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Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
UNIVERSITÀ DEGLI STUDI DELLA BASILICATA
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BG3.24. Forest under pressure: the need to understand causes, mechanisms and forest adaptive management of dieback forests to improve their resilience

Climatic drivers of cork growth depend on site aridity

M. Colangelo[1,2], J. J. Camarero[2], A. Sánchez-Miranda[3] and L. Matías[3].

[1] University of Basilicata, School of Agricultural, Forest, Food and Environmental Sciences, Potenza, Italy_[2]Pyrenean Institute of Ecology (IPE-CSIC), Zaragoza, Spain
[3]Department of Plant Biology & Ecology, University of Seville, Seville, Spain Contact: michele.colangelo@unibas.it

Instituto Pirenaico de Ecología CSIC

- Cork is one of the main non-timber forest products in the world.
- Climate warming may lead to increased aridification and reduce cork production Iberian Peninsula region.
- Lack assessments of climate-cork relationships across ample geographical and climatic gradients explicitly considering site aridity.

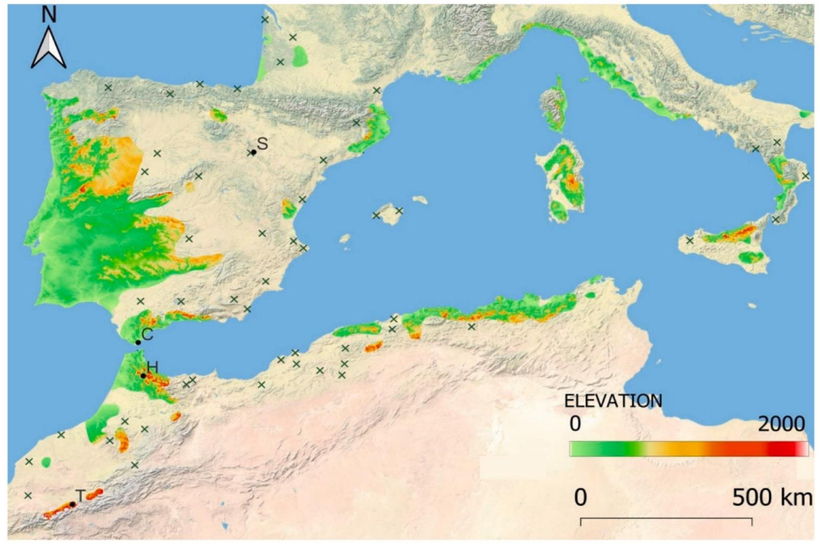
METHODOLOGY

We quantified cork growth by measuring cork ring width and related it to climate variables and a SPEI drought index using dendrochronology. Four cork oak (*Quercus suber* L.) forests located from north eastern Spain to south western Morocco and subjected to different aridity levels were sampled.

Site	Latitude N (º)	Longitude W (º)	Elevation (m a.s.l.)	AI	Dbh (cm)	Cork porosity (%)
Sestrica	41.501	1.634	859	0.57	31.4 ± 6.1	4.4 ± 1.1a
Comares	36.101	5.515	410	0.68	34.0 ± 9.1	8.0 ± 2.0b
Chaouen	35.161	5.322	532	0.84	38.1 ± 7.2	9.2 ± 1.8b
Toufliht	31.472	7.423	1684	0.64	36.1 ± 8.7	7.2 ± 1.5b

Table 1. Study sites. Different letters indicate significant differences between sites (Tukey tests, $p < 0.05$). AI is the aridity index with lower values indicating greater aridity. Values are means ± SD.

(a)



(b)

(c)

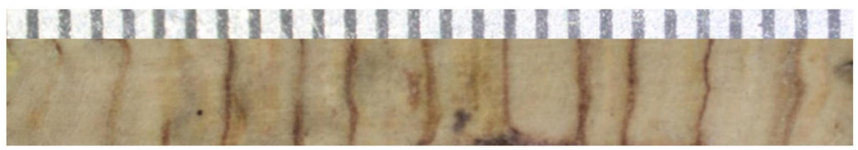


Figure 1. (a) Map of the *Quercus suber* distribution area in the western Mediterranean Basin (green patches and symbols; orange symbols indicate naturalized locations) showing the location of the four study sites (S, Sestrica; C, Comares; H, Chaouen; and T, Toufliht). (b) Stem with cork from Sestrica site and view of rings in a cork piece. (c) Cross-section of cork showing conspicuous rings (the space between lines is 1 mm in the scale bar).

Hypothesis

Strongest response of cork ring-width to water availability (precipitation, cumulative water deficit measured using a drought index) would be observed in the most arid site along the studied climatic gradient.

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MAIN OUTCOMES

Warm conditions in spring to early summer, when cork is formed, reduced cork width, whereas high precipitation in winter and spring enhanced it

A negative summer water balance, driven by elevated temperatures and high evapotranspiration rates, is detrimental for cork production.

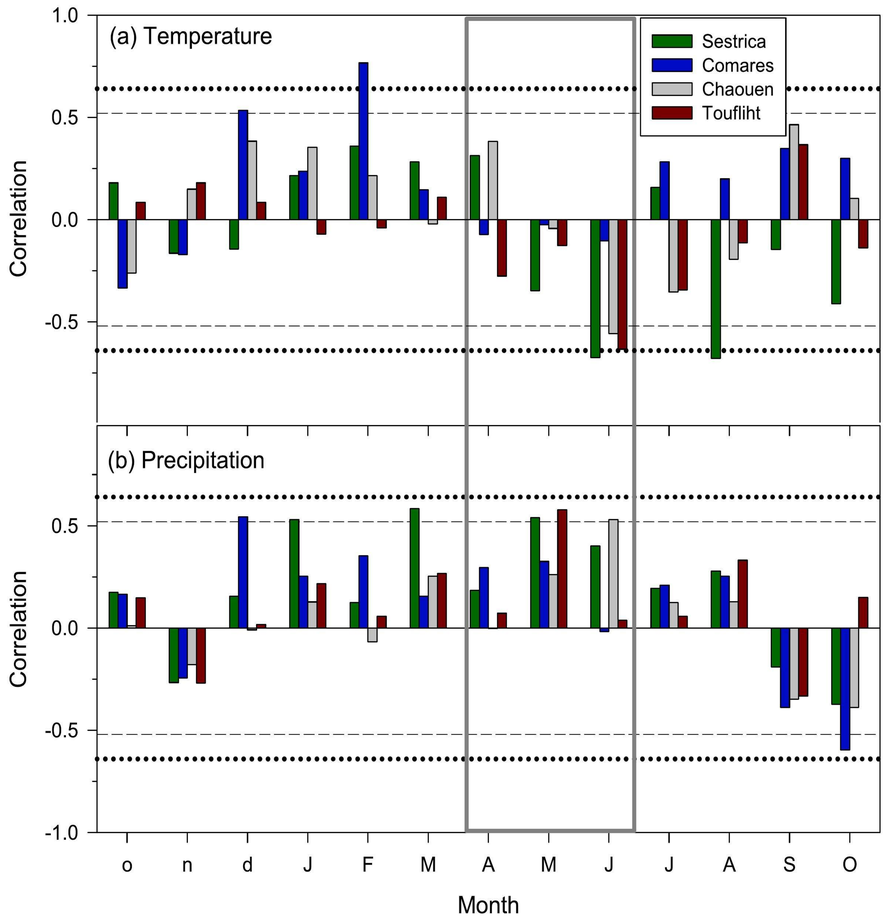

Fig. 4. Relationships (Pearson correlation) between monthly climate variables and mean site series of indexed cork ring width. The dashed and dotted horizontal lines show the 0.05 and 0.01 significance levels, respectively. Correlations were calculated from the prior to the current October (lowercase and uppercase letters). Cork growth mainly occurs from April to June (grey box).

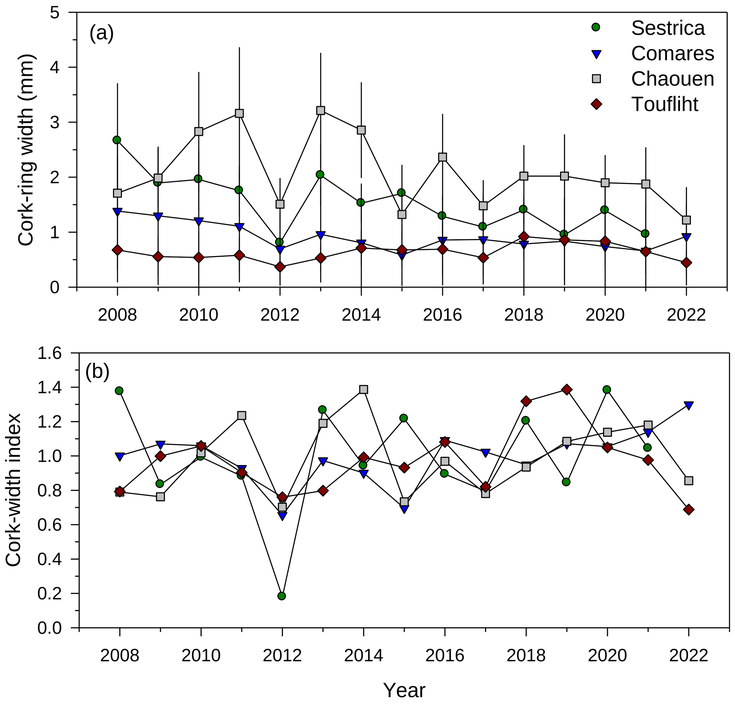

Figure 3. Raw (a) and (b) detrended series of cork-ring widths and indices, respectively. Values of cork ring width are means ± SD.

Site	No. sampled trees	Best-replicated period	Cork ring width (mm)	AR1	MS	rbar
Sestrica	14	2008–2021	3.06 ± 1.01bc	0.15	0.42	0.65
Comares	10	2008–2022	1.82 ± 0.48b	0.50	0.33	0.42
Chaouen	16	2008–2022	4.20 ± 1.20c	0.11	0.45	0.44
Toufliht	10	2008–2022	1.28 ± 0.30a	0.45	0.30	0.51

Table 2. Statistics of cork ring-width series. Different letters indicate significant differences between sites (Tukey tests, $p < 0.05$). Values are means ± SD.

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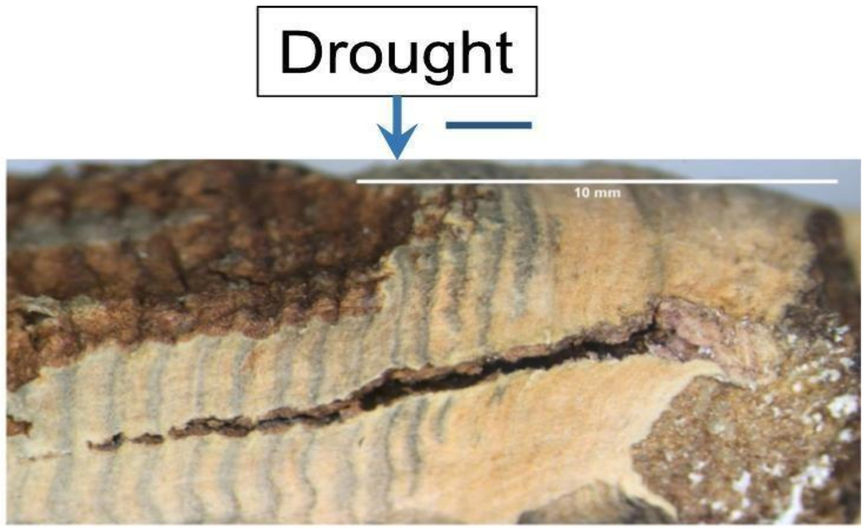
MAIN OUTCOMES

Negative impact of dry-warm summers and long-term droughts on cork growth is more marked in continental, seasonally dry cork oak stands compared to wet, cooler sites.

Such sensitive sites are not necessarily located near the southernmost distribution limit of cork oak in north western Africa.

The precipitation during the hydrological year emerges as a suitable proxy for cork production in dry continental sites.



CONCLUSIONS

Assessments of climate-cork relationships in the western Mediterranean basin could be used as analogues to forecast the impacts of aridification on future cork production. Further research is essential to better characterize cork growth responses to climate across different sites and to understand the underlying mechanisms behind these patterns.

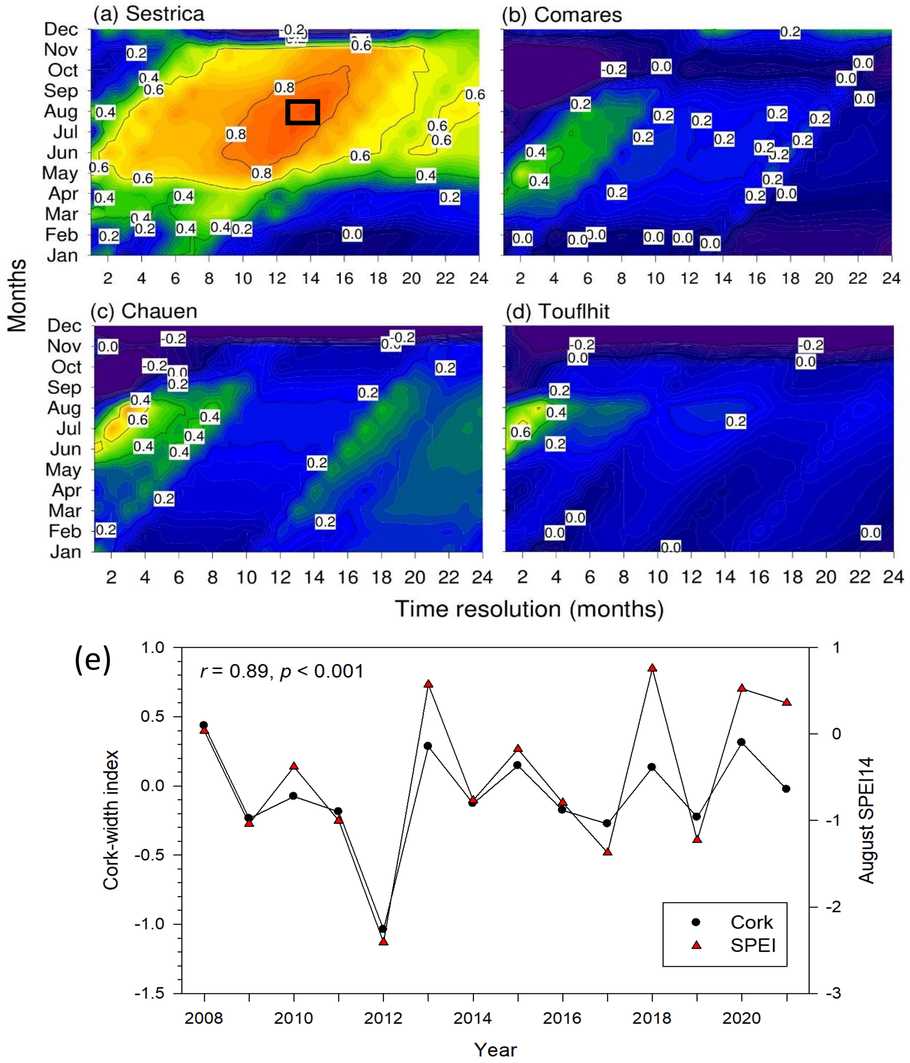


Figure 2. Relationships (*r*, Pearson correlations) between monthly SPEI values, calculated at 1- to 24-month resolutions (x axes), and mean site series of indexed cork ring width. Correlation coefficients higher than 0.52 are significant at the 0.05 level. The maximum correlation was obtained in Sestrica considering the 14-month SPEI in August (square in plot (a)) and it is shown in the line-scatter plot (e).

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