



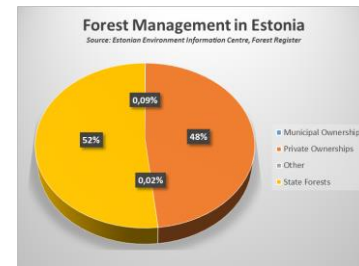
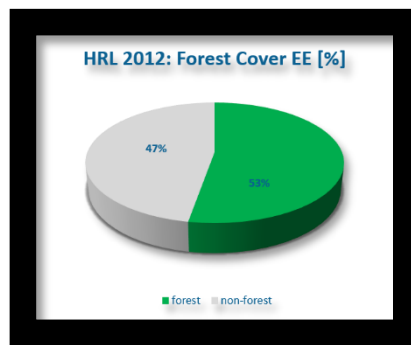
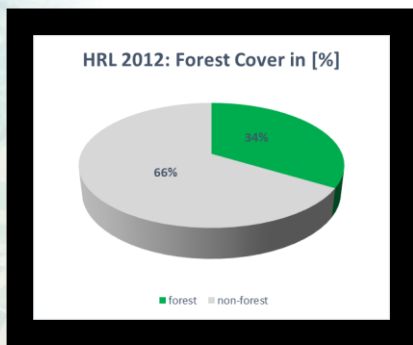
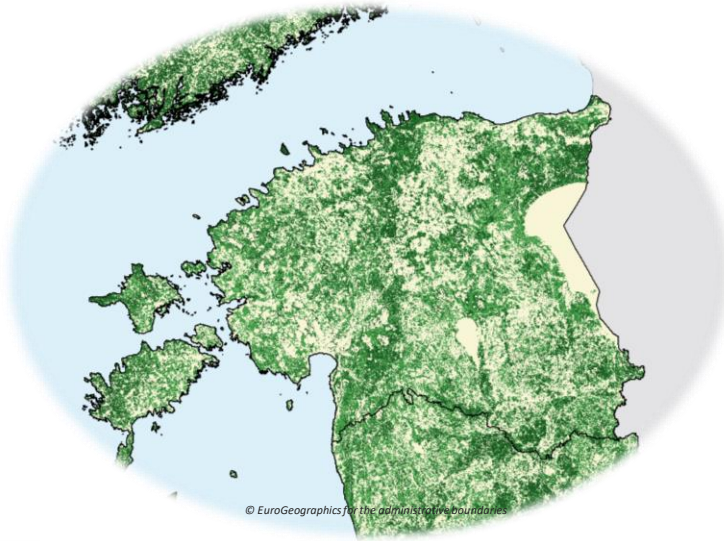
Copernicus Land Monitoring Service

Forest damage detection supported by
the HR Forest Layer



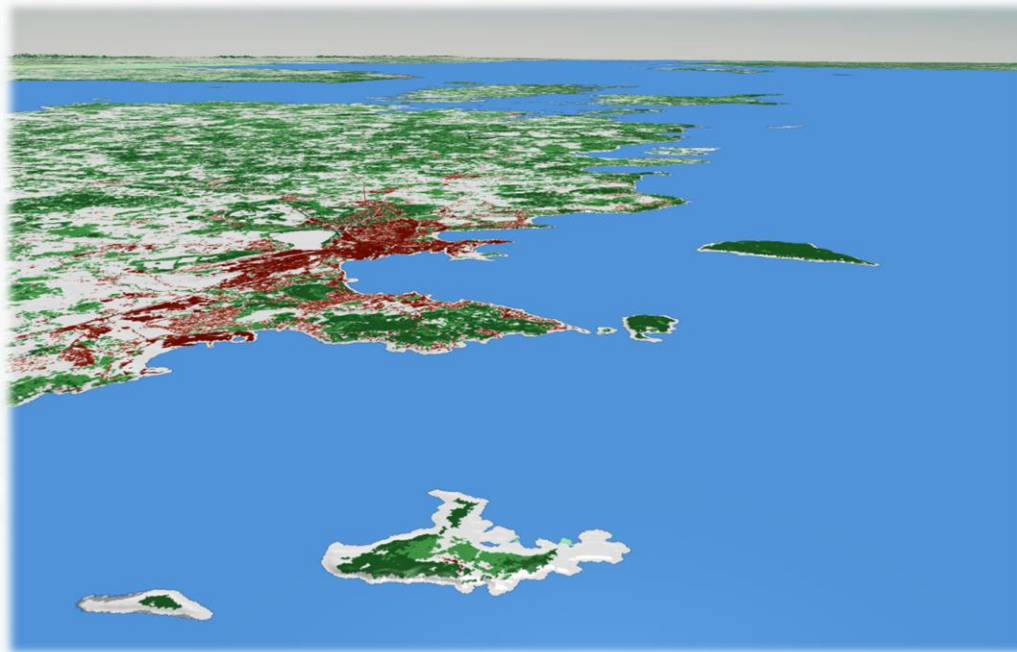
Introduction

- The 20m High Resolution Layer (HRL) Forest provides information on the spatial extent, distribution and characteristics of tree cover for the whole of Europe (EEA-39 countries).





Introduction



3D-View on Tallinn:

- *HRL FTY 2012 (green)*
- *HRL IMD 2012 (rot)*
- *EU-DEM (height)*

- This submodule shows how the Copernicus HR Forest Layer can be used to support damage detection in forests.³



Introduction

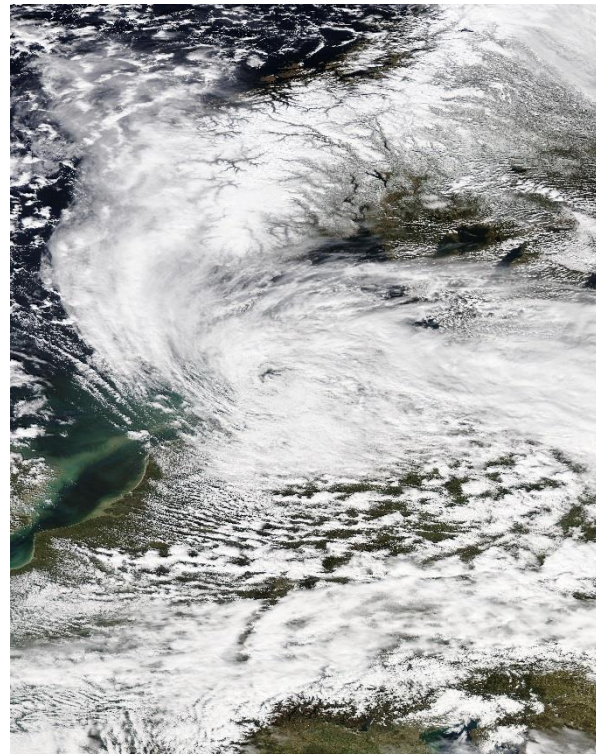
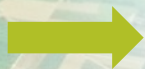
- Damages in managed forests (due to pests, weather or fire) result in a loss of trees and can have large commercial or environmental impacts. Locating and quantifying forest damage at an early stage can limit the losses.
- Concept of forest damage detection
- Making use of Copernicus EO data and the HRL Forest Layer, together with additional pre-/post-event EO observations.
- **Use case:** A German forest owner association wants to assess the damages caused by storm *Niklas* in March/April 2015 nearby Munich.



Storm Niklas

- Origin: nearby Iceland
- Duration: 29/03 – 02/04/2015
- Max. wind speed: 192 km/h
- Damage in Germany:
 - Total damage ca. 750 millions EUR
 - Forest damage: ca. 2 millions m³

Rapid and consequent removal operations
of storm-damaged timber by governmental,
local and private forestry operations to
prevent bark-beetle infestations



NASA - <http://lance-modis.eosdis.nasa.gov/cgi-bin/imagery/realtime.cgi>



Input Data

- High Resolution Layer Forest
 - Tree Cover Density
 - Forest Type
- VHR True colour Image Mosaic 2012
- Pre- and post-event VHR multispectral satellite data



Download of Copernicus Forest products (1)

- <http://land.copernicus.eu/>

Copernicus is an European system for monitoring the Earth. Data is collected by different sources, including Earth observation satellites and in-situ sensors. The data is processed and provides reliable and up-to-date information about six thematic areas: land, marine, atmosphere, climate change, emergency management and security. The land theme is divided into four main components:



Global

provides a series of bio-geophysical products on the status and evolution of the land surface at global scale at mid and low spatial resolution



Pan-European

provides information about the land cover and land use (LC/LU), land cover and land use changes and land cover characteristics



Local

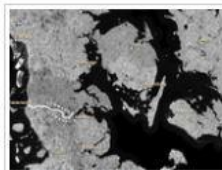
focuses on different hotspots, i.e. areas that are prone to specific environmental challenges and problems



Reference data

All of the Copernicus services need access to in-situ data in order to ensure an efficient and effective use of Copernicus space-borne data

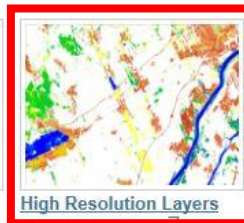
Pan-European



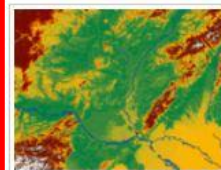
[Image Mosaics](#)



[CORINE Land Cover](#)



[High Resolution Layers](#)



[Reference Data](#)

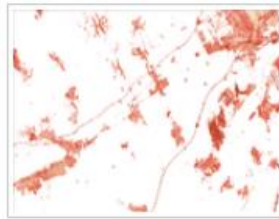


[Related Pan-European products](#)

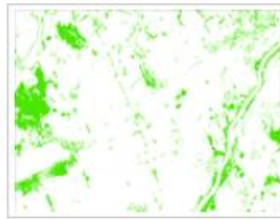


Download of Copernicus Forest products (2)

High Resolution Layers



Imperviousness



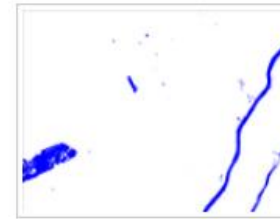
Forests



Grassland

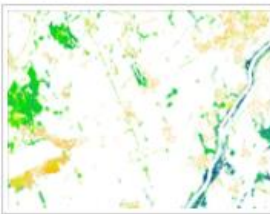


Wetlands

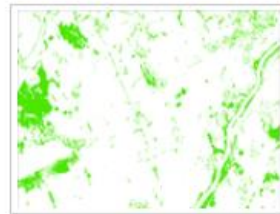


Permanent Water Bodies

Forests



Tree Cover Density 2012

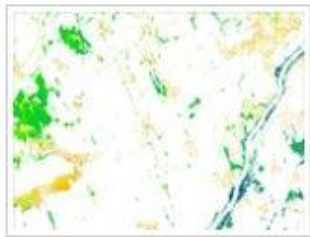


Forest Type 2012



Download of Copernicus Forest products (3)

Forests



Tree Cover Density 2012

- 20m pixel-based product
- 0-100% Tree Cover Density
- 2 class categories: all non-tree areas; tree cover

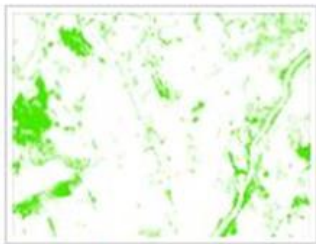


TCD-020m E40N20

Raster

20m

703.8 MB



Forest Type 2012

- 20m spatial resolution
- 0.5 ha Minimum Mapping Unit
- 10-100% Tree Cover Density
- 3 thematic classes: non-forest, broadleaved, coniferous



FTY-020m E40N20

Raster

20m

131.5 MB





Integrating Pan-European Image Mosaics (1)

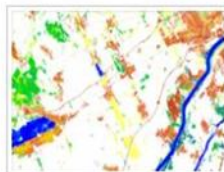
Pan-European



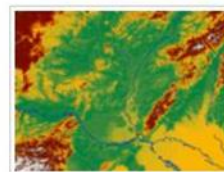
[Image Mosaics](#)



[CORINE Land Cover](#)



[High Resolution Layers](#)

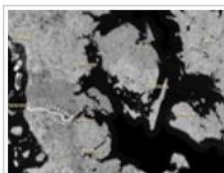


[Reference Data](#)

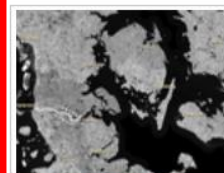


[Related Pan-European products](#)

Image Mosaics



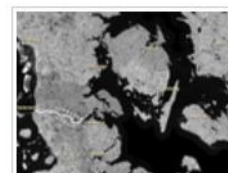
[High Resolution](#)



[Very High Resolution](#)



Very High Resolution



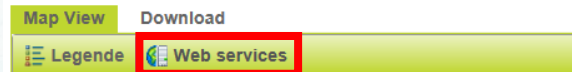
[True colour image 2012
\(Core 3, VHR - 2.5m\)](#)

True colour image 2012 (Core 3, VHR - 2.5m)



Integrating Pan-European Image Mosaics (2)

True colour image 2012 (Core 3, VHR - 2.5m)



Web services in this map

[VeryHighResolution2012](#)



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Copy link to add as WMS server to your GIS



Commercial Catalogue Search: e.g. AIRBUS DS (1)

- <http://www.intelligence-airbusds.com/>

AIRBUS
DEFENCE & SPACE

GERMANY English Search ok Join / My account

Products & Services Markets Ordering **GeoStore** Contact us Commercial network Satellite Image Gallery

Welcome to GeoStore

Easy-to-use online purchasing for reliable image delivery

Search Buy Follow

Quick search :
By ID By Location
By ID

DEFINE AOI
Draw Modify **Upload**

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Catalogue Search: e.g. AIRBUS DS (2)

Optical Results

Optical Results 1 -14

Sort by: Default (cloud cover and date)

SPOT 1.5-m - Jun 4, 2015 Res: 1.50m Inc Ang: 24.0° Cloud: 0.0%	<input checked="" type="checkbox"/>					
SPOT 1.5-m - Jul 6, 2014 Res: 1.50m Inc Ang: 11.8° Cloud: 0.2%	<input checked="" type="checkbox"/>					

Target Mode: ☐

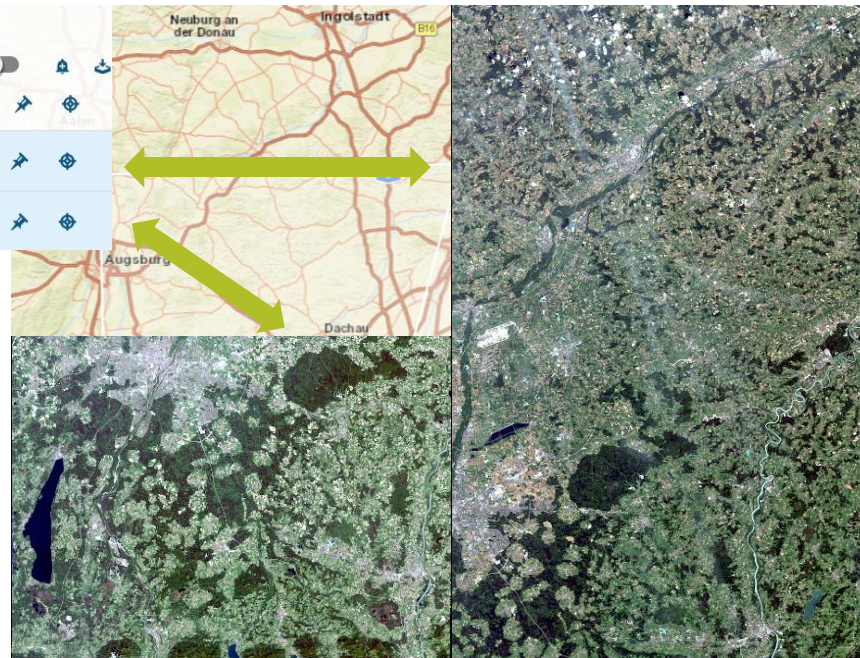
Image information

[View on map](#)

Date	2014, July 6th 09:47:39
Cloud Cover	0%
ID	DS_SPOT6_201407060947245_FR1_FR1_FR1_E012N48_03008
Incidence Angle	11.78562°
Resolution	1.5m
Satellite	SPOT 6
Sensor Family	Multispectral

[Detailed information](#)

[know more about SPOT 6 products](#)



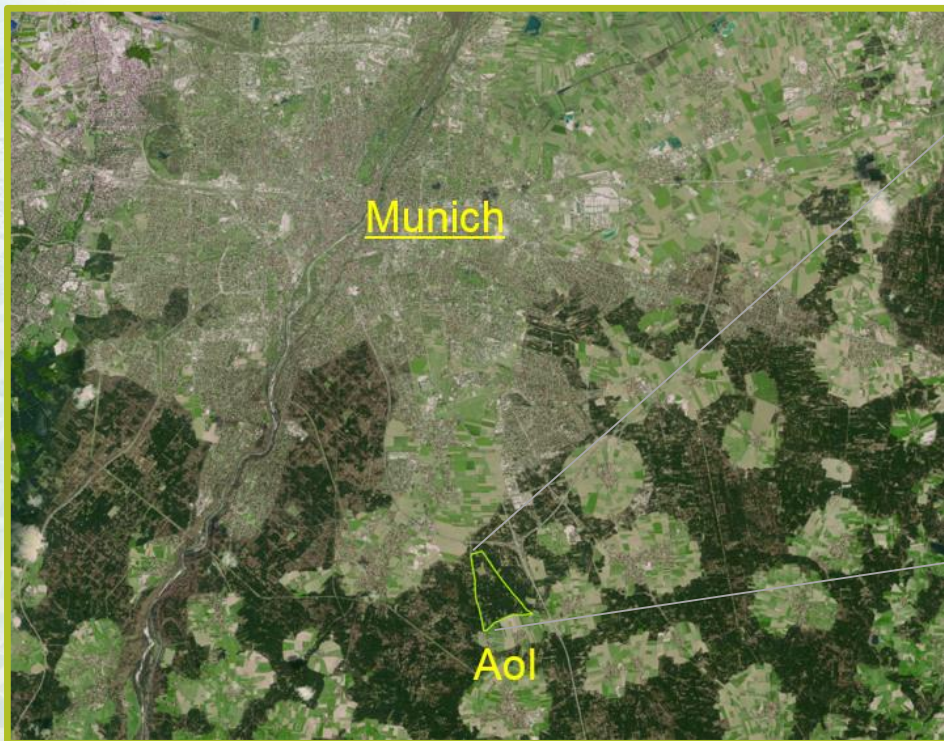
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Land
Monitoring

Storm Damage Investigation



True colour image 2012 (Core 3, VHR - 2.5m) WMS overlaid with Aol



Area: 280 ha



Familiarizing with the Area of Interest (Pre-event)

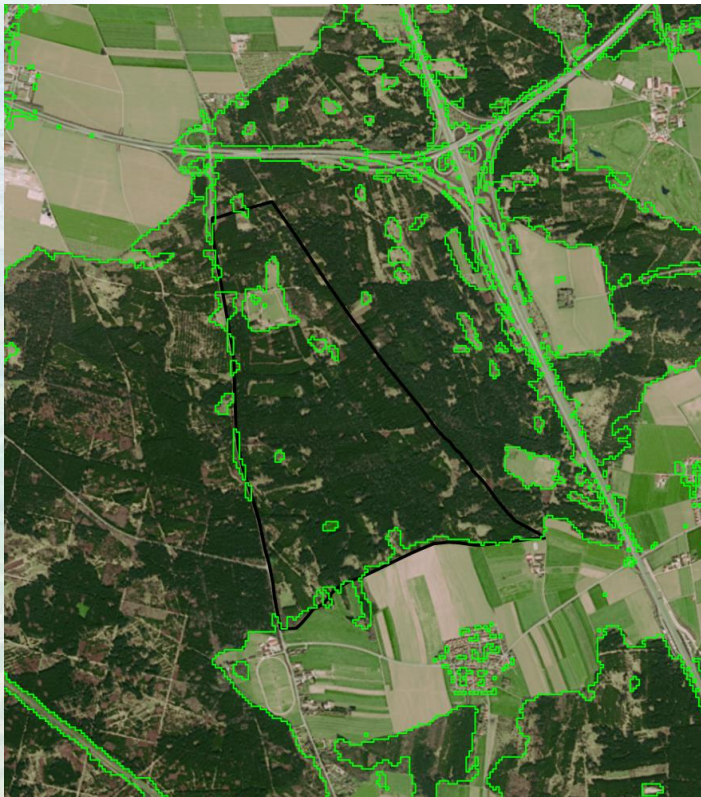


Tools and Layers:

- Geographic Information System (GIS)
- Aoi shapefile
- WMS: CORE_03 2.5m VHR mosaic (true colour)



Adding HRL Forest Information (1)



Tools and Layers:

- Adding 20m pixel-based tree cover mask derived from HRL Forest / Tree Cover Density product



Adding HRL Forest Information (2)



Tools and Layers:

- Adding 20m Forest Type information



SPOT-6 1.5m VHR Acquisitions



© Airbus Defence and Space 2016

Pre-event scene

- acquired on 2014-07-06
- 1.5m multispectral VHR image
- false colour infrared representation
- Alternative(s): VHR imagery (1-2.5m) from ESA Data Warehouse



SPOT-6 1.5m VHR Acquisitions



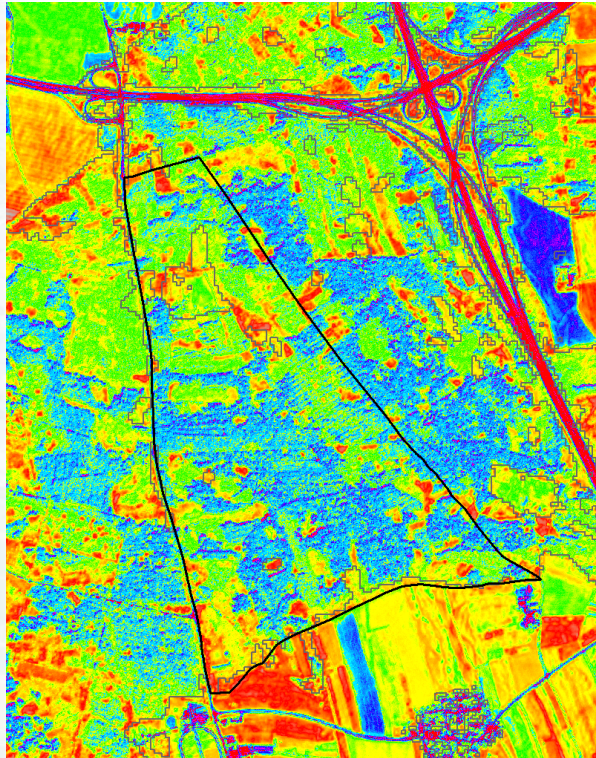
© Airbus Defence and Space 2016

Post-event scene

- acquired on 2015-06-04
- 1.5m multispectral VHR image
- false colour infrared representation
- forest damages clearly visible



NDVI Calculation – 2015-06-04



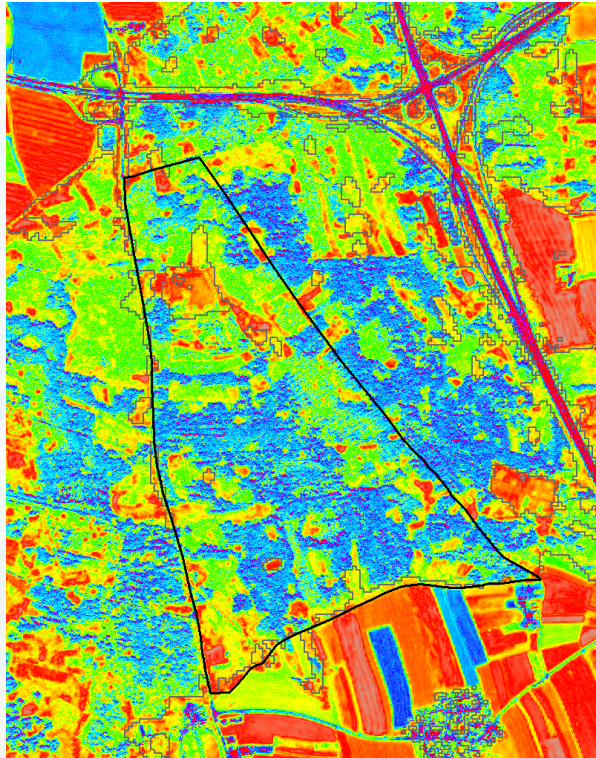
Normalized Difference Vegetation Index

- well-established vegetation indicator
- easy to implement and interpret
- provides information on the level of photosynthetic activity
- values range from -1.0 to +1.0

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$



NDVI Calculation – 2014-07-06



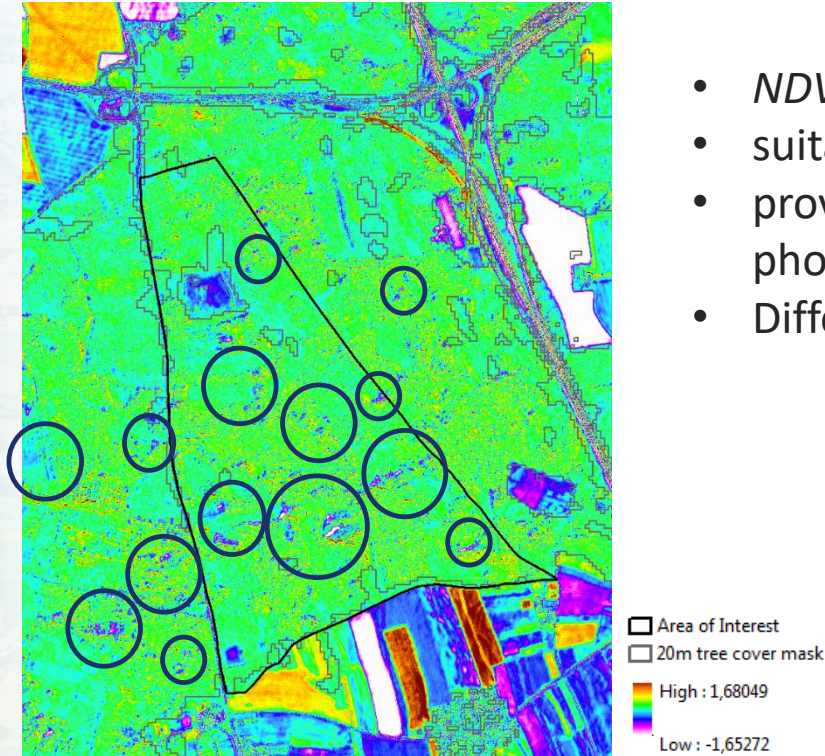
Normalized Difference Vegetation Index

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- values range from -1.0 to +1.0

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$



NDVI Difference as Damage Indicator



- $NDVI t_0 - NDVI t_1$
- suitable for rapid change assessment
- provides information on changes within photosynthetic activity
- Difference values range from -2.0 to +2.0

BUT, sensitive to:

- image co-registration
- sensor viewing angles
- vegetation phenology
(i.e. good forest mask needed)



Damage Detection Steps – Summary

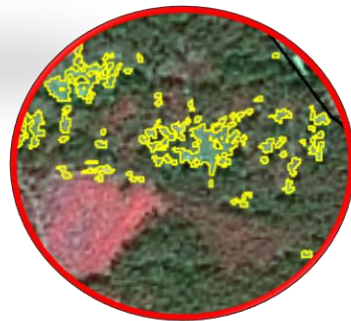
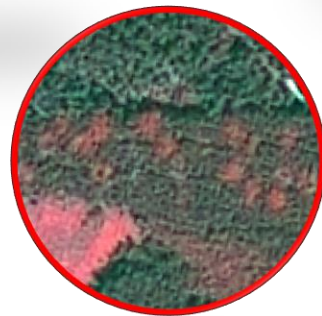
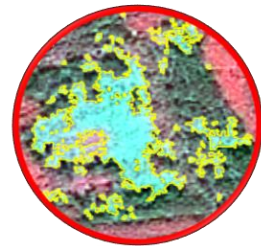
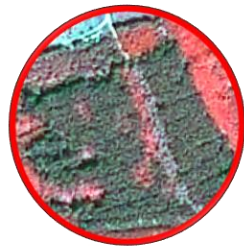
- Classify forest characteristics (e.g. NDVI, tree cover density) pre- and post-event at VHR resolution
- Difference calculation: forest characteristics $t_0 - t_1$
- Apply size and TCD difference threshold to identify damaged areas
- Intersect changes with tree type information
- Statistical evaluation



Land
Monitoring

CLMS SUBMODULE

Damage Detection Results



Pre-event

Post-event



Results

- High Resolution Layer Forest supports identification of forest damages (e.g. storm damages)

Tree Type	Damaged areas	Area [ha]	Area [%]
Broadleaved	138	0.14	2.5
Coniferous	558	5.62	97.5
	696	5.77	100
<i>Percentage of damaged forest: 2.07%</i>			