Reference Data Requirements for Tree Species Classification

German forest inventories and their application in large scale, satellite based TSC

Forest Research Institute Baden-Württemberg

KlimBa-Workshop Göttingen 2022
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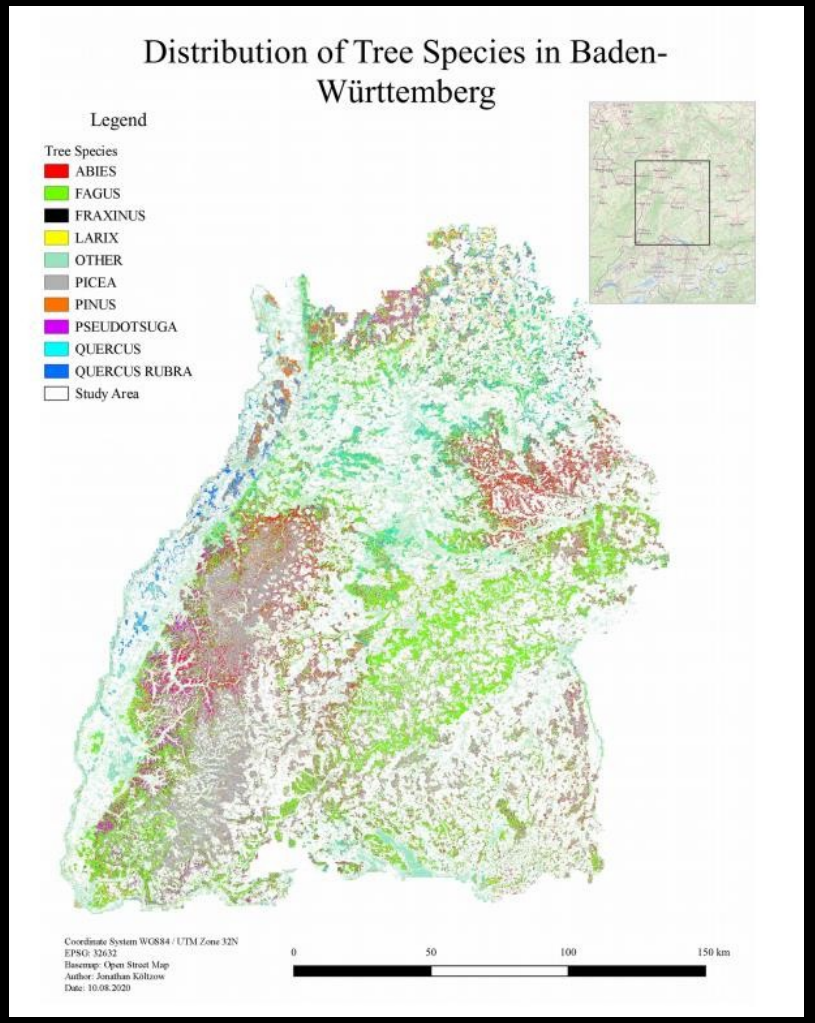
Overview

- What work has been done previously on the topic of tree species classification at the Forest Research Institute Baden-Württemberg (FVA-BW)?
- What training and validation data can be derived from federal forest inventories?
- Which species specific challenges have to be taken into account?
- How the Future Forest project (FU Berlin) will validate its classification

Project Overview (F³ @ FVA-BW)

- 10 classes, later 8 classes
- Sentinel 2 MSI, one scene of summer 2017
- Training: Federal forest inventory stands (FE)
- Validation: Federal forest inventory plots (BI)
- Balanced Random Forest (n = 3376)
- S2 Bands, CHM, DEM, climate and soil



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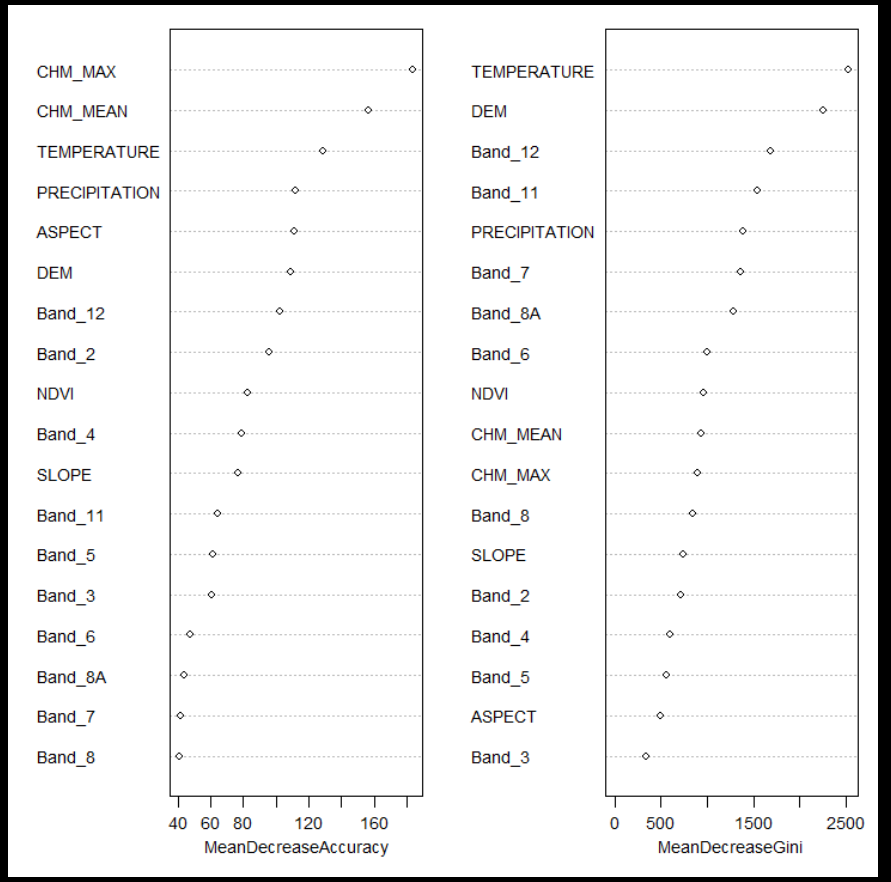
Random Forest Accuracy

- Achieved a low OOB error of 4.47% with some confusion between conifers
- When the prediction was compared to an independent testing set, accuracy sank drastically among most species
- ~85% UA for Fagus Sylvatica, Pinus Sylvestris and Picea Abies
- Pseudotsuga and Picea Abies tend to be overestimated
- Low accuracy hints at quality disparities between training and testing data.

Improving Classification Acc.

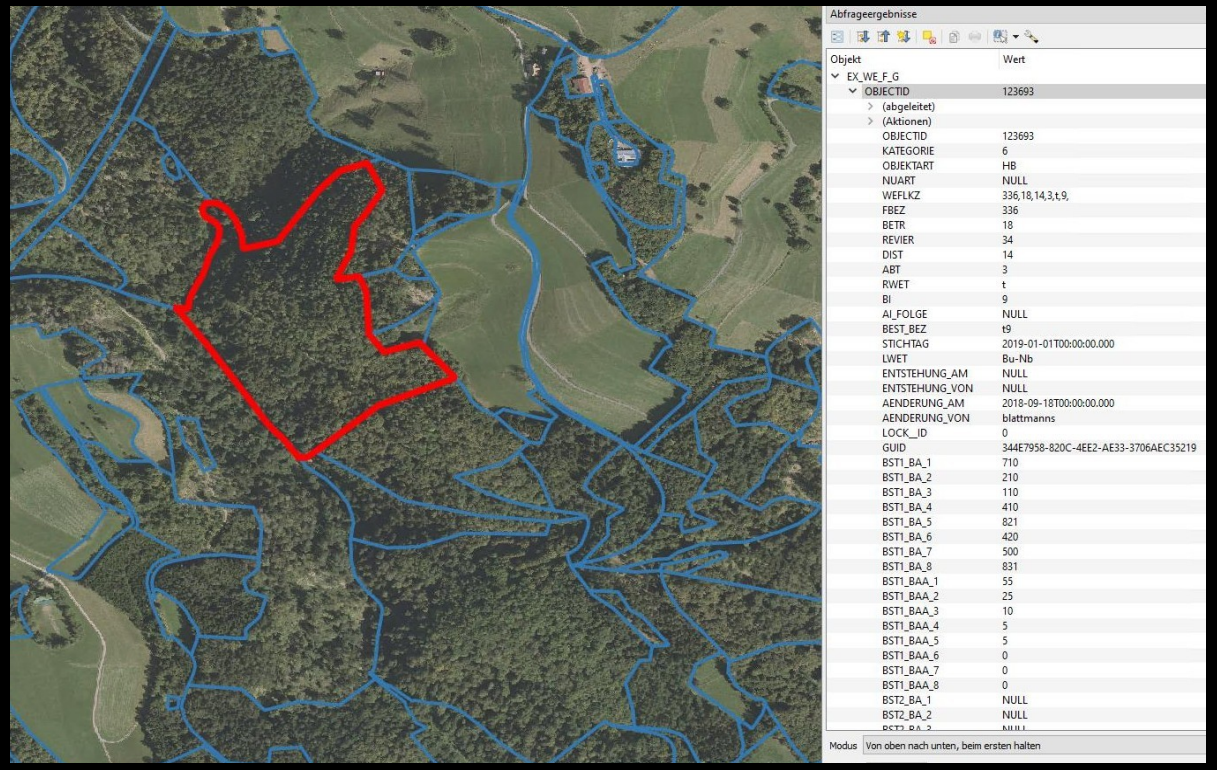
There‘s a need to:

- Increase the amount of training samples and improve model tuning
- Assure data quality of testing and training sets
- Validate the product in a real world situation
- Address species specific challenges



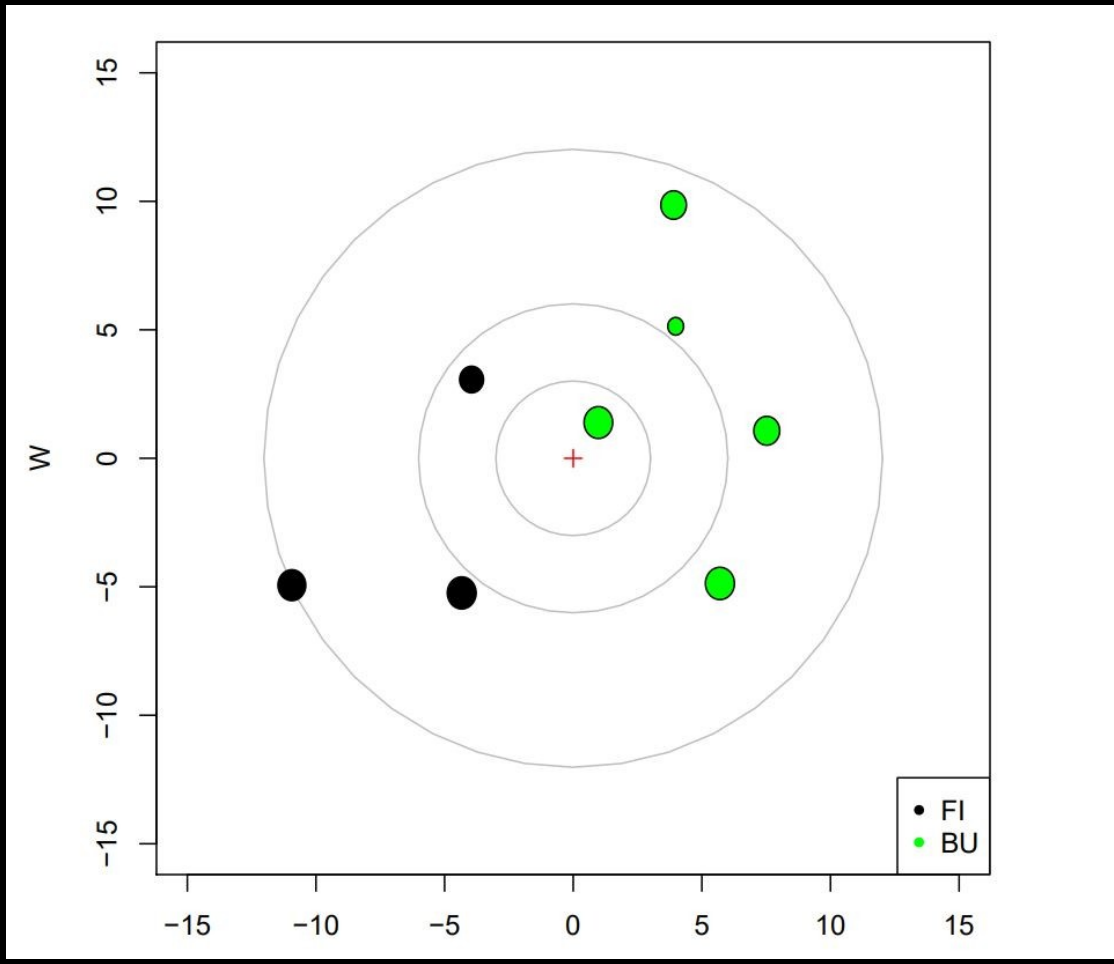
Forsteinrichtung (FE)

- Running inventory, containing estimates of tree species composition
- Only completely pure stands should be used for training to avoid mixed pixels
- Tree species information is of low reliability, polygon size influences the amount of erroneous pixels
- Outlier detection helps to identify wrong estimates



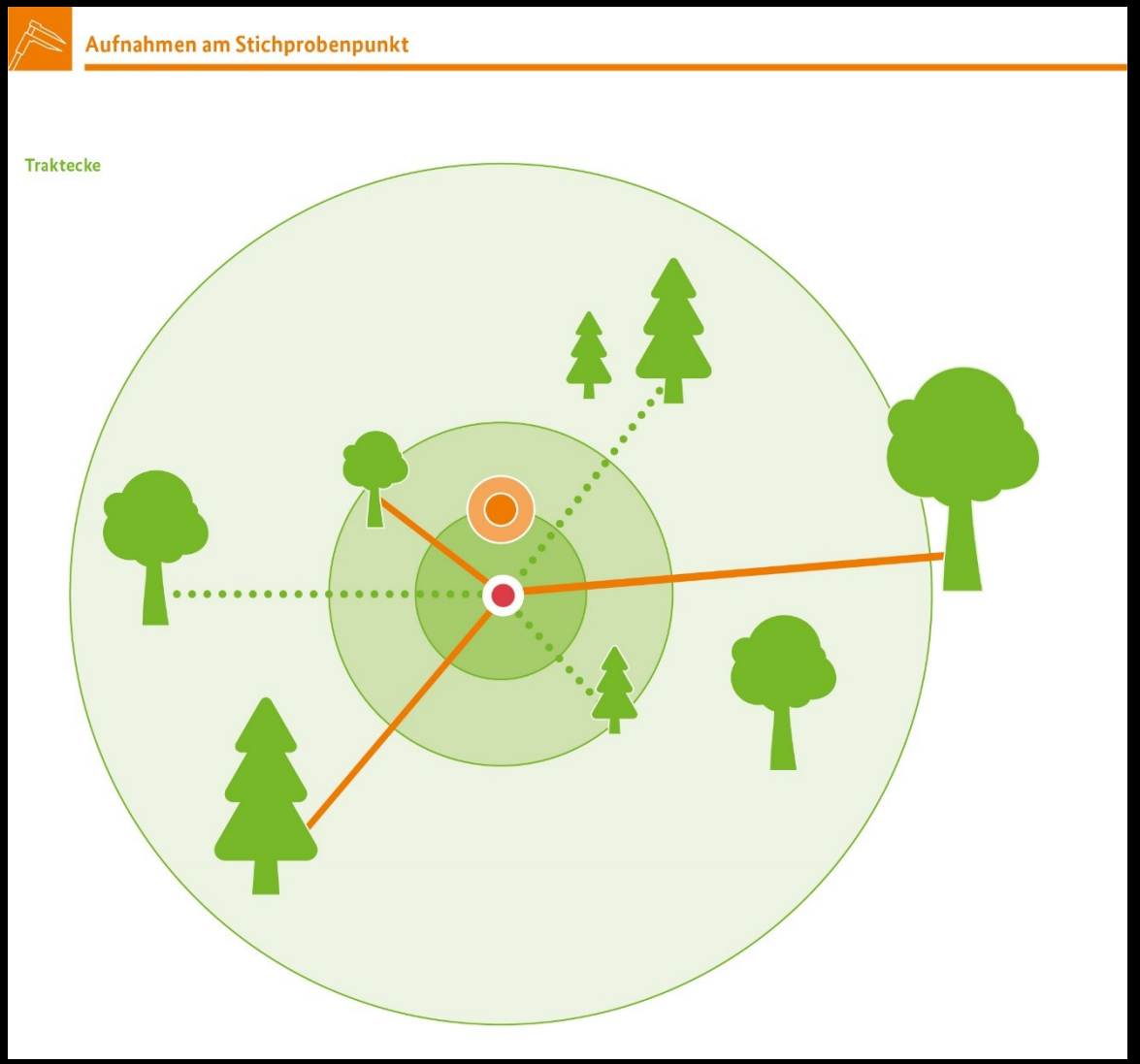
Betriebsinventur (BI)

- Point-wise, grid forest inventory
- Conducted in a r=12m circle
- High likelihood that all major trees are listed
- Highest quality data set available
- Distance from center for each tree given
- GPS inaccuracy needs to be considered



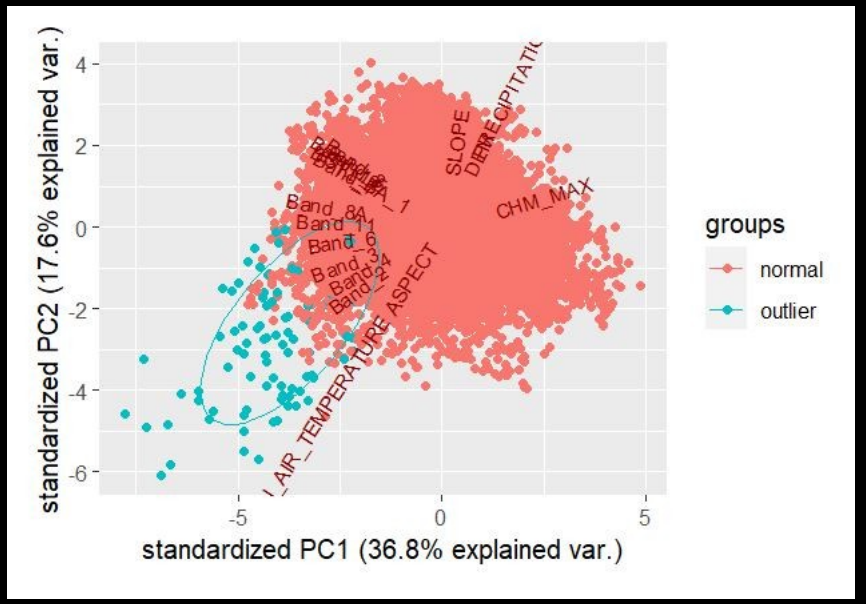
National Forest Inventory

- Similar grid pattern as BI
- Point-wise inventory, no fixed distance
- Whether or not a tree is surveyed, depends on its BHD and its distance from the center



Lack of canopy specific inventories

- Given inventories are designed for wood estimation not crown coverage and species composition
- BI and NFI have potential errors in regard to geo location, trees from the canopy might not be surveyed
- FE only consists of estimates,
  the error often depends on stand size.
- Aerial Imagery and data driven outlier detection could be used to increase data quality



Tree spectroscopy

The canopy’s reflectance values in aerial or satellite imagery depend on:

- Individual tree health
- Tree age and genetics
- Climate condition and recent weather influence at the date of capture
- Elevation and aspect
- Canopy closure and undergrowth, added to the signal
- Neighboring trees contributing to mixed pixels

Detecting Spruce

- The most prevalent tree species in forests in BW
- Often planted in mono-culture across all elevations
- Largest class in training data sets

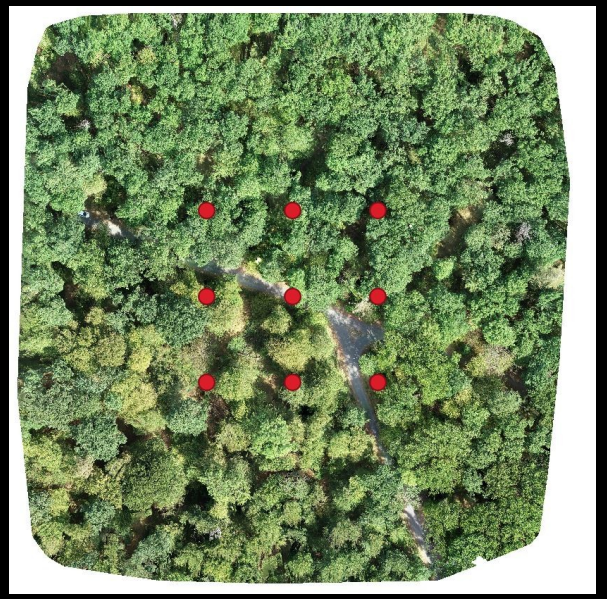
- Susceptible to bark beetle infestations, might lead to high spectral variance
- High probabilities for spruce in RF due to DEM being among the most important predictors

Detecting Ash

- Very few pure stands, more likely to occur in mixed pixels
- Ash dieback leads to high spectral variance
- Low amount of training data available due to being a minor species
- Might need a different classification setup, e.g. SVM
- Most of these problems also apply to other species, such as Fir and Larch.

Future Forest Project

- Tries to classify 8 different tree species using a deep neural network
- Uses the FORCE Sentinel-2 data cube
- Country-wide mapping
- Focus on validation with a high res data set



Summary

- A meaningful check of training and testing data needs to be conducted
- Wrongly labeled data can be identified using data driven outlier detection
- In satellite imagery, mixed pixels and co-dominant species pose a challenge
- Classification results should always be tested on a separate data set of the highest quality possible