



Growing
ideas
through
networks

High-resolution UAV Imaging for Forest Productivity Monitoring

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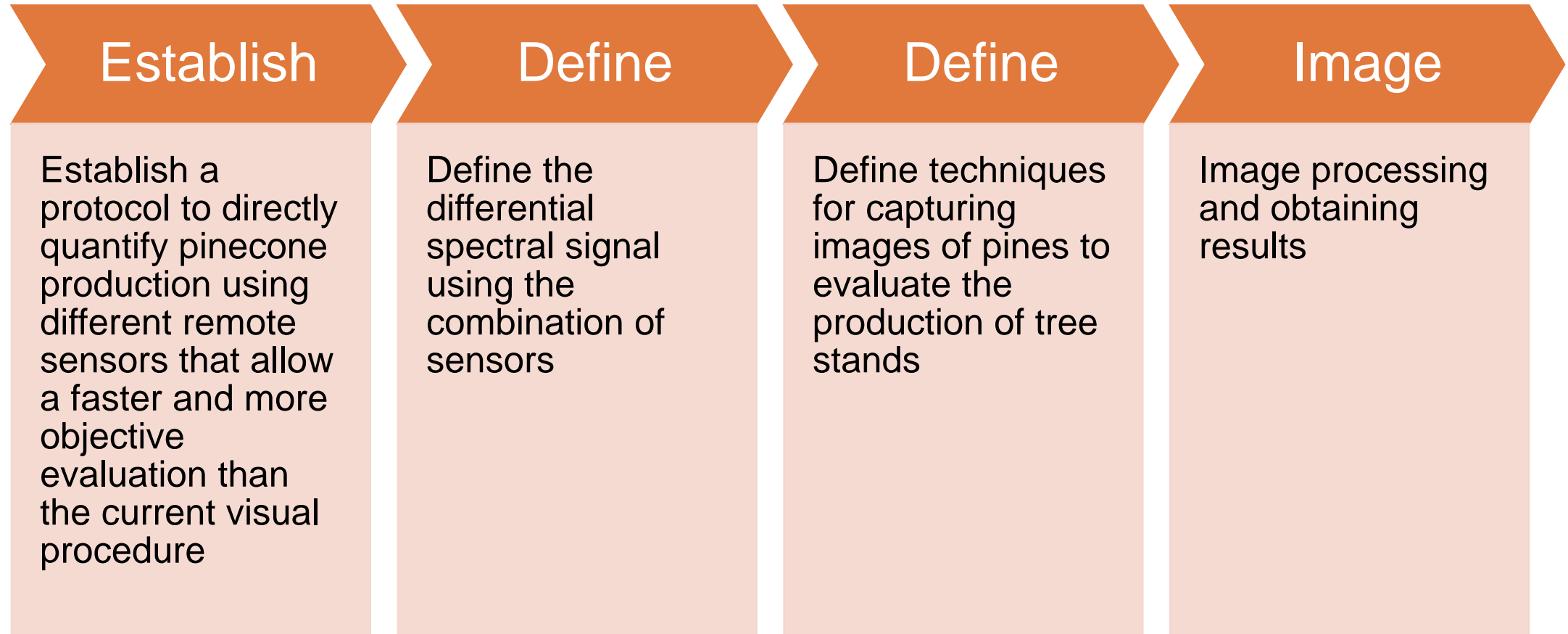
University of Barcelona, Spain



Funded by the Horizon 2020 Framework Programme
of the European Union



General Objectives

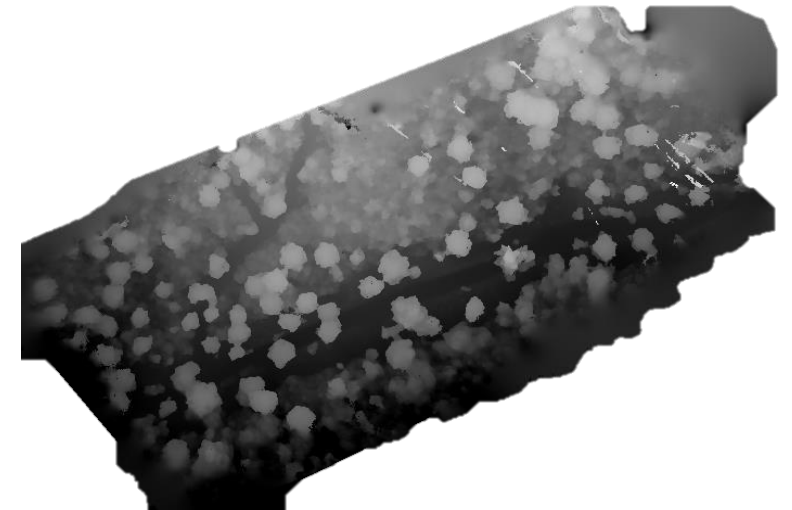


First UAV flights of natural stands of *Pinus pinea* captured with multispectral cameras

Airinov 4C Infrared multispectral Orthomosaic (CIR, color infrared) made from the multispectral images captured by the drone from 30 m a.g.l., so that calculations can also be made on the height of each tree once the classified and segmental images are displayed.



Color Infrared (CIR)



Digital Elevation Model (DEM)

Vegetation Indexes, Airinov Multispec 4c spectral characteristics

NDVI (Normalized Difference Vegetation Index)

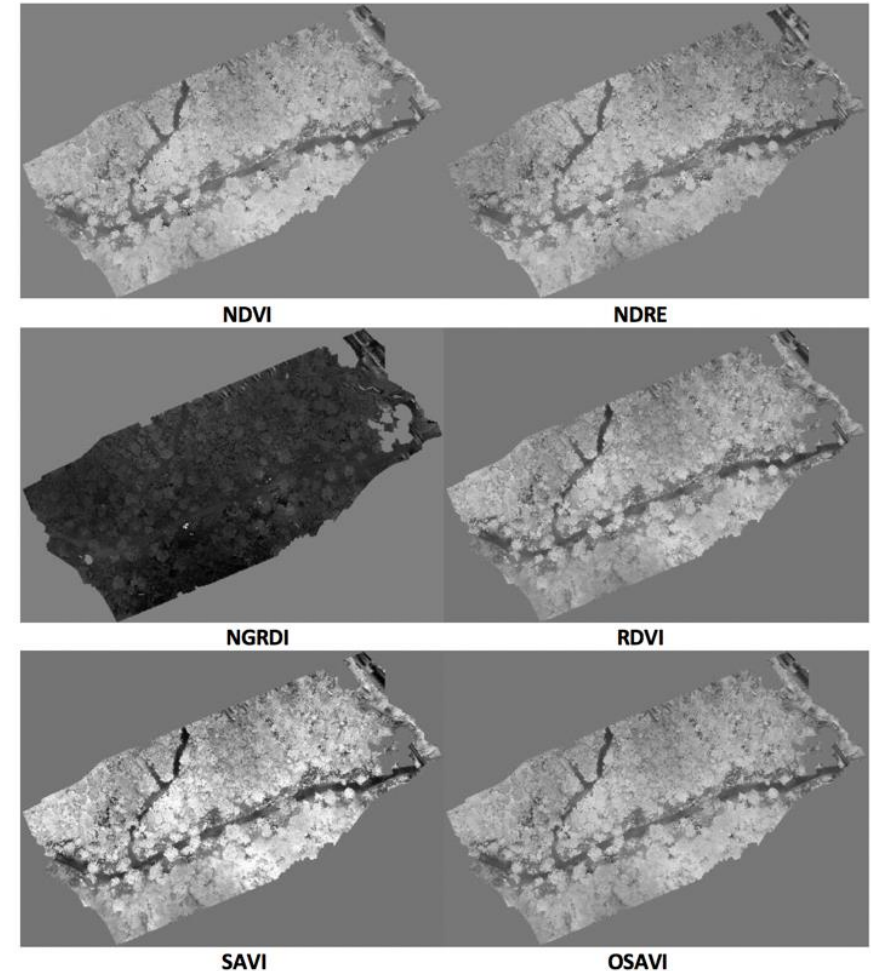
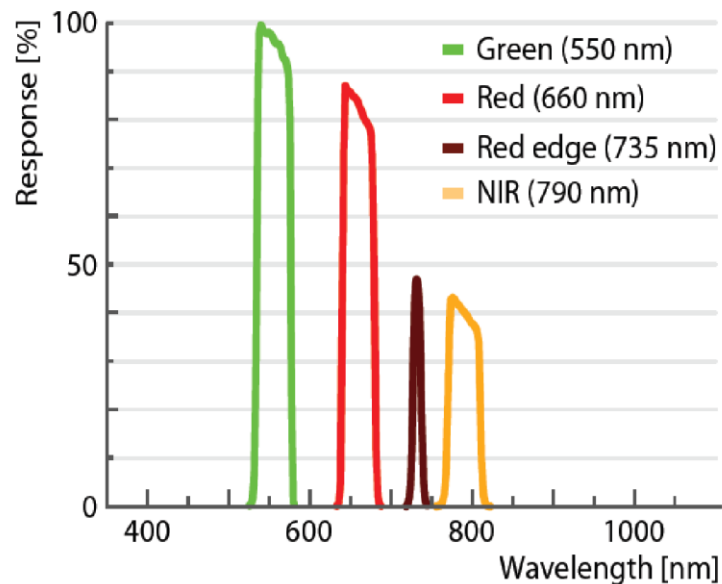
NDRE (Normalized Red Edge Index)

NRGDI (Normalized Red Green Difference Index)

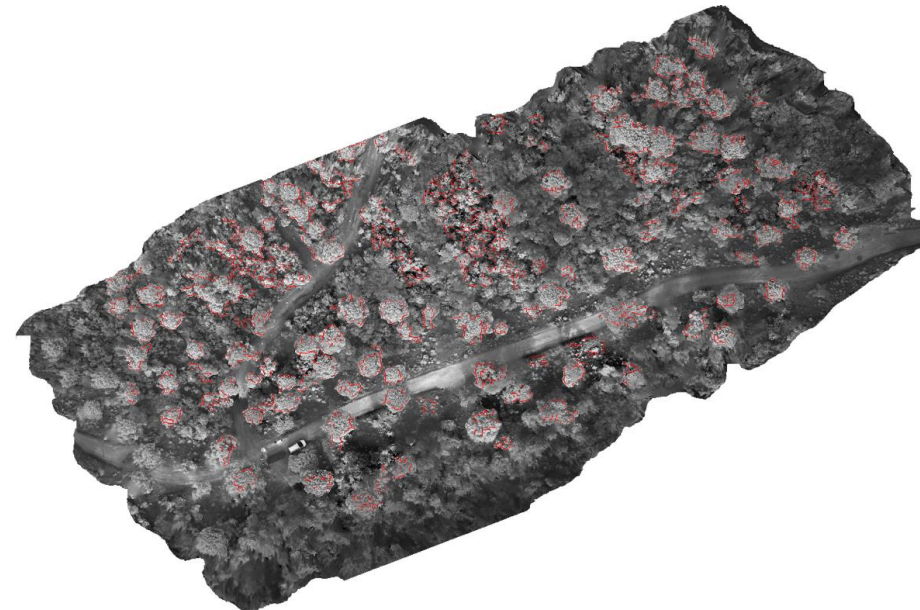
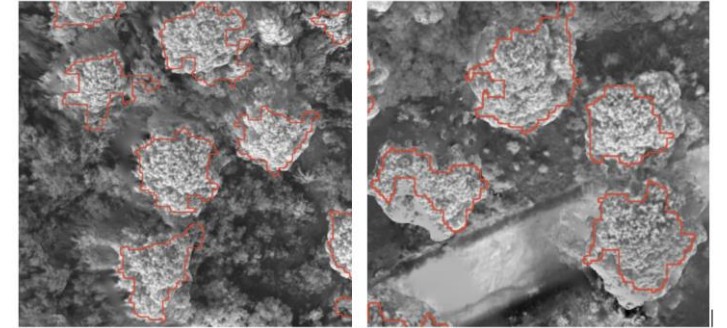
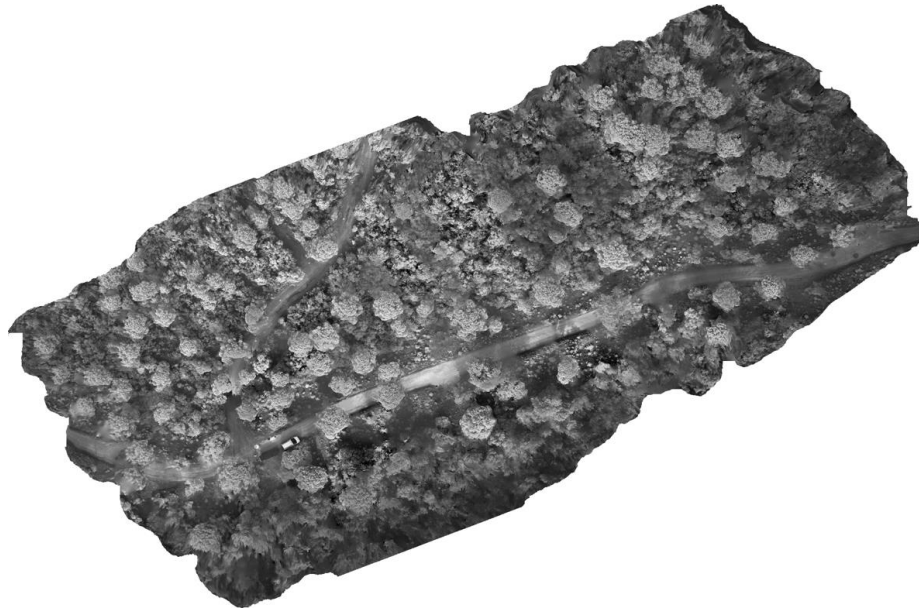
RDVI (Renormalized Difference Vegetation Index)

SAVI (Soil Adjusted Vegetation Index)

OSAVI (Optimized Soil Adjusted Vegetation index)

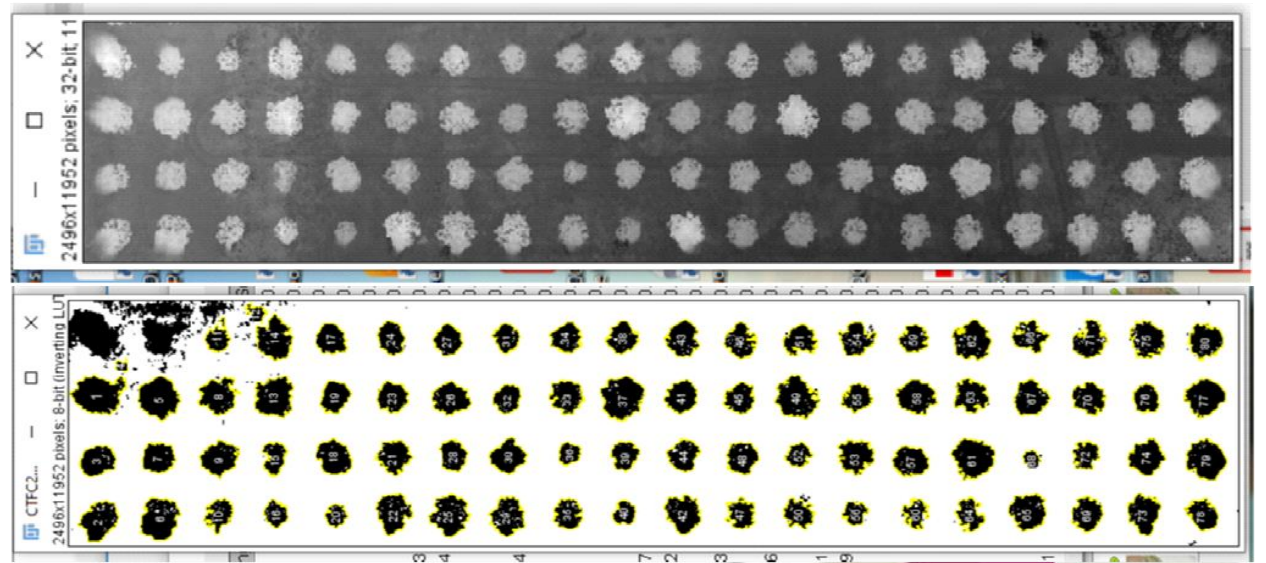


Segmentation of the forest to identify and outline the individual trees of *Pinus pinea* in Matlab



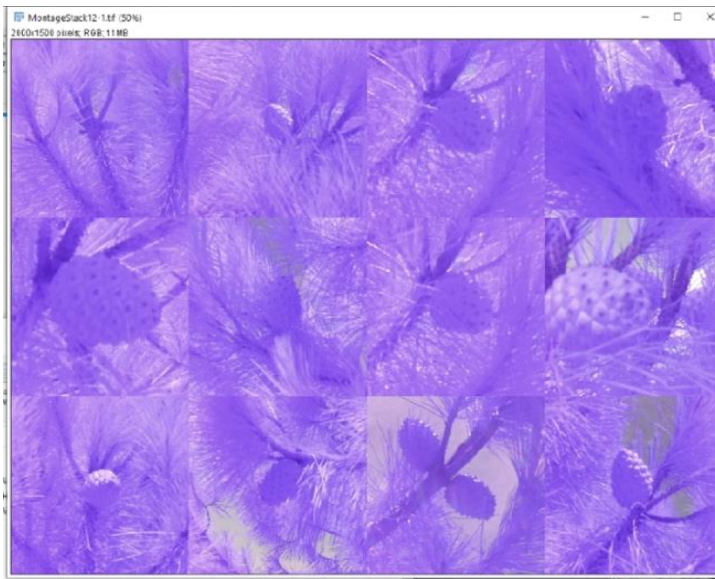
Evaluation of forest plantation productivity using UAVs

Segmenting trees in FIJI (ImageJ) from RGB UAV images and SfM to make DEM/DVM.

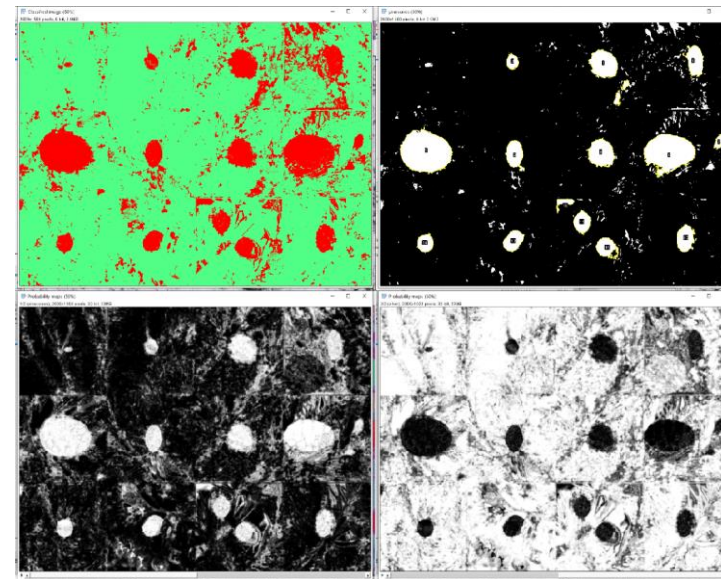


Counting Pinecones with Machine Learning (fastRandomForest)

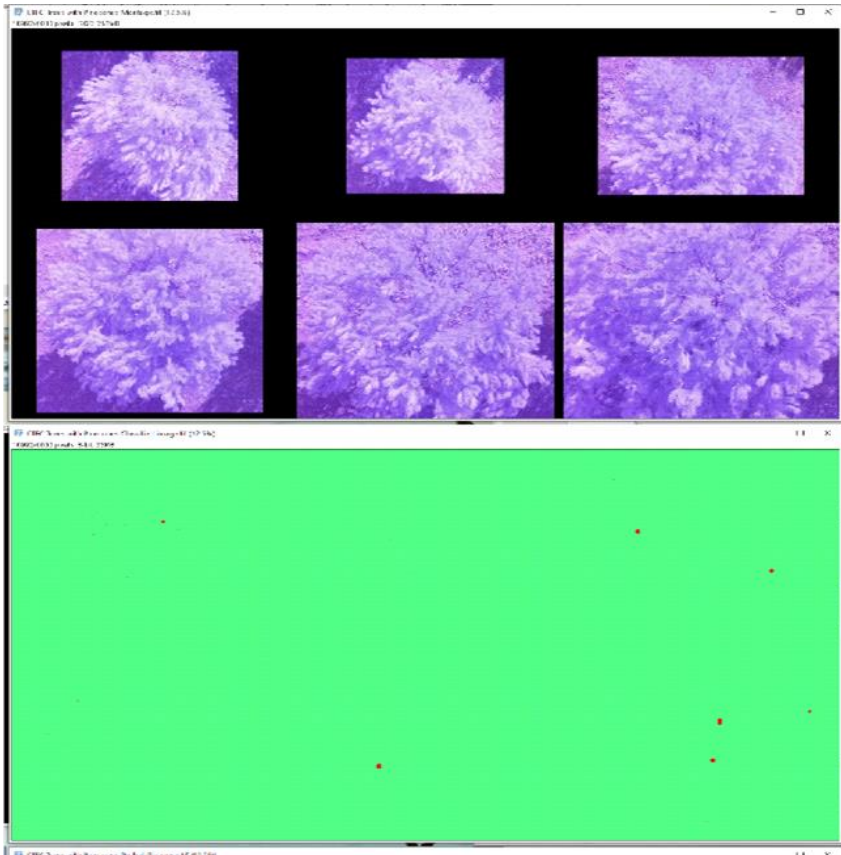
Montage image of pinecones taken from the field using the modified RGB camera of NIR-R-G at 12 MP.



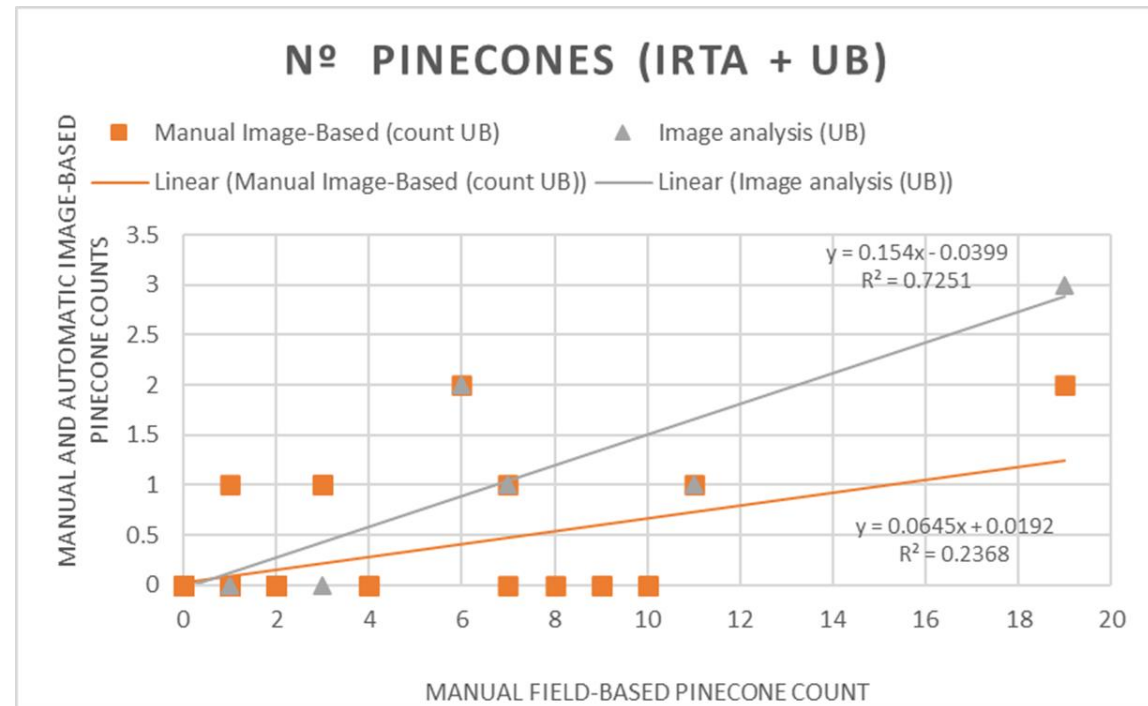
Modified-RGB image montage
fastRandomForest classification
map, probability maps, and
pinecone counts.



Counting Pinecones with Machine Learning (fastRandomForest)

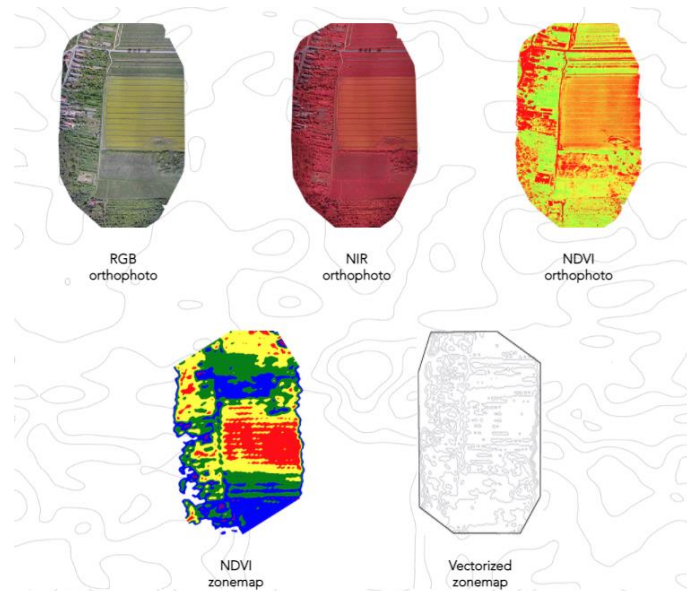


Correlation between manual image-based counts (a best-case scenario) and manual field-based counts (real ground truthing) for 12 MP modified-RGB (Green-Red-Near Infrared) images collected at the IRTA plantation site taken at 15 m above ground level.

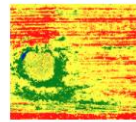


Counting Pinecones with newer sensors

Capture of more UAV images covering the visible (RGB) and near-infrared at different phenological stages of *Pinus pinea*. A new near-infrared NDVI sensor with an integrated GPS will be acquired to capture RGB images using the DJI Mavic 2 Pro compact UAV.



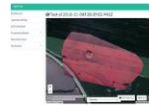
Vegetation health analysis



DJI NDVI upgrade enables a DJI Phantom 4 series or Mavic series drone to capture near-infrared (NIR) imagery in order to carry out vegetation health analysis by NDVI calculation.

You can scout your crops by simply flying over the fields with the NDVI-upgraded drone. Processing the images gives instant help in identifying the problematic areas.

Free online processing application



The DJI NDVI upgrade includes free and unlimited access to our online software by which the RGB or NIR images can be processed to orthophotos, digital elevation models, zone maps, etc.

By our georeferenced NDVI colormap, the stressed vegetation or the problem spots can be easily identified.

The vectorized zone map can be uploaded to precision farming machines by which zone based cultivation can be implemented.

Functionality, warranty



AgriCam DJI NDVI upgrade leaves the original Phantom 4, Mavic Pro or Mavic 2 camera and gimbal intact. The drone can be used just like before.

The AgriCam camera can be integrated into the drone's controlling system, including autopilot and auto survey functions.

Our NDVI upgrade extends the drone capabilities. It will be able to take normal and NDVI imagery simultaneously.

The integration does not affect the DJI warranty.

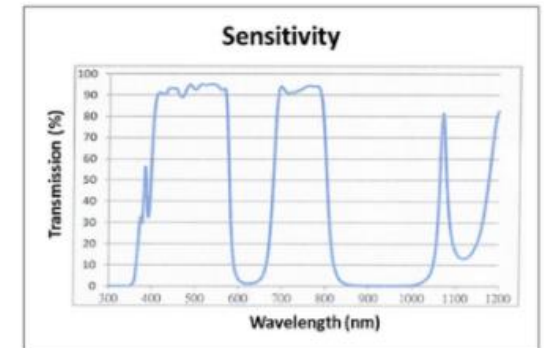
Technology



Low cost - high value



Easy installation





UNIVERSITAT DE
BARCELONA



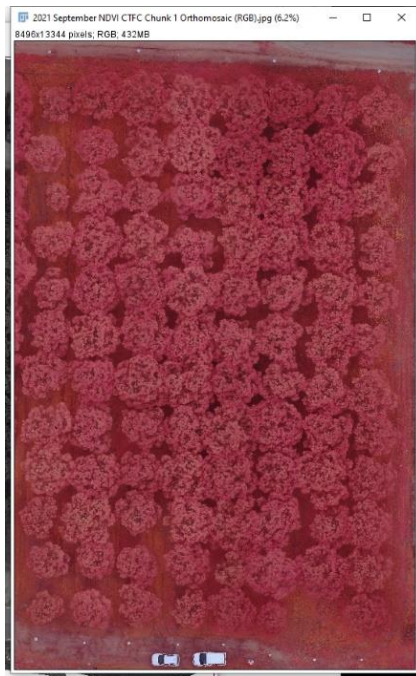
QualityPinea ForestScanner FIJI Plugin

**Image processing toolkit for UAV RGB, UAV
Agrocam NDVI NIR-G-B, and UAV DEM processing:**

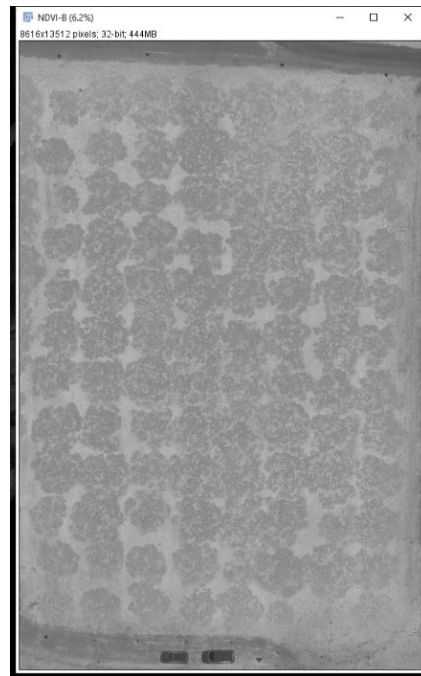
<https://github.com/sckefauver/QualityPinea>
<https://gitlab.com/sckefauver/MosaicTool>

Evaluation of Forest Productivity using UAVs

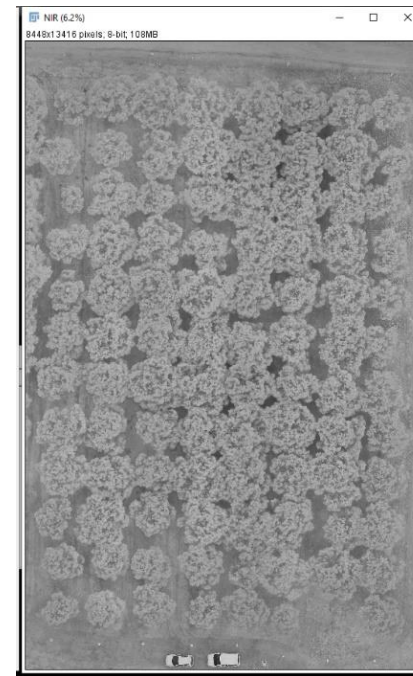
Agrocam CIR
(NIR-G-B as RGB)



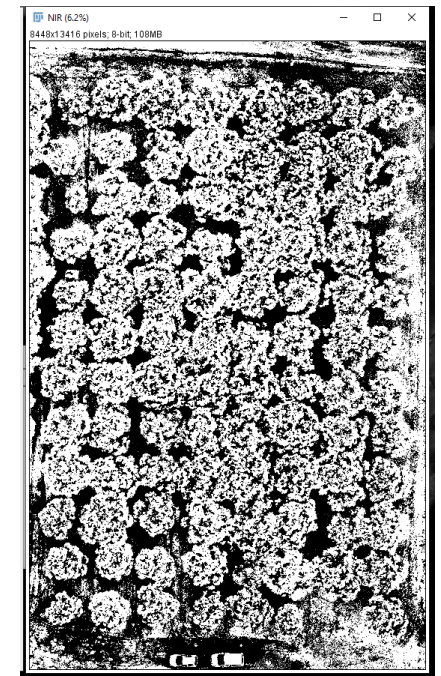
NDVI-B Agrocam



NIR Agrocam

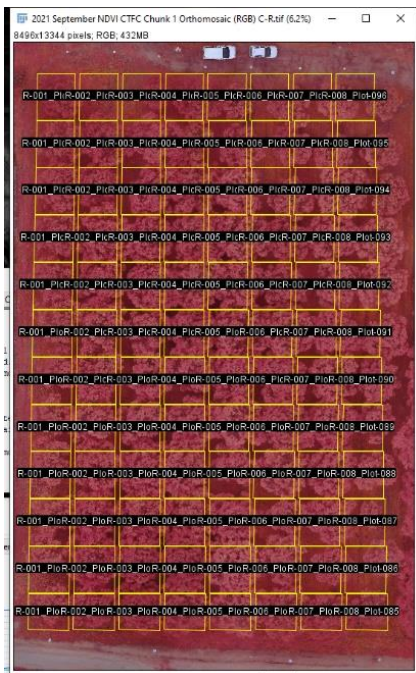


Vegetation Density
using NDVI automatic
thresholding.

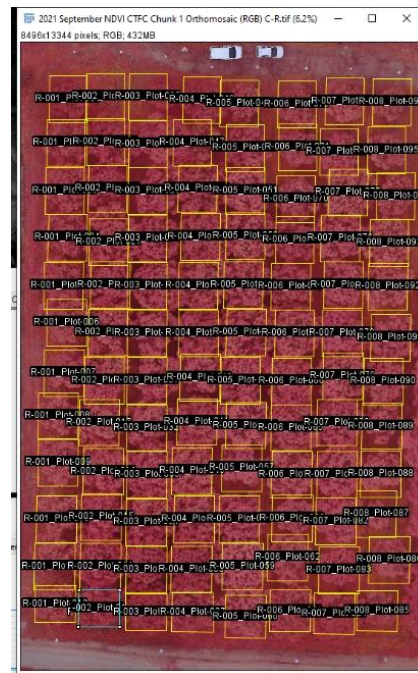


Evaluation of Forest Productivity using UAVs

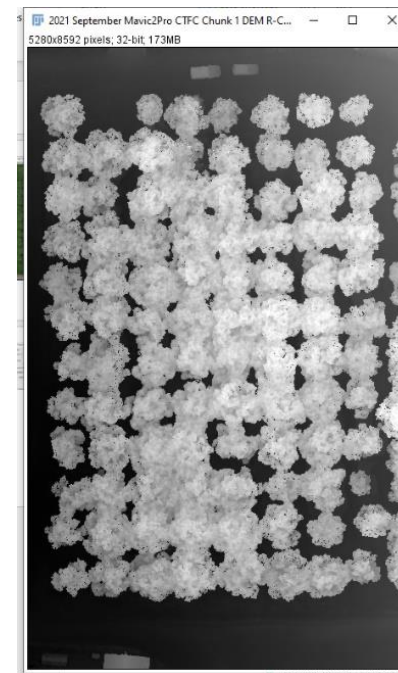
Agrocam CIR
(NIR-G-B as RGB)



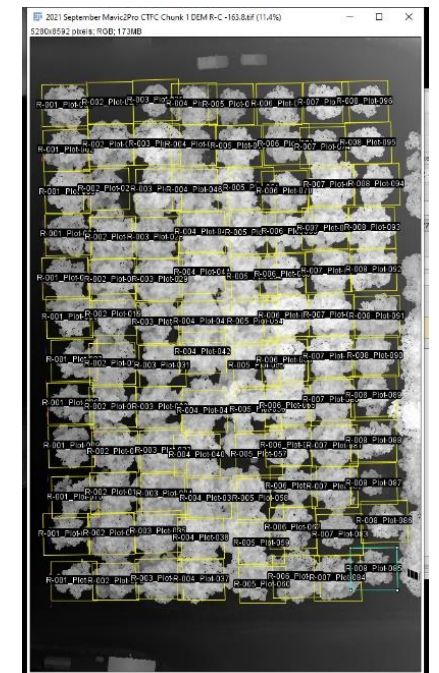
MosaicTool semi-automatic
Segmentation Process



Digital Vegetation/Elevation
Model (DEM/DVM)



MosaicTool semi-automatic
Segmentation Process



ForestScanner

A collaborative forest management research and development project between the University of Barcelona, Centre Tecnològic Forestal de Catalunya, the Cooperativa Forestal de Catalunya, and the Centre Nacional de la propietat forestiera. Developed by Shawn C. Kefauver, UB, and Jose Armando and Juan Jose at Universidad de Ibague.

ForestScanner 0.1 beta

UAV RGB UAV Agromam NDVI UAV DEM

Options

Batch Input: [Browse]

Result File: [Browse]

MosaicTool

ForestScanner

Ready Process

ForestScanner 0.1 beta

UAV RGB UAV Agromam NDVI UAV DEM

Options

Batch Input: [Browse]

Result File: [Browse]

MosaicTool

ForestScanner

Ready Process

ForestScanner 0.1 beta

UAV RGB UAV Agromam NDVI UAV DEM

Options

Batch Input: [Browse]

CSV Output: [Browse]

CSV Delimiter: Comma

MosaicTool

ForestScanner

Ready Process

Ceres Scanner - 2.11-beta

Home General Scanner Options

Broodpix: NGRDI/TGI

Options

Batch Input: [Browse]

CSV Output: [Browse]

CSV Delimiter: Comma

Save GA USA Unigram

HIS color space

Breedpix (Casadesu et al., 2007, Casadesu and Villegas, 2014)

Cie-Lab

Cie-Luv

- Green Area (GA) [pixels with $60^\circ \leq \text{Hue} < 180^\circ$]
- Greener Green Area (GGA) [pixels with $80^\circ < \text{Hue} < 180^\circ$]
- Crop senescence index (CSI) $\frac{100 \times (GA - GGA)}{GA}$ (Zaman-Allah et al., 2015)

Ready Process

Ceres Scanner - 2.11-beta

Home General Scanner Options

Broodpix: NGRDI/TGI

Macro Codons

Batch Input: [Browse]

Save NGRDI Images? [Browse]

Save TGI Images? [Browse]

Results File: [Browse]

NGRDI TGI

Normalized Green - Red Difference Index (NGRDI)

$$= \frac{(\text{Green DN} - \text{Red DN})}{(\text{Green DN} + \text{Red DN})}$$

(Hunt et al., "Evaluation of digital photography from model aircraft for remote sensing of crop biomass and nitrogen status," 2005)

Triangular Greenness Index (TGI)

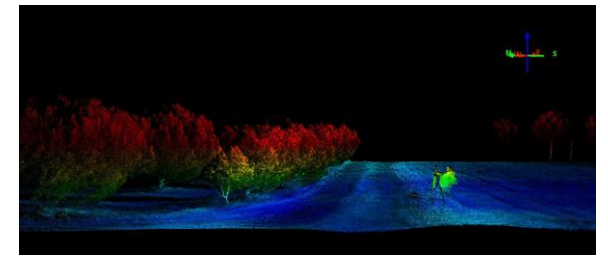
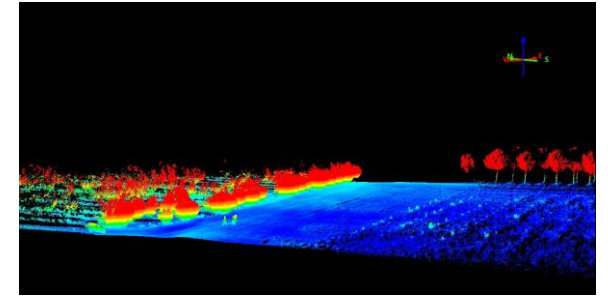
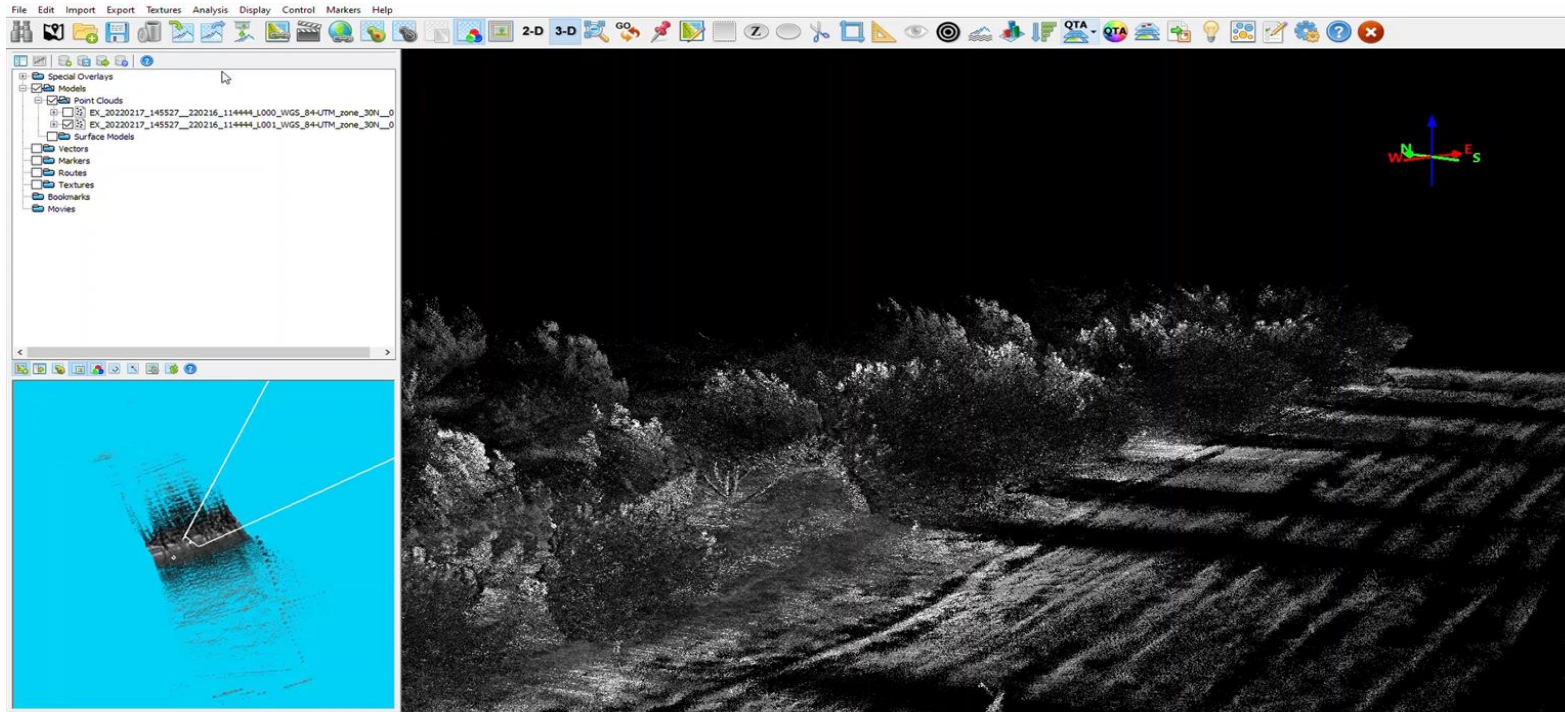
$$= -0.5 [190(R670 - R550) - 120(R670 - R480)]$$

(Hunt et al., "A visible band index for remote sensing leaf chlorophyll content at the canopy scale," 2013)

Ready Process

Evaluation of Forest Productivity using UAVs, new sensors

Collaboration with the company ECOESPACIO to take LiDAR for the measurement and segmentation of pines.



Thank you

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