Forest disturbance detection using deep learning approaches

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This presentation participates in OSPP
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MOTIVATION

Although **insect outbreaks** and **wind** damage account for a large proportion of forest damage, there is no global and long-term data set on such damage, unlike the case of **fire** and **drought** [1].

In order to **counteract** this **data gap**, methods to classify different disturbance types are needed. Deep Learning methods applied to high resolution satellite data can fill this gap.

Here we want to distinguish between wind and insect disturbances.

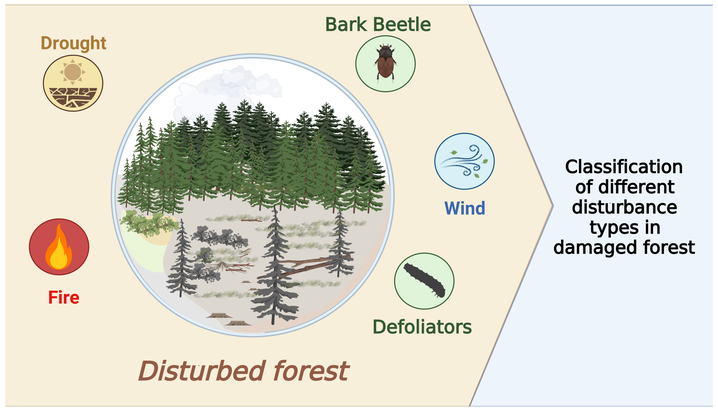
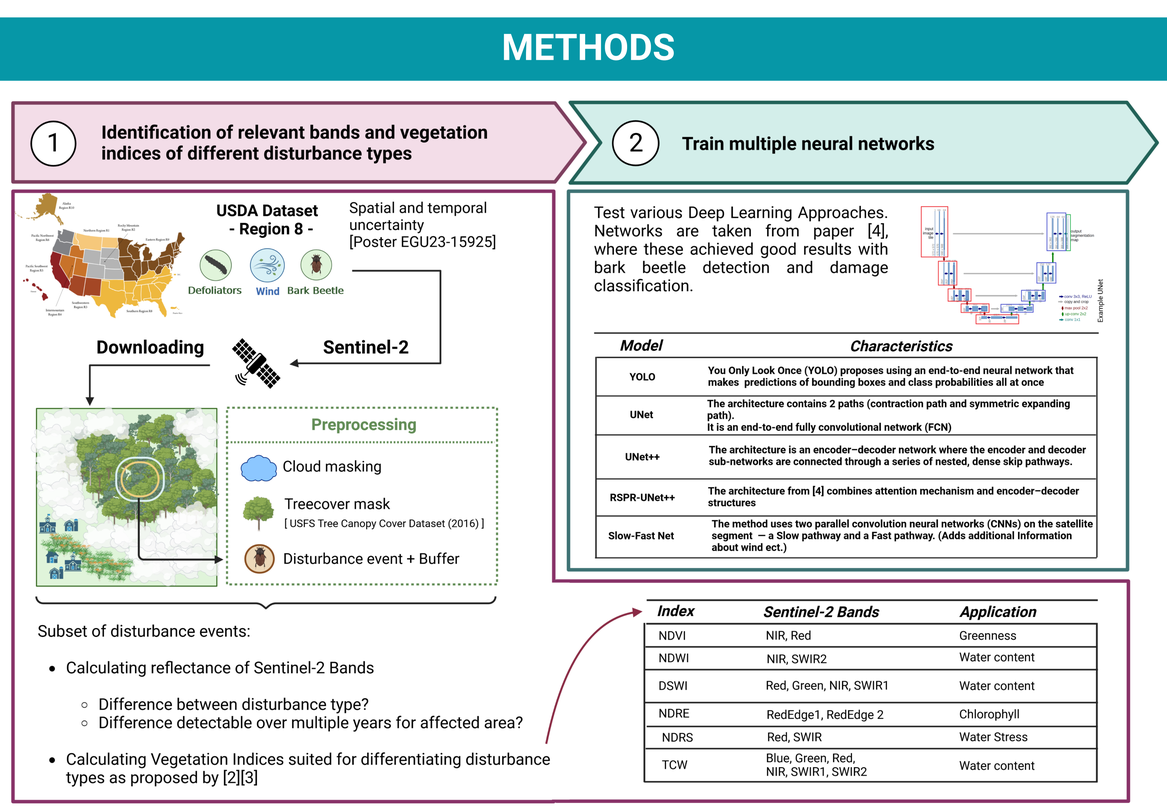


Fig. 1: Due to the lack of methods to differentiate between different types of forest disturbances, such methods are to be developed.

METHODS



Model	Characteristics
YOLO	You Only Look Once (YOLO) proposes using an end-to-end neural network that makes predictions of bounding boxes and class probabilities all at once
UNet	The architecture contains 2 paths (contraction path and symmetric expanding path). It is an end-to-end fully convolutional network (FCN)
UNet++	The architecture is an encoder–decoder network where the encoder and decoder sub-networks are connected through a series of nested, dense skip pathways.
RSPR-UNet++	The architecture from [4] combines attention mechanism and encoder–decoder structures
Slow-Fast Net	The method uses two parallel convolution neural networks (CNNs) on the satellite segment — a Slow pathway and a Fast pathway. (Adds additional Information about wind ect.)

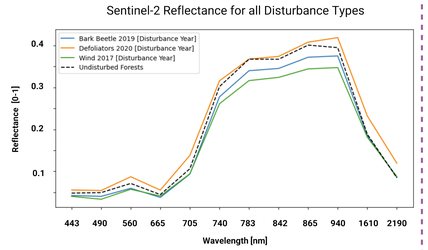
Index	Sentinel-2 Bands	Application
NDVI	NIR, Red	Greenness
NDWI	NIR, SWIR2	Water content
DSWI	Red, Green, NIR, SWIR1	Water content
NDRE	RedEdge1, RedEdge 2	Chlorophyll
NDRS	Red, SWIR	Water Stress
TCW	Blue, Green, Red, NIR, SWIR1, SWIR2	Water content

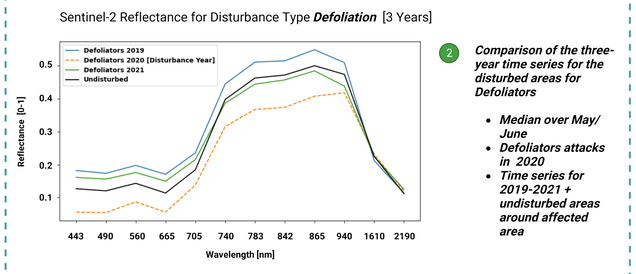
Fig. 2: Overview of the successive steps of the research work: **(1)** Download disturbed areas from the USDA record via Sentinel-2 and pre-process them, including finding suitable bands and vegetation indices. **(2)** Test different deep learning methods to classify the data into the different disturbance types.

PRELIMINARY RESULTS - STEP 1

1 *Comparison between all disturbance types + undisturbed areas*

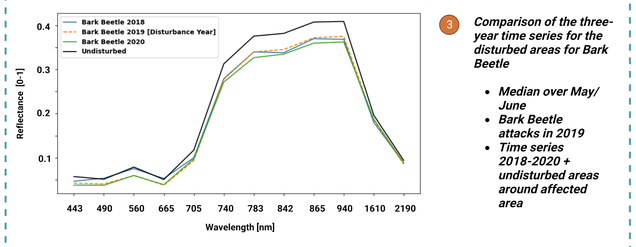
- *Median over May/June for scenes with max. 30% cloud cover*
- *Median of all disturbed pixels for each Sentinel-2 band, based on USDA classification*





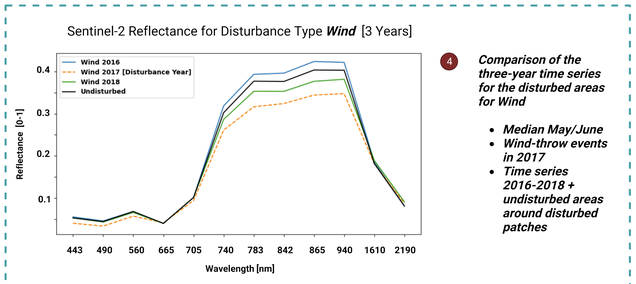
2 *Comparison of the three-year time series for the disturbed areas for Defoliators*

- *Median over May/June*
- *Defoliators attacks in 2020*
- *Time series for 2019-2021 + undisturbed areas around affected area*



3 *Comparison of the three-year time series for the disturbed areas for Bark Beetle*

- *Median over May/June*
- *Bark Beetle attacks in 2019*
- *Time series 2018-2020 + undisturbed areas around affected area*



4 *Comparison of the three-year time series for the disturbed areas for Wind*

- *Median May/June*
- *Wind-throw events in 2017*
- *Time series 2016-2018 + undisturbed areas around disturbed patches*

Fig. 3: Calculation of the median of all disturbed pixels in May/June for the respective Sentinel-2 band values of the disturbance types.

CONCLUSION

Disturbance effects can be seen in Sentinel-2 reflectance spectra, comparatively with undisturbed forest, at last for May/June of the disturbance year
It is evident that for all three events studied, the NIR bands in particular have a large influence.

The three-year survey of the bands show that the year in which the damage occurred in the forest is clearly distinguishable from the other years - with the exception of the bark beetle infestation, which is presumably still in the green attack phase at this time (May/June).

Another reason might be uncertainty in the labels, as discusses in poster EGU23-15925.

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ForExD
Forest vulnerability to compound extremes and disturbances in a changing climate

This project is funded by the European Union (ERC StG, ForExD, grant agreement No. 101039567). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Council. Neither the European Union nor the granting authority can be held responsible for them.

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