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Climate Change and Extreme Events
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Lightning talk slides

Impacts of extreme wind speeds and other factors on vegetation disturbances in the German railway network - *Rike Lorenz, Barry Gardiner, Nico Becker, Uwe Ulbrich, Marc Hanewinkel*

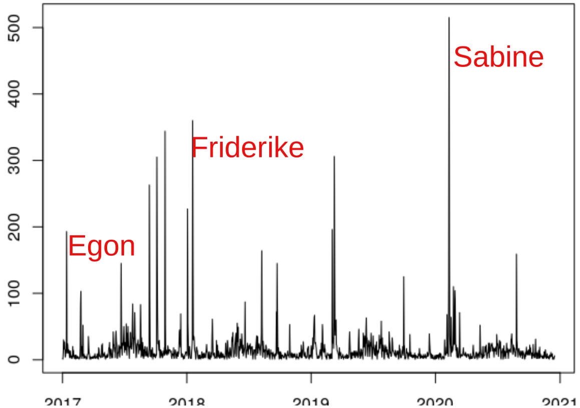

Fig. 1: Number of daily tree and branch fall events: Winter storms leav a very clear signal

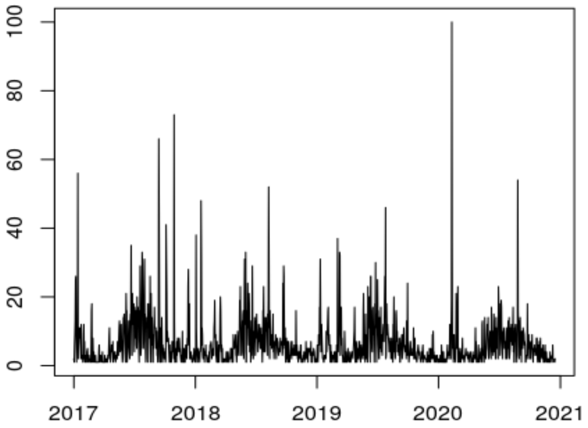

Fig. 2: Number of daily branch fall events:
Clear seasonality with peaks in summer

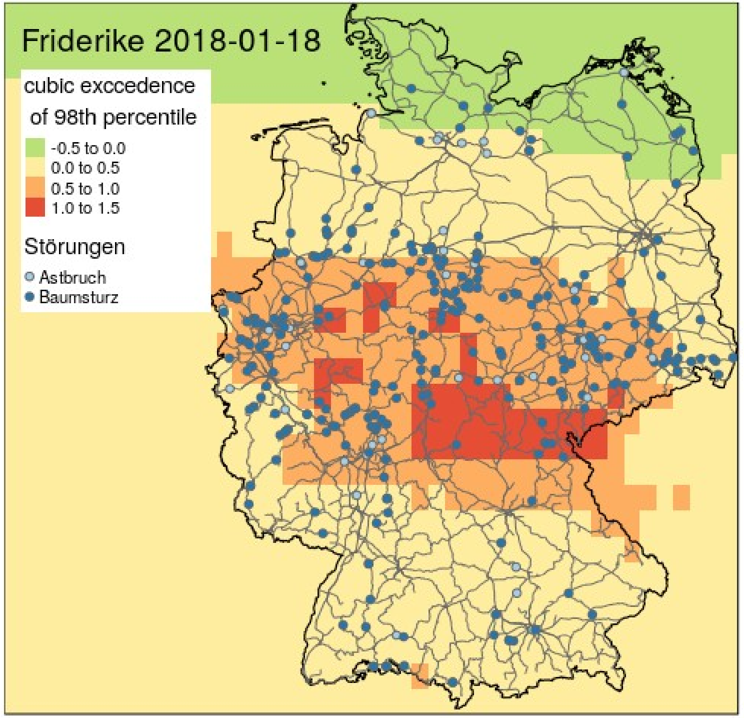

Fig. 3: High gust speeds (over 98th percentile) and disturbance events (blue points) during storm Friderike – events do not necessarily occur in areas of highest gust speeds

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First conclusions:

- Wind speed is an influential factor on vegetation disruptions (tree fall & branch fall) but other factors play an important role.
- The influential factors ond tree fall and branch fall differ strongly e.g. temperature and seasonality seems to have a strong effect on branch fall but not on tree fall.

Goals:

- Identify weather conditions and sequences relevant for wind induced vegetation damages
- Explore occurrence probabilities in present and future climate conditions.

Methods:

Logistic Regression & Random Forest

Outlook:

- Prevention of railway disruption and damage
- Insight on questions of forestry and forest ecology connected to climate change

Input Data:

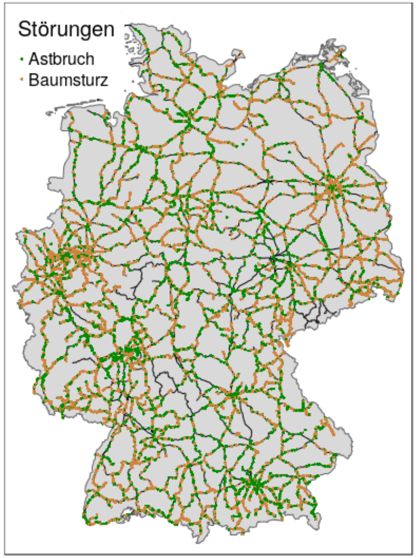
Era 5 – Met. data

Vegetation data

Soil and stand data

Railway data

Disturbance Data:



20.000 tree fall and branch fall events 2017-2020

Additional slides

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Impacts of extreme wind speeds and other factors on vegetation disturbances in the German railway network

Rike Lorenz, Barry Gardiner, Nico Becker, Uwe Ulbrich, Marc Hanewinkel

https://www.ksta.de/panorama/keine-zuege-wegen--friederike--das-steckt-hinter-der-sturm-strategie-der-deutschen-bahn-29523080

Introduction

- vegetation disturbances (branch and tree falls) due to high wind speeds → damages to railway infrastructure, train delay, collisions
- Several thousand disturbances per year
- Deutsche Bahn is removing around 30.000 trees per year
- Storm events a major reason for vegetation disturbance

Motivation:

- researching the factors and processes connected to vegetation damage might improve damage and disruption prevention
- insight on questions of forestry and forest ecology connected to climate change

Goals:

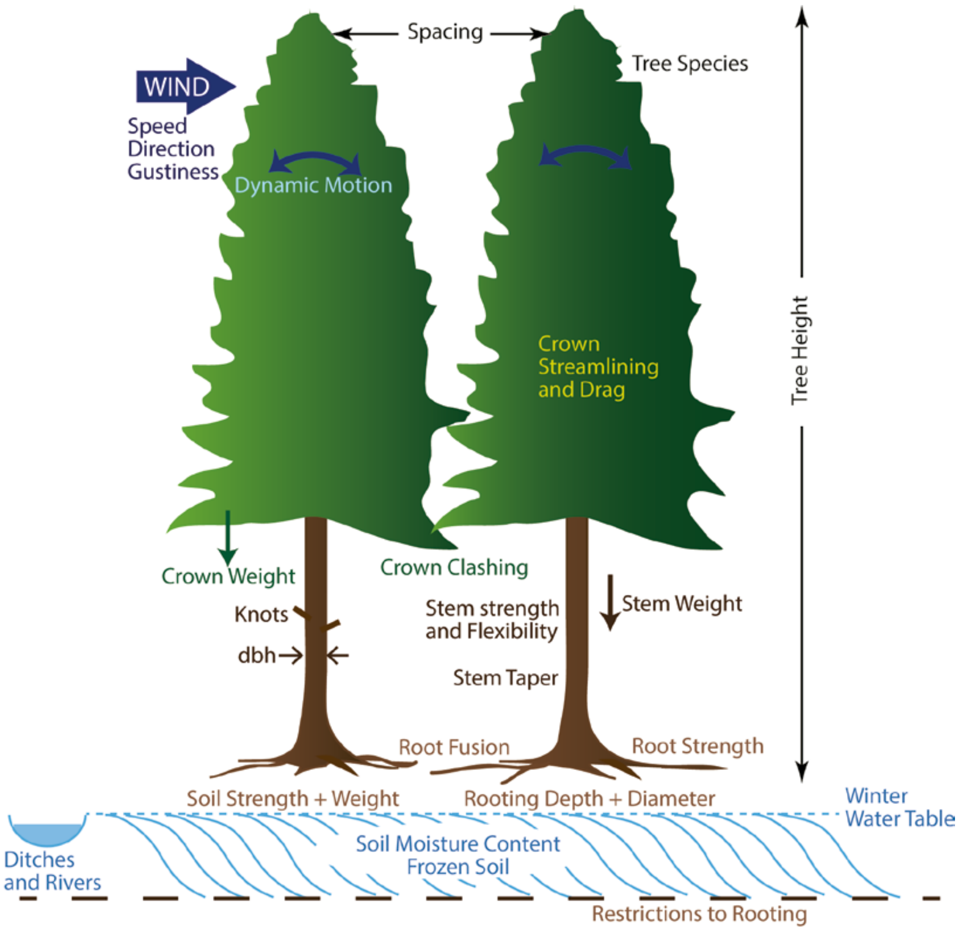
- Identify weather conditions and sequences relevant for wind induced damages
- Explore occurrence probabilities of relevant large-scale winter storms, their characteristics and impacts for present and future climate conditions.

https://weather.com/de-DE/wissen/umwelt/news/2020-11-08-gegen-sturmschaden-so-viele-baume-lasst-die-bahn-jahrlich-fallen

Influencing factors

The susceptibility of individual trees and tree stands to wind damage is controlled by:

- the properties of the wind climate (wind spe duration and gustiness)
- forest structure (e.g. fragmentation, even-aged/uneven-aged)
- tree/stand characteristics (e.g. species, heig diameter at breast height, crown and rooting characteristics and stand density)
- Site conditions (e.g. soil type and topograph
- forest management (e.g. spacing, thinning, fertilization, final cutting)



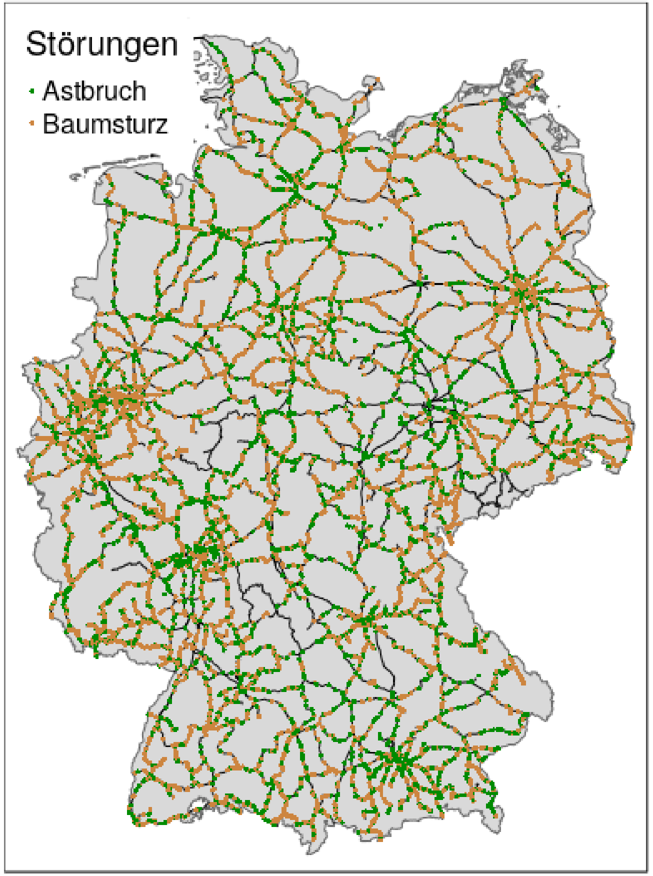
Gardiner et al. 2013: Living with Storm Damage t Forests

Data

Tree fall and branch fall events alongside German railway system 2017 – 2020

Attributes:

- Start and end time of removal
- Coordinate
- Reason for disturbance (Branch fall, tree fall)
- Route section number
- Number affected trains
- Additional information



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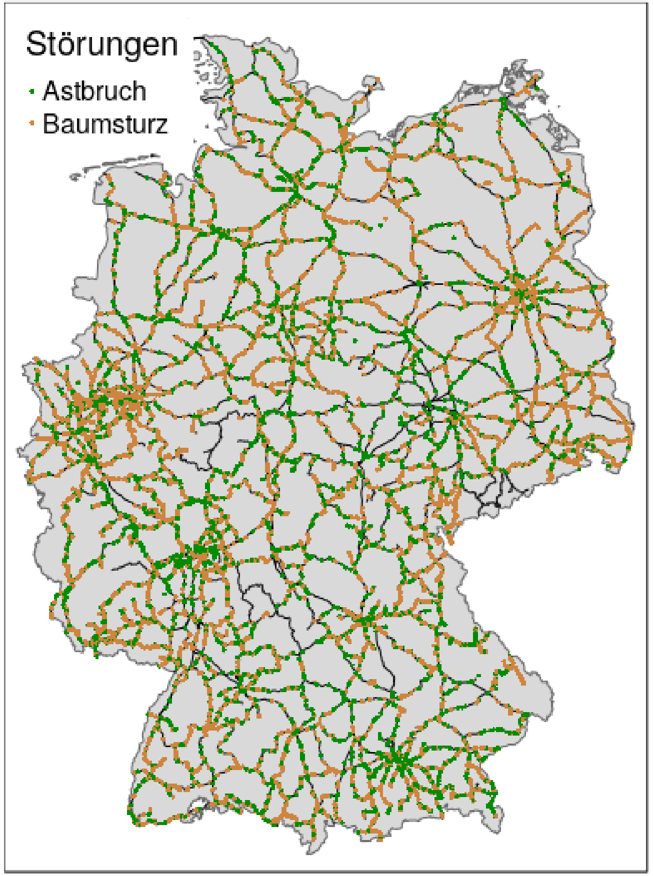
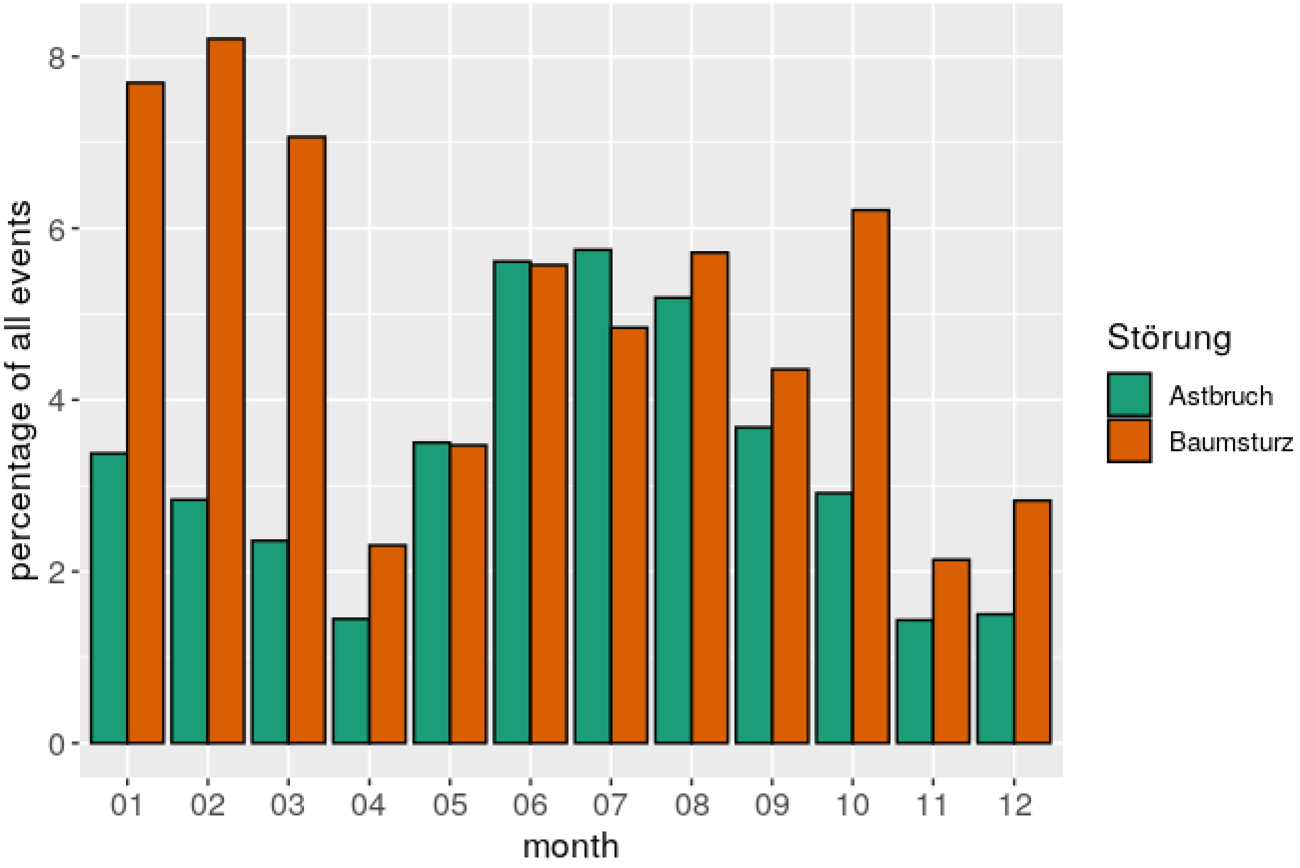
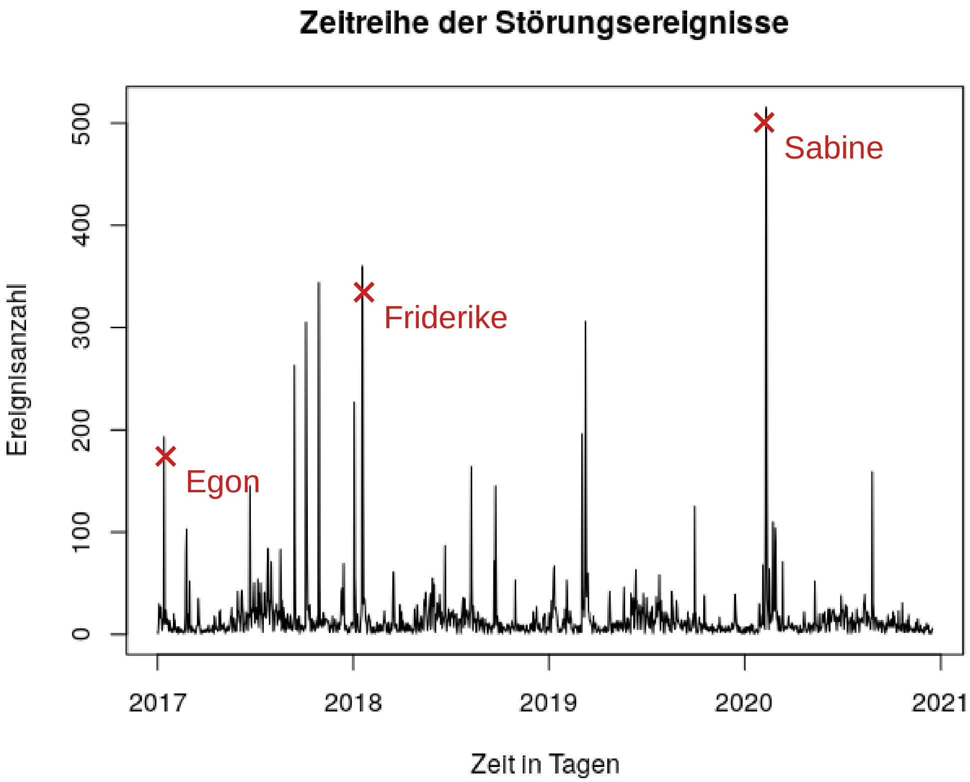
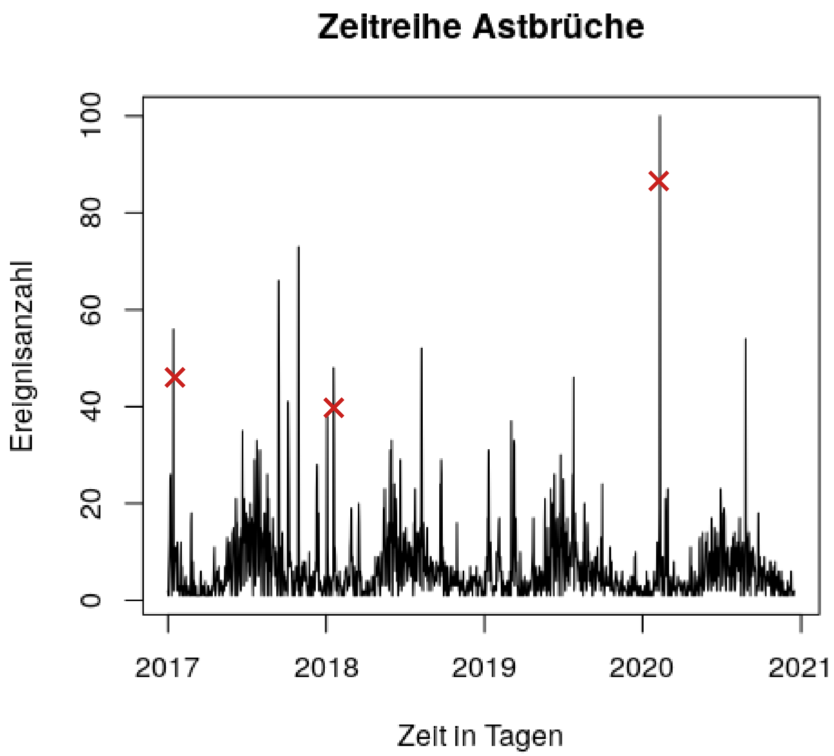


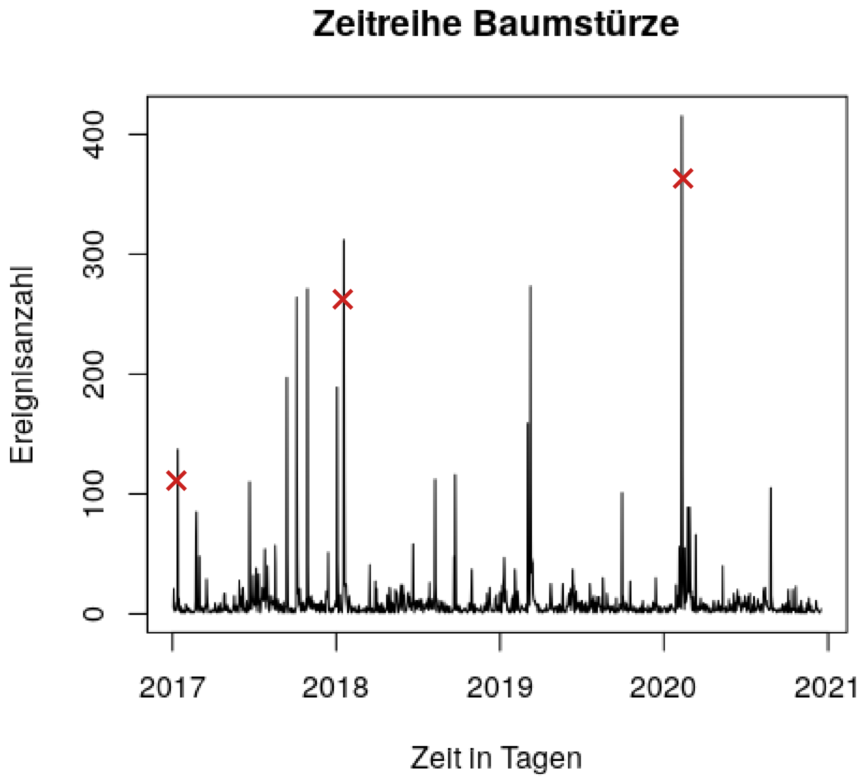




- Egon 2017-01-13: 193 events
- Friderike 2018-01-18: 360 events
- Sabine 2020-02-10: 515 events



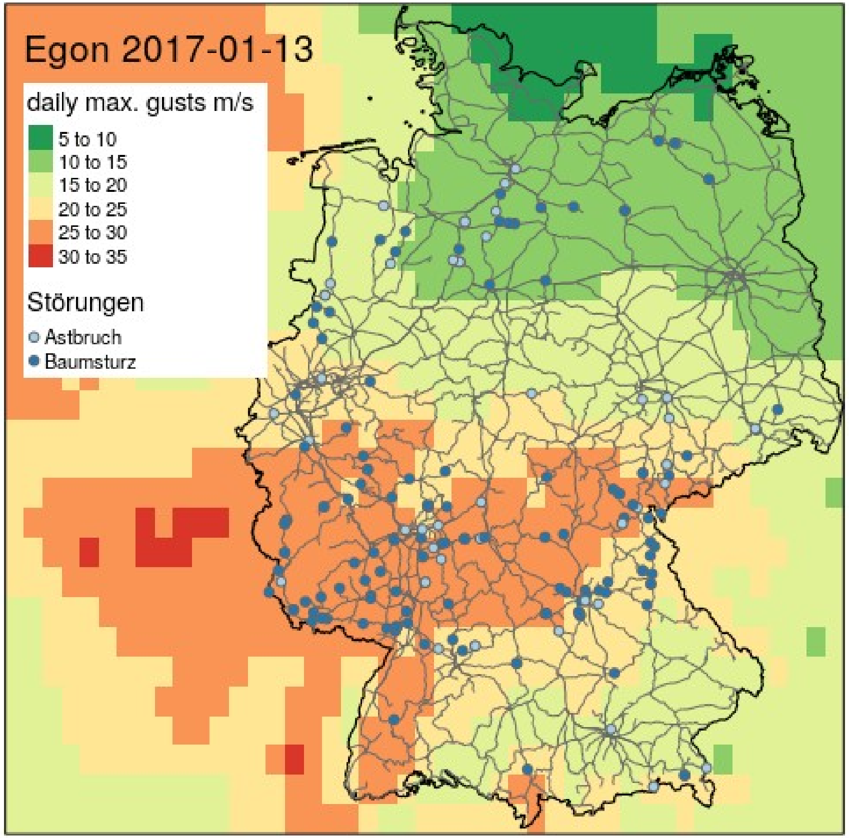
Zeitreihe Astbrüche
Ereignisanzahl
0
20
40
60
80
100
2017
2018
2019
2020
2021
Zeit in Tagen

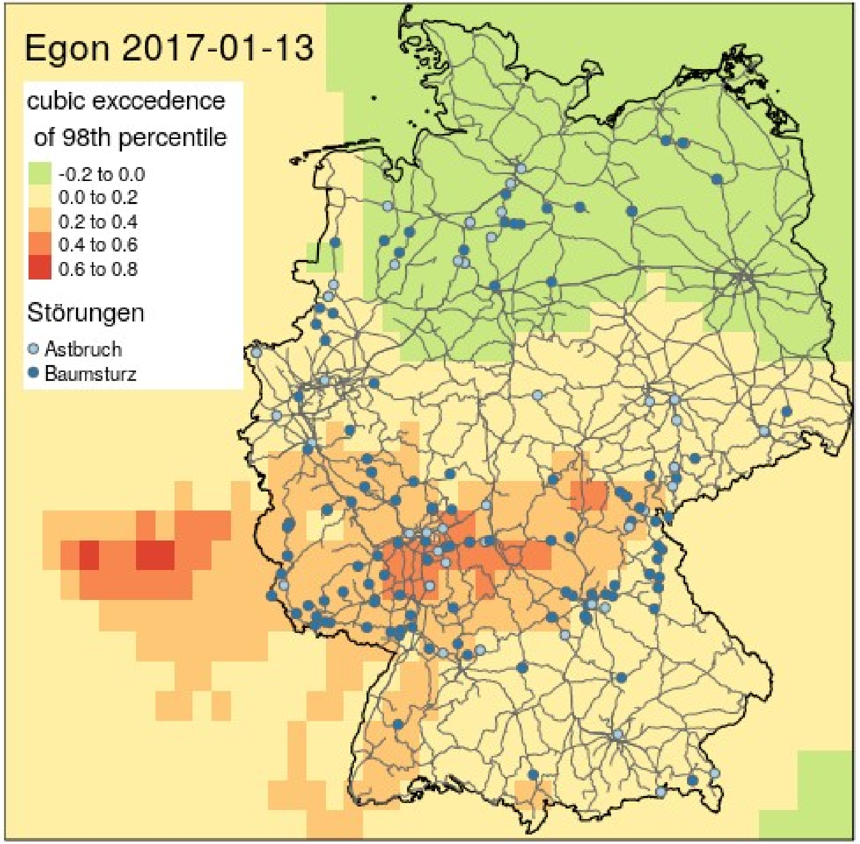


Zeitreihe Baumstürze
Ereignisanzahl
0
100
200
300
400
2017
2018
2019
2020
2021
Zeit in Tagen

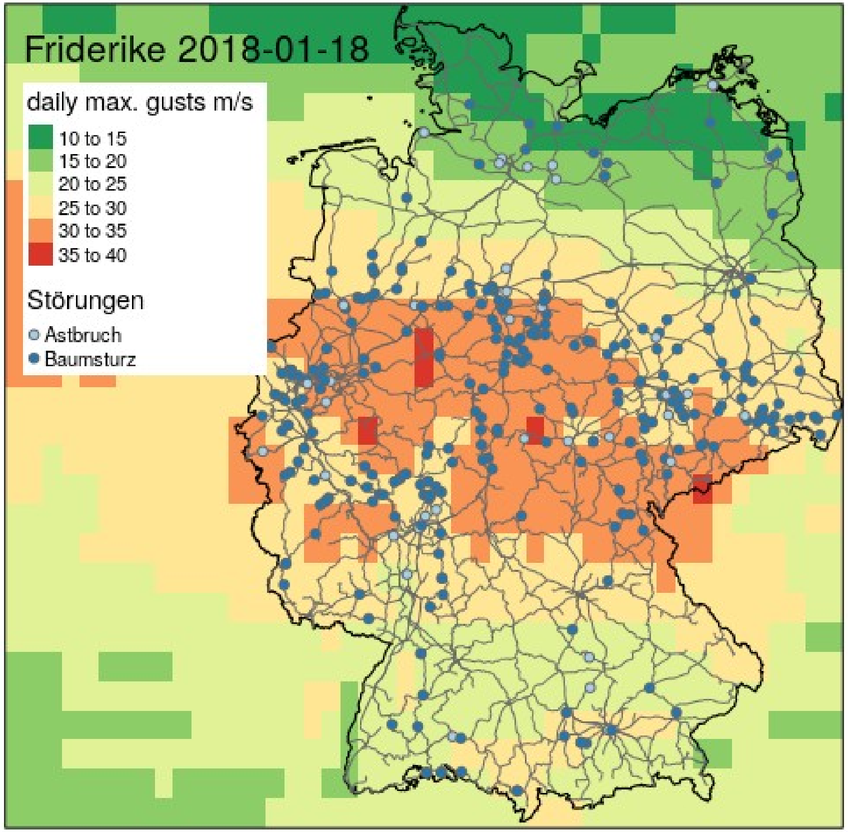
Case study Egon

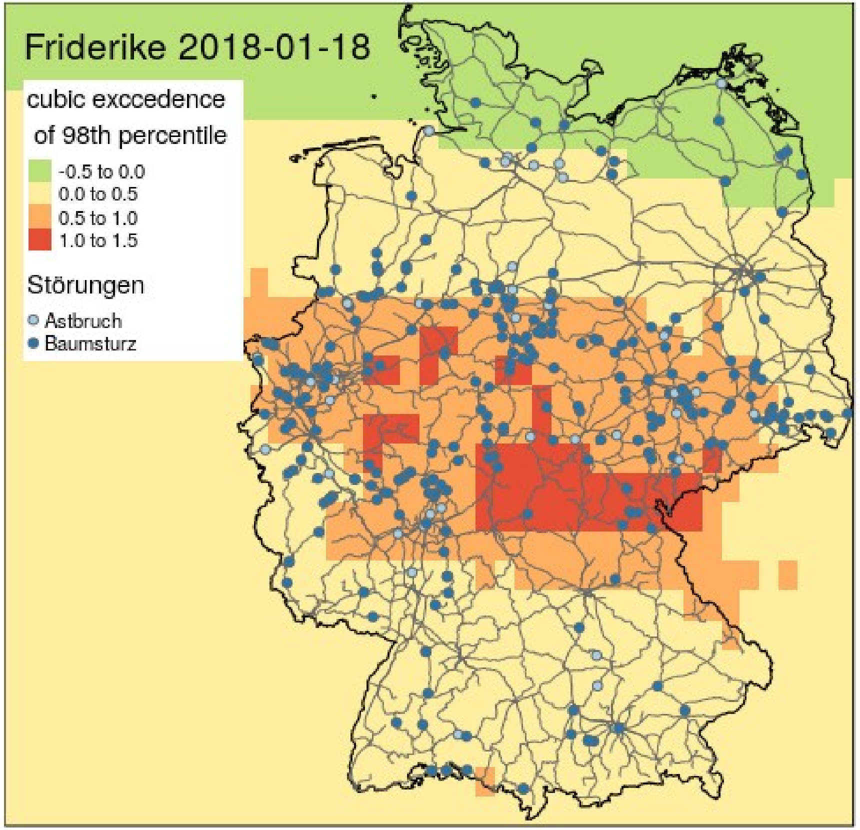
Cubic exceedence of the 98th percentile $\left(\frac{v}{v98}-1\right)^3$



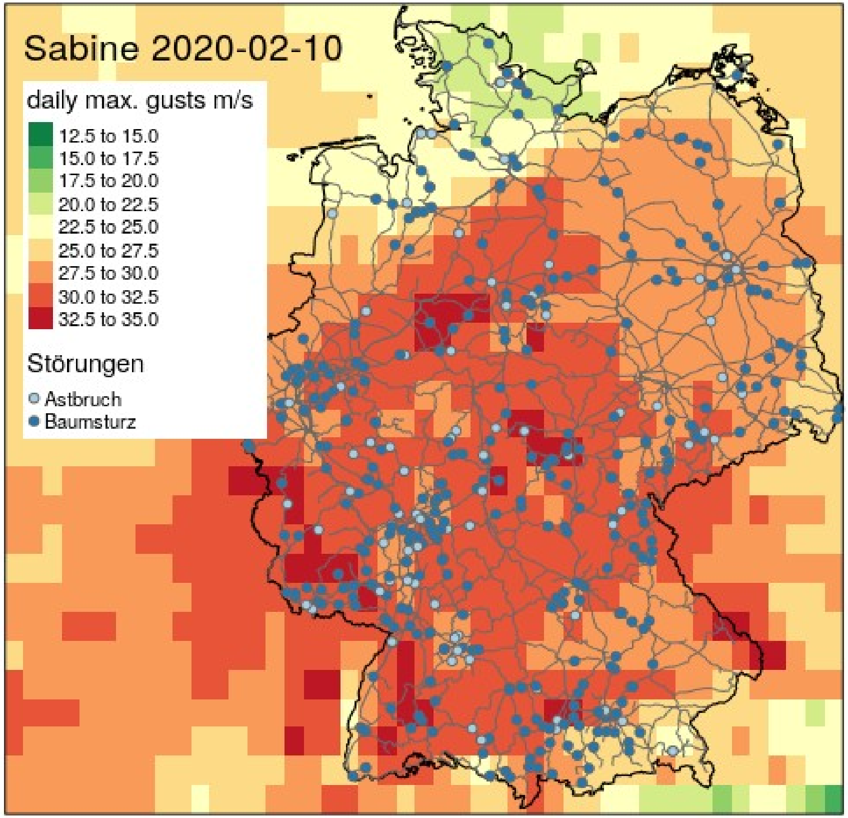


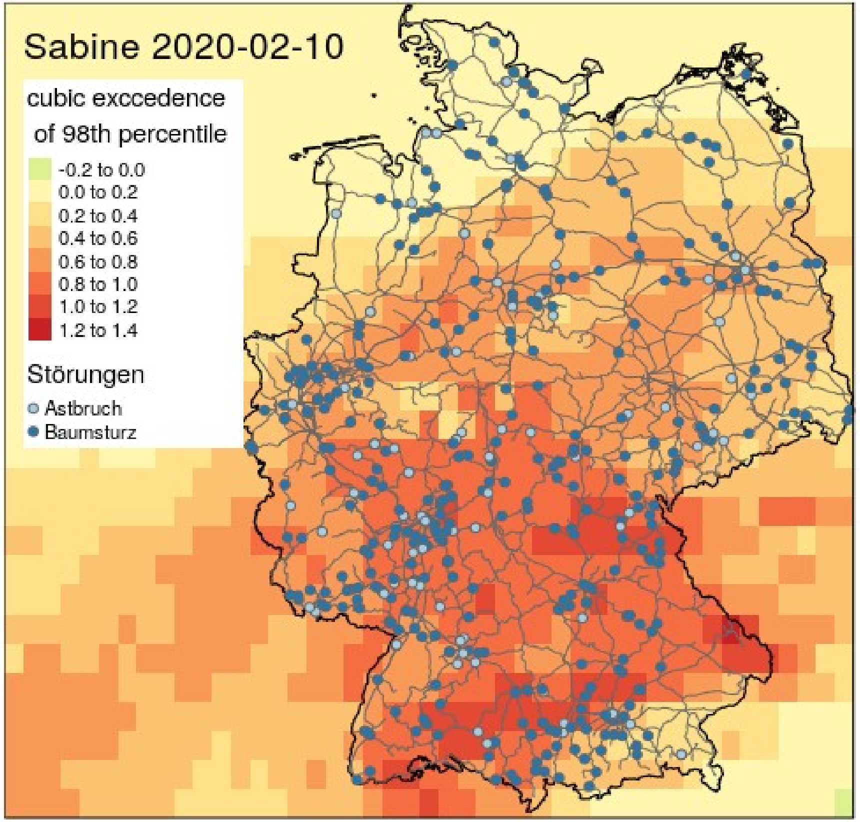
Case study Friderike





Case study Sabine





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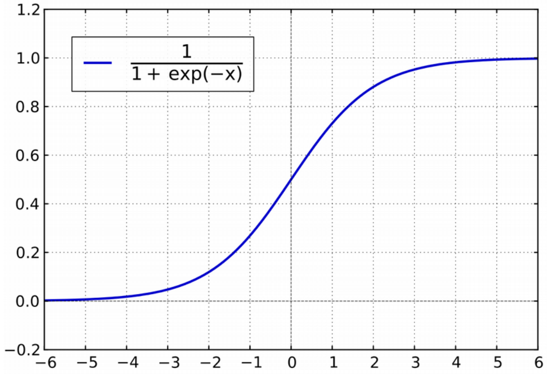
Planned Methods

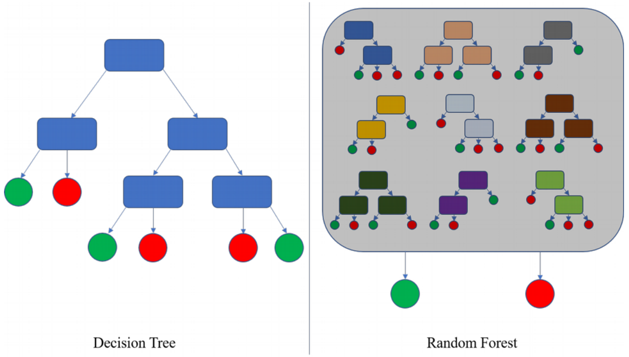
- Use and compare Logistic Regression Model & Random Forest Model
- Logistic Regression: State of the art
- Random Forest: Hart et. Al 2019 and Kabir et. Al 2018 showed that RF achieve best prediction accuracy compared to other ML methods
- Impact data: disturbance records (tree fall and branch fall) along the railway system (Deutsche Bahn)
- Predictor variables: meteorology, vegetation, stand parameters, railway parameters …
- Output: probability that a disturbance occurs in an area

Hart, E., Sim, K., Kamimura, K., Meredieu, C., Guyon, D., & Gardiner, B. (2019). Use of machine learning techniques to model wind damage to forests. Agricultural and Forest Meteorology, 265, 16–29. https://doi.org/10.1016/j.agrformet.2018.10.022

Kabir, E., Guikema, S., & Kane, B. (2018). Statistical modeling of tree failures during storms. Reliability Engineering & System Safety, 177, 68–79. https://doi.org/10.1016/j.ress.2018.04.026



https://de.wikipedia.org/wiki/Logistische_Regression



https://commons.wikimedia.org/wiki/File:Decision_Tree_vs._Random_Forest.png

Parameters

Meteorology
- Daily max gusts
- Max gusts on prev. days
- Exceedence of the 98th percentile of the day
- Exceedence of the 98th percentile
- Wind direction
- mn. T of the day
- mn. T of prev. days
- Daily precipitation
- precipitation of prev. days
- (Frost days)
- Snow depth/ snow fall

Vegetation
- Biomass (Raster data)
- Canopy height (Raster data)
- Species & Genus (Raster data)
- Landuse Type (CORINE)

Temporal
- Season
- Growing season?

Site
- Soily Type (BUEK)
- Soil moisture (SPEI)
- Elevation (DEM)
- TOPEX

Railway
- Average number of occurences per spatial unit
- Distance between railway and trees ?