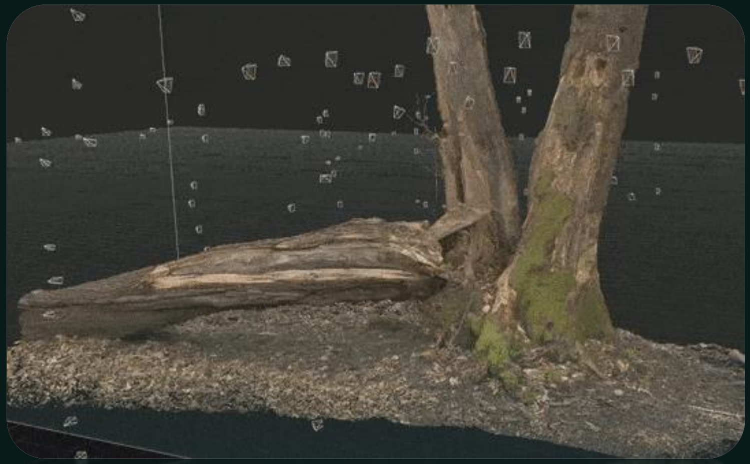
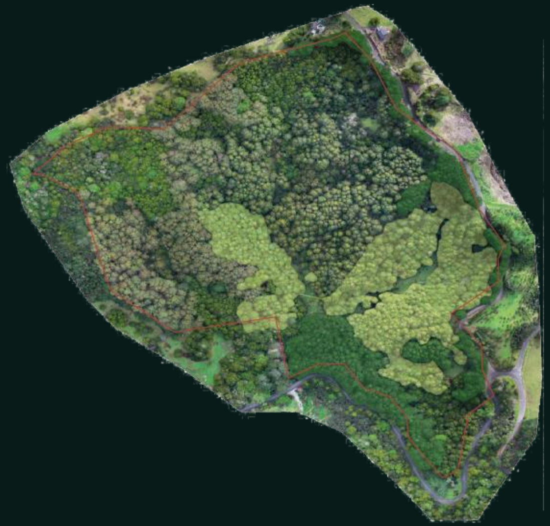
UAV Photogrammetric Point Clouds for Shrub Species Classification

JUAN PEDRO CARBONELL-RIVERA

Introduction

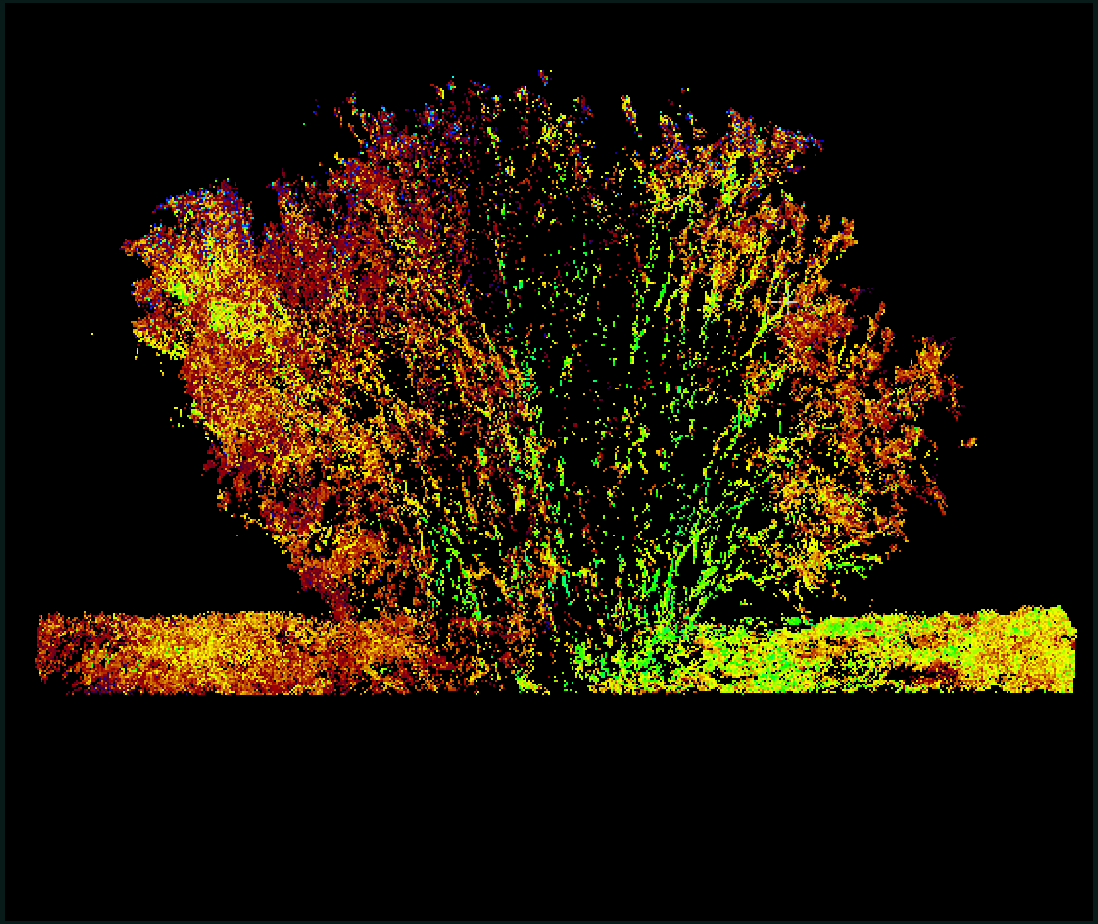
The application of photogrammetry to UAV flights allows us to obtain point clouds, three-dimensional models and orthophotos.



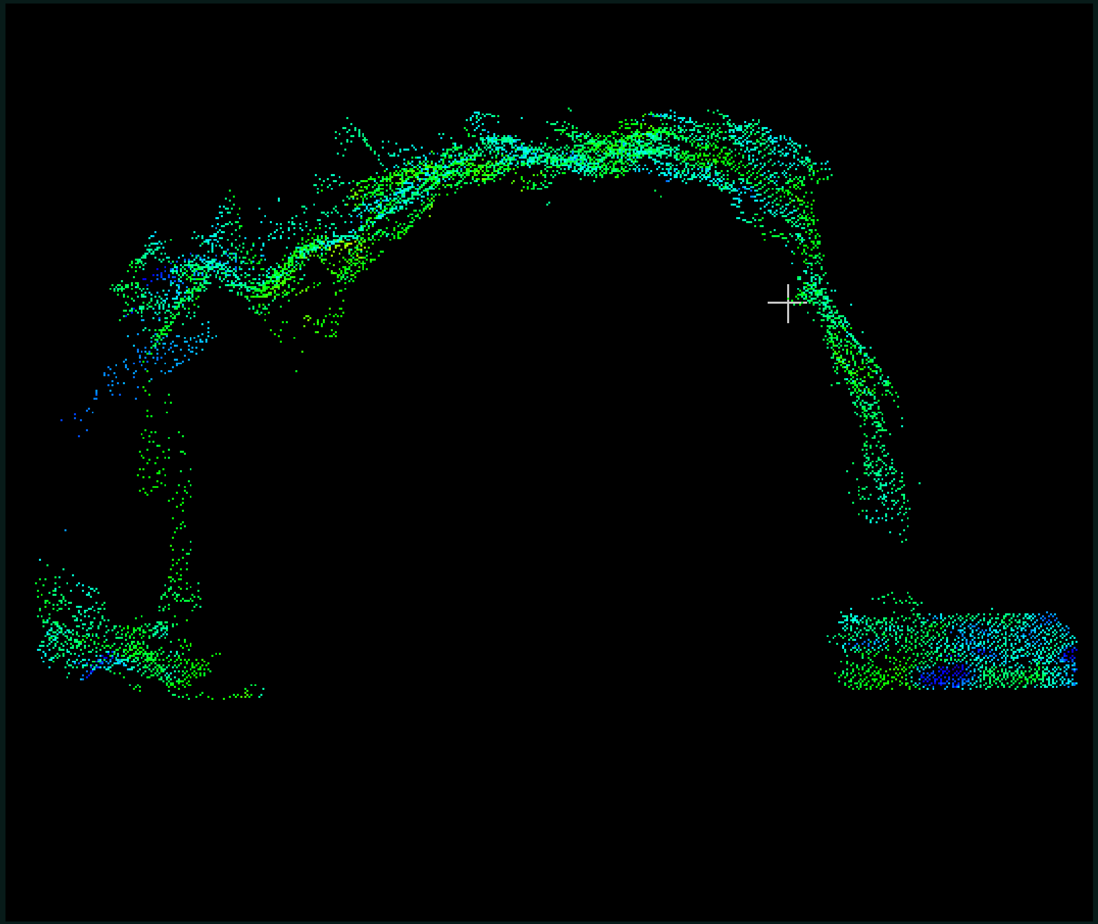


Photogrammetric point clouds provide **geometric** and **spectral information**.

TLS



UAV

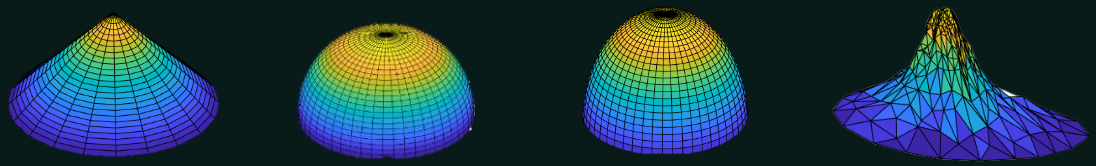


Comparison of measurements of *Nerium oleander* L. by classical measurements, Terrestrial Laser Scanner (TLS) and UAV-derived imagery
XVIII Spanish Association of Remote Sensing Congress

CGAT

OBJECTIVES

- To determine the feasibility of using point clouds derived from UAV-DAP for dendrometric analysis.
- To compare the total height (Ht), perimeter (P), area (A), conical volume (Vco), volume of a semi-ellipsoid of revolution (Vs), hemispherical volume (Ve) and volume calculated from the triangulation of the point cloud (Vt).



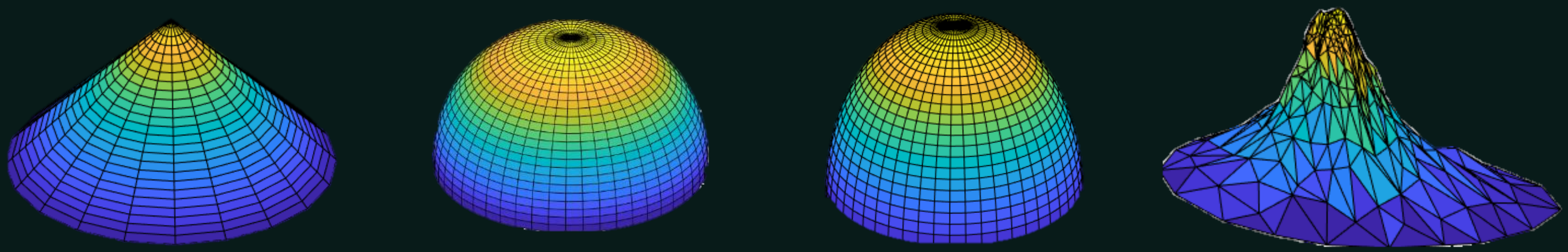
Comparison of measurements of *Nerium oleander* L. by classical measurements, Terrestrial Laser Scanner (TLS) and UAV-derived imagery

XVIII Spanish Association of Remote Sensing Congress, 2019

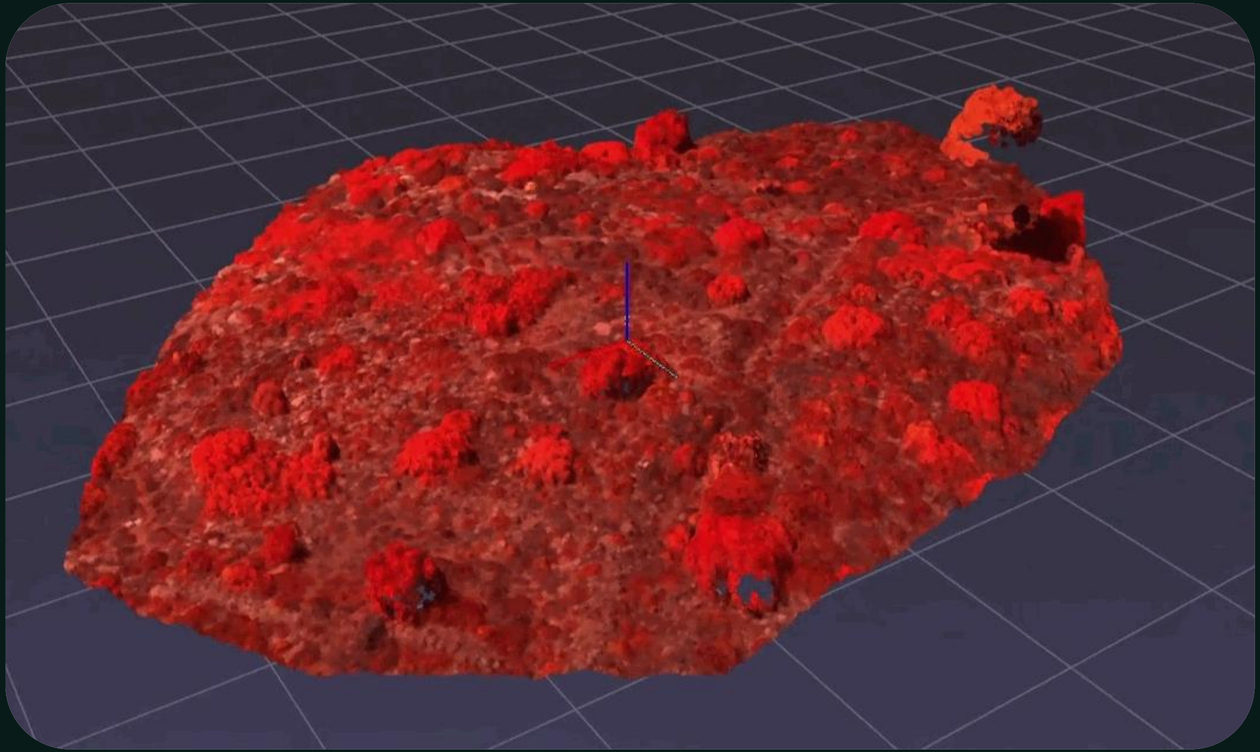
HIGHLIGHTS

- It is possible to derive dendrometric parameters in shrubs using UAV-DAP.
- No significant differences were found between classical measurement, TLS, and UAV, with a high correlation between techniques in all analyzed parameters.

Parameter		UAV-TLS
H_t (m)	Equation	$H_{t\text{-}TLS}=0,8148*H_{t\text{-}UAV}+0,4932$
	R^2 | RMSE	0,94 | 0,24
P (m)	Equation	$P_{TLS}=0,7241*P_{UAV}+2,8642$
	R^2 | RMSE	0,94 | 1,35
A (m^2)	Equation	$A_{TLS}=0,7744*A_{UAV}+1,8745$
	R^2 | RMSE	0,94 | 1,64
V_s (m^3)	Equation	$V_{s\text{-}TLS}=0,7298*V_{s\text{-}UAV}+3,1765$
	R^2 | RMSE	0,95 | 7,87
V_{co} (m^3)	Equation	$V_{co\text{-}TLS}=0,7298*V_{co\text{-}UAV}+1,5883$
	R^2 | RMSE	0,95 | 2,39
V_e (m^3)	Equation	$V_{e\text{-}TLS}=0,6804*V_{e\text{-}UAV}+2,3486$
	R^2 | RMSE	0,92 | 4,08
V_t (m^3)	Equation	$V_{t\text{-}TLS} = 0,5854* V_{t\text{-}UAV}+ 0,7853$
	R^2 | RMSE	0,98 | 3,74



Photogrammetric point clouds provide **geometric** and **spectral information**.



- What can these point clouds bring us in forestry?
  - Segmentation of individuals
  - Species classification
  - Direct measurement of variables (heights, crown diamenter…)
  - Application of allometric equations
  - Derive variables that can be used for their introduction in forest fire modeling

Class3Dp: A supervised classifier of vegetation species from point clouds

Environmental Modelling & Software, Volume 171, 105859

HIGHLIGHTS

- Class3Dp is a supervised classifier software of coloured point clouds based on 3D and spectral information.
- The software is designed to classify plant species in RGB and multispectral point clouds.
- Class3Dp calculates up to 48 features and supports five machine learning models.

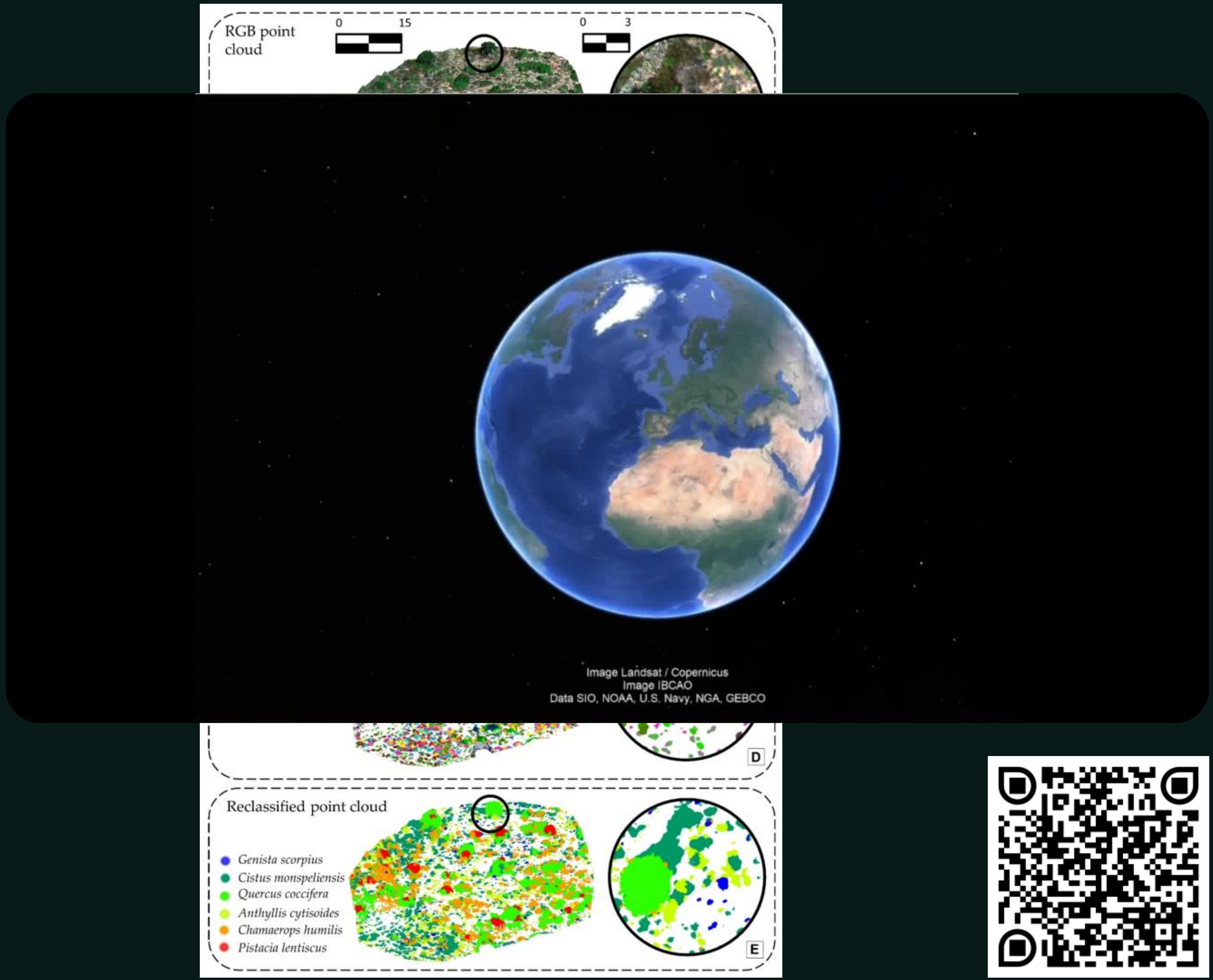
Feature type	Classification	Name	Description
Spectral	RGB and MS	Blue	Blue value of the point
Spectral	RGB and MS	Green	Green value of the point
Spectral	RGB and MS	Red	Red value of the point
Spectral	MS	RedEdge	RedEdge value of the point
Spectral	MS	NIR	NIR value of the point
Spectral	MS	ARVI	Atmospherically Resistant Vegetation Index
Spectral	RGB and MS	BI	Brightness
Spectral	RGB	CIVE	Colour Index of Vegetation
Spectral	MS	DVI	Differential Vegetation Index
Spectral	MS	EVI	Enhanced Vegetation Index
Spectral	RGB	GLI	Green Leaf Index
Spectral	MS	GNDVI	Green Normalized Difference Vegetation Index
Spectral	RGB and MS	GR	Green divided by red
Spectral	MS	IPVI	Infrared Percentage Vegetation Index
Spectral	RGB	MGVRI	Modified Green-Red Vegetation Index
Spectral	MS	MSAVI	Modified Soil-Adjusted Vegetation Index
Spectral	MS	MSR	Modified Simple Ratio Index
Spectral	RGB and MS	NBRDI	Normalized Blue-Red Difference Index
Spectral	MS	NDVI	Normalized Difference Vegetation Index
Spectral	RGB and MS	NGBDI	Normalized Green-Blue Difference Index
Spectral	RGB and MS	NGRDI	Normalized Green-Red Difference Index
Spectral	RGB	NormG	Normalized Greenness
Spectral	MS	OSAVI	Optimized Soil Adjusted Vegetation Index
Spectral	MS	RDVI	Renormalized Difference Vegetation Index
Spectral	RGB and MS	RGRI	Red Green Ratio Index
Spectral	MS	RVI	Ratio Vegetation Index
Spectral	RGB	SAVI	Soil Adjusted Vegetation Index
Spectral	MS	SARVI	Soil and Atmospherically Resistant Vegetation Index
Spectral	MS	SR	Simple Ration Vegetation Index
Spectral	MS	SRxNDVI	Simple Ratio × Normalized Difference Vegetation Index
Spectral	RGB	VARI	Visual Atmospheric Resistance Index
Spectral	RGB	vNDVI	Visible Normalized Difference Vegetation Index
Neighbourhood spectral	MS	NDVI_mean	Mean NDVI of the point and its Neighbouring points
Neighbourhood spectral	MS	NDVI_std	Standard deviation NDVI of the point and its Neighbouring points
Neighbourhood spectral	RGB	NGRDI_mean	Mean NGRDI of the point and its Neighbouring points
Neighbourhood spectral	RGB	NGRDI_std	Standard deviation NGRDI of the point and its Neighbouring points
Geometrical	RGB and MS	X	Coordinate X of the point
Geometrical	RGB and MS	Y	Coordinate Y of the point
Geometrical	RGB and MS	Z	Height of the point
Neighbourhood geometrical	RGB and MS	Numbers	Number of neighbours
Neighbourhood geometrical	RGB and MS	Dist_mean	Mean distance of the point with its Neighbouring points
Neighbourhood geometrical	RGB and MS	Dist_std	Standard deviation of the point with its Neighbouring points
Neighbourhood geometrical	RGB and MS	Z_mean	Mean height of the point and its neighbours
Neighbourhood geometrical	RGB and MS	Z_std	Standard deviation height of the point and its neighbours
Neighbourhood geometrical	RGB and MS	Dif_Z	Neighbourhood maximum height minus Neighbourhood minimum height
Neighbourhood geometrical	RGB and MS	Z_Zmin	Point height minus Neighbourhood minimum height
Neighbourhood geometrical	RGB and MS	Zmax-Z	Maximum Neighbourhood height minus point height
Neighbourhood geometrical	RGB and MS	Sum_λ	Sum of eigenvalues
Neighbourhood geometrical	RGB and MS	Omnivariance	Three-dimensional distribution of the points in the Neighbourhood
Neighbourhood geometrical	RGB and MS	Eigenentropy	Shannon entropy of the normalized eigenvalues
Neighbourhood geometrical	RGB and MS	Anisotropy	Change of the Neighbourhood in different directions
Neighbourhood geometrical	RGB and MS	Planarity	Two-dimensionality of the Neighbourhood on the x and y axes.
Neighbourhood geometrical	RGB and MS	Linearity	Neighbourhood dimensionality on one axis.
Neighbourhood geometrical	RGB and MS	Surface Variation	Surface roughness in all three dimensions
Neighbourhood geometrical	RGB and MS	Sphericity	Resemblance of the Neighbourhood to the shape of a perfect sphere
Neighbourhood geometrical	RGB and MS	Verticality	Z component of the normal vector

Classification of Mediterranean Shrub Species from UAV Point Clouds

Remote Sensing. 2022, 14, 199

HIGHLIGHTS

- Classification of 11 shrub and one tree species in the Natural Park of Sierra Calderona.
- UAV DJI Inspire 2 equipped with a multispectral camera (Micasense RedEdge).
- Overall accuracies of 81.9% and 96.4% were obtained for test sites 1 and 2.

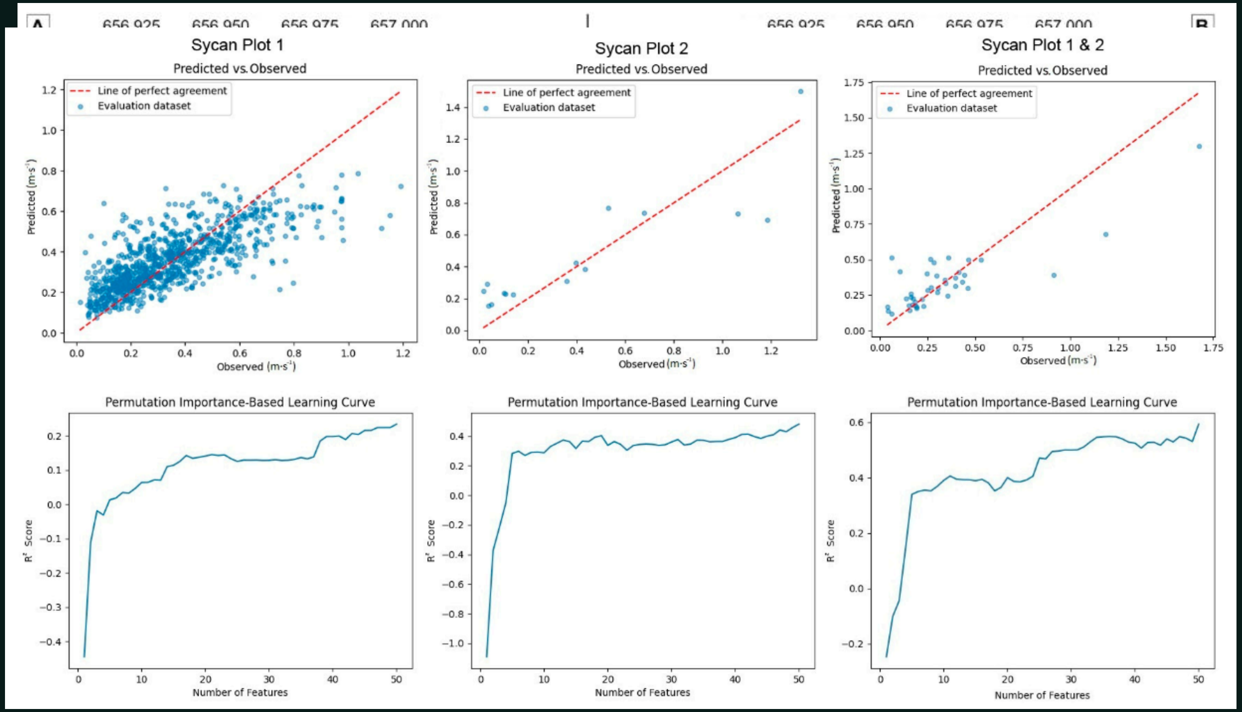


Relationships of Fire Rate of Spread with Spectral and Geometric Features Derived from UAV-Based Photogrammetric Point Clouds

Fire. 2024, 7(4), 199

HIGHLIGHTS

- Examines the relationship in prescribed burns between RoS and various geometrical, spectral, and neighborhood variables from UAV-derived point clouds.
- Identifies geometric variables like planarity and spectral indices such as the normalized blue–red difference index (NBRDI) as related to fire RoS.

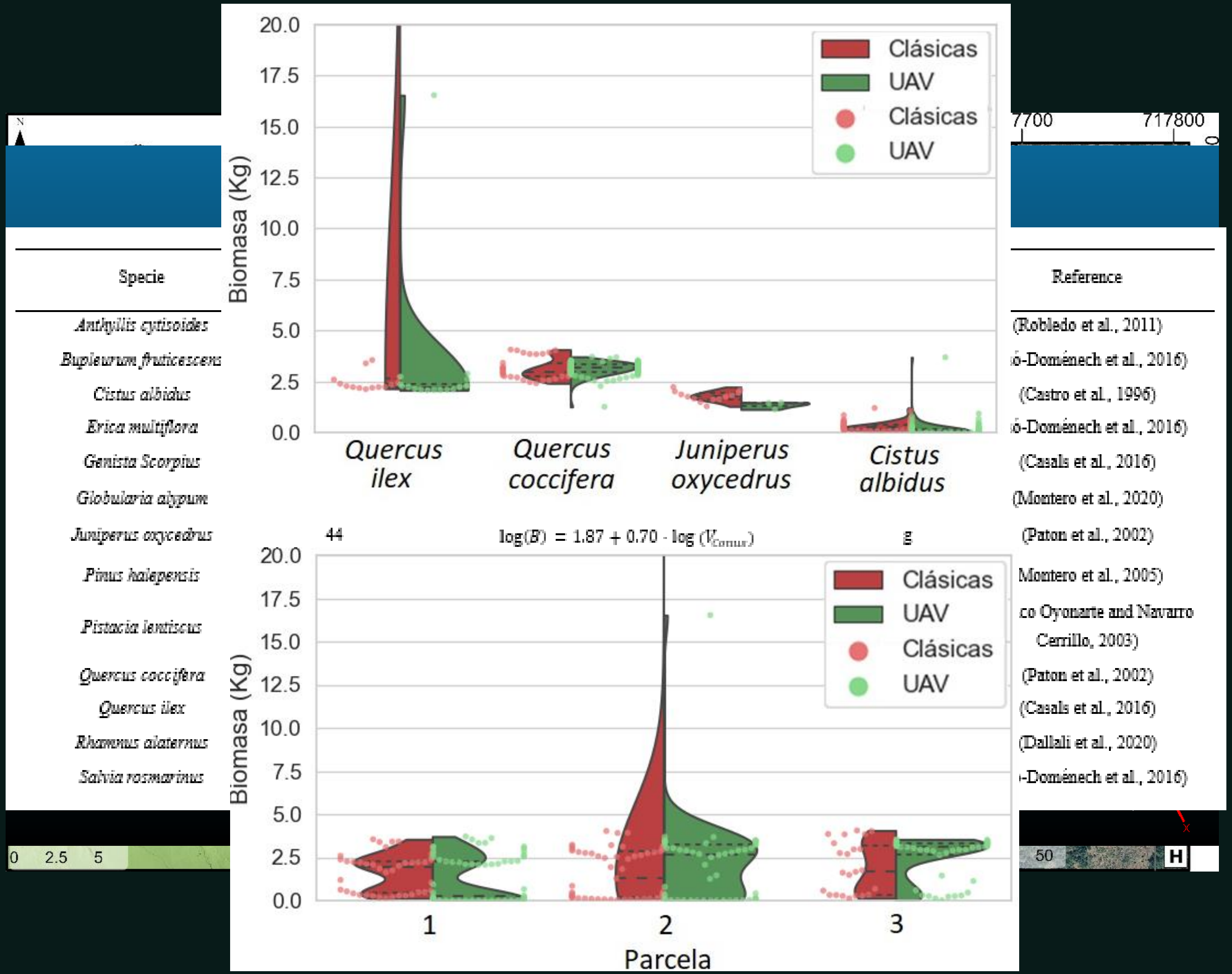


Biomass estimation from UAV-based digital aerial photogrammetric (DAP) point clouds in Mediterranean forest

Work in progress…

HIGHLIGHTS

- Individuals were segmented and classified into 13 different species.
- Biomass of each individual was estimated using species-specific allometric equations obtained from literature review



Thank you!

Juan Pedro
Carbonell-Rivera

Juacarri@upv.es

@Jua_carri