Cross-Practice Innovation Fund

WWF

Fighting the Invisible Enemy

Early detection of bark beetle attacks in Romania to combat illegal logging and mitigate effects of natural hazards

The story

1 of the 9 Awardees of 2023

People from all Practices and Regions have been reviewing 71 applications from which 9 were selected

Cross-Practice Innovation Fund

DESIGNING FOR IMPACT AT SCALE

https://sites.google.com/wwfint.org/innovation-fund/awardees-fy23?authuser=2

Project

- The project aimed to perform an appropriate assessment (DDS Due Diligence Systems) on salvage logging using remote techniques to identify spruce forests affected by bark beetle outbreaks that show a physiological decline.

- The instrument will offer
  - a transparent investigation /forecast of salvage logging authorisation, and
  - Furthermore, preventive measures (DDS) could be developed, both in terms of illegal logging and mitigating the effects of natural hazards;
  - It may be a relevant tool fit to be used at the national/European level

Project Summary

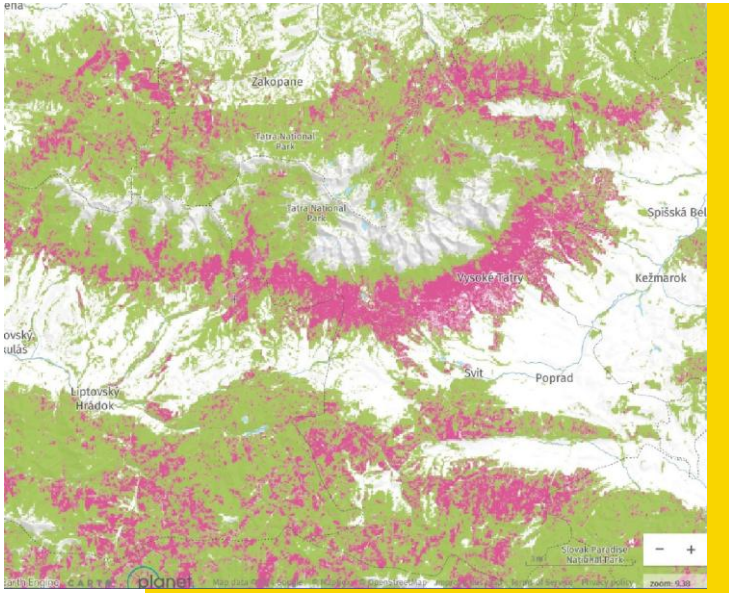
- **Context:** Bark beetle outbreaks affect forest structure and composition, nutrient cycling, erosion processes, reduction in carbon uptake, and increase the fire risk causing economic loss.
- **Specific problem**:
  - The infested tree goes through three stages of attack: green, red, and grey attacks. While in red and grey attacks the degradation of the tree needles can be observed visually by regular field observations (visible change in color), **during the green attack stage, the foliage remains green and is difficult to detect this stage by traditional ground field survey**
  - To preclude a mass outbreak, early detection of bark beetle infestation in the “green attack” stage is, therefore, a decisive step in forest management.

BARK BEETLE OUTBREAKS

Climate change is expected to increase the frequency and severity of bark beetle outbreaks in Europe. These outbreaks negatively impact forest resilience and biodiversity and affect forest structure and composition.

The “red” and “grey” attack stages occur after the new generation of insects has already flown.

Early detection of bark beetle infestation in the “green” stage is key to allowing urgent removal of infested trees.



Project's innovation

Multispectral sensors installed on flying drones

Early Detection

Remote sensing method using UAV equipped with multispectral sensors is able to cover larger areas in a relatively short period

Automatized analysis

Aerial imagery and its automatic interpretation provide objective evidence for justifying salvage logging interventions

Prevents abuses

Objective documentation for the DDS prevents abusive harvesting authorizations and resolve controversial decisions

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Project's steps

RESEARCH

Service provider identified and pilot zone located

PRECLINICAL

First flight test

EXPERIMENT

drafting the research protocol on the ground and using a drone

RESULTS

Helped improving ToR for services and drone

CONCLUSIONS

What worked, improved timeline and possibility for scaling

The team

The University of Agricultural Science and Veterinary Medicine of Cluj Napoca, Faculty of Forestry and Cadaster.

They have experts in entomology and remote sensing data collection and interpretation.

Technical findings were important in drafting a more sustainable MoF for the service contract

Test flight. Lessons learned. Moving forward.

- aerial remote sensing data collection (drone) can collect data from large areas (1,000 ha) at good resolution;
- standardised agricultural settings in terms of multispectral bands and standard NDVI calculation seem not to be the best approach since the results discriminate only between coniferous and broadleaf stands

Pilot site

Location

Altitude between
1067m and 1324m
in the Black Sea 1975 elevation system.

Mount “Muntele Mare”, Valea Ierii Village, Cluj county.

Forest

Surface area 47 ha,
composition 10 MO,
age 75 years,
relatively equien character.

Finding the instrument

Characteristics of the drone used for testing

DJI Mavic 3 Multispectral (or Mavic 3M) drone
Used for agricultural and forestry applications.
It has two cameras

RGB (visible) camera

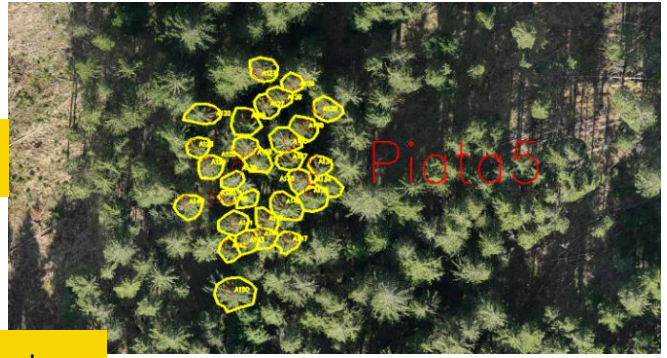
1/2.8-inch CMOS sensor with an effective resolution of 5 MP.
The field of view is 73.91° (61.2° x 48.10°) and has an equivalent focal length of 25 mm.
F/2.0 aperture, fixed focus

Multispectral camera

Four spectral bands: **Green (G): 560 ± 16 nm; Red (R):** 650 ± 16 nm; Red Edge (RE): 730 ± 16 nm; Near Infrared (NIR): 860 ± 26 nm

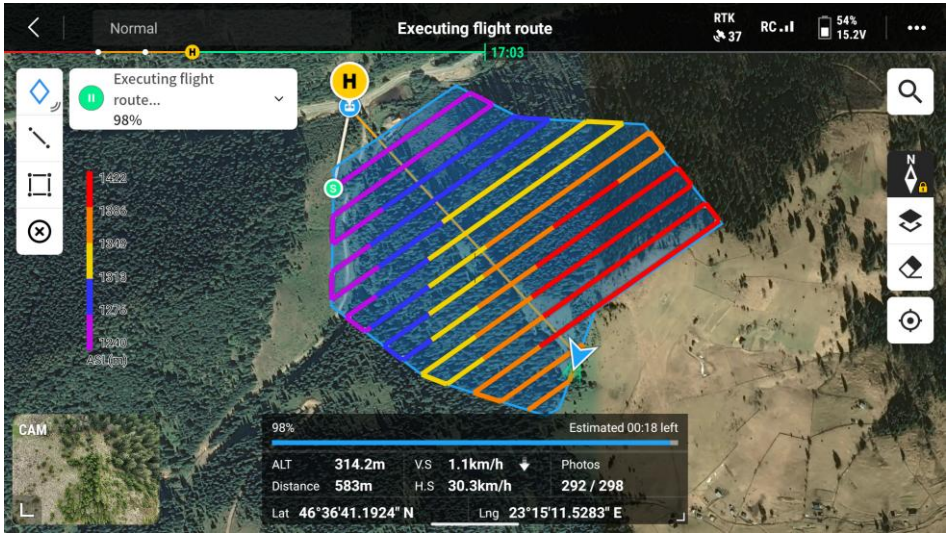
Tree with nameplate

Sample plots



Automatic flight plan

Flights calendar



zbor	data	ziua din an	nr zile intre zboruri
1	12 aprilie	102	-
2	26 aprilie	118	16
3	30 aprilie	122	4
4	10 mai	132	10
5	22 mai	144	12
6	7 iunie	160	16
7	12 iunie	165	5
8	27 iunie	178	13
9	21iulie	205	27
10	9 septembrie	260	55
durata experimentului 103 zile			

Results

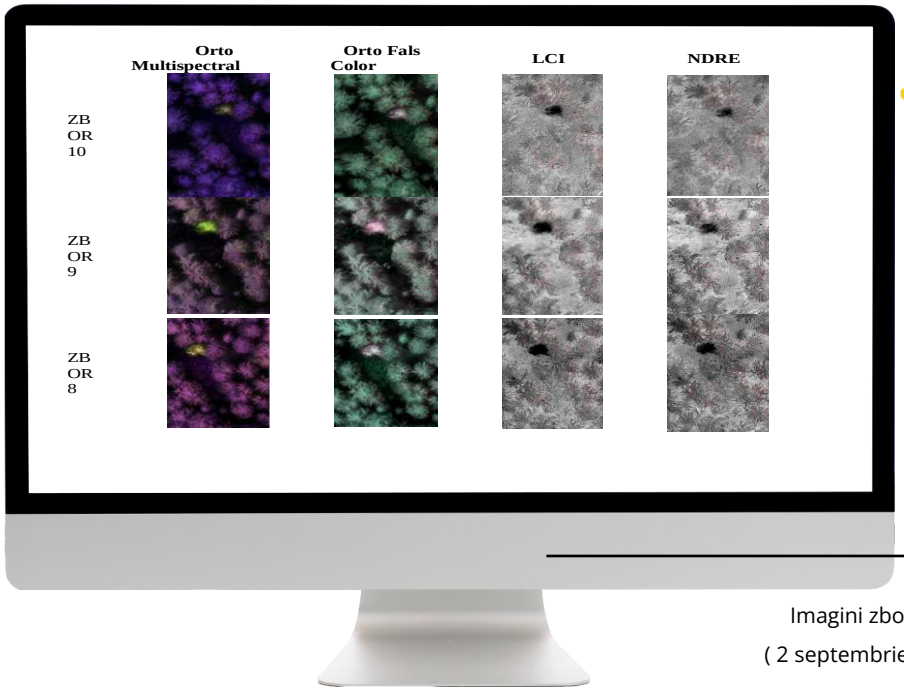
Thus, spectral reflectance values and vegetation indices calculated from orthorectified and radiometrically calibrated images were statistically analyzed by linear discriminant analysis (LDA) using IBM SPSS Statistics software, version 20.

The individual vegetation index values failed to capture significant differences between damaged and healthy trees, especially since they were intended to differentiate by symptoms class

Climatic context for the project period

Ziua	Temperatura medie (°C)	Temperatura maximă (°C)	Temperatura minimă (°C)	Precipitații medii (mm)	Viteza medie a vântului (Km/h)
1	14.7	20.7	11.9	0	15.6
2	9.4	12.6	2	0	8.1
3	5	10.2	0.7	4.83	7.4
4	4.6	7.3	1.9	0.76	5.4
5	8	12.7	3.8	0.25	5.7
6	9.6	13.6	6.2	0	6.7
7	9.7	15.1	6.4	1.52	5
8	10.8	17.6	6.6	0	4.6
9	14.6	20.9	8.7	0	4.1
10	15.1	20.9	11.3	0	5
11	14.3	19.5	11.5	0	4.3
12	13	19.2	8.7	0	4.6
13	11.4	16.7	7.5	0	5.6
14	13.8	19.4	8	0	7.8
15	15.7	21.2	12	0	11.3
16	11.9	18.7	7.5	0	9.6
17	0.7	12.2	-0.6	22.61	3.9
18	-0.9	1.5	-2.5	1.27	6.9
19	-1.5	3	-4.4	2.79	4.3
20	1.4	8.2	-3.9	6.35	4.4
21	2.9	8.9	-0.6	1.78	4.3
22	1.2	4	-0.5	8.64	1.7
23	3.6	10.4	-0.9	1.78	6.3
24	3.8	7.5	1	27.43	5
25	1.8	5.3	-0.3	2.29	2.6
26	3.6	9.6	-0.5	2.54	4.6
27	6.9	13	1.7	0	4.6
28	10.7	17.2	4.6	0	4.3
29	12.1	17.8	7	0	3.3
30	10.5	15.9	5.7	0	3.9
Media	**7.9**	**13.4**	**4**	**84.84**	**5.7**

Results



LDA classification of the images Flight 10 - Following cross-validation, **the detectability was 36.7%**

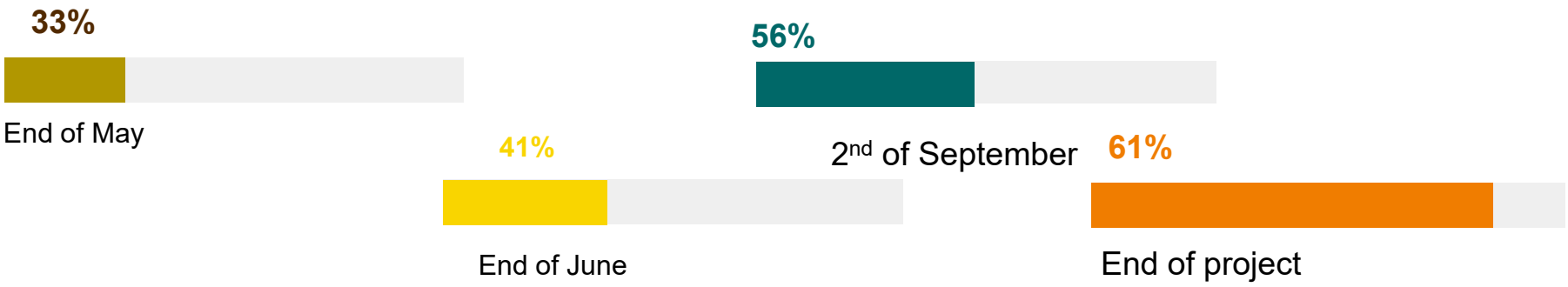
Visual raster analysis 3 operators, with only those trees confirmed by at least 2 of the operators being considered validly identified.

Imagini zbor 10 (2 septembrie 2024)	Orto Multispectral	Orto Fals color	Indicele de vegetatie LCI	Indicele de vegetatie NDRE
Gradul de detectabilitate - GD%	49	59	54	57
Eroarea de detectabilitate -E%	29	27	35	43
Acuratetea detectarii –AC%	24	39	23	17

Rezults validation

The detectability of infested trees based on their spectral signature was limited primarily by the performance of the equipment used **(PA is directly related to the characteristics of the drone used**), which recorded values of 6% on the flight of May 5 and the percentage increases steadily until September 2 (21%).

The accuracy of the method (UA) - which is directly related to the adequacy of the classification algorithm used on the data set obtained, shows below values
the overall accuracy at this date is 61% (of the trees identified as affected only in this percentage are also validated from the ground)



Lessons

What can we learn and improve further??

Tips for improving the flights. What to avoid:

- shaded areas, as they can affect image quality and lead to errors in data processing.
- areas with substantial differences in level.
- rocky areas have been avoided as they disturb visibility and affect image quality.
- Areas with dense vegetation were avoided, as this can affect visibility and image alignment.
- areas with overhanging trees (canopy). Overlapping images can lead to errors in data processing.

TOOL – to be improved

Performance of the equipment used Similar studies to the one in question show that increased detectability is achieved in the NIR band at wavelengths between 900 and 1200 nm

Circle of life and climate change

The first Beatles flight was atypical because it started earlier than in other years and was interrupted due to climatic conditions

Adaptability

Not realising the normal flight curve directly influenced the physiology of infested trees and indirectly the possibilities of early detection by specific means of remote sensing.

At the end

WWF's We conclude that better results in terms of both the number of trees detected and the period in which this is done can be obtained under similar conditions (terrain and facilities) in the situation where we are dealing with very strong infestations, characteristic of the progradation phase, when the response of trees is much more uniform, but over a period of about 2 years

TO BE CONTINED...

Next steps

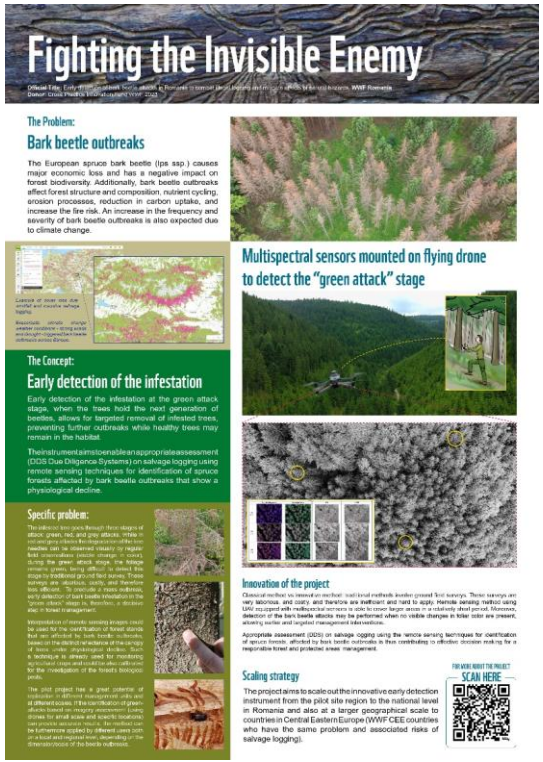
Identify funds
Improve the instrument
Include in the team with other interested persons or universities
Extend the periods for performing the analysis

The highly promising idea for scaling

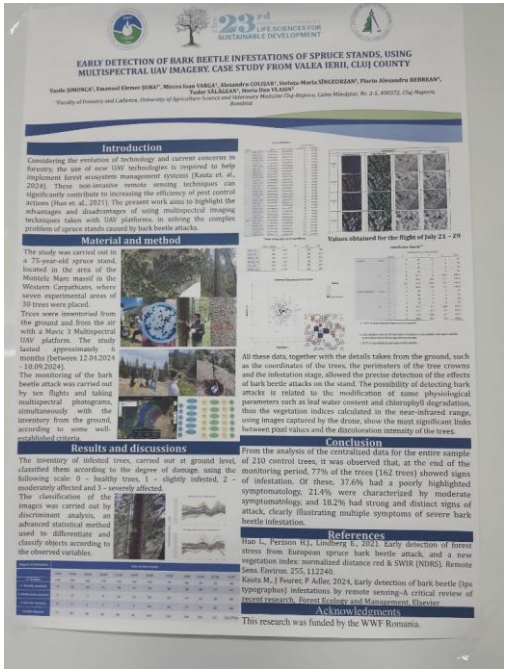
Comunicating the story and results

Inspiration Gallery

https://sites.google.com/impacthub.net/innovation-wwf/inspiration-gallery

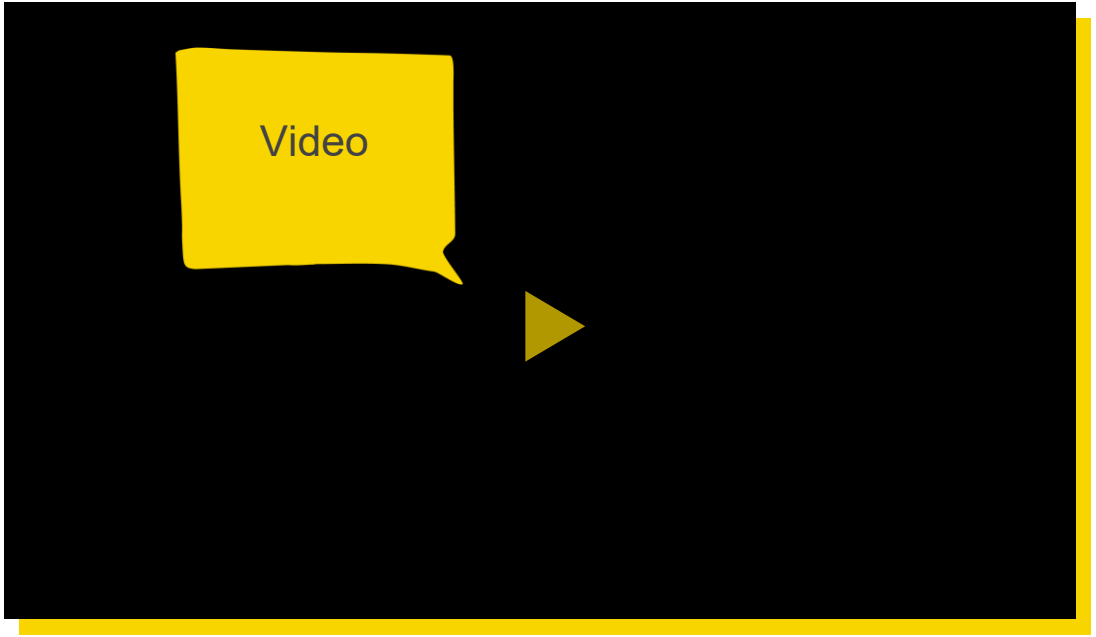


The project was presented by USAMV during the poster presentation, part of the 23rd International Conference" *Life Sciences for Sustainable Development*", Cluj-Napoca, Romania, between 26th– 28th September 2024



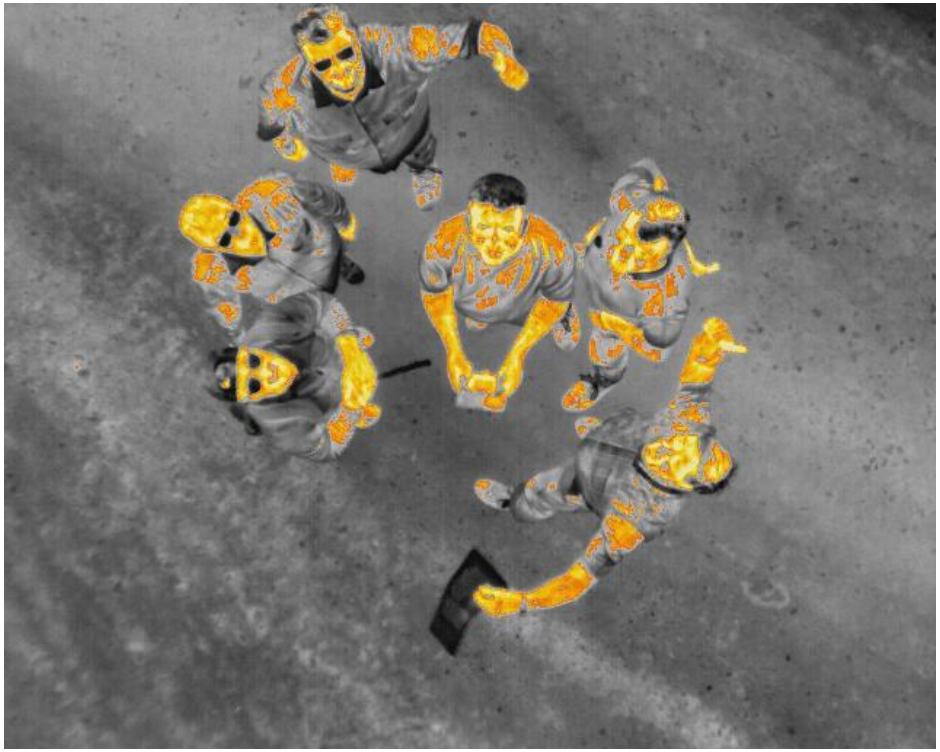
THIS IS A VIDEO!

Apart from the 2 workshops organized by WWF Romania, th eproject team together witn Innovation tema menaged to finalise




Bark
Beetle

Thank you!



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