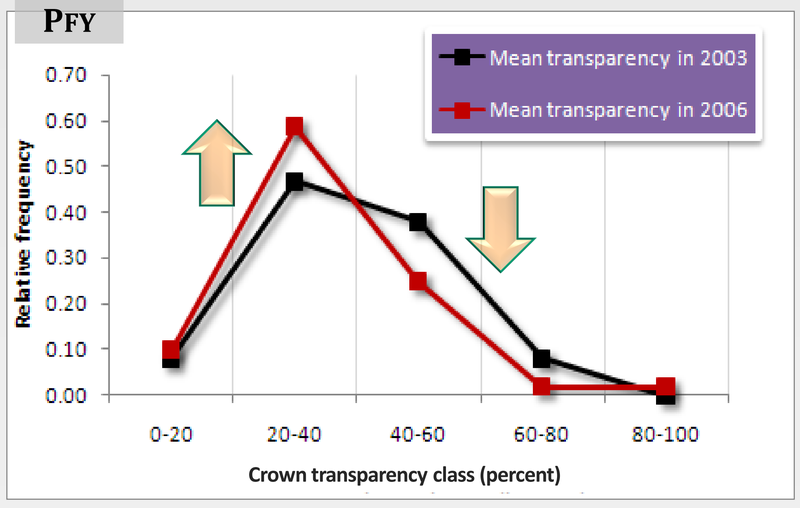


SNP

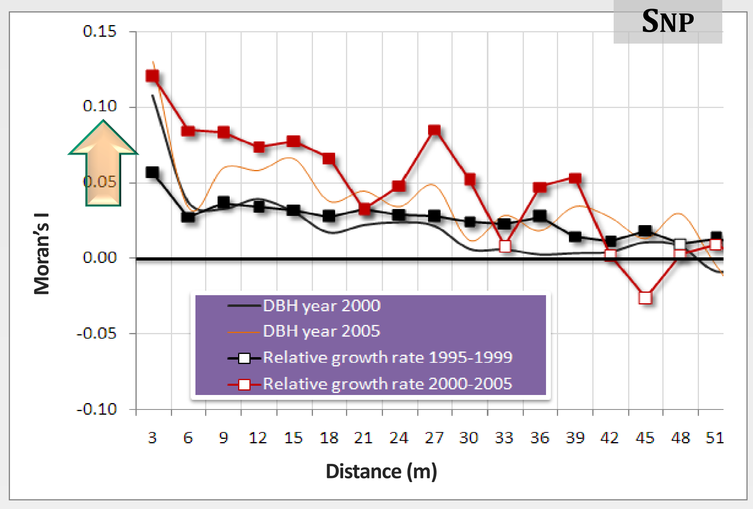
MOR



PFY



SNP



COMPETITION

- Regularizes spatial pattern of survivors
- Drives spatial similarity of growth rates

WATER DEFICIT

- Rapidly effects tree vitality (defoliation)
- Tree decline mediated by growing space

ROOT PATHOGENS

- Increase degree of tree clumping
- Spatially differentiate tree growth

Discussion

❑ We ascertained the role of stress agents in shaping the spatial pattern of declining Scots pine stands. Altered stand structures will lead to different pathways of forest dynamics driven by the interaction of exogenous and endogenous drivers.

❑ Patterns of tree vigor and their variation through time provided insights on the agents of the ongoing decline in each stand.

❑ When coupled with spatially explicit information and analyzed through time, vitality indicators can be used as a proxy for the analysis of multi-factorial decline processes. The spatial signature left by predisposing and contributing stress agents on tree growth and survival can be used to trace back determinants of decline in stands with complex dieback dynamics.