

Forest disturbances under climate change: Interactions of bark beetle outbreaks with fire, windthrow and drought



Motivation

Forests provide multiple ecosystem goods and services such as timber, freshwater, clean air and biodiversity. Forest disturbances like bark beetles, fire, windthrow and drought influence ecosystem services by modifying stand structure and species composition. Climate change is expected to intensify these disturbance regimes, both through changes in mean values of e.g. temperature and precipitation, and through an increase in extreme events. To assess the future development of forest ecosystems and the associated risks and opportunities, the disturbance regimes and their mutual interactions have to be considered.

Why bark beetles?

- Bark beetles are of **socio-economic relevance**.
- The life history of bark beetles is **sensitive to temperature** and thus susceptible to climatic change.
- The **population dynamics** of bark beetles is assumed to be **linked to other disturbances** which will alter as well, rendering estimates of climate change impacts on shifts of severity and frequency of bark beetle outbreaks particularly challenging.



Main Questions

1. What interactions exist between disturbances?
2. How large is the relative impact of each disturbance (bark beetles, fire, drought, windthrow) for forest development?
3. Does the relative impact of disturbances change with climatic change?
4. Will the bark beetle outbreak risk increase with climate change in the case study region Bavaria when disturbance interactions are considered?

Methods

We use a **process based forest gap model** at the landscape scale (LandClim) that includes

- environment dependent **forest growth**
- the main **forest disturbances** fire, windthrow, drought and bark beetles.

Literature review on disturbance interactions

Fire and bark beetles

Two sided interaction:

1. Fires → bark beetles
 - Negative long-term effect by shaping **stand structure**
 - Positive short-term effect by reducing **tree defence**
2. Bark beetles → fire
 - Positive influence by increasing **fuel load**.

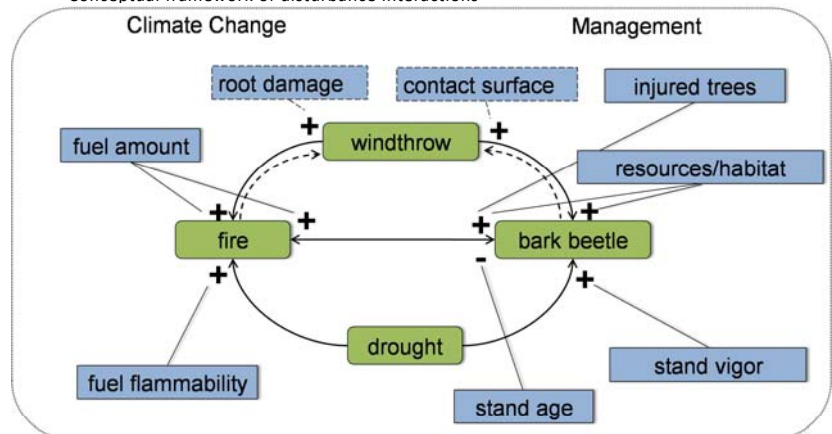
Drought and bark beetles

- Positive interaction: Drought induces **stress** in trees that are subsequently weakened and more susceptible to infestations.

Windthrow and bark beetles

- Positive interaction by **habitat creation**: Windthrown trees can serve as easily accessible habitat.

Conceptual framework of disturbance interactions



Outlook

We will focus on the interaction between bark beetles and drought, with Bavaria as case study region. This interaction appears to be the most important with respect to climate change because dryer conditions are projected for many regions in Bavaria. In a second step, we will consider the influence of windthrow which is a disturbance affecting large areas in Bavaria and also interacting positively with bark beetle infestations.