Combining stand-level and remote sensing data to model post-fire recovery of Mediterranean tree-forest communities – A case of study in Spain.

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Introduction

- Mediterranean forests are recurrently affected by **wildfires**.
- Fire activity is expected to **accelerate in the future**.
- Understanding the factors that govern the recovery of forest communities is essential to **mitigate the negative effects of wildfires**.

Objectives

- **Build a predictive model** of post-fire recovery in typical Mediterranean tree-communities.
- **Identify the key drivers** of the recovery process.
- Focus on stand structure, composition and biodiversity.

Study area

Pinus halepensis | ***Pinus nigra*** | ***Pinus pinaster*** | ***Quercus ilex***

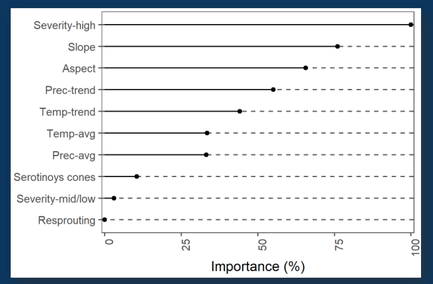
Location of the six surveyed fire sites burned in the summer of 1994 in Spain (above) and illustrations of the four tree-communities analyzed in the study (below).

1. Post-fire recovery state:

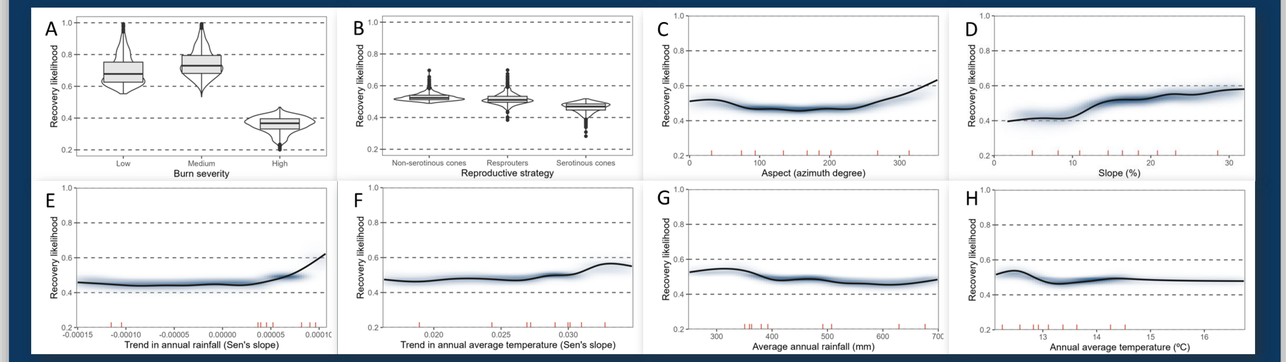
- **Burned and unburned control plots** were compared using cluster analysis. Unburned plot were placed in the "tree-dominated forest" typology while **burned plots** were classified as either "transitional woodlands" or "shrubland and grassland".
- **Burn severity** had a significant effect on the post-fire recovery albeit strongly modulated by **local topography**.
- The majority of **burned plots showing recovery traits** were located in **north-facing steep slopes (>15%)**.
- On the contrary, the majority of **burned plots not recovered** (i.e., "shrubland and grassland" typology) tend to appear in southern slopes.

2. Key predictors:

Severity level, slope, and aspect were consistently the most influential factors on post-fire recovery.



3. Post-fire recovery likelihood and its driving factors:



Response curves showing the likelihood of the post-fire recovery per driving factor.

A) Level of severity; **B)** Dominant reproductive strategy; **C)** Aspect (azimuth degrees); **D)** Slope of the terrain (%); **E)** Trend in annual rainfall (Sen's slope); **F)** Trend in annual temperature (Sen's slope); **G)** Average annual rainfall (mm); **H)** Average annual temperature (ºC).

Methodological flow

1. **Geospatial data acquisition and processing**
   a) Stand-level **data collection** ~25 years after fire (131 burned, 72 unburned).
   b) Estimation of **burn severity** through the GeoCBI (a modified version of the Composite Burn Index) using Landsat-5 TM imagery.
   c) Modelling **local topography** (slope and aspect) using ALS-LiDAR data.
   d) Extraction of **climatic variables** (temperature and precipitation trends) from the ERA5-Land reanalysis dataset.
2. **Modelling of post-fire recovery and its driving factors**
   - Post-fire recovery was inferred from the **similarity** between the burned and unburned plots.
   - The influence of the drivers was estimated by fitting **Random Forest** of likelihood of recovery.

Results and main conclusions

- Serotinuous species (***Pinus halepensis* and *Pinus pinaster***) were the most frequently affected by high severity burns.
- Resprouter (***Quercus ilex***) and especially non-serotinous (***Pinus nigra***) communities were more frequently affected by low to medium severity burns.
- After a period of ~25 years, **only 25% of the burned plots were considered recovered**, either because of their moderate burn severity or being in a favourable environmental setting.
- Post-fire recovery **driving factors** were:
  - ✓ Low-to-moderate burn severity.
  - ✓ Favourable topographical setting, especially the shading effect of steep NW slopes (>15%).
  - ✓ Warmer and more humid climate.

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