EARLY WARNING SIGNALS OF NORWAY SPRUCE DECLINE IN EASTERN EUROPE

Andrei Popa[1,2], Ernst van der Maaten[3], Ionel Popa[1,4], Marieke van der Maaten-Theunissen[3]
1 National Institute for Research and Development in Forestry Marin Dracea, Romania
2 Faculty of Silviculture and Forest Engineering, Transilvania University of Brasov, Brasov, Romania
3 Chair of Forest Growth and Woody Biomass Production, TU Dresden, Tharandt, Germany
4 Center for Mountain Economy (CE–MONT), Vatra Dornei, Romania

This presentation participates in OSPP
Outstanding Student & PhD candidate Presentation contest

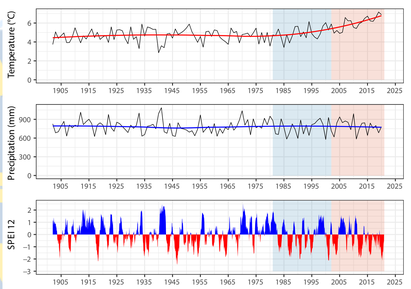
1. INTRODUCTION

Climate change is affecting forest ecosystems all around the globe, in particular through warming as well as increases in drought frequency and intensity. Norway spruce (*Picea abies* (L.) Karst.) as one of the most important coniferous tree species at the European level is likely to be at risk. Severe droughts during the vegetation period may, for example, negatively affect its resilience and ability to resist bark beetle attacks. This has been observed in Central Europe after the extreme dry years 2018-2020 through large-scale dieback. In Eastern Europe, no such decline has been reported so far, posing the question **how these forests will develop in the future?** This study evaluates early warning signals (EWS) in Norway spruce of different age along an elevational gradient in the Eastern Carpathians, Romania.

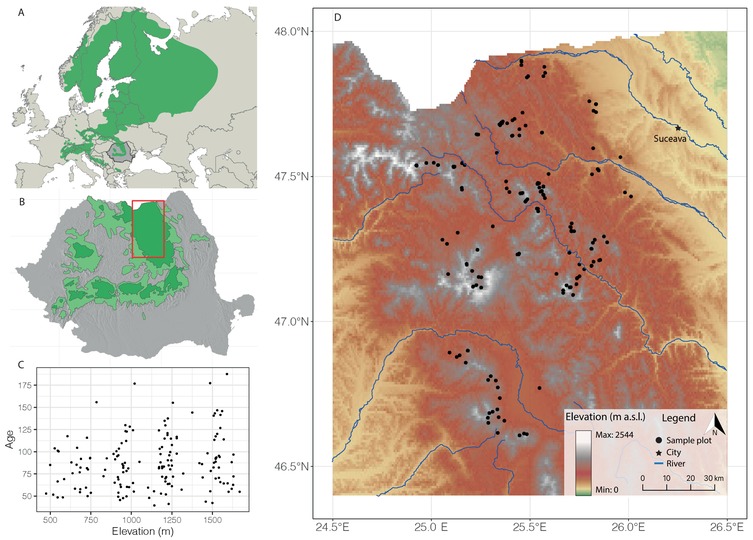
2. METHODOLOGY

Tree-ring samples were collected from 157 even-aged managed forest stands within the natural distribution range of the Norway spruce in the Eastern Carpathians, covering an elevational gradient from 475-1675 m a.s.l. Per stand, increment cores were extracted at breast height from at least 20 dominant trees in the years 2021 and 2022. Cores were prepared and tree-ring widths (TRW) measured according to standard dendrochronological procedures. TRW measurements were transformed into basal area increments (BAI).

We focus on the EWS (*i*) **growth decline** (detected in BAI series using Mann-Kendall trend tests), and (*ii*) changes in **growth sensitivity** (over the first-order autocorrelation (AC) and standard deviation (SD)).



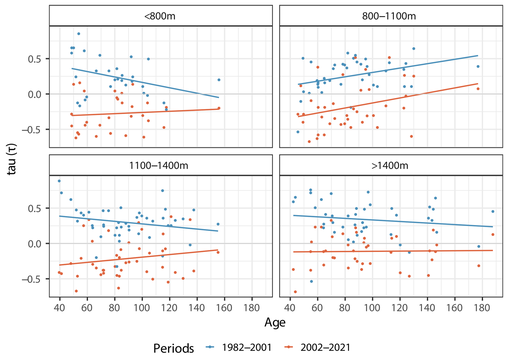
Climatic trends in the study area. *SPEI 12* Standardized Precipitation Evapotranspiration Index with a scale parameter of 12 months. Climate data derived from gridded CRU TS4.05.



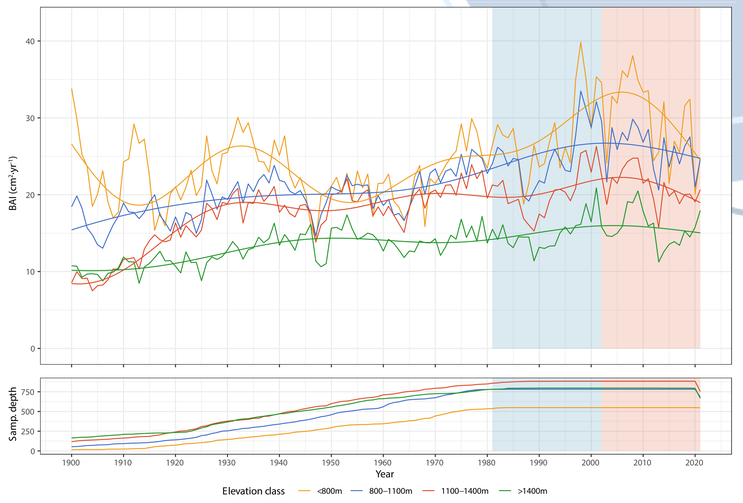
Norway spruce distribution in (A) Europe (dark green colour), and (B) Romania (natural distribution – dark green, artificial distribution – light green, study area – red line). (C) Age and elevation, and (D) location of studied stands (black circles).

3. RESULTS

The BAI series show an increasing trend until 2002 for all elevational classes. In 2003 (i.e. one of the driest years in the study region), a major reduction in BAI was recorded at all elevations, which was highest at the lower elevations.

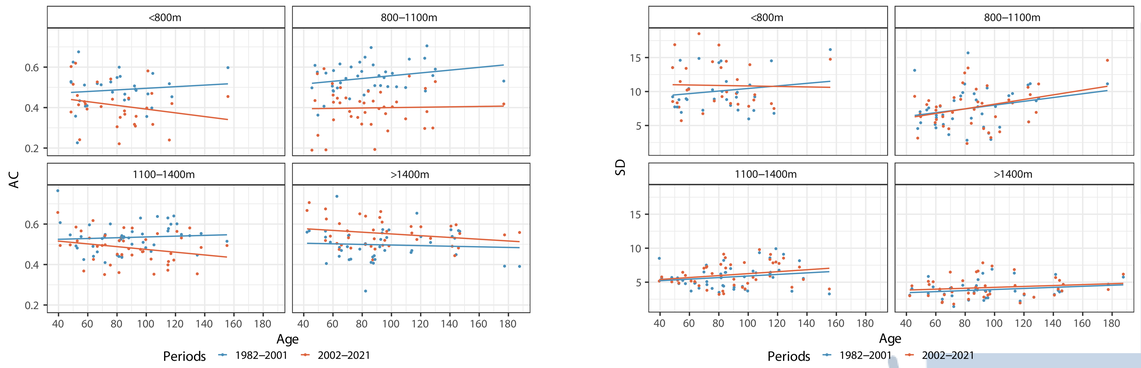


The direction of long-term BAI trends as quantified through Mann-Kendall tau coefficients in the two investigated periods plotted over mean stand age for four elevational classes.



Raw basal area increment dynamics and smoothed trend lines calculated using a GAMM for the four elevational classes, and the sample depth, i.e. the number of trees included in the analyses. The filled areas represent the two study periods 1982-2001 and 2002-2021 in blue and red, respectively.

A change in the BAI trends from positive to negative between the periods 1982-2001 and 2002-2021 can be observed for all elevations, which is a clear EWS for Norway spruce decline.



Growth sensitivity as quantified over AC and SD

4. CONCLUSIONS

Overall, our results indicate a high vulnerability of Norway spruce in the Eastern Carpathians, posing an alarming signal about the future of this tree species in Eastern Europe.

Acknowledgements: This work was supported by project CresPerfInst (contract 34PFE/30.12.2021) and project PN-III-P4-PCE-2021-1002 financed by the Ministry of Research, Innovation and Digitization, Romania
Corresponding author: Andrei POPA (*popa.andrei.dorna@gmail.com*)