Forest Disturbances and Ecosystem Dynamics in a Changing World

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How do functional traits and climate drive interspecific differences in disturbance-induced tree mortality?

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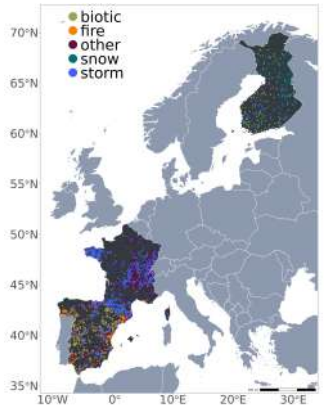
Context and objectives

- The frequency, size and magnitude of **natural disturbances** is increasing in European forests (1).
- Tree species are differentially affected by disturbances (2; 3), but the factors explaining **interspecific differences in sensitivity** remain poorly understood.
- *Objective*: investigate the effects of species-level (i) **functional traits** and (ii) **mean climatic conditions** on the sensitivity to **fire, snow, storm and biotic disturbances**.

Material and Methods

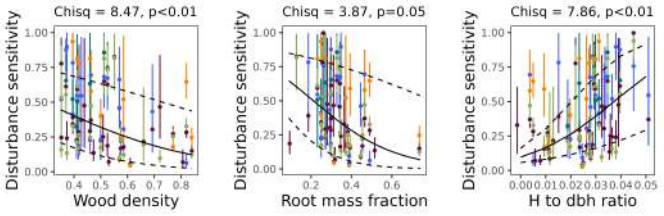
- We compiled **National Forest Inventory (NFI)** data from **Spain**, **France** and **Finland** on 128834 trees in 7526 plots disturbed either by storm, fire, biotic, snow, or other disturbances.
- We used **Bayesian statistics** to model tree mortality probability as a function of **disturbance nature** and **intensity**, tree **size** and **status** within the stand. A key originality in this approach is to jointly estimate tree-level mortality and plot-level disturbance intensity (2).
- We analysed how species **disturbance sensitivity** (*i.e.* annual predicted mortality probability for a reference disturbance nature, intensity, tree size and status) is related to their **functional traits** and their **climate optimum**.



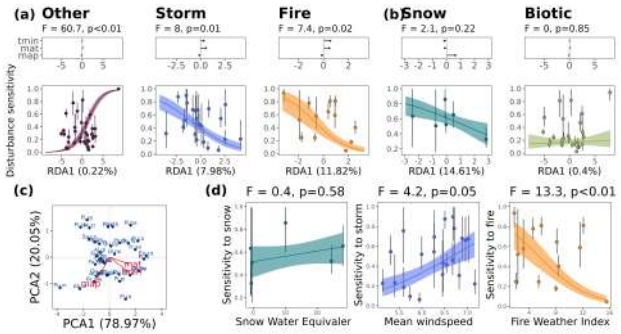
Results

Effect of functional traits on disturbance sensitivity

- Species with low height to dbh ratio (F=11.6, p<0.01) and a high wood density (F=17.2, p<0.01) are more resistant to storm disturbances
- Species with high bark thickness (F=7, p=0.02) and stomata conductance (F=22.1, p<0.01) are more resistant to fire
- Species with a low C/N ratio (F=5.9, p=0.02) are more resistant to biotic disturbances
- When all disturbance types are analysed together species sensitivity is negatively correlated to wood density and to the root mass fraction, and positively correlated to the height dbh ratio (see below)



Effect of species mean climate on disturbance sensitivity



- Species from warm and dry climates are less sensitive to fire and storm
- Species distributed in fire prone areas (as measured by the Fire Weather Index) are more resistant to fire while species distributed in areas exposed to higher wind speeds are more storm-sensitive.
- Species sensitivity to snow and biotic disturbances are not explained by the average climatic conditions in which trees grew

Conclusions

- Tree species sensitivity to disturbances is linked to their functional traits and climate optimum.
- As climate change is likely to radically change the disturbance regimes across Europe, our study unravels key relations between traits and disturbance sensitivity which could help to forecast how species will be impacted by novel disturbance type.

References

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