NW-FVA

Nordwestdeutsche
Forstliche Versuchsanstalt

Predicting Tree Mortality by Comparing Standardized Drought Indices

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Introduction

Tree mortality in German forests has risen sharply since the 2018 drought, with rates remaining high. This trend disrupts the carbon balance as the ability of forests to sequester carbon decreases, and stored carbon is released during decomposition, turning forests from carbon sinks into carbon sources and exacerbating climate change.

Data & Methods

Using long-term monitoring data from the **forest condition survey [1]** (1984–2023, with 882105 yearly observations at 419 BZE and 2065 WZE plots) and standardized drought indices, mortality rates were modeled using Generalized additive models with integrated smoothness estimation.

Standardized variables expressed via drought indices:

- **SPI [2]**: Precipitation
- **SPEI [3]**: Climatic water balance (P-PET)

Drought Class	Value [σ]	Probability [%]
Moderate Drought	-1.5 to -1	9.2
Severe Drought	-2 to-1.5	4.4
Extreme Drought	< -2	2.3

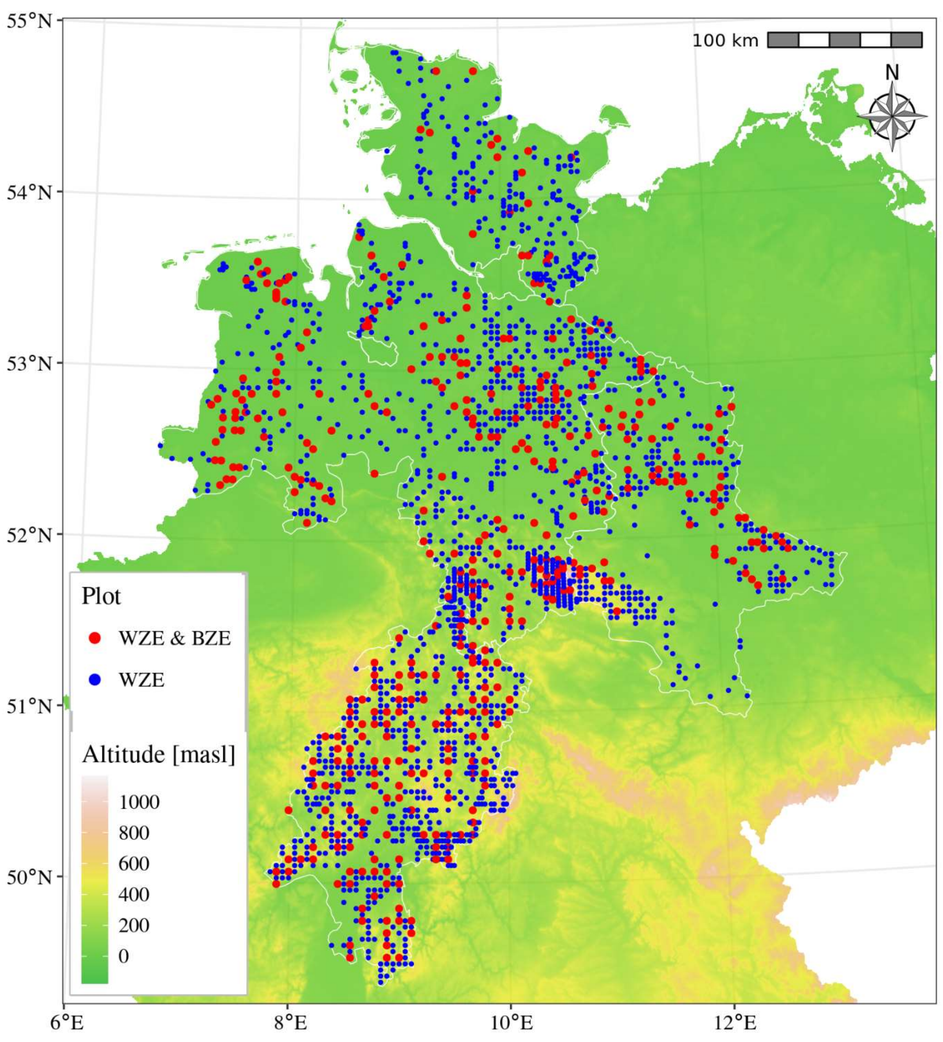

Fig. 1: Plots with Mortality Data of Forest Condition Survey

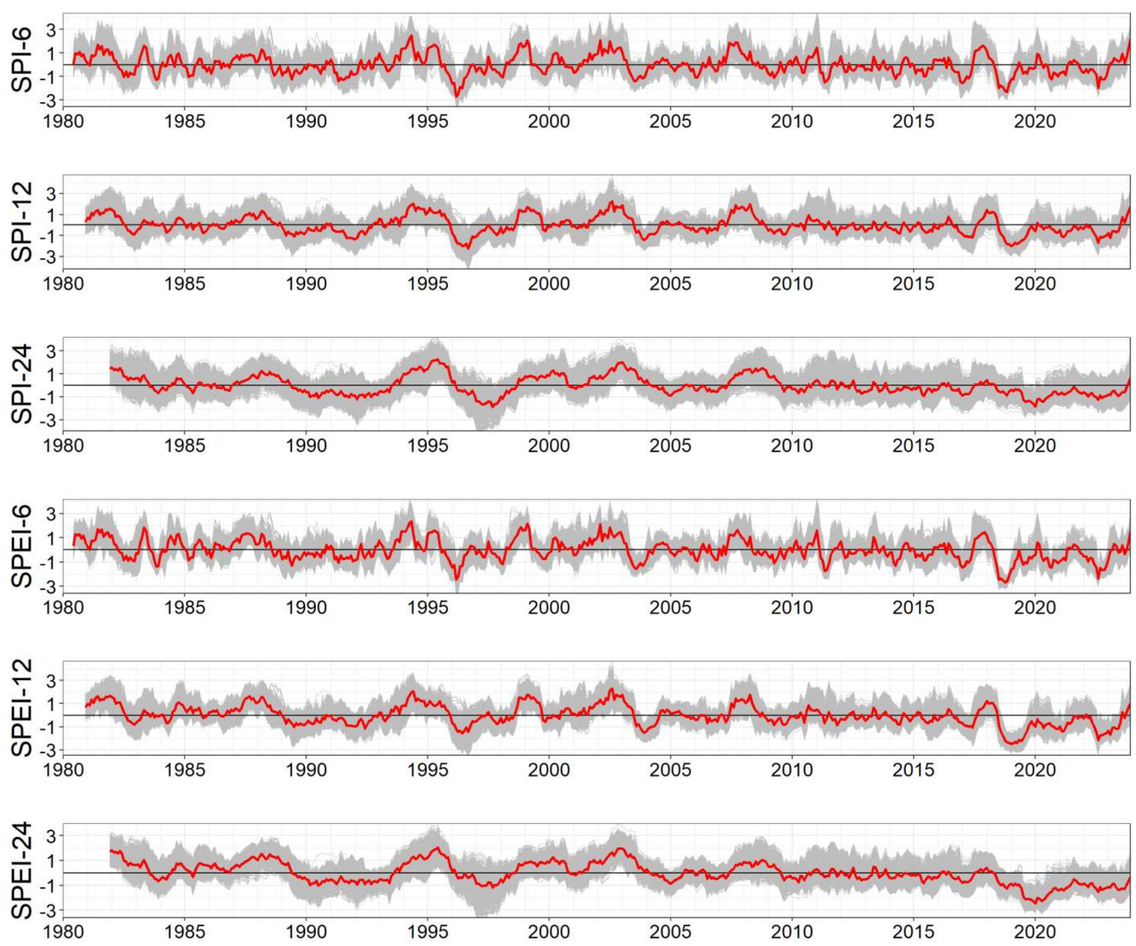

Fig. 2: Drought Indices on Stand Scale (red = mean)

Results

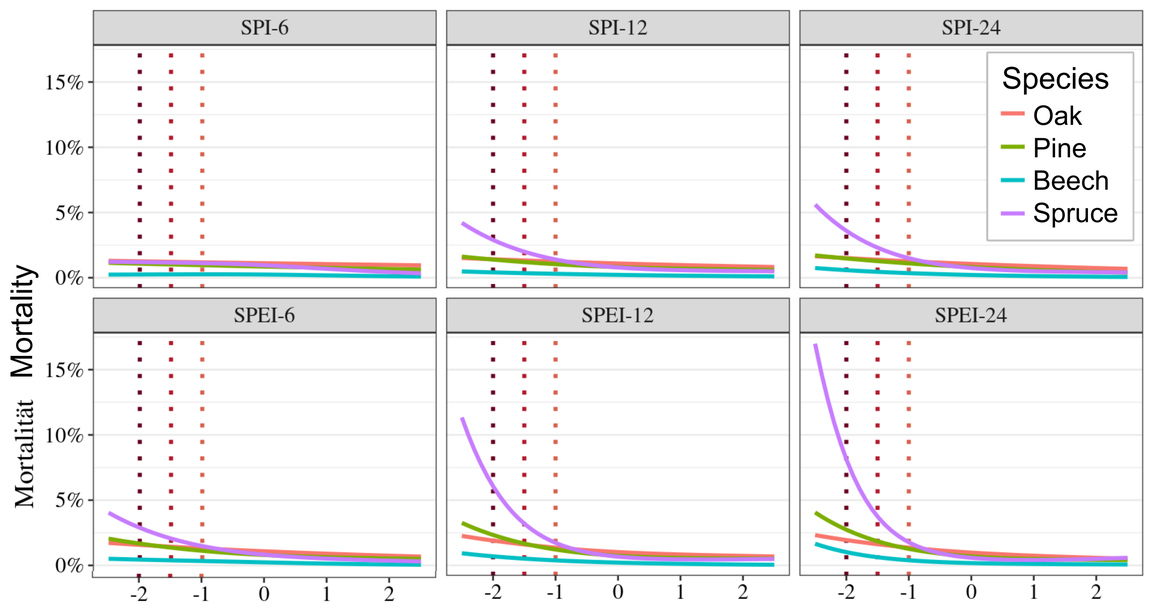

Fig. 3: Mortality Predictions for Tree Species during Drought

SPEI, particularly with a two-year preceding condition, best explains mortality changes. Mortality rises with drought intensity and duration, with spruce showing the highest mortality rates with up to 15% during extreme droughts. The 2018–2020 drought provides a reference point; however, future droughts are likely to be even more severe and prolonged, making past observations an insufficient benchmark for assessing their full impact. Adaption and mitigation strategies to cope with such events are urgently needed.

Literature:

[1} WZE und BZE: Wellbrock, N., Eickenscheidt, N., Hilbrig, L., Dühnelt, P., Holzhausen, M., Bauer, A., Dammann, I., Strich, S., Engels, F., & Wauer, A. (2018). Leitfaden und Dokumentation zur Waldzustandserhebung in Deutschland. Thuenen Working Paper(84), 88

[2] SPI: McKee, T. B., Doesken, N. J., & Kleist, J. (1993). The Relationship of Drought Frequency and Duration to Time Scales. 17(22), 179–183

[3] SPEI: Vicente-Serrano, S. M., Beguería, S., & López-Moreno, J. I. (2010). A Multiscalar Drought Index Sensitive to Global Warming: The Standardized Precipitation Evapotranspiration Index. Journal of Climate, 23(7), 1696–1718.

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