

National Park Hunsrück-Hochwald - Forest Types -

Legend:

- Coniferous Forest
- Deciduous Forest
- No Forest

Processing:

The forest type map was created using a random forest classification approach based on Sentinel-2 satellite imagery. The workflow includes the following steps:

1. **Data Preparation:** A Sentinel-2 image stack was extended by additional derived features (see p. 2, Features) and used as input. Sample polygons representing deciduous and coniferous-forest areas were created.
2. **Model Training:** A Random Forest classifier was trained using a spatial 3-fold cross-validation to ensure spatial separation between training and validation data.
3. **Prediction** The trained model was applied to the NLPHH masked Sentinel-2 feature stack to generate a coniferous/deciduous-forest map.

Sources:

- European Space Agency (2025). *Copernicus Data Space Ecosystem*.
 S2C_MSIL2A_20250511T103641_N0511_R008_T32ULA_20250511T132601.
 [2025-07-01]
- University of California, Berkley. Global Administrative Areas Version 4.1
www.gadm.org (2025). [2025-07-01].

CRS: ETRS89 UTM Zone 32 (EPSG: 25832)

Author: Fabian Schumacher

Affiliation: Trier University

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Accuracy Assessment

1) Error matrix:

Thematic map		Validation			User's accuracy	Total class area (m ²)	Wi
		1 (Coniferous forest)	2 (Deciduous forest)	Total			
1	50	0	50	1.0	19479600.00012	0.2349	
2	3	47	50	0.94	63447900.00041	0.7651	
Total	53	47	100		82927500.00053		
Producer's accuracy	0.83652	1.0			0.95409		

2) Accuracy:

Overall:

Overall Accuracy	Standard deviation
0.95409	0.02596

User:

	User's accuracy	Standard deviation
1 (Coniferous forest)	1.0	0.0
2 (Deciduous forest)	0.94	0.03393

Producer:

	Producer's accuracy	Standard deviation
1 (Coniferous forest)	0.83652	0.07747
2 (Deciduous forest)	1.0	0.0

2b) Accuracy matrix of estimated area proportion:

User:

Thematic map	Validation	
	1 (Coniferous forest)	2 (Deciduous forest)
1	1.0	-
2	0.06	0.94

Producer:

Thematic map	Validation	
	1 (Coniferous forest)	2 (Deciduous forest)
1	0.83652	-
2	0.16348	1.0

3) Error matrix of estimated area proportion:

Thematic map	Validation		Wi
	1 (Coniferous forest)	2 (Deciduous forest)	
1	0.2349	-	0.2349
2	0.04591	0.71919	0.7651
total	0.28081	0.71919	

4) Quadratic error matrix of estimated area proportion:

Thematic map	Validation	
	1 (Coniferous forest)	2 (Deciduous forest)
1	-	-
2	0.00067	0.00067
total	0.02596	0.02596

5) Class area adjusted:

	Area adjusted (m ²)	Error	Lower limit	Upper limit	Coefficient of variation	Uncertainty
1 (Coniferous forest)	23286474.00015	2152577.34088	19067422.41202	27505525.58828	9.24 %	0.18118
2 (Deciduous forest)	59641026.00038	2152577.34088	55421974.41225	63860077.58851	3.61 %	0.07074
total	82927500.00053					

Accuracy assessment results for the two maps. Assessment was performed according to the methodology of Olofsson et al. (2014) with the QGIS plugin AcATAmA (Llano, X., v25.7, 2025).

References:

Llano, X. (2025), SMBY-C-IDEAM. AcATAmA - QGIS plugin for Accuracy Assessment of Thematic Maps, version 25.7. Available in <https://github.com/SMBY-C/AcATAmA>

Olofsson, P., Foody, G. M., Herold, M., Stehman, S. V., Woodcock, C. E., & Wulder, M. A. (2014). Good practices for estimating area and assessing accuracy of land change. Remote Sensing of Environment, 148, 42-57.

Additional information: Preprocessing

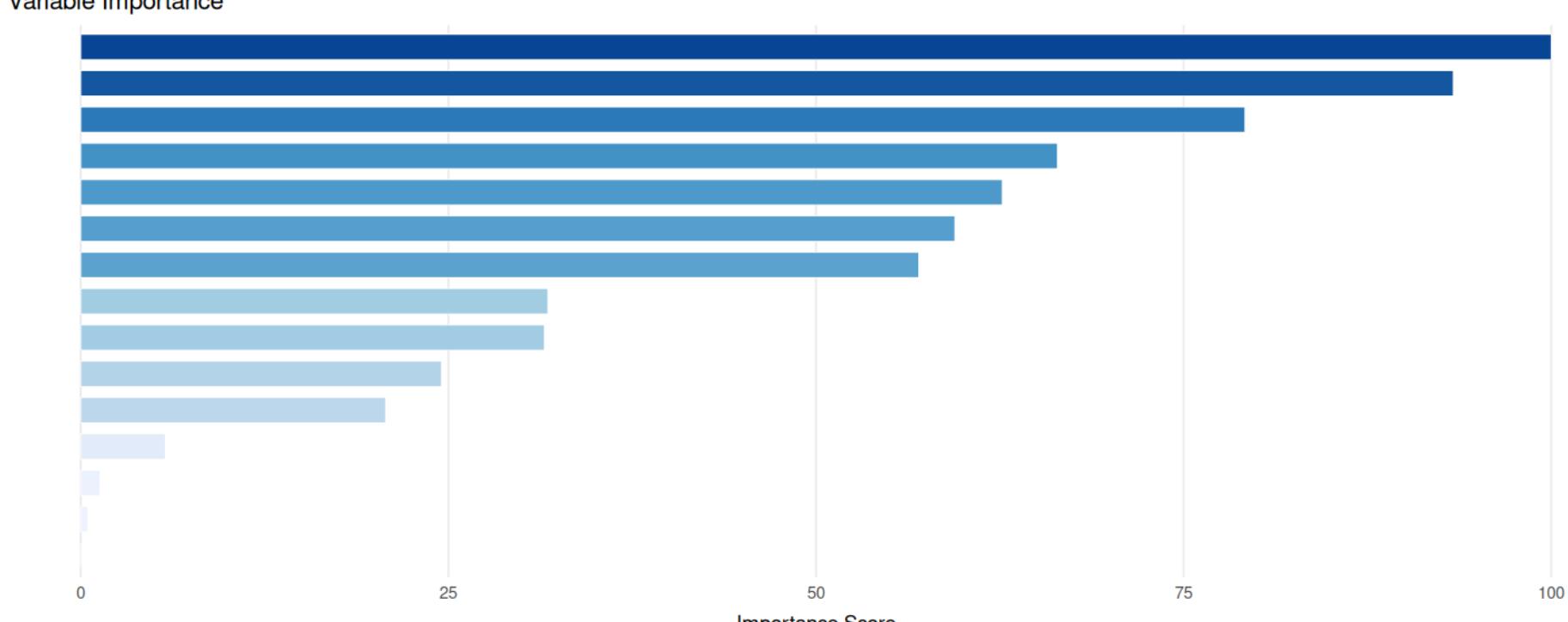
The preprocessing step prepares the multi-band Sentinel-2 image stack used for the forest/non-forest classification. The workflow includes:

- Data:** Sentinel-2 bands (B02–B12) at 10m and 20m resolution were loaded from a single acquisition date.
- Resampling and Reprojection:** All 20m bands were resampled to 10m resolution to ensure consistency across all layers and the image stack was projected to the UTM coordinate system (EPSG:25832).
- NDVI and NDVI Texture Metrics Calculation:** The NDVI was computed from the NIR (B08) and Red (B04) bands and added as an additional feature. Additionally spatial textures of NDVI were calculated using 3x3 and 5x5 moving windows (standard deviation and mean) and added as additional features for model training.

Features:

Band / Feature	Short Name	Description
Blue	B02	Visible blue band (490 nm) – useful for water body and atmospheric analysis.
Green	B03	Visible green band (560 nm) – reflects vegetation vigor and soil background.
Red	B04	Visible red band (665 nm) – useful for vegetation discrimination and NDVI calculation.
Red Edge 1	B05	First red edge band (705 nm) – sensitive to chlorophyll content in vegetation.
Red Edge 2	B06	Second red edge band (740 nm) – helps detect vegetation stress.
Red Edge 3	B07	Third red edge band (783 nm) – supports vegetation classification and biophysical retrieval.
Near Infrared	B08	NIR band (842 nm) – highly reflective for healthy vegetation; used in NDVI.
Red Edge 4	B8A	Narrow NIR band (865 nm) – useful for fine vegetation differentiation.
SWIR 1	B11	Short-wave infrared band (1610 nm) – useful for vegetation moisture and soil discrimination.
SWIR 2	B12	Short-wave infrared band (2190 nm) – helpful in land cover and fire mapping.
NDVI	NDVI	Normalized Difference Vegetation Index – indicator of vegetation greenness and biomass.
NDVI Standard Deviation (3x3)	NDVI_3x3_sd	Texture: spatial heterogeneity in NDVI over a 3x3 kernel.
NDVI Standard Deviation (5x5)	NDVI_5x5_sd	Texture: spatial heterogeneity in NDVI over a 5x5 kernel.
NDVI Mean (3x3)	NDVI_3x3_mean	Texture: local mean NDVI over a 3x3 window – captures patch-level vegetation.
NDVI Mean (5x5)	NDVI_5x5_mean	Texture: local mean NDVI over a 5x5 window – useful for forest homogeneity.

Variable Importance



Variable importance of the random-forest model fitted to the training data.