MODIS, Sentinel-2 and UAV data for prediction / detection of bark beetles in Slovenia

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(2) <u>https://www.zdravgozd.si/projekti/podlubniki/rezultati.aspx</u>

Acknowledgement: This research was funded within the framework of the CRP research programme / V4-1623 project by the Slovenian Ministry of Agriculture, Forestry and Food, and by the Slovenian Research Agency.

Multi-scale prediction / detection of bark-beetle attacks

Spatial level, resolution	Target variable	Sensor
Entire country, 1 x 1 km ²	Amount of sanitary felling (m ³ /ha) in the next year	MODIS 250 m NDVI and EVI composites
Regional, Forest stand @ 20 x 20 m ²	Amount of BB-attacked growing stock (m ³ /ha)	Sentinel-2A and Sentinel-2B 20 m MS data, NDVI, EVI
Local, Individual tree @ 0.2 x 0.2 m ²	Tree crown discoloration and defoliation	MicaSense (UAV platform) MS data, NDVI

MODIS-based prediction of bark beetle-related sanitary felling at country level, resolution 1 x 1 km²

- Prediction of BB-related sanitary felling <u>for the coming year</u> <u>based on this year</u> time series of NDVI and EVI 16-day composites (23 x 2 composites)
- Additional explanatory variables: monthly precipitation, monthly temperature, relief elevation
- Model type: Random forest
- Machine learning tool: CLUS 2.7 (<u>https://dtai.cs.kuleuven.be/clus/index.html</u>)
- Reference data: yearly sum of spruce/fir sanitary felling
- Model trained on data from 2002 to 2018
- Model correlation 0.61 based on 10-fold crossvalidation (0.95 on training data)
- Best predictors of next year sanitary fellings:
 - 1. EVI
 - 2. NDVI
 - 3. Temperature

MODIS-based prediction of bark beetle-related sanitary felling at country level, resolution 1 x 1 km²



Sentinel2-based detection of bark beetle attacks Regional level, resolution 20 x 20 m²

- Estimation of BB-attacked growing stock (m³/ha) based on 10-day time series of Sentinel-2A, Sentinel-2B 20-m data, NDVI and EVI
- Additional explanatory variables: Days since Jan 1st to date of attack (detection in the field), Sentinel2 image delay (= imagery age since attack).
- Model type: Random forest
- Machine learning tool: CLUS 2.7 (<u>https://dtai.cs.kuleuven.be/clus/index.html</u>)
- Reference data: field detection of attack location, amount and date
- Model trained on data from 2017 to 2019
- Model correlations (10-fold crossvalidation)
 - Sampling 1 pixel at each attack location: R = 0.57
 - Sampling 3x3 pixels at each attack location: R = 0.78
 - Sampling 5x5 pixels at each attack location: R = 0.82



UAV-based detection of bark beetle attacks at individual tree level, resolution 20 x 20 cm²

- Classification of tree crown discoloration and defoliation at individual tree level based on MicaSense RGB and IR imagery
- Target variables (classes):
 - tree crown discoloration: class 0 (no damage), ..., class 3 (dead tree)
 - tree crown defoliation: class 0 (no damage), ..., class 4 (dead tree)
- Explanatory variables: mean and standard deviation of image channels, NDVI, EVI within radii of 1 m, 2 m, 4 m, 8 m, respectively, centered on tree-tops (tree-tops identified from the photogrammetric DSM)
- Model type: Random forest
- Machine learning tool: CLUS 2.7 (<u>https://dtai.cs.kuleuven.be/clus/index.html</u>)
- Reference data: tree-level field inventory of 15 hot spots (tree location, tree crown status, tree species)
- UAV aerial data acquisition (nearly) simultaneous with field inventory.
- Model accuracies, estimated on unseen data:
 - tree crown discoloration: 74.7 %
 - tree crown defoliation: 51.1 %

