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A Glance at the World Forest by Machine Learning

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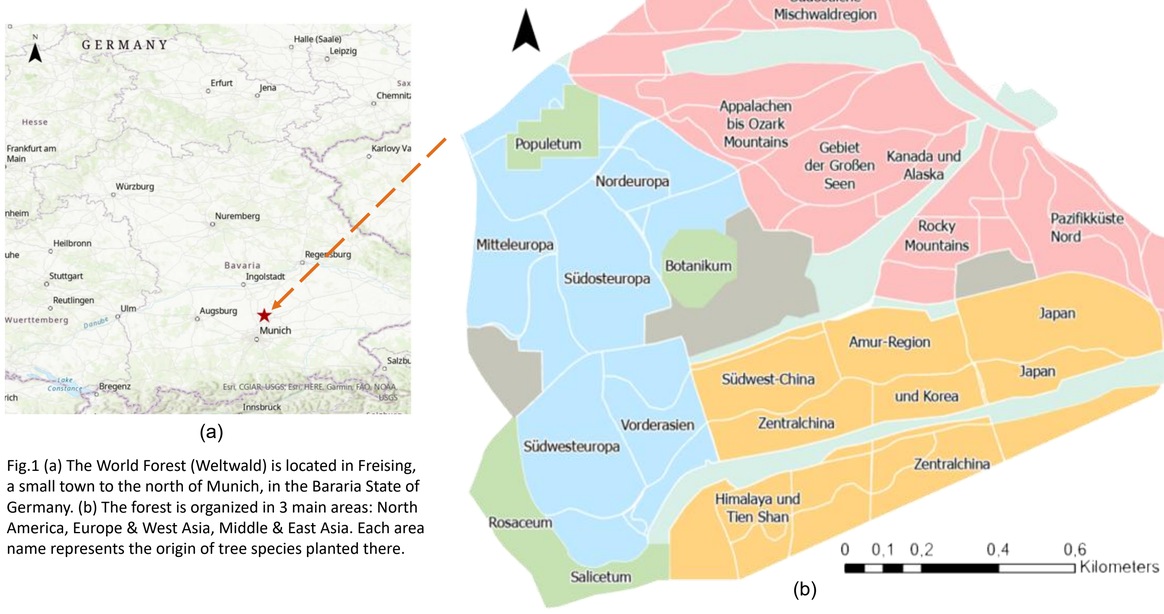
Background

The World Forest Freising is well-known for its large collection of tree species all over the world. In an area of about 100 ha, more than 300 species have been gathered since the first plant in 1987, making the forest area a valuable resource for forest mapping and tree species studies.

Objective

The objective of the study is to identify more tree species in Europe based on machine learning techniques & remote sensing datasets. For the first step, existing models are tested to gain an overall review.



(a)

(b)

Fig.1 (a) The World Forest (Weltwald) is located in Freising, a small town to the north of Munich, in the Bararia State of Germany. (b) The forest is organized in 3 main areas: North America, Europe & West Asia, Middle & East Asia. Each area name represents the origin of tree species planted there.

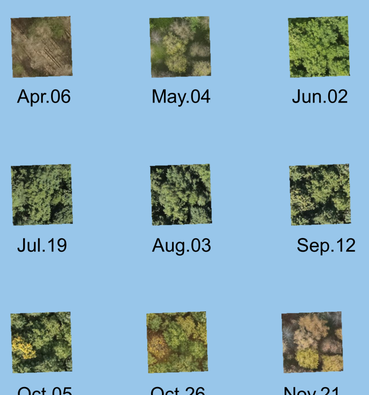
UAV Data

The UAV RGB data (including blue, green, red and near-infrared bands) were achieved in a series of field campaigns in the year of 2020, in the world forest (Weltwald) Freising. The field campaigns were conveyed more frequently from April to October (once in a week) to capture the phenological changes of the forest areas, while less frequent field works were also done at beginning and end of the year. A DJI Phantom 4 Multispectral carrying its original RGB sensors did the job.

Data Sampling

Sample scenes in rectangular shapes were selected and extracted manually from the original UAV images, where a validation database is provided by the Bavarian state institute of forestry (LWF). The sample fields were selected with the following criteria:

They should be either easy to be identified from the image with human eyes (e.g. bare grounds and roads), or inside the extent of the parcels, which are recorded in the validation database (for tree parts), so that the classification in the next step whould be accurate.

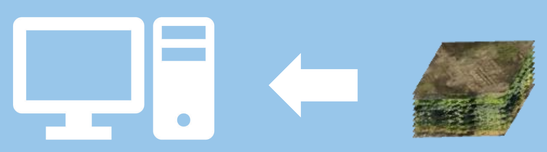


(a)

Images of a time series were put into a stack to provide the phenological information. The image stacks as the training data will be later fed into the machine learning models.
Another group of images, pairing to each of the sample scenes respectively, were the classification of each scene, which was done by human-eye with the help of the validation database. These served as the mask layers for the machine learning model.

U-net Model

A U-net model, which was applied before to species classification of black forest (Schiefer et al., 2020) is selected as the first testing target in this study. In the former study, only the classification of single UAV images were modeled. This study tries to model with time series data, which reveal the phenological patterns of diefferent tree species.



(c) (b)

Fig.2 Work Flow: (a) phenological change of oak trees (*Quercus robur*) on the UAV images. (b) put the time series data into a stack . (c) feed the data to a machine learning model, train the model, make predictions & evaluate accuracy of the model.

Conclusion

There is a high potential of applying time series UAV data, containing phenological patterns of different tree species, to forest classification, in terms of identify more tree species.
Machine learning technology makes this easier and more reliable.
With the data of the world forest Freising, involving various world-wide samples of tree species, the task becomes more interesting as well as more challenging.

What's next?

Further research is planned to be focused on improving the machine learning mechanisms, in order to improve the utilization of phenological information from the time-series images, as well as expanding the mapping area and thus increasing the number of species being mapped.
In addition, a possible upscaling to satellite datasets (Sentinel-2) will follow up.

Schiefer, F., Kattenborn, T., Frick, A., Frey, J., Schall, P., Koch, B., & Schmidtlein, S. (2020). Mapping forest tree species in high resolution UAV-based RGB-imagery by means of convolutional neural networks. ISPRS Journal of Photogrammetry and Remote Sensing, 170, 205–215.
UAV mission in Weldwald. 2020. Chair of eco-climatology, TUM school of life sciences.
Parcels of tree species planted in Weldwald in shapefile data. processed by LWF.