

## SUBTOPIC: 3.3 MANAGING MEDITERRANEAN AGRO- SILVOPASTORAL SYSTEMS

Using quantile regression to evaluate the impact of different factors in the cork caliper of cork oak trees in montado agroforestry ecosystem

*AUTHOR AND CO-AUTHORS:*

*[Joana Amaral Paulo \(joanaap@isa.ulisboa.pt\)](mailto:joanaap@isa.ulisboa.pt), Paulo Neves Firmino, Sónia Pacheco Faias, Margarida Tomé*

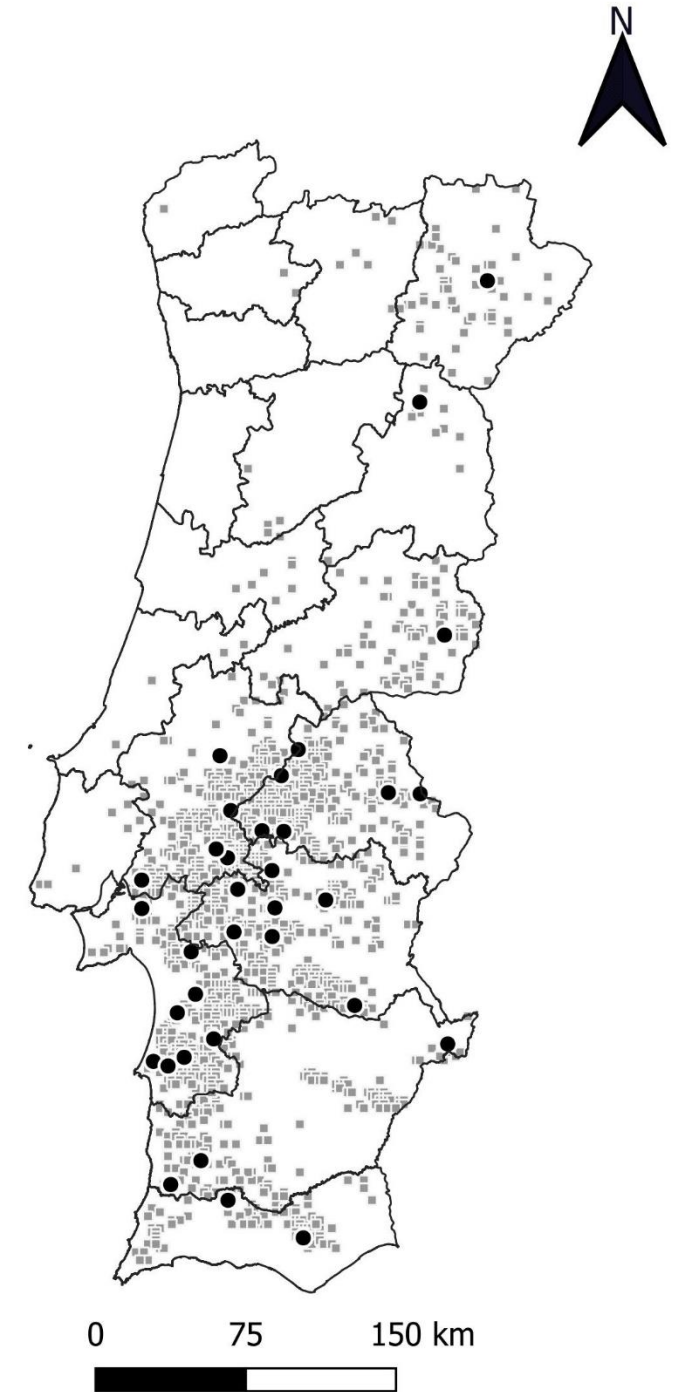


INSTITUTO  
SUPERIOR DE  
AGRONOMIA  
*Universidade de Lisboa*

# Context



- Cork oak (*Quercus suber*):  
Mediterranean basin distribution
- *Montado*: agrosilvopastoral ecosystem
- Non-wood forest product: cork
- Minimum period between cork extraction in Portugal: 9 years
- Diversity of cork products: natural cork stoppers are the main one
- Centro de Estudos Florestais (Instituto Superior de Agronomia) long term research line based in a national permanent plot network

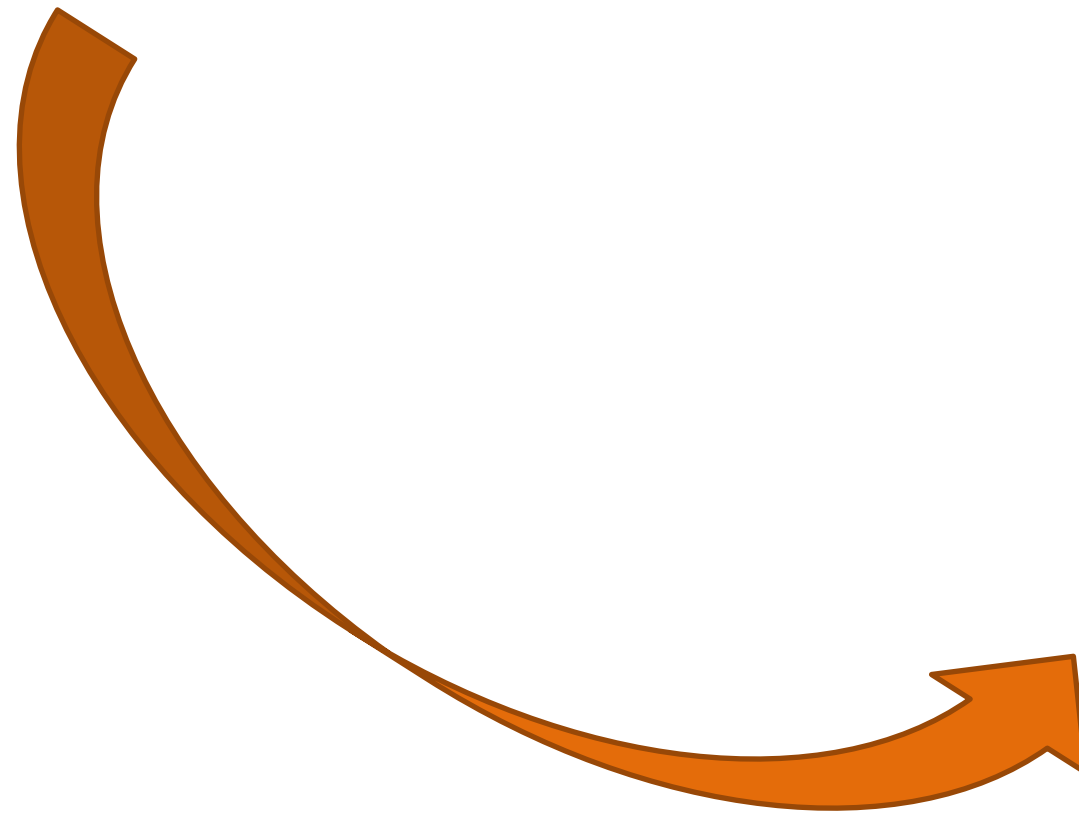


# State of the art

The relationship between cork annual growth and climate is well established in the scientific literature?

Yes, for the “average” tree response!

For variables such as precipitation, average temperature and drought...



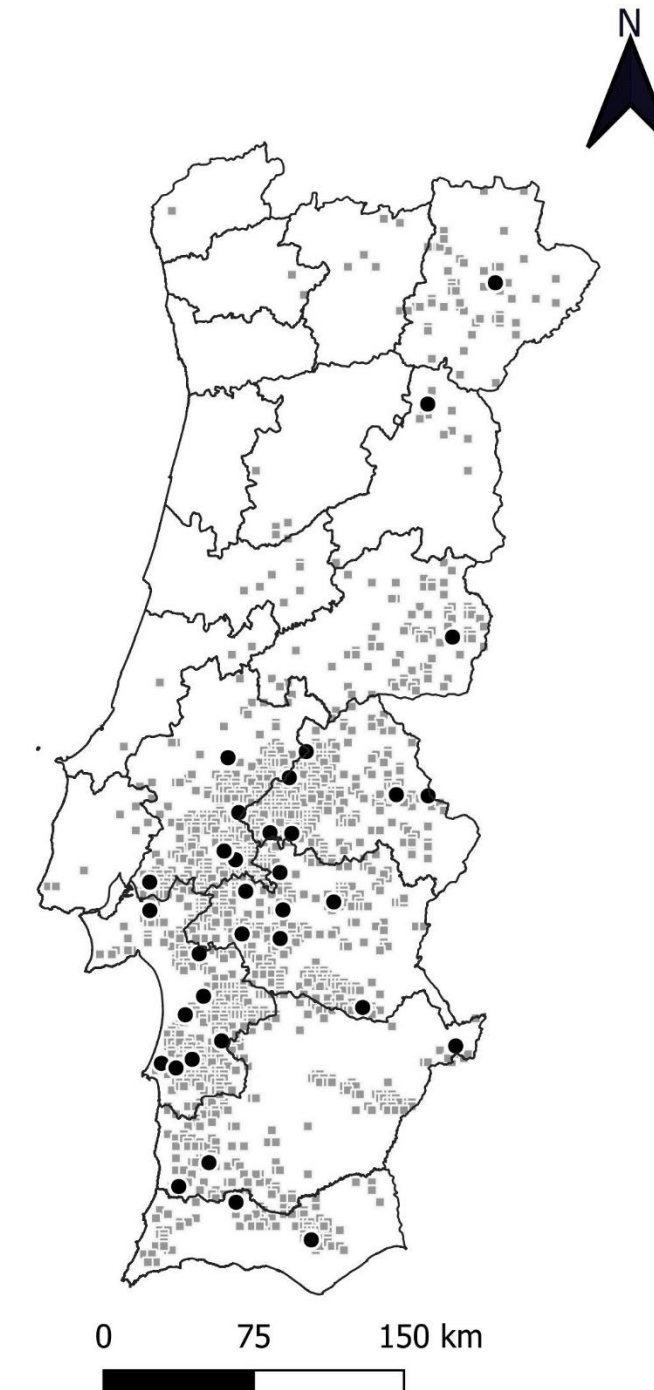
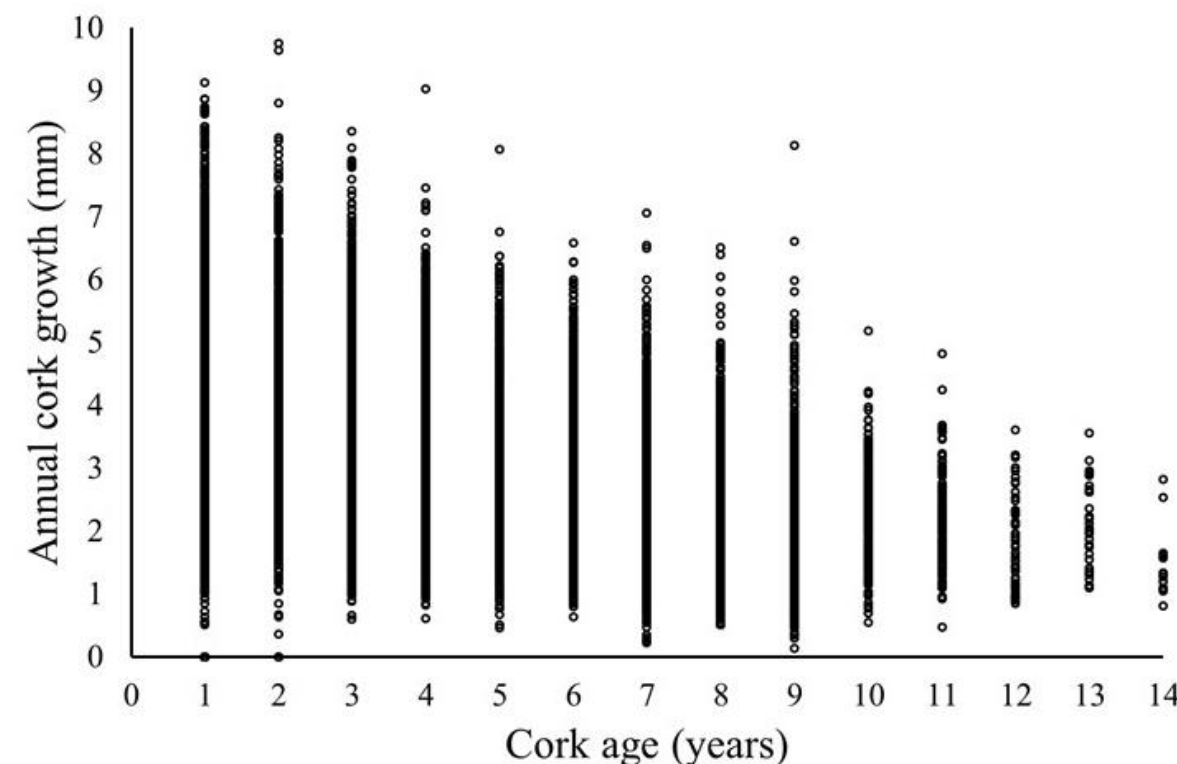
## Research question

**Are climate variables affecting all trees in the same way?**



# Materials and methods

- 35 plots (see map)
- site index ranges from 10.7 to 16.2 m at base age 80 years
- Cork samples extracted between 1996 and 2005.
- Years included in the data set: 1988 to 2004.
- The final data set included 1024 cork samples, with 9153 confirmed annual growth measurements.

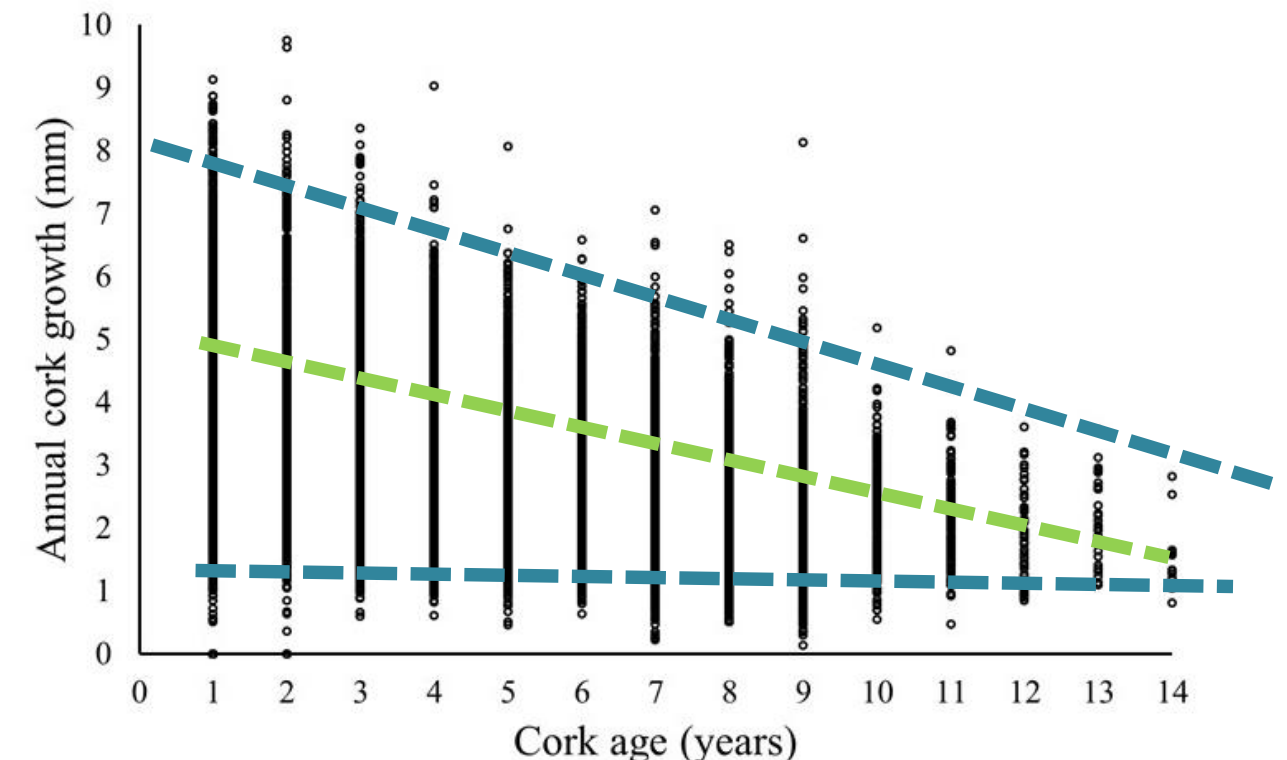


# Materials and methods

- The complex interactions existing between the variables considered are difficult to account for using more frequent statistical approaches (e.g. ordinary least squares regression).
- **Quantile regression**, instead, aims at **estimating different quantiles** of the response variable, given certain values of the predictor variables.

**Task 1:** model quantiles of annual growth cork growth and cork caliper

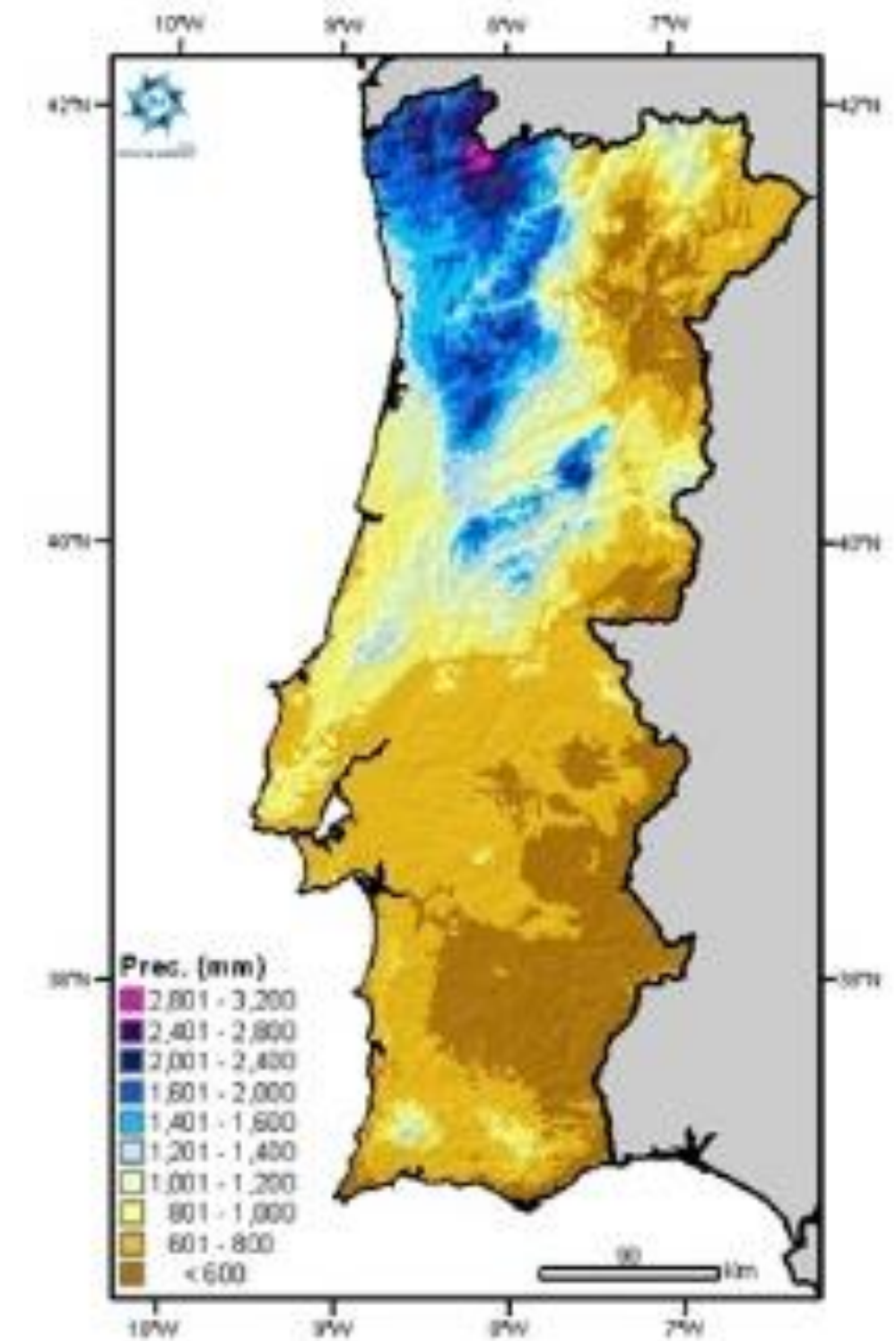
**Task 2:** using the developed models, map the percentage of cork extracted (9 years of growth) that is suitable for natural cork stopper production.



# Results (Task 1)

**Precipitation** confirmed a positive relationship to annual cork growth for all of the quantiles. **This relationship is not linear.** Instead it has a downward parabolic shape with an optimum annual average precipitation value.

This value is decreasing for the trees from higher quantiles of cork thickness, that when growing in locations with precipitation values close or higher to **1000 mm** might not respond to an increase in water availability.

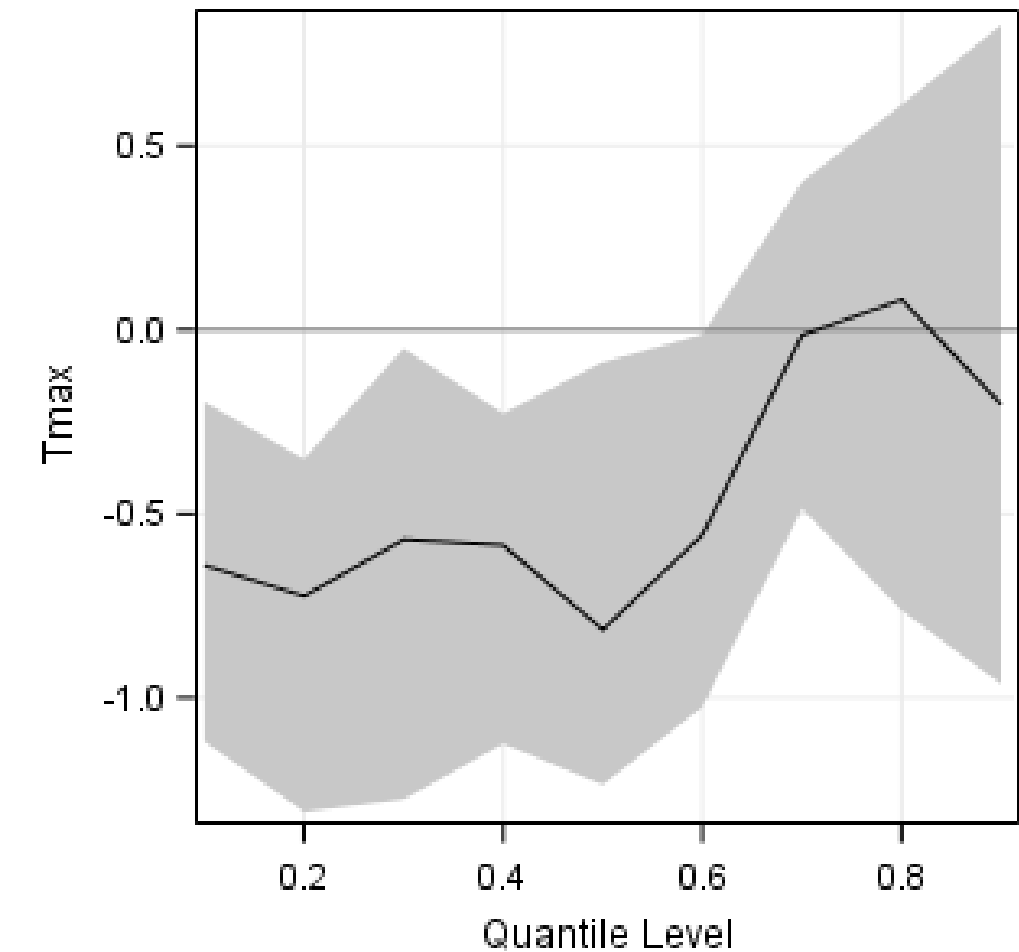


# Results (Task 1)

**Maximum annual temperature** was shown to negatively affect the cork annual growth and cork thickness.

For cork thickness obtained after 9 years of growth, this was only observed for the **trees under the 6<sup>th</sup> quantile**.

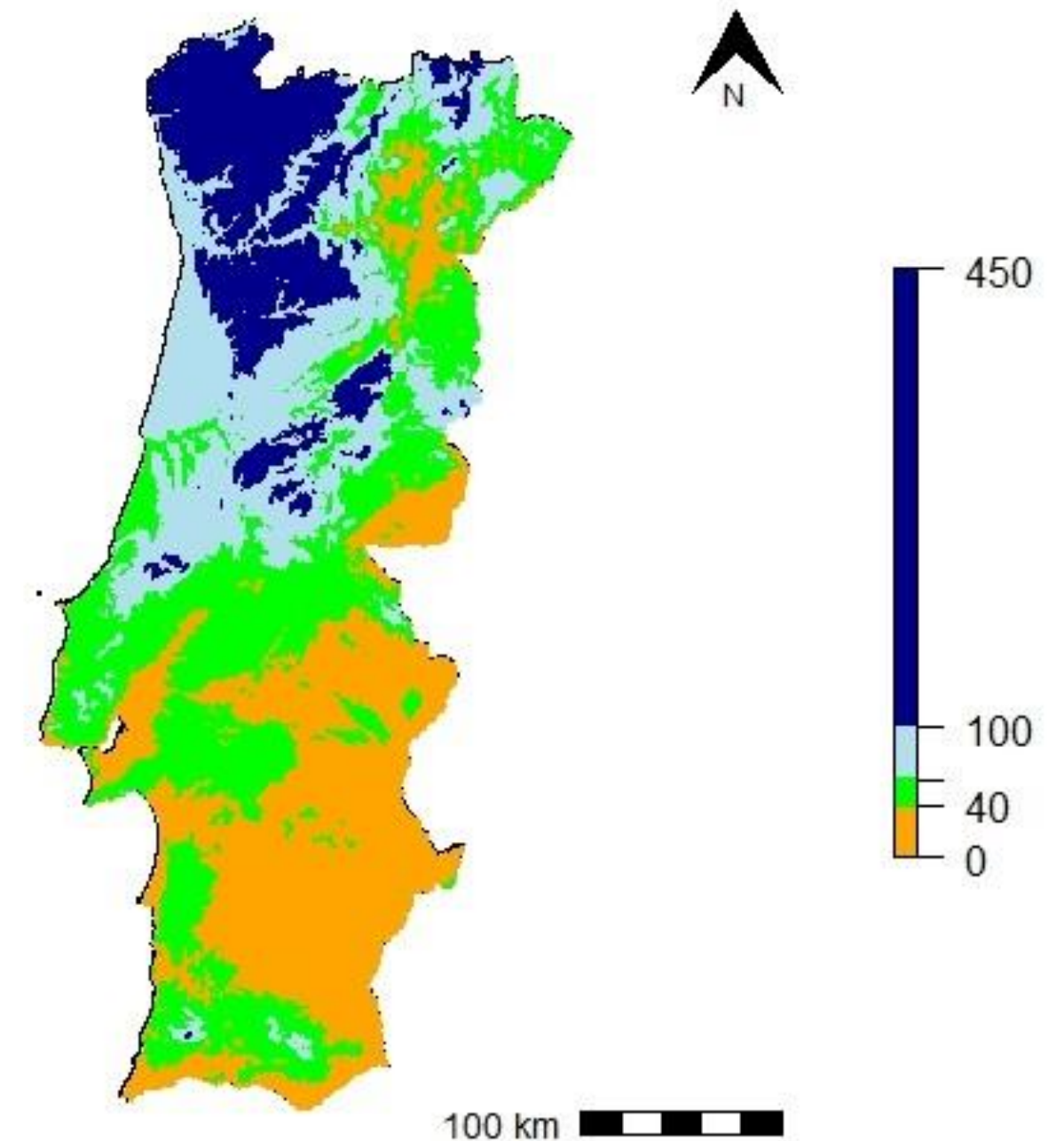
These trees are more vulnerable to heat waves, which are expected to be more frequent under **climate change**.



# Results (Task 1)

The **Lang Index** ( $LI = Pt/T$ ) showed the importance of the ratio between the precipitation and temperature variables.

The **downward parabolic relationship** between annual cork growth and this index showed that the **best cork growth conditions are found for values around 60**, corresponding for the transition between semi-arid climate and humid climate.



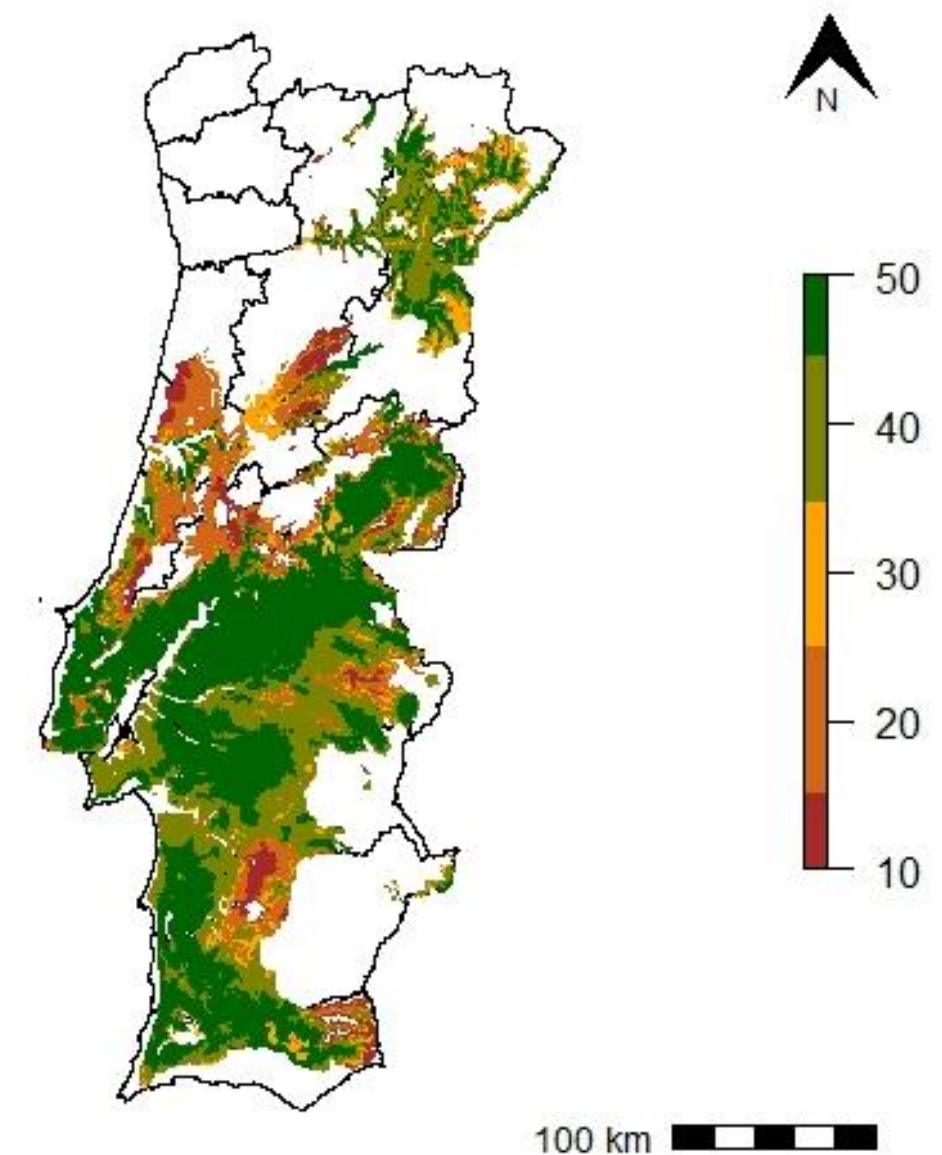


# Results (task 2)

Mapping of the **percentage of cork suitable for natural cork stopper production** showed **higher values are expected in the Southern and Central coastal regions and along the Tagus River basin.**

The Northern coastal and mountain regions, characterized by Lang index values larger to 60 (humid climates), present lower estimated values for the percentage of cork suitable for natural cork stopper production.

Rollable Cork Percentage



# Research question

Are climate conditions (and other factors) affecting all trees in the same way?



# Conclusions

- **Climate affects differently the cork growth, and ultimately cork thickness, of trees from different quantiles.**
- **An increase in precipitation might not be translated by and increase cork calliper in all trees of the same stand.**
- **Trees producing thinner cork are more affected by an increase of maximum temperatures.**



# AGROFORESTRY SYSTEMS AND INNOVATIONS

European Journal of Forest Research  
<https://doi.org/10.1007/s10342-021-01379-8>

ORIGINAL PAPER



## Quantile regression for modelling the impact of climate in cork growth quantiles in Portugal

Joana Amaral Paulo<sup>1</sup> · Paulo Neves Firmino<sup>1</sup> · Sónia Pacheco Faias<sup>1</sup> · Margarida Tomé<sup>1</sup>

Received: 1 May 2020 / Revised: 7 January 2021 / Accepted: 10 April 2021  
© The Author(s), under exclusive licence to Springer-Verlag GmbH Germany, part of Springer Nature 2021

### Abstract

The annual growth and the thickness of cork are known to be highly variable between trees located in the same geographical location. Researching how climate variables affect different trees within the same site is a step forward for the management of cork production since current knowledge focusses only on the average tree response. Quantile regression methodology was

## CONTACTS:

Joana Amaral Paulo ([joanaap@isa.ulisboa.pt](mailto:joanaap@isa.ulisboa.pt))

<https://fenix.isa.ulisboa.pt/qubEdu/homepage/isa114126/>

## Published here:

<https://link.springer.com/article/10.1007/s10342-021-01379-8>

<https://repository.incredibleforest.net/oppla-factsheet/20702>

