



Service for operational monitoring of coniferous forest insect infestation

Vassil Vassilev, Nadya Tsvetkova

GEO Polymorphic Cloud

Copernicus Relays, Bulgaria



GEO Polymorphic Cloud



GEO Polymorphic Cloud

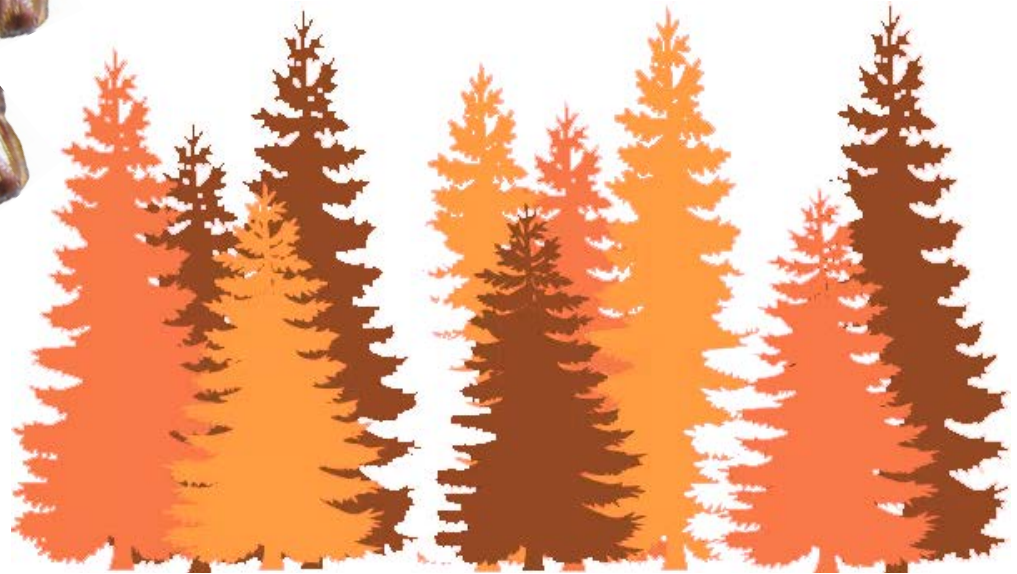


<http://geopolymorphic-cloud.org>

BARK BEETLES AND FORESTS



1-12 mm in length



Bark beetles are integral part in the ecosystem: influence biogeochemical cycle, forest productivity, provide habitats for other species, shape forest structure, but sometimes ...

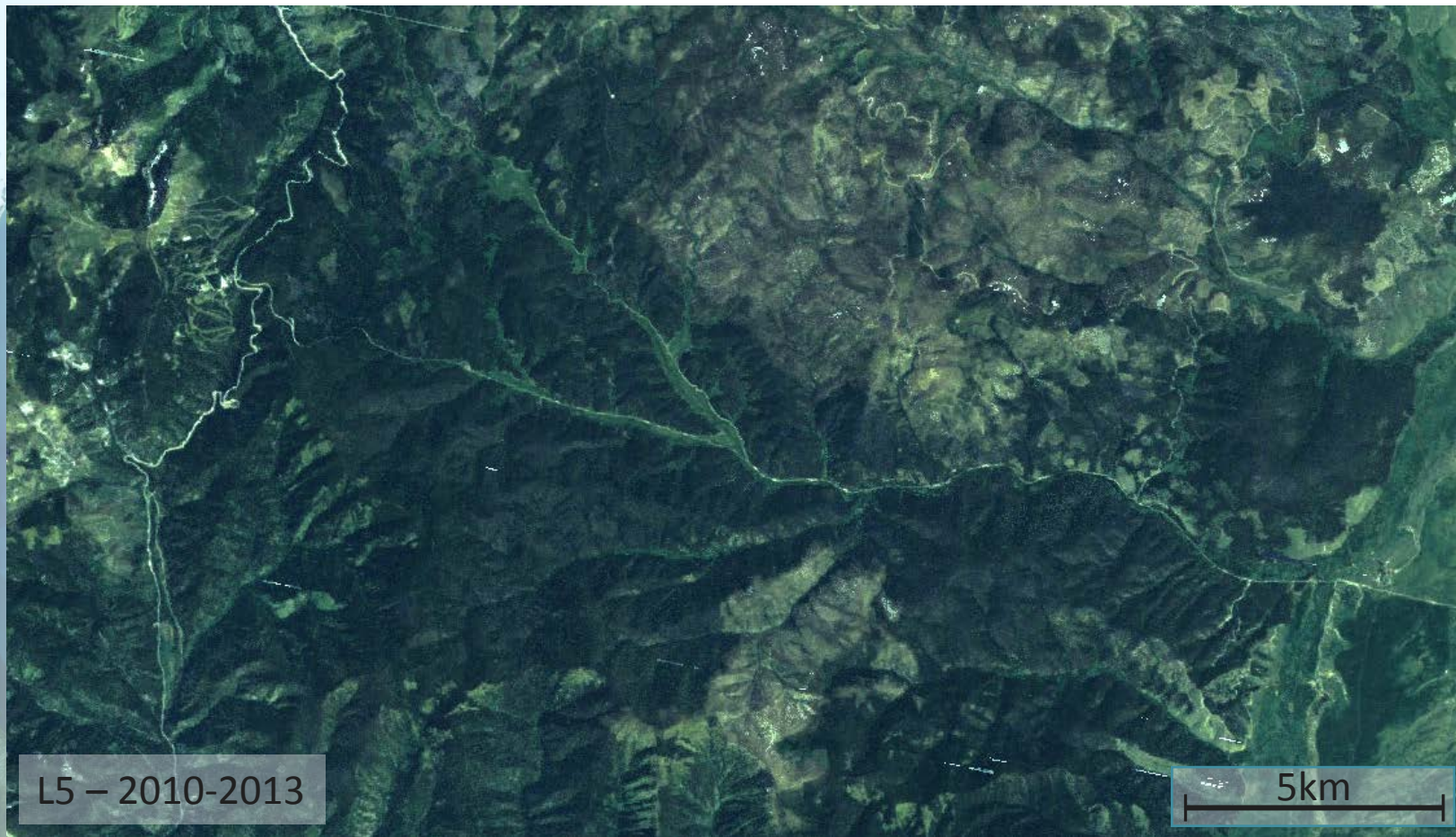
BARK BEETLES INFESTATION IN FORESTS

Plana Mountain, Bulgaria

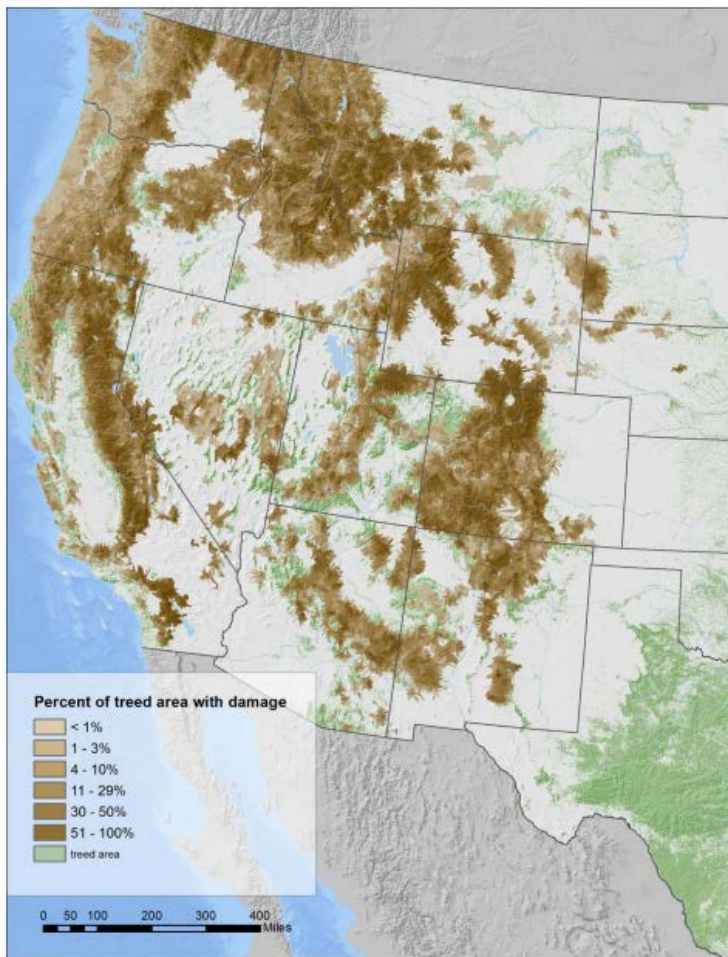


Oct 2017

DAMAGES IN NORTH AMERICA – SOUTH WEST MONTANA



MAP OF BARK BEETLE DAMAGES IN WESTERN US



AREAS WITH TREE MORTALITY FROM BARK BEETLES
SUMMARY FOR 2000 – 2016, WESTERN US

17 YEAR FOOTPRINT FOR ALL WESTERN BARK BEETLES
= 54.3 M ACRES

(approx. 220 000 km²)

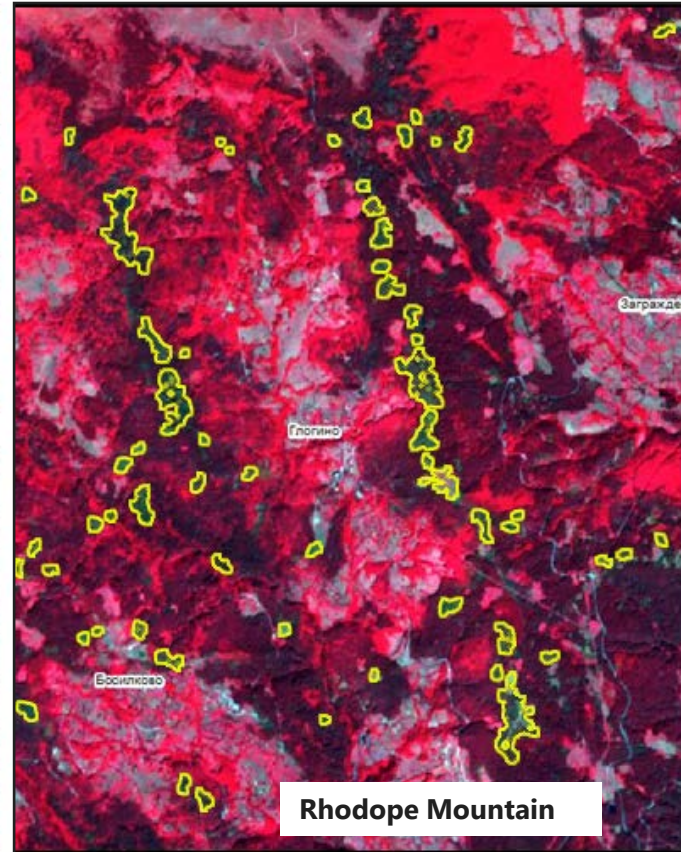
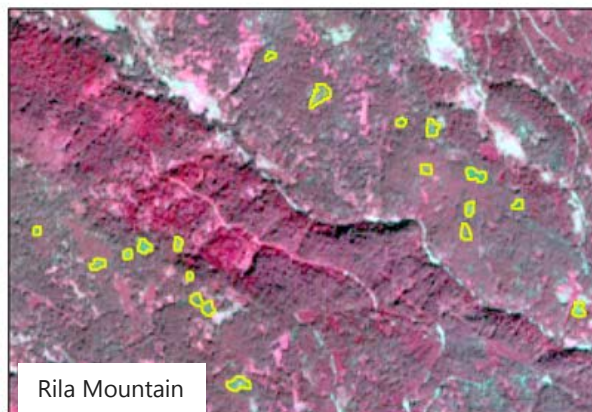
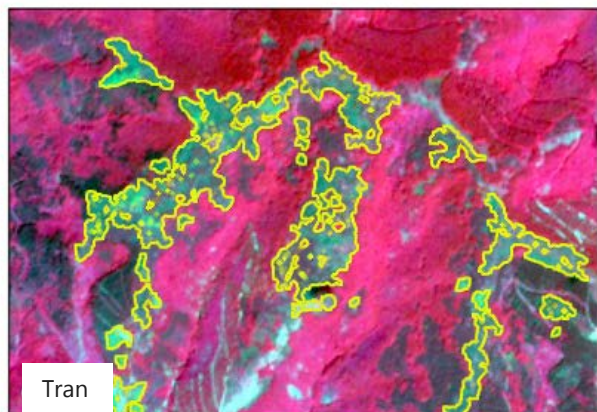
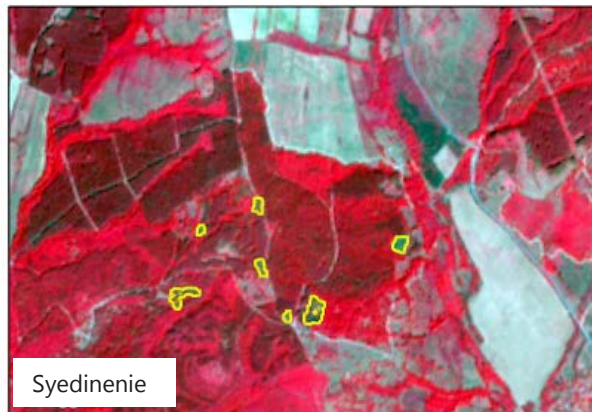
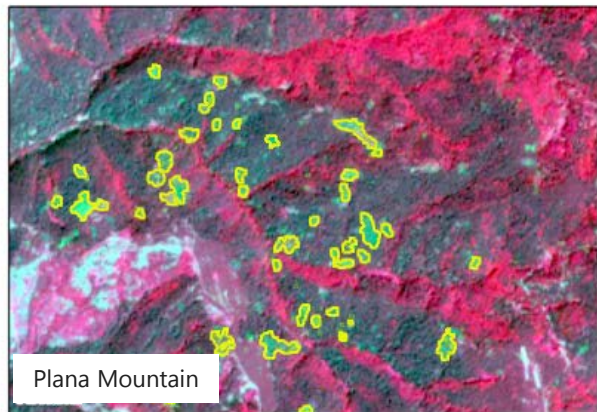
SOURCE:

https://www.fs.fed.us/foresthealth/technology/pdfs/MpbWestbb_Summary.pdf

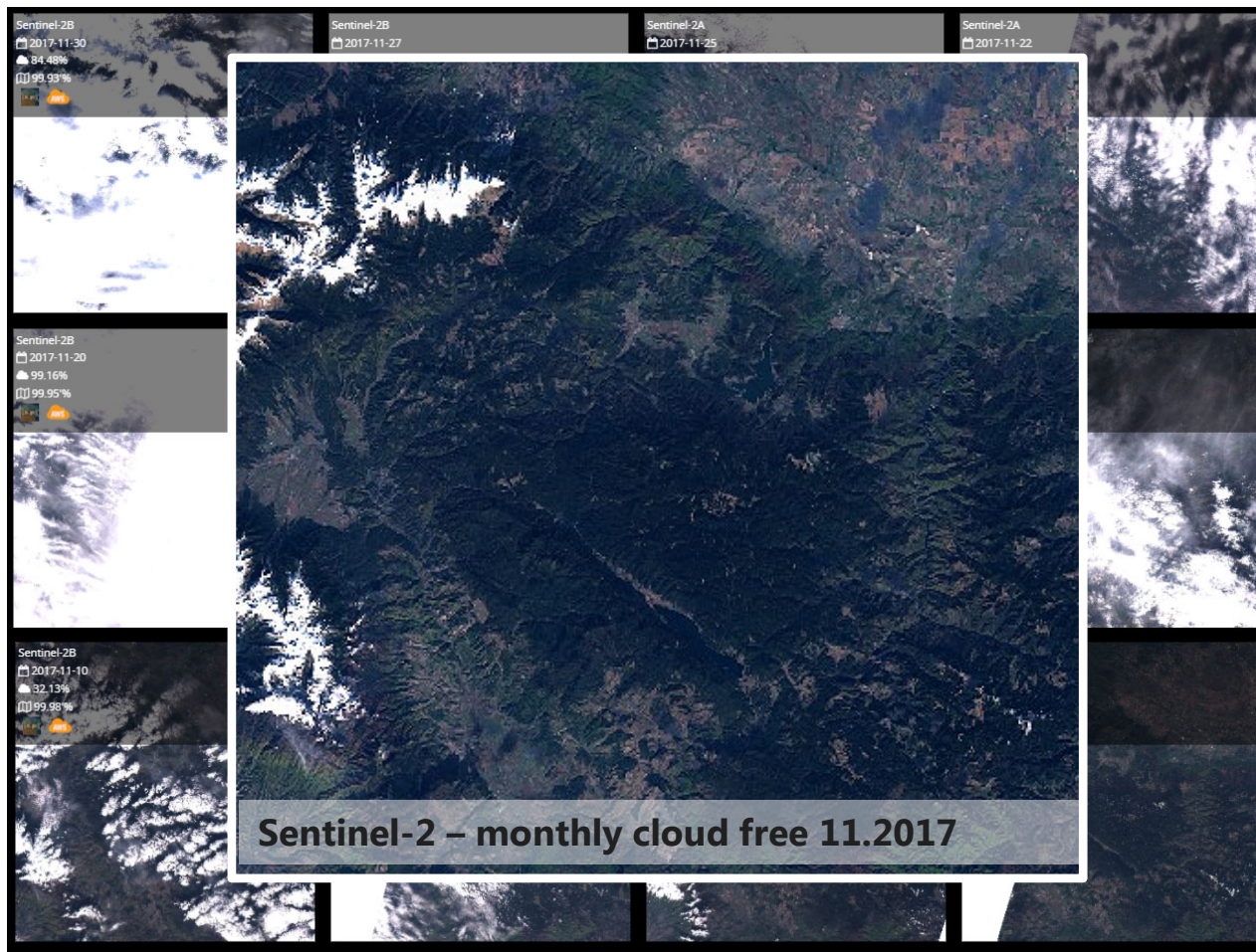


Photo: K. Buxton, BC Ministry of Forests, Lands and Natural Resource Operations.

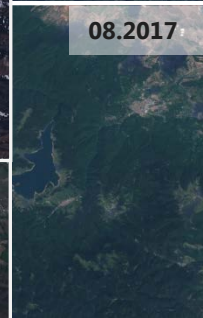
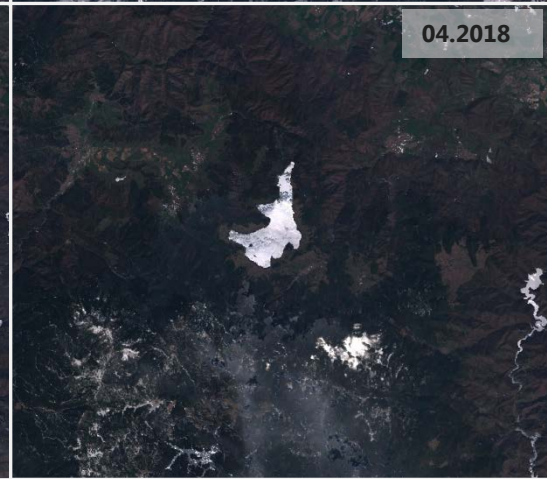
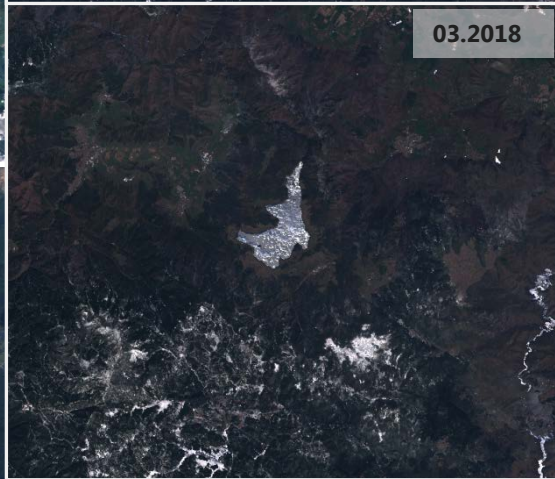
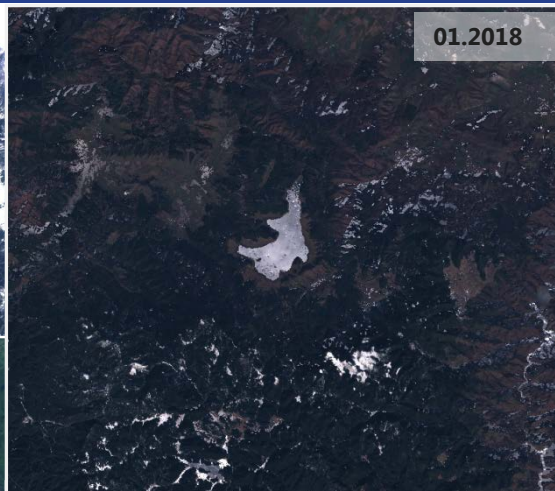
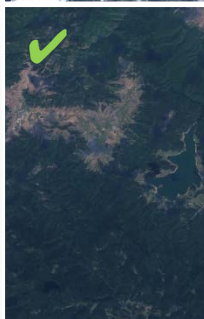
BARK BEETLE INFESTATION - BULGARIA



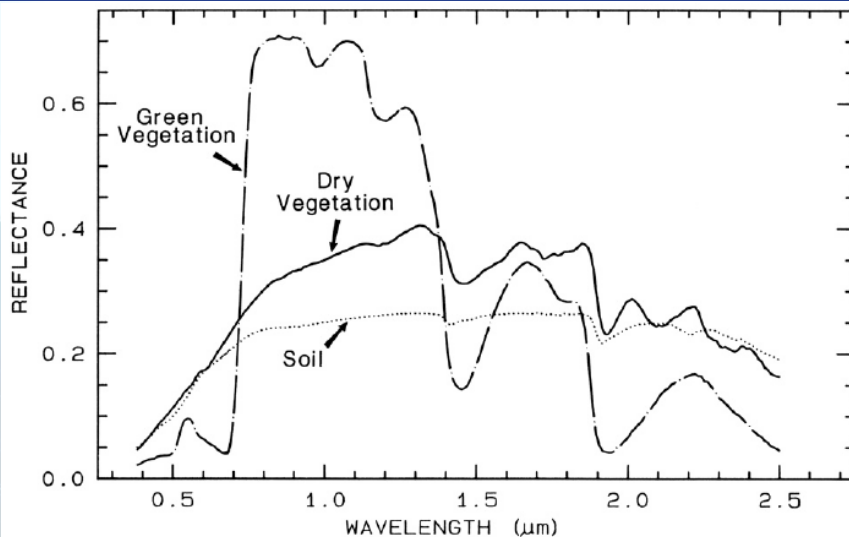
THE OBLIGATORY DATA SOURCE – EO DATA



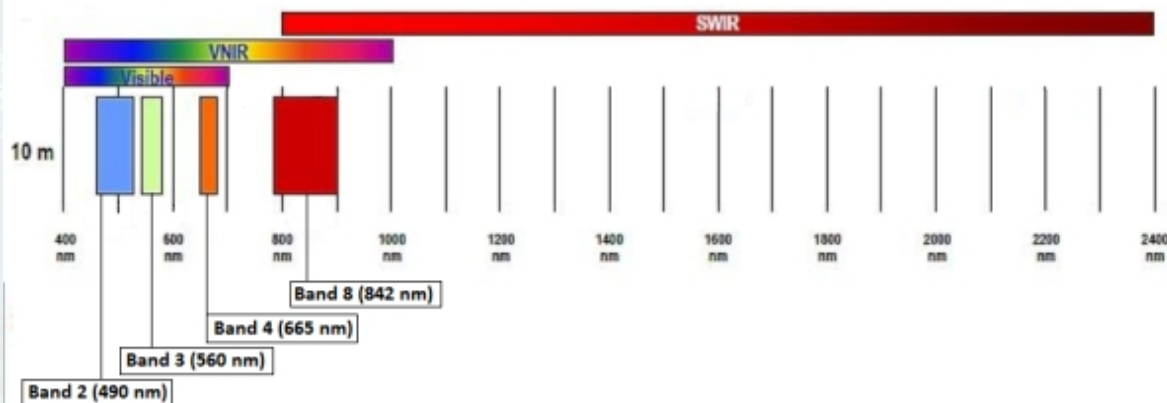
THE OBLIGATORY DATA SOURCE – EO DATA



HOW TO SEPARATE DRIED VEGETATION?

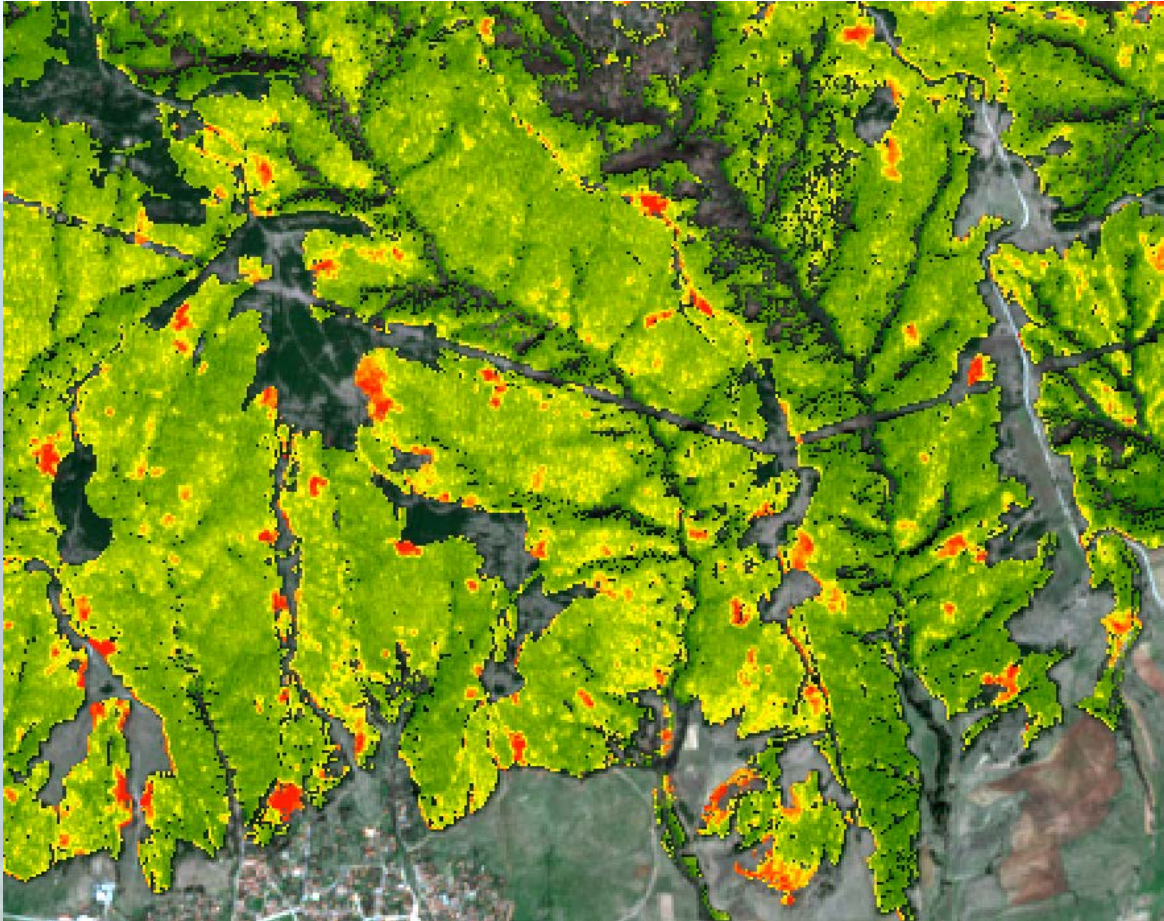


Reflectance spectra of photosynthetic (green) vegetation, non-photosynthetic (dry) vegetation and a soil (after Clark 1999, fig. 1.18)



Sentinel-2 10 m spatial resolution bands: B2 (490 nm), B3 (560 nm), B4 (665 nm) and B8 (842 nm)
Source: ESA

VEGETATION INDICES



Normalised Difference Vegetation Index

NDVI – index of
plant "greenness"
or photosynthetic
activity

Ratio of red and
near infrared bands

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

Index DataBase

A database for remote sensing indices

 [Start](#) | [What is IDB?](#) | [How to use?](#) | [Credits](#) | [Contact](#) | [Feedback](#) | [»](#)

IDB



Sensor: Sentinel-2A

Sentinel-2A

Select other Sensor.

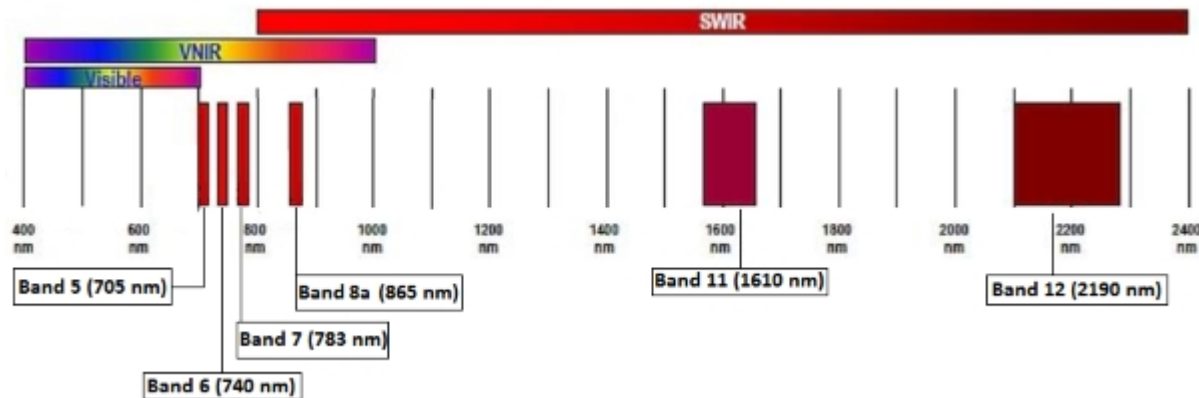
Basic information

Name	Sentinel-2A
Full Name	
Bands	13
Spectrum [nm]	433-2280
Spat.Res. [m]	10-60
Inclination	98.6
Orbit Height	797
Orbit Type	
Platform	
Operator	ESA
Date of Launch	2015-06-23
status	
Comment	
Usable for Indices	yes
Description	

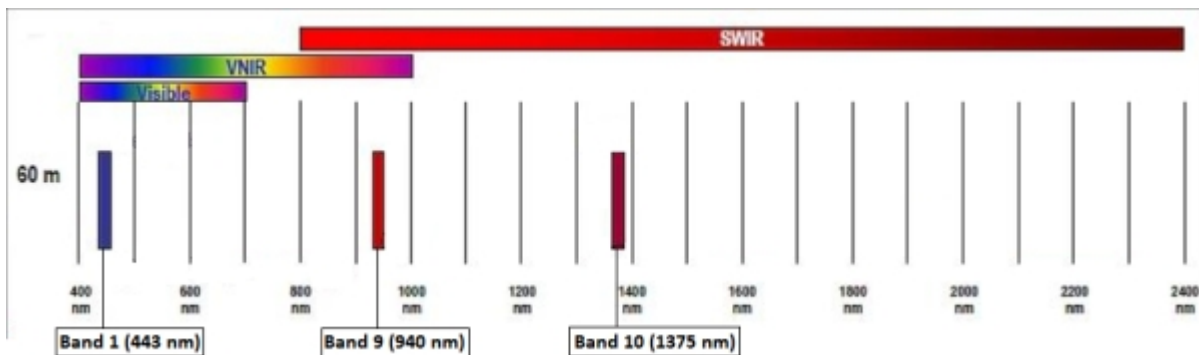
Close to 250 remote sensing indices

<https://www.indexdatabase.de/db/s-single.php?id=96>

VEGETATION INDICES

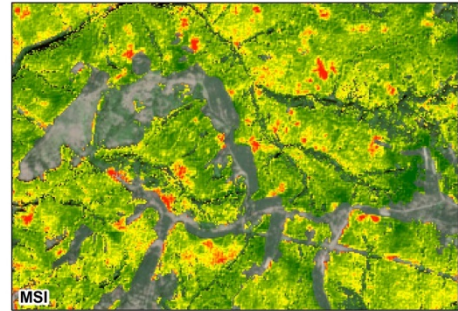
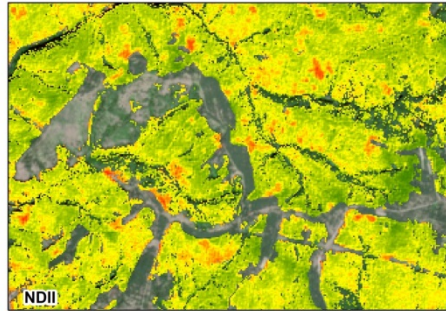
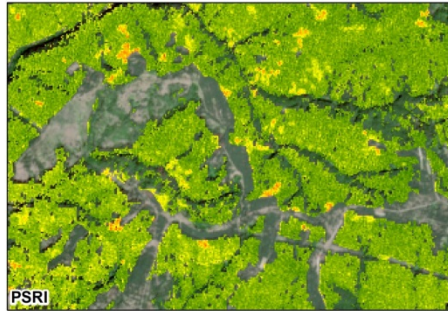
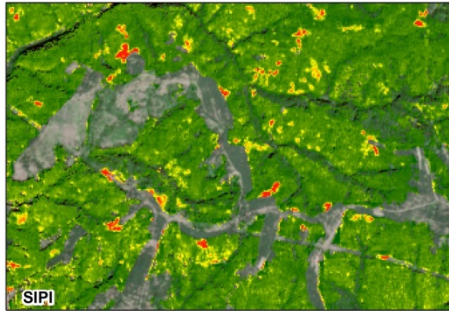
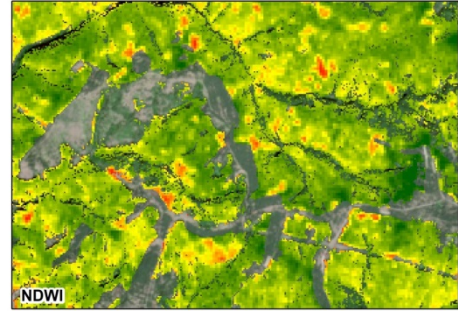
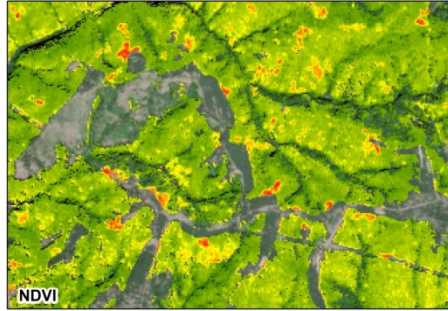


S-2 20 m spatial resolution bands. Source:ESA



S-2 60 m spatial resolution bands. Source:ESA

VEGETATION INDICES – JUST FEW EXAMPLES

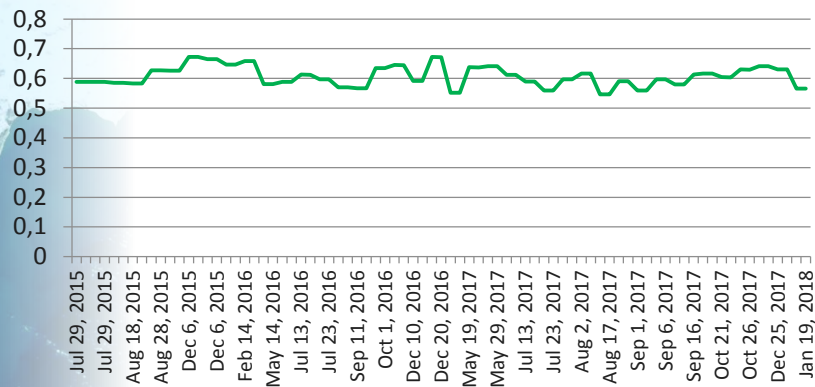


Sensitive to Chl.A content

Sensitive to water content

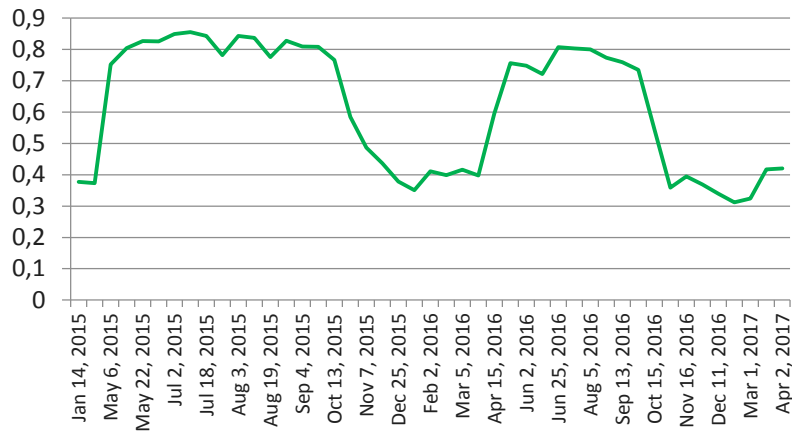
NDVI OVER THE YEAR – HEALTHY VEGETATION

NDVI coniferous forest



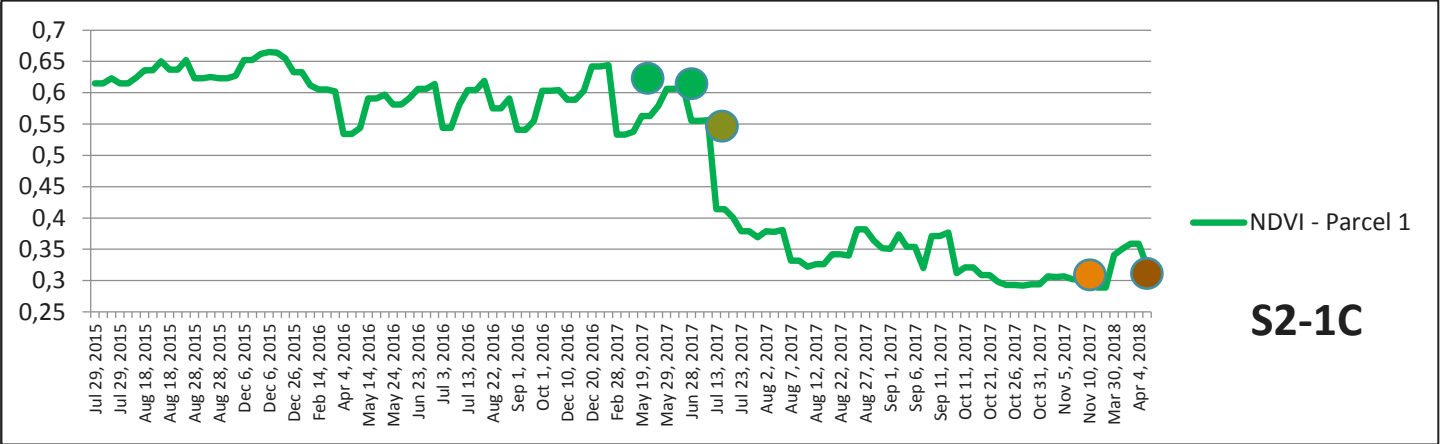
S2-1C

NDVI deciduous forest



S2-1C

NDVI CHANGE OVER TIME – INFESTED TREES



REFERENCE DATA – FOREST MAP

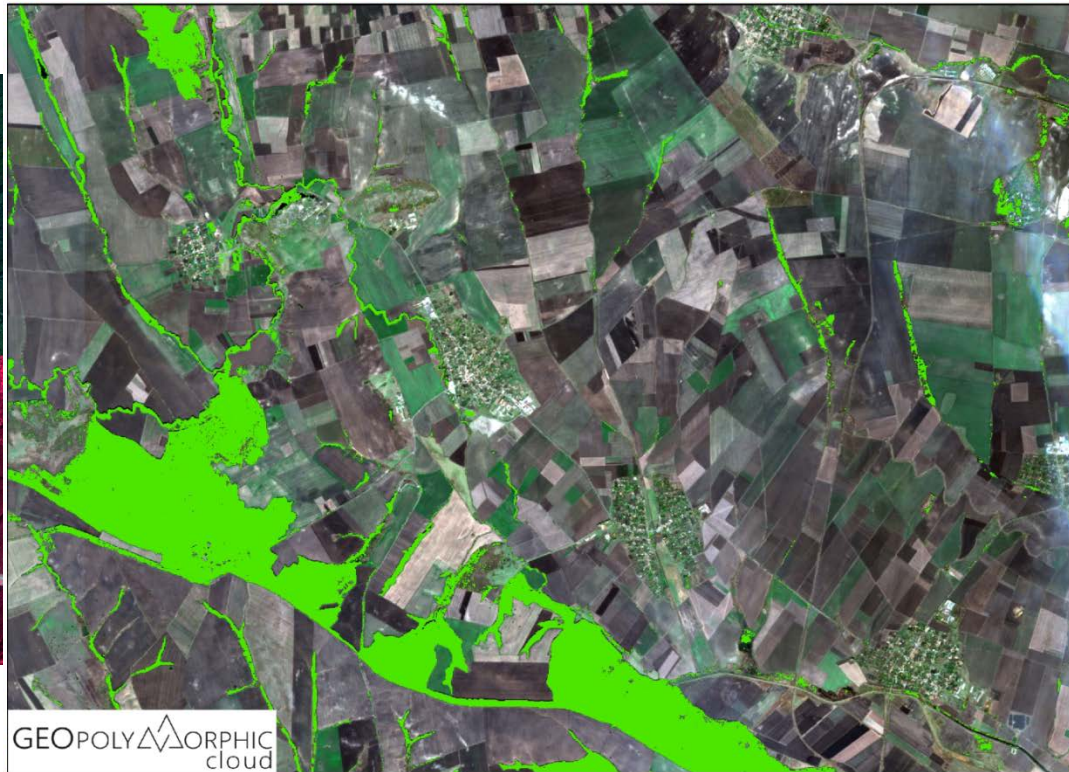
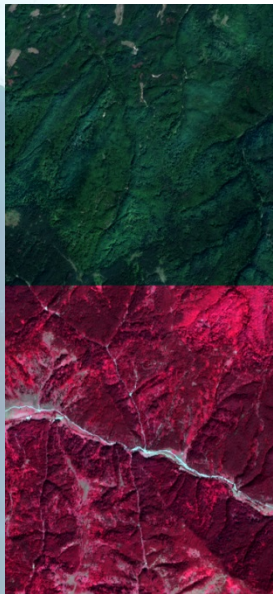
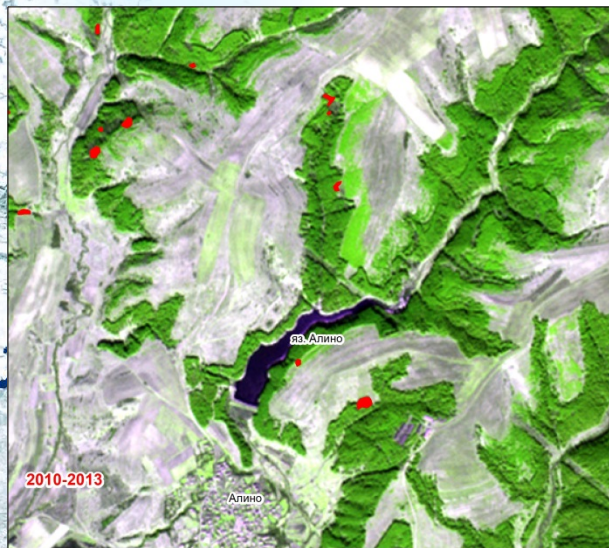


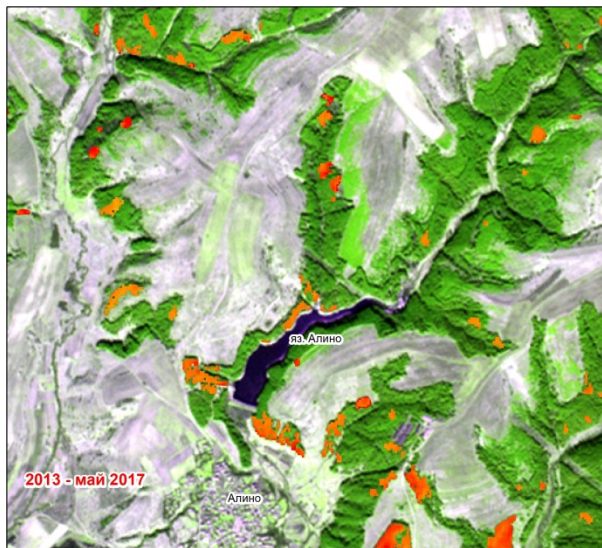
Image Fusion

SAR & Optical

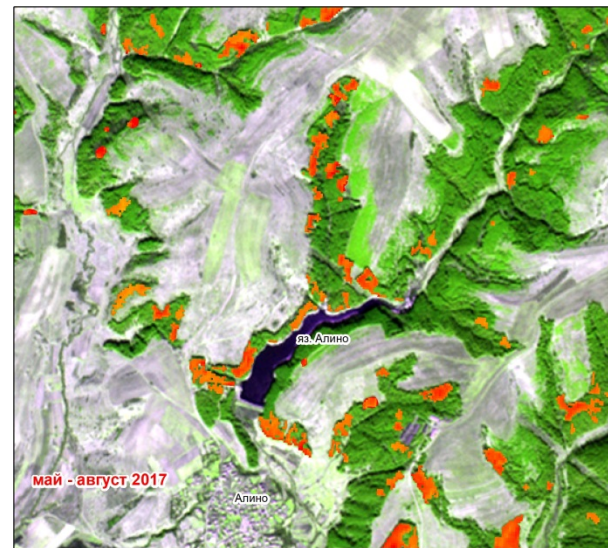
MONITOR SEASON DAMAGES



2010 - 2013

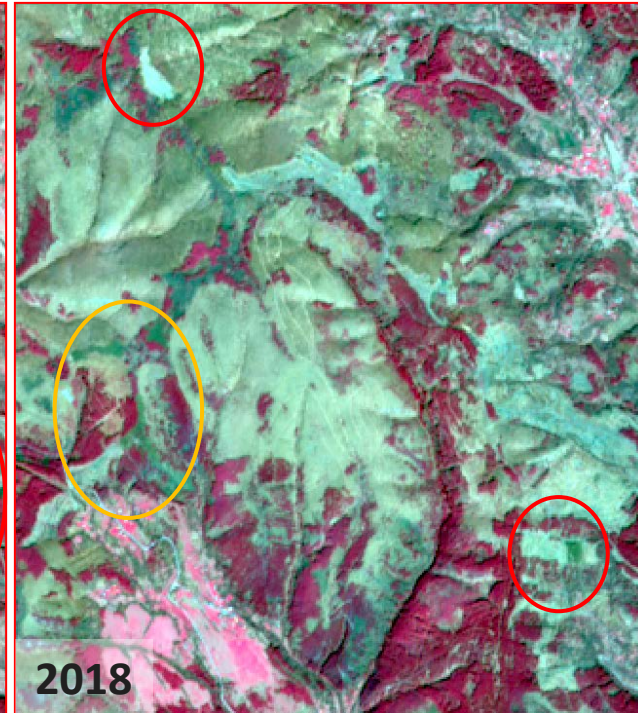


2013 – May 2017



May – August 2017

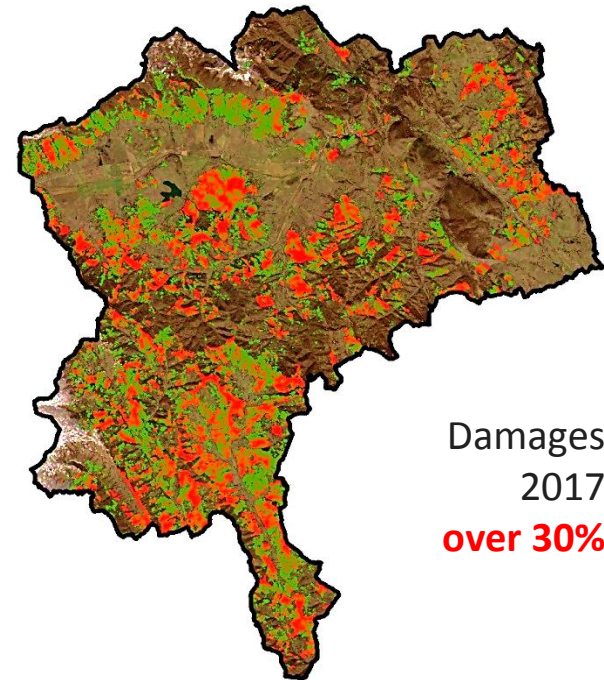
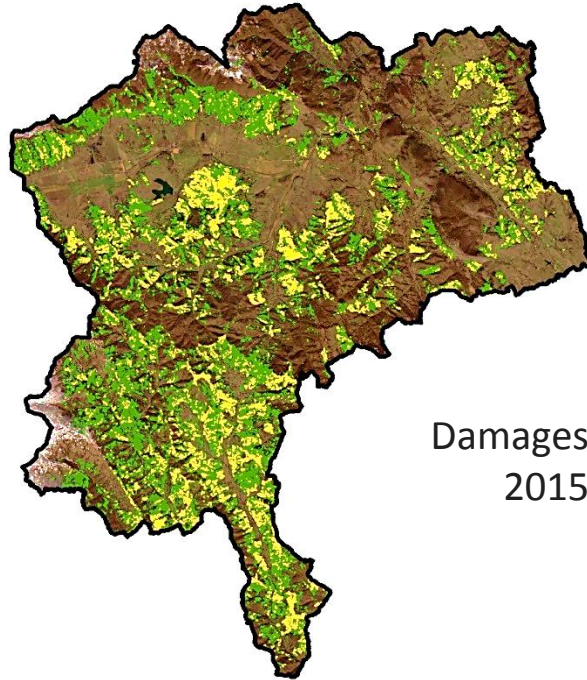
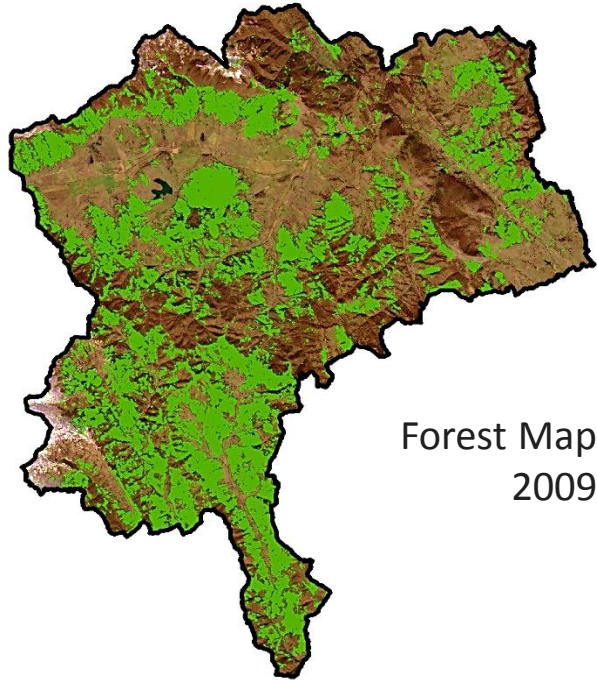
PHENOLOGICAL STAGES COMPARISON



The temporal resolution of Sentinels allows monitoring of changes in different stages of the vegetation phenology.

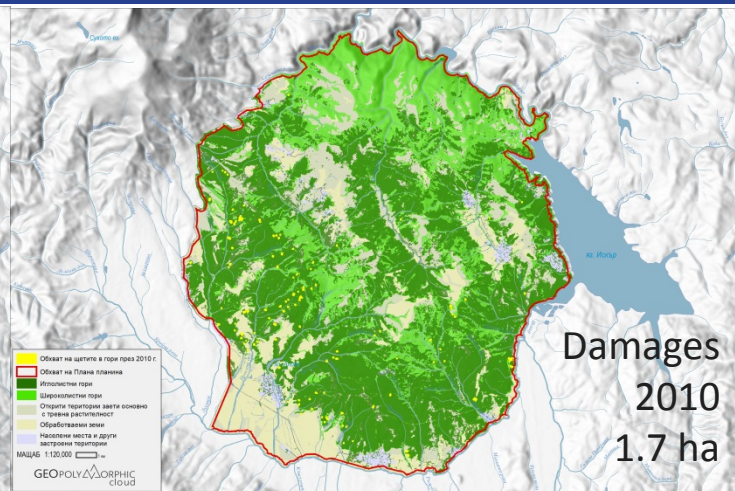
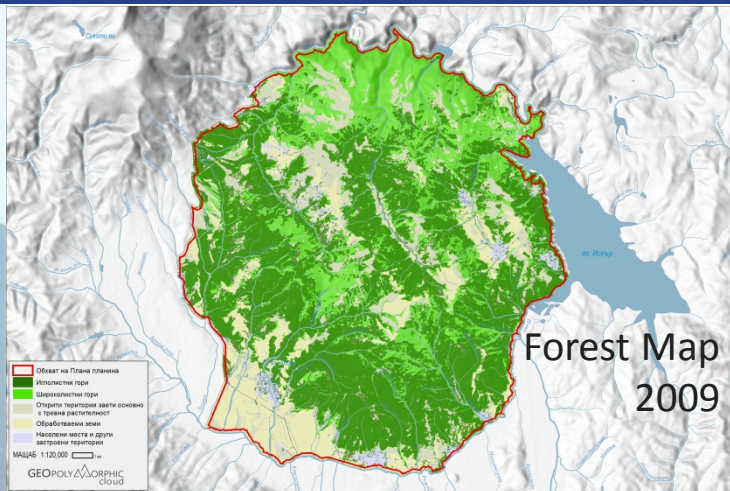
Example: vegetation status in April – 2009, 2017, 2018. *2009 from RapidEye

DAMAGE CALCULATIONS – TRAN FORESTRY

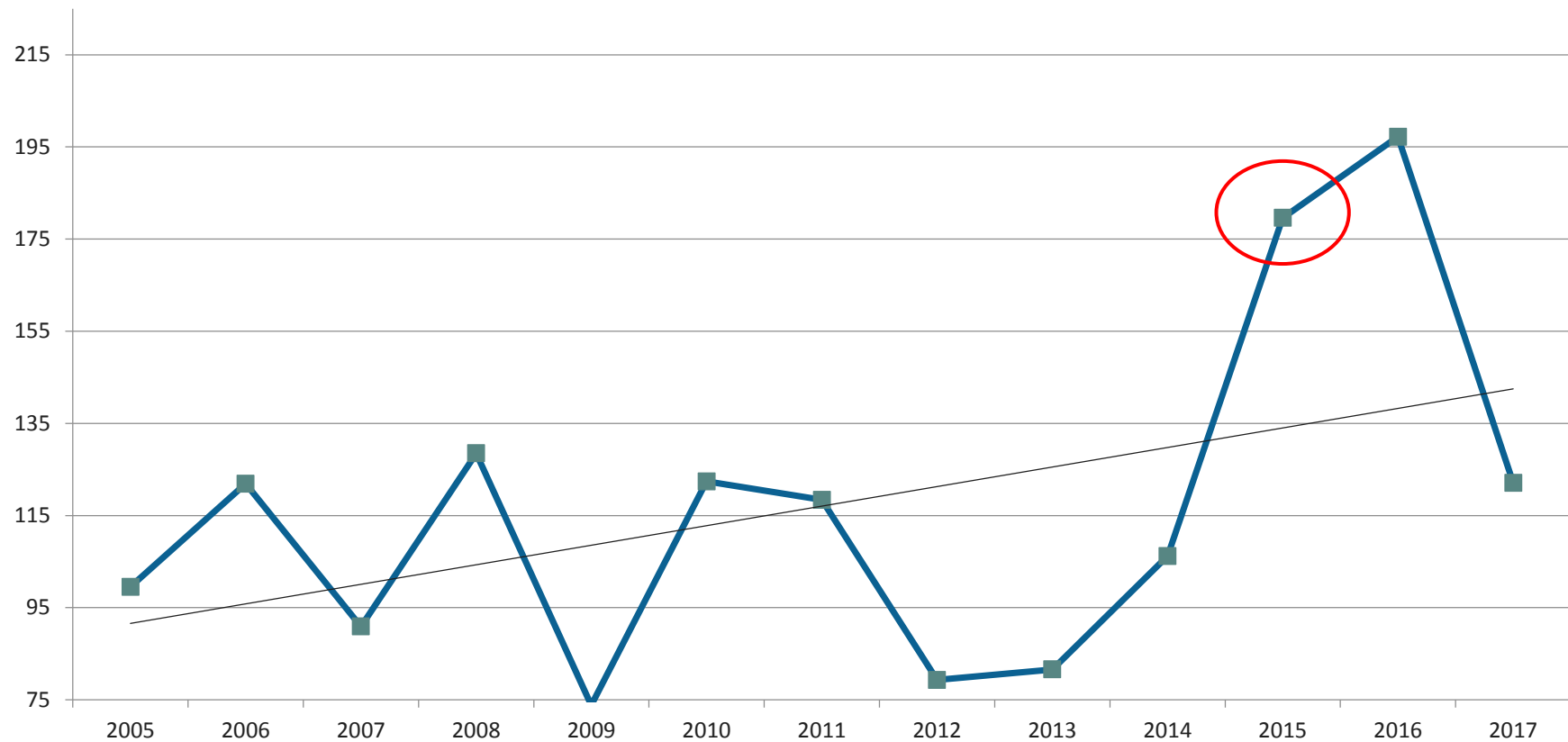


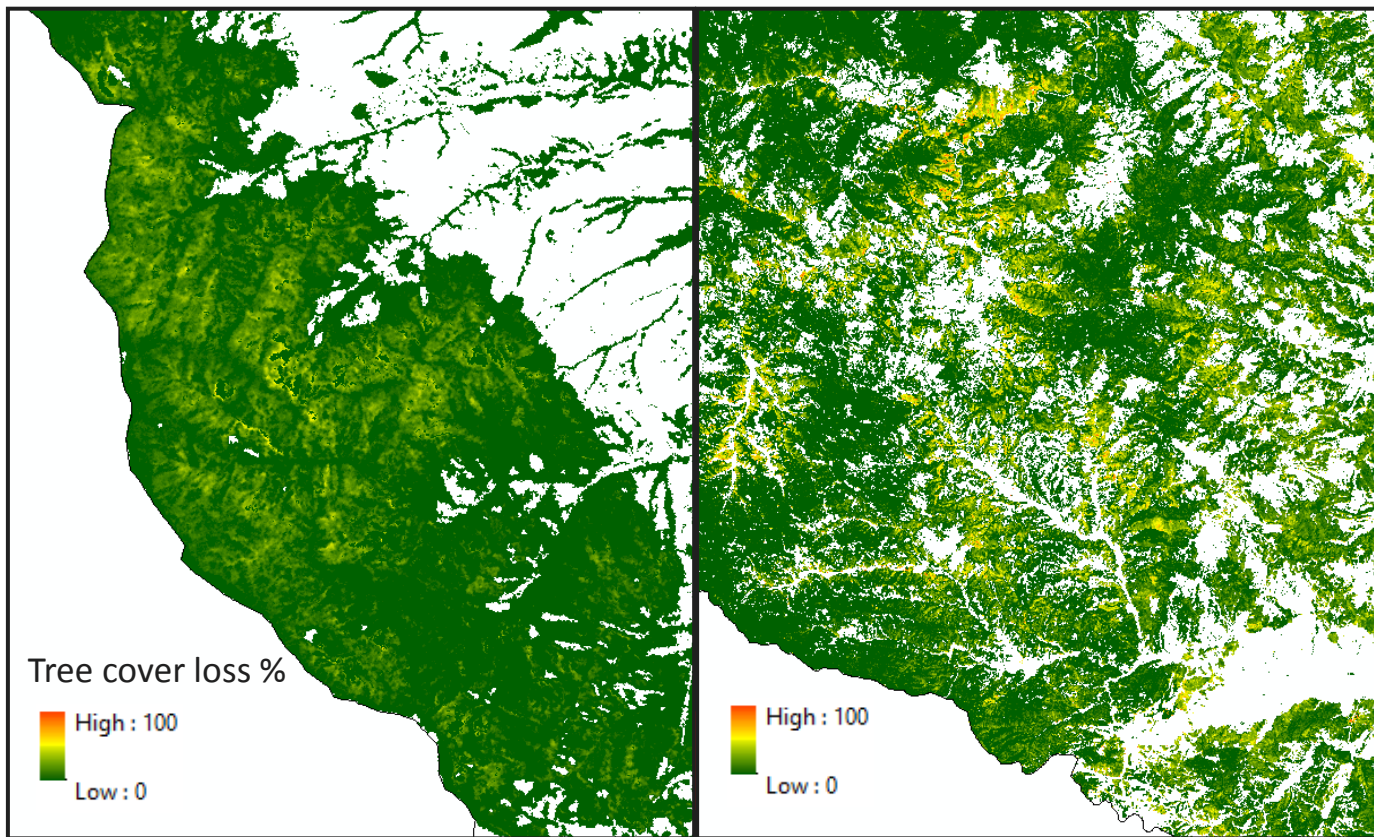
Calculations of damaged areas due to insect infestation in Tran Forestry

DAMAGE CALCULATIONS – PLANA MOUNTAIN



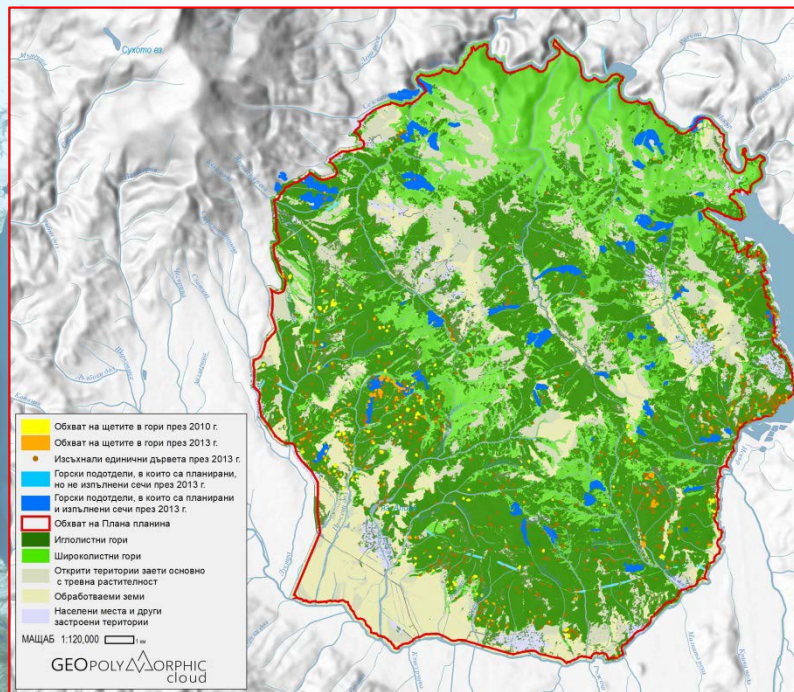
Winter Rainfall mm (sum: Oct, Mar)



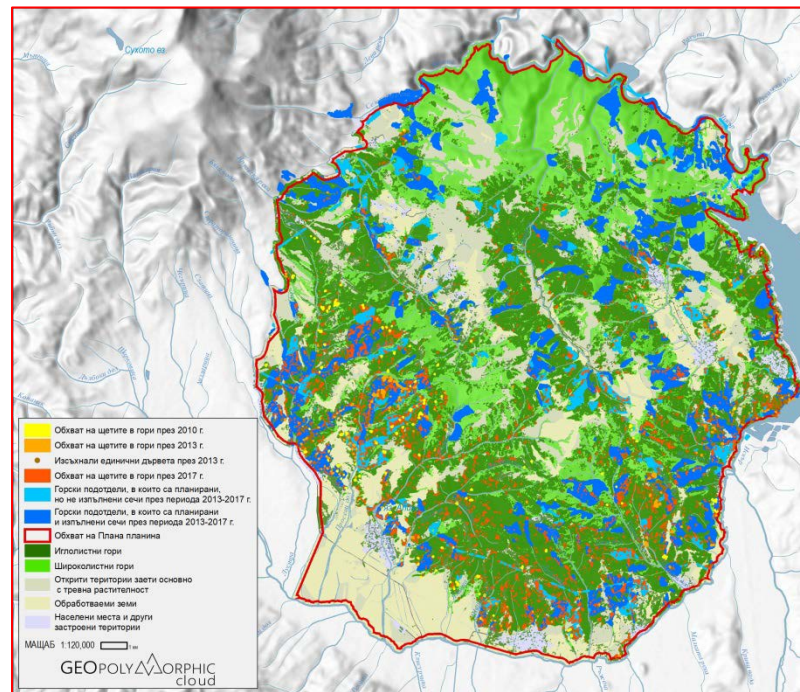


Tree Cover Density 2012/2015 – Copernicus Land Monitoring Service

<https://land.copernicus.eu/pan-european/high-resolution-layers/forests/tree-cover-density>



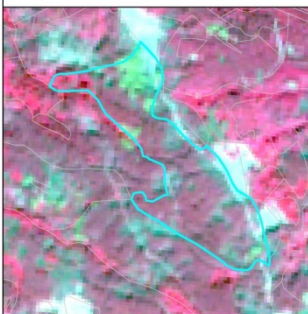
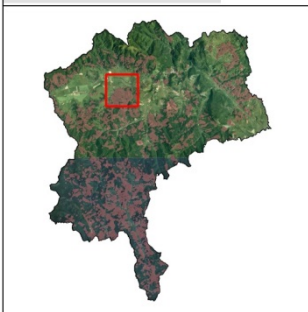
Sanitation Cutting 2013



Sanitation Cutting 2017

INTEGRATE THE RESULTS

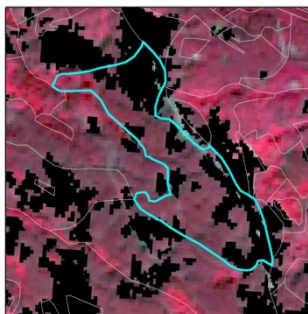
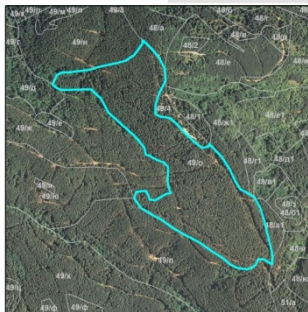
СИГНАЛЕН ЛИСТ



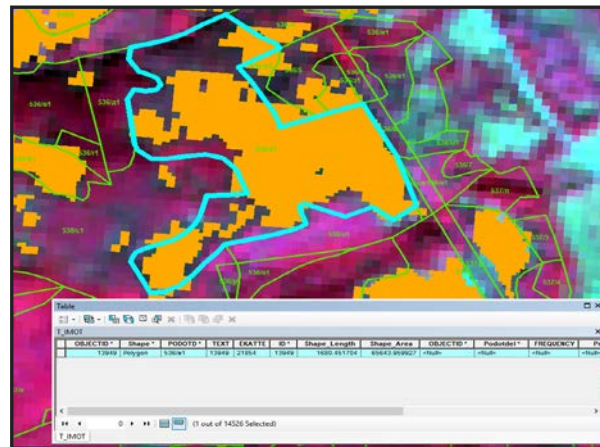
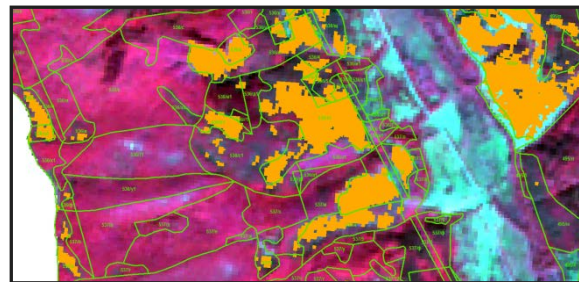
РДГ: Кюстендил
ДГС: Трън
Землище: с. Ярповци (ЕКАТТЕ 87566)
Горски отдел и подотдел: 49-о
Вид подотдел: семенно насаждение
Дървесен вид: бял бор
Участие: 10
Възраст: 25
Плънота: 0.9
Бонитет: 4
Кадастрален имот: 201.11
Собственост: Държавна частна

ДГС ТРЪН

Горски подотдел: 49-о

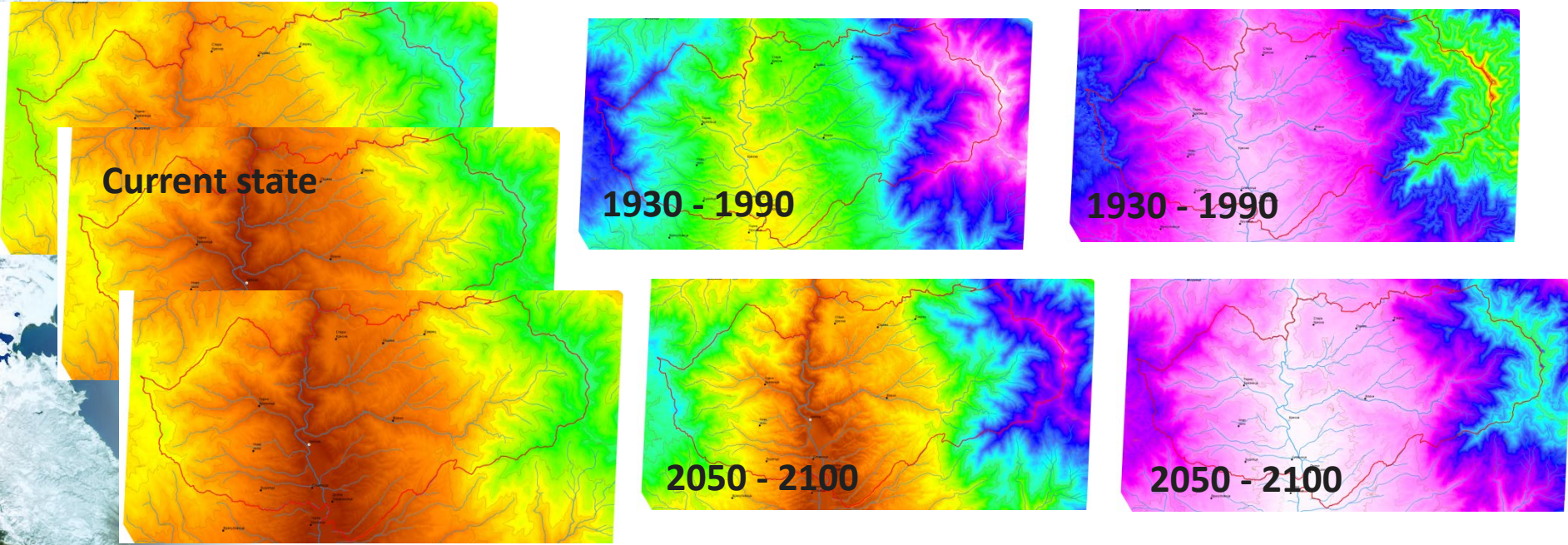


Повреди, установени по спателитно изображение:
Класификация: Сухене
Площ на повредата (дка): 151.25
Процент на повреда: 60
Установяване на повредата: август 2017
Източник на информация: Sentinel 2A, 17.08.2017 г.
Промяна в обхвата на повредата: новооткрита
Предприети мерки: -
Повреди, установени на място:
Класификация: Сухене
Площ на повредата (дка): 151.25
Процент на повреда: 60
Дата на посещение: 15.09.2017
Предписание: -



Integration of results in the information systems and documentation of the users

Microclimatic modelling – needed for better reforestation planning



The figure consists of six maps of a mountainous region, arranged in a 2x3 grid. The maps use a color scale from blue (cold) to red (hot) to represent microclimatic conditions. The top row shows the 'Current state' and two historical periods (1930-1990). The bottom row shows two future projections (2050-2100) and another historical period (1930-1990). The maps illustrate how microclimatic conditions have changed and are projected to change over time, which is crucial for reforestation planning.

Current state

1930 - 1990

1930 - 1990

2050 - 2100

2050 - 2100

Parameters: Monthly $t_{\min}$, $t_{\max}$, t_{avg} ,
 $P_{\min}$, $P_{\max}$, P_{avg} , Hardiness zones

Parameters: climate
changes scenarios

Parameters: bioclimatic
indices

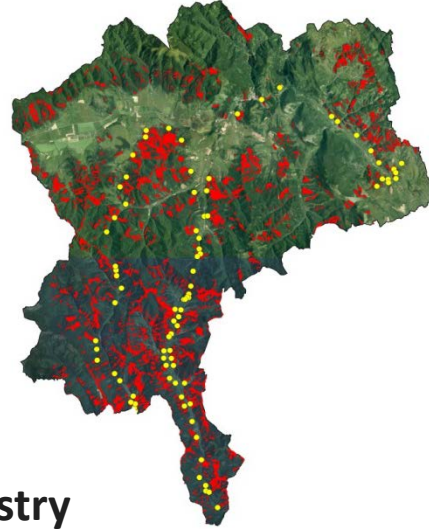


Sanitation cuts

Tran Forestry



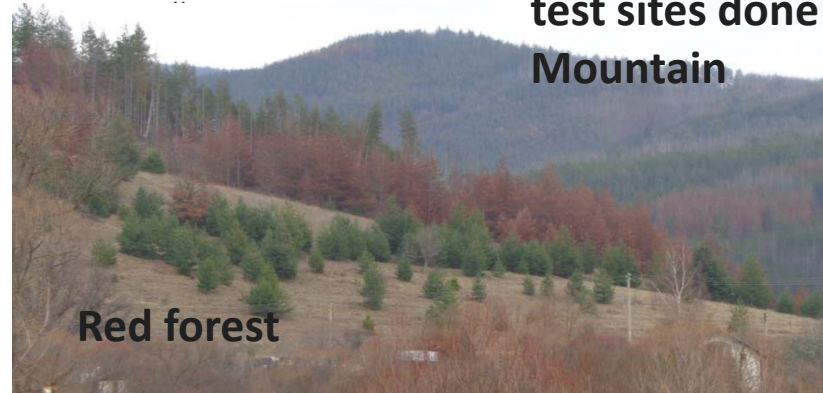
Dead forest > 1year



**More than 80 forest
stands checked**

**1 polygon wrongly
classified – rare
plantation**

**The same number of
test sites done in Plana
Mountain**



Red forest



Thank you for your
attention!

office@geopolymorphic-cloud.org

<http://geopolymorphic-cloud.org>



GEO Polymorphic Cloud



GEO Polymorphic Cloud



<http://geopolymorphic-cloud.org>

Full report on:

http://geopolymorphic-cloud.org/publications/2018_01_Forest_Damage.pdf

