

Airborne LiDAR in forest management: forest inventory, fuel models and scale change

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Regional Forest inventory and fuel model inventory

Using low point-density airborne LiDAR and remote sensing for:

Forest
resources
planning
(large scale)

Forest
resources
management
(short scale)

Fuel models
(large scale)

Intro /
Objectives

Project for a regional government

GINFOR

Web platform for forest management and planning

context

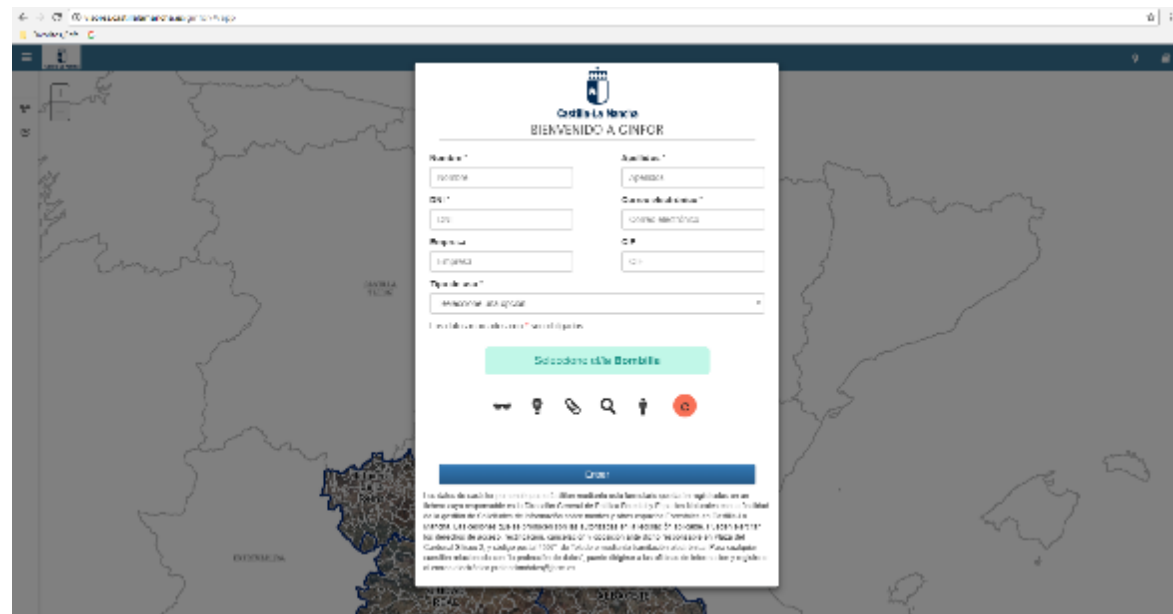


Project for a regional government

GINFOR

Web platform for forest management and planning

context



challenge

3 main challenges:

methodology
integrating two
scales with
available data

information
volume / scale
8M ha / 3M
forested ha

time
9 months

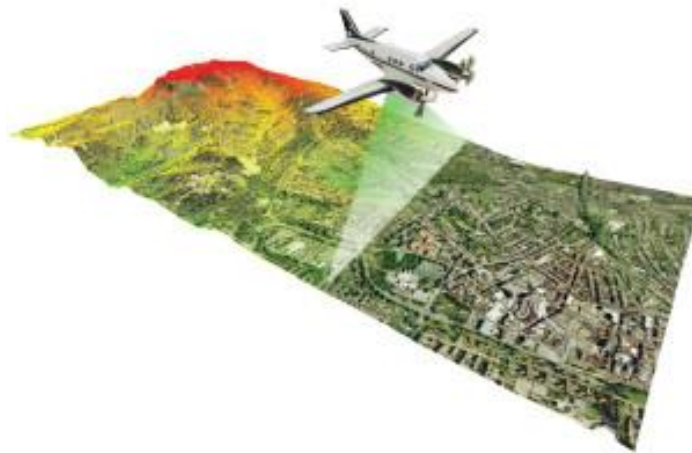
Data



Data

Forest Inventory

- LiDAR (PNOA): 30.000 .laz files
- Spanish Forest Map + Spanish National Inventory
- Field work: 720 field plots



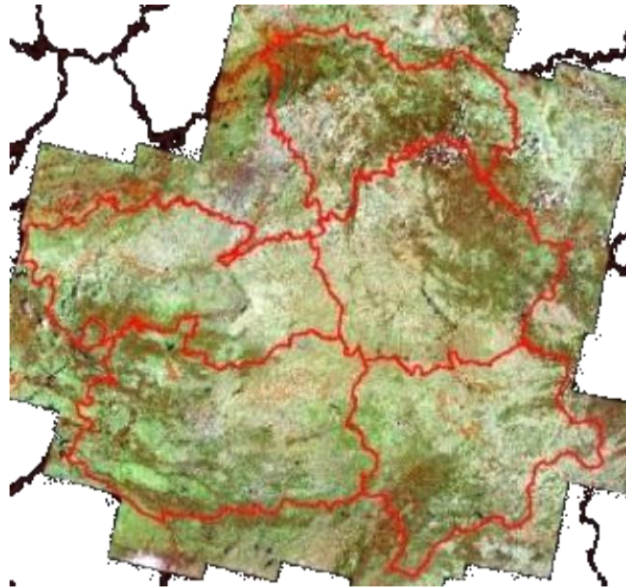
Data

Fuel models

- Spectral Info: combination of spectral, temporal and spatial resolution information
- LiDAR (PNOA)
- Field data: +1700 polygons in field



Mosaic MODIS-SPOT-LANDSAT

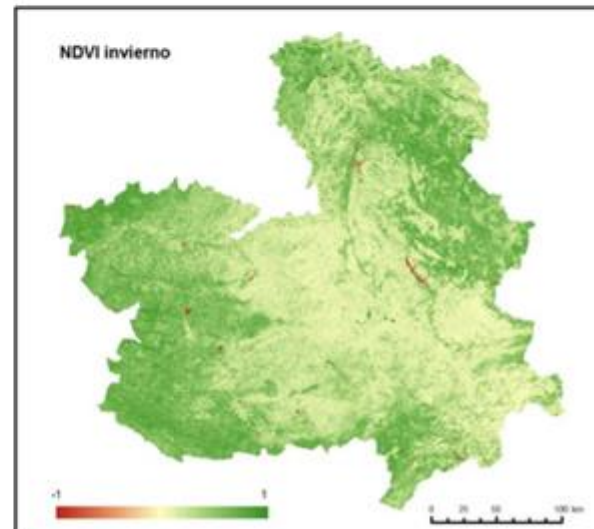
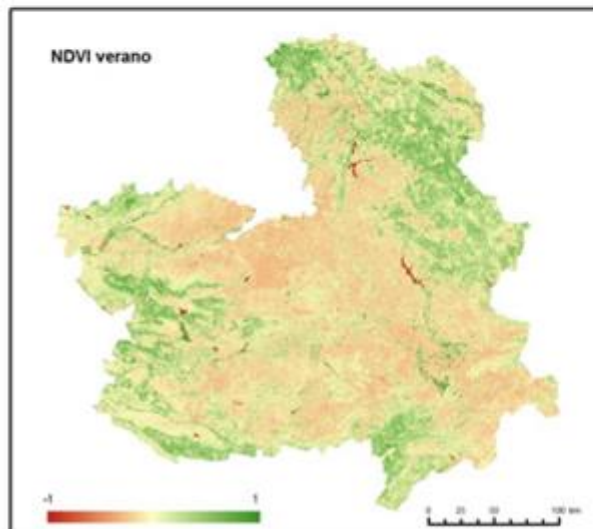
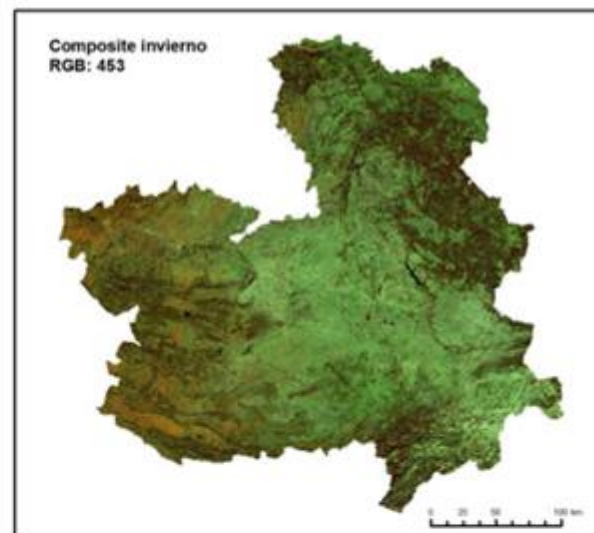


Data

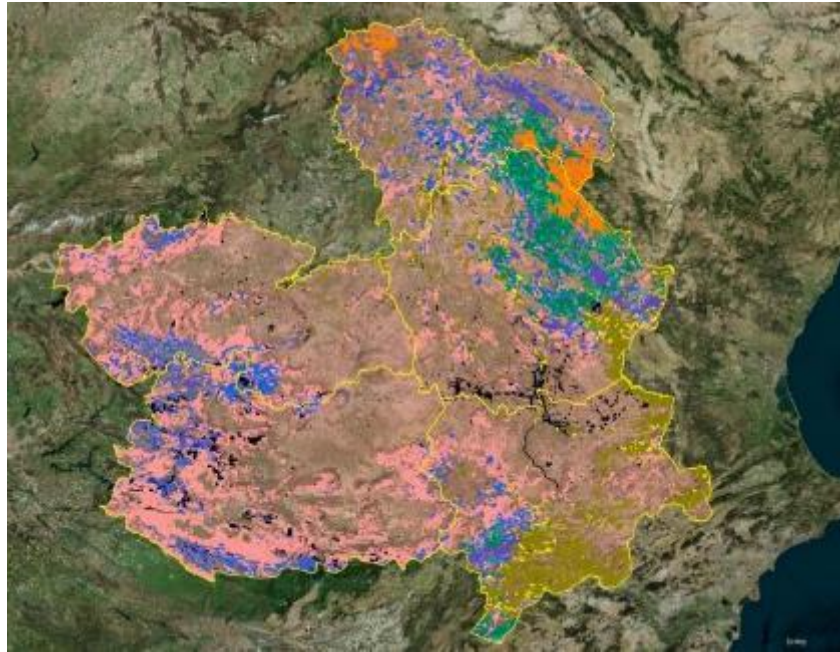
Temporal, spatial and spectral resolution

Data

LANDSAT

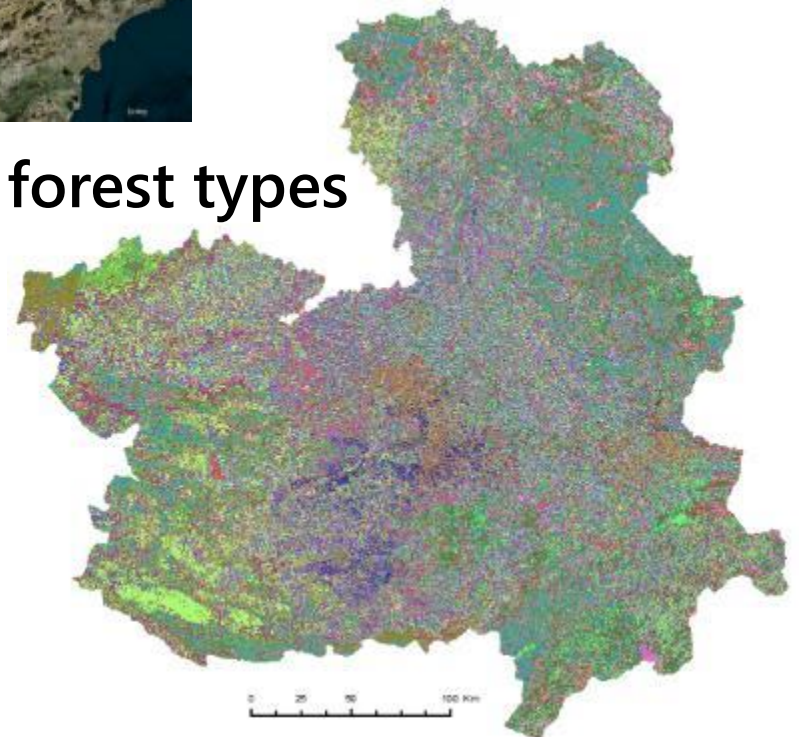


Stratification



11 strata: main forest types

70 clusters: main forest types



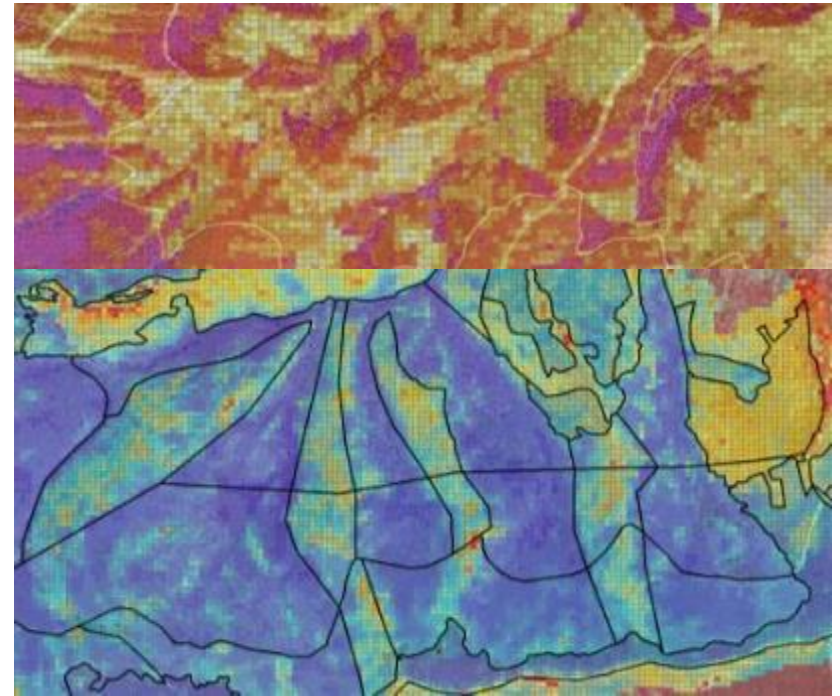
Regional Forest Inventory



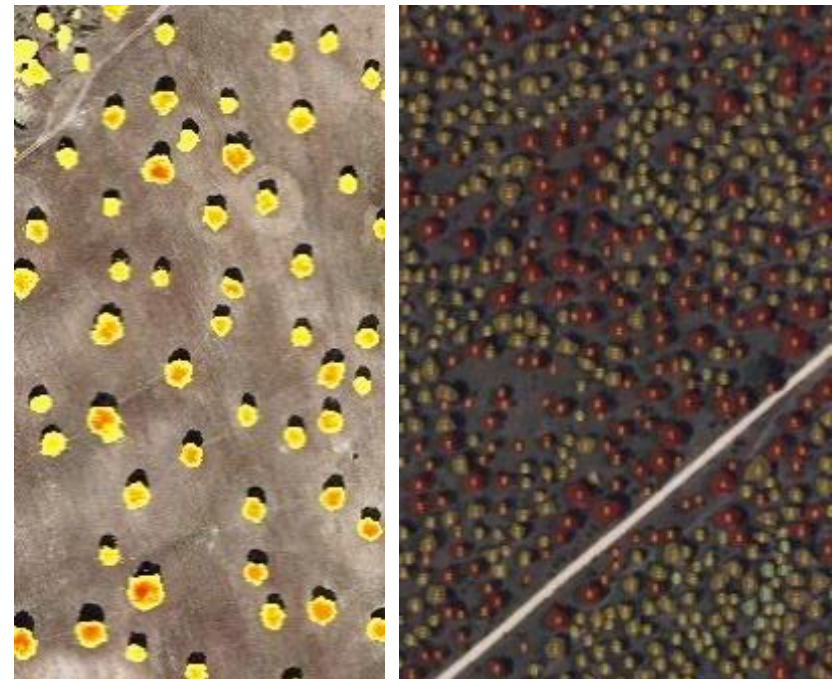
Processes

LiDAR inventory methodologies

- Stand level

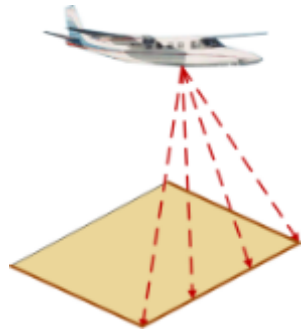


- Individual tree



Processes

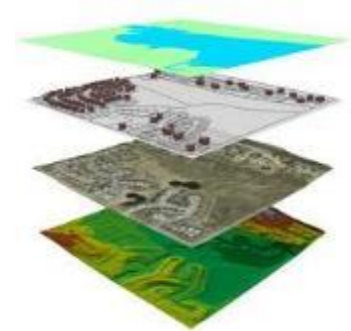
Phases



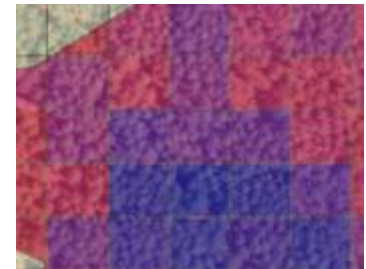
Data surveys



- Plot calculation
- LiDAR data processing
- LiDAR metrics in plots
- Model fitting
- Validation
- Calibration



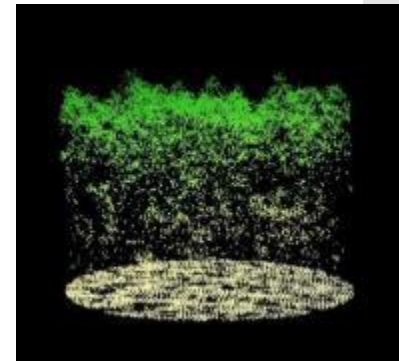
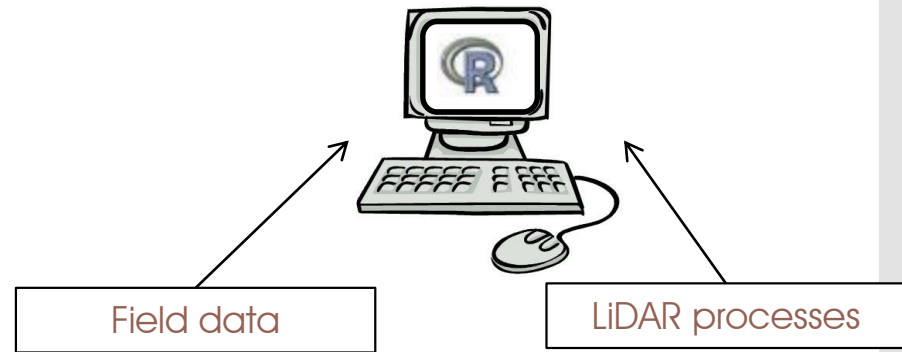
Thematic cartography
(SV, Ho, G, Dg, N, VI)



Forest Inventory flux

LiDAR model fitting

$$N = a_0 + LFCC^{a1} \cdot LH_{95}^{a2} \cdot LI_{10}^{a3}$$



LiDAR model fitting Results

Examples

$$\begin{aligned} \text{Potential models} &\rightarrow V = T \cdot I \cdot \text{var}_1^{\text{parm}_1} \cdot \text{var}_2^{\text{parm}_2} \cdot \dots \cdot \text{var}_n^{\text{parm}_n} \\ \text{Exponential models} &\rightarrow V = e^{(T \cdot I + \text{parm}_1 \cdot \text{var}_1 + \text{parm}_2 \cdot \text{var}_2 + \dots + \text{parm}_n \cdot \text{var}_n)} \end{aligned}$$

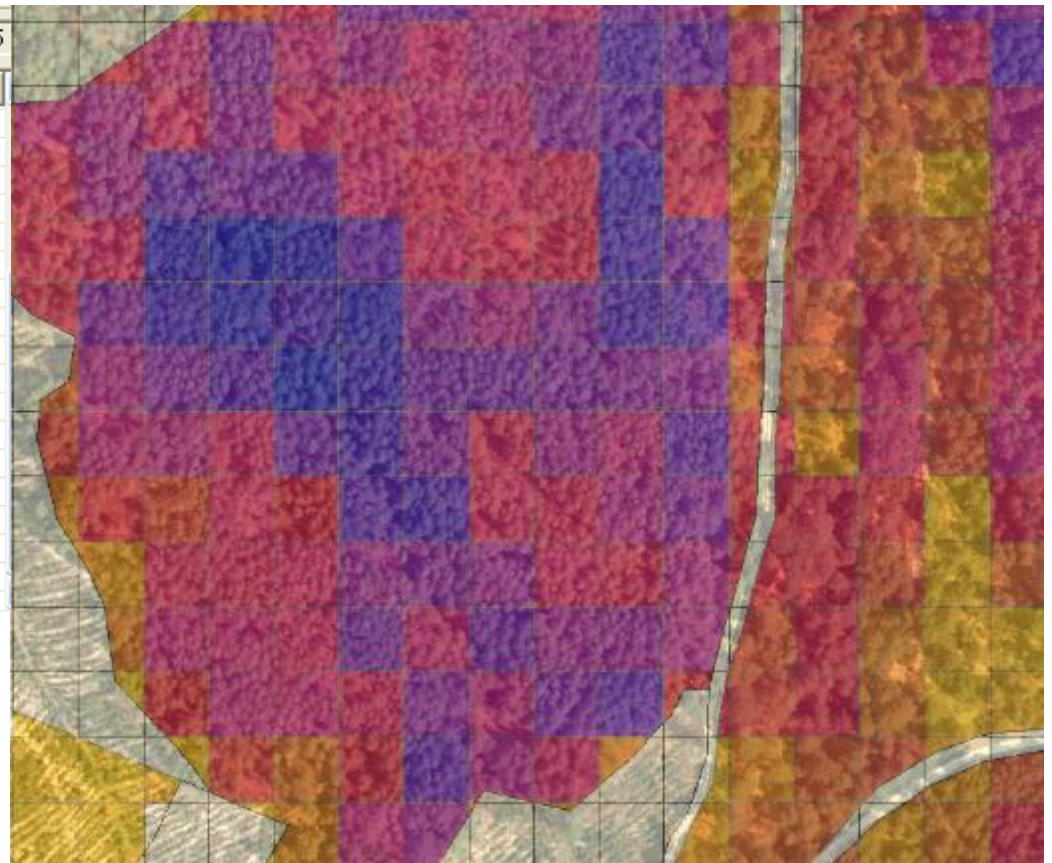
- **Unbiased, precise, parsimonious** models
- **Biological sense** of independent variables: cover, height percentiles...
- **Simultaneous fitting** in order to constrain worst fitting variables
- **Validation:**
 - Other inventories (from forest management projects)
 - Independent samples: relascope plots
 - Comparison with NFI data

Forest inventory in 25x25m pixels

for 11 strata covering 3M ha

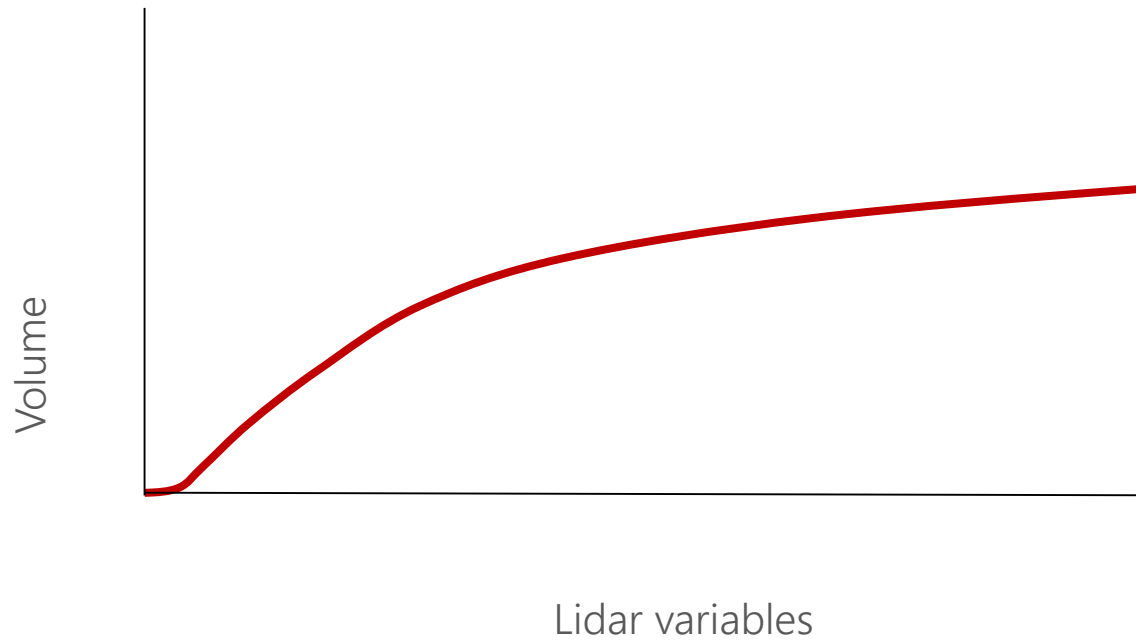
Results

Location:	490.478,722 4.628.145,25
Field	Value
EstLIDAR_o	Masas puras nigra
ID_celda	12135
MUP	89
EstLIDAR	Masas puras nigra
Identifiler	12135
LHP25	9,691628
LHP75	12,291845
LHP95	14,108473
LFCC	92,762577
Ho	16,159026
N	985,206617
Dg	21,958224
G	36,679409
V	234,85191
VSC	153,278623
IAVC	5,265942
VLE	11,641337



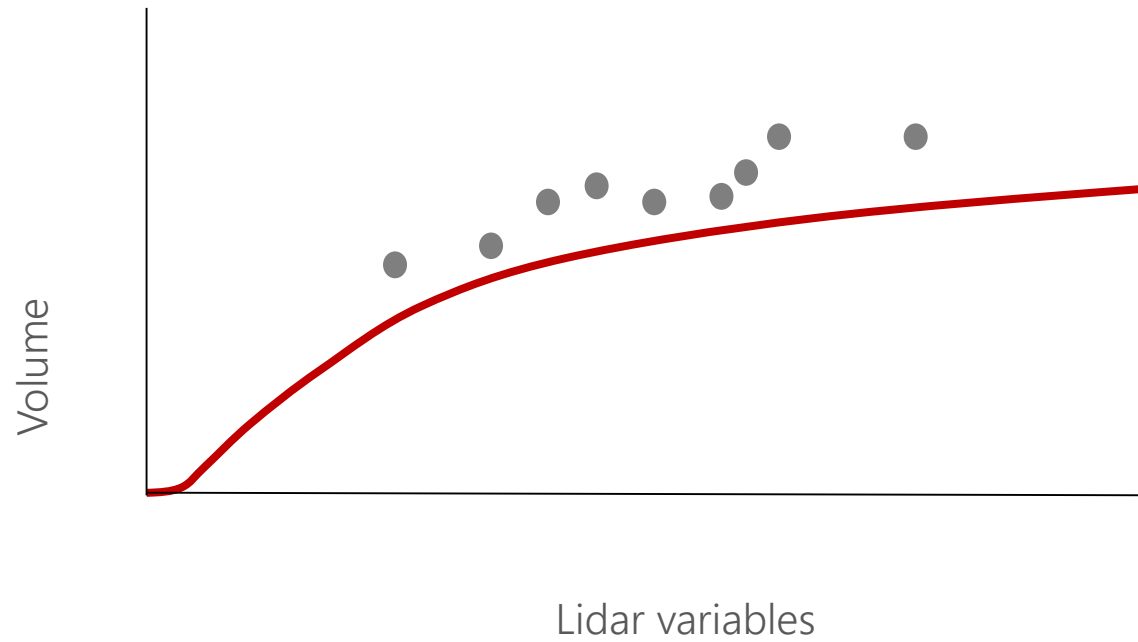
CALIBRATION

Calibration
Scale change



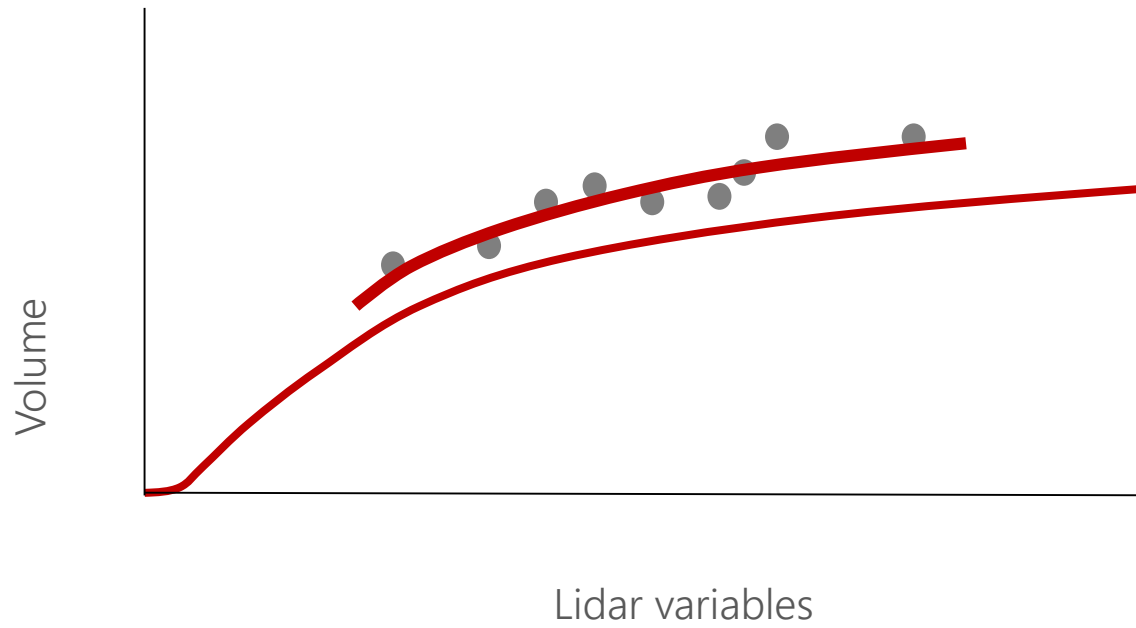
CALIBRATION

Calibration
Scale change



CALIBRATION

Calibration
Scale change



CALIBRATION

Procedure

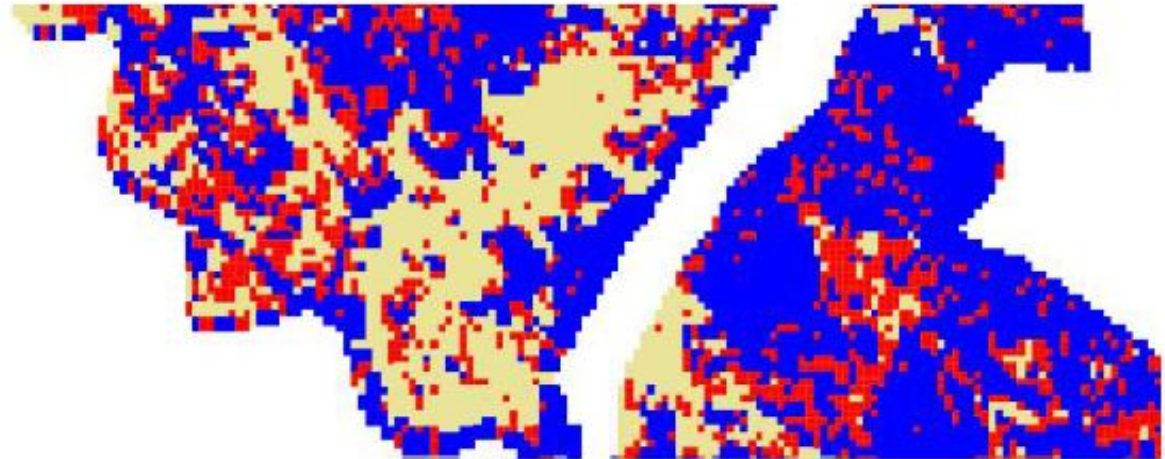
- On the fly calibration system
- For every variable, takes the dependent and every independent variable related
- All calibration alternatives with significant changes are set to a short list
- Among the short list, the calibration equation chosen is the one that maximizes the RMSE reduction

Calibration Procedure

Differential
results

Hotspots

Priority areas

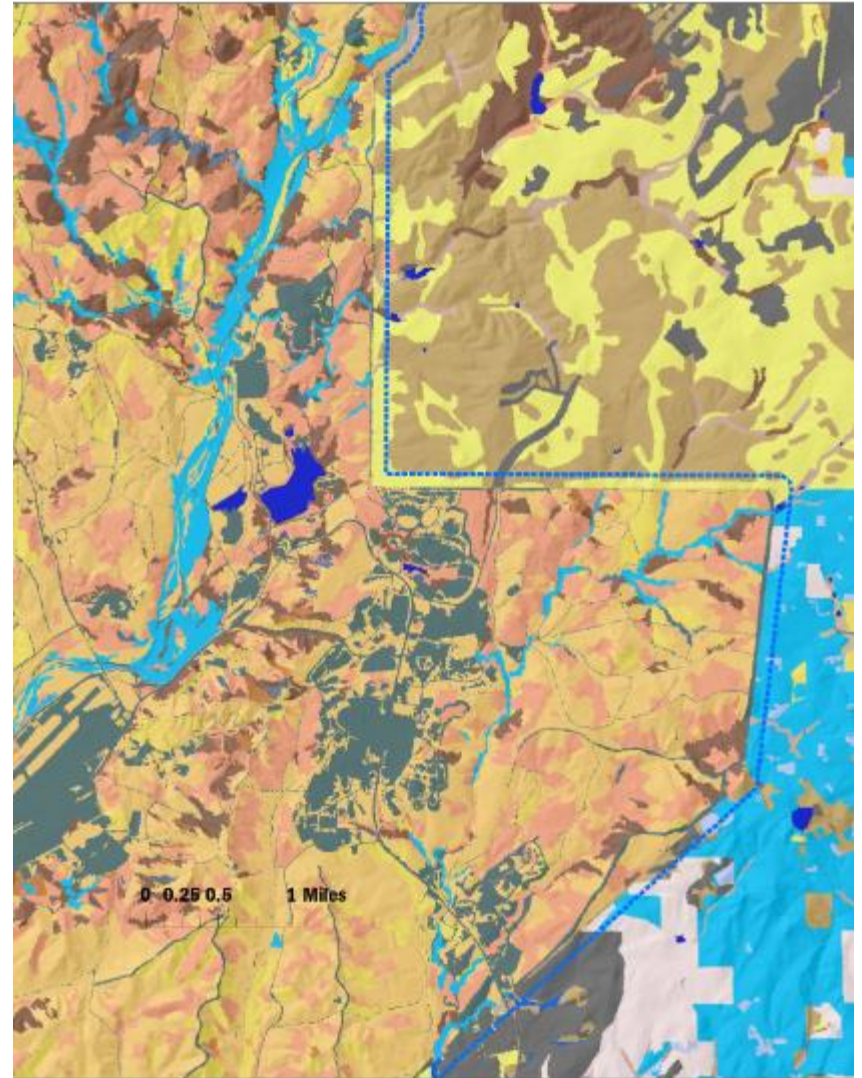


Calibration tool

On the fly calibration based on dependent/independent variable effect on model errors. Iterative system.



Fuel model inventory



Most used classification

Fuel models



- ✓ Modelos estándar / de Rothermel (1973) / de Anderson (1982) / NFFL. 13 modelos
- ✓ "Ampliación" de los modelos estándar de combustible (Scott y Burgan, 2005). 40 modelos

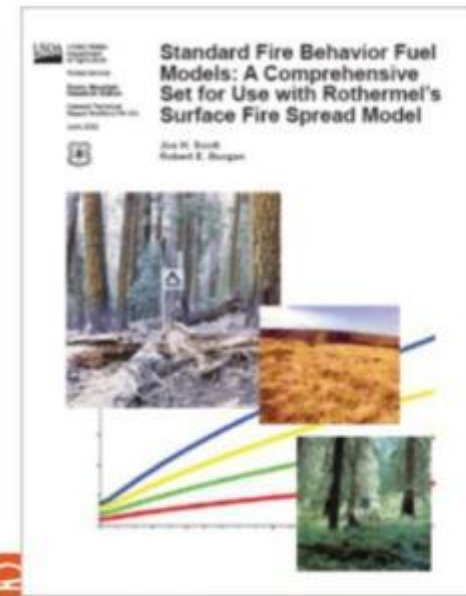
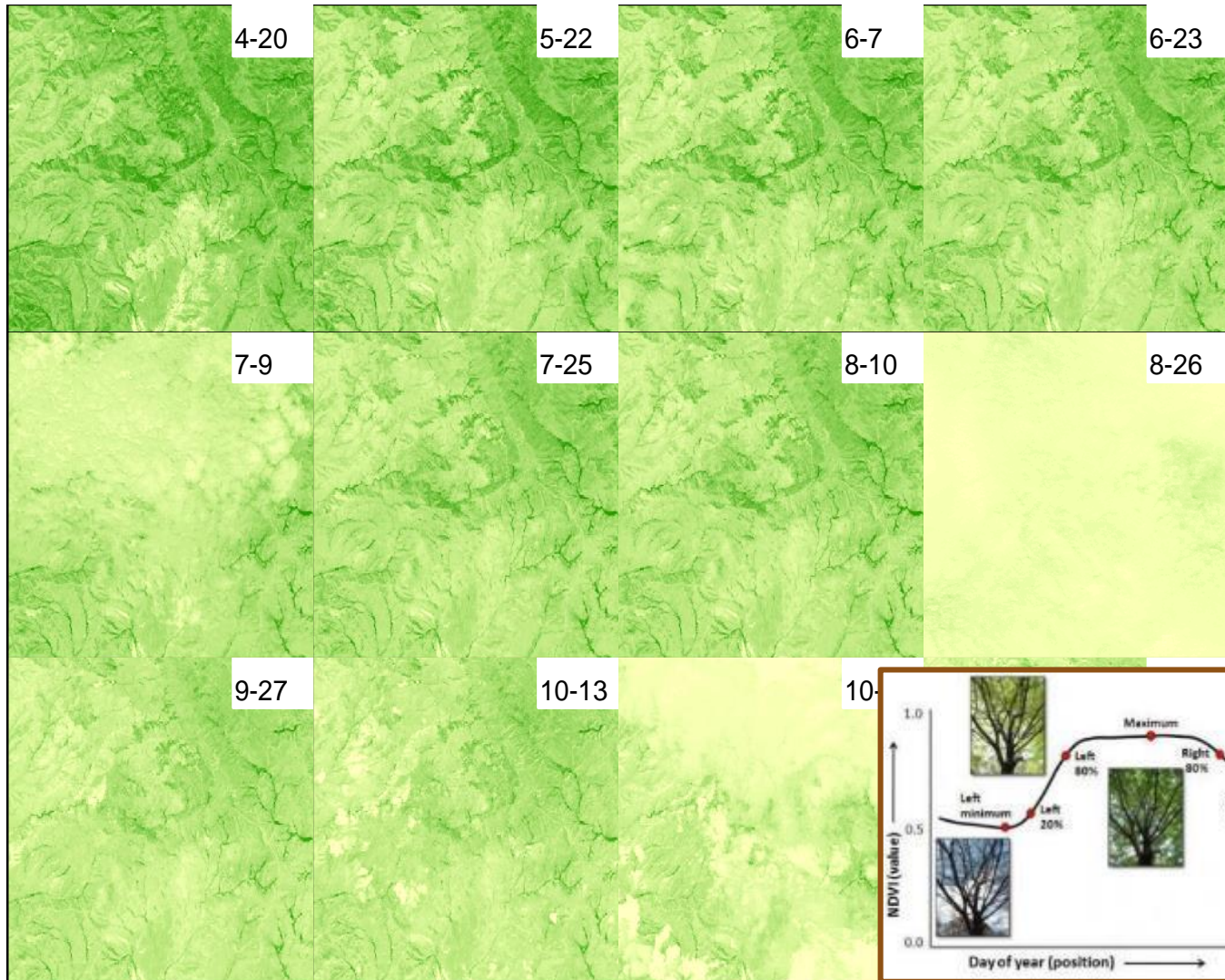


IMAGE Preprocessing



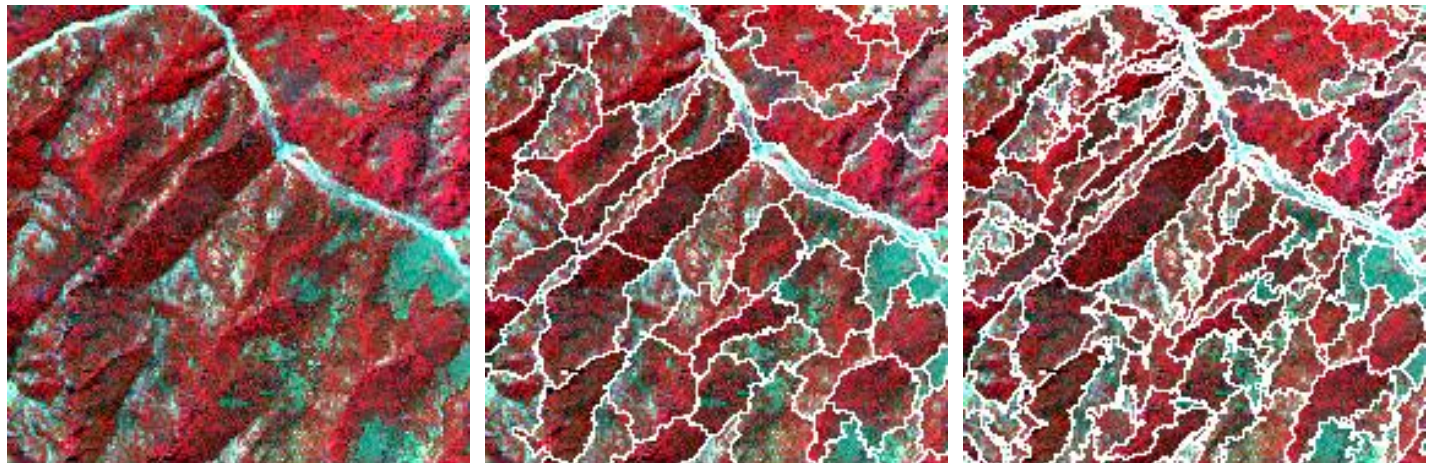
Different values along the vegetative period

Preprocessing

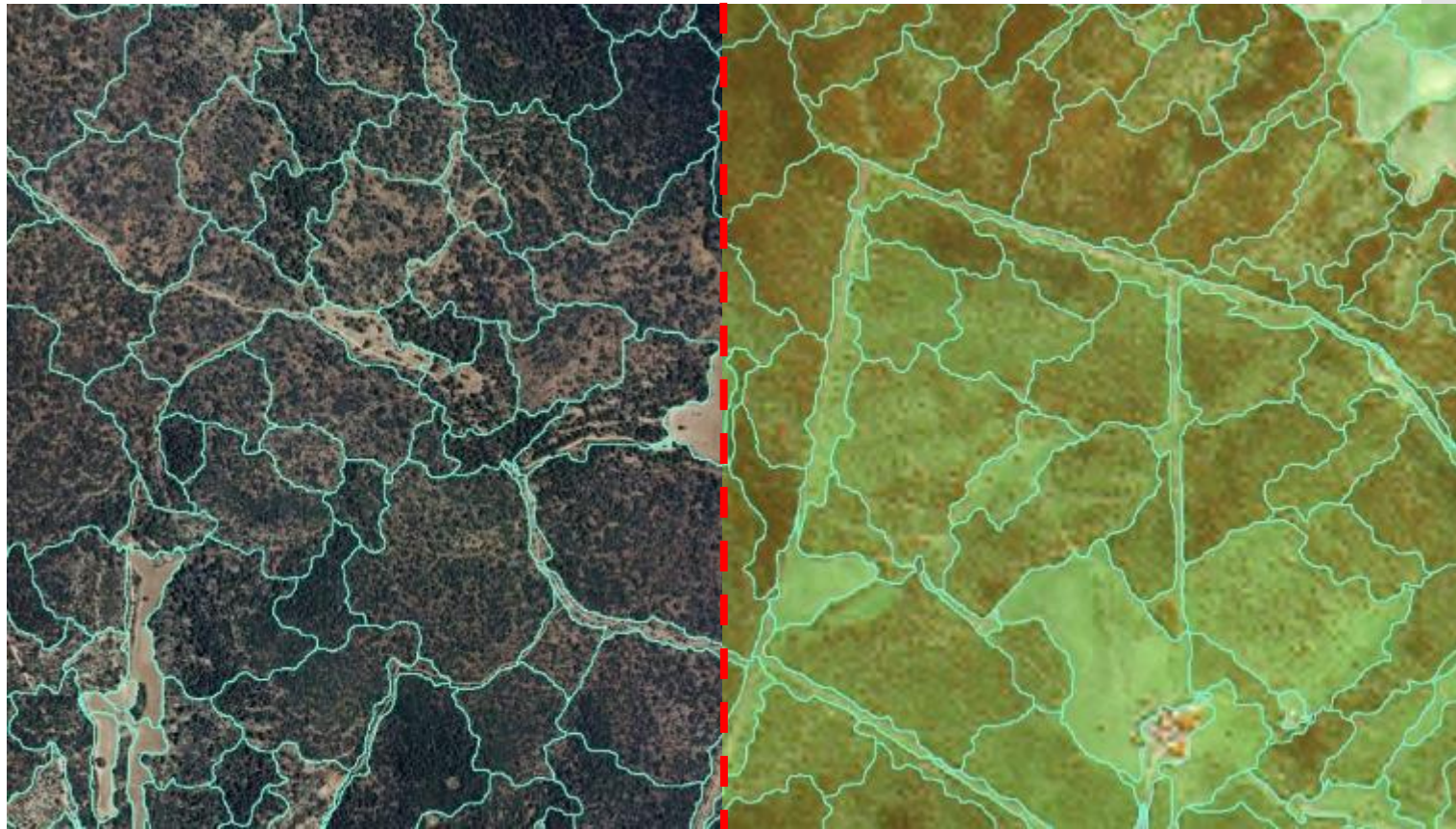


Definition of basic unit

Object Based Image Analysis (OBIA)

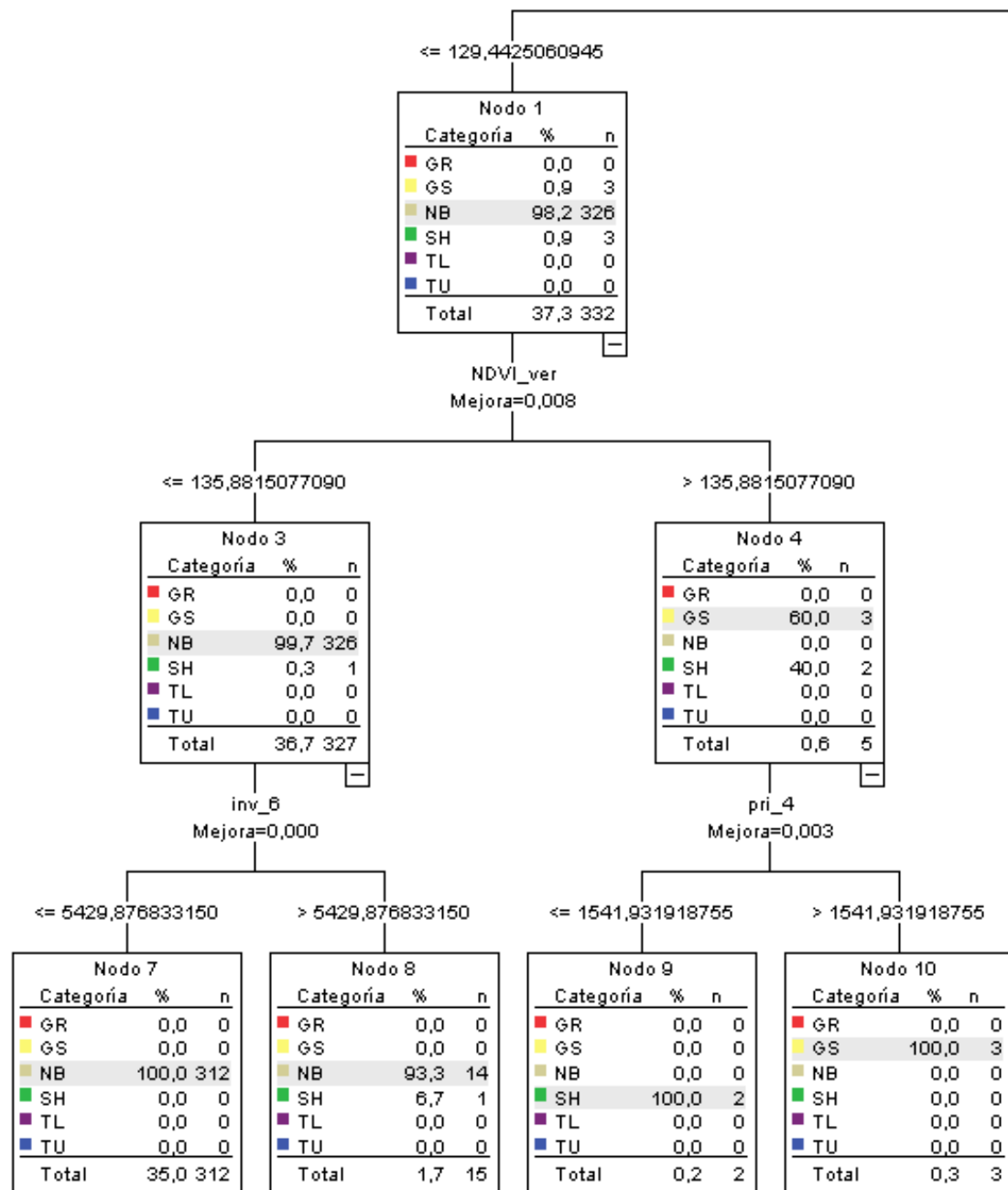


Some examples



Preprocessing
Polygons

Processing Fuel model classification



Phases

Fuel modeling

Assign de LiDAR, spectral, geographic variables... to polygons

Rule definition (training areas)

Goodness of fit assessment (validation)

Assign rules to a whole (polygons)

Expert revision (node analysis)

Verification (fire behaviour)

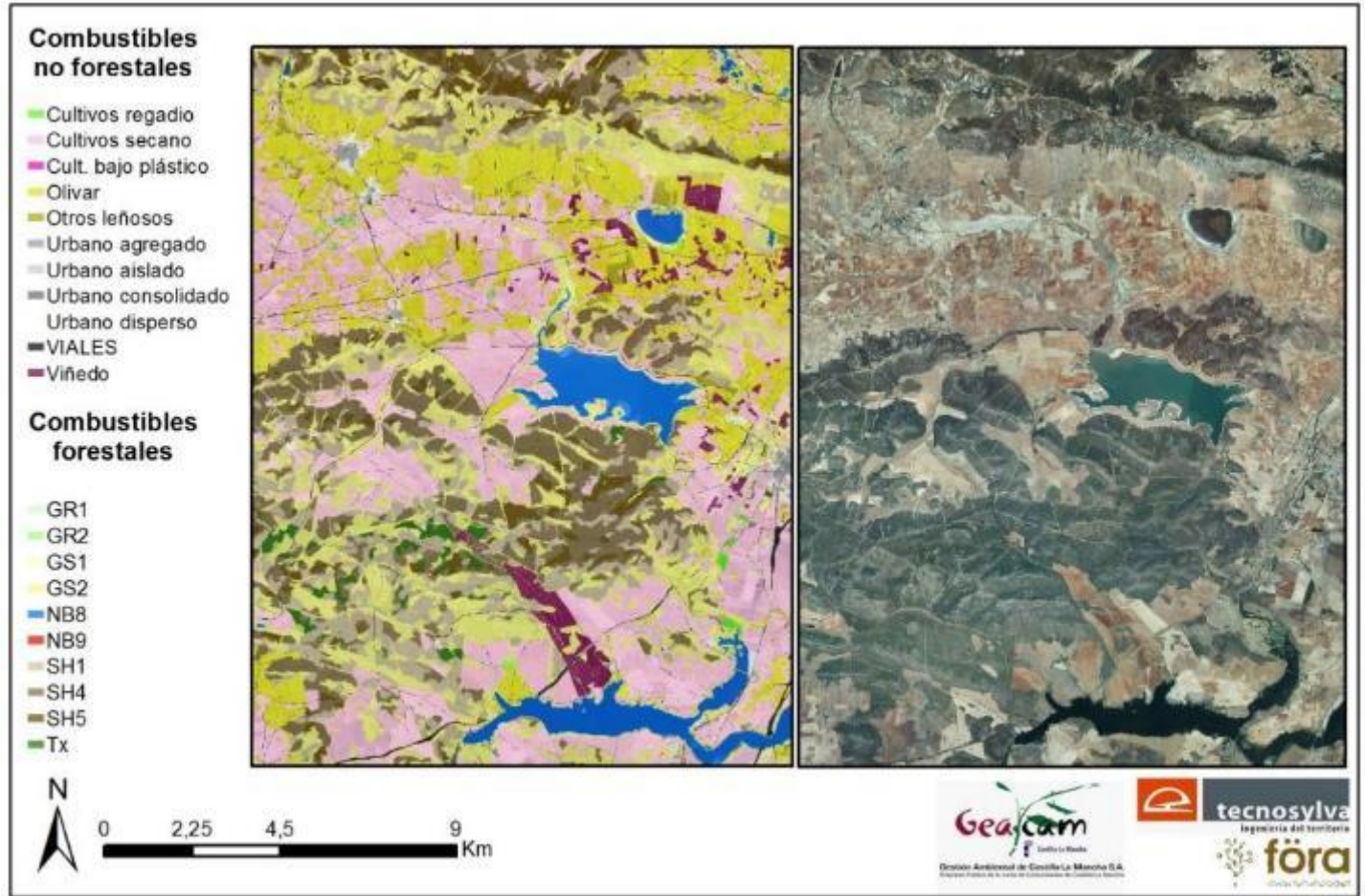
Cartography

Scott and Burgan

Clasiffication

Results:

SCOTT AND BURGAN



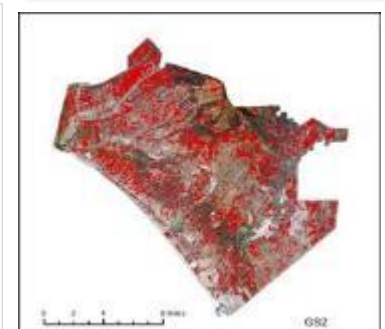
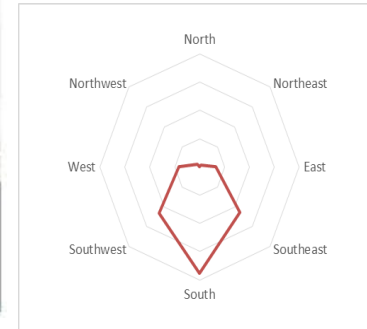
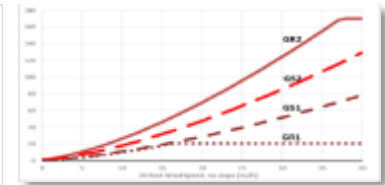
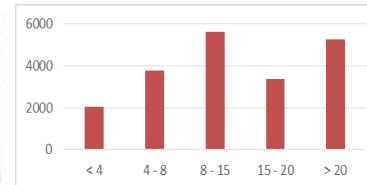
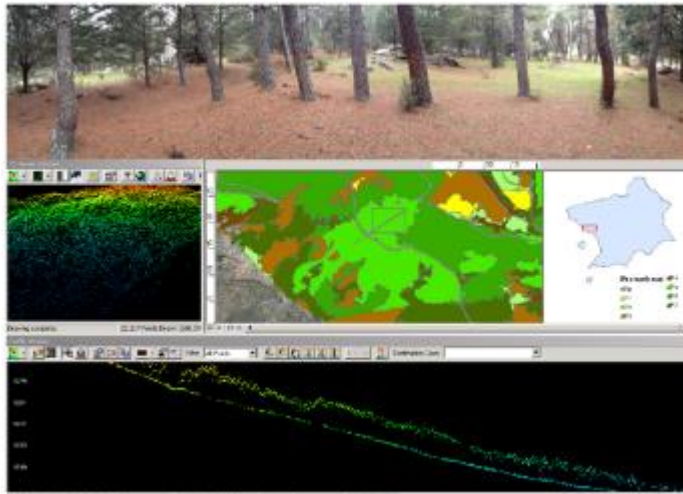
Cartography to be integrated in fire simulation:



Behaviour
modeling

Fuel model guide

Results



¿Questions?



Thanks!



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