



# SCERIN-10 Workshop on Earth System Observations and 10<sup>th</sup> Anniversary



## National Forest Disturbance Type and Severity Monitoring in Bulgaria

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Forest Disturbance Inventory using Remote Sensing (FoReS) project - ESA PECS

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→ THE EUROPEAN SPACE AGENCY



**Background and justification:** A wide range of natural disturbance agents are affecting forest health in many regions, including Bulgaria, where forest fires, ice and snow break, and insects outbreaks are serious problems for forest managers. The FoReS project is a step towards establishing a remote sensing-based service that would provide standardized and verified map products to better quantify and assess forest disturbance extent and effects.

**Objective(s):** The main objective of the activity is to develop and validate a set of remote sensing-based forest disturbance products, i.e. Forest disturbance type (FDIT) map, Forest disturbance severity (FDIS) map, and Post-fire regrowth (PFIR) map. In particular, the methodology behind each product will be presented and tested. In addition, user requirements will be collected and preliminary design of an operational service providing those products (the FoReS platform) will be developed.

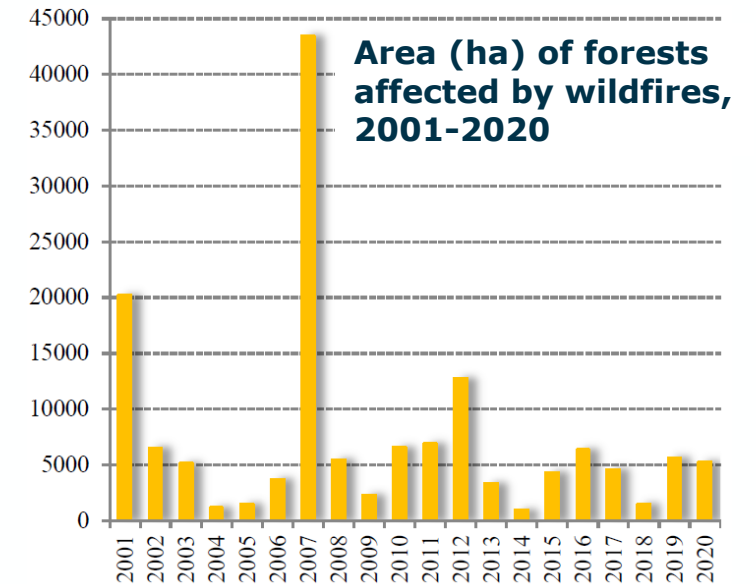
# Natural Disturbances in Bulgarian Forests

## The scale of the problem

- In 2021 **disturbances** caused by different natural factors were observed in forests with area of **52 000 ha**
- Over **41 000 ha** pine plantations were affected by **bark beetle** between 2013 and 2019, with extremely large damages in 2017
- Over **51 000 ha** forest areas were affected by 4984 **wildfires** between 2011 и 2020

## Information needs

- For planning (short-term) forestry operations (e.g. mitigation)
- For long-term monitoring, analysis, modelling, etc.



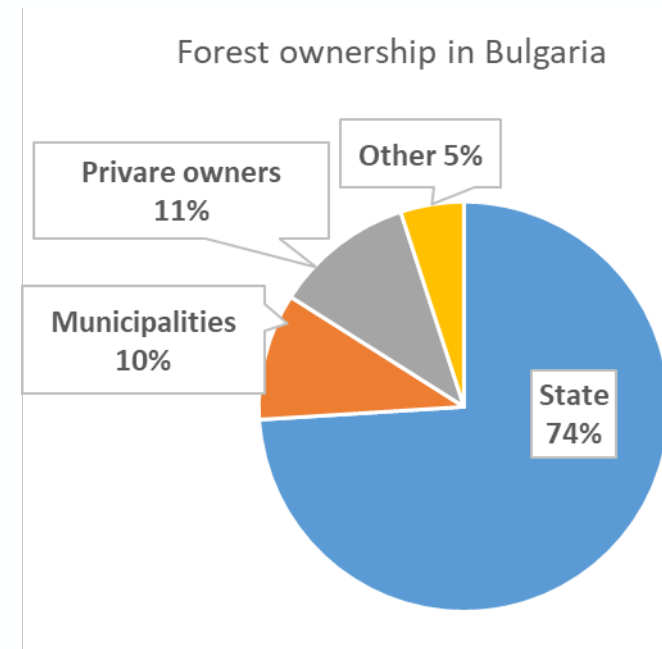
\* Sources: <http://www.iag.bg/data/docs/Prognoza2022.pdf> , [http://www.iag.bg/data/docs/Analiz\\_pogari\\_2021.pdf](http://www.iag.bg/data/docs/Analiz_pogari_2021.pdf) , Executive Forest Agency, Белилов и Георгиев. Наука за гората, 2020, 91-98

- Defining User and System Requirements for a service which will provide EO-derived geo-information products for forest disturbance monitoring;
- Proposing a preliminary architecture design of the service;
- Proposing and testing methodologies, workflows and algorithms for generating three dedicated forest disturbance geo-information products:
  1. Forest disturbance type (FDIT)
  2. Forest disturbance severity (FDIS)
  3. Post-fire regrowth (PFIR)



## Identifying potential users

- National and regional authorities responsible for forest management, exploitation and preservation (Ministries, Agencies, National/Nature Park Directorates, State Enterprises);
- Scientific organizations (Universities and Research Institutes);
- NGOs.





## Consultations with potential user

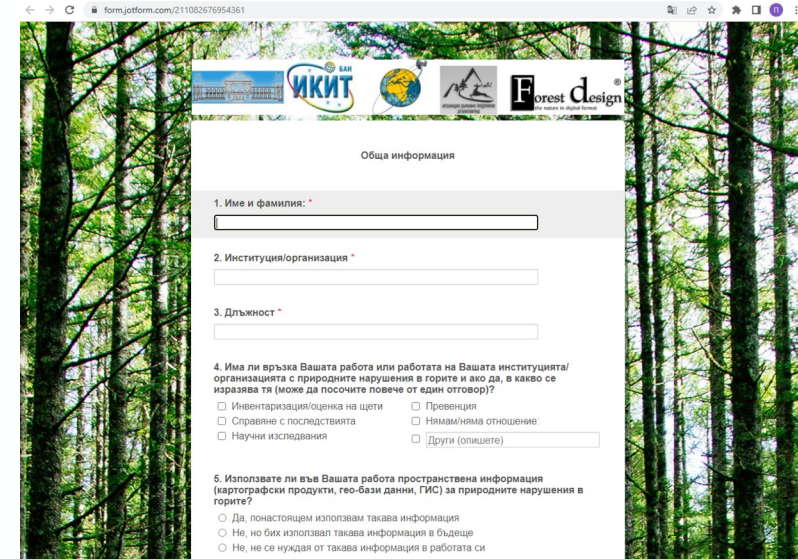
- Online survey (32 respondents) and user meeting
- Questions about the service and the products

How interactive? Web or Desktop? On demand or fixed timing? etc.

## User and System requirements definition

- Balancing user needs and feasibility

The user can generate products himself and set some parameters. Web-based system. Fixed timing (annual products).



## Field data collection

- 4 test sites (25 plots): UAV, expert evaluation of disturbance severity (SWSE), TLS (Forest Design)

## Other reference data

- VHR satellite imagery (NoR), Database of natural forest disturbances in Bulgaria (ExFA), Orthophoto map of Bulgaria (MA), MODIS and VIIRS active fire data (EFFIS), etc.

## Description of reference data and products' validation procedures



## Architecture of the FoReS platform

- An **online-based** information system for **generating, visualizing, and disseminating** of a set of products relevant to **disturbance monitoring**.

Page 1  
<https://www.fores.com/admin>

Начало | Карта | Изтегляне | **Инструменти** | Вход | Регистрация

**Създаване на заявка**

Заявка №: \*  Година: \*  Описание на заявката:

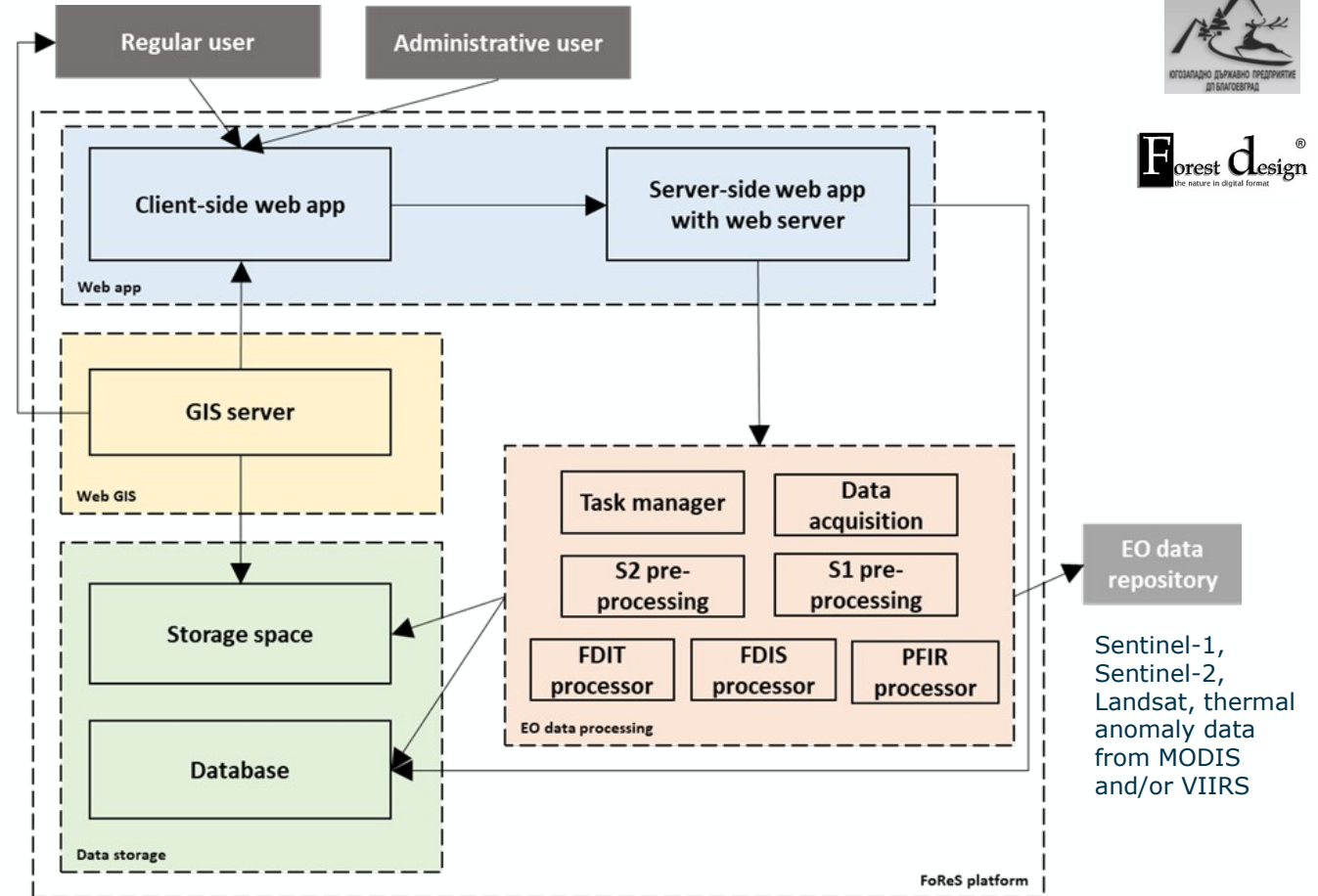
Файл с граница на район: \*.shp, \*.kml, \*.geojson, etc. **Избери файл** | Файл с термални аномалии: \*.shp, \*.kml, \*.geojson, etc. **Избери файл**

Избери продукти: \*  
 FDIT и FDIS  PFIR

Максимално облачно покритие:  Начало на периода:    
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 Процентил:   
 Прагови стойности:

**Списък на заявките**

Избери	Заявка №	Описание на заявката	Дата на създаване	Състояние	Отчет
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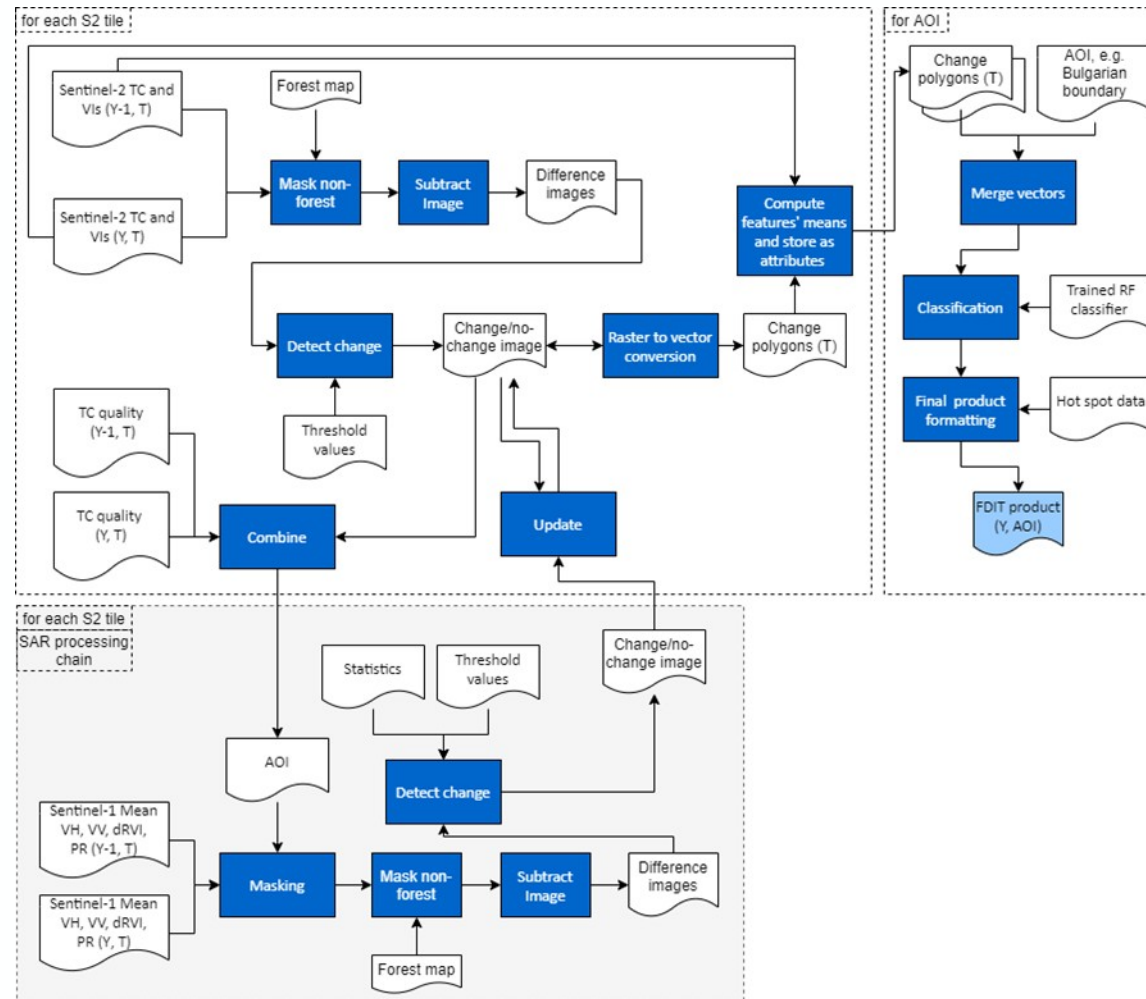




## Products' algorithms

### Forest disturbance sentinel type (FDIT)

1. Change detection (S1 and S2)
2. RF classification



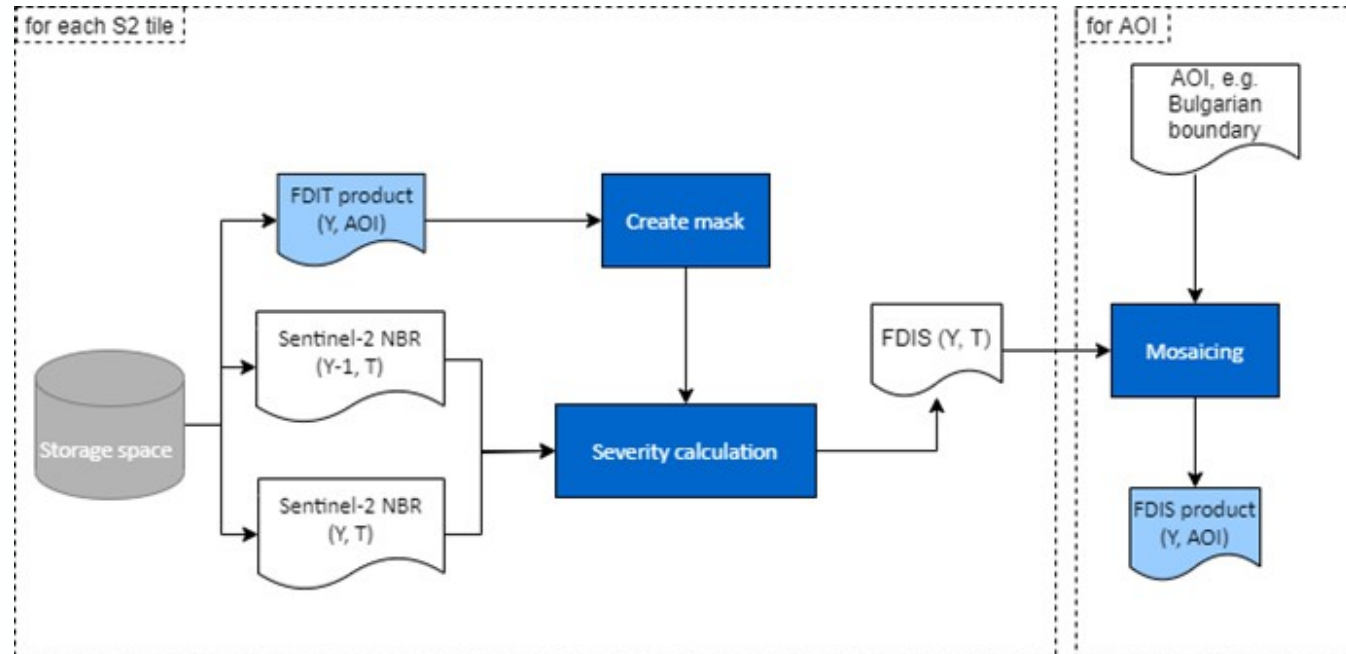
## Products' algorithms

Forest disturbance severity (FDIS)

Use FDIT as a mask

Normalized Burn Ratio (Key and Benson, 2006)

$$((NBR_{y-1} - NBR_y) / (NBR_{y-1} - NBR_b)) * 100$$



## WP4: Prototype Service Implementation and Testing

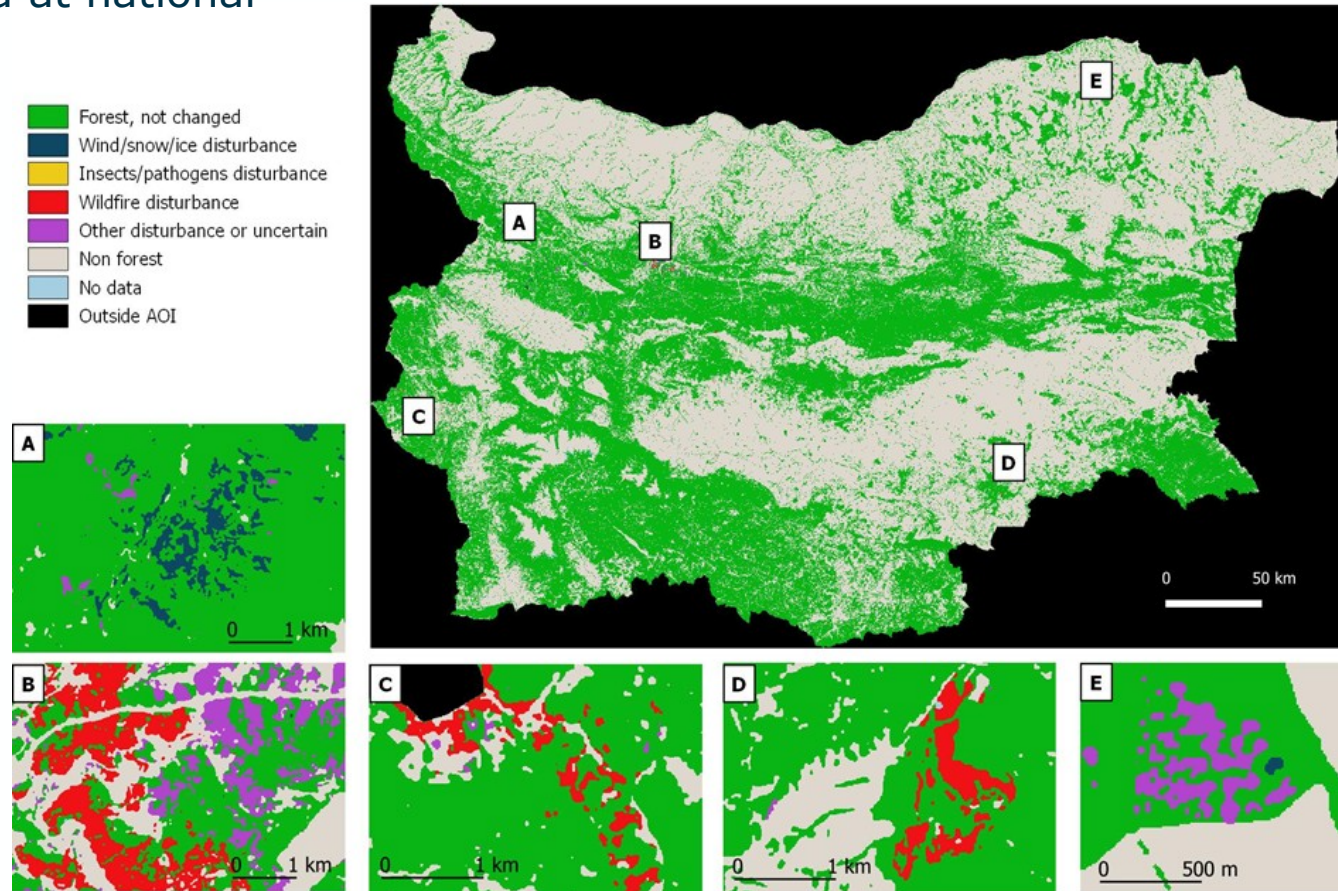
The FDIT prototype product was generated at national level for the 2019, 2020, and 2021

### Overall Accuracy

	2019	2021
5 classes	46 %	51 %
2 classes	76 %	85 %

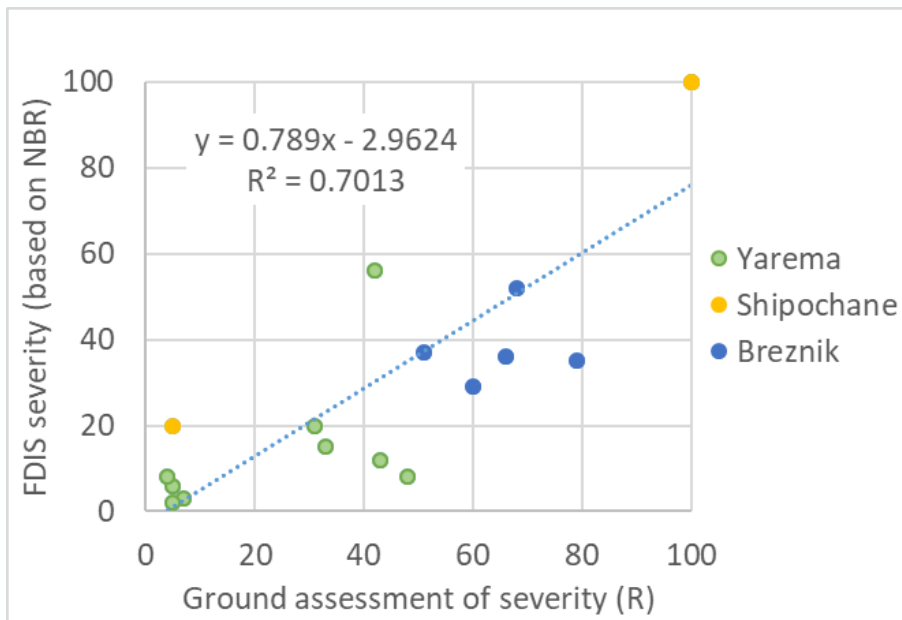
The proposed algorithm has important limitations and needs to be revised in the part concerning the classification of disturbance types. However, the change detection part of the algorithm is performing relatively well. The information about the presence or absence of disturbance may still be useful and a corresponding product be part of the FoReS platform.

- Forest, not changed
- Wind/snow/ice disturbance
- Insects/pathogens disturbance
- Wildfire disturbance
- Other disturbance or uncertain
- Non forest
- No data
- Outside AOI

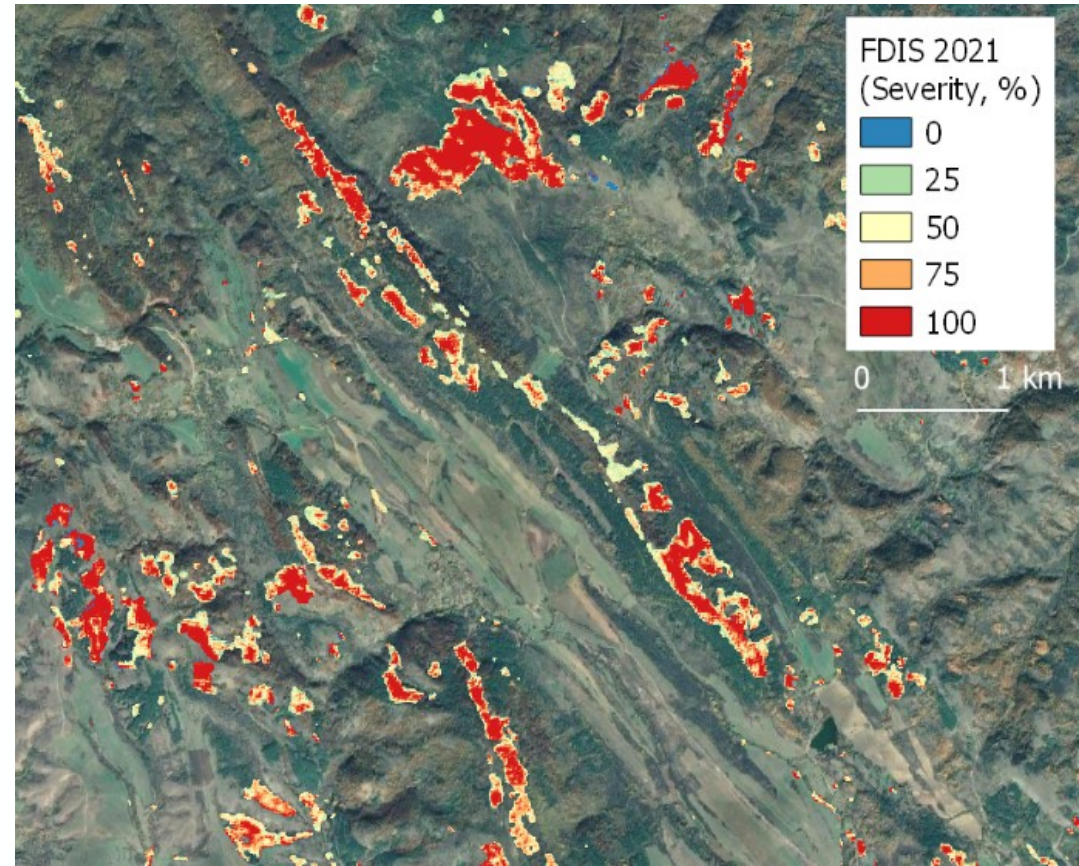


## WP4: Prototype Service Implementation and Testing

The FDIS prototype product was generated at national level for the 2019 and 2021



The correlation between the FDIS severity measure and ground assessment of tree damage utilizing a standard methodology ( $R^2=0.7$ ) shows that the FDIS product is promising as a complement to the traditional approach.



# Summary of Main Achievements

- Survey was carried out to study user needs for EO-based service for forest disturbance monitoring
- The concept and architecture of a web-based platform for forest disturbance monitoring, based on Sentinel data, were proposed
- Algorithms for three specialised geo-information products were developed
- Test versions of the products were generated and evaluated
- Forest disturbance detection with Sentinel data at national scale was successfully demonstrated
- A disturbance severity measure based on NBR was proposed and found to be correlated with ground-based measurements of tree damage



- A follow-on project to carry out the software development and actual operational implementation of the FoReS platform
- A software company and a User need to be involved in this activity.
- Enhancement of the algorithms – better discrimination of disturbance types (e.g. by incorporating weather data), calibration of the FDIS disturbance severity measure with ground data.
- Development of new products – e.g. adding more operational flexibility (on-demand products, shorter production interval)





# Thank you for your attention !

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