![Project brief]

Project brief

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Storm damage in forests: Insights into Level II data

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- **Storm damage on Level II plots occurs nationwide**
- **Conifers overrepresented among damaged trees**
- **Allocation of damage to individual storm events not always unambiguous**

In the project "WINMOL" we deal with the detection and prediction of storm damage in forests using storm damage and forest growth models. The data of the intensive forest environmental monitoring (Level II) comprise time series on individual tree parameters, site characteristics, and the causes of damage and mortality on 68 legally defined plots and further permanent observation plots.

Background and aims

Since 2005, winter storms have been identified as one of the largest causes of damage in relation to climate and weather extremes in studies by the European Environment Agency (EEA; EEA 2015). In Germany, damaged wood in the order of several million cubic meters accumulates annually (Destatis 2022). In addition to this primary damage caused by windthrow and stem breakage, secondary damage such as an increased risk of pest infestation and oversaturation of the timber market can also occur. In the course of anthropogenic climate change, an increase in extreme weather events is expected, after which the risk of storm damage will also increase (EEA 2015).

In addition to individual tree parameters such as height and breast height diameters, stand and site characteristics are of interest in estimating the storm damage vulnerability of a stand. In the Level II monitoring network, information on main tree species and tree species composition, water availability, exposure, and soil properties, among others, are recorded. With this in mind, we provide an overview of the occurrence of storm damage on Level II sites and its spatial and temporal distribution. Measurements during the period from 1992 to 2021 are considered, and the scope in terms of number of trees and parameters measured varies greatly depending on the year and the area considered.

Approach/Methodology

In a first step, we classify individual trees from the crown condition and growth surveys in the Level II database according to recorded storm-related damage and present the spatial distribution of documented storm damage in the affected areas and the main tree species according to inventory data. Trees are categorized as "damaged," i.e., removed as a result of storm damage, affected by windthrow or stem breakage, and "not identified as damaged". This classification is based on the encoding of the reasons for elimination in the crown condition and growth surveys.

Next, we look at the data set in terms of individual trees affected:

- How many trees were affected by storm damage?
- How frequently are different tree species represented?
- What gust speeds occurred during the strongest winter storms in the observation period on the Level II plots?
- In which years was the damage documented?

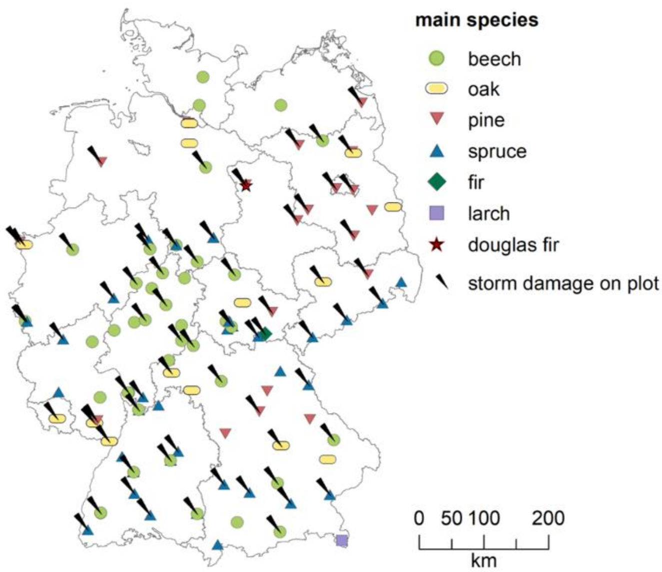

Figure 1: Occurrence of storm damage with at least one affected tree on Level II plots in the period 1992-2021 (classified by main tree species).

The storm data presented show the maximum gust speeds on Level II plots for the strongest storm events in the corresponding years (Fig. 2A). We extract these velocities from raster data of the historical Winter Storm Atlas for Germany (Schindler and Jung 2020) for the coordinates of the Level II plots (Fig. 1). Afterwards, we select the maximum velocity for each storm from all extracted velocities.

Key findings

Storm damage on Level II plots occurred almost all over Germany (Fig. 1). Areas with the main tree species beech, oak, pine and spruce were affected. These are also the most frequent main tree species on Level II plots.

Overall, spruce (31%), beech (29%), pine (20%), and oak (11%) dominate among the 20,858 trees considered. Numerically, these tree species are also the most represented among the damaged trees: Spruce (572 trees), beech (188 trees) and pine (101 trees) and to a much lesser extent oak (18 trees). Proportionally, damage is documented for 9% of spruce, 3% of beech, 2% of pine, and 1% of oak. Conifers represent 53% of all trees and are strongly overrepresented among the damaged trees with 77%.

When looking at the damage to individual trees, it is noticeable that the mainly affected tree species vary between the documentation dates (Fig. 2A). Thus, in 2000, 2009 and 2014, most storm damage was recorded for spruce. In 2007, on the other hand, beech trees were affected to a greater extent. For this year, it is also possible, by analyzing the comments in the different surveys, to attribute much of the documented damage to storm Kyrill (January 2007).

Overall, it should be noted that the storm damage was not necessarily documented in the year of the event, but was assigned to a subsequent survey, and in some cases to previous surveys. Since the growth survey is conducted every five years, there can be an offset of several years between actual damage and recording in some cases. As a result, the attribution to a specific storm event can often not be determined without a doubt. The distribution of storm-damaged timber cut across Germany from 2006 (Fig. 2B) also shows a different pattern than the distribution of the number of trees with storm damage on Level II plots.

Outlook

To use Level II data for the evaluation and adjustment of wind risk models and statistical models in the WINMOL project, we note the following points:

- Documented damages have to be related to wind speeds.
- Depending on availability, other time-dependent influencing variables (e.g., medium- and long-term meteorological observations such as heavy rainfall, water shortages, recurrence rates of storm events, mean wind speed, etc.) should also be considered.
- Assumptions on the use of data for modeling need to be made: e.g., what are acceptable assumptions on the time lag between damage event and damage assessment?

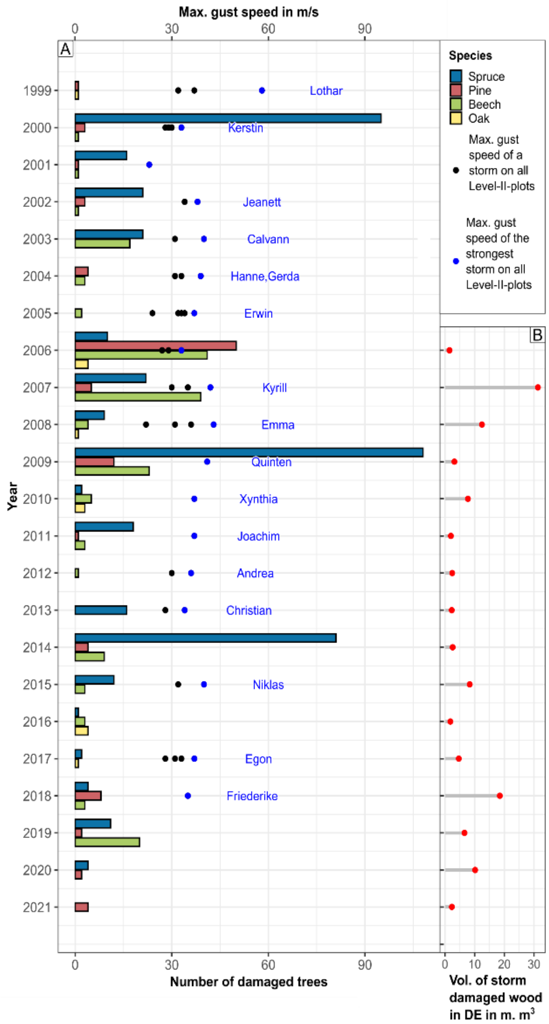

Figure 2: Storm-replaced trees per year on Level II plots and gust speeds (A) and storm-damaged timber volumes (2006-2021) in DE (B). Data basis: gust speeds: Schindler and Jung 2020; damaged wood quantities: Statistisches Bundesamt (Destatis), Genesis-Online; 41261-0003; dl-en/by-2-0; own presentation.

Further Information

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Publications

European Environment Agency (EEA) (2015): Economic losses from climate-related extremes in Europe URL: https://www.eea.europa.eu/ims/economic-losses-from-climate-related (last accessed: 03.06.22).

Schindler and Jung (2020): Winterstürme über Deutschlands Wäldern 1981–2018. Allg. Forst- u. J.-Ztg., 190, 205-214.

Statistisches Bundesamt (Destatis 2022), Genesis-Online; 41261-0003; dl-de/by-2-0.

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