Predicting the severity of defoliation due to the pine processionary moth using remote sensing and UAV imagery

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BACKGROUND

Pine processionary moth (PPM), *Thaumetopoea pityocampa*, is one of the major defoliating insects in Mediterranean forests.

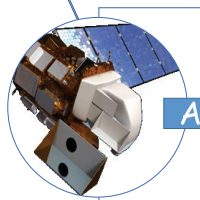
After PPM outbreaks, defoliated stands may not be refoliated in the following years, resulting in significant reductions of the tree growth.

Despite the annual forest health survey and mapping in Catalonia, Spain, it requires more timely information which enables to monitor the latest forest condition.

Espunyola was selected as a severely attacked study area where *Pinus nigra* and *P. sylvestris* are primary host trees with the elevation range at 600-900 m.

OBJECTIVES

For improving the current monitoring system spatially and temporally,



A. Analyze Landsat-based vegetation indices (VI) for predicting the severity of defoliation by the recent PPM outbreak (winter 2015-2016)

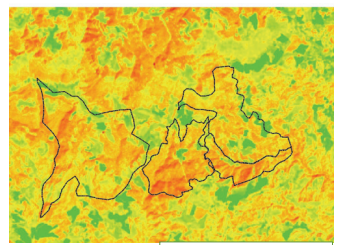
B. Calibrate the VI models with defoliation degrees interpreted by unmanned aerial vehicle (UAV) imagery for severity classification

ALERTAFORESTAL Supported by Obra Social "la Caixa"

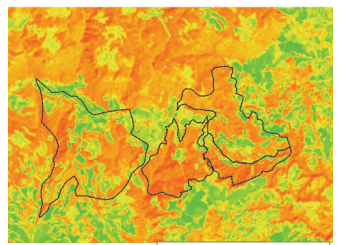
METHODOLOGY

Input → Analysis → Output

A. VI (pre-outbreak) - VI (post-outbreak) = dVI



VI (2015)



VI (2016)

Index	Acronym
Middle Infrared Wavelengths	MID
Moisture Stress Index	MSI
Normalized Difference Moisture Index	NDMI
Normalized Difference Vegetation Index	NDVI
Normalized Burn Ratio	NBR

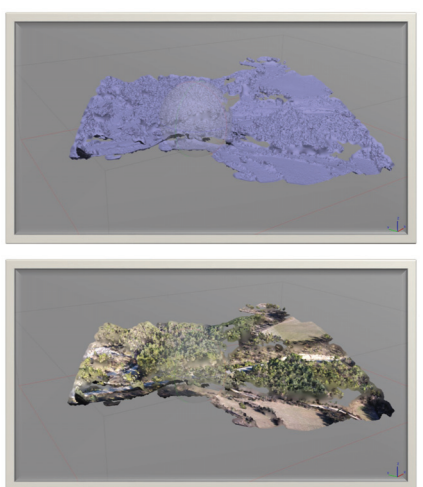
dVI

Sketch maps

A. Landsat 8 images → Vegetation indices → Change detection (dVI) → Predicted variable (x)

B. UAV images → Image processing → Visual defoliation (%) → Observed variable (y)

B. 3D model by PhotoScan



B. Visual interpretation on orthomosaic

RESULTS

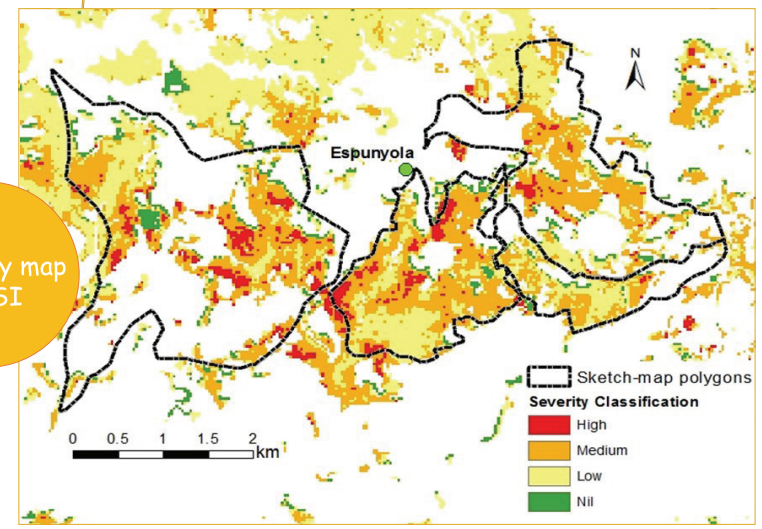
Linear regression models

Index	Equation	R^2 ($p < 0.001$)
dMID	y = -0.0707x - 2.5194	0.817
dMSI	y = -0.1414x - 3.5906	0.810
dNDMI	y = 0.02x - 1.7503	0.637
dNDVI	y = 0.0265x - 2.7228	0.787
dNBR	y = 0.0209x - 4.9571	0.743

Threshold classification

Index	Defoliation (%)			
	0 (Nil)	30 (Low)	70 (Medium)	100 (High)
dMID	-35.64	-459.96	-1025.73	-1450.06
dMSI	-25.39	-237.56	-520.44	-732.61
dNDMI	87.52	1587.52	3587.52	5087.52
dNDVI	102.75	1234.82	2744.26	3876.33
dNBR	237.18	1672.59	3586.46	5021.87

Severity map dMSI



CONCLUSIONS

Validation — New additional UAV images should be incorporated in the further study to improve the classification accuracy and validate previously calibrated results in the same study area or adjacent areas affected.

Ground truth — The UAV technology holds great potential as ground-truth data for cost-effectively monitoring the current health of forests.

Ecosystem services — Combining UAV images with satellite data should be considered to validate model predictions of the future forest condition for developing Ecosystem Service tools.