Title: Understanding forest damage in Germany: Finding key drivers to help with future forest conversion of climate sensitive stands

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Project Description:

Recently climate change has contributed to the decline in forest health, and European forest health monitoring data (Eichhorn et al 2017) are increasingly being used to investigate the effects of climate change on forests in order to decide on forest management strategies for mitigation. Forests in Germany have been badly affected and climate change now appears to be the major cause of defoliation (Eickenscheidt et al, 2019). The results of a German-wide analysis in Eickenscheidt et al indicate a strong association between drought stress and defoliation for all four main tree species (spruce, beech, pine and oak). South-western Germany, which experienced high water deficits in the drought year 2003, is the region with the highest defoliation since that time. The analysis in Eickenscheidt et al (2019) showed that the intensity and duration of defoliation following drought stress varies between species of tree. Thus, in order to mitigate effects of climate change the state Baden-Wuerttemberg (BW) wants to plant tree species which are resistant to drought and heat. In the coming decades, it plans to carry out a large scale forest conversion to more mixed forests with a high diversity of species, so that biological pests, such as bark beetles, can't spread as easily as in monoculture forests, and also to improve water balance. In 2019 in total 43% of the forest area in BW was considered to be significantly damaged: that is trees had more than 60% defoliation in the crown. In particular tree species that were previously thought to be climate-resilient were also badly affected by heat, drought and storms in recent years. The main tree species currently making up the forests appear to be no longer suitable for the climate in BW.

In this project you will analyse yearly forest health monitoring data of the main species made available by the Forest Research Institute Baden-Wuerttemberg in order to identify the site characteristics (topography, soil, water budget and climate) which are associated with damage. The aim is to describe the nature of the associations and ranges of variables for optimal conditions. The outcome of the analysis will help to formulate hypothesis regarding the causes of damage. Defoliation of trees is measured as a percentage of needles in the tree crown which can be classified into light, medium and severe damage (11- 25%, 26-60%, 61-99% defoliation).

A wide range of statistical methods could initially be used to describe patterns in the data, and find the variables with strong joint associations with damage, including regression models (GLMs, GAMs, mixed model extensions etc, e.g. Wood, 2017), and clustering and classification methods (SVM, random forest, k-means etc, e.g. Hastie, Tibshirani and Friedman, 2009).

Model checking, visualization and cross validation methods are likely to be important. Resampling methods could be used to investigate model/variable selection uncertainty.

References

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