Appendix A.

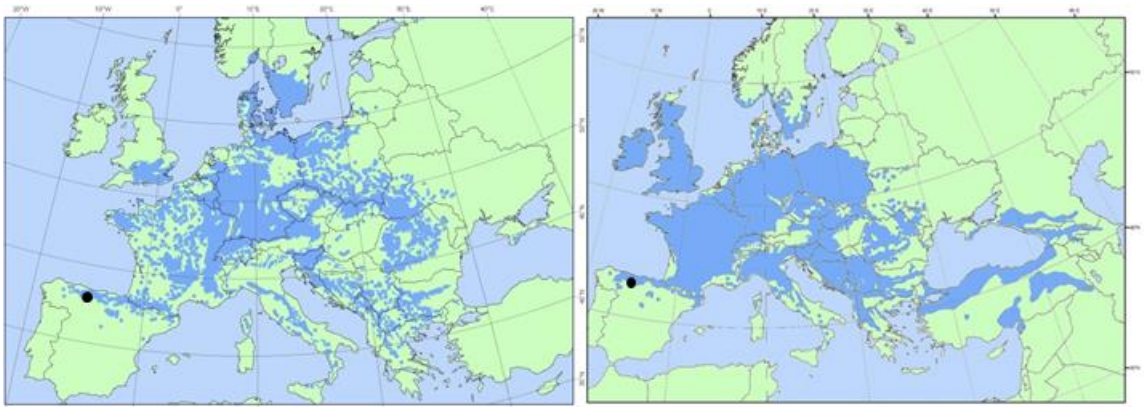

Figure A.1. Distribution of *Quercus petraea* (left) and *Fagus sylvatica* (right) in Europe (EUFORGEN, 2009a, 2009b). Black points show the location of the study site in northwestern Spain.

References for appendix A

EUFORGEN (2009a). Distribution map of Beech (*Fagus sylvatica*). www.euforgen.org.

EUFORGEN (2009b). Distribution map of Sessile oak (*Quercus petraea*). www.euforgen.org.

Appendix B.

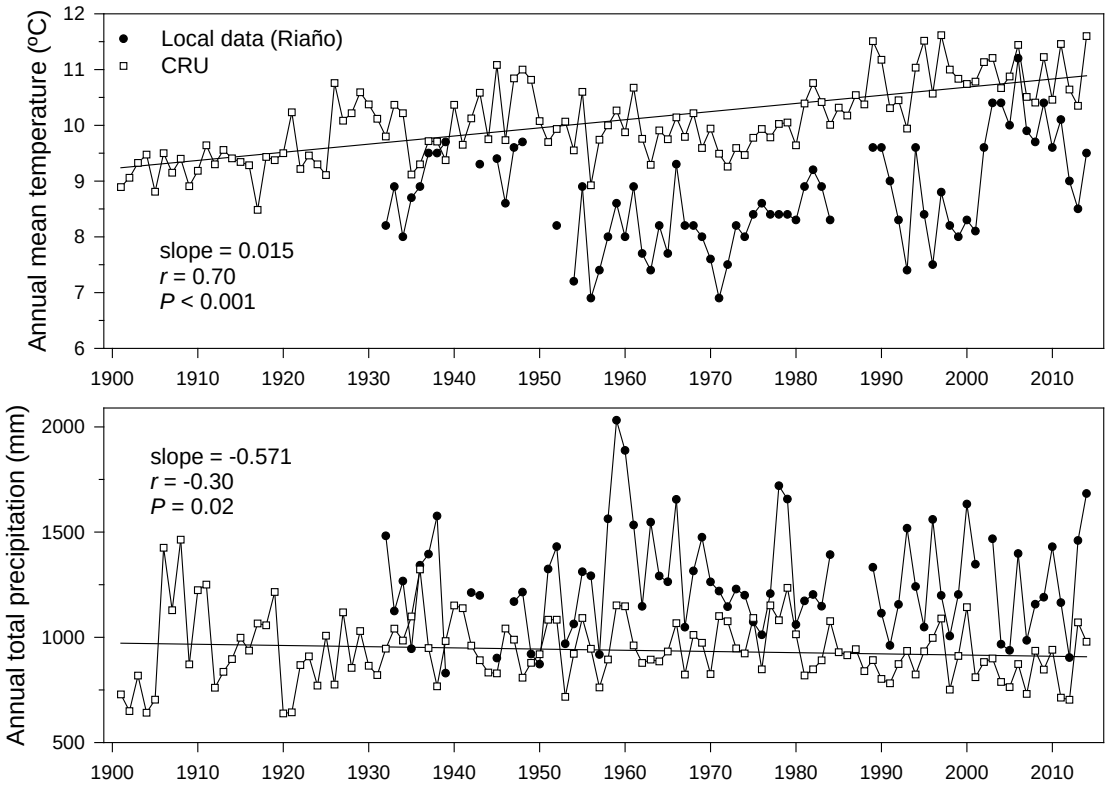

Figure B.1. Climatic trends (annual mean temperature and precipitation) in the study area calculated using annual gridded (CRU data, empty symbols) and local climate data (Riaño station, AEMET, filled symbols, data with gaps). Simple regressions have been fitted in CRU temperature and precipitation. Pearson correlations between AEMET and CRU series were 0.62 ($P < 0.001$) and 0.49 ($P < 0.001$) for temperature and precipitation, respectively.

Appendix C.

Tree age at 1.3 m was estimated as follows: In those cases where cores reached the pith, age estimation was performed through cross-dating of the rings. In the other cases, we first estimated the missing length to the pith and then the number of innermost lost rings. In these partial cores we used the arc of the innermost rings to estimate the length of the missing radius using a graphical method based on the convergence of xylem rays at the pith (Rozas, 2003). In partial cores without conspicuous arcs, the length of the missing radius was estimated as the distance to the geometric center of the tree, assuming concentric growth. In the latter case, estimation was carried out by subtracting the corresponding cored length to the measured radius in field, previously subtracting an estimated width of the bark. Bark thickness was estimated based on tree diameter using equations from the Second Spanish National Forest Inventory (DGCONA, 1998). Functions used to estimate the bark thickness of beech (C_F) and oak (C_Q) are:

$$C_F = -0.00001d^2 + 0.0284d + 0.3545 \quad \text{(C.1)}$$

$$C_Q = 1.4407d^{0.4071} \quad \text{(C.2)}$$

where d is tree diameter measured at 1.3 m.

In partial cores, the number of missing rings in beech (NMR_F) and oak (NMR_Q) was estimated using an empirical model of initial radial growth, a function of both the distance from the pith, and the mean radial growth rate of the 5 rings adjacent to the largest arc visible on the core (Rozas, 2003). We used these equations:

$$NMR_F = 3.41 - 3.15MRG5 + 2.07d - 0.037d^2 + 0.0002d^3 \quad \text{(C.3)}$$

$$NMR_Q = 3.37 - 2.26MRG5 + 1.22d - 0.022d^2 + 0.0001d^3 \quad \text{(C.4)}$$

where $MRG5$ is the mean growth rate of the innermost 5 rings of the core and d is the tree diameter at 1.3 m.

References for appendix C

DGCONA 1998. Segundo Inventario Forestal Nacional. 1986-1996. Ministerio de Media Ambiente, Spain.

Rozas, V., 2003. Tree age estimates in *Fagus sylvatica* and *Quercus robur*: testing previous and improved methods. Plant Ecol 167, 193-212. https://doi.org/10.1023/A:1023969822044

Appendix D.

To reconstruct forest disturbances, growth releases were detected through a quantification study of abrupt growth increments using the *TRADER* package in R (Altman *et al*., 2014). For beech and oak we employed the method proposed by Splechtna *et al*., (2005), which reduces the numbers of false releases (Altman *et al*., 2014). This method comprises two steps. Firstly, the average radial growth over the preceding 10-year period and the average radial growth over the subsequent 10-year period are calculated for each year of the growth series of each tree and the percentage growth change is obtained (Nowacki and Abrams, 1997). A release candidate is only considered if the growth pulse exceeds a 50% growth change threshold. Secondly, the boundary-line method (Black and Abrams, 2003), which standardizes the percentage growth change, is applied to the release candidates to remove the influence of age, size and other variables on growth (Black and Abrams, 2004). We followed Black and Abrams (2003), who defined moderate and major releases as those falling within 20–49.9%, and 50–100% of the boundary-line, respectively. Since the boundary-line method requires a large data set for calculating the boundary function (Black *et al*., 2009), it was only calculated for beech. In the case of oak we used the boundary function proposed by Altman *et al*. (2013) for this species.

The boundary-line function obtained for beech was the following:

$$y = -0.01825 + 5.28364e^{-0.83170x} \quad \text{(D.1)}$$

and the boundary-line function used for oak was (Altman *et al*., 2013):

$$y = 5.0067e^{-0.664x} \quad \text{(D.2)}$$

where *x* are the 0.5 mm segments of growth (Black *et al*., 2004).

For more information on release structures and the past disturbance regime of the studied forest see Rubio-Cuadrado *et al.* (2018).

References for appendix C

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Rubio-Cuadrado, A., Camarero, J.J., del Río, M., Sánchez-González, M., Ruiz-Peinado, R., Bravo-Oviedo, A., Gil, L., Montes, F., 2018. Long-term impacts of drought on growth and forest dynamics in a temperate beech-oak-birch forest. Agr Forest Meteorol 259, 48-59. https://doi.org/10.1016/j.agrformet.2018.04.015

Splechtna, B.E., Gratzer, G., Black, B.A., 2005. Disturbance history of a European old-growth mixed-species forest - A spatial dendro-ecological analysis. J Veg Sci 16, 511-522. https://doi.org/10.1111/j.1654-1103.2005.tb02391.x

Appendix E.

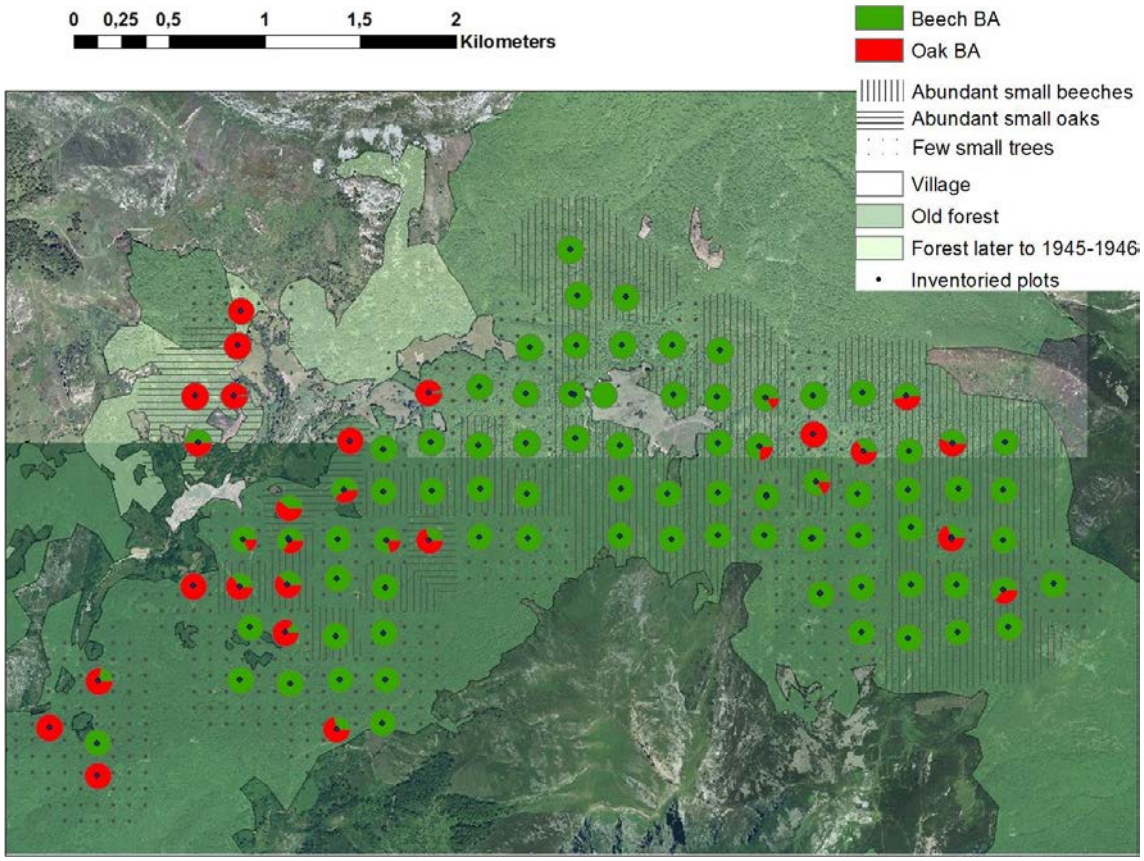

Figure E.1. Map of the sampled area. Pies indicate the proportion of basal area by species. The areas marked as “abundant small beeches” have been obtained from the plots included in clusters P2 and M2. The areas marked as “abundant small oaks” have been obtained from the plots included in cluster M1. The areas marked as “few small trees” have been obtained from the plots included in clusters P1 and M3 (see Table 1 and Fig. 1). The presence of a continuous forested area in this site was assessed by inspecting aerial photographs from 1945-1946 (PNOA, Instituto Geográfico Nacional, Spain).

Appendix F.

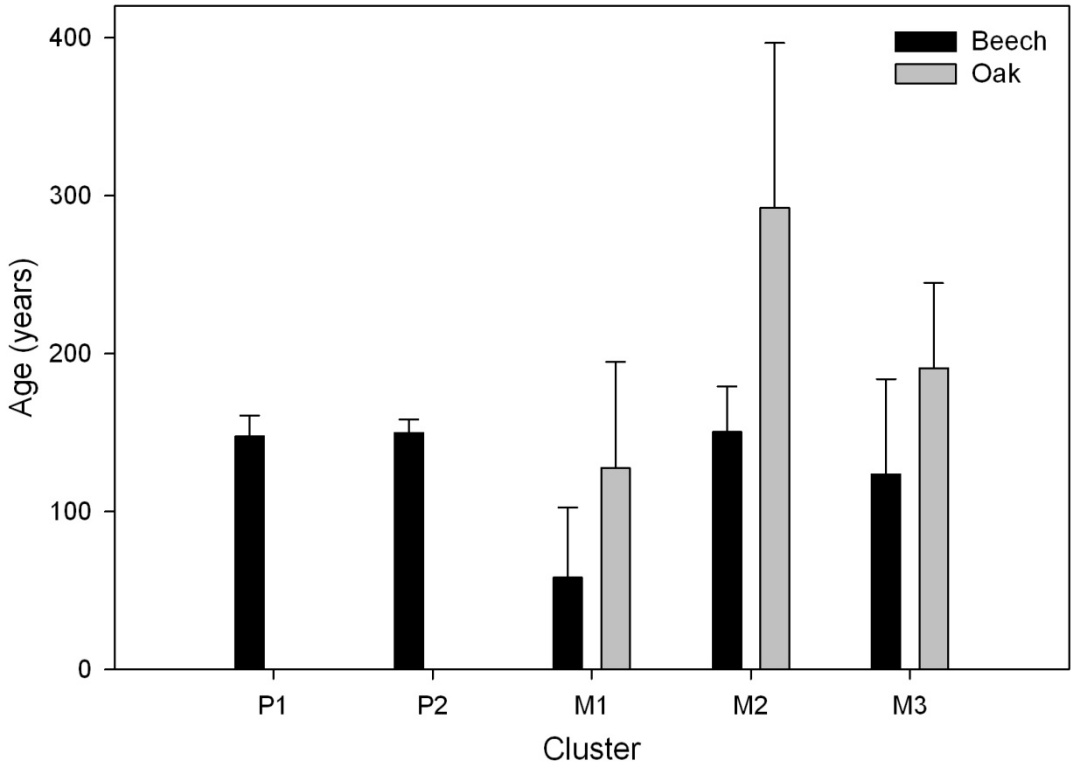

Figure F.1. Comparison of mean ages between clusters (clusters's names are as in Table 1). Error bars indicate the 95% confidence intervals.