An assessment of aerial carbon stock combining forest inventory data with LiDAR-derived canopy and topography metrics

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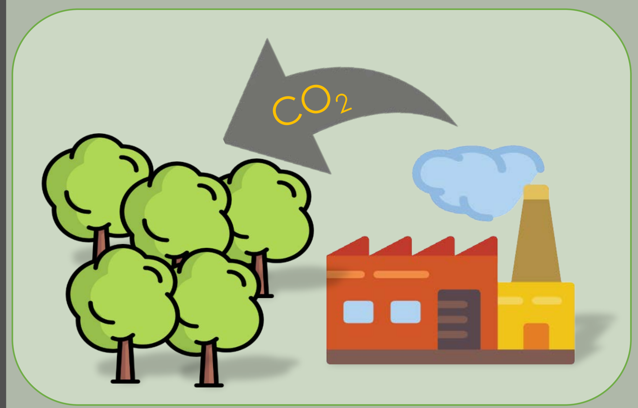
Introduction

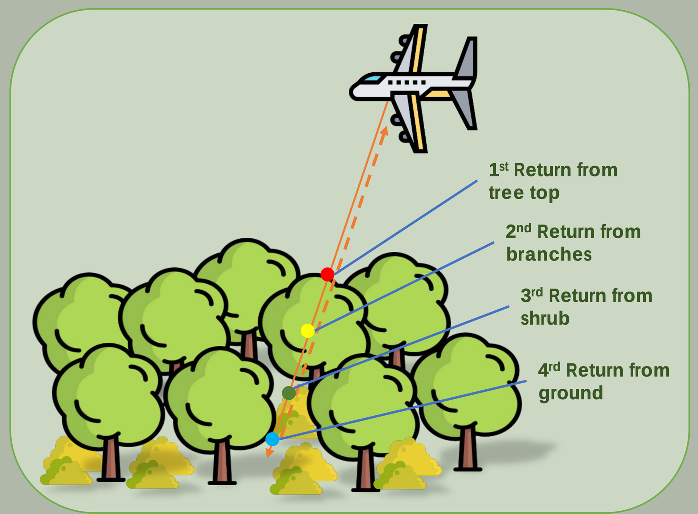
Forests are the second largest land cover in the world, occupying 27.7% of the planet's continental surface [1]. These areas are **the main carbon pools** and therefore play a crucial role in regulating the terrestrial carbon cycle and global warming processes [3,4].



The diversity in plant formations implies that the carbon sink capacity is also very wide. For this reason, it is **complex to quantify** carbon stocks in whole agro-forested areas [3].

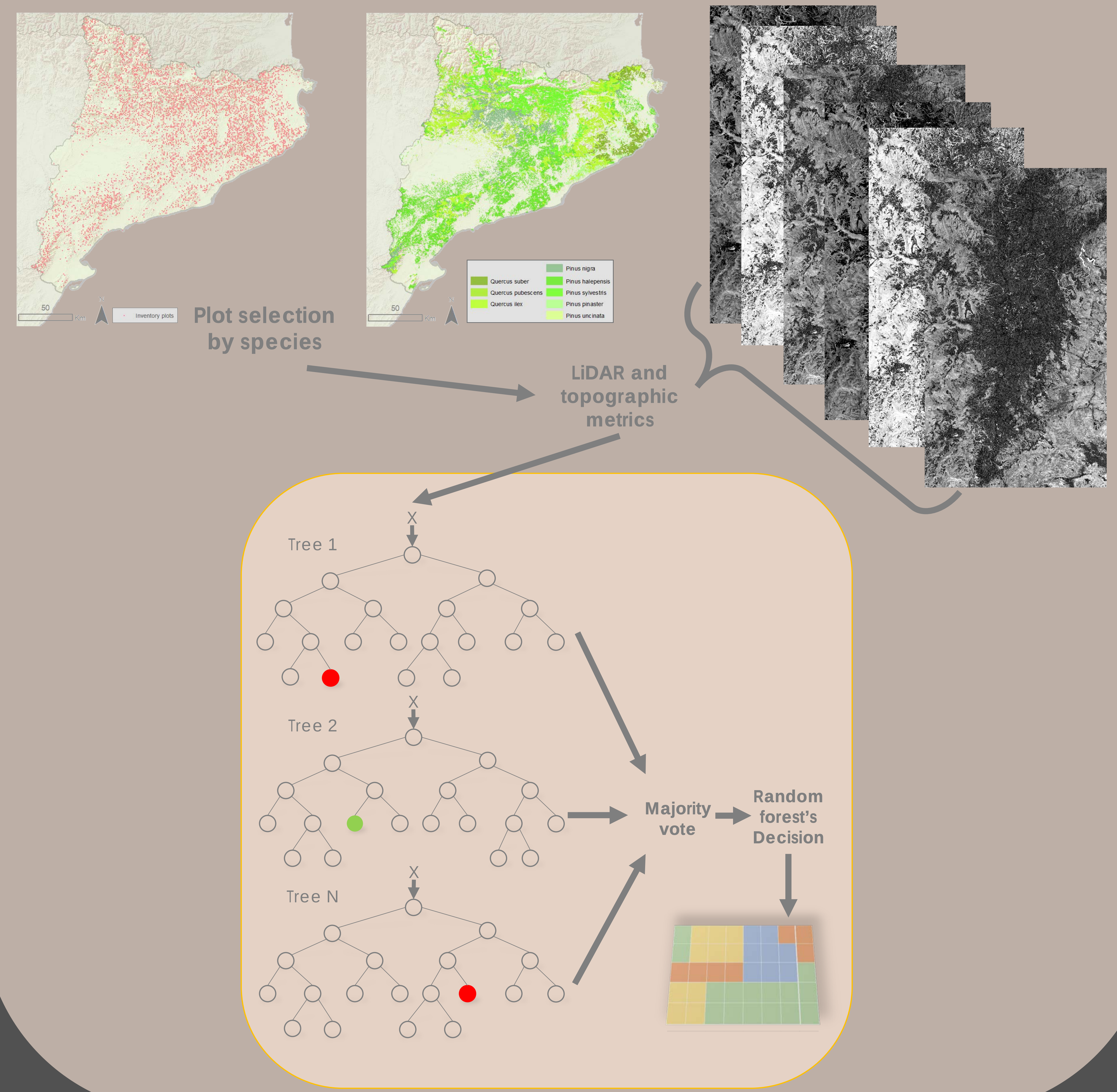
Airborne LiDAR (**L**ight **D**etection **A**nd **R**anging), also known as ALS, provides high accurate **3D point** clouds of vegetation and terrain and allows **forest inventory and mensuration** by means of forest structure analysis [2]. The Spanish Geographic Institute (IGN) has developed the PNOA program, which serves a low point density LiDAR (0.5 points/m²) for the whole Spanish territory (~500.000 km²)

THE GOAL: To model and spatialize Sequestered Carbon in Mediterranean Forests (Catalonia, Spain), through a Random Forest algorithm, using LiDAR-PNOA data and topographic metrics as independent variables



Methodology

Random Forest is a **Machine Learning** ensemble classifier that uses a multitude of **decision trees** to classify. The nodes of tree decision are divided using the best variables selected from a random sample.



Results

Specie	R^2
Pinus halepensis	0,83
Pinus nigra	0,83
Pinus sylvestris	0,78
Pinus uncinata	0,82
Quercus ilex	0,83
Quercus pubescens	0,81
Quercus suber	0,80

Data

Independent Variable

Aerial Carbon from 4th Spanish Forest Inventory

Dependent Variables

LiDAR-derived Forest metrics

$$M_{height} = \frac{\sum_{i=1}^{N} x_i}{N}$$

$$SD_{height} = \sqrt{\frac{\sum_{i=1}^{N}(x_i-\mu)^2}{N}}$$

$$Kurt_{height} = \frac{\sum_{i=1}^{N}(x_i-\mu)^4}{(N-1)\sigma^4}$$

$$Skew_{height} = \frac{\sum_{i=1}^{N}(x_i-\mu)^3}{(N-1)\sigma^3}$$

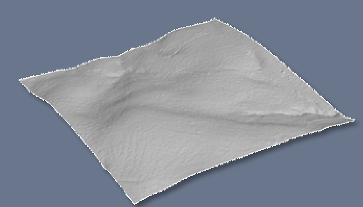
$$\text{Canopy relief ratio (CCR)} = \frac{\mu - x_{i\,min}}{x_{i\,max} - x_{i\,min}}$$

$$Canopy\ Cover = \frac{\sum_{i=1}^{N} r_{i\,first} > 0.2\ m}{\sum_{i=1}^{N} r_{i\,first}} \times 100$$

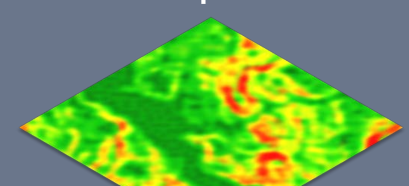
95th height percentile

LiDAR-derived Topographic metrics

Elevation



Slope



Conclusions

The combination of **Forest inventory** data and **LiDAR-based** forest and topographic **metrics enable modelling and spatializing carbon stock at landscape level**. Random Forest regression performance supports the reliability of the models (R^2>0.78). Further developments will explore carbon stock in scrubland communities as well as several improvements to measure biomass at stand level.

ACKNOWLEDGEMENTS

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