WHICH SITE FACTORS FAVOR THE BARK BEETLE CALAMITY IN THE NORTHERN HARZ REGION FROM 2018 TO 2022?

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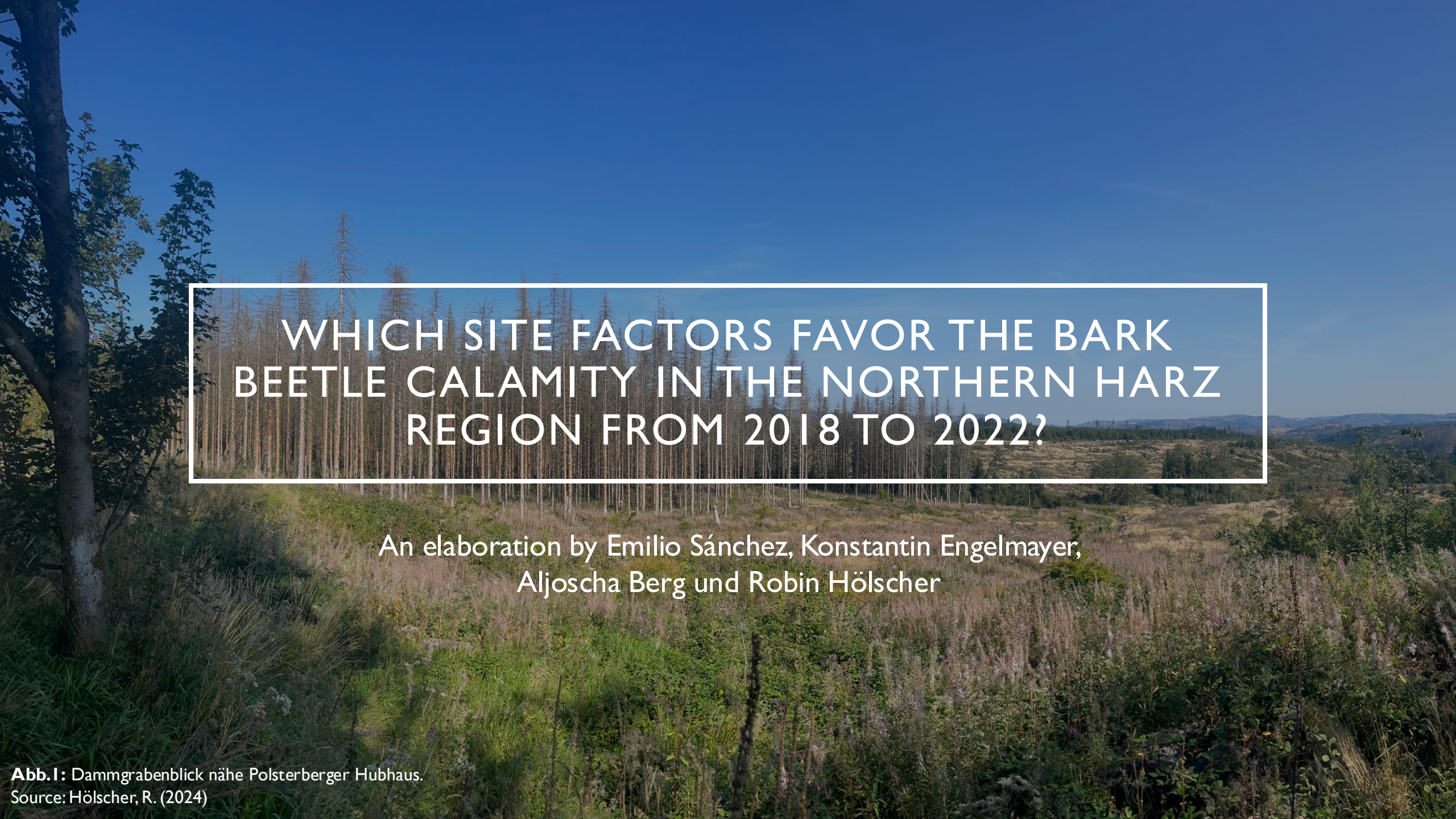


Abb.1: Dammgrabenblick nähe Polsterberger Hubhaus.
Source: Hölscher, R. (2024)

INTRODUCTION

- **Main Goals:**
  - Identify factors which influence the spread of bark beetles
  - Use machine learning model to predict bark infestation and analyse variable importance
  - Statistical analysis of healthy and dead spruce areas

- Dead spruce forest used as proxy for bark beetle spread

WHAT IS KNOWN FROM THE LITERATURE?

BARK BEETLES SPREAD

- Climatic factors and climate change
- Host plant availability and stress
- Forest management and forestry practices
- Biotic interactions
- Landscape structure and fragmentation
- Anthropogenic influences

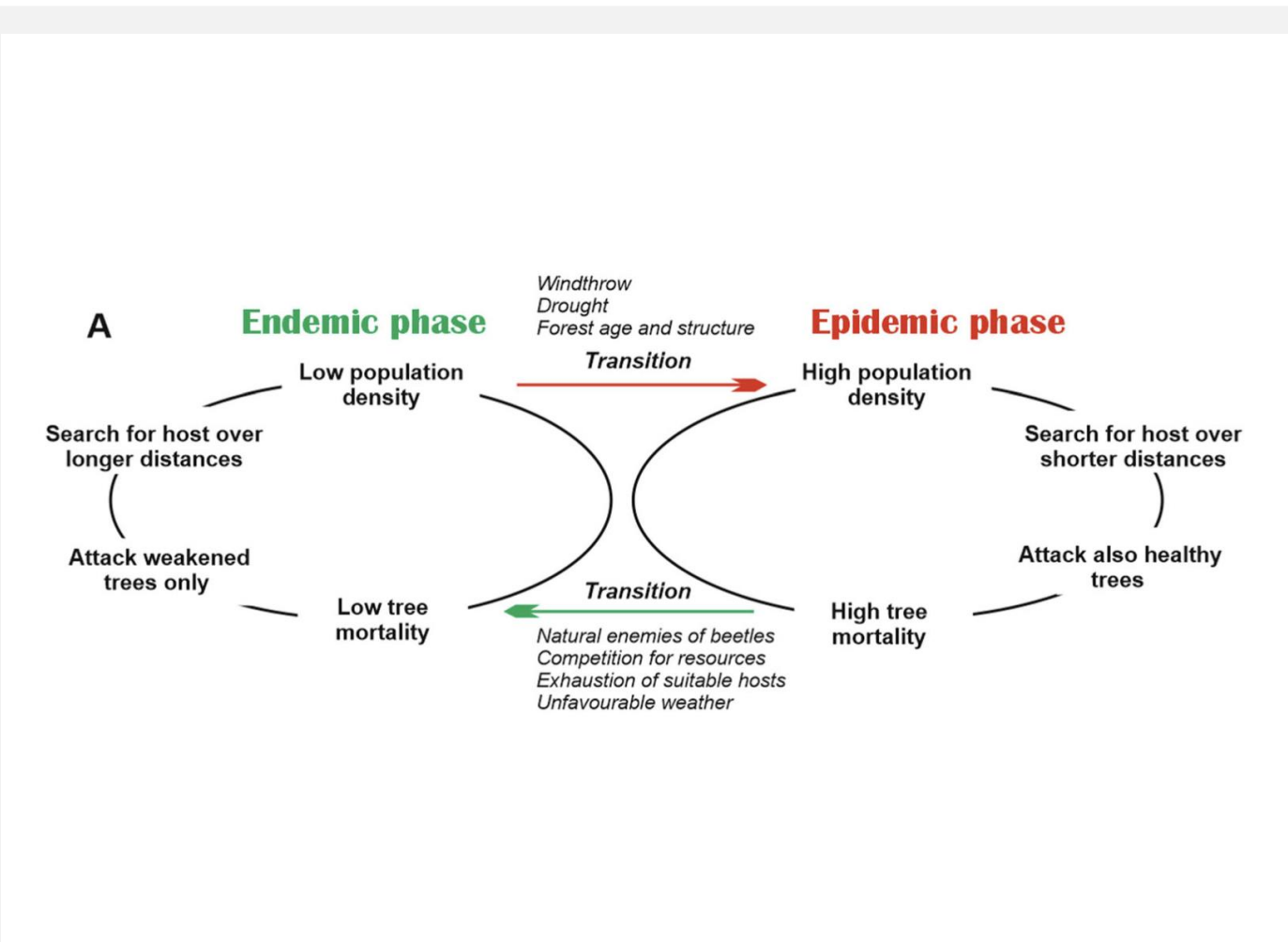
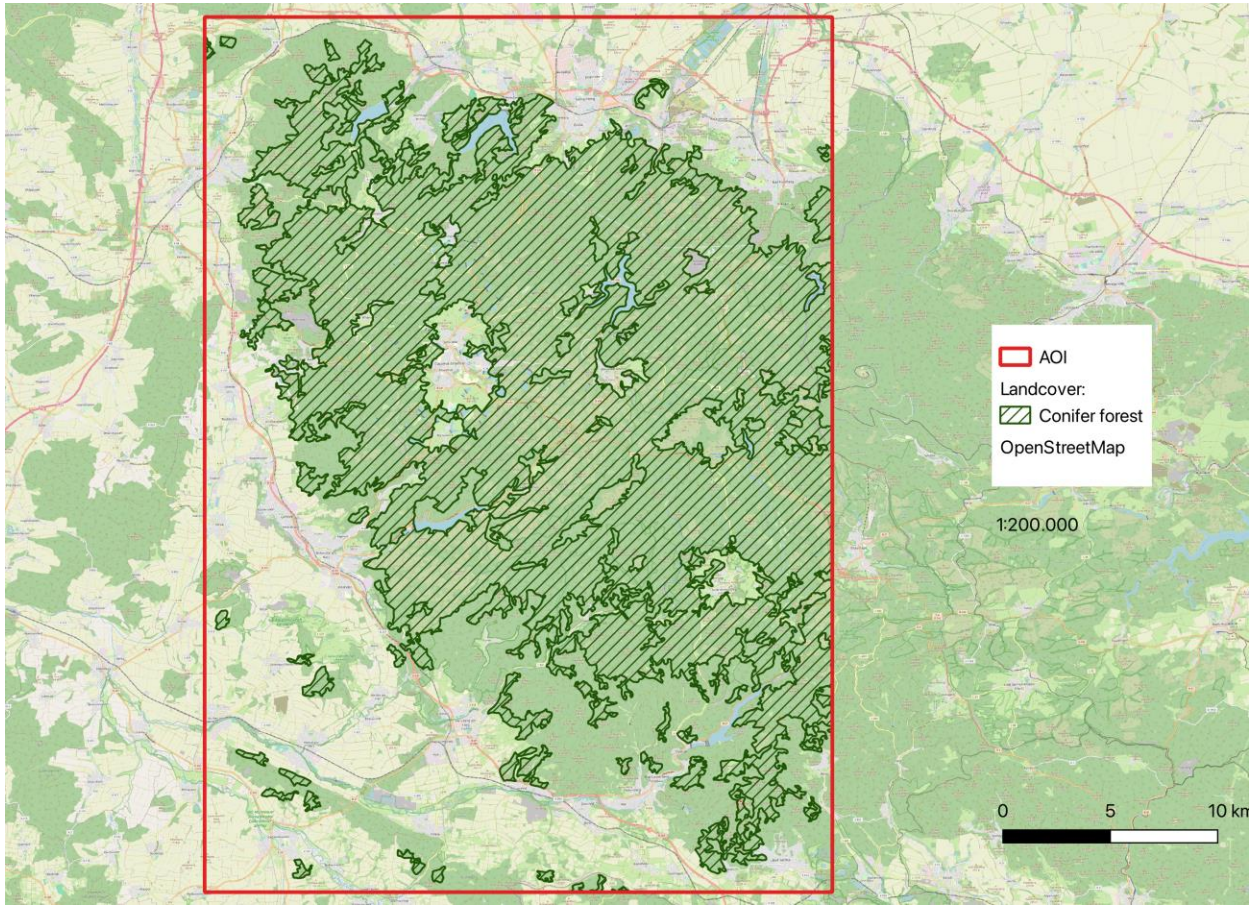


Abb.5: Scheme of barkbeetle population dynamics.
Source: Hlásny, König et al. 2021, Bark Beetle Outbreaks in Europe: State of Knowledge and Ways Forward for Management, S.141

HYPOTHESIS

- Dry conditions and high temperatures favour the spread of the bark beetle
- Impact of climatic variables is more important than topographics
- Strong influence of damage from previous year is expected



CONIFER FOREST AREA 2018

Abb.3: Conifer Forest Area created with QGIS, Base Layer OSM, Data from Copernicus 2018
Source: https://land.copernicus.eu/en/products/global-dynamic-land-cover

CALAMITIES 2018-2022

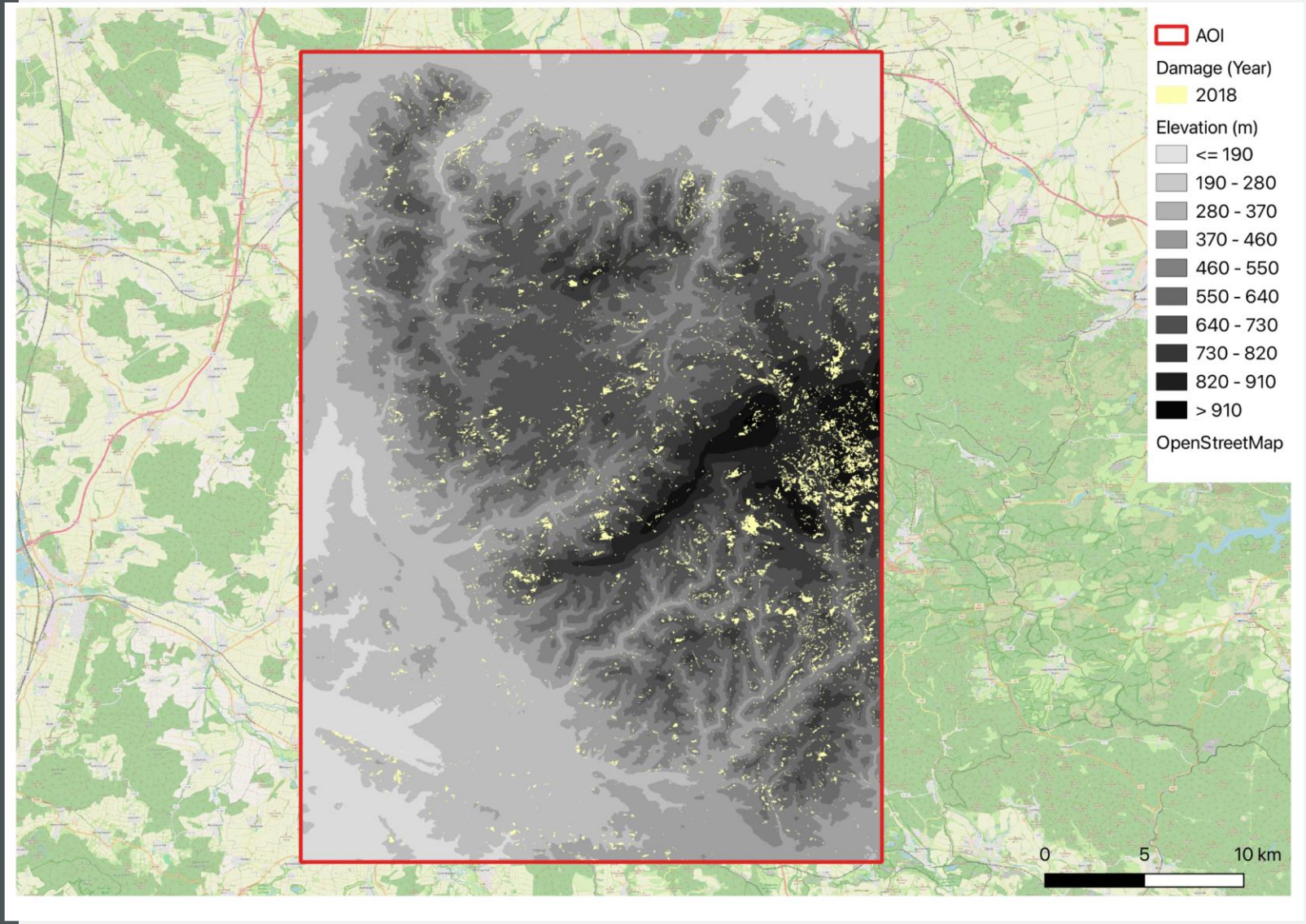
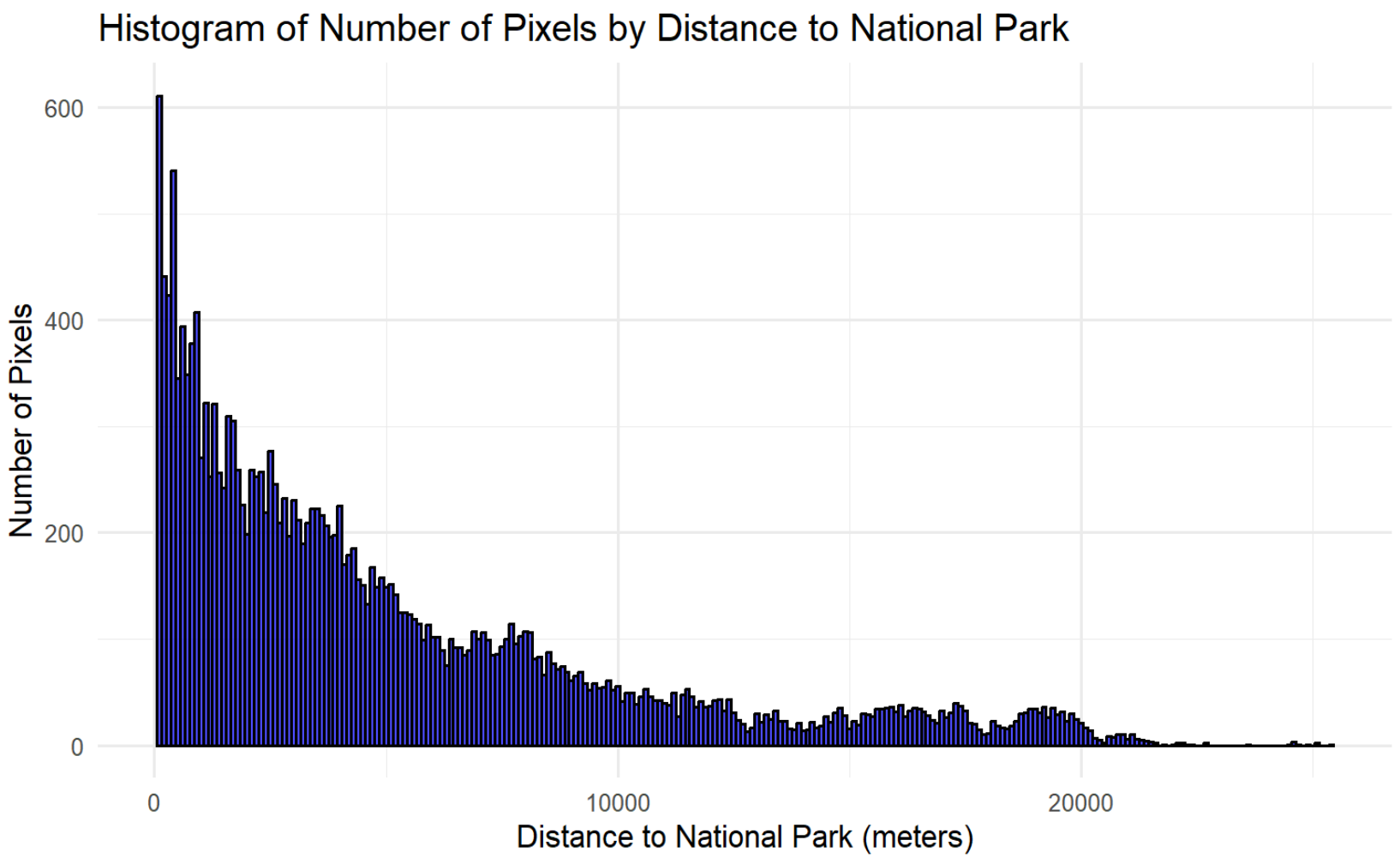
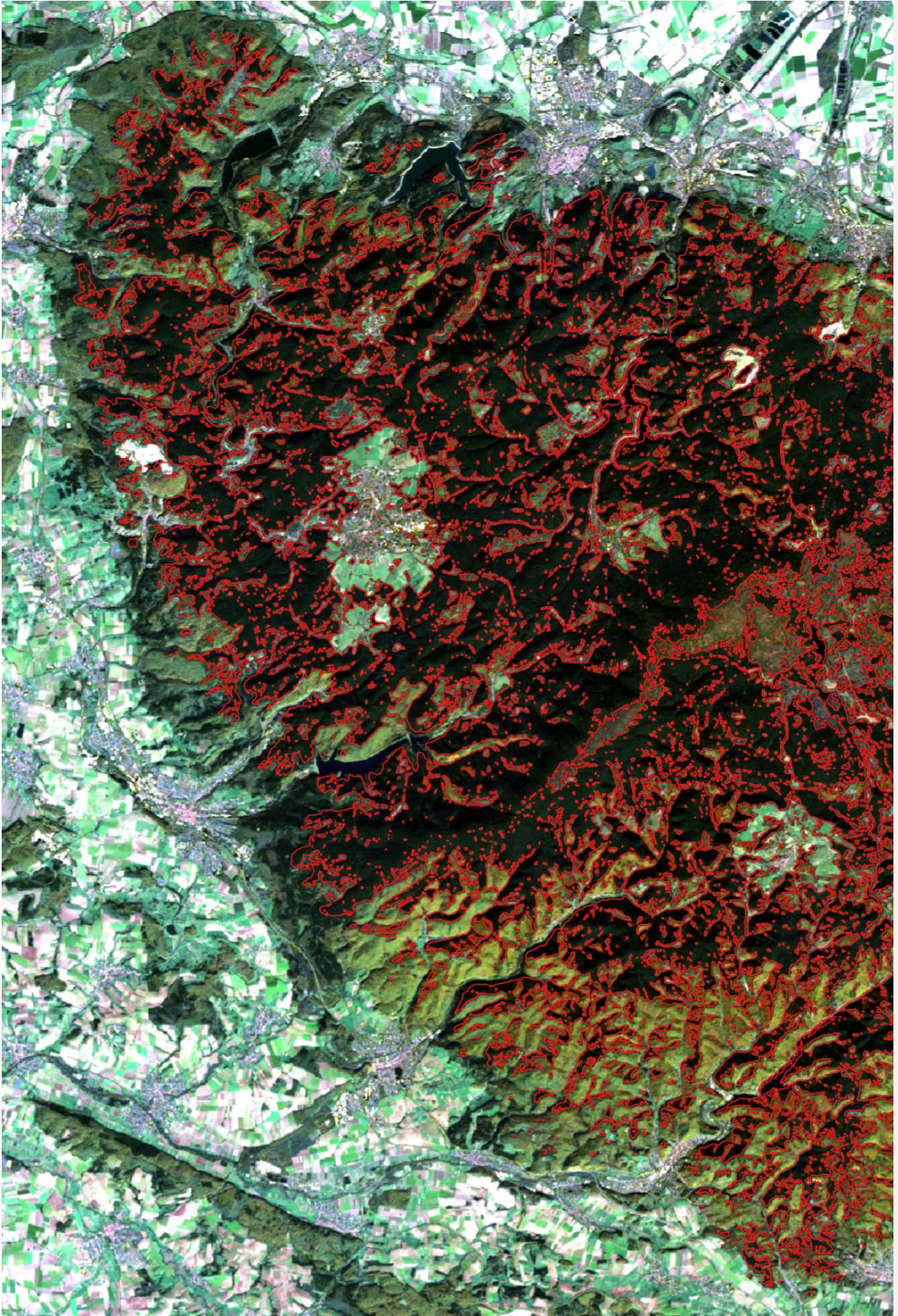


Abb.4: BarkBeetleCalamities visualised with ELC 10 and OSM as Baselayer
Source: https://www.openagrar.de/receive/openagrar_mods_00094212



IT'S THE NATIONAL PARK'S FAULT!



MODELING

- Corine Land Cover and Thünen Institute calamity data are too coarse for Harz analysis.

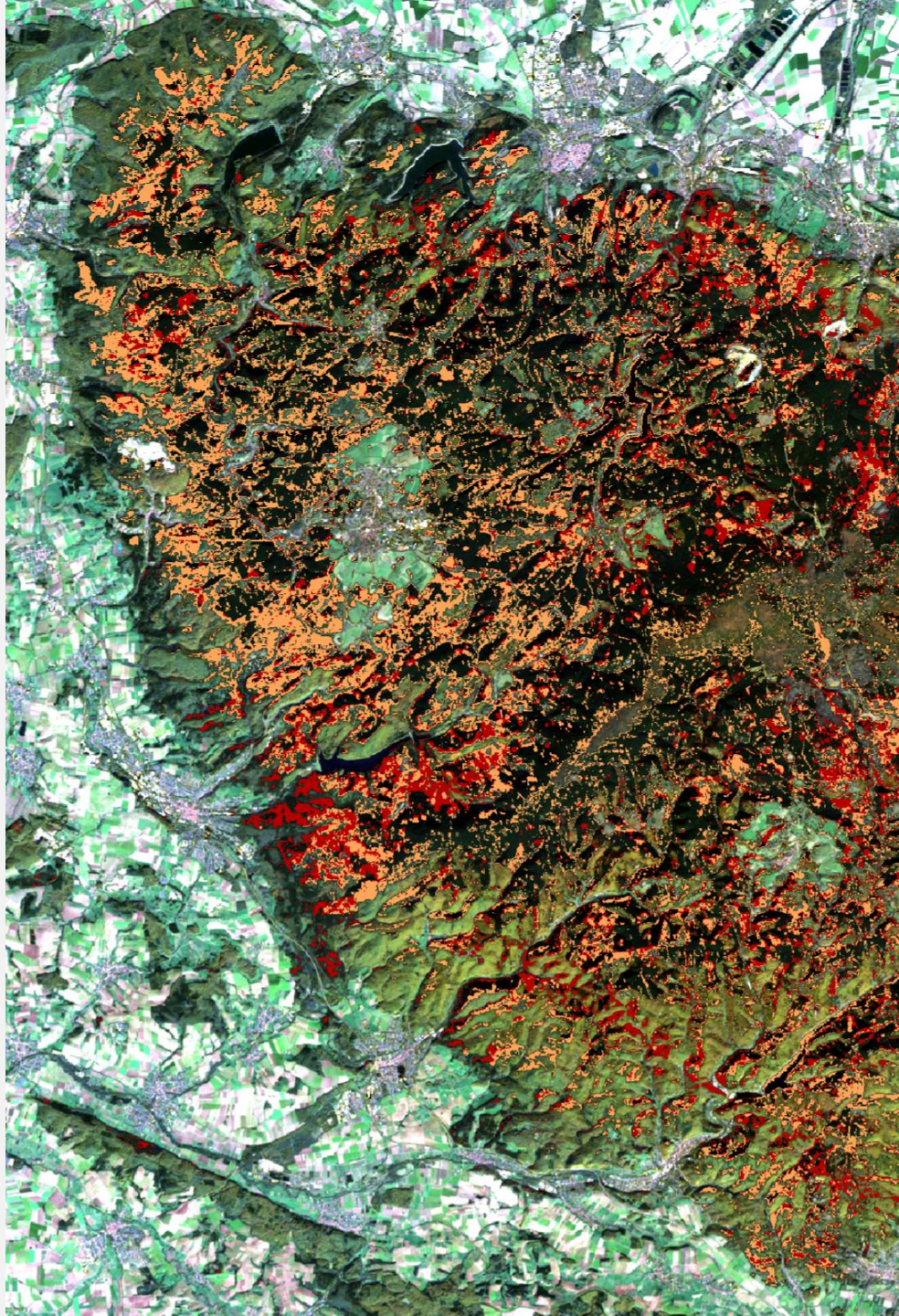
→ **Own Spruce forest and damage analysis needed to be done**

- Forest of 2018 to 2020 was classified using random forest

→ **High Kappa and Accuracy**

RESULTING DAMAGE CLASSIFICATION

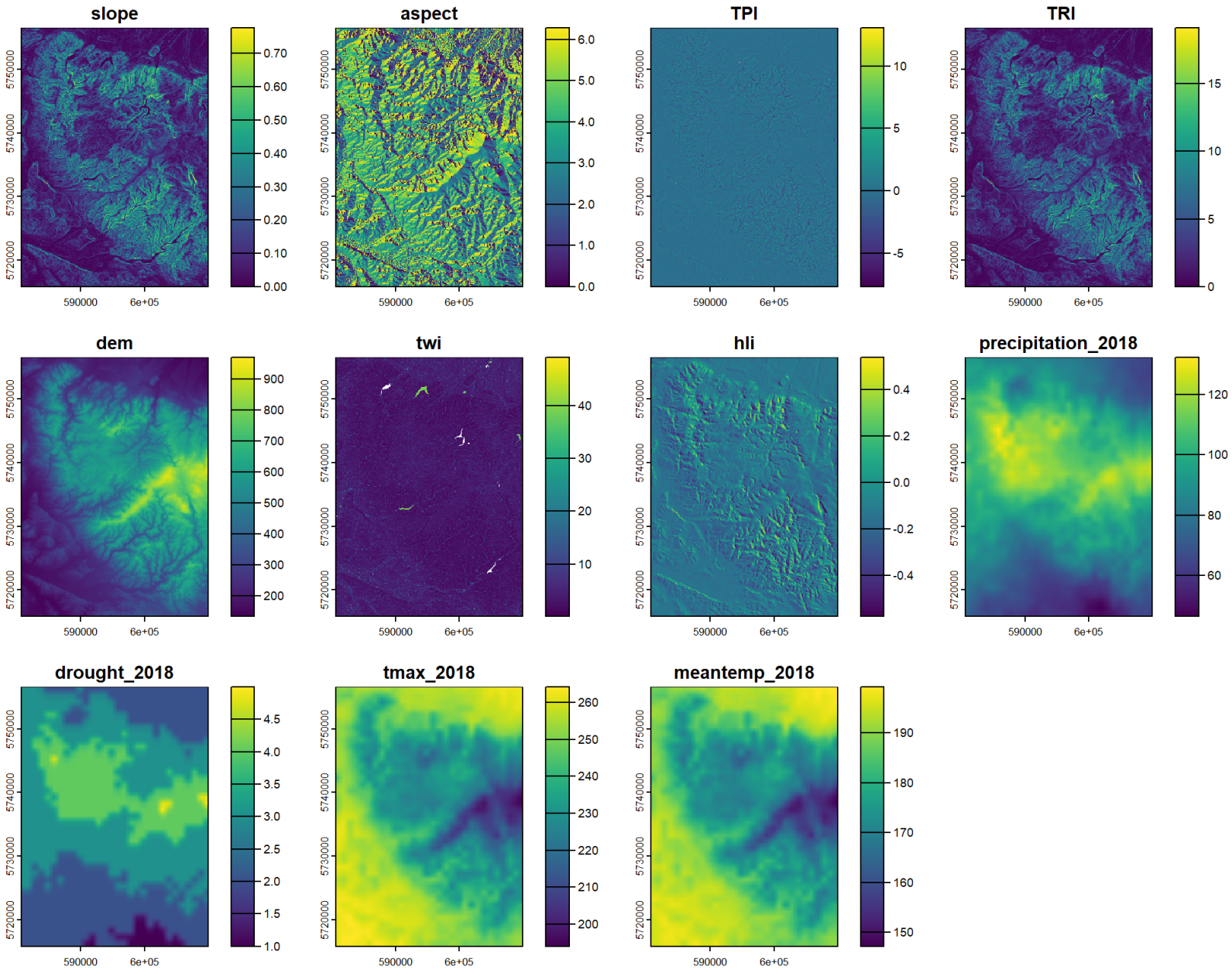
- Orange: 2019 (died between winters of 2018 and 2019)
- Red: 2020 (died between winters of 2019 and 2020)

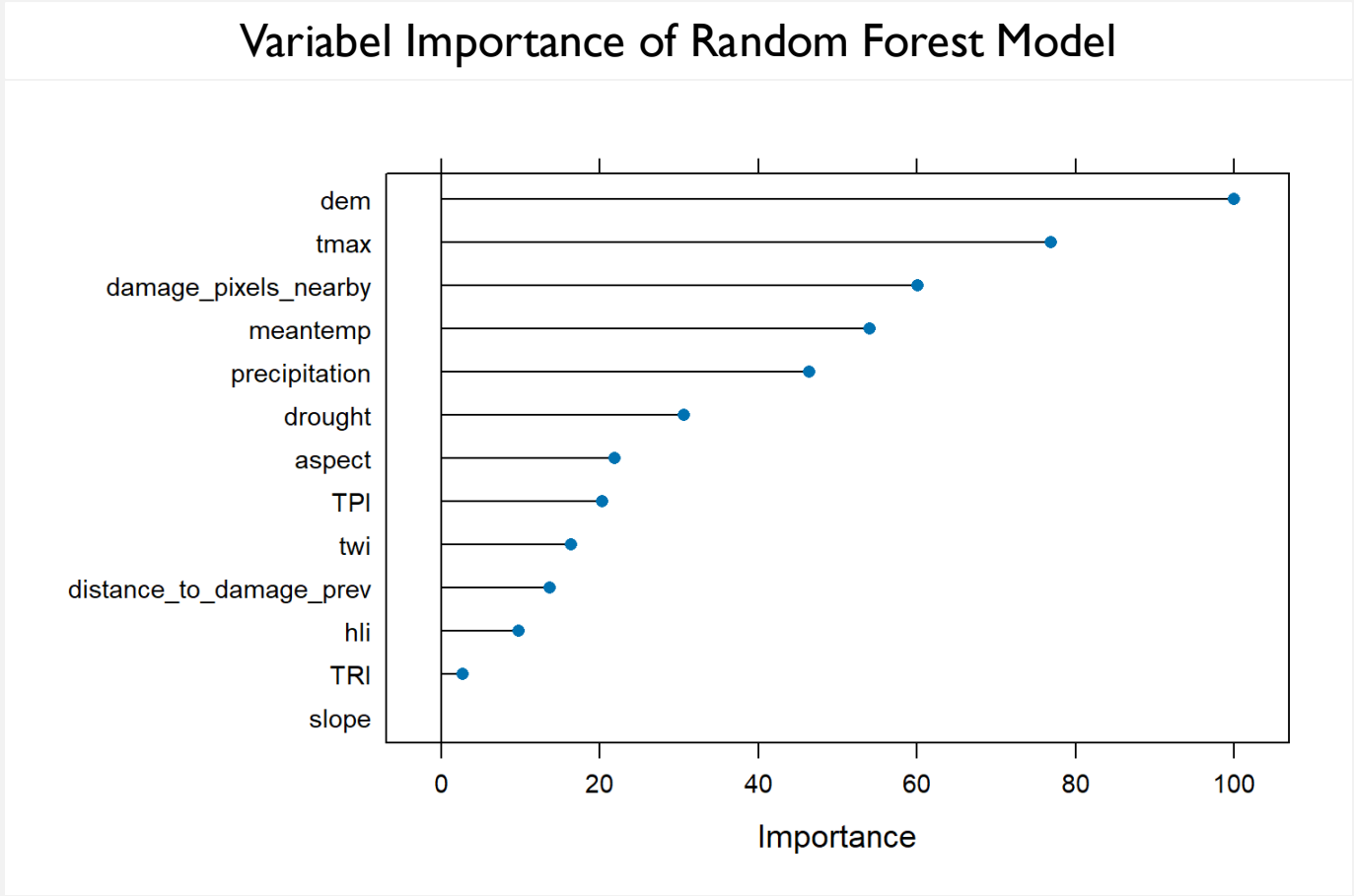


DATA FOR CALAMITY PREDICTION

- Seasonal climate data 2018 - 2022 (DWD; https://opendata.dwd.de/climate_environment/CDC/grids_germany/seasonal/)
- DEM 2020 (ELC 10; https://arxiv.org/abs/2104.10922)
- ~~*(Damaged areas 2018 – 2022 (Thünen-Institut; https://www.openagrar.de/receive/openagrar_mods_00094212))*~~
- ~~*(Landcover 2018 (Copernicus; https://land.copernicus.eu/en/products/global-dynamic-land-cover))*~~
- Own landcover and damage analysis
- Landsat 8 (Nasa, https://earthengine.google.com/)

Predictors


slope
aspect
TPI
TRI
dem
twi
hli
precipitation_2018
drought_2018
tmax_2018
meantemp_2018
5750000
5740000
5730000
5720000
590000
6e+05



VARIABLE IMPORTANCE

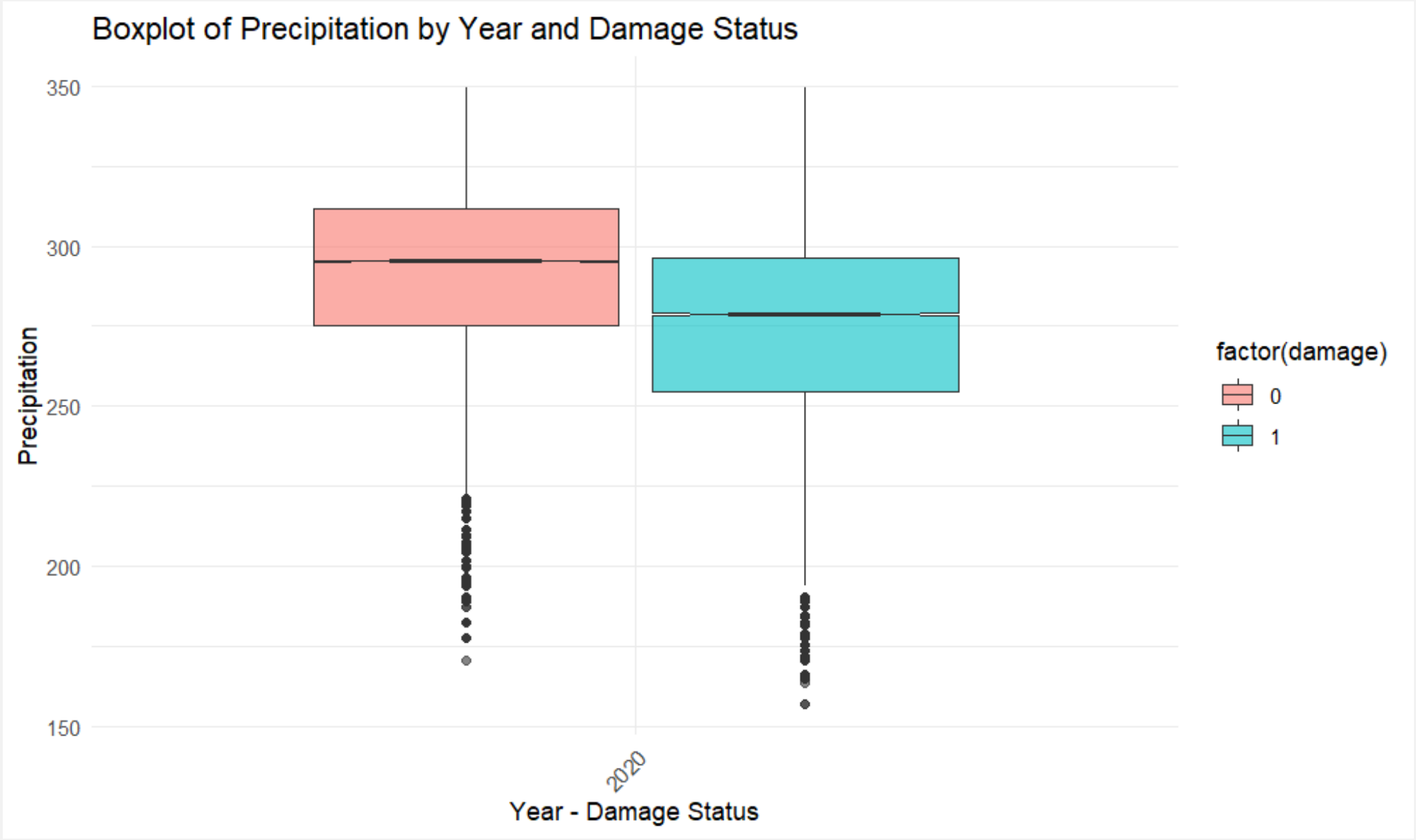
- Machine learning random forest model
- Radom selected training and testing points for 2019
- 70% training/ 30% testing
- 310385 data points

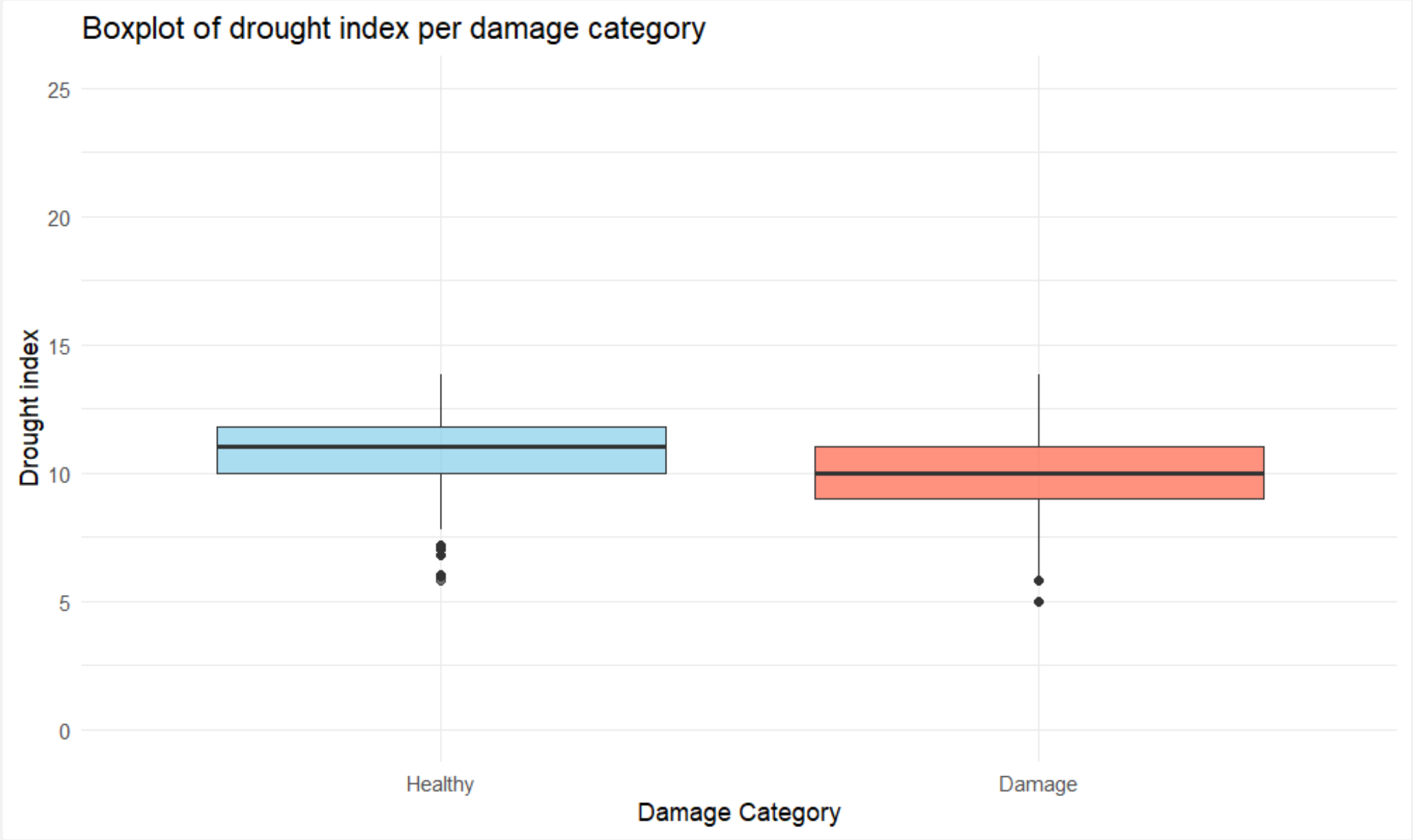
MODEL VALIDATION

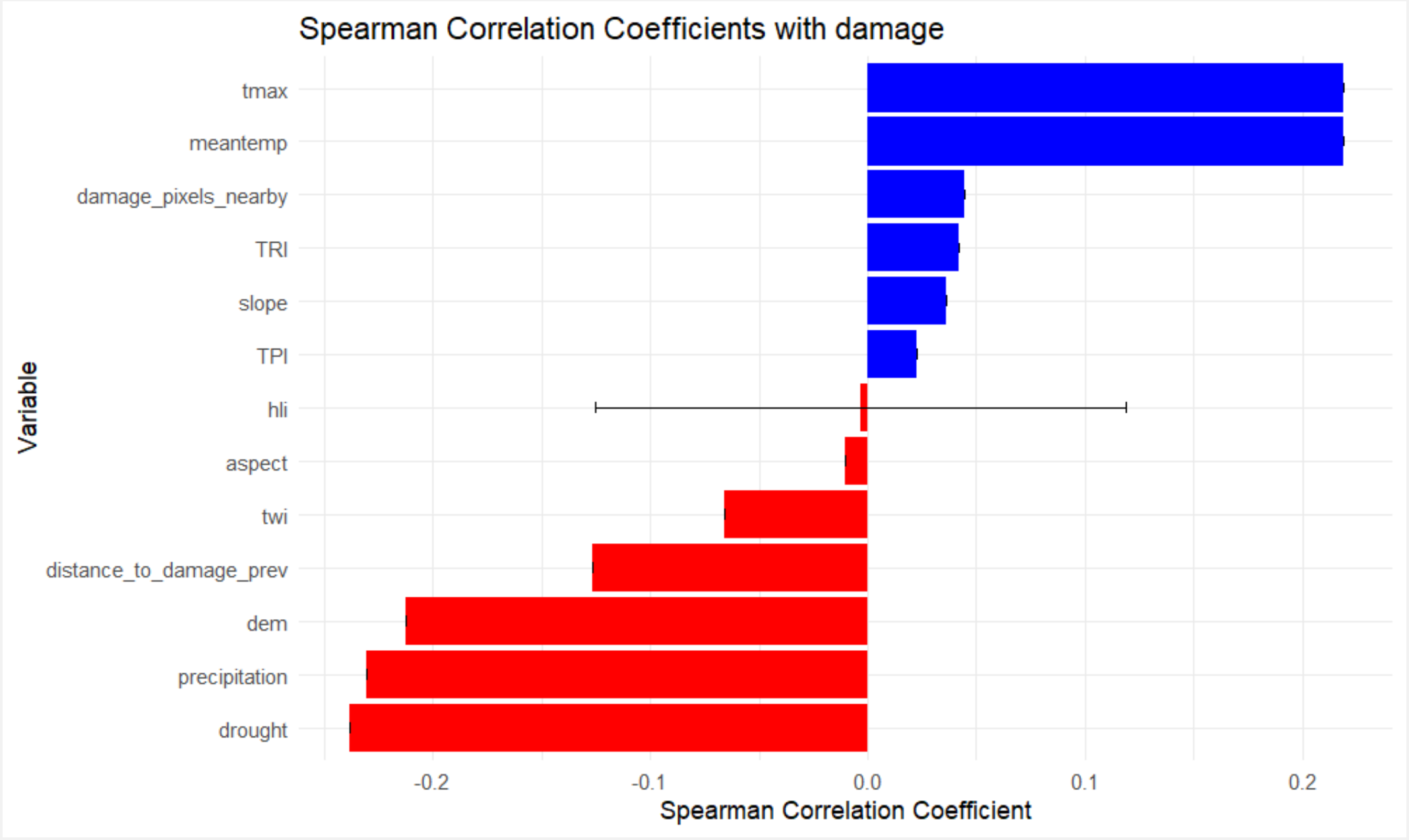
- Training
  - Accuracy: 0.8254316
  - Kappa: 0.5680289
- Testing
  - Accuracy: 0.8328
  - Kappa: 0.5845

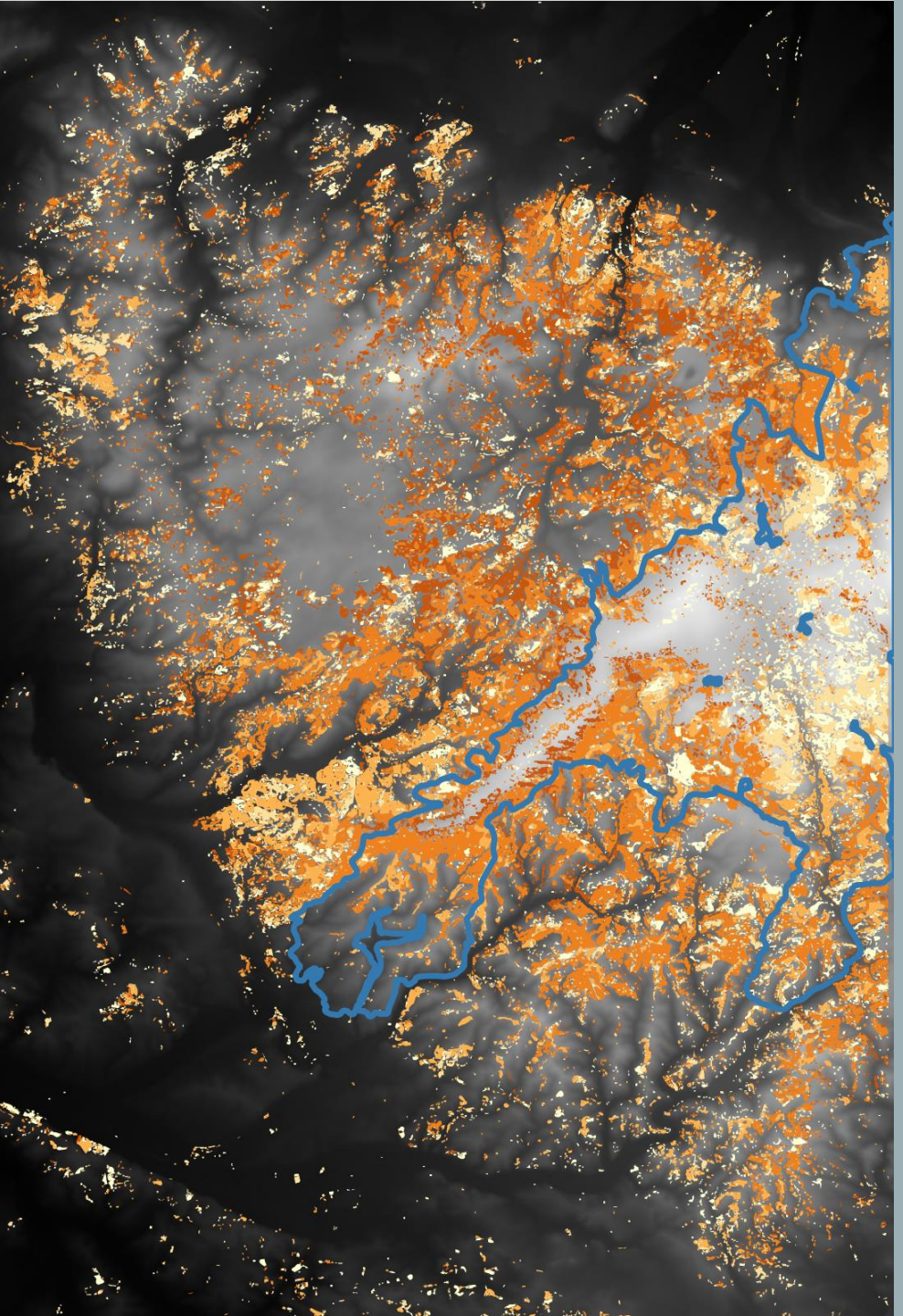
Confusion Matrix and Statistics

Prediction	damaged	healthy
damaged	17793	11829
healthy	3731	59732


Boxplot of Precipitation by Year and Damage Status
350
300
250
200
150
Precipitation
2020
Year - Damage Status
factor(damage)
0
1


Boxplot of drought index per damage category
Drought index
25
20
15
10
5
0
Healthy
Damage
Damage Category


Spearman Correlation Coefficients with damage
tmax
meantemp
damage_pixels_nearby
TRI
slope
TPI
hli
aspect
twi
distance_to_damage_prev
dem
precipitation
drought
Variable
-0.2
-0.1
0.0
0.1
0.2
Spearman Correlation Coefficient



IT'S (PROBABLY) NOT THE NATIONAL PARK

OUTLOOK

- Importance of data particularly before 2018
- Detailed and validated damage classification
- Wind and forest density data could help

- Plenty of room for more scientific work
- Can help to take the weight of the Nationalpark

LITERATURE

- Biedermann, Peter H. W.; Müller, Jörg; Grégoire, Jean-Claude; Gruppe, Axel; Hagge, Jonas; Hammerbacher, Almuth et al. (2019): Bark Beetle Population Dynamics in the Anthropocene: Challenges and Solutions. In *Trends in ecology & evolution* 34 (10), pp. 914–924. DOI: 10.1016/j.tree.2019.06.002.

- Hlásny, Tomáš; König, Louis; Krokene, Paal; Lindner, Marcus; Montagné-Huck, Claire; Müller, Jörg et al. (2021): Bark Beetle Outbreaks in Europe: State of Knowledge and Ways Forward for Management. In *Curr Forestry Rep* 7 (3), pp. 138–165. DOI: 10.1007/s40725-021-00142-x.

- Langner, N., Puhm, M., Deutscher, J., Wimmer, A., Adler, P., Backa, J., Eisenecker, P., Reinosch, E., Wiesehahn, J., Hoffmann, K., Oehmichen, K. (2024). FNEWS-Jahresprodukte 2018 bis 2022. https://doi.org/10.3220/DATA20240307175924-0

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