Dendroecología y vulnerabilidad al decaimiento en el Levante y SE de la Península Ibérica

Raúl Sánchez-Salguero +50 co-authors

RED SEGUIMIENTO DECAIMIENTO FORESTAL

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UNIVERSIDAD PABLO DE OLAVIDE SEVILLA

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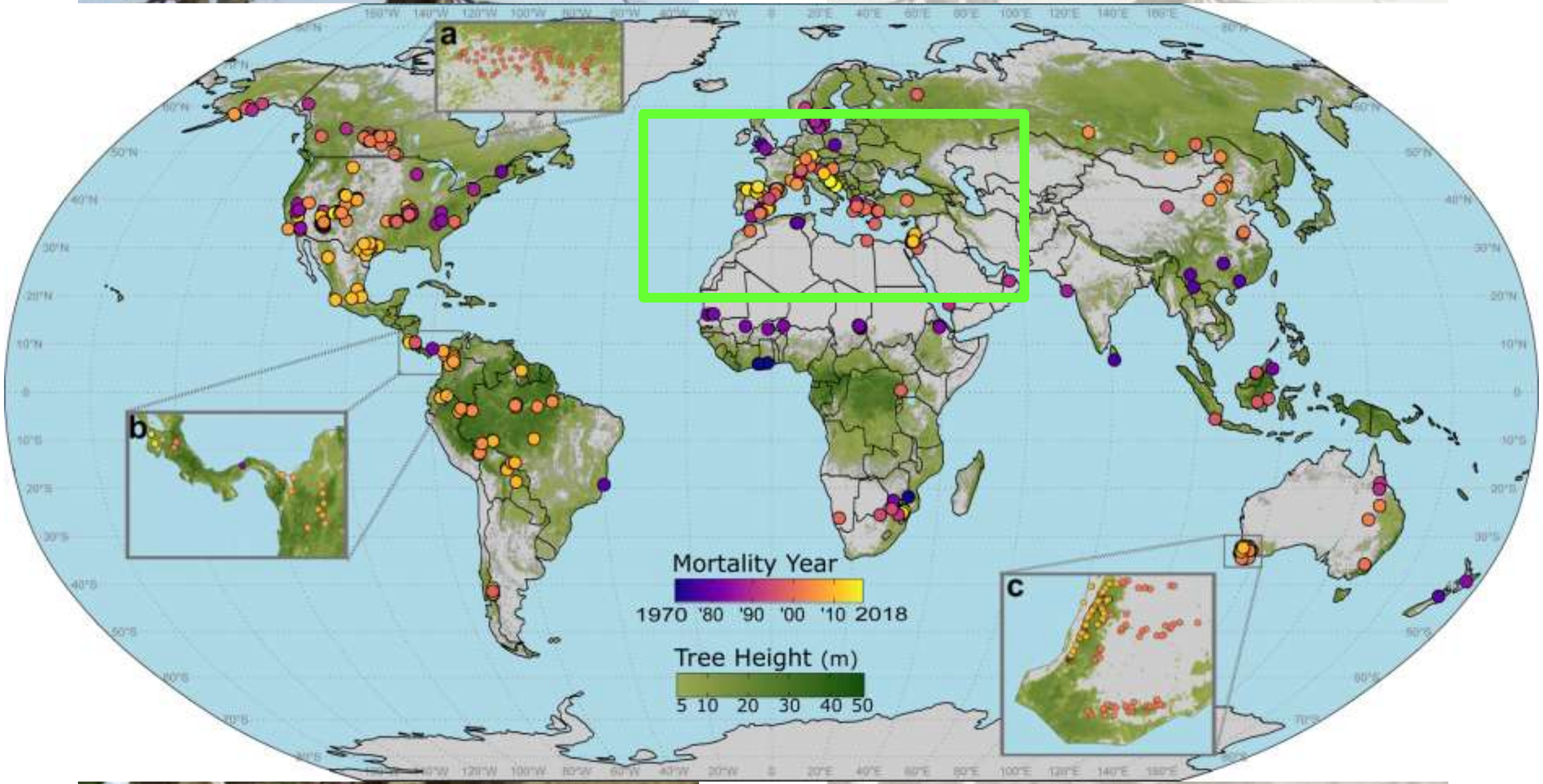
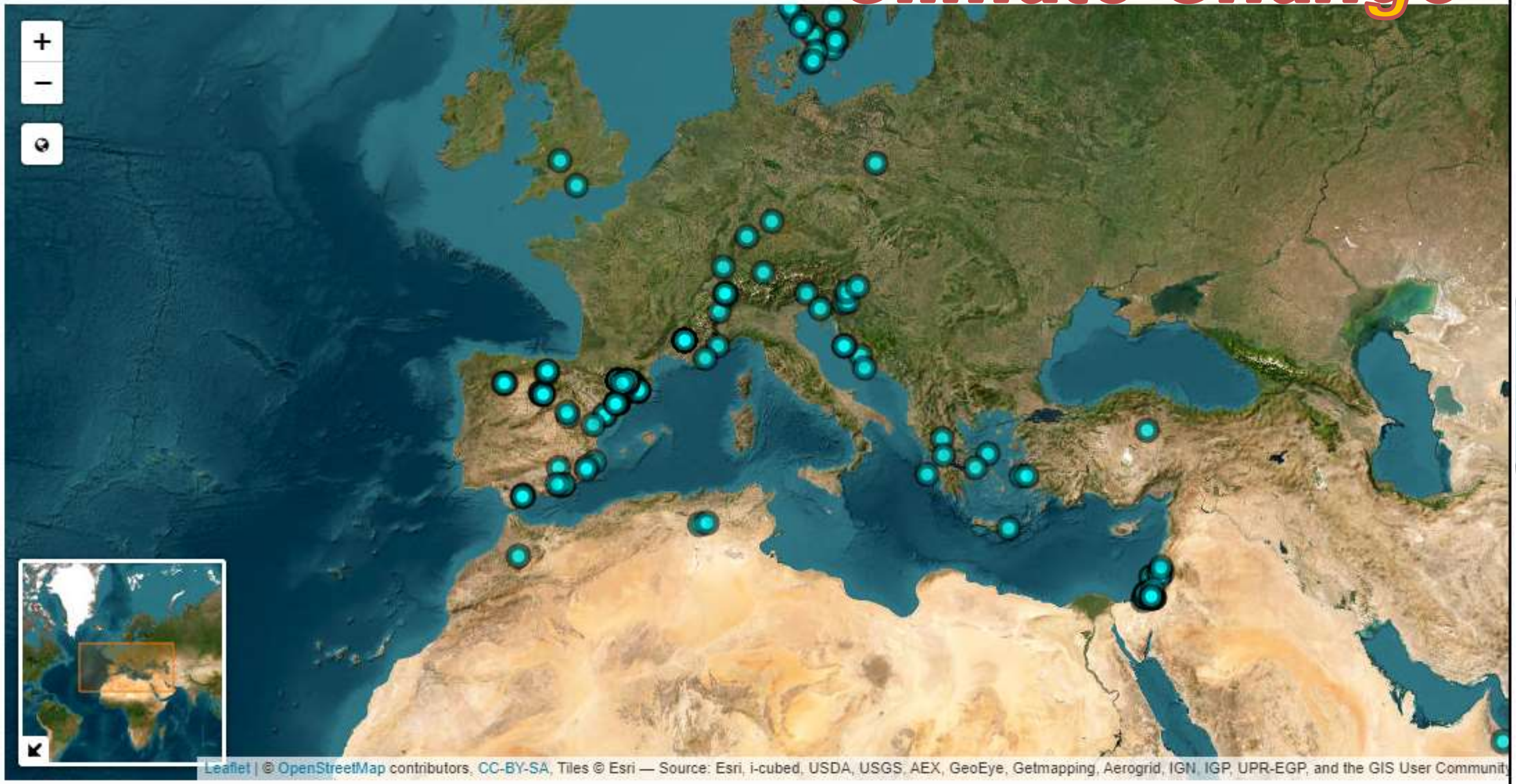


Hammond et al. 2022 Nat. Comm.

Forest Stability? Climate Change



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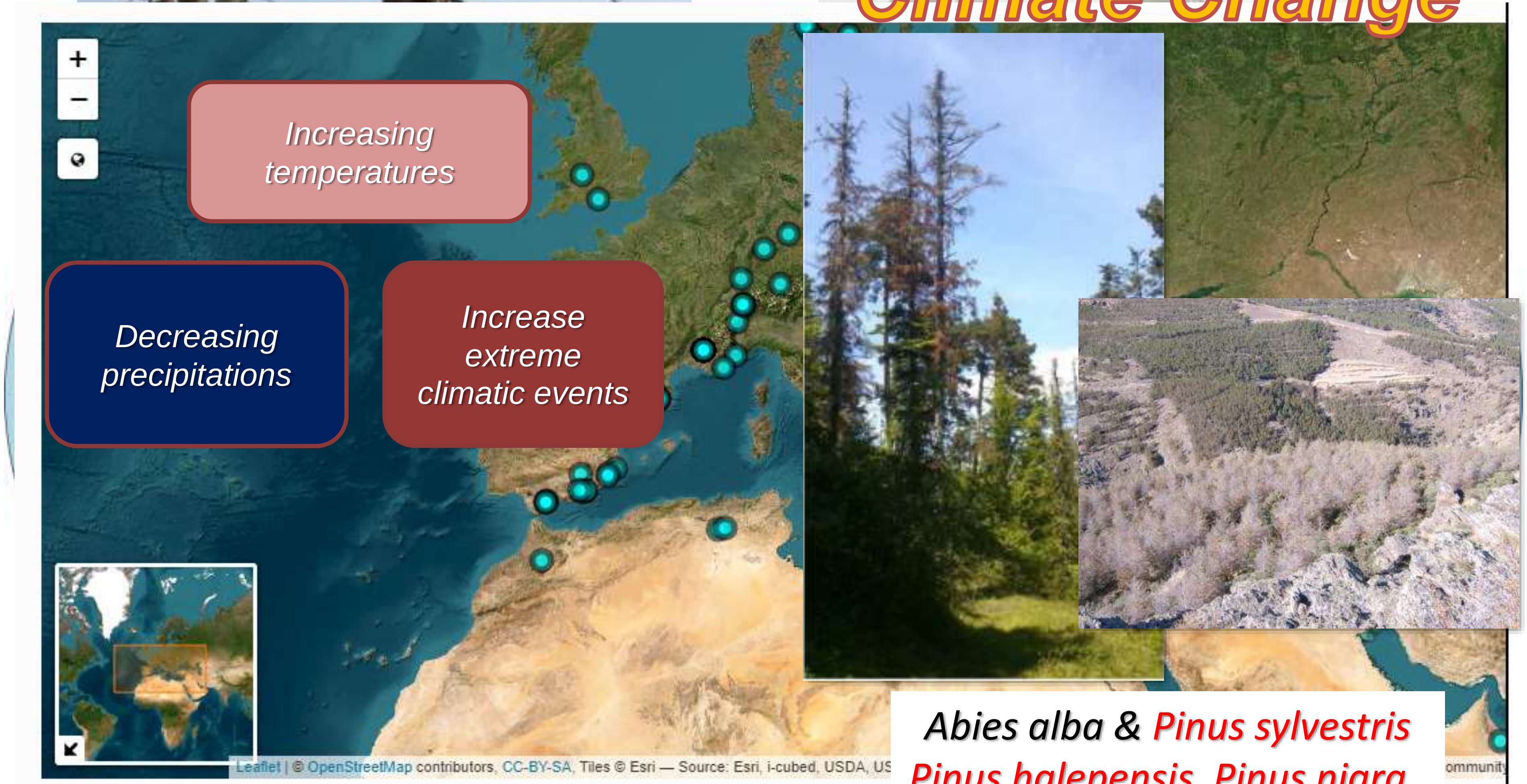
Forest Stability?
Climate Change



Abies alba & *Pinus sylvestris*
Pinus halepensis, *Pinus nigra*,
Pinus pinea & *Pinus pinaster*
Cedrus atlantica

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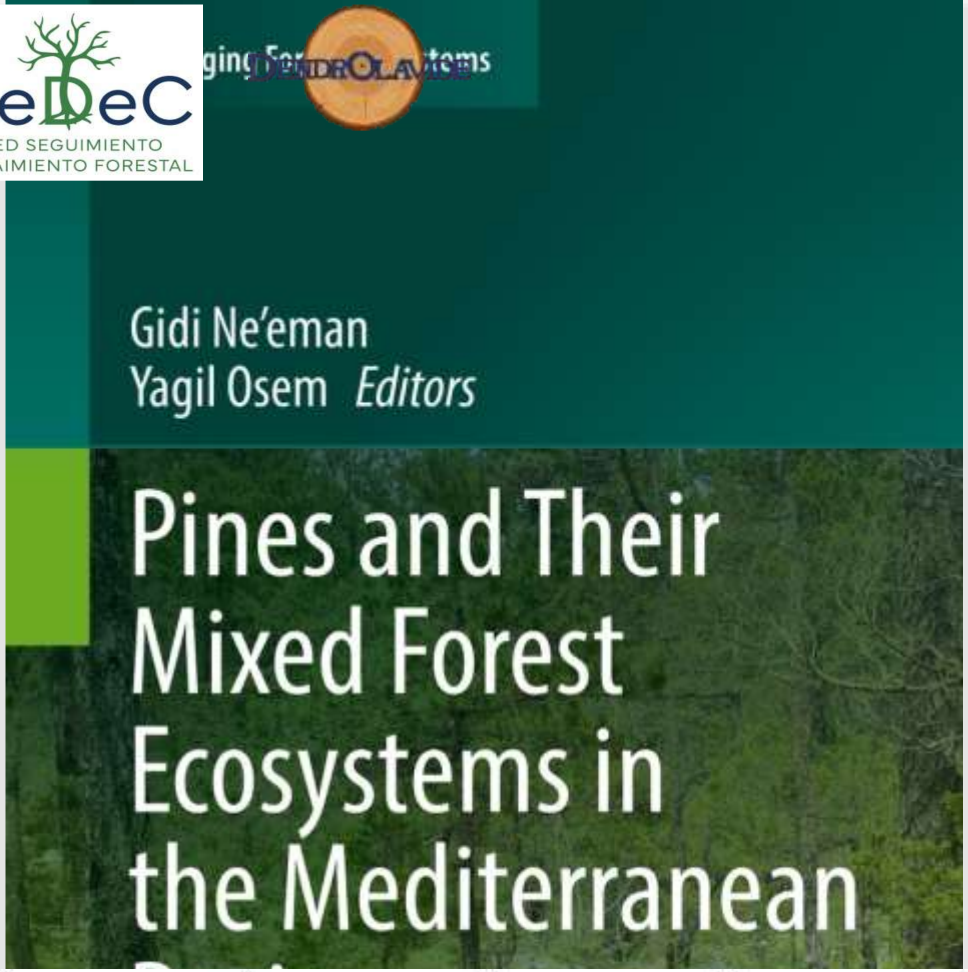

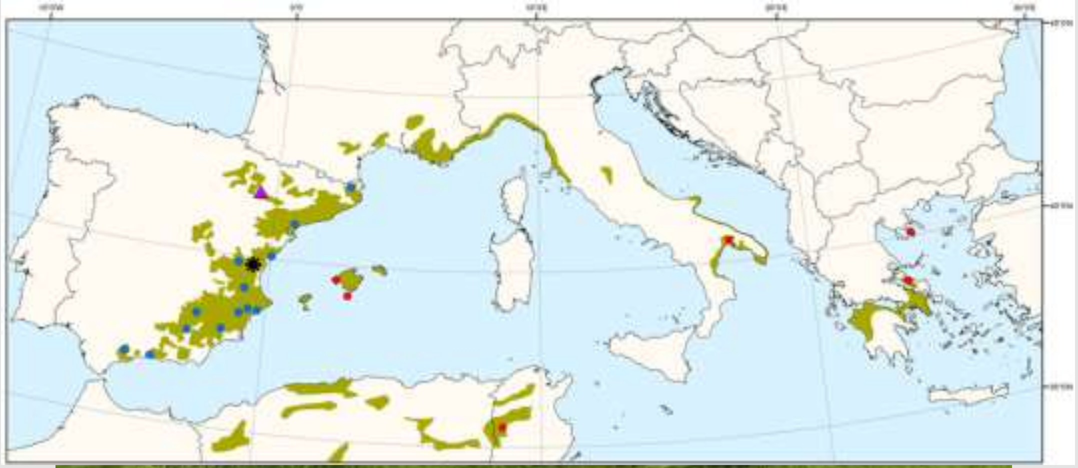

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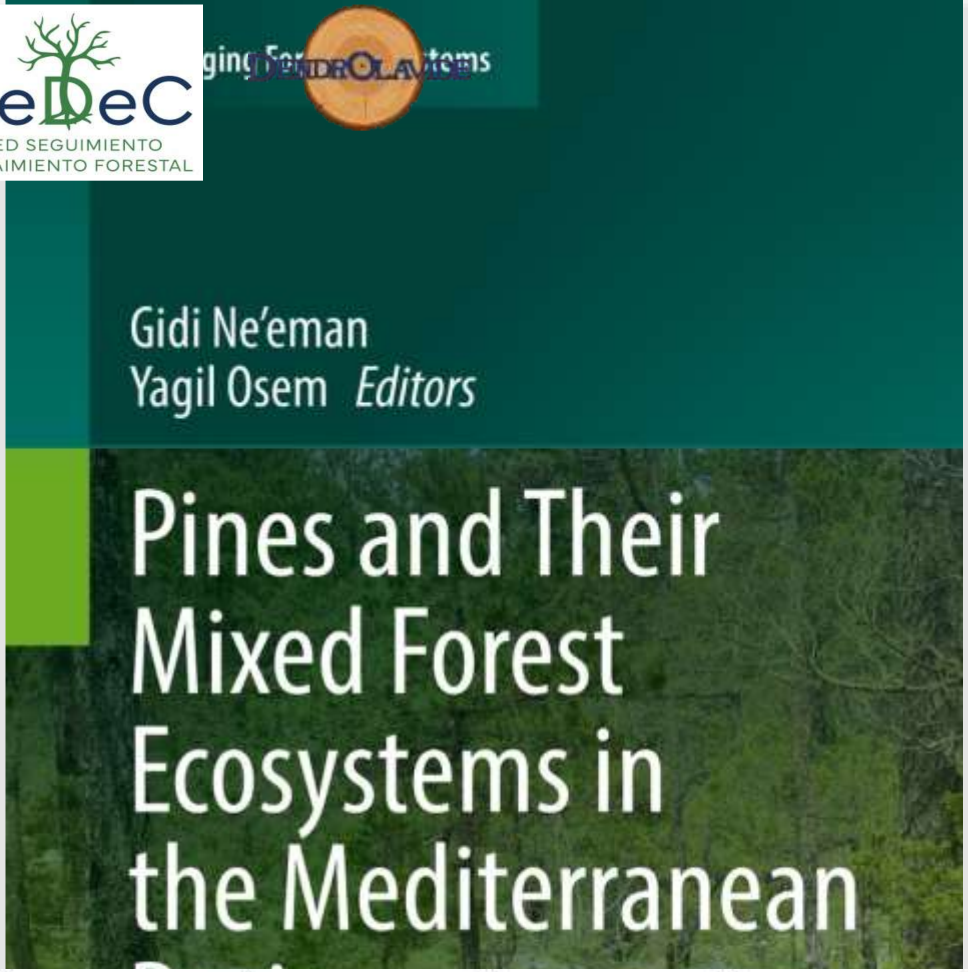

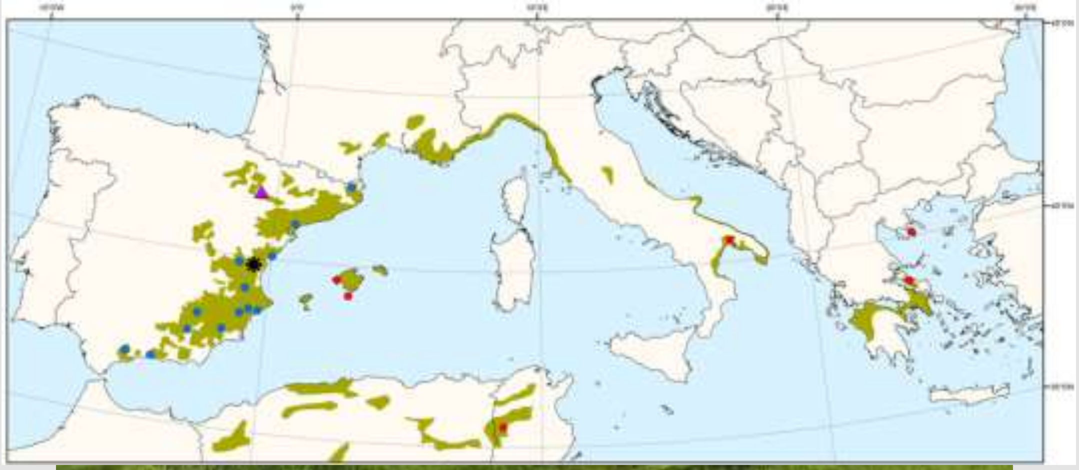

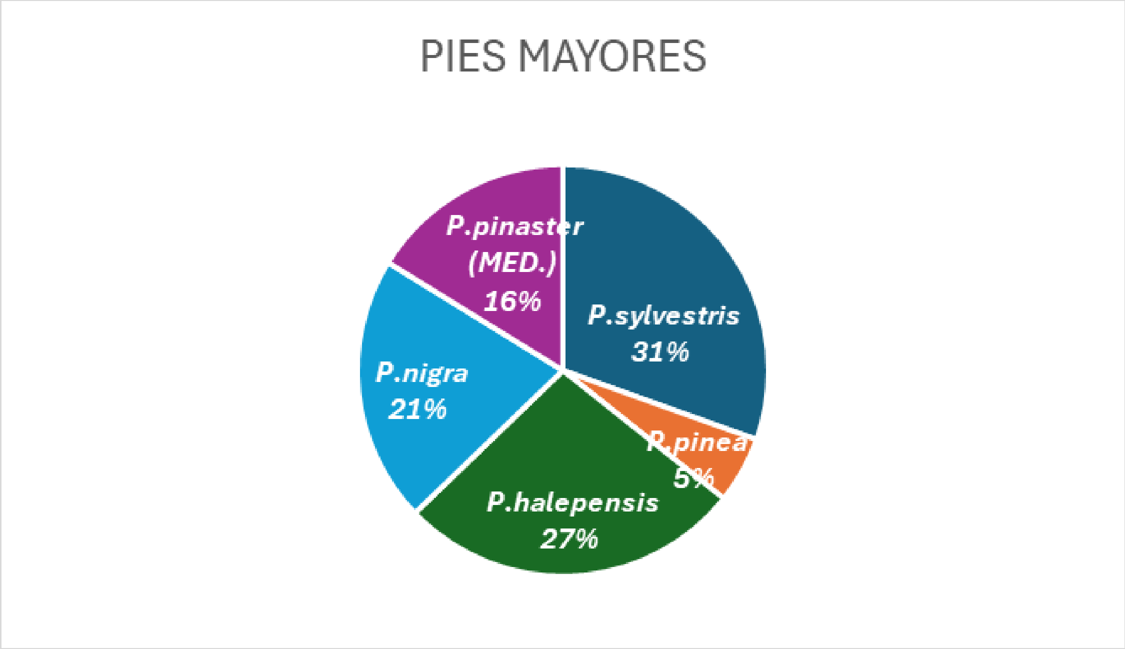

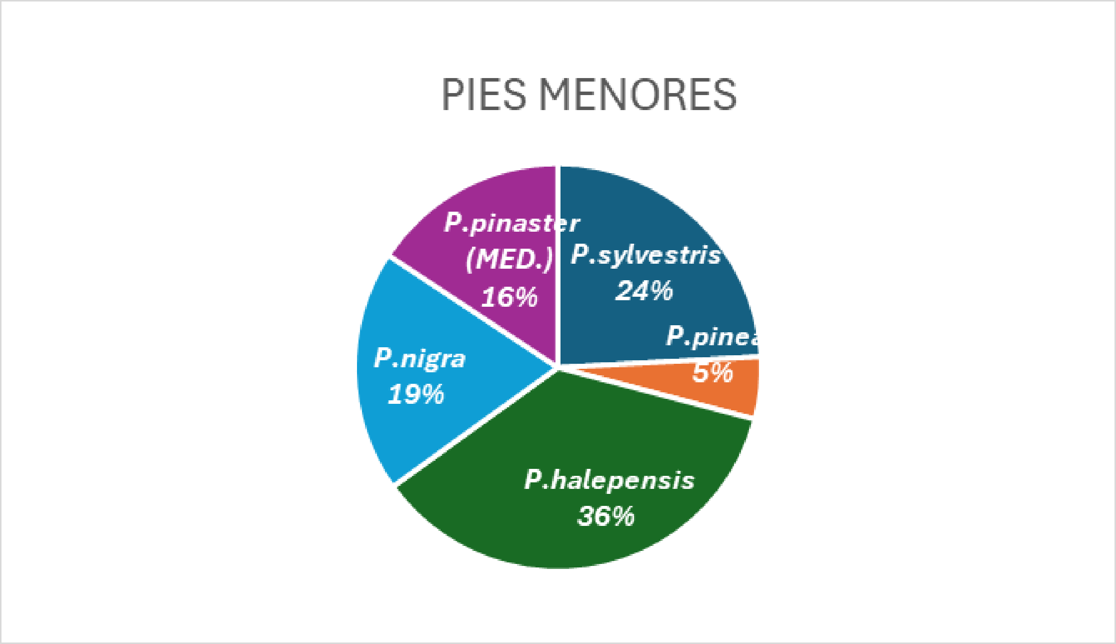

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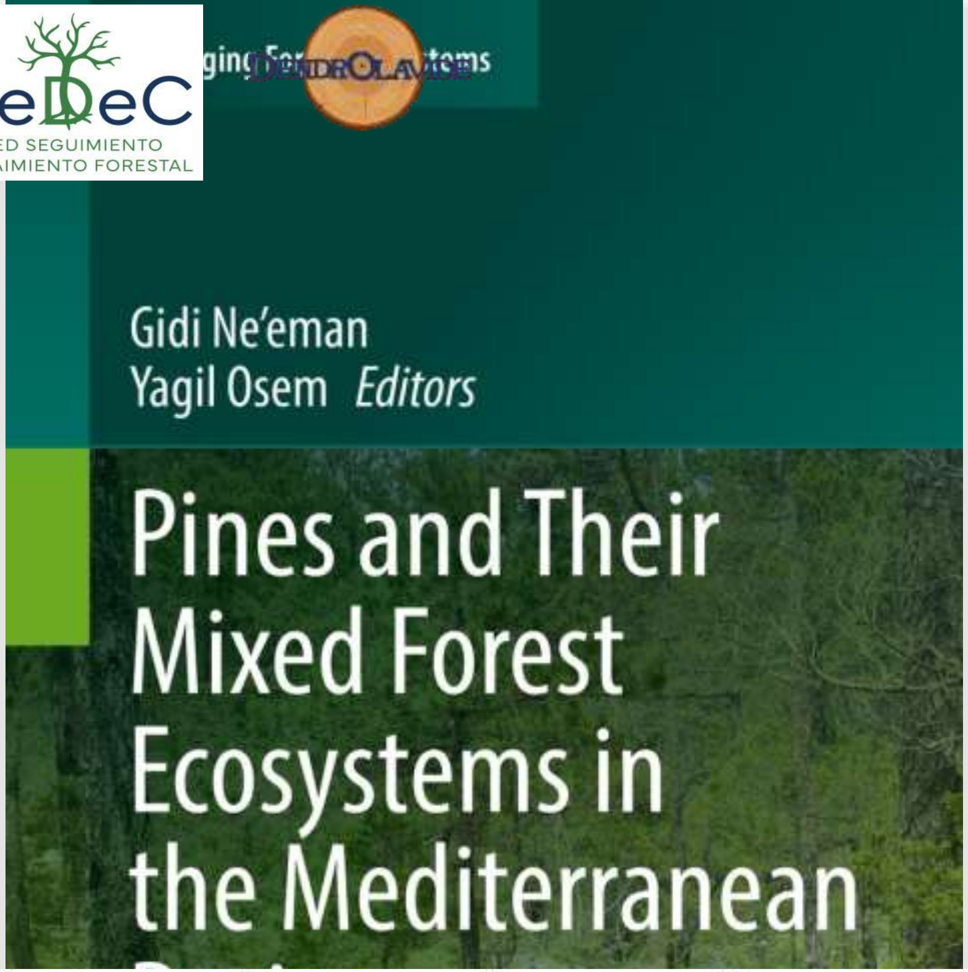

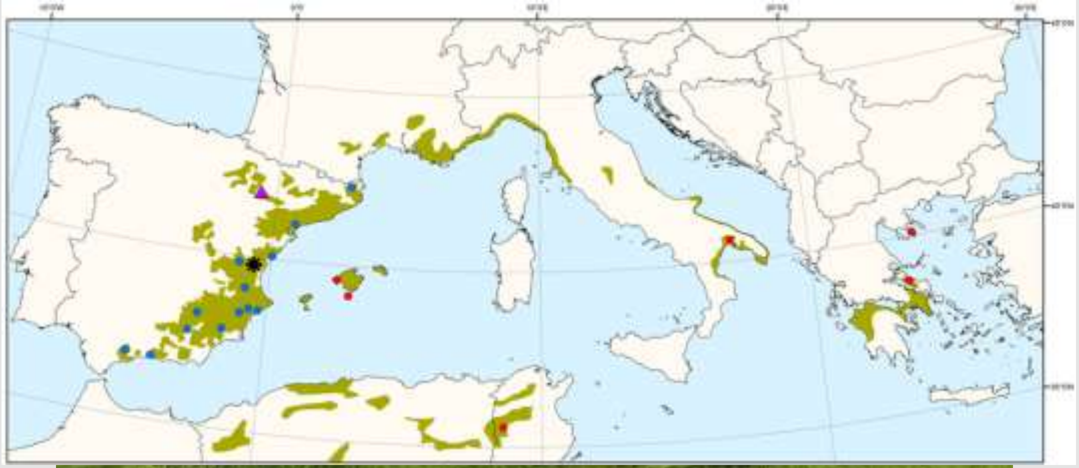

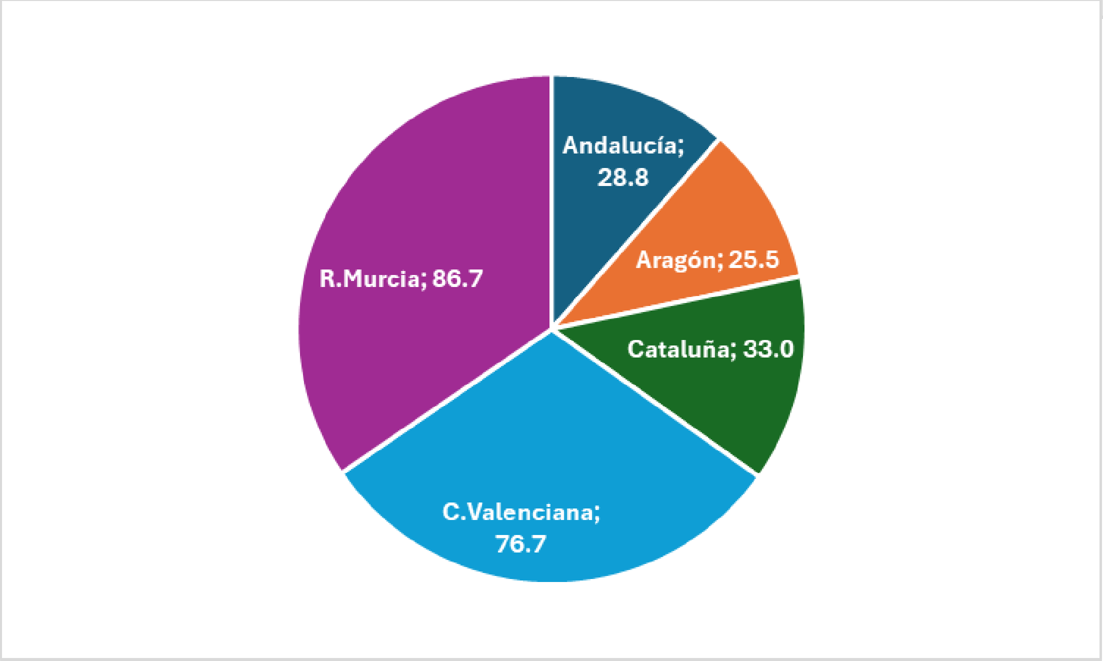

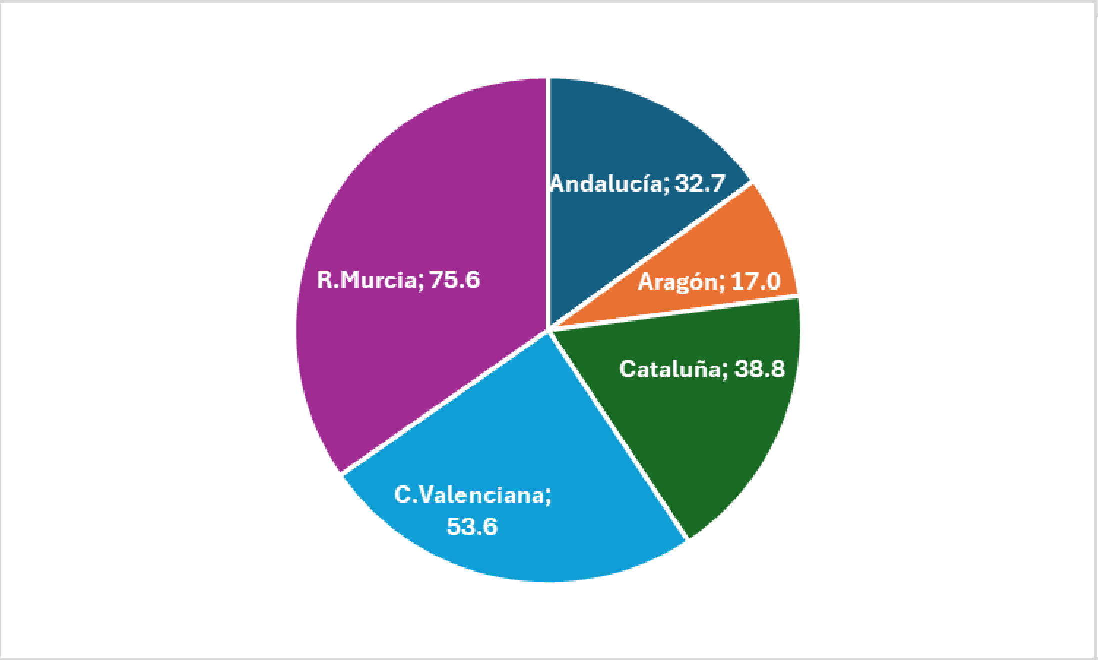

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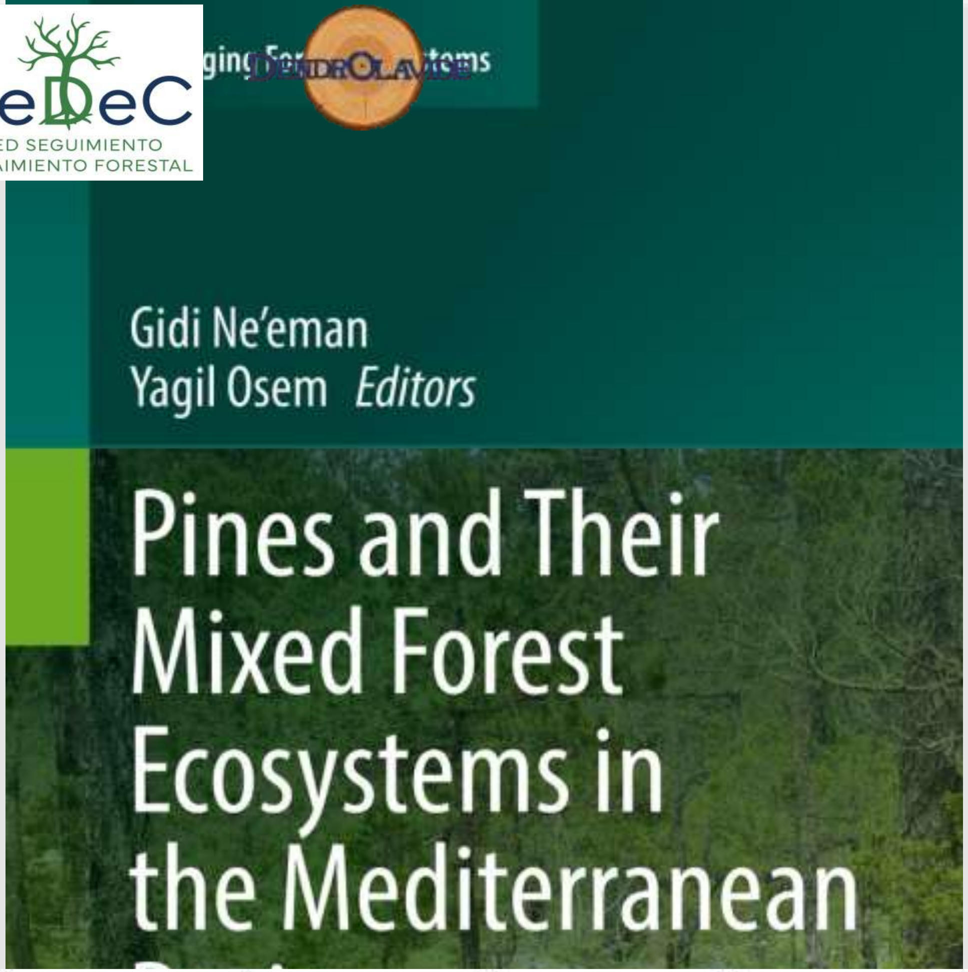

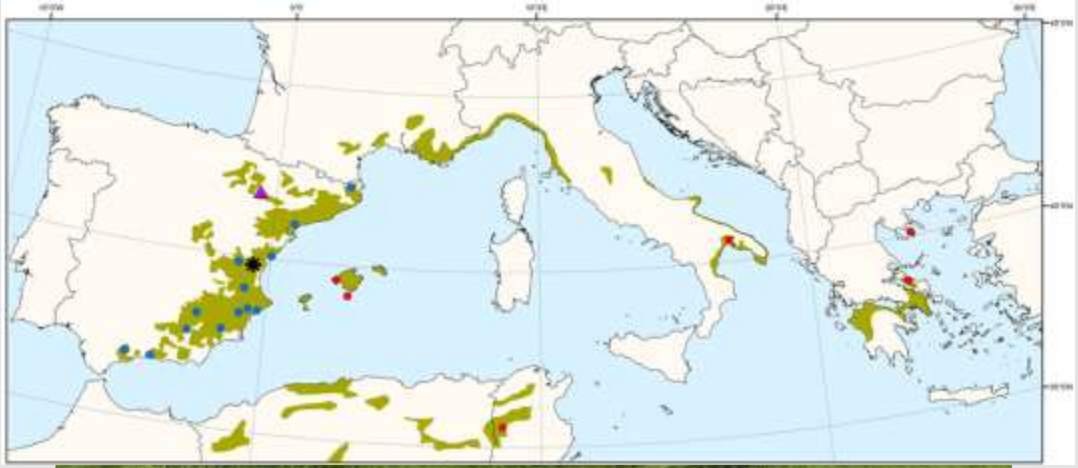

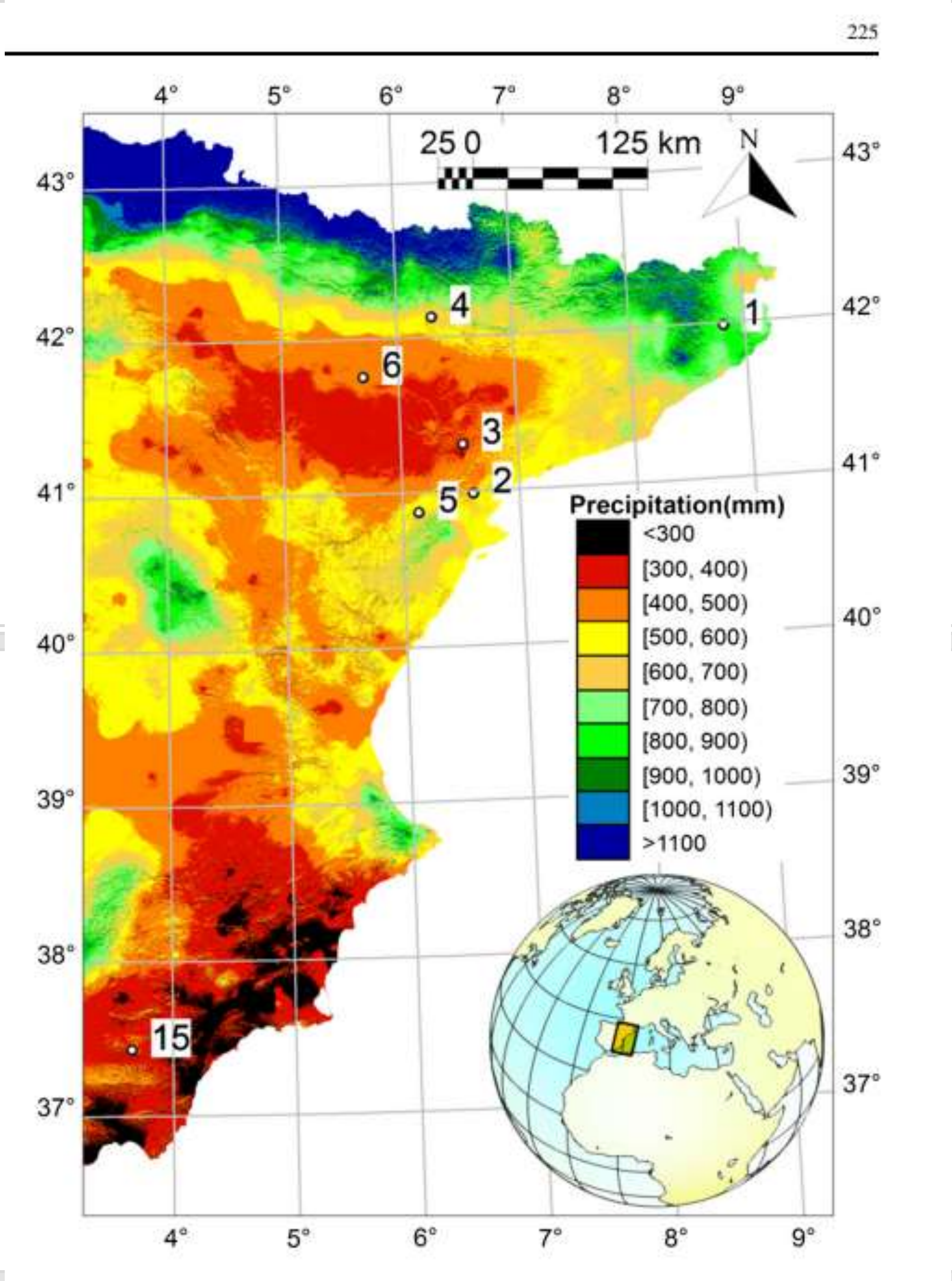

Almería

Almería • Bajo Palio

CONSECUENCIAS DEL CAMBIO CLIMÁTICO

La Sierra de los Filabres, bajo estudio

Medio Ambiente analizará la zona debido al decaimiento forestal motivado por la sequía y las plagas. Las últimas lluvias, ungüento momentáneo.

Medioambiente ■ *Naturaleza*

CONSERVACIÓN DE LA NATURALEZA

Los bosques catalanes se están convirtiendo en un cementerio vegetal por la falta de agua

Tras tres años de sequía extrema, la vegetación forestal supera sus límites de adaptación y empieza a sucumbir en masa. En las serranías litorales, los árboles resecos predominan en el paisaje

Árboles resecos en el Parque Serralada Litoral, en Barcelona. (Jose Luis Gallego)

La sequía extrema arrasa los montes de la Región de Murcia: más de un millón de pinos muertos

La muerte de más de un millón de pinos en la Región de Murcia agrava la desertificación, dispara el riesgo de incendios, empeora la calidad del aire y acelera la pérdida de biodiversidad. Un daño ambiental con consecuencias directas sobre el clima, la salud y la economía

28 Abr 2025 | Rosa Roda

La enfermedad que afecta a los pinos carrascos en el litoral del sur de Alicante se trata de la «fisiopatía del pino carrasco»

Por AHSA / 4 agosto, 2024

Copa de uno de los grandes pinos que bordean el canal de Riegos de Levante (S

El pasado mes de enero la Asociación de Amigos de los Humedales del Sur de Alicante (AHSA) se dirigió mediante un escrito a la Dirección Territorial de Alicante de la Consellería de Medio Ambiente advirtiendo de lo

Jueves, 23 de octubre de 2025

Diario de Teruel

TERUEL BAJO ARAGÓN COMARCAS CULTURA DEPORTES EN LA ÚLTIMA OPINIÓN EDICIÓN DIGITAL HEMEROTECA SOCIEDAD

Felipe Sancho explica las características del muérdago a los asistentes a la jornada celebrada en Alcalá de la Selva

El muérdago y la sequía se han convertido en la principal amenaza para los pinares de Gúdar-Javalambre y Albarracín

El CITAte explica en Alcalá de la Selva el proyecto Fite Druida, que trabaja en su valorización

New Phytologist

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Research

Intraspecific variation in the use of water sources by the circum-Mediterranean conifer *Pinus halepensis*

Jordi Voltas[1], Devon Lucabaugh[1], Maria Regina Chambel[2] and Juan Pedro Ferrio[1]

[1]Department of Crop and Forest Sciences – AGROTECNIO Center, University of Lleida, Rovira Roure 191, Lleida E-25198, Spain; [2]CIFOR-INIA, Ctra.de La Coruña km 7.5, E-28040 Madrid, Spain

Forest Ecology and Management 424 (2018) 205–215

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FOREST ECOLOGY AND MANAGEMENT

Ecotypic variation and stability in growth performance of the thermophilic conifer *Pinus halepensis* across the Mediterranean basin

Jordi Voltas[a,*], Tatiana A. Shestakova[a,b], Theofania Patsiou[c], Giovanni di Matteo[d], Tamir Klein[e]

[a] *Department of Crop and Forest Sciences – AGROTECNIO Center, University of Lleida, Avda. Rovira Roure 191, 25198 Lleida, Spain*
[b] *Siberian Federal University, st. L. Prushinskoy 2, 660075 Krasnoyarsk, Russia*
[c] *Institute of Botany, University of Basel, Schönbeinstrasse 6, CH-4056 Basel, Switzerland*
[d] *Council for Agricultural Research and Economics, Research Centre for Agriculture and Environment (CREA), Rome, Italy*
[e] *Department of Plant and Environmental Sciences, Weizmann Institute of Science, 234 Herzl Street, Rehovot 7610001, Israel*

New Phytologist

Research

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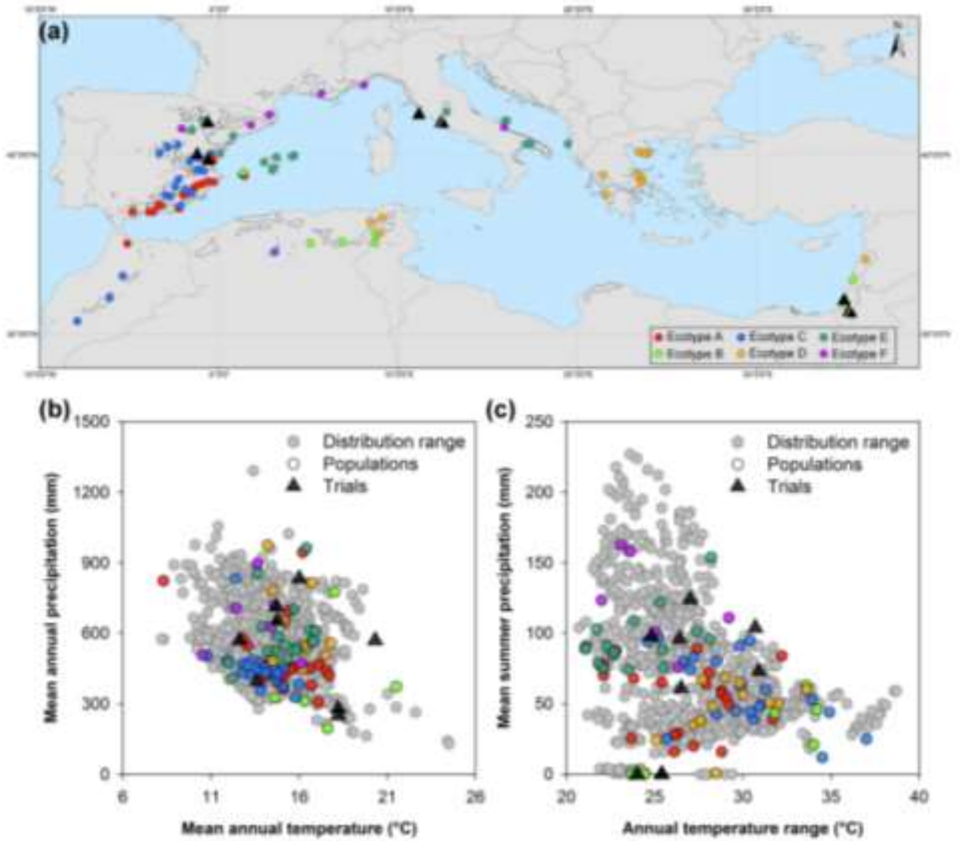

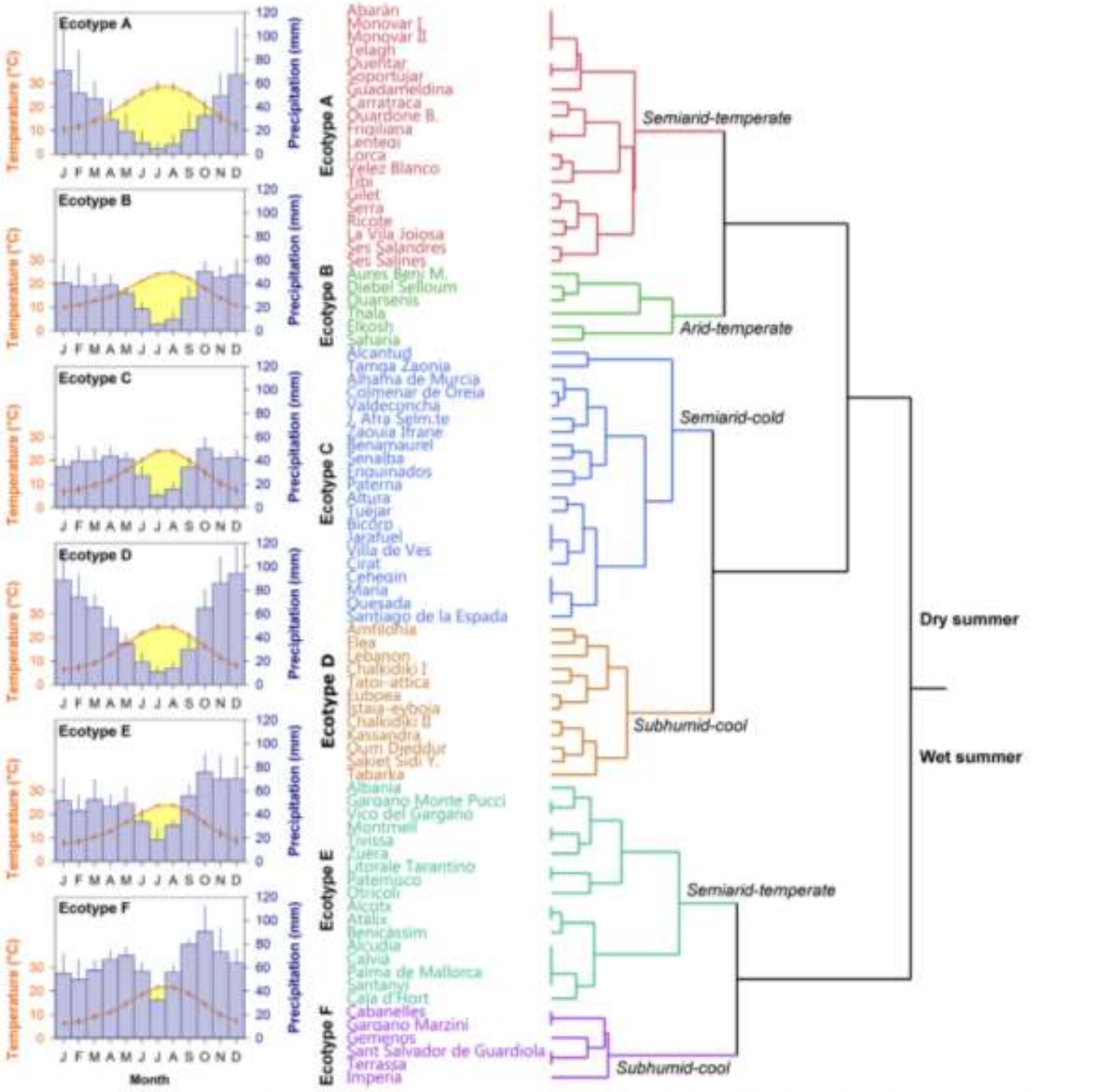

2. Dendrogram of the classification of *P. halepensis* populations into ecotypes according to climate (CRU-based classification). The climate characteristics of each pe are succinctly described in the dendrogram following Le Houérou (2004) and are shown in detail by climographs (left panels), where the average monthly s of populations at origin (and their standard deviation across populations) are indicated. The area of the climographs in yellow indicates the drought period, s, the period when mean monthly temperature exceeds twice the amount of total precipitation.

ated in terms of the probability of one ecotype outperforming

3. Results

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Plant Ecology

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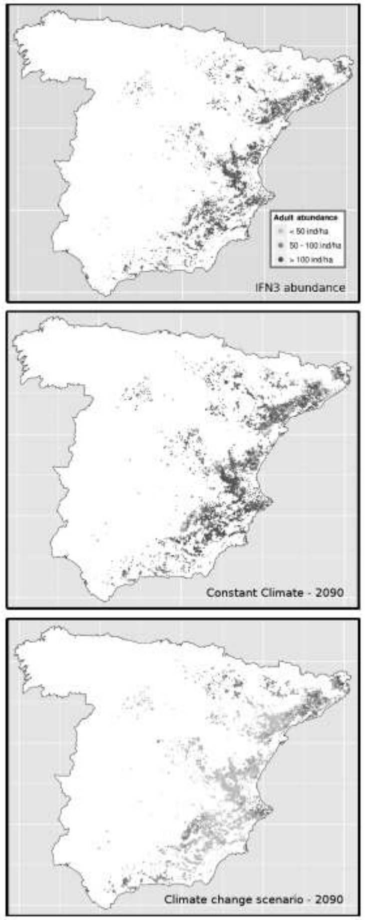
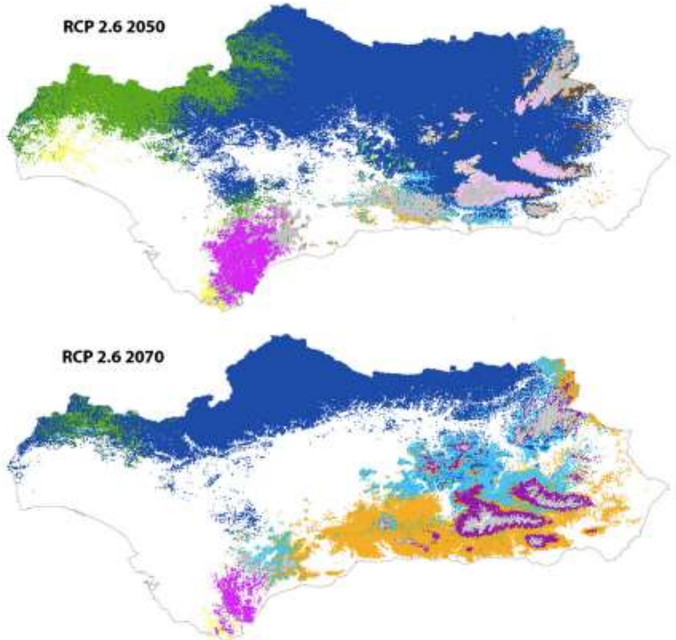
academic.oup.com/jpe

Projecting the distribution and abundance of Mediterranean tree species under climate change: a demographic approach

David García-Callejas[1,], Roberto Molowny-Horas[1] and Javier Retana[1,2]*





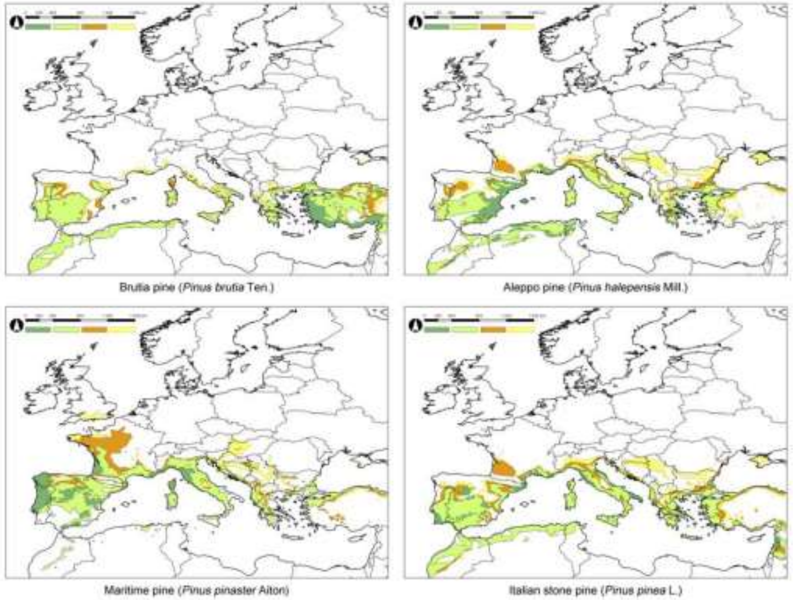


Fig. 2. Expansion: current distribution (dark green), modeled potential distribution in the reference period (light green), and modeled potential distribution in the periods of 2011–2040 (orange) and 2041–2070 (yellow) of the four studied *Pinus* species.

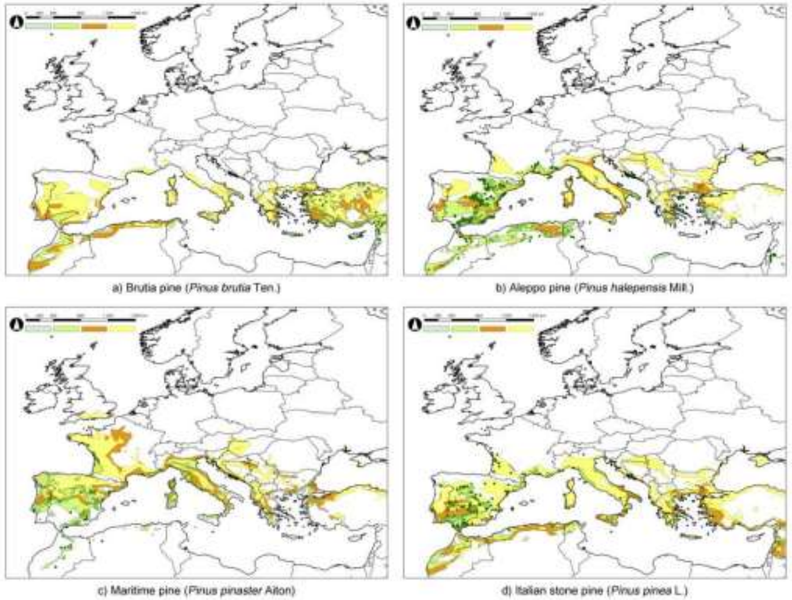


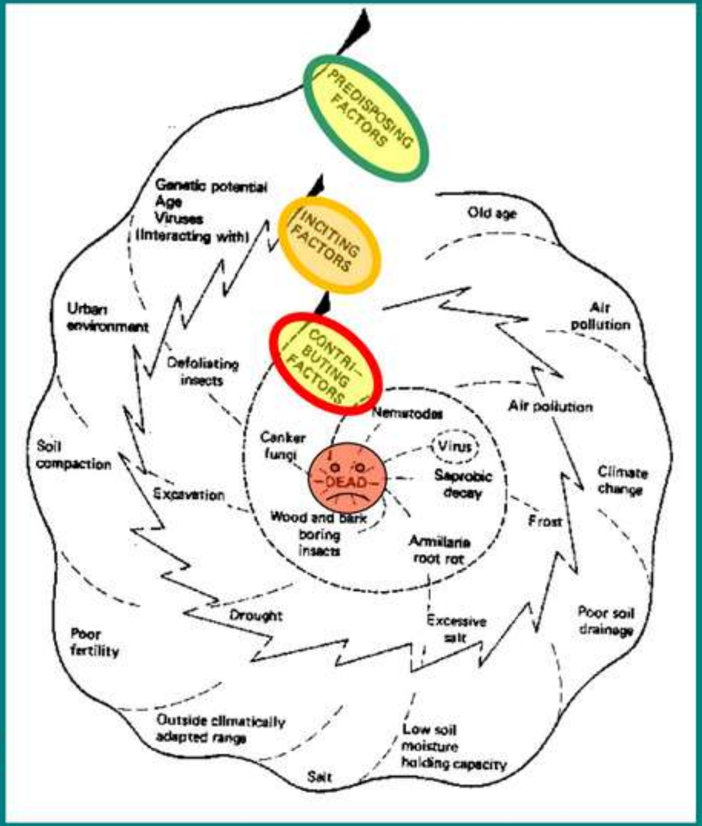
Fig. 3. Retraction: current distribution (dark green hatch and points), modeled potential distribution in the reference period (light green), and modeled potential distribution in the

Drivers of Forest Dieback

Manion (1991) conceptual model.

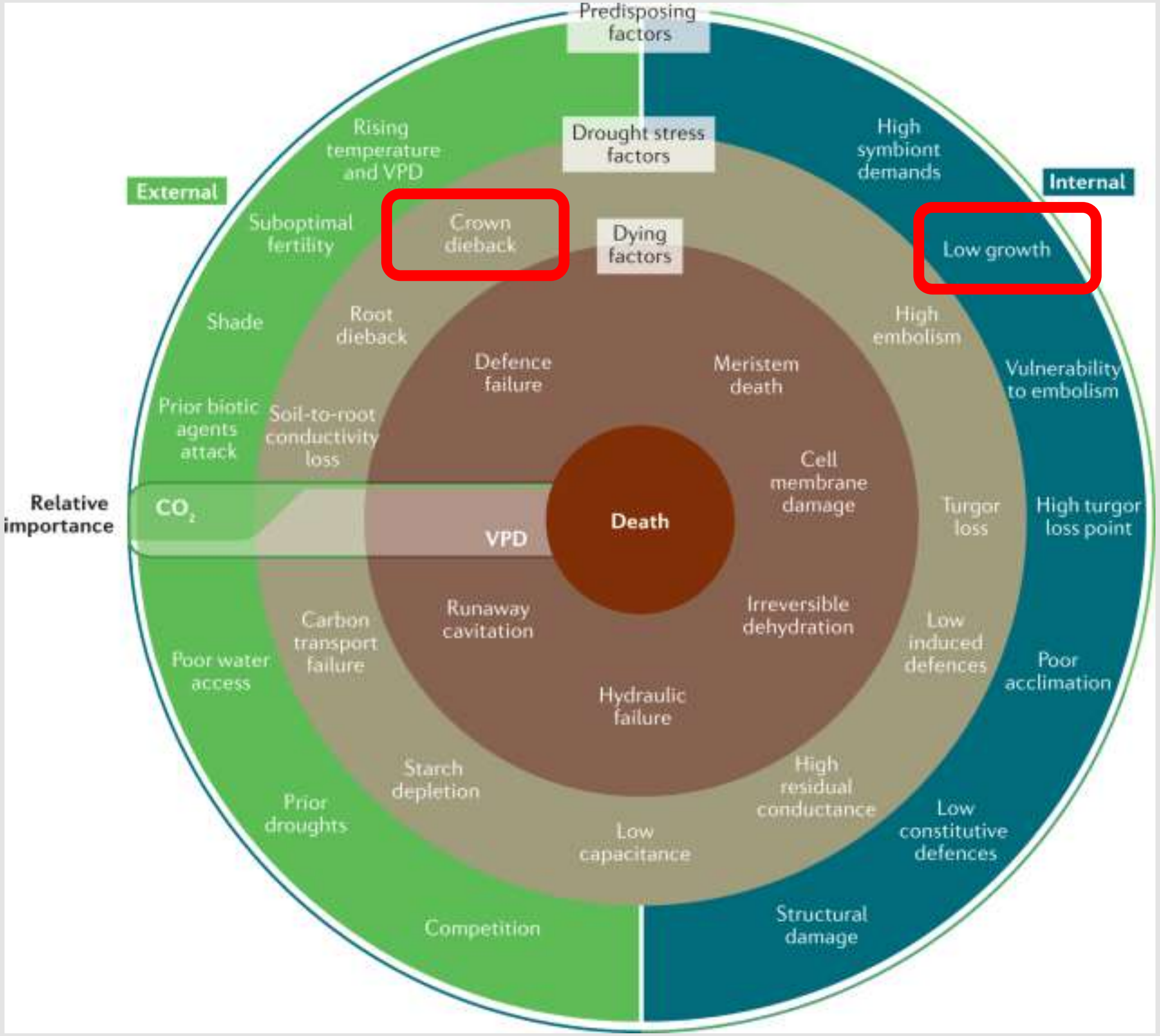
Decline is caused by interacting abiotic and biotic factors (decline disease spiral) classified in three groups:

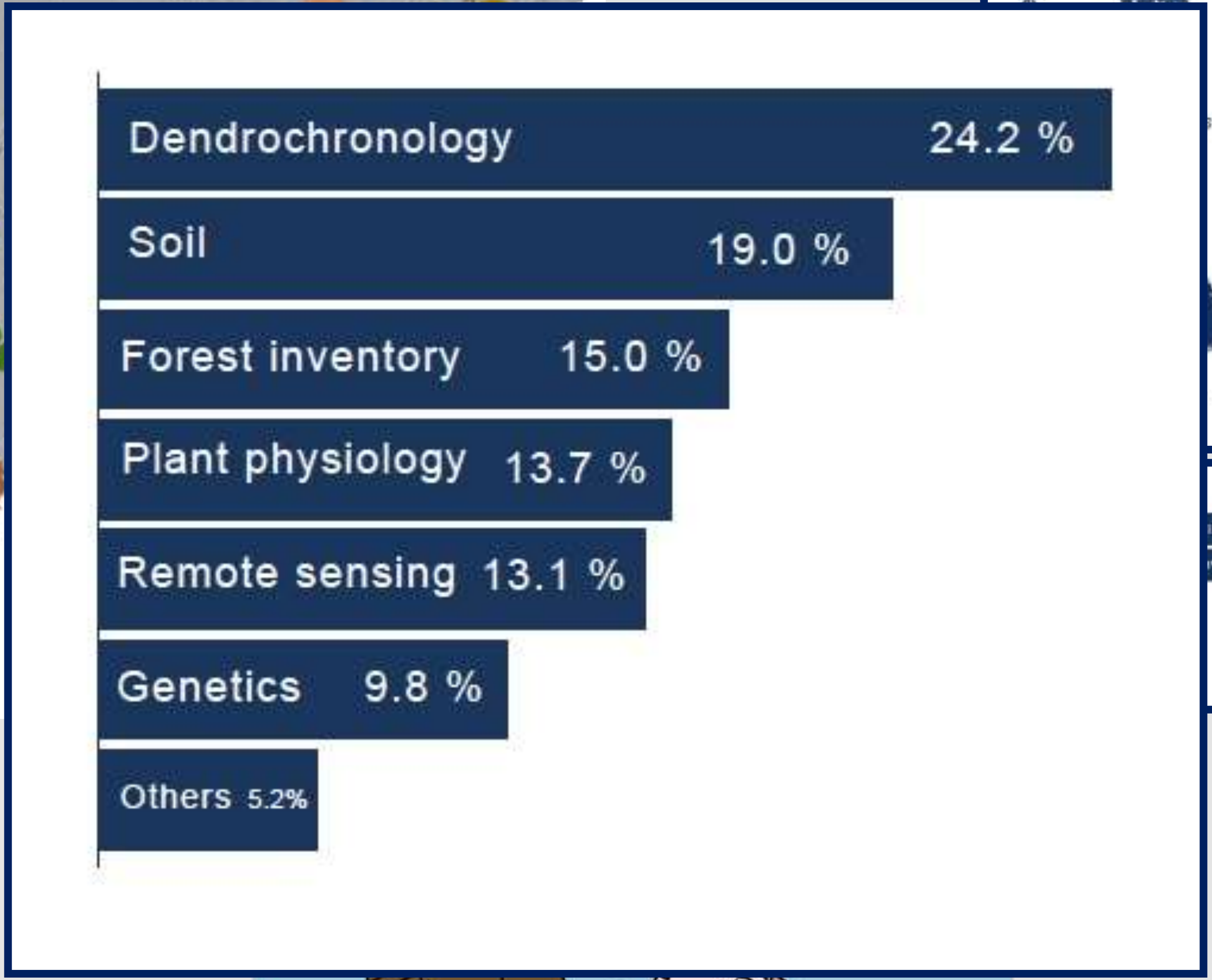
- PREDISPOSING factors: long-term drivers (climate, site, soil, age, genetic pool, historical use). Reduce tree vigor.
- INCITING factors: short-term stressors (reduce C storage, enhance branch mortality and casue defoliation) such as droughts, frosts, insects, mechanical damages.
- CONTRIBUTING factors: opportunistic (secondary) organisms which contribute to kill the already weakened tree (e.g., root fungi, scolitids, etc.).

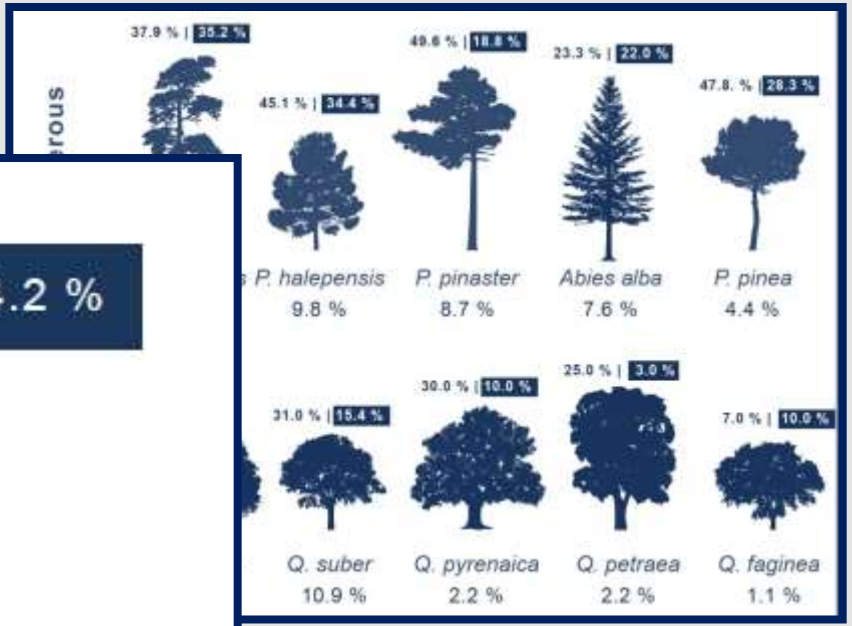


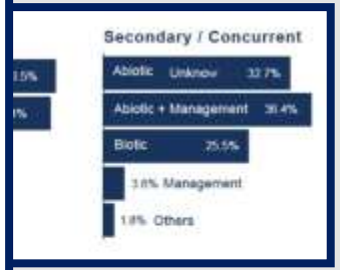
Manion (1991, 2002)

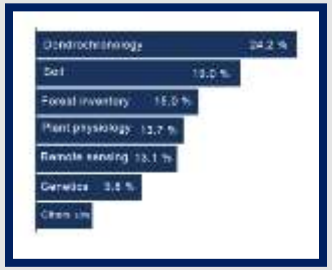
Drivers of Forest Dieback



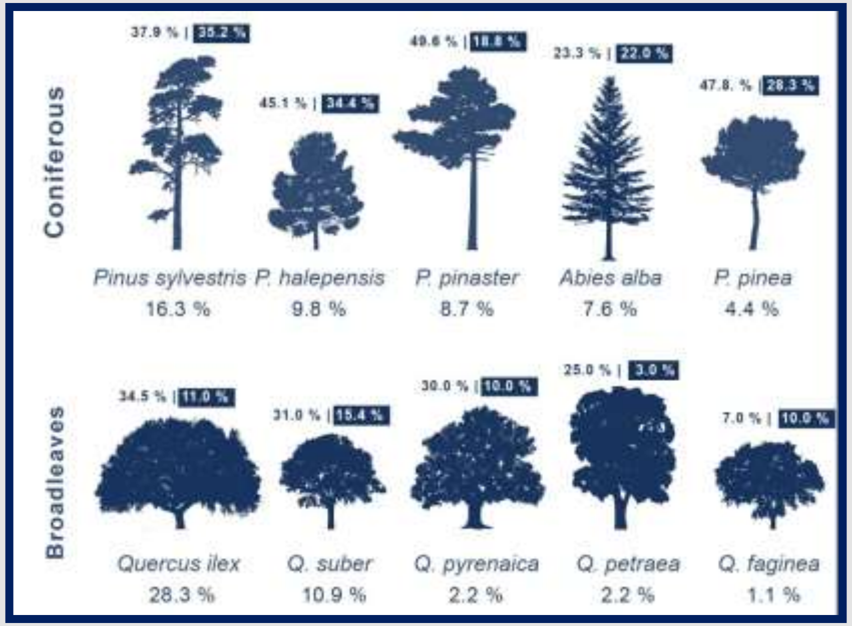


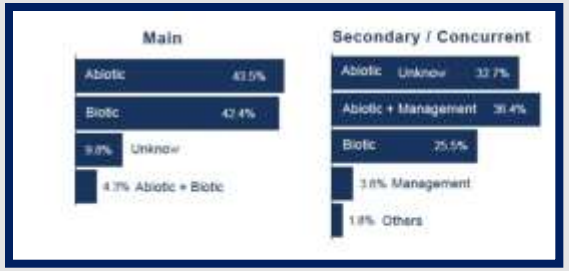


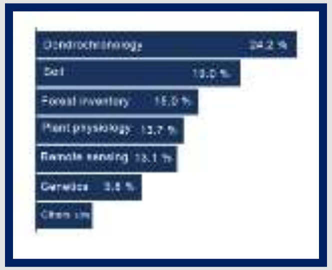




Pérez-Luque et al. 2025







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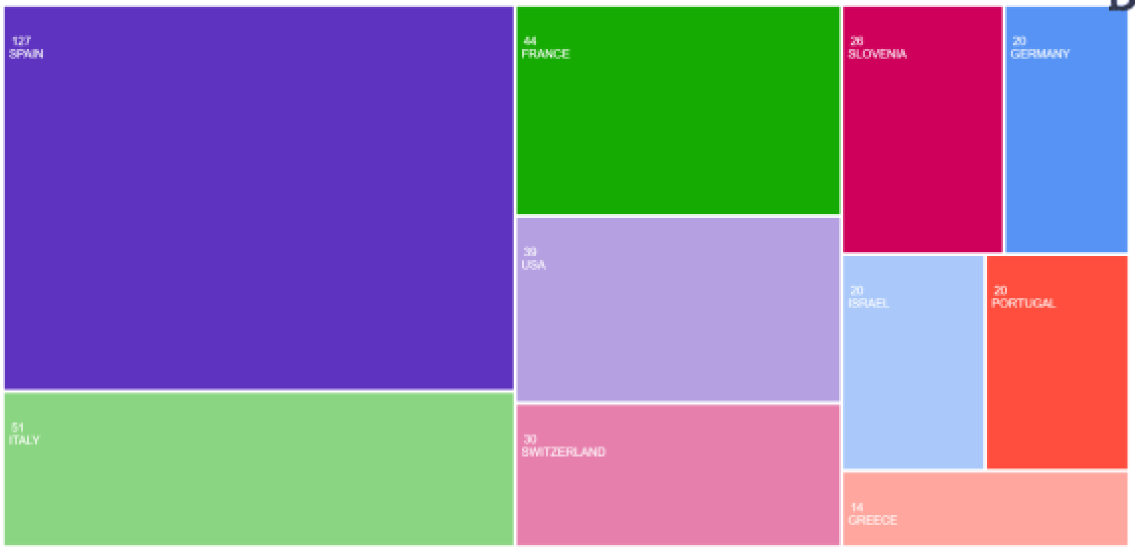
256 tree-rings and Pinus halepensis



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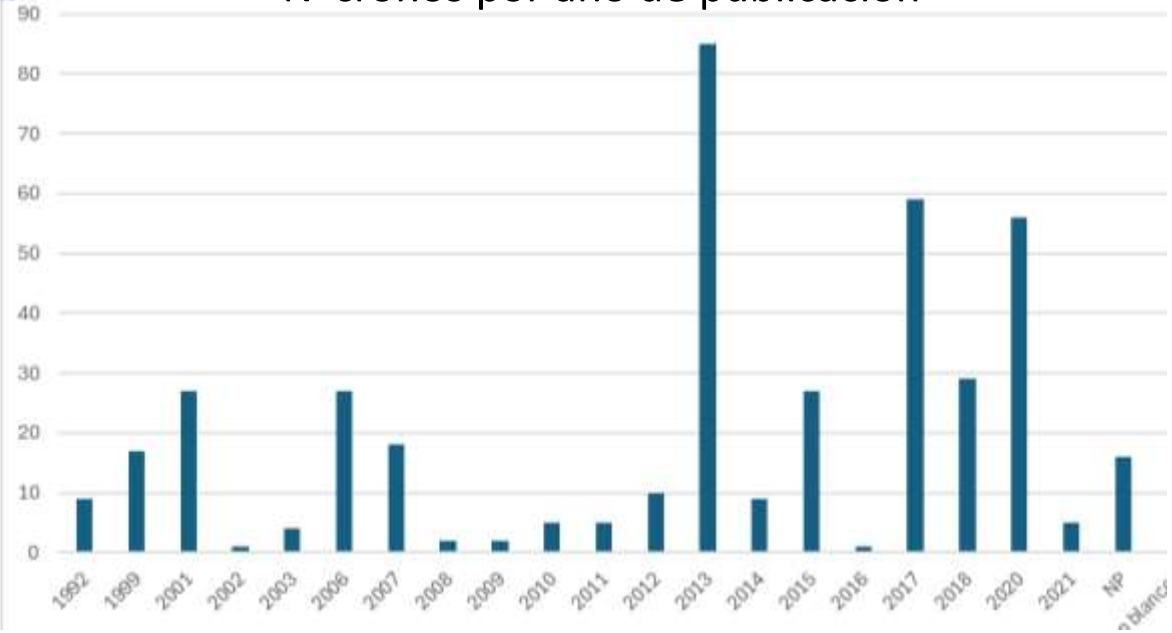

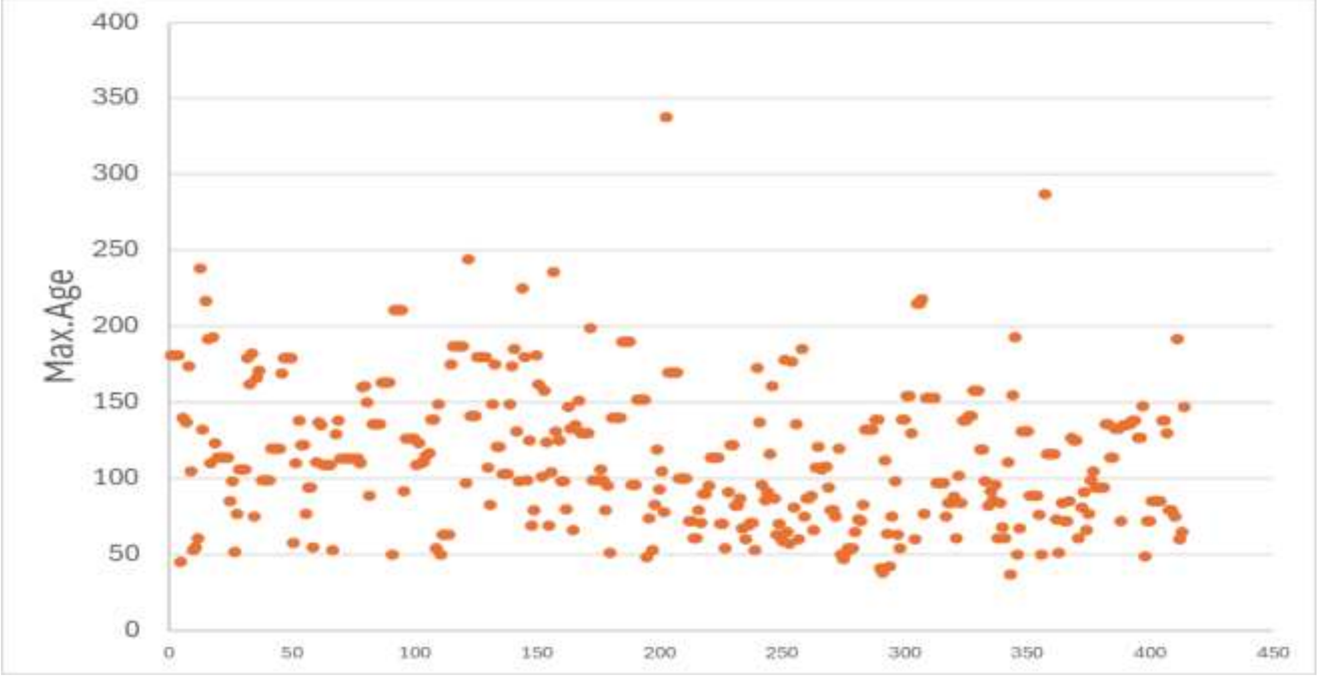

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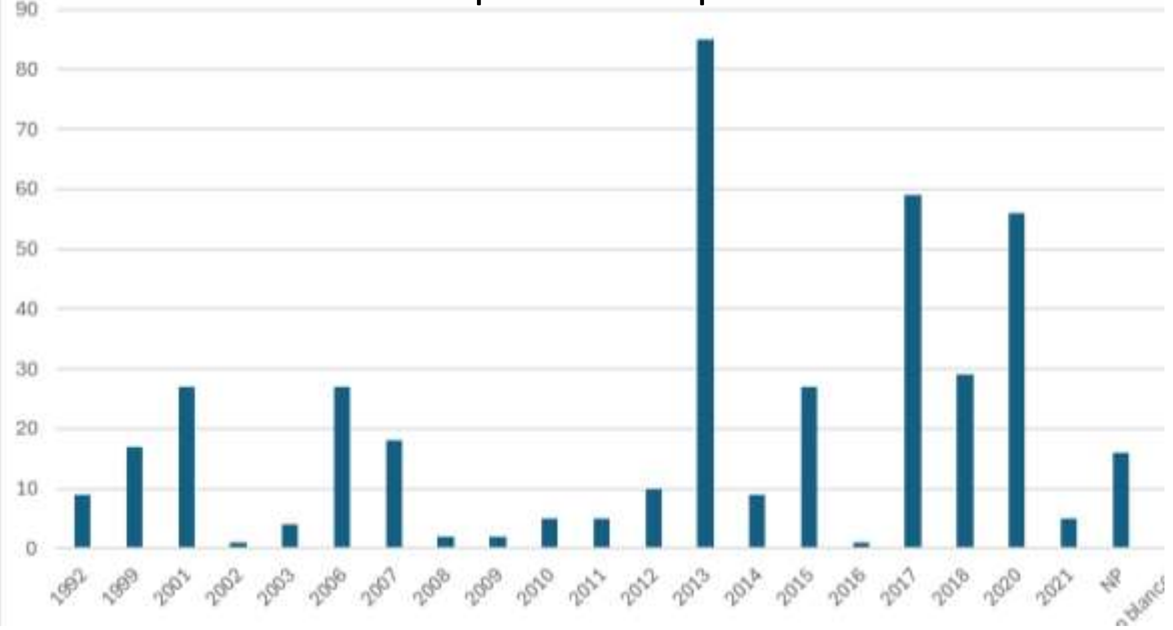
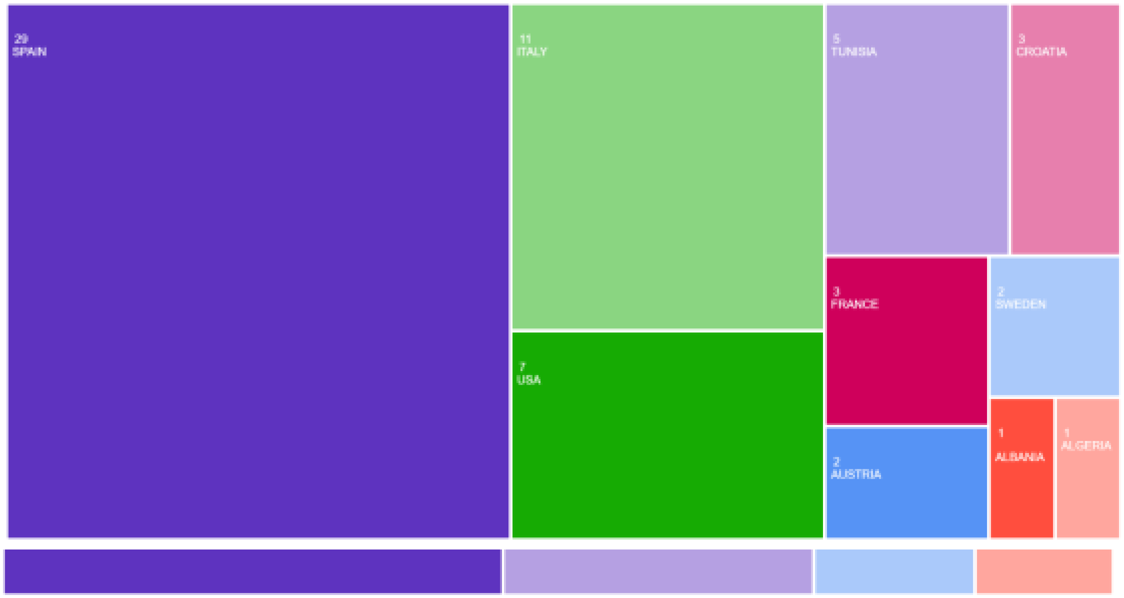
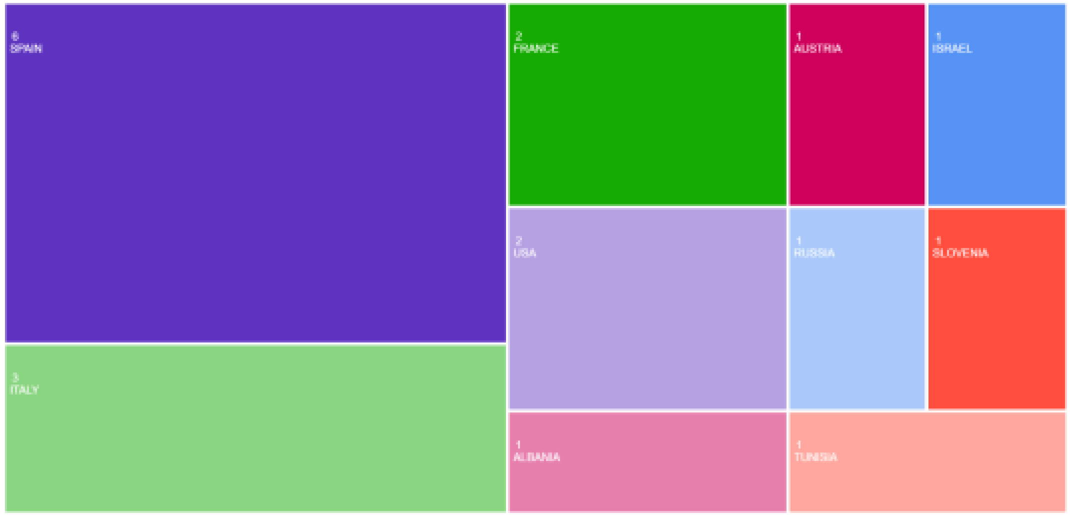
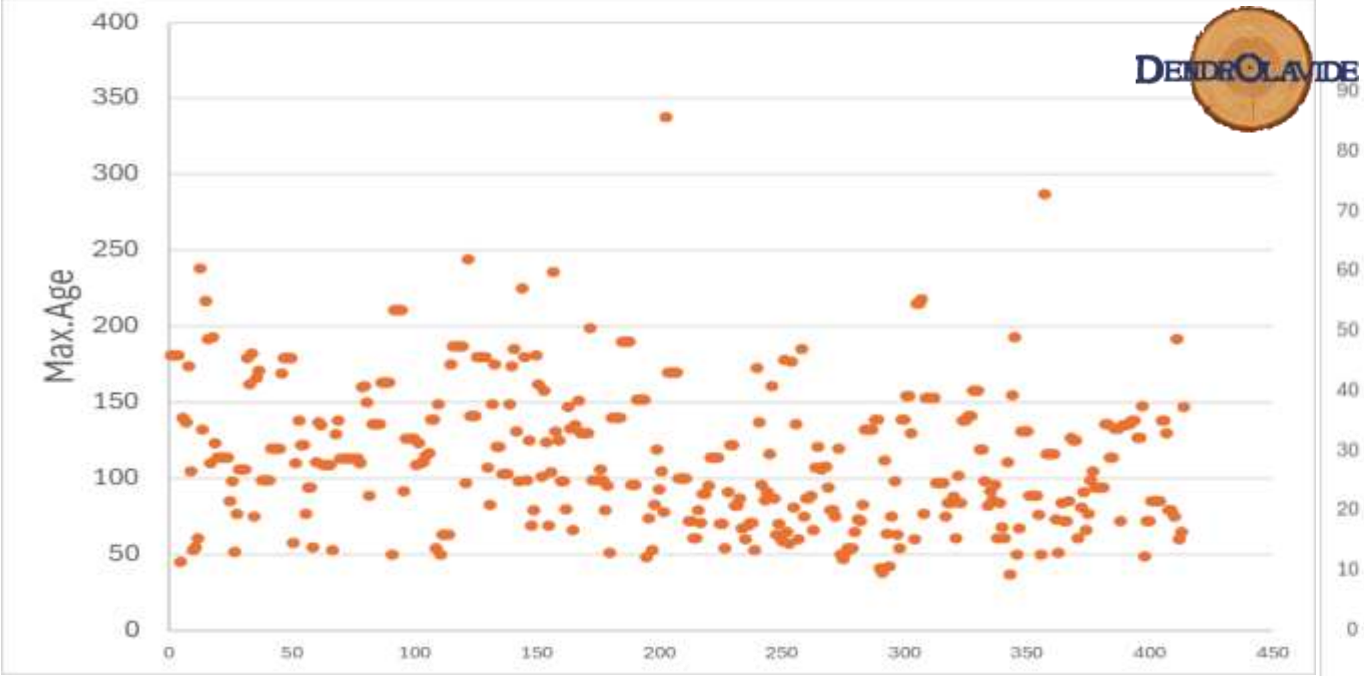


53 forest dieback and *Pinus halepensis*



11 forest dieback, tree rings and *Pinus halepensis*





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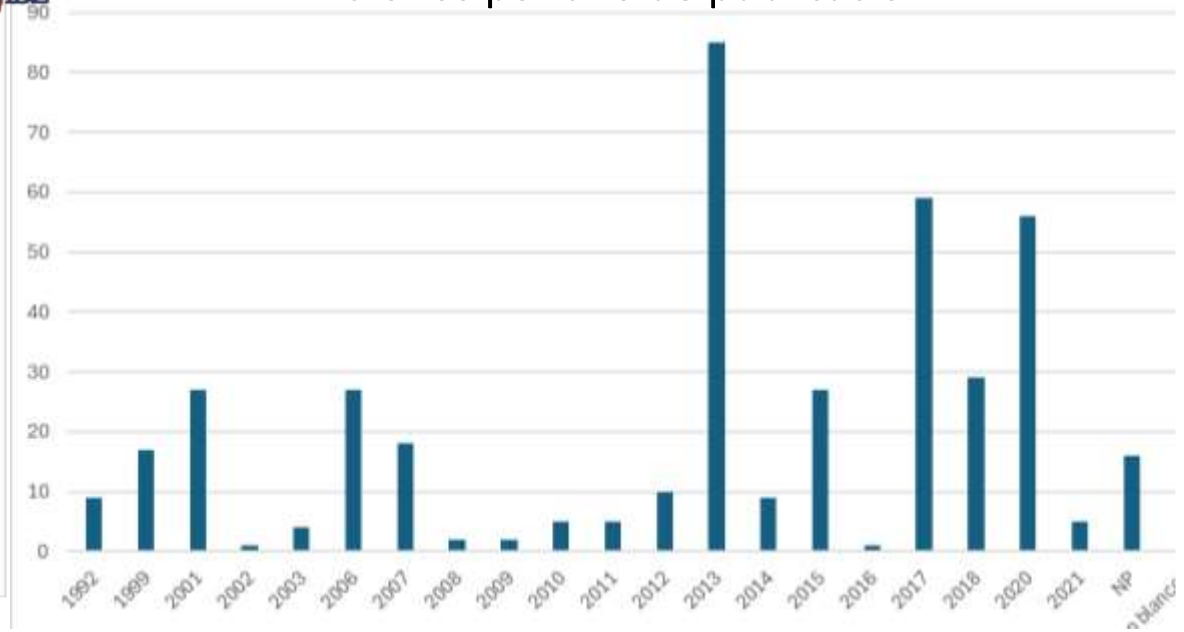
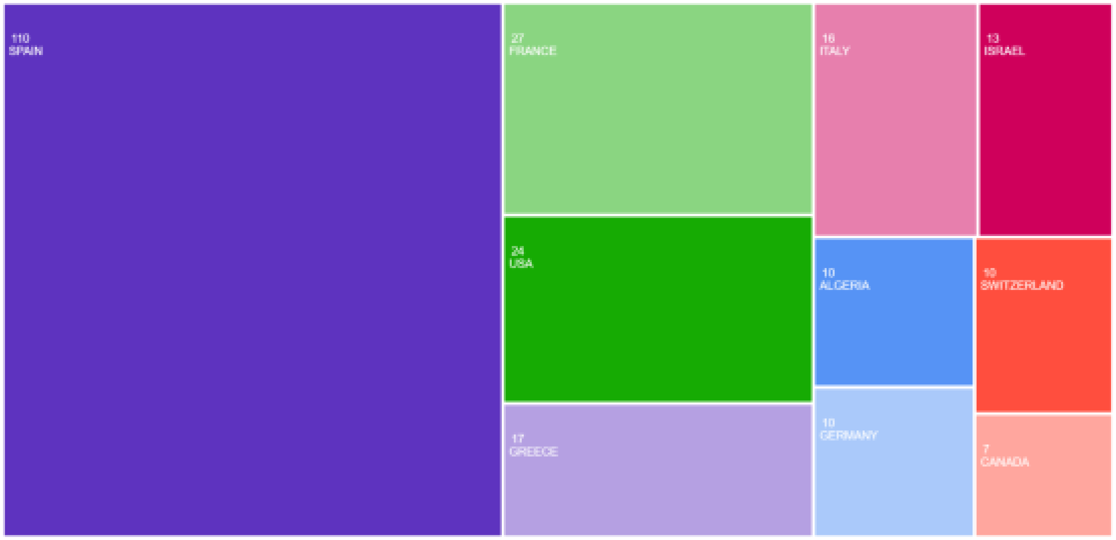
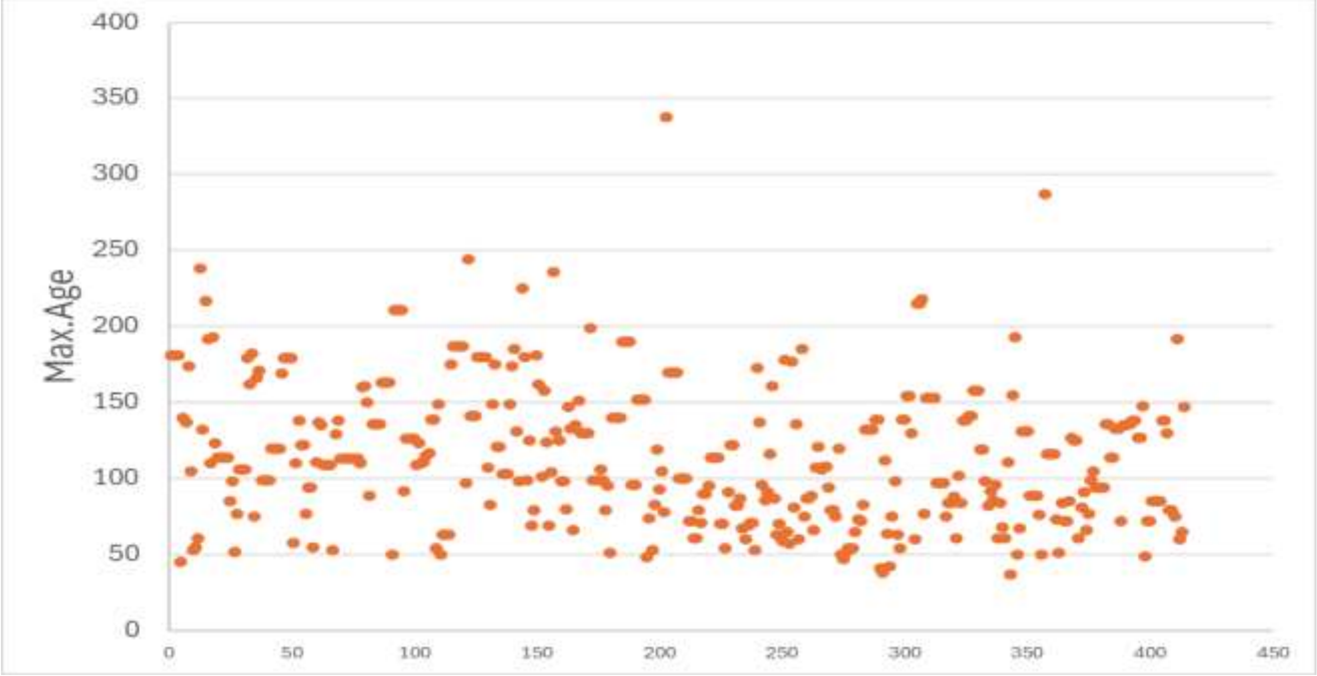
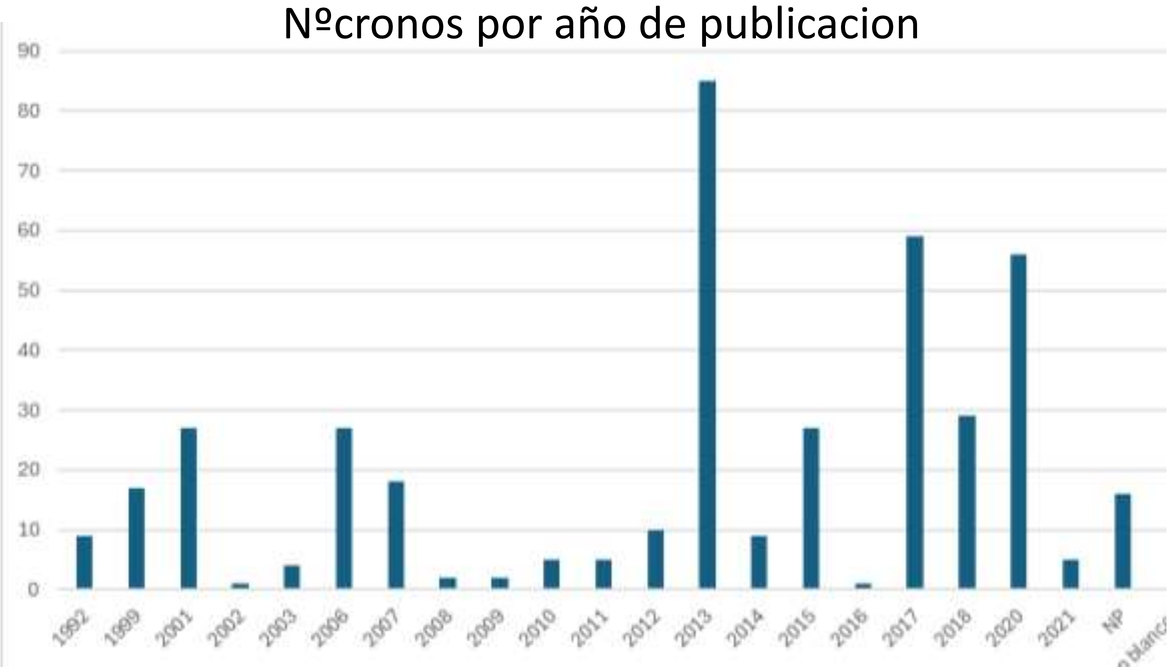


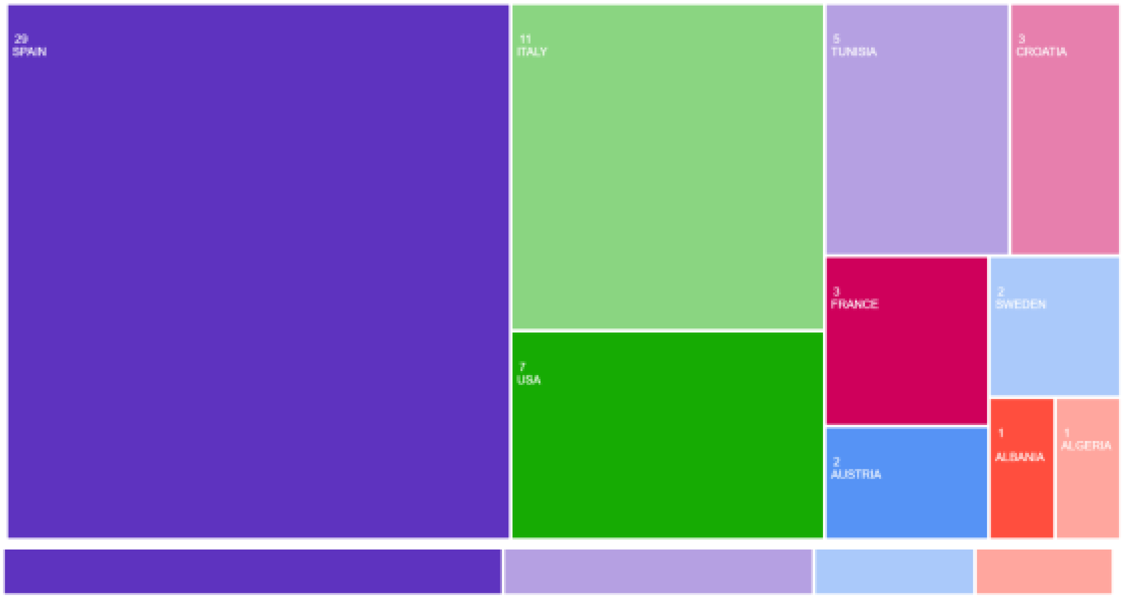
204 forest decline and Pinus halepensis



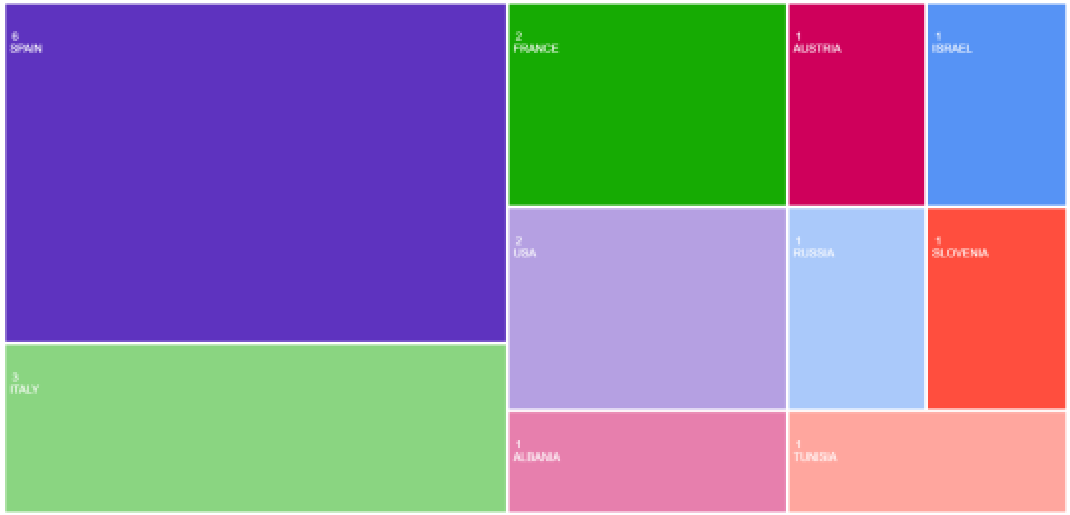


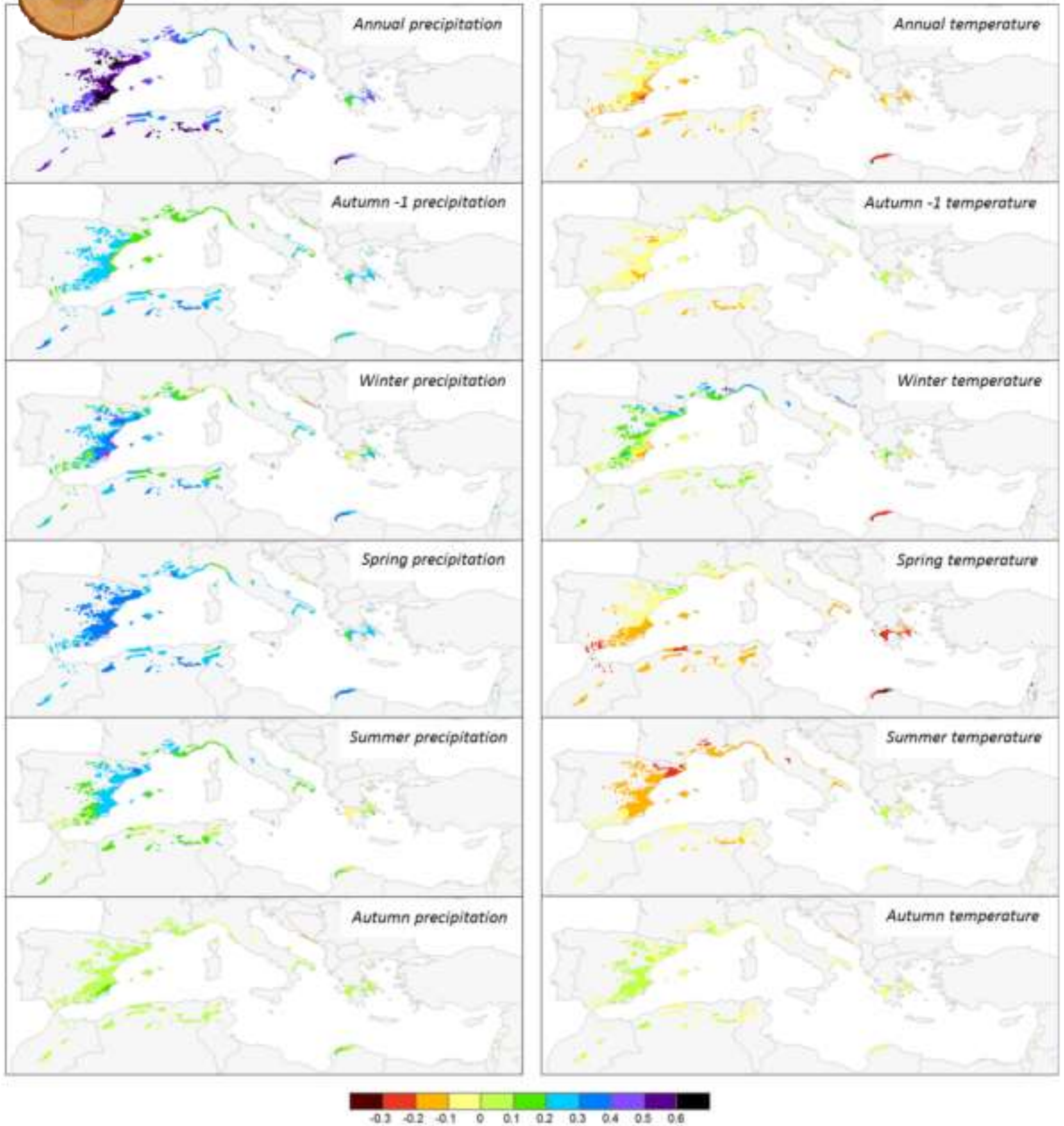


53 forest dieback and *Pinus halepensis*



11 forest dieback, tree rings and *Pinus halepensis*





De Luis et al., 2013, PlosOne

Veuillen et al., 2023 Agr.For.Met

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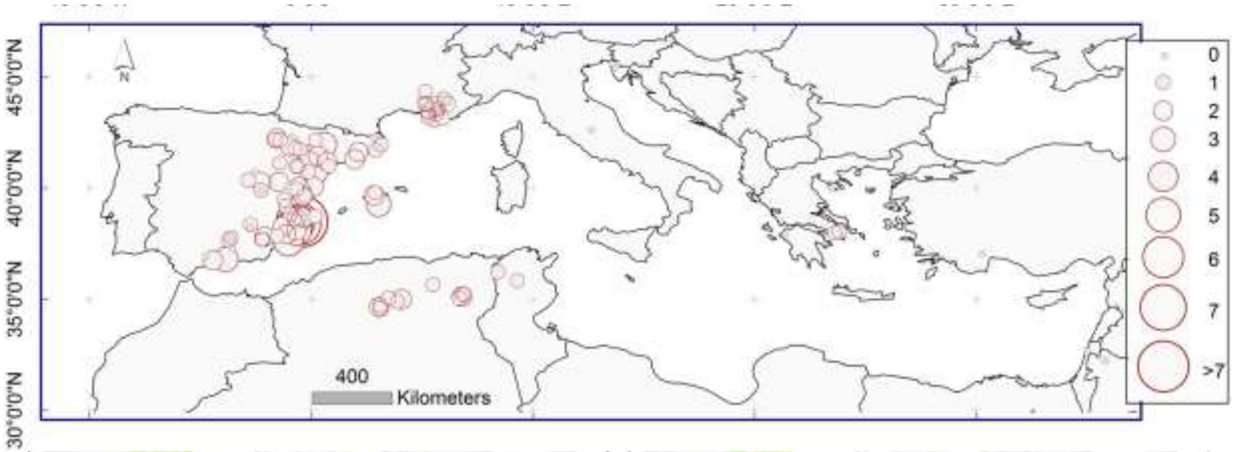
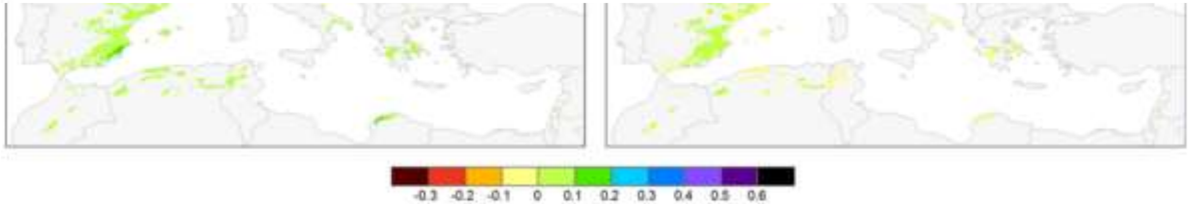
ORIGINAL RESEARCH
published: 31 May 2016
doi: 10.3389/fpls.2016.00727

Missing Rings in *Pinus halepensis* – The Missing Link to Relate the Tree-Ring Record to Extreme Climatic Events

Klemen Novak[1,2*], Martin de Luis[1], Miguel A. Saz[1], Luis A. Longares[1], Roberto Serrano-Notivoli[1], Josep Raventós[2], Katarina Čufar[3], Jožica Gričar[4], Alfredo Di Filippo[5], Gianluca Piovesan[5], Cyrille B. K. Rathgeber[6], Andreas Papadopoulos[7] and Kevin T. Smith[8]





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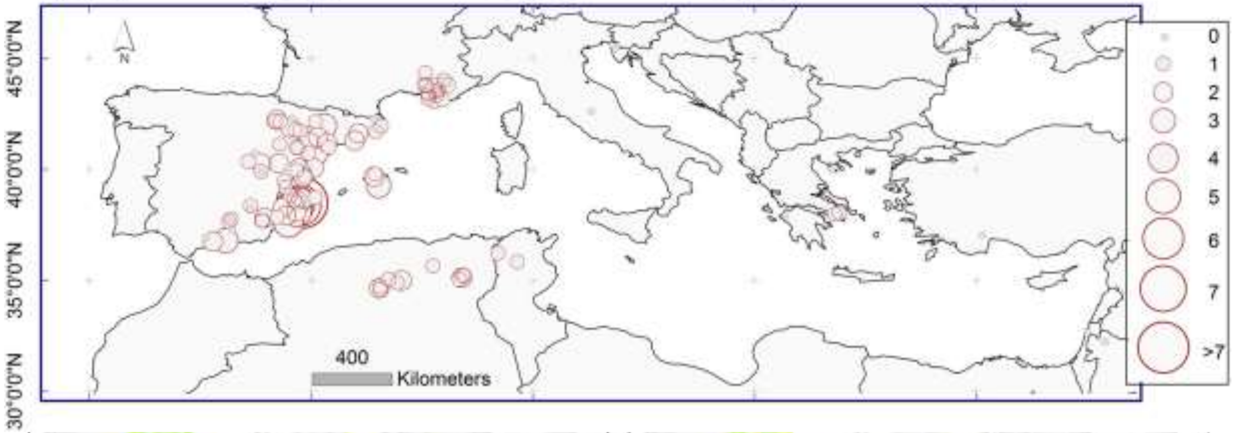

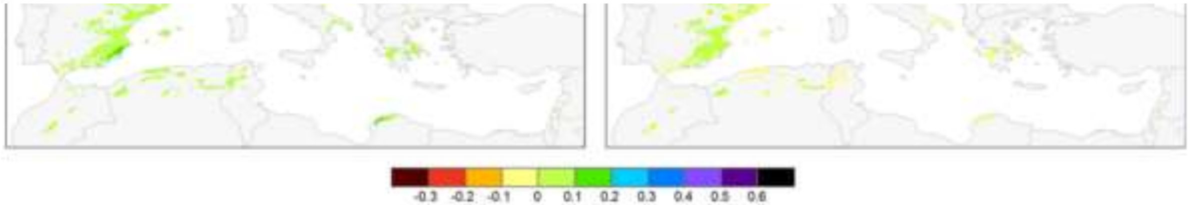

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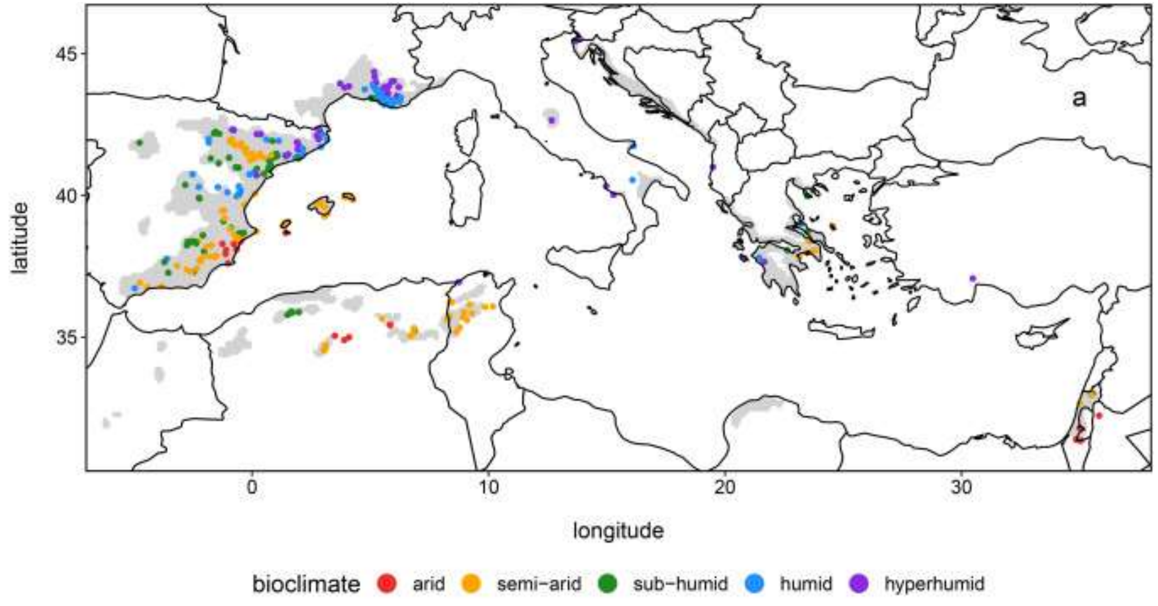
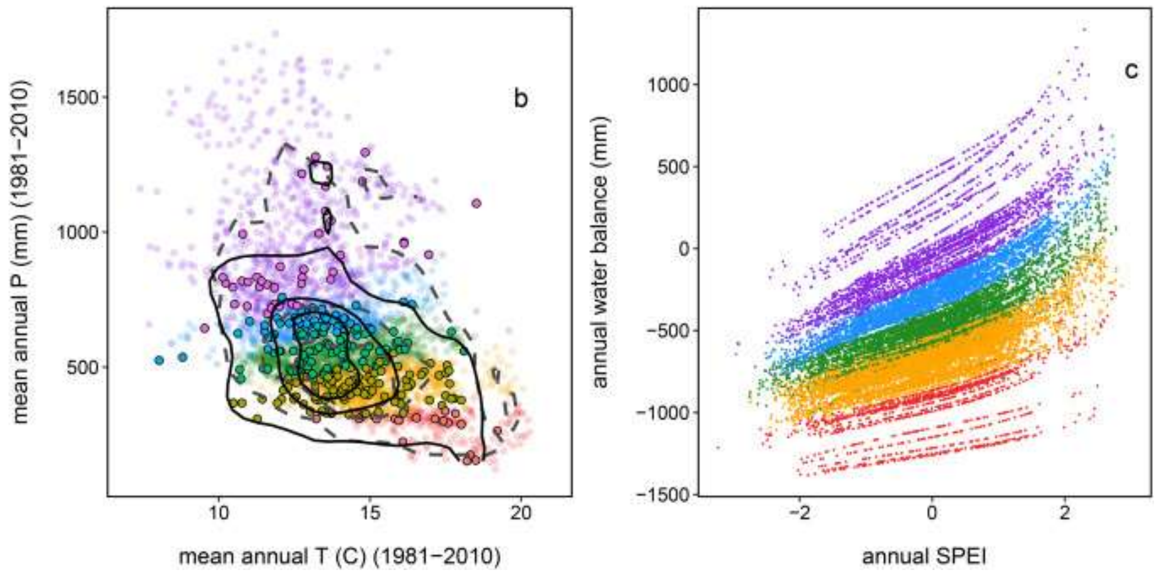
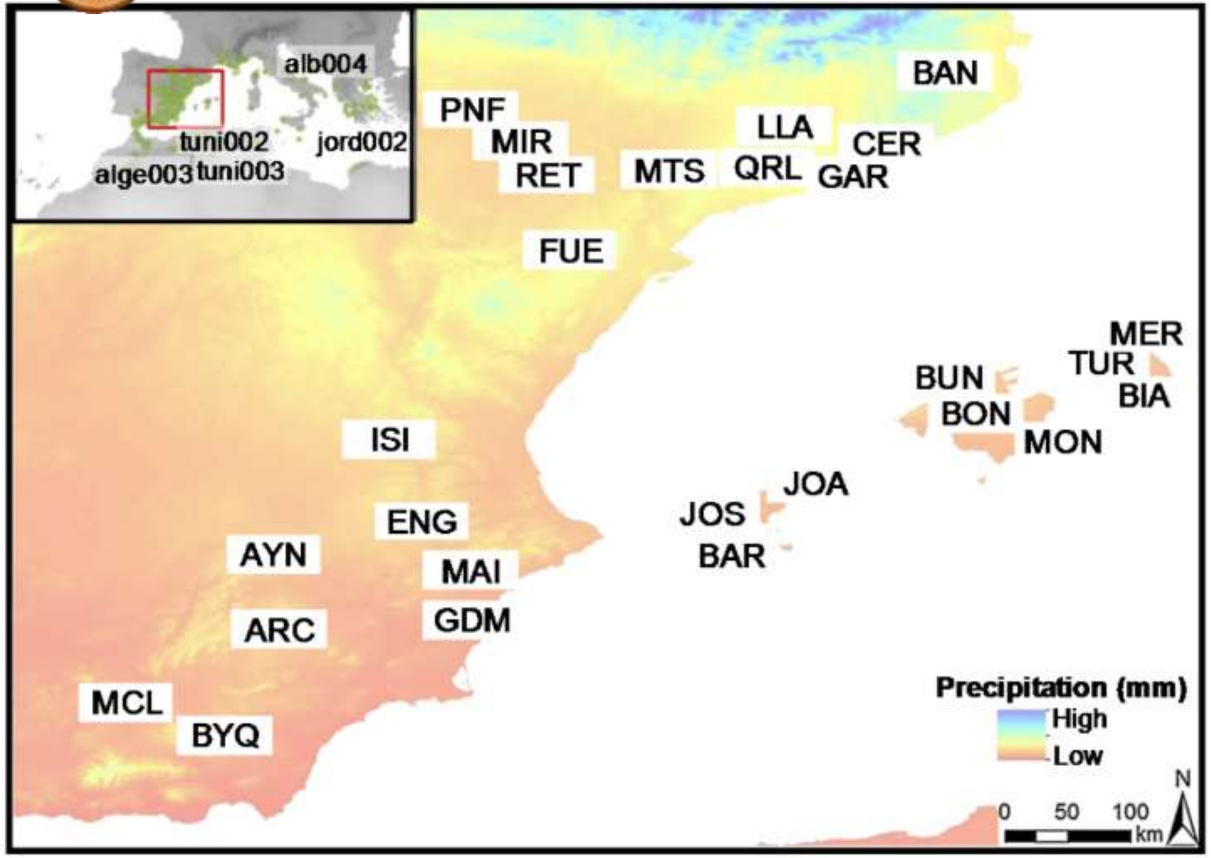




Veuillen et al., 2023 Agr.For.Met



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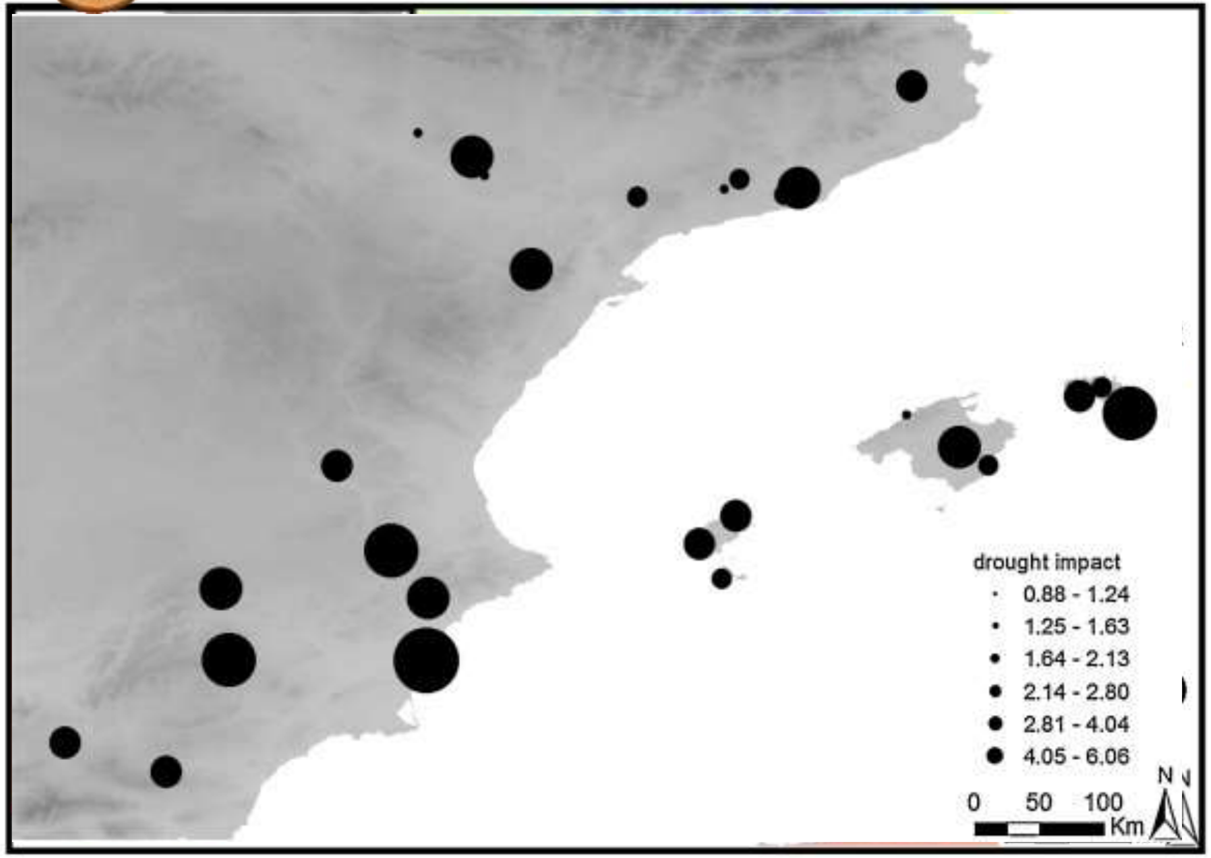
Gazol et al. 2017. AgrForMet
Camarero, Sánchez-Salguero et al., 2020



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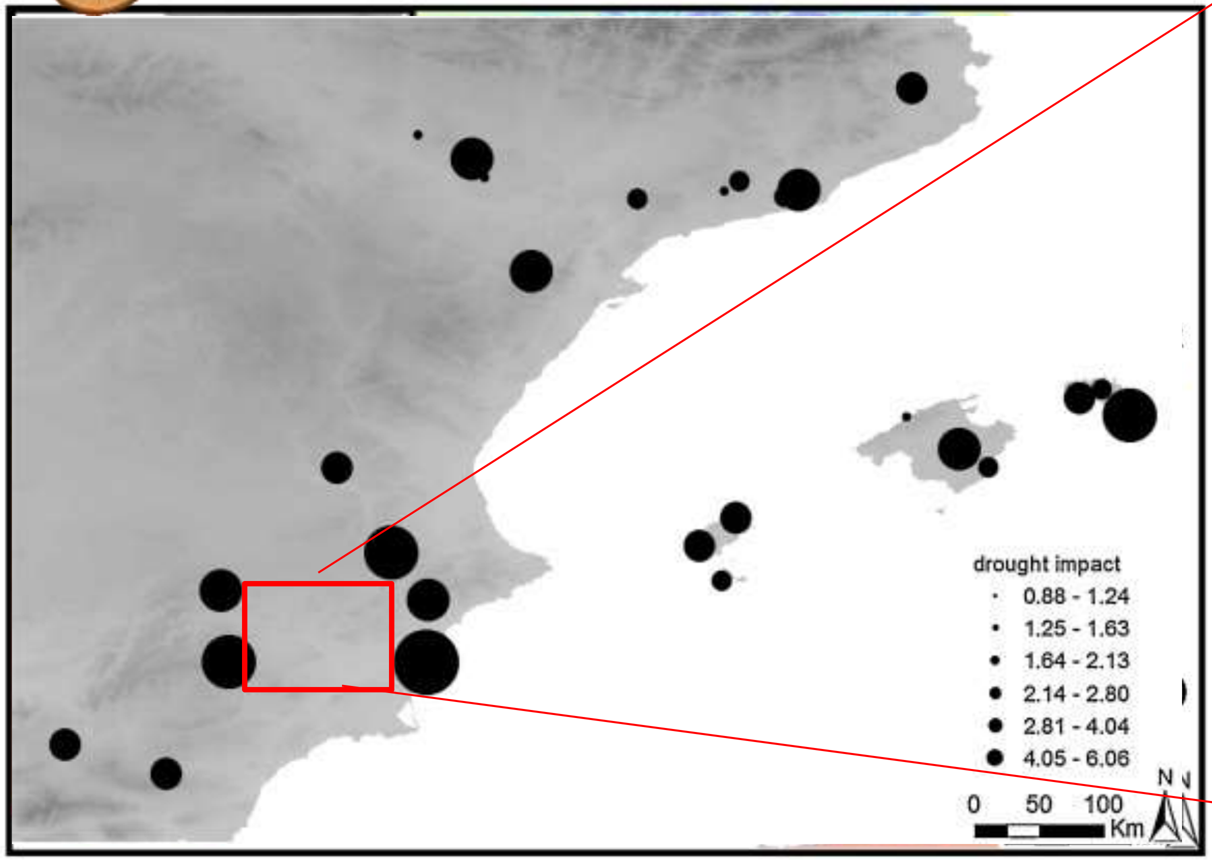

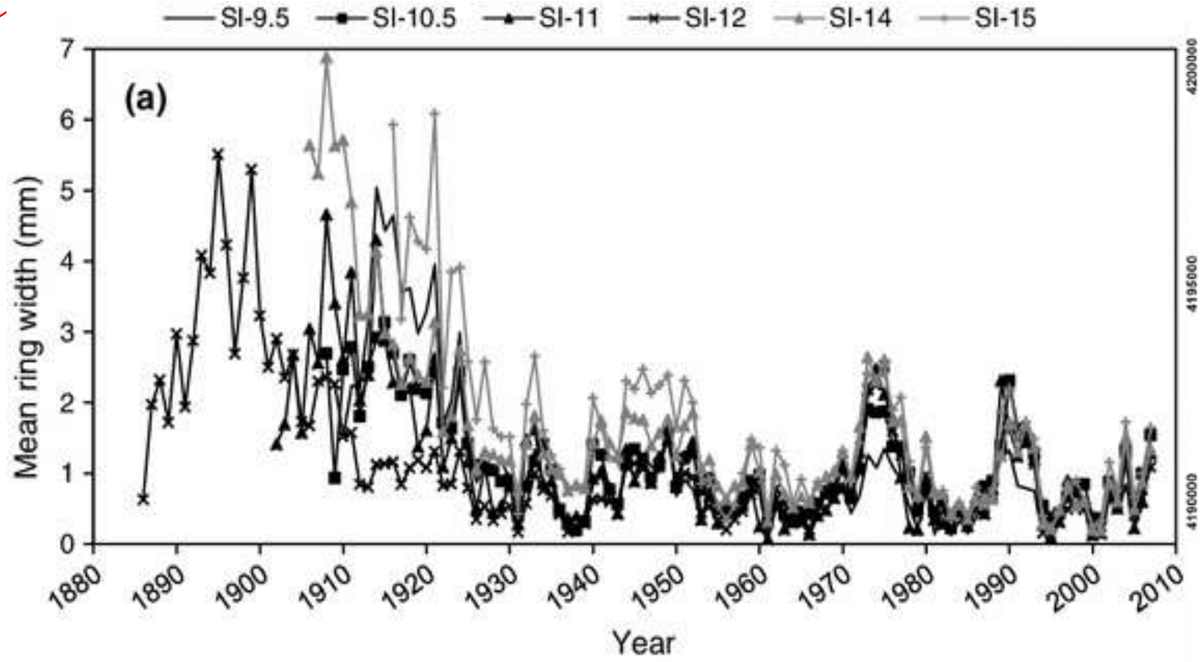

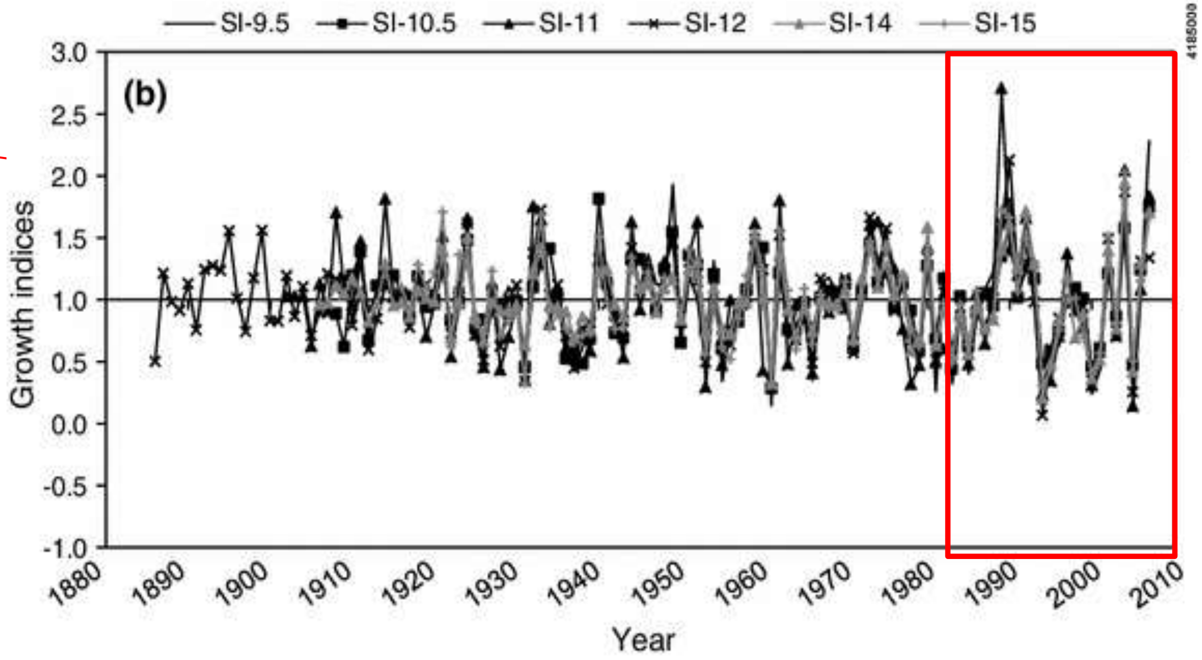

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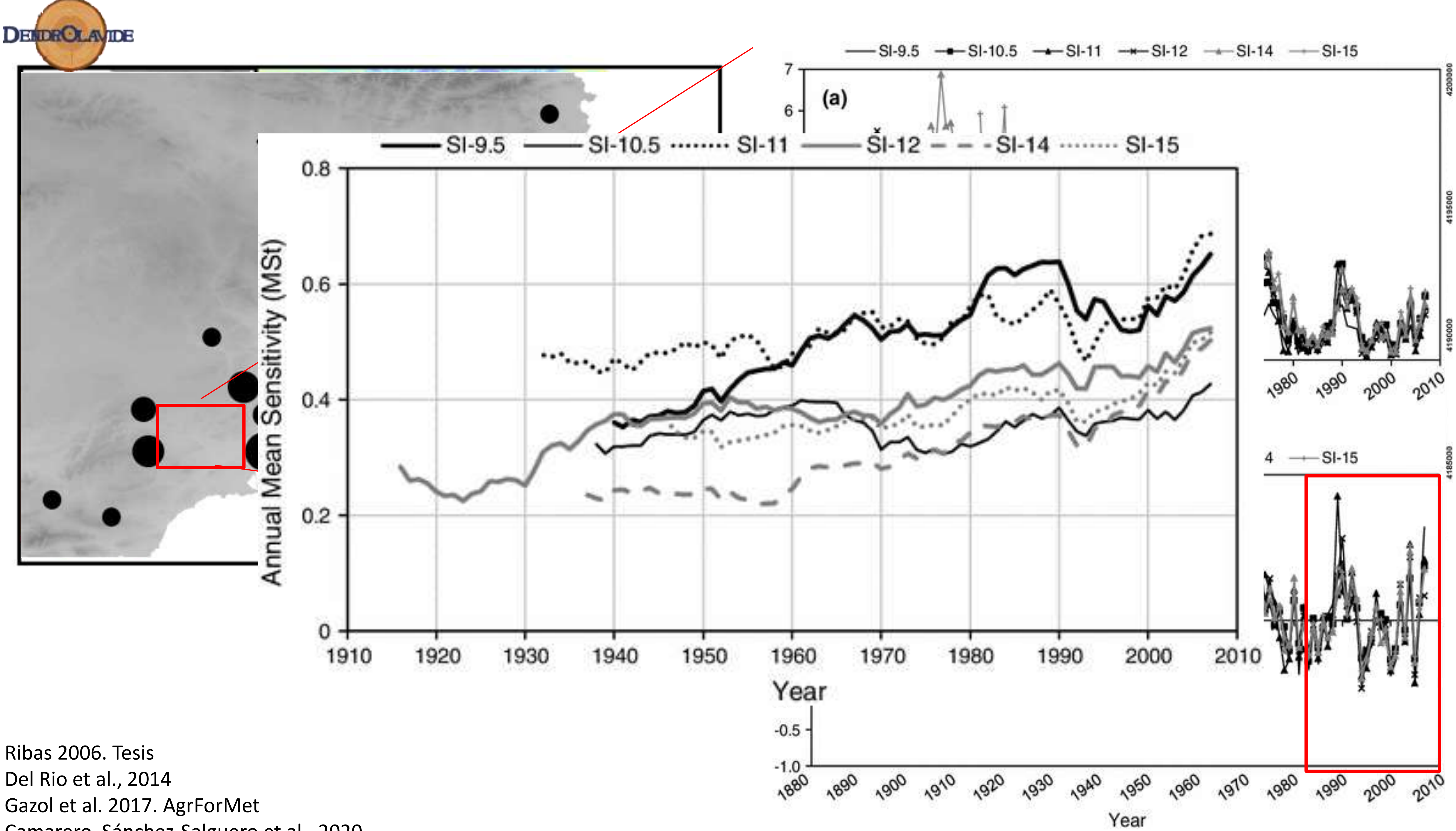

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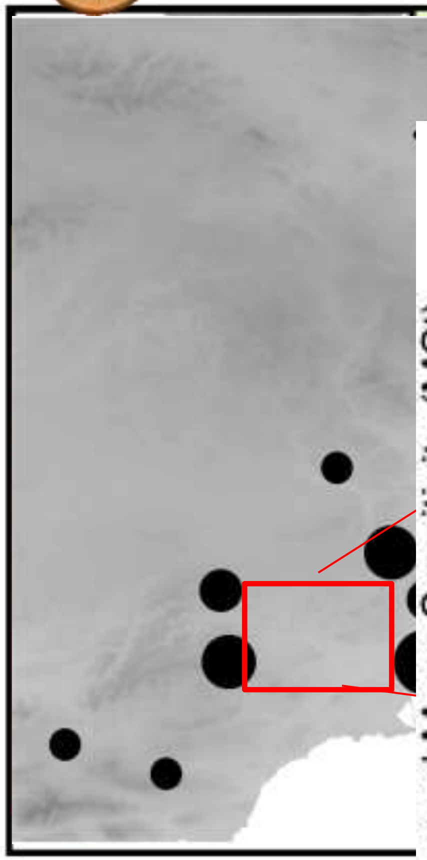

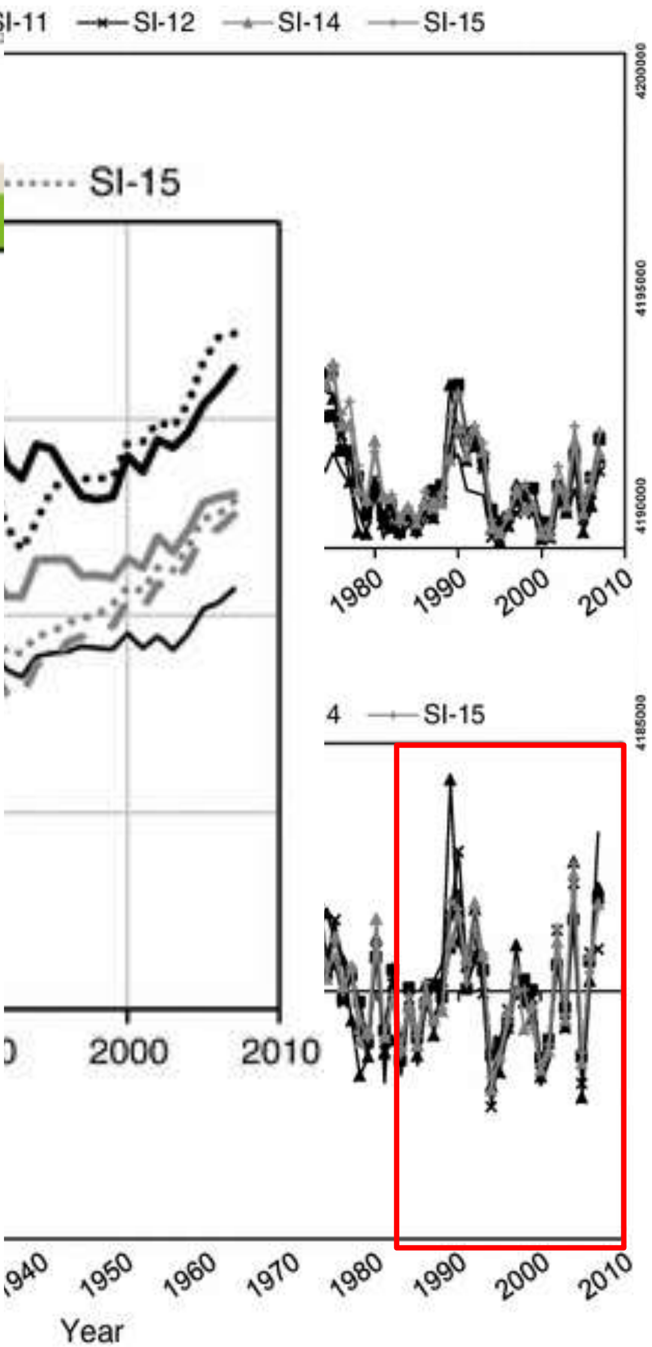

Ribas 2006. Tesis
Del Rio et al., 2014
Gazol et al. 2017. AgrForMet
Camarero, Sánchez-Salguero et al., 2020

DETERMINACIÓN DE LAS CAUSAS DE DECAIMIENTO DE LAS MASAS NATURALES DE PINARES DE *Pinus halepensis* Mill. EN LA PROVINCIA DE ZARAGOZA

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RESUMEN

En los últimos años se ha detectado un decaimiento general del arbolado de las masas naturales de pino carrasco (*Pinus halepensis* Mill.) de las Bárdenas Aragonesa y Montes de Zuera y Castejón, todas ellas localizadas en la provincia de Zaragoza en la región de procedencia "Monegros-Depresión del Ebro". En este trabajo se caracteriza fitoclimáticamente estas masas, utilizando los trabajos de CÁMARA (1998,1999) basados en los sistemas de ALLUÉ-ANDRADE (1990;1997) y se

Análisis de los factores de decaimiento en una repoblación de *Pinus halepensis* en el Sistema Ibérico zaragozano

ALQUÉZAR, J.M. [1]; CENTENO, F. [2], CUBERO, D. [2]; GIL-PELEGRÍN, E. [1], IBARRA, N [2], MARTÍN BERNAL, E. [3]; PEGUERO-PINA, J. J. [1]. , SÁNCHEZ-MIRANDA, A [4];

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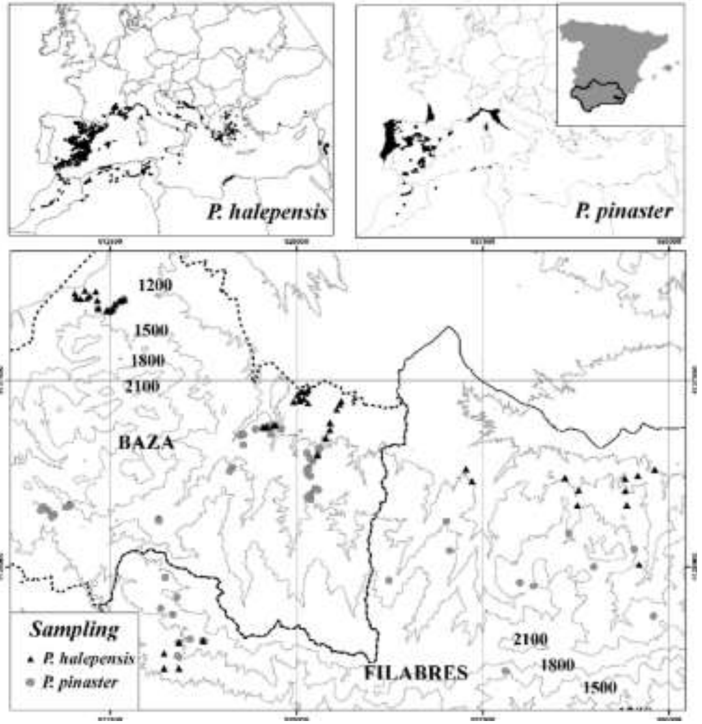
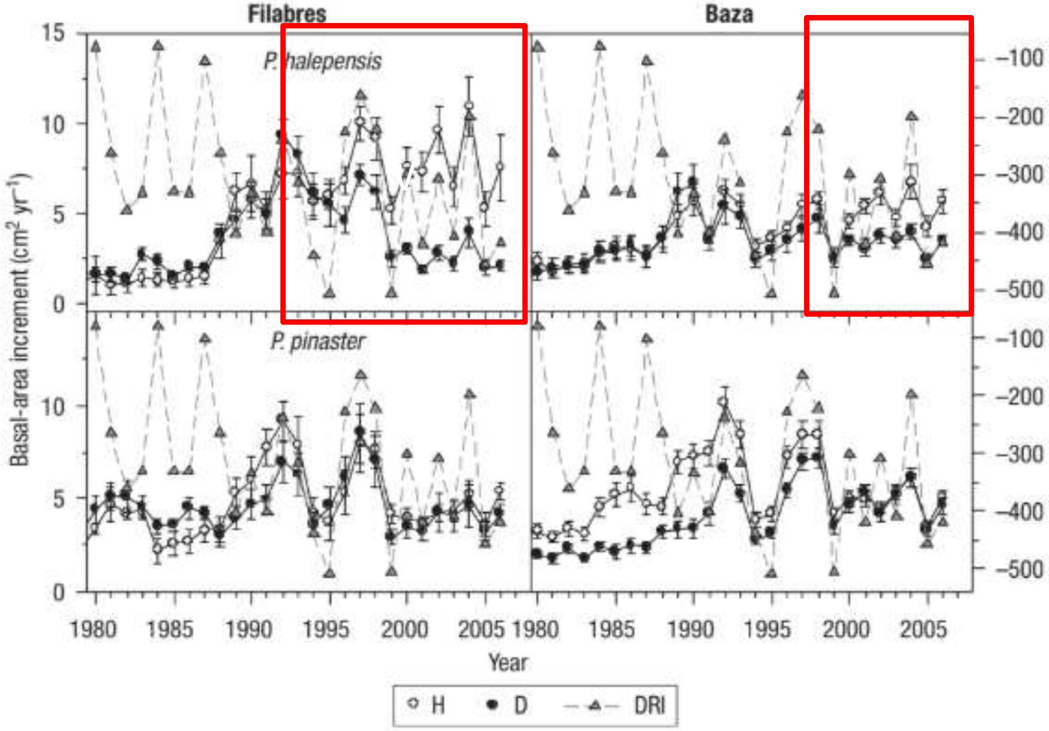
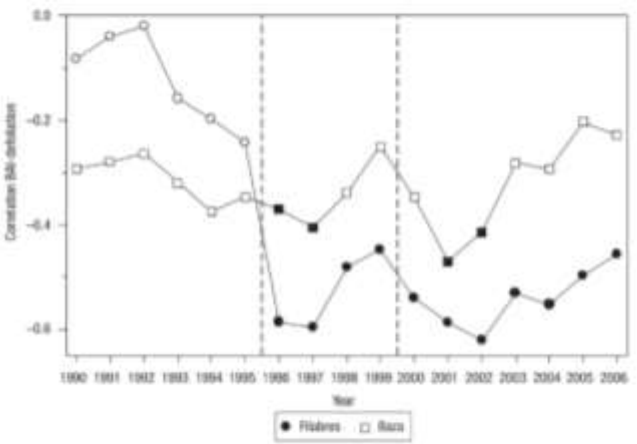
Drought-induced growth decline of Aleppo and maritime pine forests in south-eastern Spain

R. Sánchez-Salguero[1,2]*, R. M. Navarro-Cerrillo[2], J. J. Camarero[3] and A. Fernández-Cancio[1]







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Forest Ecology and Management 357 (2015) 126–137

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Reduced growth sensitivity to climate in bark-beetle infested Aleppo pines: Connecting climatic and biotic drivers of forest dieback

Gabriel Sangüesa-Barreda [a,*], Juan Carlos Linares [b], J. Julio Camarero [a]

[a] Instituto Pirenaico de Ecología (IPE-CSIC), Avda. Montañana 1005, Apdo. 202, 50192 Zaragoza, Spain
[b] Departamento de Sistemas Físicos, Químicos y Naturales, Universidad Pablo de Olavide, Ctra. Utrera km. 1, 41002 Sevilla, Spain

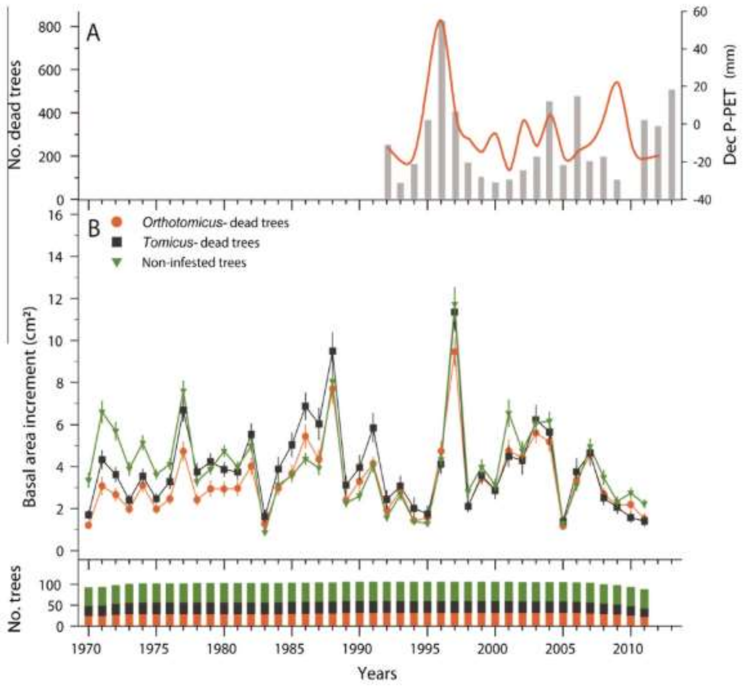


Fig. 1. Growth and mortality patterns. (A) Number of dead trees of Aleppo pine in the study area from 1996 to 2013. The red line indicates the December water balance (P-PET). (B) Basal area increment (means ± SE) of the three types of Aleppo pines (dead *Orthotomicus*- and *Tomicus*-infested trees and non-infested living trees) is shown for the 1970–2011 period. The bars indicate the sampling depth (number of trees measured).

100 YEARS Journal of Ecology

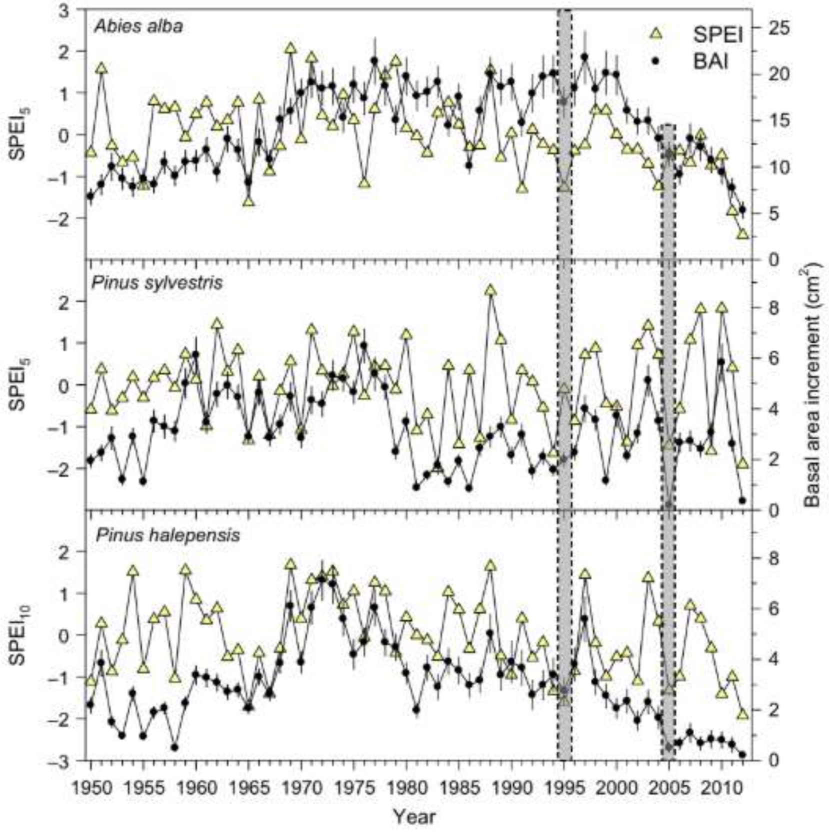
Journal of Ecology 2015, **103**, 44–57 doi: 10.1111/1365-2745.12295

SPECIAL FEATURE

FOREST RESILIENCE, TIPPING POINTS AND GLOBAL CHANGE PROCESSES

To die or not to die: early warnings of tree dieback in response to a severe drought

J. Julio Camarero[1,2*], Antonio Gazol[3], Gabriel Sangüesa-Barreda[3], Jonàs Oliva[4] and Sergio M. Vicente-Serrano[3]



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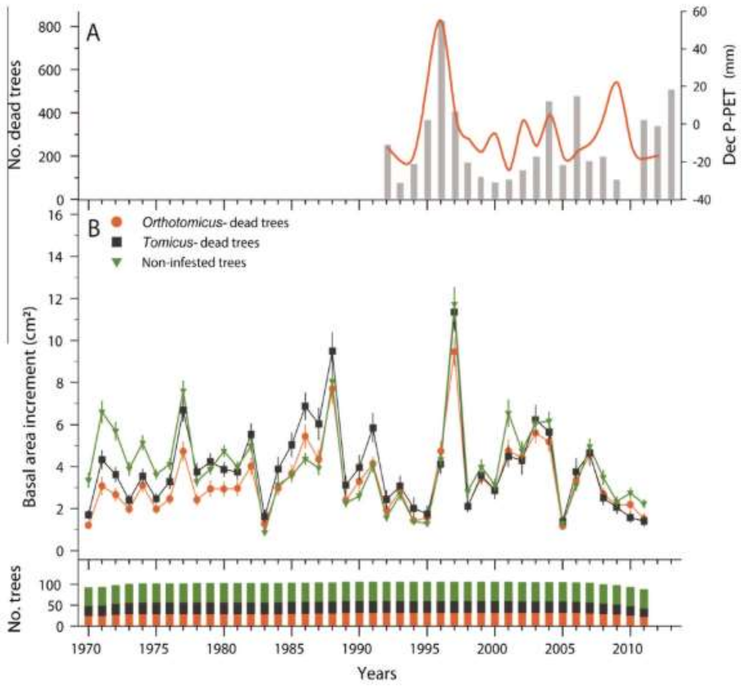

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SPECIAL ...
FOREST ...

To die ... ck in respo...

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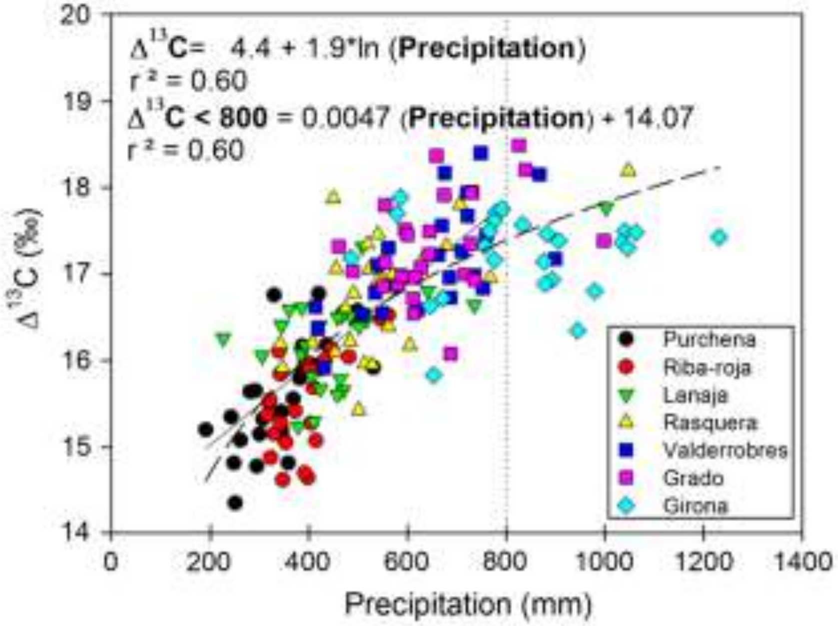
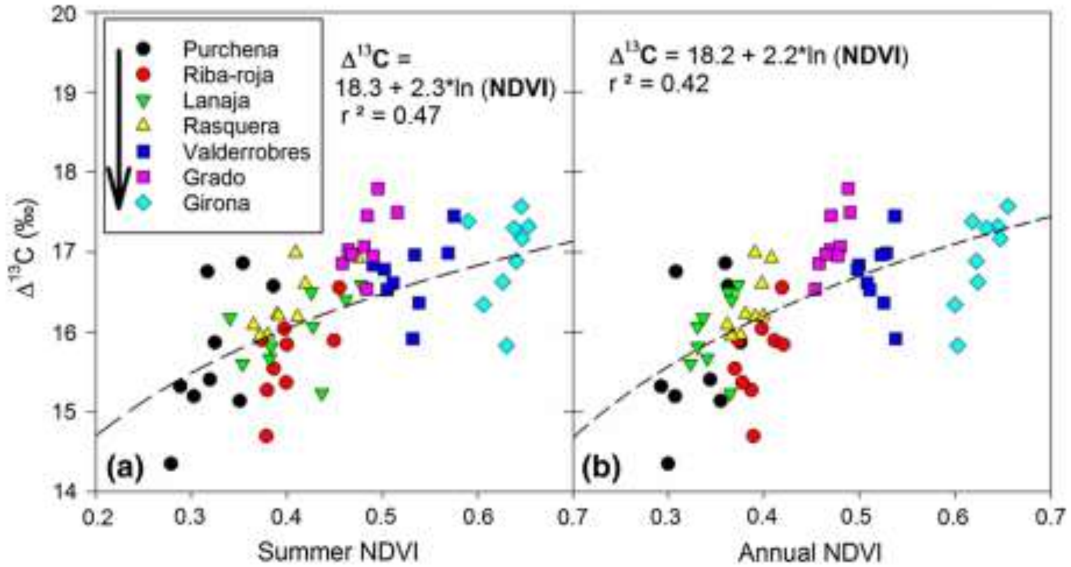
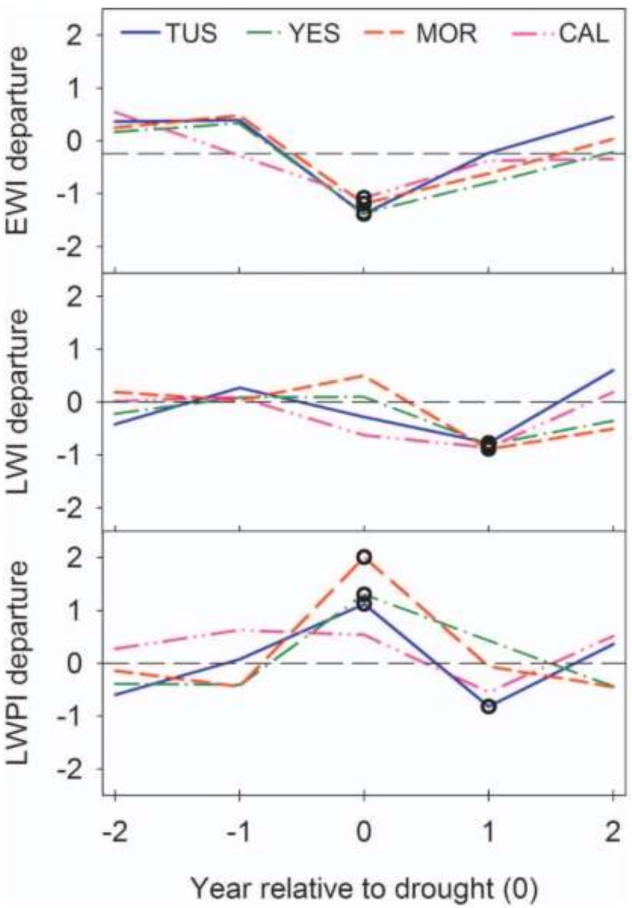




ESEARCH, Vol. 74(1), 2018, pp. 1-14
...doi.org/10.3959/1536-1098-74.1.1

HOW DO DROUGHTS AND WILDFIRES ALTER SEASONAL RADIAL GROWTH IN MEDITERRANEAN ALEPPO PINE FORESTS?

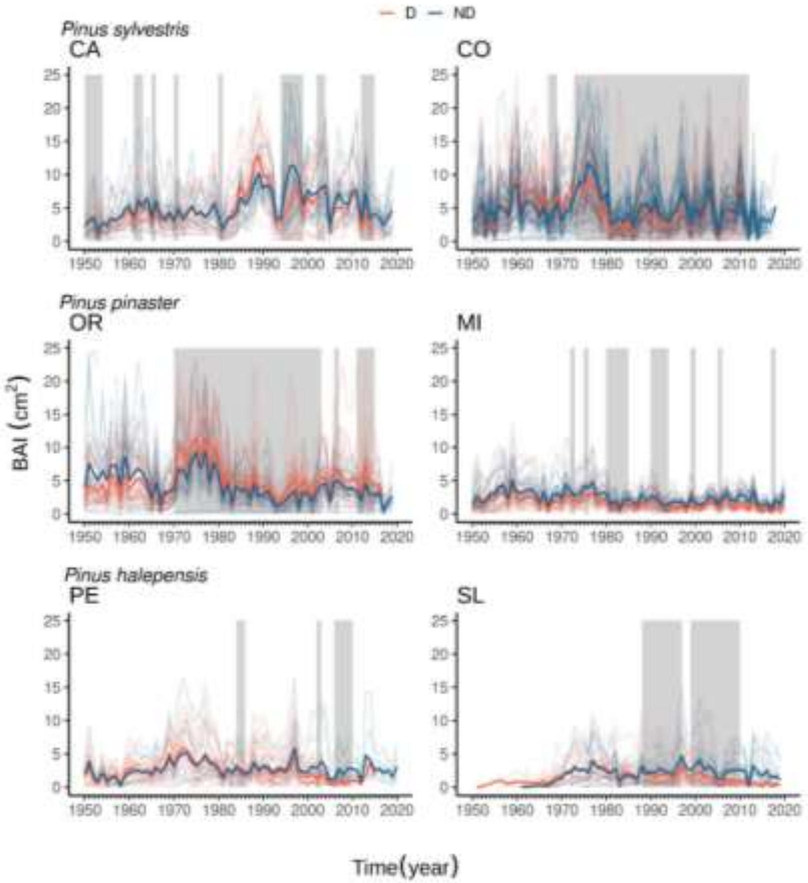
RAQUEL ALFARO-SÁNCHEZ[1]*, J. JULIO CAMARERO[2], RAÚL SÁNCHEZ-SALGUERO[2,3], VALÉRIE TROUET[4], and JORGE DE LAS HERAS[4]



forests
MDPI
Article

Drought Drives Growth and Mortality Rates in Three Pine Species under Mediterranean Conditions

Cristina Valeriano [1,2], Antonio Gazol [1], Michele Colangelo [1,3] and Jesús Julio Camarero [1,*]



Mixed Pine Forests in a Hotter and Drier World: The Great Resilience to Drought of Aleppo Pine Benefits It Over Other Coexisting Pine Species

Antonio Gazol[1]*, Jonàs Oliva[2,3], Cristina Valeriano[1], Michele Colangelo[1] and Jesús Julio Camarero[1]

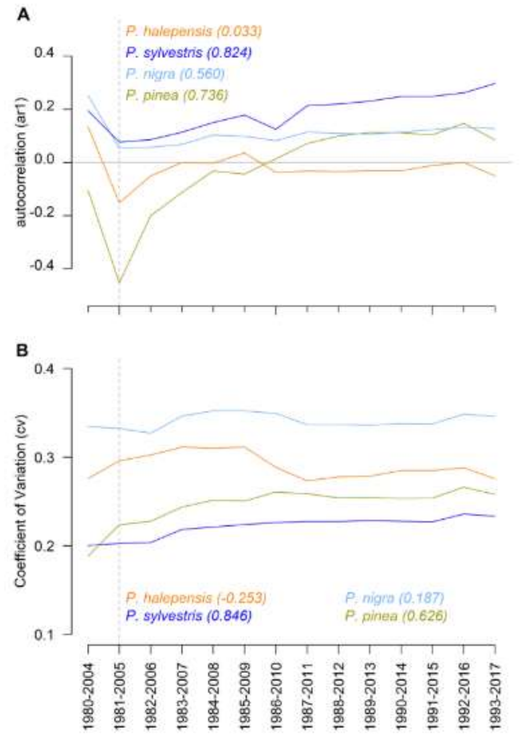


FIGURE 6 | Early warning signals of drought-induced growth decline for each pine species. The first order autocorrelation **(A)** and the coefficient of variation **(B)** in the chronology of each species were calculated using 25-year moving windows for the period 1980–2017. Different colors correspond to each species and the number in parenthesis indicate the non-parametric Kendall tau correlation for the statistic of each species. The dashed line indicates the 2005 drought.

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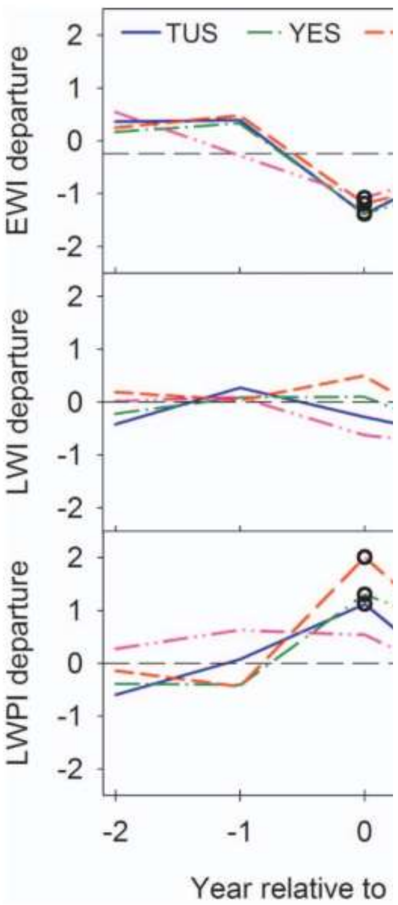
…ESEARCH, Vol. 74 (1), 2018, pp. 1-14
…dx.doi.org/10.3959/1536-1098-74.1.1

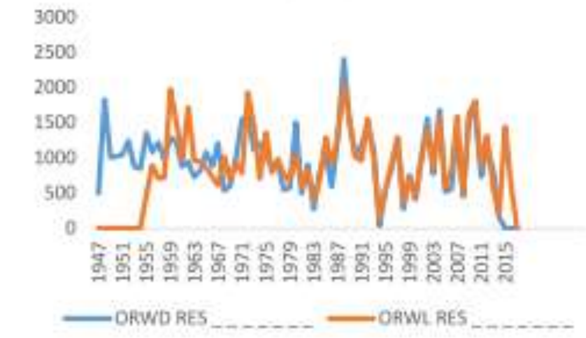
HOW DO DROUGHTS AND WILDFIRES …
GROWTH IN MEDITERRANEAN A…

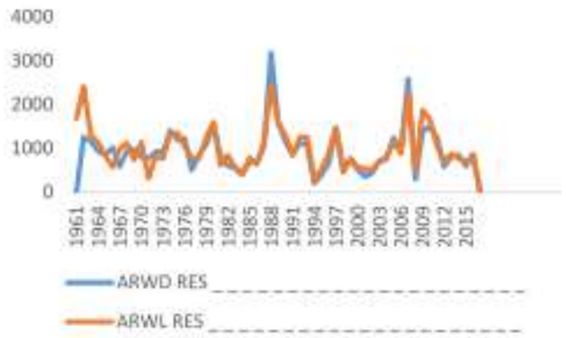
RAQUEL ALFARO-SÁNCHEZ[1]*, J. JULIO CAMARERO[2], RAÚL …
and JORGE DE LAS H…

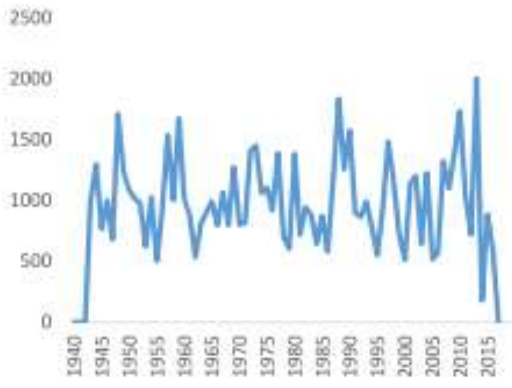


3. PRELIMINARY DENDROCHRONOLOGICAL RESULTS

2017 dendrochronological sampling of living and dead trees

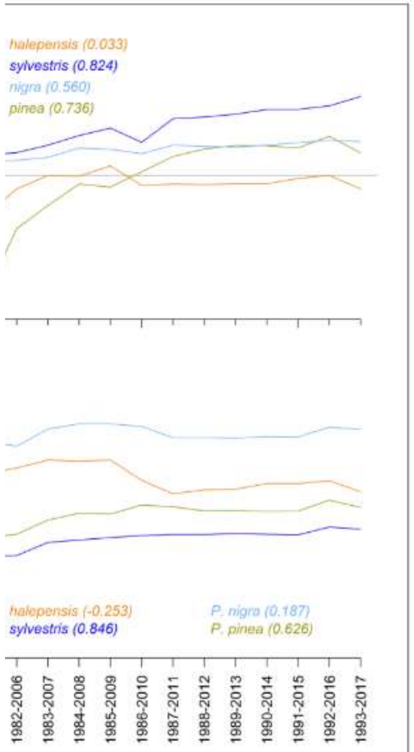






Mixed Pine Forests in a Hotter and …: The Great Resilience to … Aleppo Pine Benefits It … Coexisting Pine Species

…, Cristina Valeriano[1], Michele Colangelo[1] and



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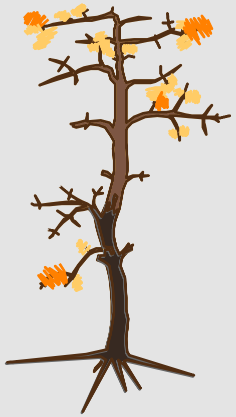
FUNDACIÓN CENTRO DE ESTUDIOS AMBIENTALES DEL MEDITERRÁNEO

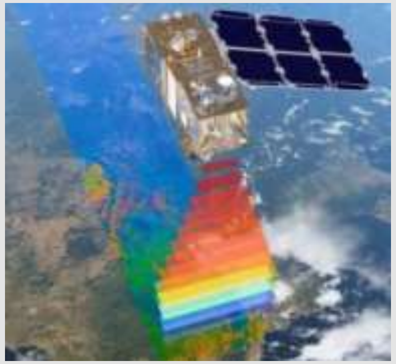
Multiproxy approach in Mediterranean pine species

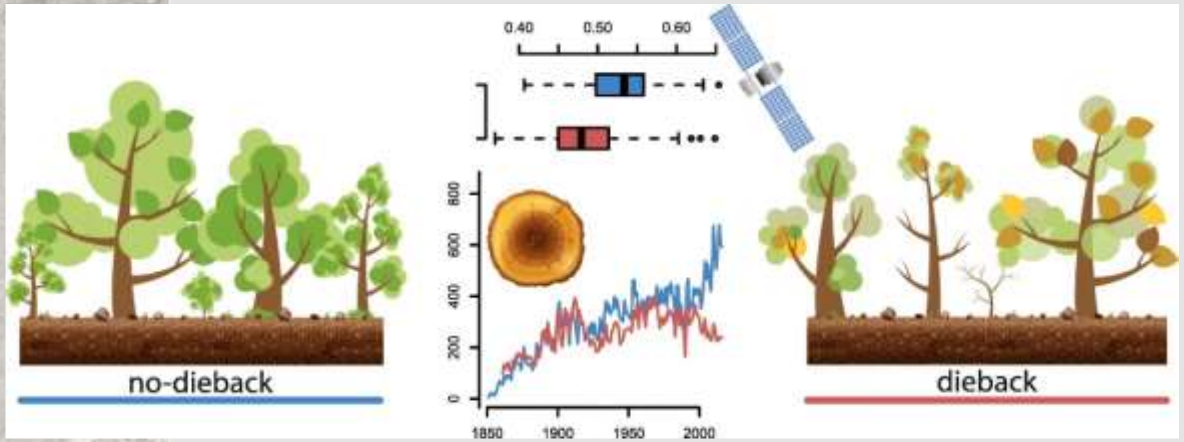
Tree-ring growth

Crown defoliation-Mortality



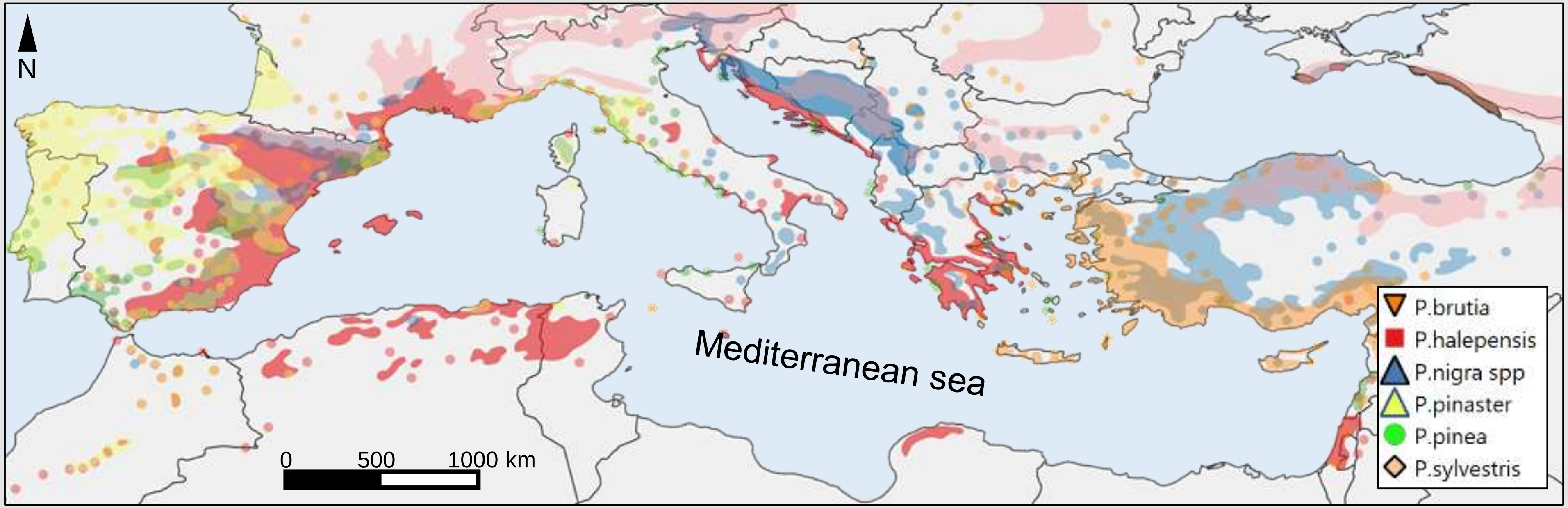
Remote sensing





Mediterranean Pines & Tree-rings (969) (< 10% ITRDB)

340 (123) *P. halepensis/brutia*, 121 *P. Pinea*, 102 *P. pinaster*, 236 *P. nigra*, 170 *P. sylvestris*



Sánchez-Salguero, Gazol et al., 2026 in preparation

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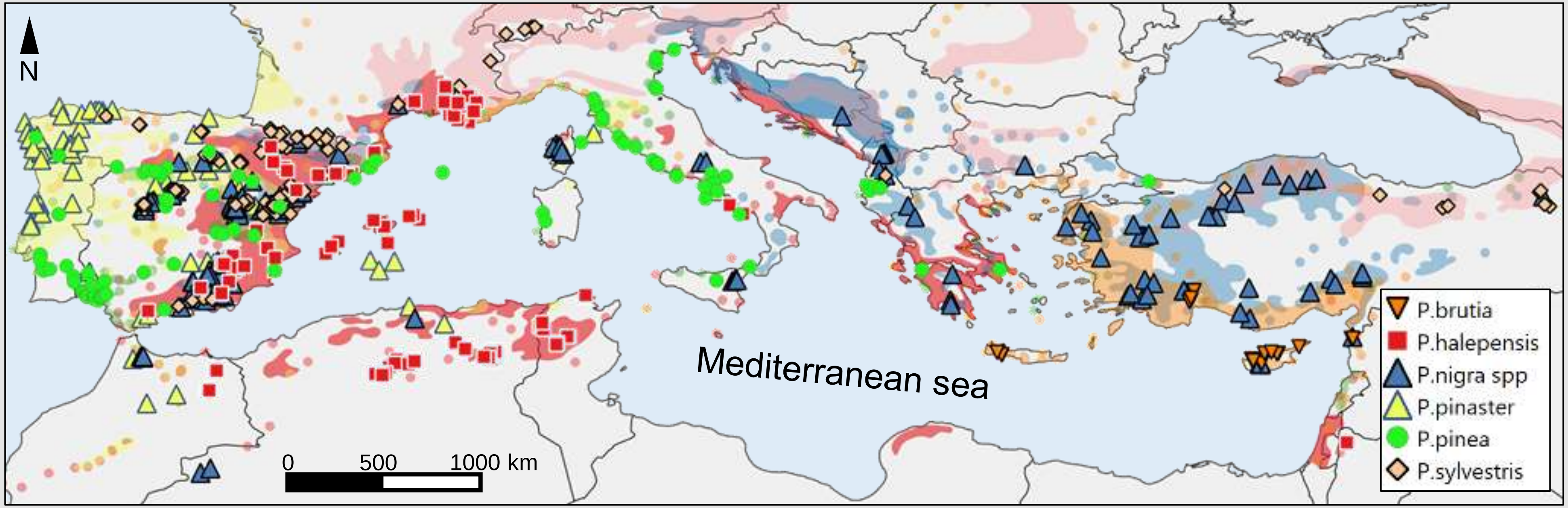
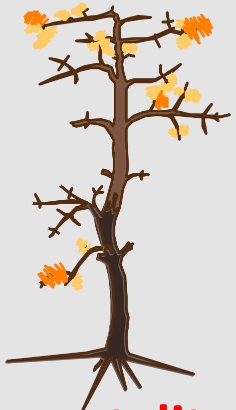


Sánchez-Salguero, Gazol et al., 2026 in preparation

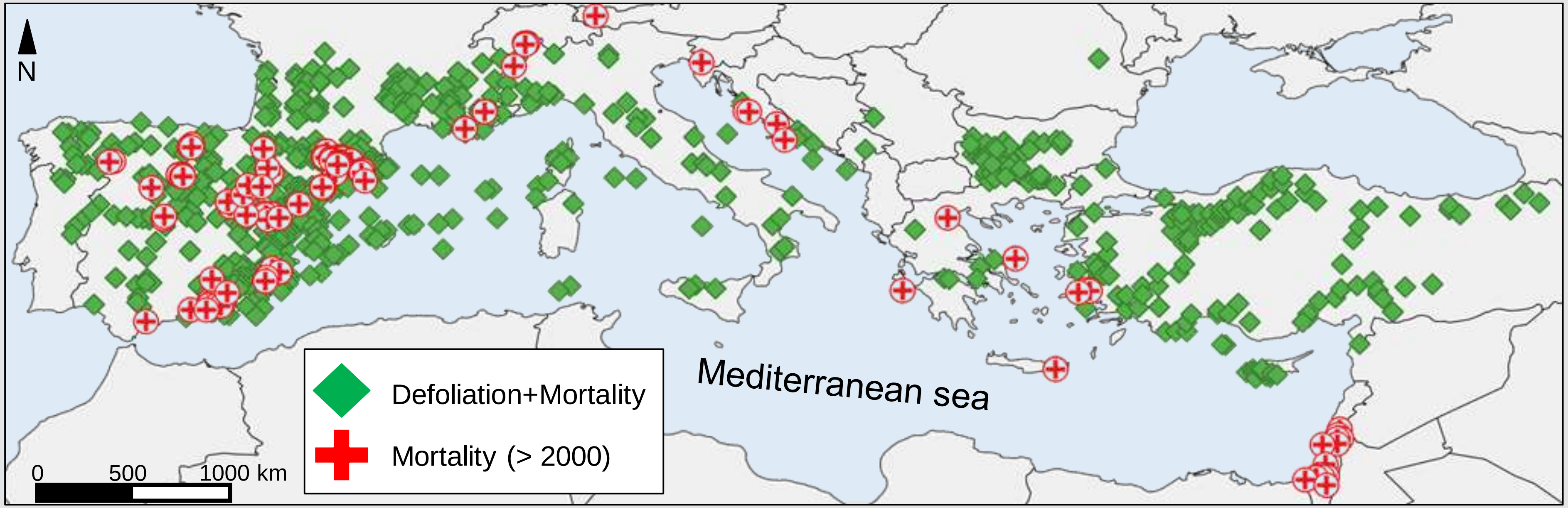
Crown defoliation and Drought-induced dieback

1029 PLOTS



856 ICP forest plots (annual 1987-2022)

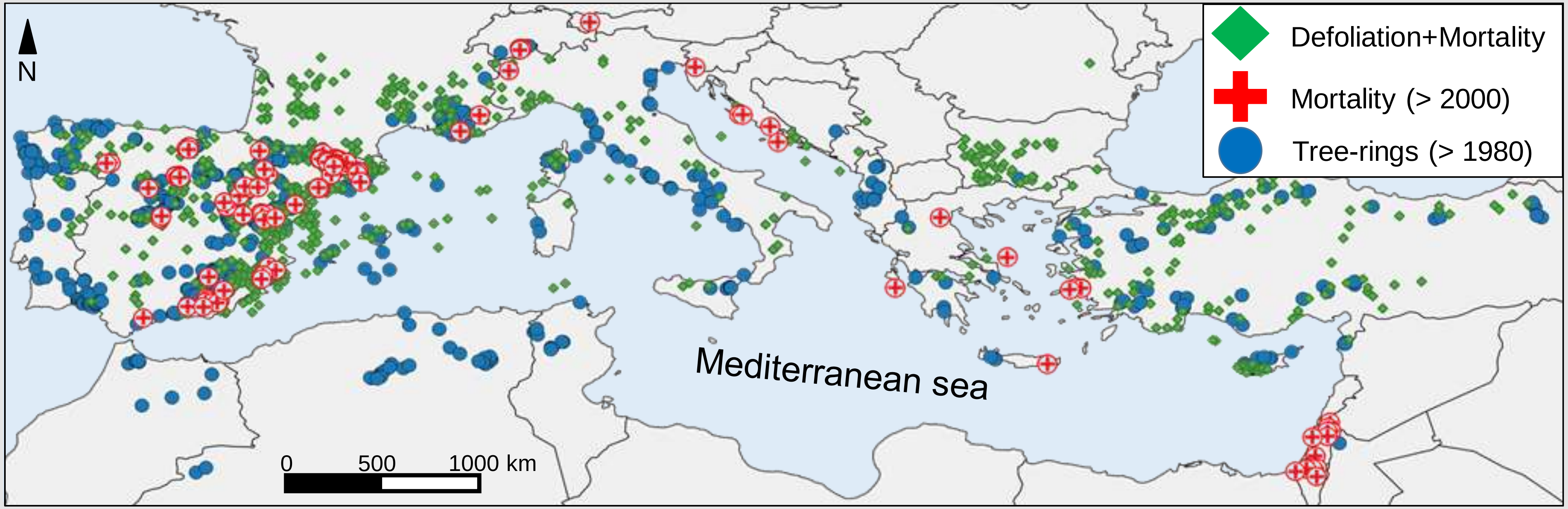
173 Tree mortality (> 2000 a.c)



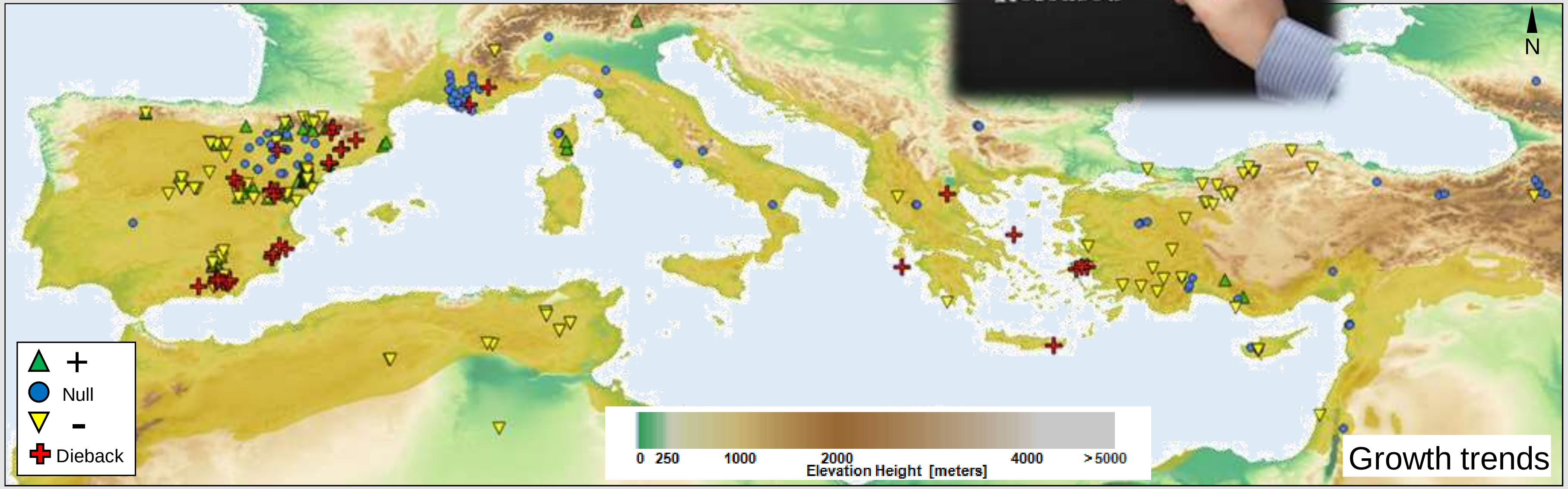
Remote sensing (Rings+Defo+Dieback = 1998 forests)

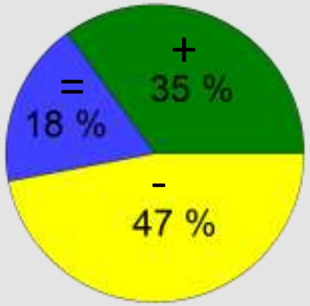
LCSC CSIC (NDVI & EVI 15-days from 1981-2022)

Laboratory of Climate Services and Climatology



Tree growth trends



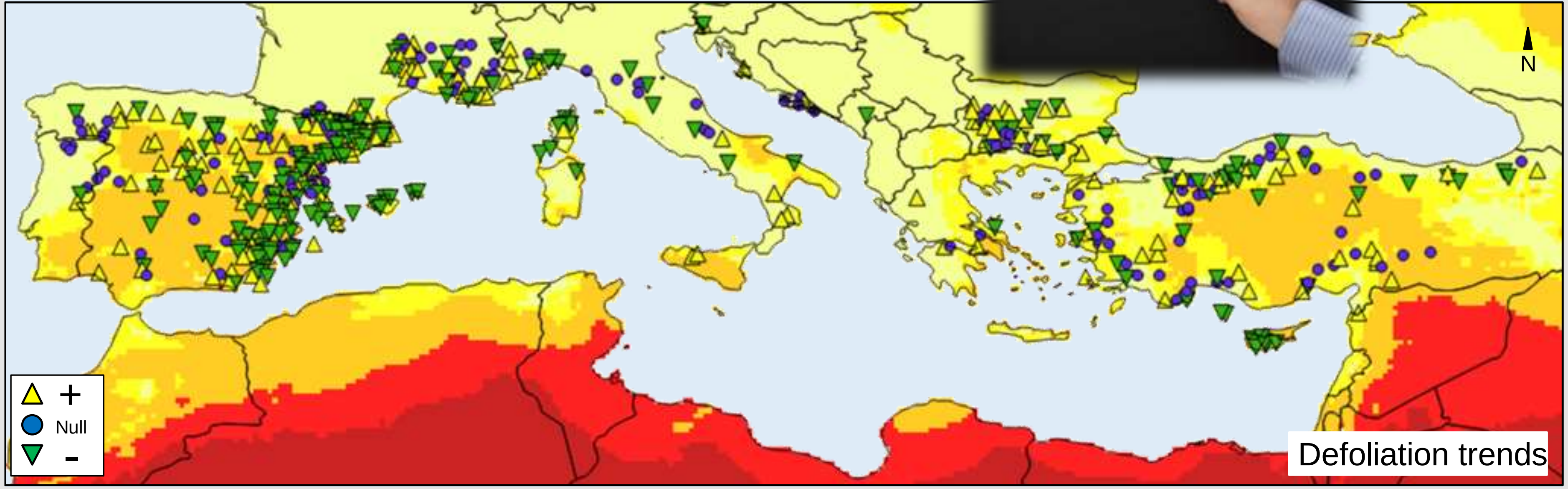


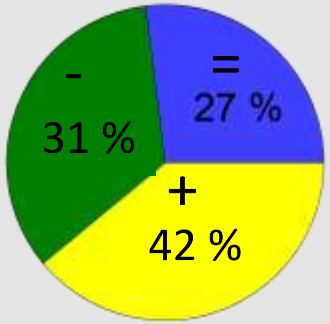
Young/-Competition
Wet high elevation

Dry edges
Continental

Sánchez-Salguero, Gazol et al., 2026 in preparation
Camarero, Gazol,& Sánchez-Salguero, 2021
Galván et al., 2014 ERL

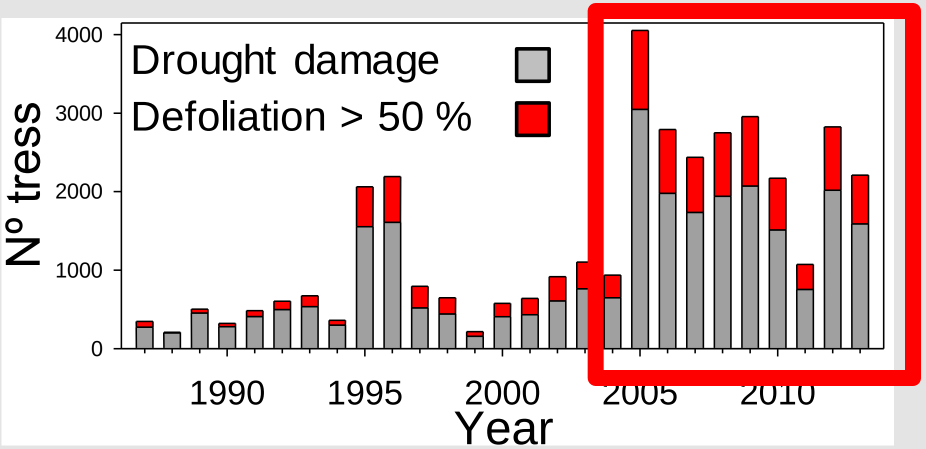
Tree Crown defoliation





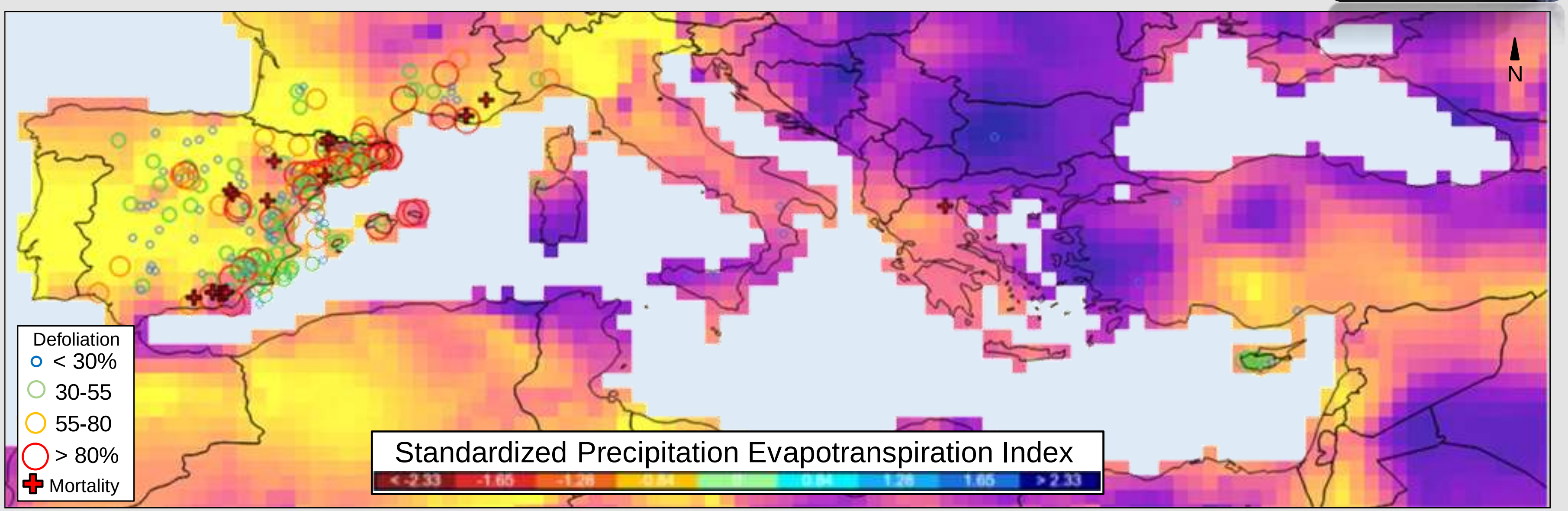
Higher CI
Edges

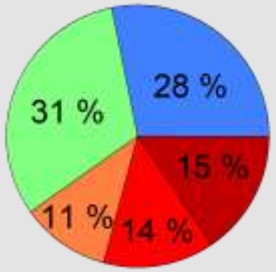
Young
Wet high elevation



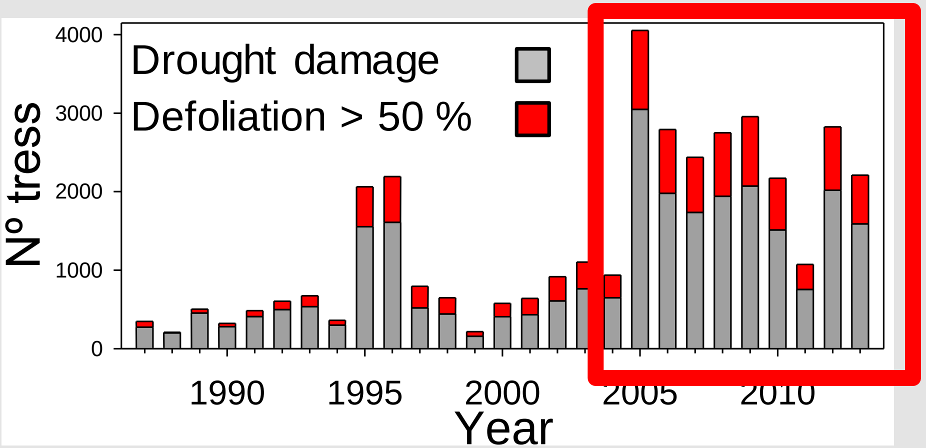
Sánchez-Salguero, Gazol et al., 2026 in preparation
Camarero, Gazol & Sánchez-Salguero, 2021

Tree Crown defoliation after extreme 2005





Defoliation
- < 30%
- 30-55
- 55-80
- > 80%
- Mortality



Sánchez-Salguero, Gazol et al., 2026 in preparation
Camarero, Gazol & Sánchez-Salguero, 2021

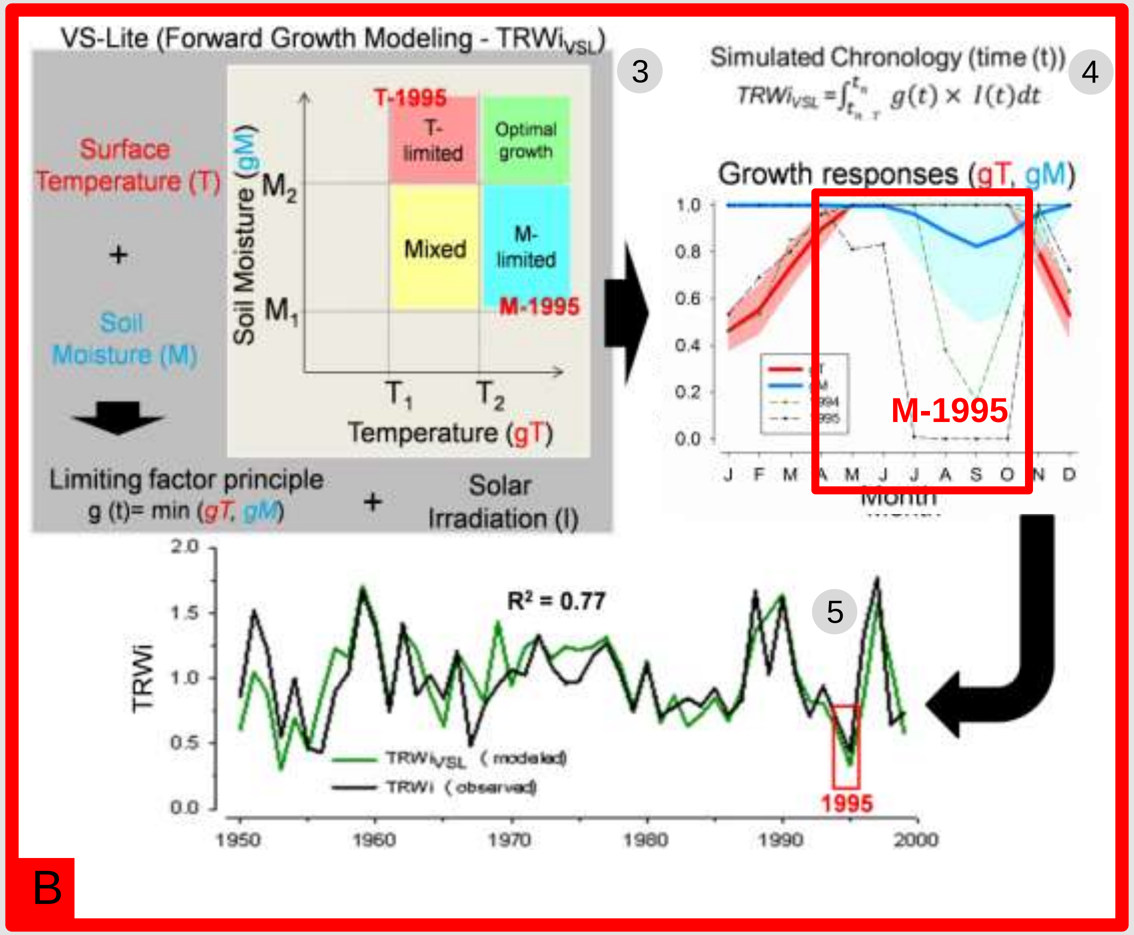
B VS-lite model for extremes

Methods

1.Growth response by VS-Lite model (T, M, I), growth parameters (T_1, T_2, M_1, M_2).

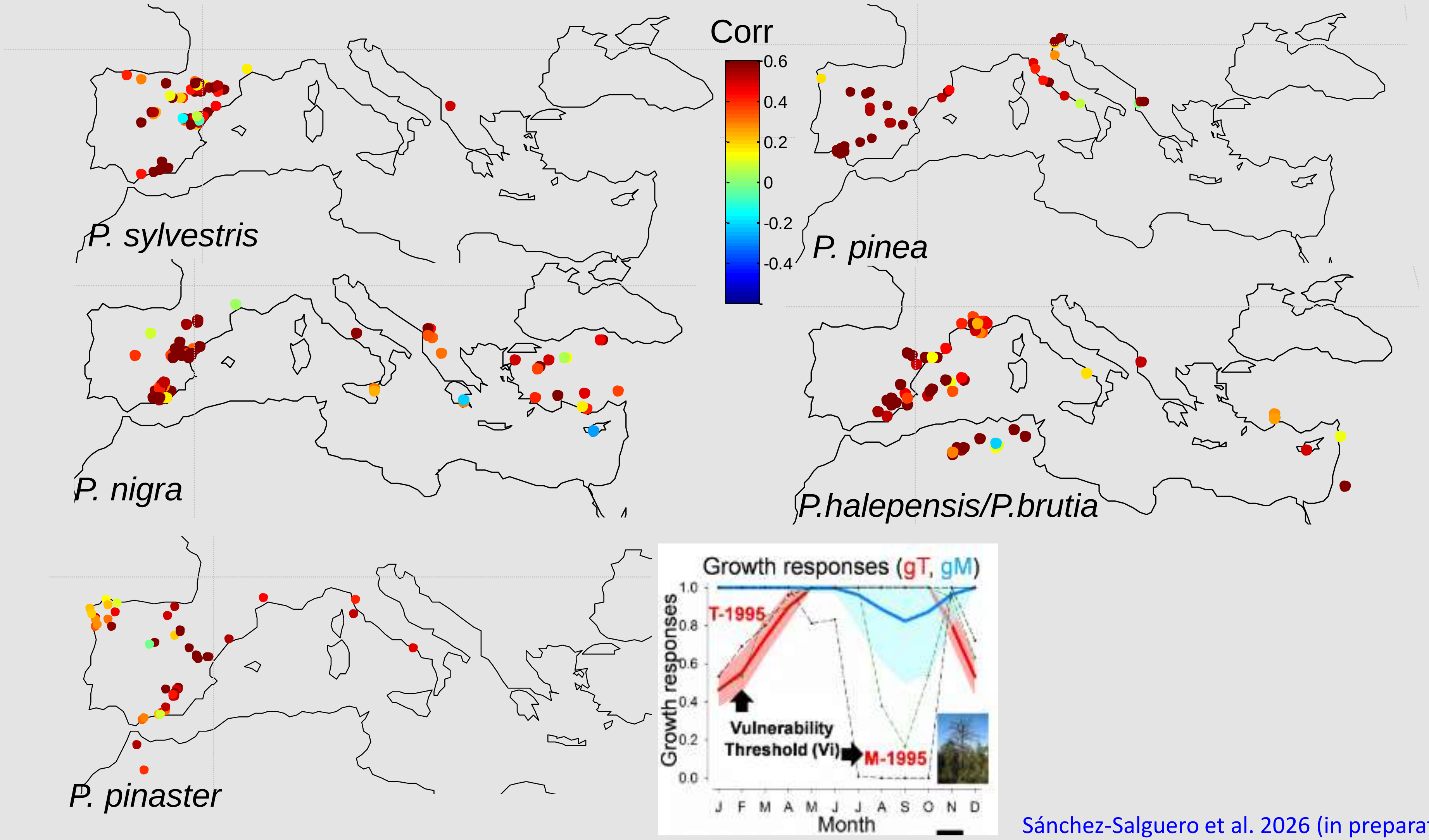
3. Comparison mean optimal growth responses *vs.* Observed drought – induced reductions.

4. The ***gM*** during extremes years was used to define Vulnerability thresholds (growing season).



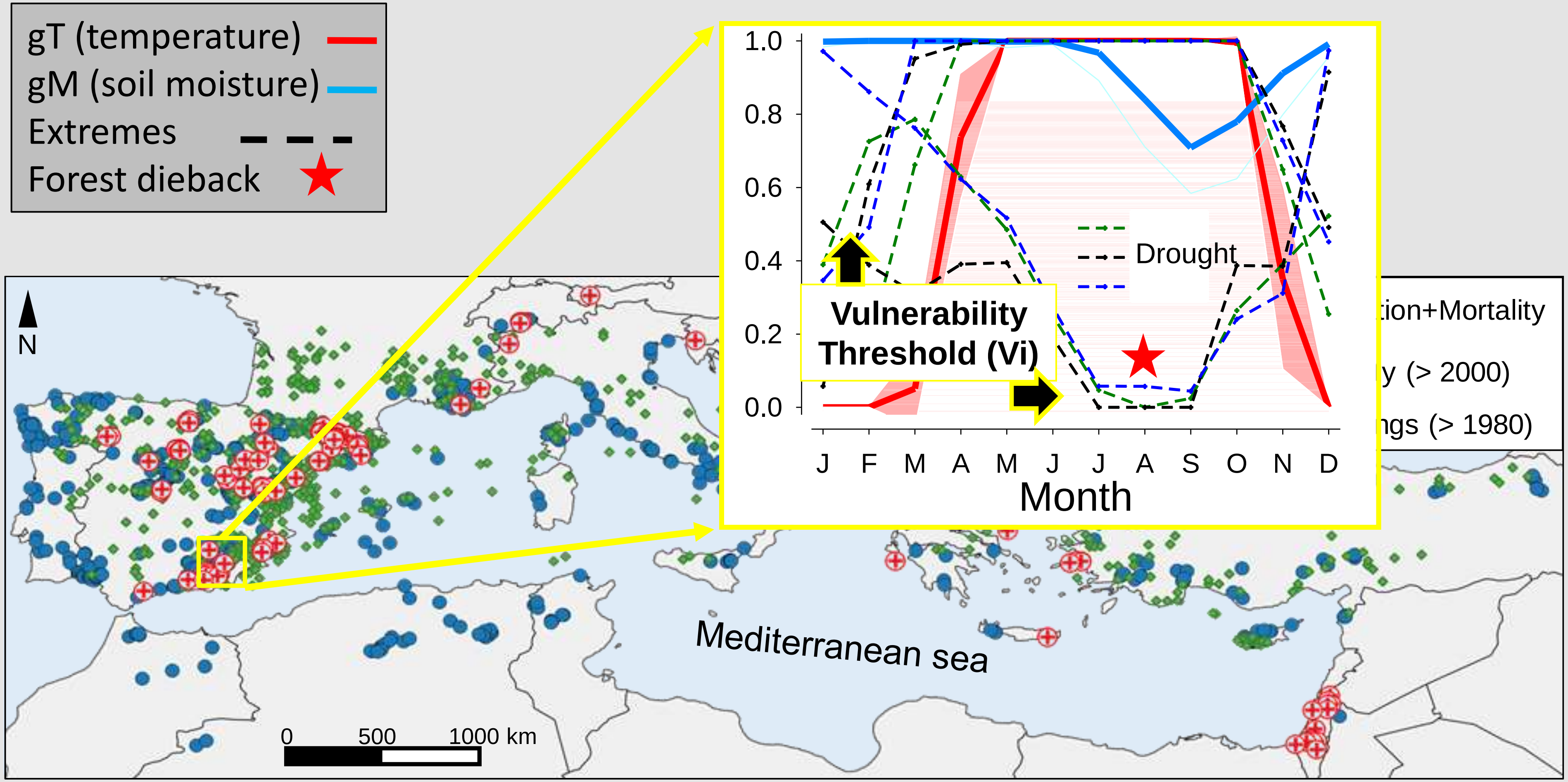
Sánchez-Salguero et al. 2017. PNAS 114 (47) E10142-E10150

Vulnerability thresholds



Sánchez-Salguero et al. 2026 (in preparation)

Vulnerability thresholds



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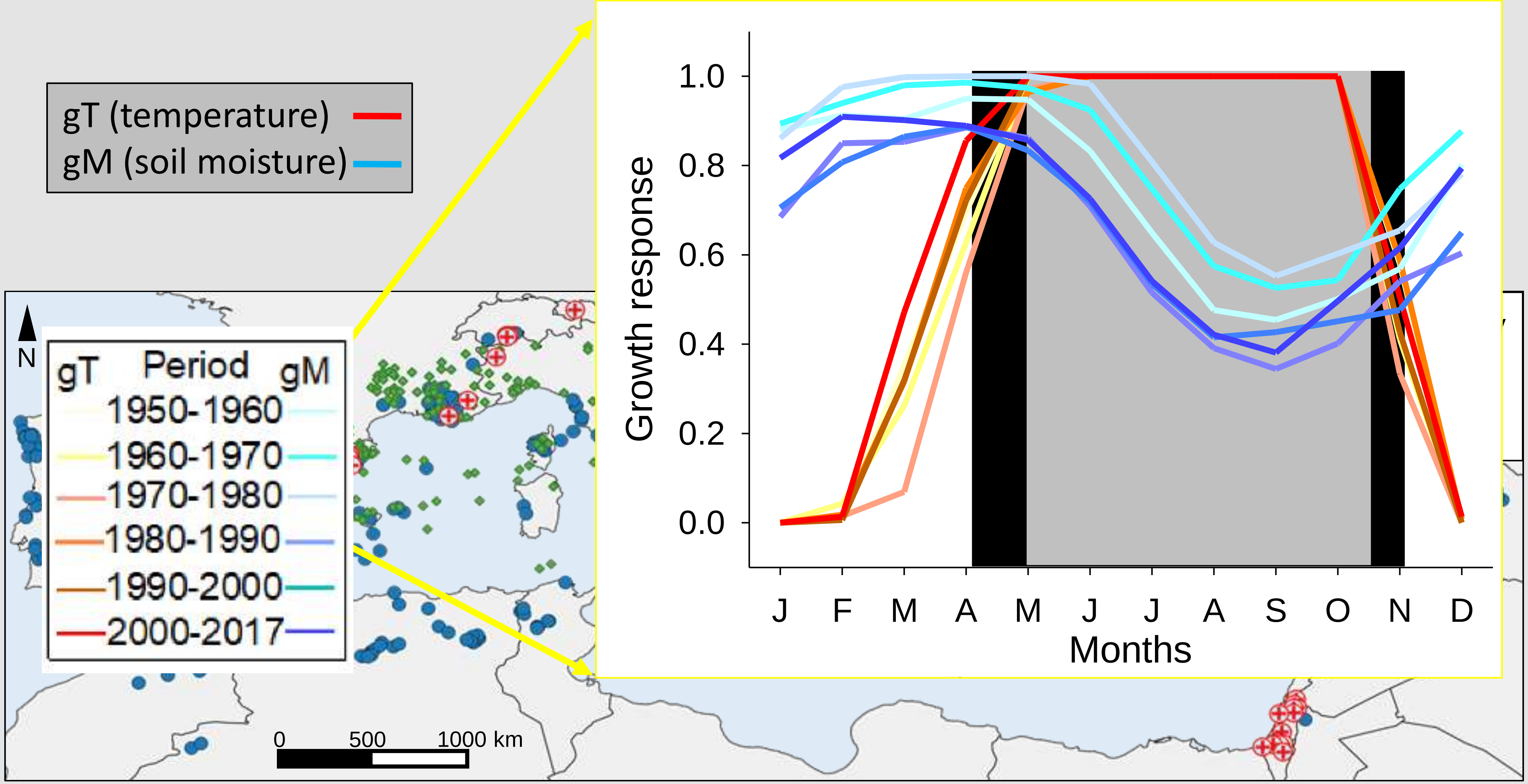
Vulnerability thresholds

gT (temperature)
gM (soil moisture)

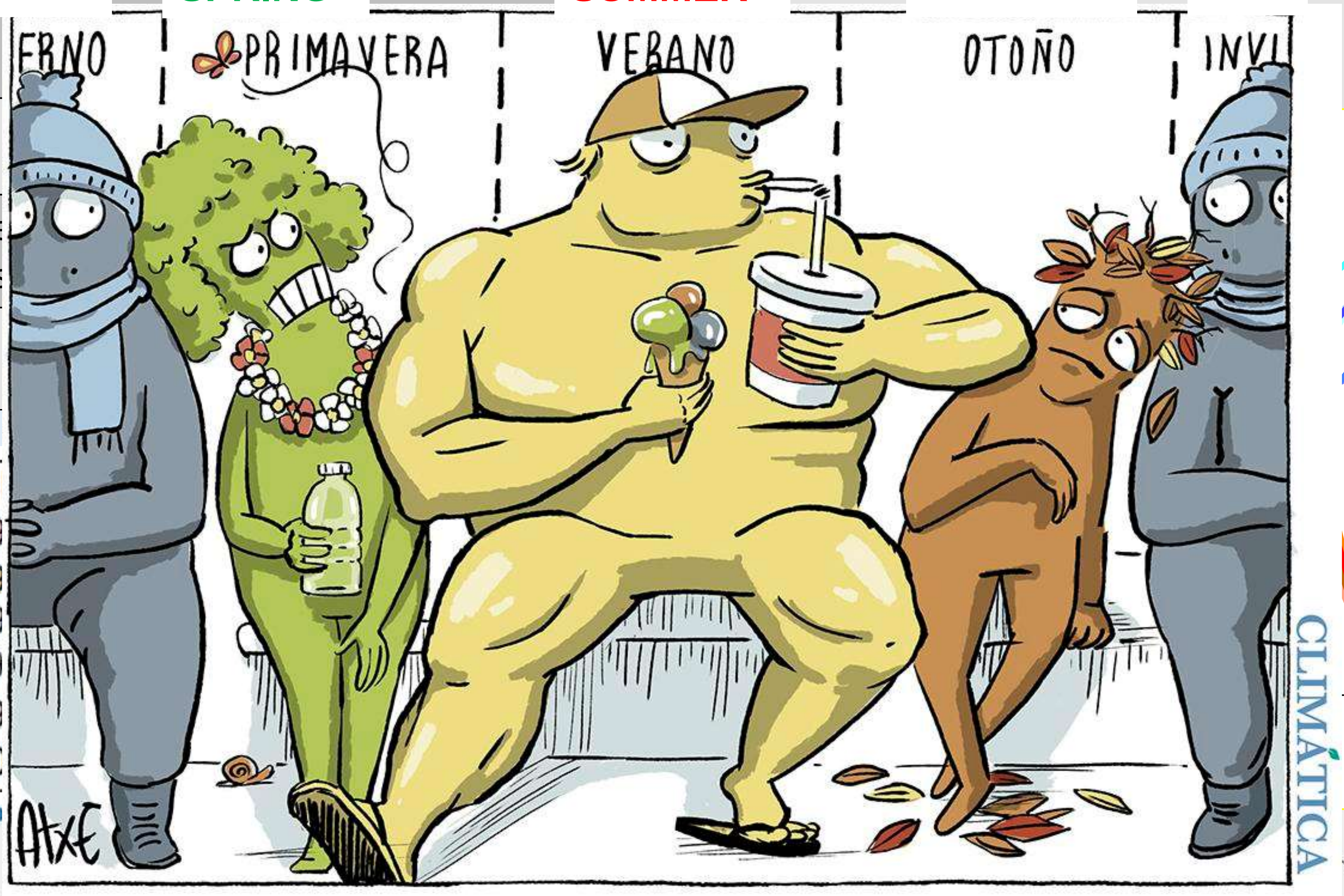


Sánchez-Salguero et al. 2026 (in preparation)

TER SPRING SUMMER AUTUMN WIN

Vuln

gT (te
gM (s



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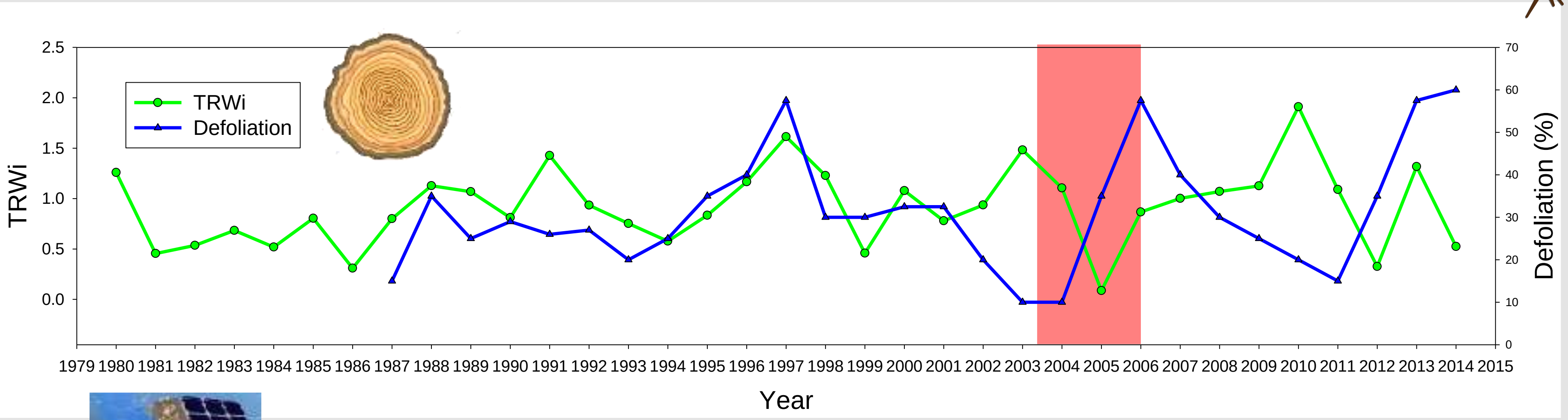
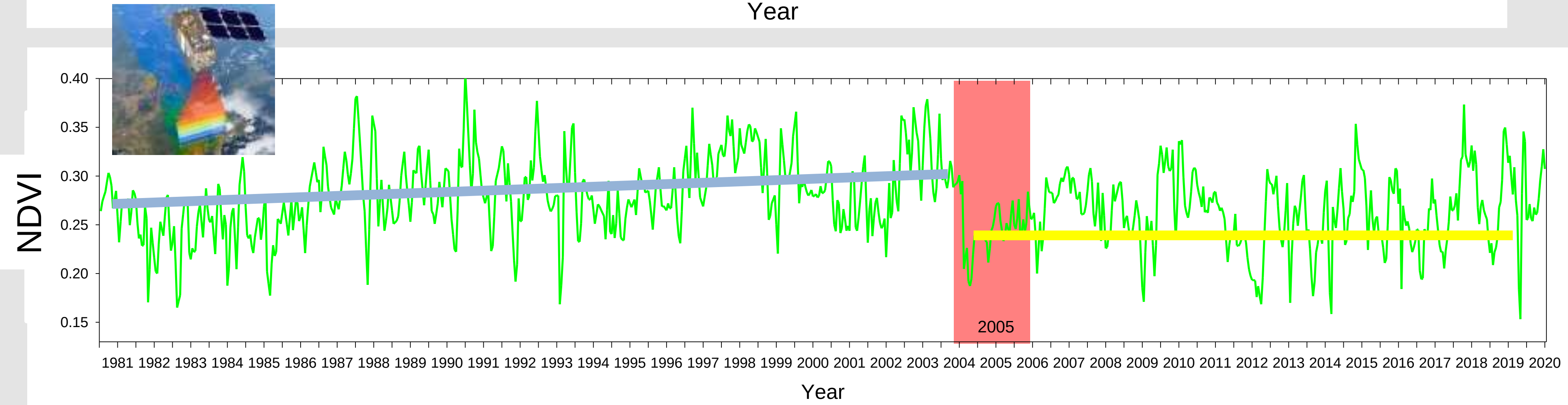
Multiproxy and point of no return





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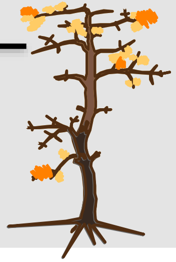
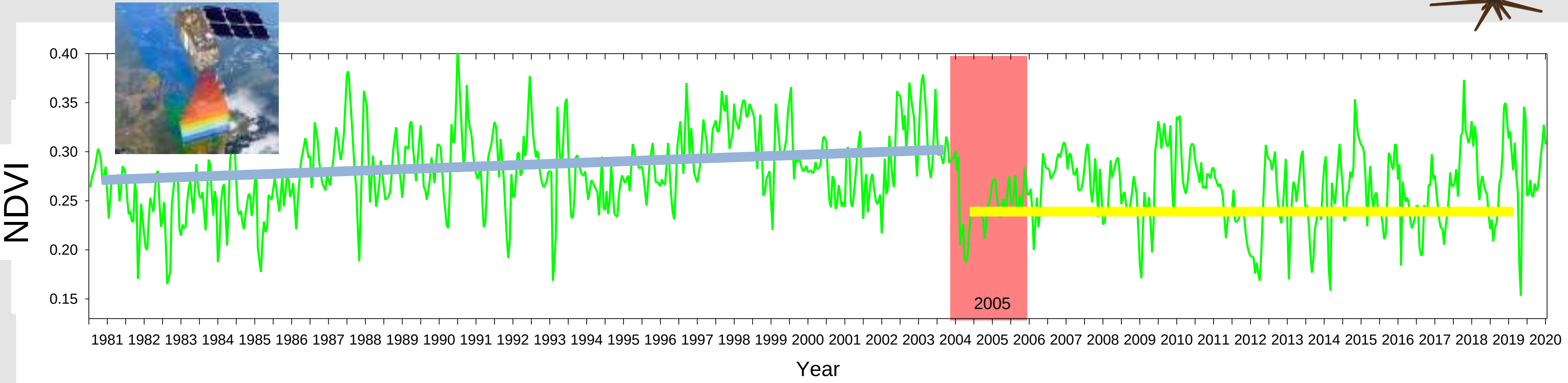
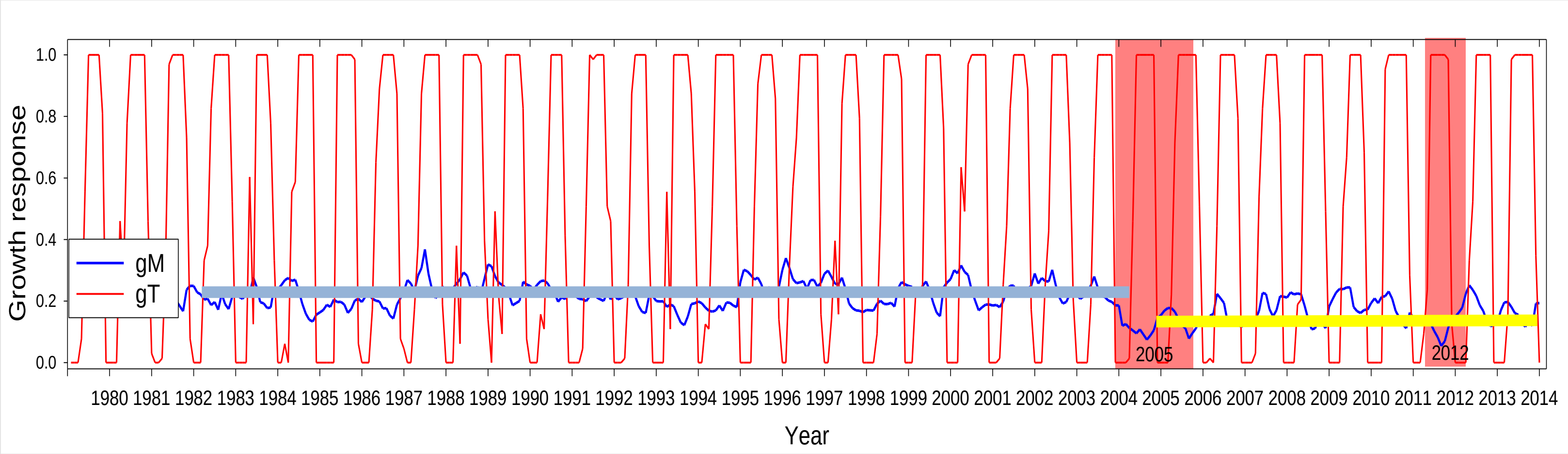


Multiproxy and point of no return





VS-lite

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DendrOlavide

Annals of Forest Science (2020) 77: 55
https://doi.org/10.1007/s13595-020-00956-y

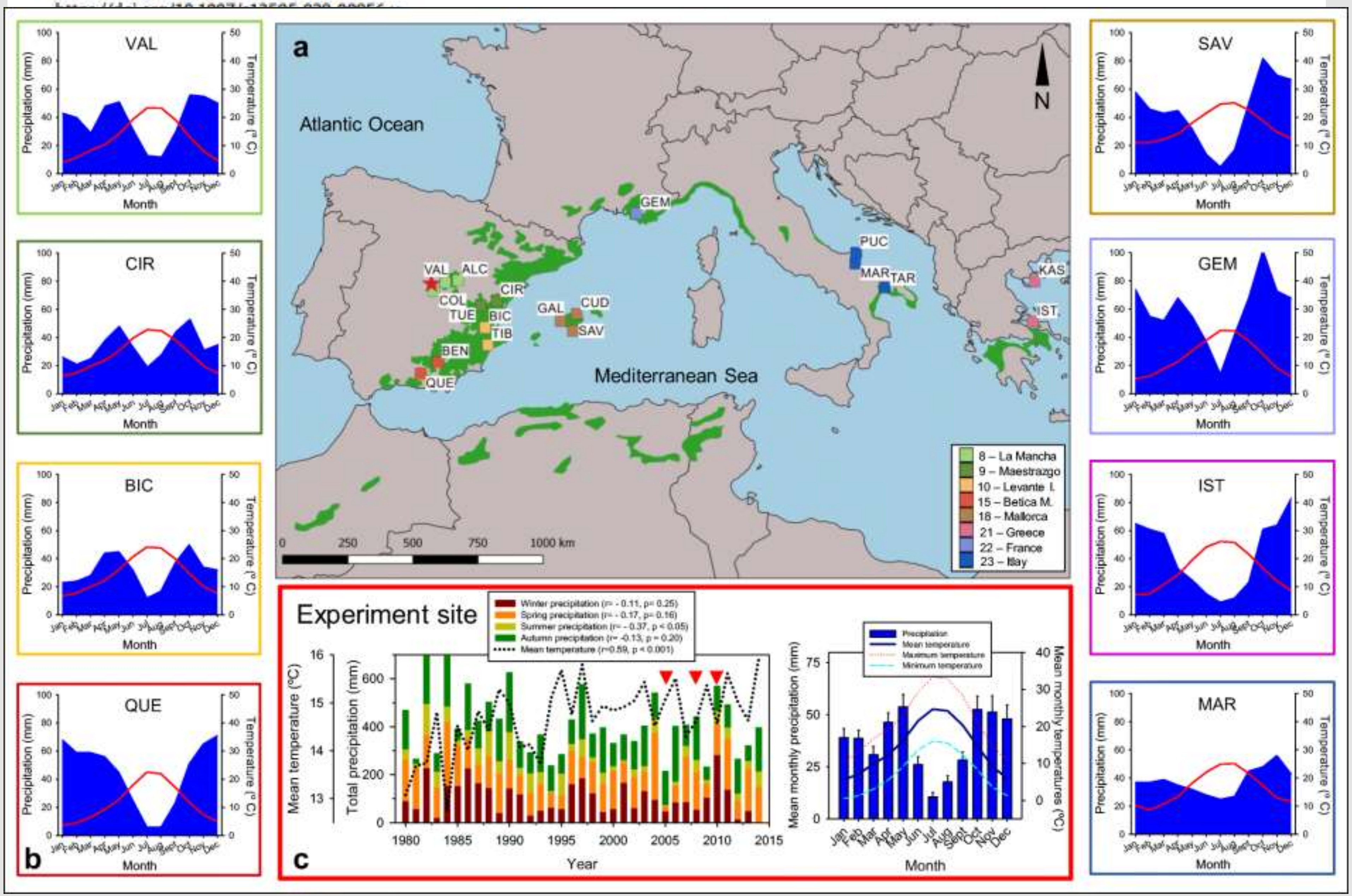
RESEARCH PAPER

Check for updates

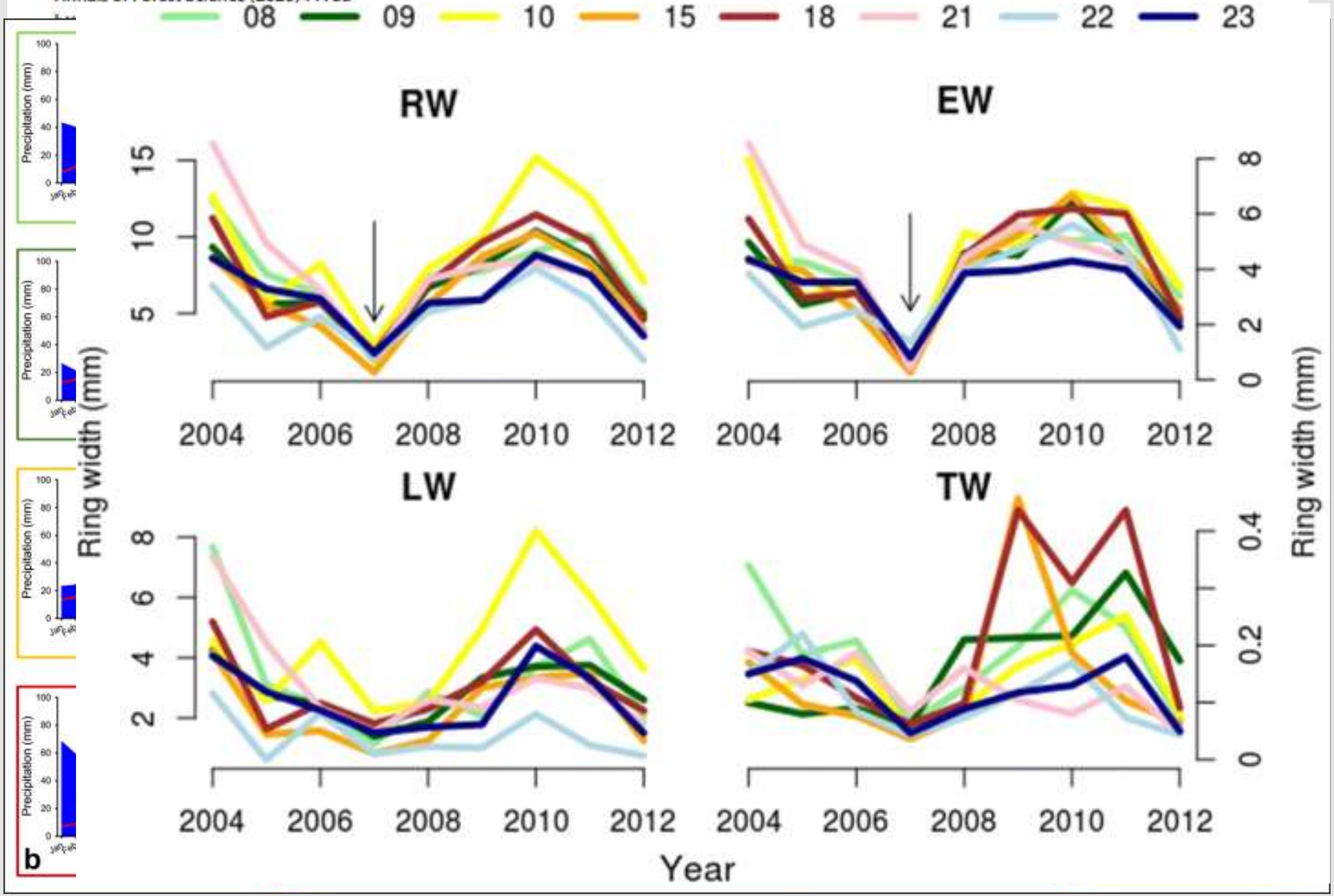
Which matters more for wood traits in *Pinus halepensis* Mill., provenance or climate?

Andrea Hevia [1,2,3] · Filipe Campelo [4] · Regina Chambel [5] · Joana Vieira [4] · Ricardo Alía [5] · Juan Majada [2] · Raúl Sánchez-Salguero [3]

Annals of Forest Science (2020) 77: 55



Annals of Forest Science (2020) 77: 55



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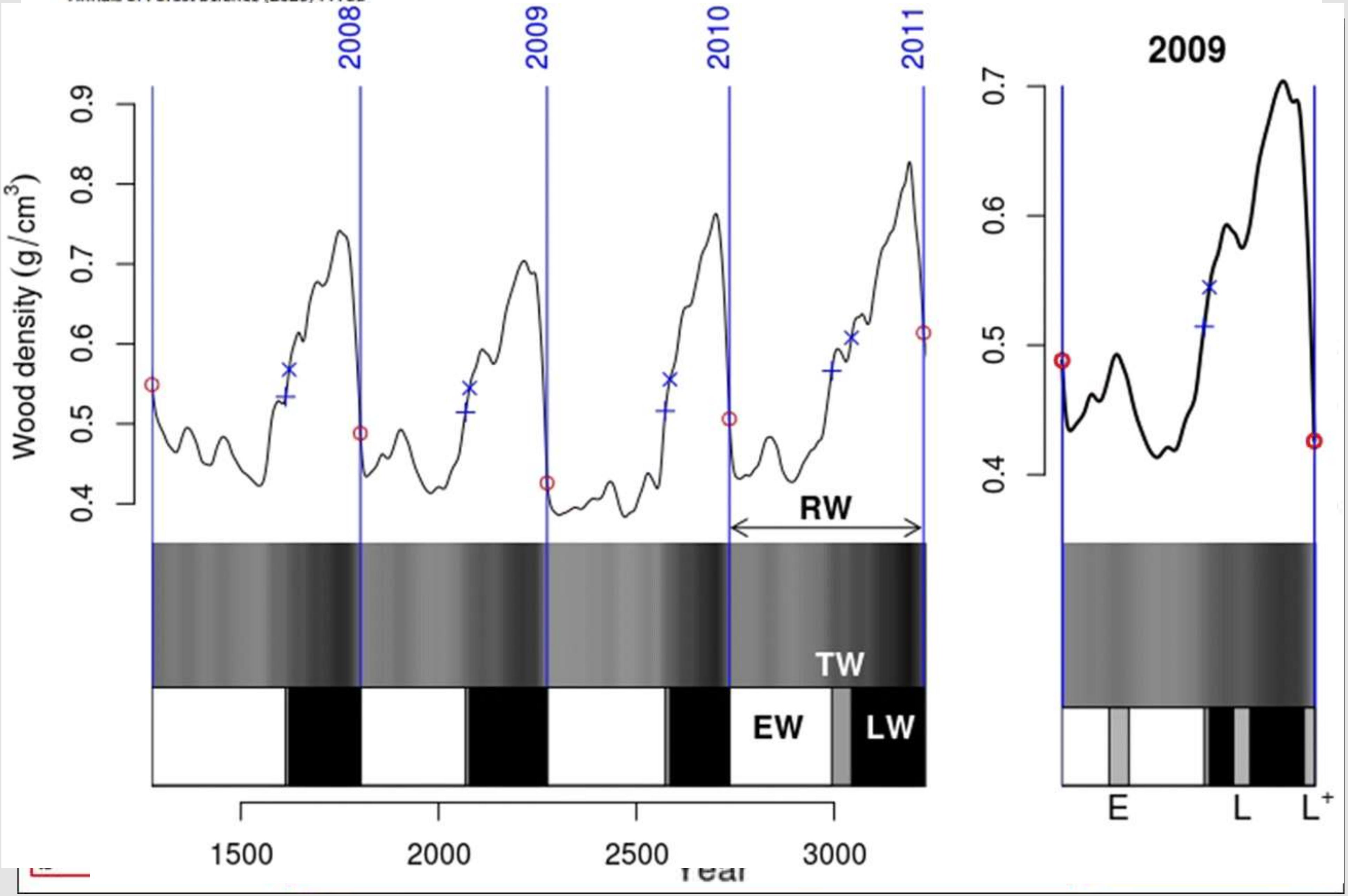
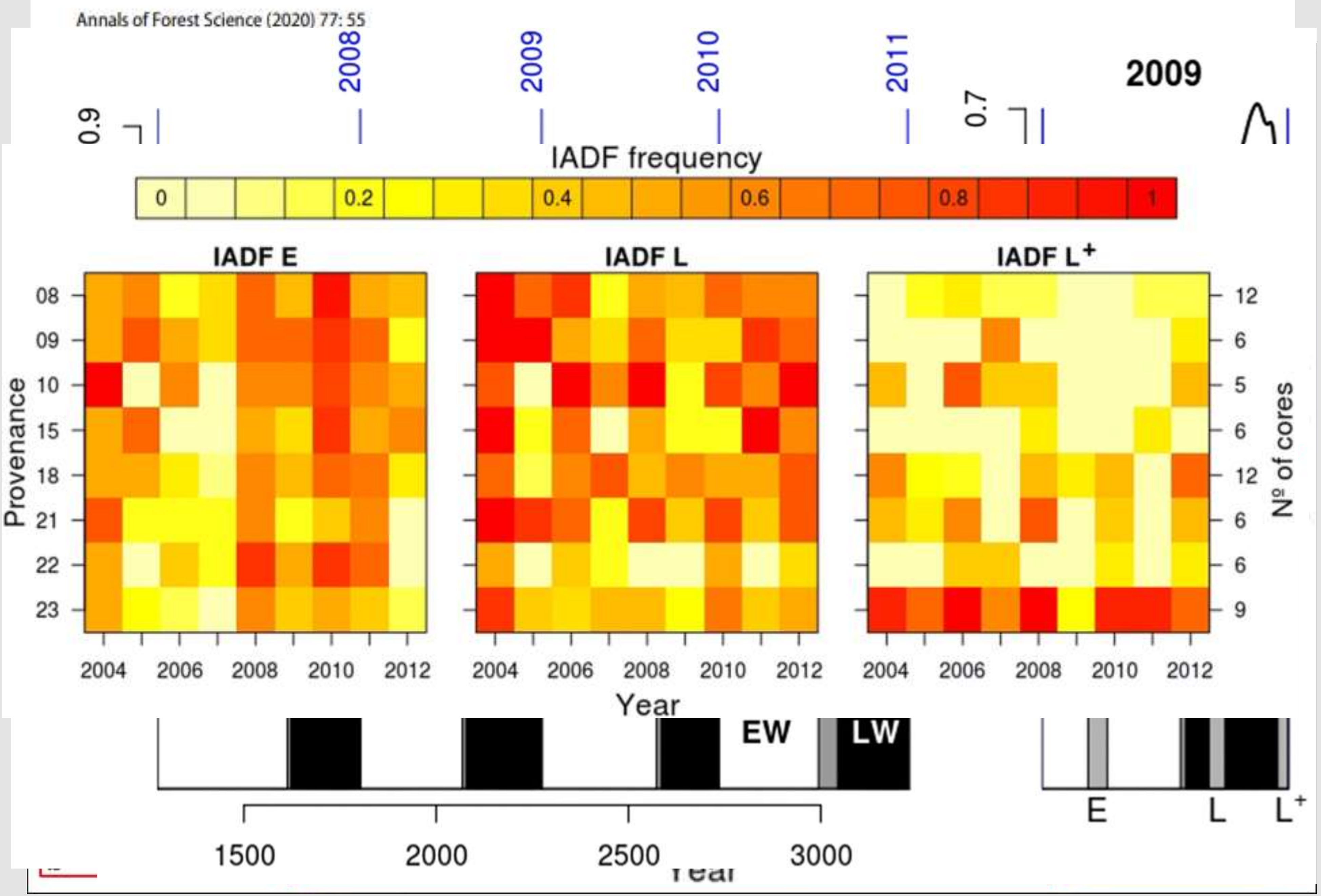
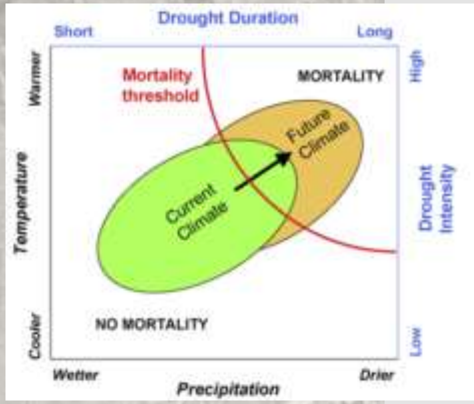


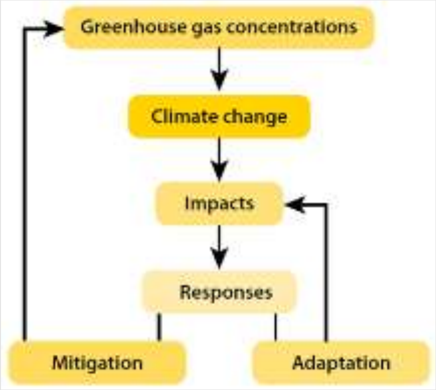


Annals of Forest Science (2020) 77: 55
2008
2009
2010
2011
2009
IADF frequency
0
0.2
0.4
0.6
0.8
1
IADF E
IADF L
IADF L+
Provenance
08
09
10
15
18
21
22
23
Nº of cores
12
6
5
6
12
6
6
9
2004
2006
2008
2010
2012
Year
EW
LW
E
L
L+
1500
2000
2500
3000

Some conclusions

- Useful for conservation and sustainable use of **forest genetic resources**
- Ecogeographically **zonation to identify future forest vulnerability and dieback**
- Identification of **better provenance for adaptive management** in 21st century
- Programms for **assisted migration based on resilience and local adaptation**
- Relevant information **to include in SDMs to forecast future vulnerability**





¡Gracias!

#WhatKillsTrees

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