Tree crown segmentation of Doñana centenary Cork Oaks with UAV images and upscaling to Sentinel-2 images

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Background

Long-term ecological monitoring program of Doñana National Park (2002) made a specific protocol to monitor "La Pajarera" population. After collecting field data, they found some causes of the steady decline in **cork oak population.**

Remotely sensed images, either from satellite, airborne or from UAVs are being used nowadays. Before studying the status of these cork oaks, it is necessary to extract reliable tree metrics.

1966

2010

Objectives

1. To produce a reliable crown segmentation from a high resolution UAV image using three visible bands: Red, Green and Blue

2. To estimate tree crown volume using the area of segmentation and the photogrammetric point cloud.

3. To assess the relationship between NDVI calculated from UAV multispectral images and NDVI pixel values from Sentinel-2 satellite.

4. To assess crown-segments endmember abundance in Sentinel-2 images using Spectral Linear Unmixing.

Flights
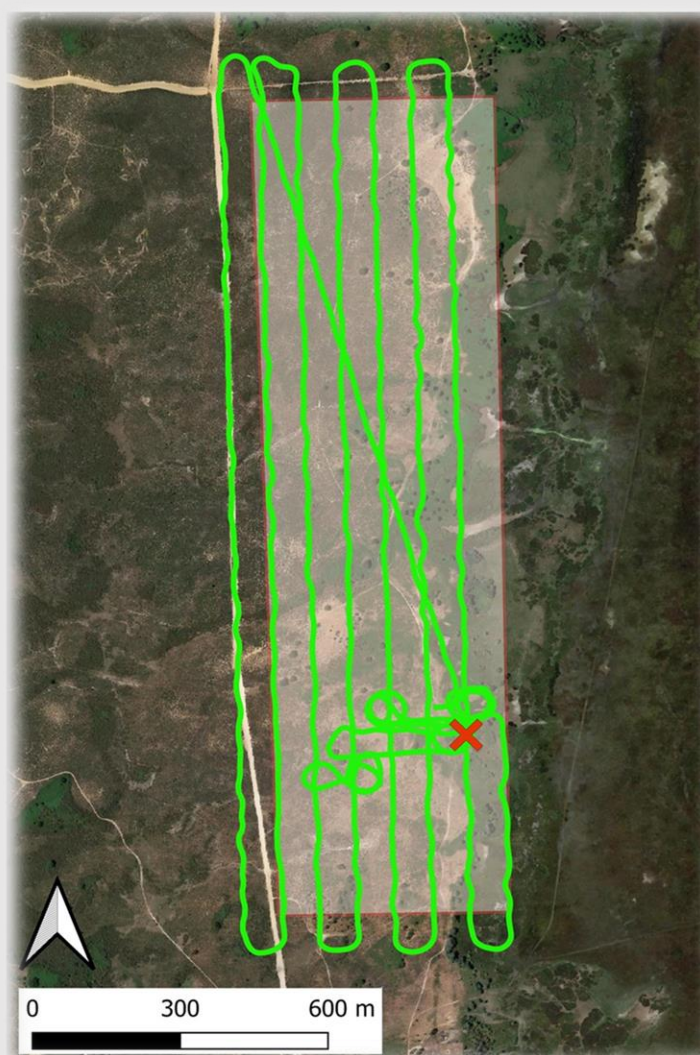
✕ Sequoia take-off point
— Sequoia route
▢ Mission area
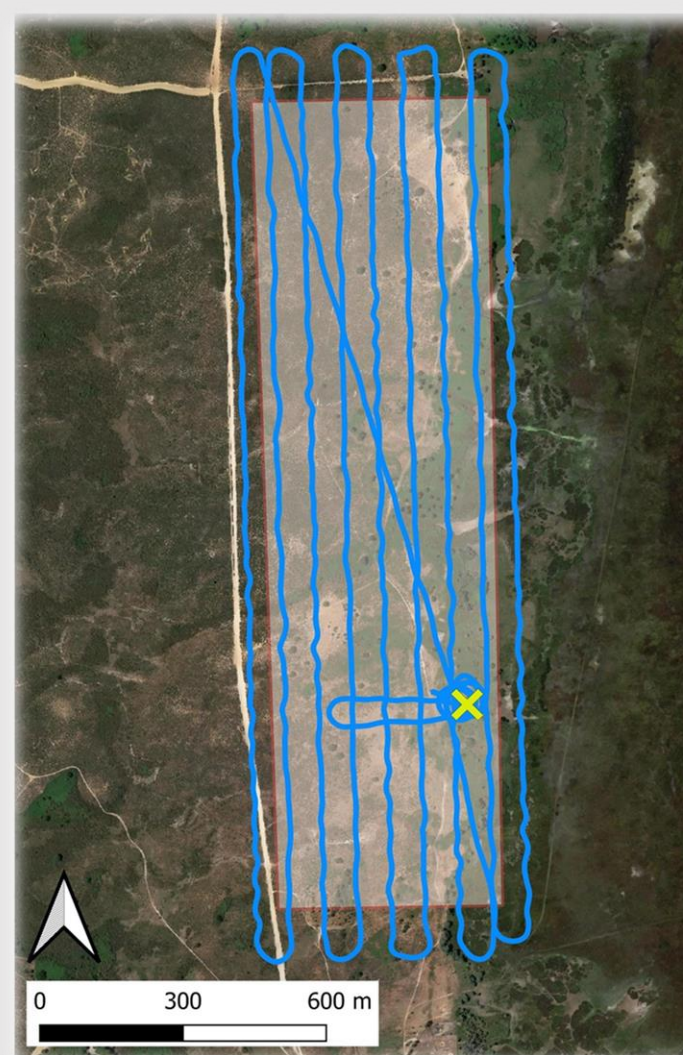
✕ SODA take-off point
— SODA route
▢ Mission area

Results

Crown segmentations

	Level 1	Level 2	Level 3
Scale	300	150	75
Image object level	First	below 300	Below 150
Band weight	R: 0.3, G: 1, B: 0.1	R: 0.4, G: 1, B: 0.2	R: 0.7, G: 1, B: 0.5
Shape	0.1	0.1	0.4
Compactness	0.9	0.9	0.6

Estimation of segmentation reliability:
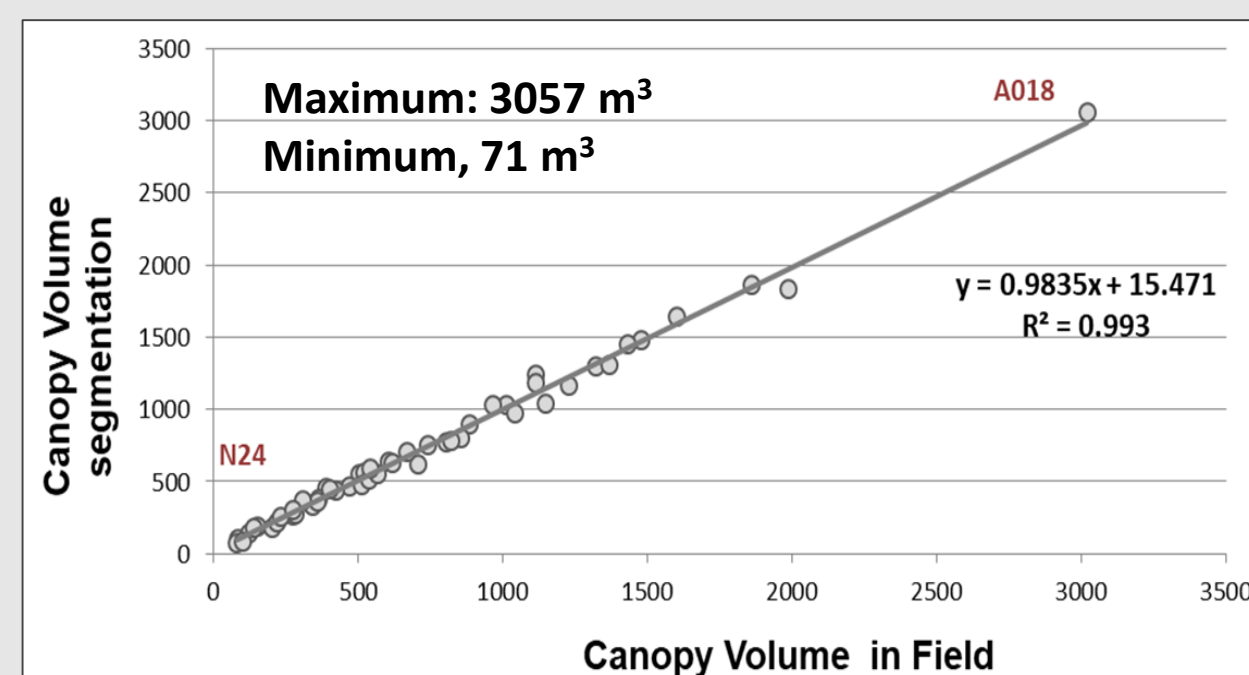Correlation between CD_F and diameter of segmentation (CD_S), Commission and Omission Error
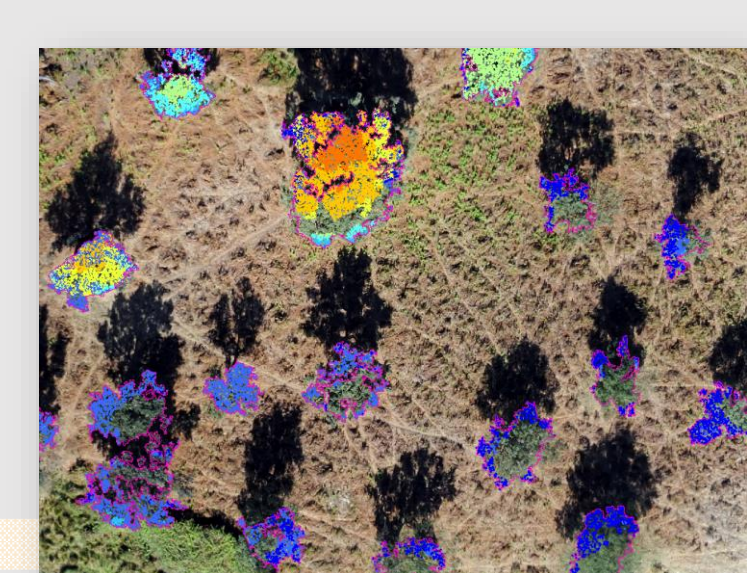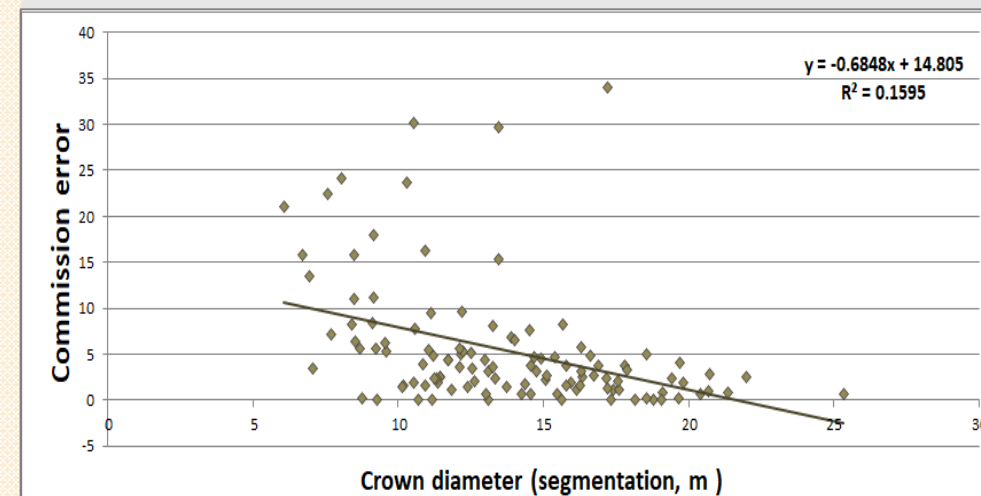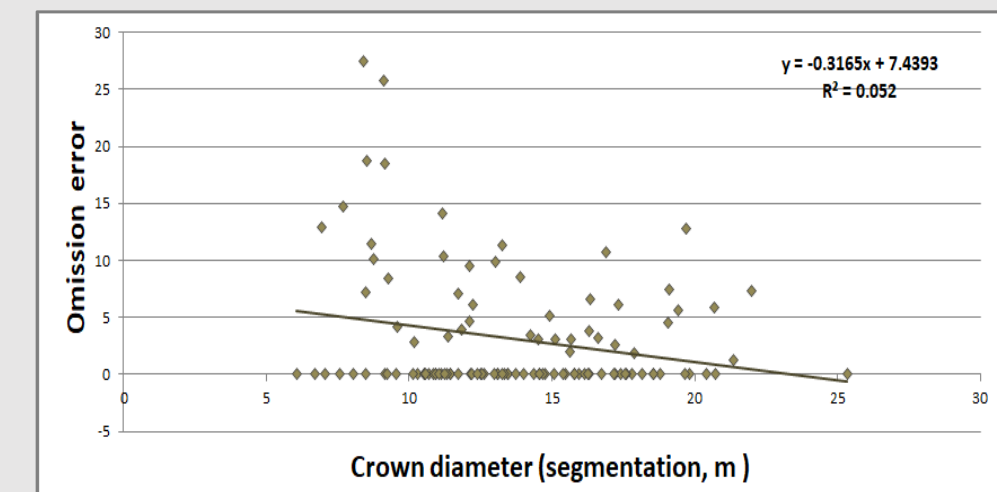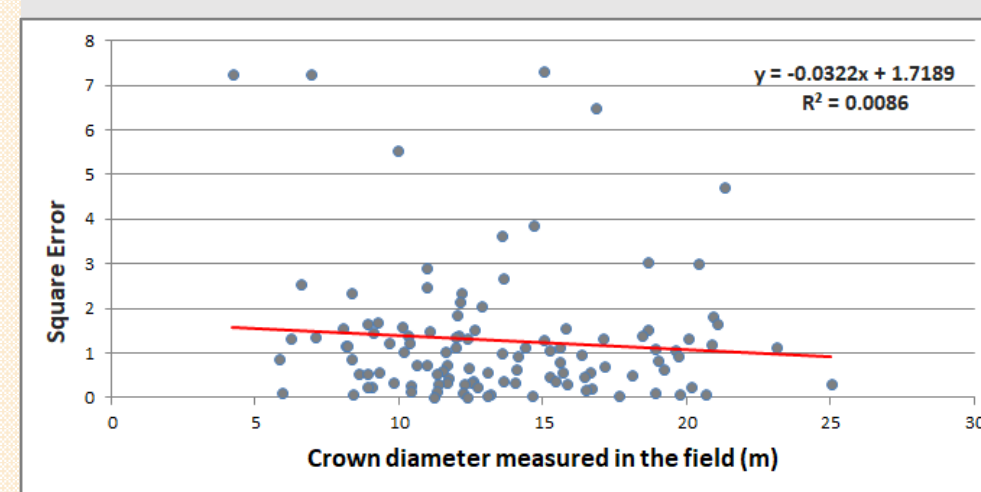
- Pearson's correlation between CD_F and CD_S: **0.9 ($p < 0.01$)**
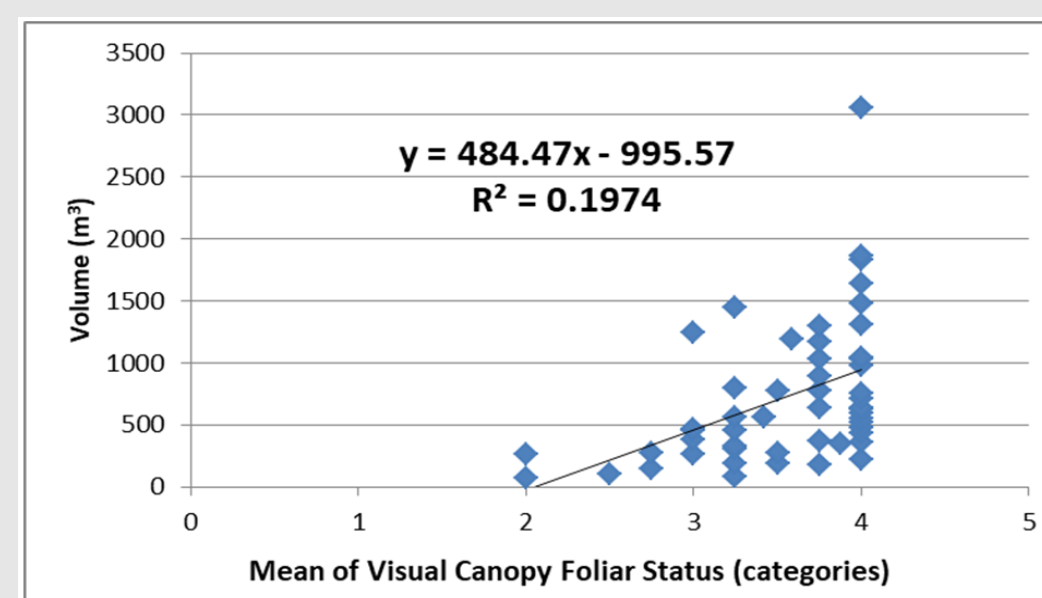- RMSE: 1.88 m. Range: 0.04 - 7.33 m
- RMSE, Commission and Omission errors are not related to crown size

$y = -0.0322x + 1.7189$
$R^2 = 0.0086$

$y = -0.3145x + 7.4393$
$R^2 = 0.052$

$y = -0.6848x + 14.805$
$R^2 = 0.1595$

Tree metric variables (TMS)

RMSE of Canopy Height below 1 metre (> 23.6 points/ m²)

Maximum: 3057 m³
Minimum, 71 m³
$y = 0.9835x + 15.471$
$R^2 = 0.993$

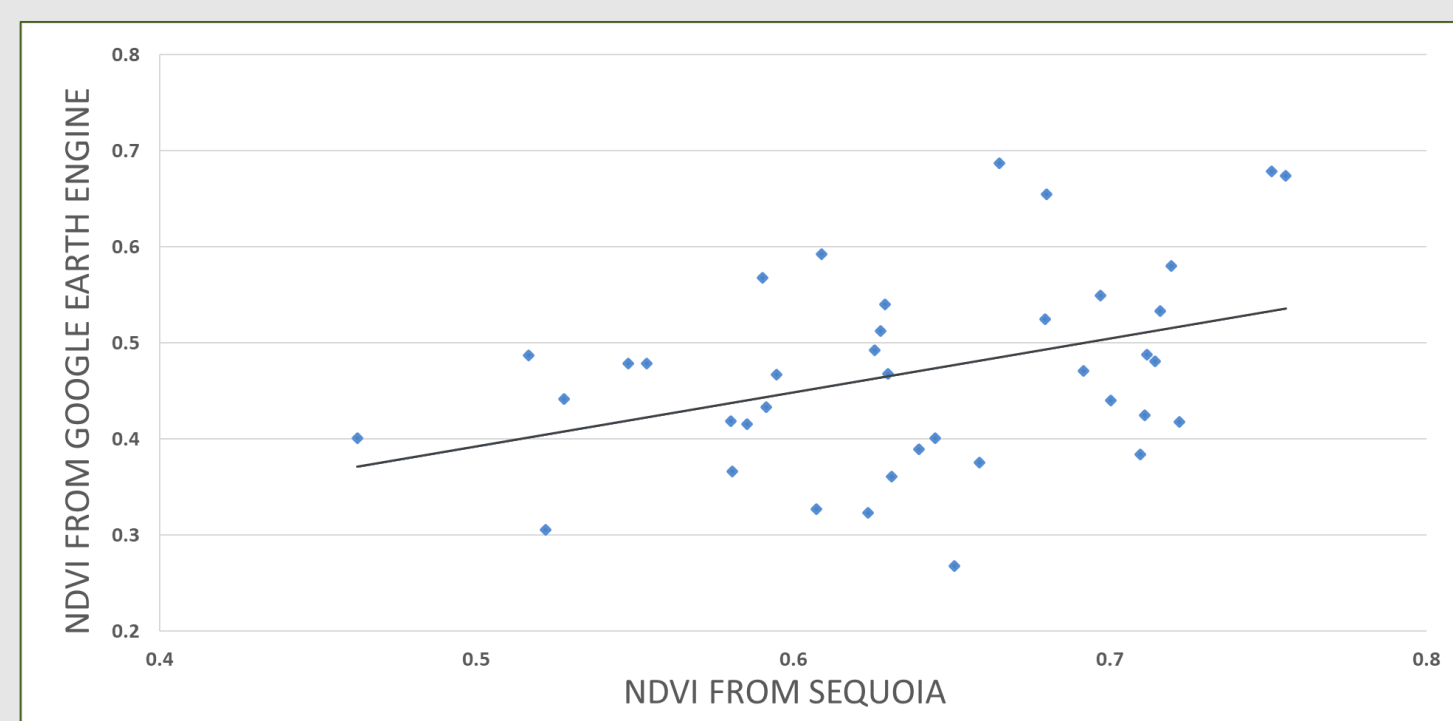*r =0.9 (p-value <0.001)

$y = 484.47x - 995.57$
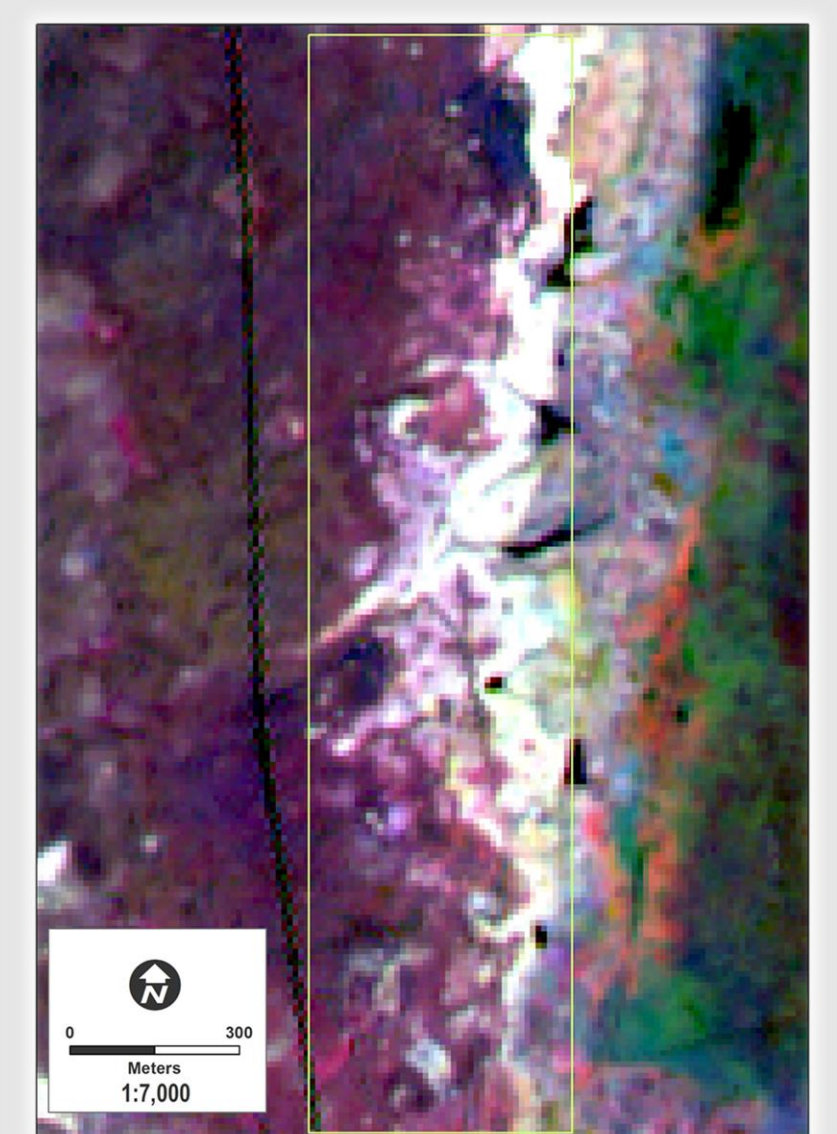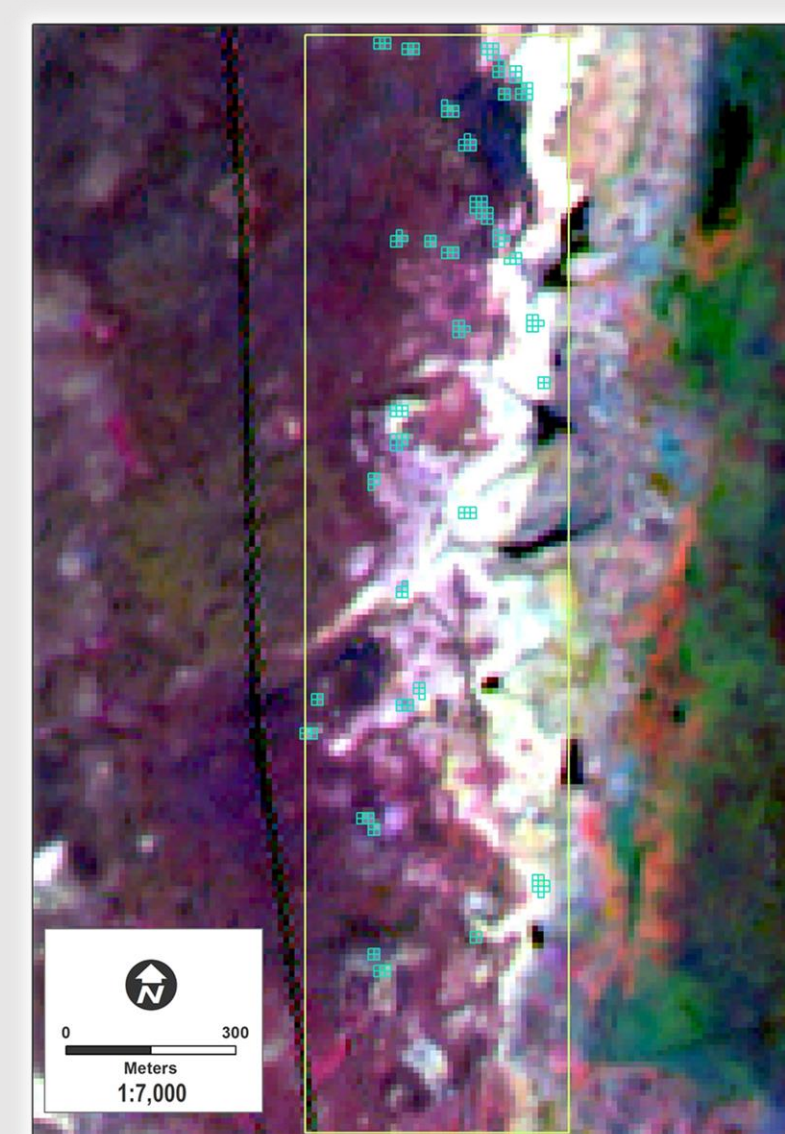$R^2 = 0.1974$

*r =0.51 (p-value <0.001)

NDVI

*r =0.4 (p-value = 0.001)

Linear Spectral Unmixing

Abundance bands: R: year 2018; G: year 2019; B: year 2020.
Blue squares (left) are the Sentinel-2 pixels intersecting with crown segments

Conclusions

1. It is possible to perform a reliable tree crown segmentation using RBG bands from a high resolution UAV image.

2. The volume of tree crowns can accurately be calculated from UAV imagery and photogrammetric points although they might be affected by other factors such as mission planning or weather that can cause an irregular point cloud density.

3. NDVI from UAV image bands and from Sentinel-2 satellite imagery are significantly correlated.

4. Linear Spectral Unmixing provided abundances of cork oaks in the Sentinel-2 pixels where other plant species are also present reaching a 70% of endmember abundance for pixels of identified tree crowns.