WEATHER EXTREMES RISKS FOR PORTUGUESE VITICULTURE

André R. Fonseca[1,2], José Cruz[1,2], Helder Fraga[1,2], João A. Santos[1,2]

[1]Centre for the Research and Technology of Agro-Environmental and Biological Sciences (CITAB)

[2]Institute for Innovation, Capacity Building and Sustainability of Agrifood Production (Inov4Agro)

Universidade de Trás-os-Montes e Alto Douro Portugal, andre.fonseca@utad.pt)

UNIVERSIDADE DE TRÁS-OS-MONTES E ALTO DOURO

12º SIMPÓSIO VITIVINICULTURA DO ALENTEJO

ABSTRACT

Grape berries and their yields can be strongly affected by the complex connections and interactions between the grapevines and the conditions of the local environment. In areas of known wine production, the yield and quality are usually improved by considering the climate, planting the best grape variety, and using specific agricultural techniques. Thus, sustainability in the winemaking sector worldwide is under pressure due to ongoing climate change, requiring adaptation at multiple levels. Portuguese vineyards will experience increasingly dry and warm conditions due to climate change, with varying degrees of intensity and frequency of weather extremes. Nevertheless, the potential effects of these extraordinary occasions and their effects on viticulture in the future are not well known. In this research, we calculated seventeen climate extreme indices for the Portuguese wine denomination of origin regions/subregions (**Figure 1**) in the historical period (1981–2010) and future periods (2041–2070 and 2071–2100), under the Representative Concentration Pathway 8.5, and based on a five-member ensemble of Regional Climate Model-Global Climate Model chain simulations. Moreover, a principal component analysis was performed for both precipitation and temperature extremes independent of each other. All of Portugal's wine regions experienced an increase in temperature extremes, predominantly in the westernmost regions. When it comes to the precipitation extremes, they show a decrease in the future and a general decline in precipitation but still are a major risk in the northeastern regions. In contrast, the dry extremes, likely bringing on severe droughts, will become much stronger. Finally, it was then possible to recognize which wine regions will be the most vulnerable to extreme weather conditions in the future. This information is essential for enabling smarter choices in the sector, including for long-term planning, climate change adaptation and risk reduction.

METHODOLOGY

A recently developed high—resolution daily dataset, Iberia01, was used for this study. This dataset, which is accessible at a 0.1° horizontal resolution, was produced using a dense network of stations over the Iberian Peninsula for the period 1971–2015. The data was extracted for mainland Portugal and for the period between 1981 and 2010. For future periods, a five-member ensemble of General Climate Model and Regional Climate Model chain experiments was considered to cover inter-model variability and reduce single model uncertainties in the final dataset results. Bias correction approach was done based on the quantile mapping method by calculating daily differences/ratios for temperature/precipitation, respectively, between the Iberia01 and each one of the five-member ensemble over the historical period 1981—2010, based on quantiles of the empirical probability distribution function. A total of seventeen indices of climate extremes were selected, of this set, ten indices refer to precipitation and seven to temperature. Zonal statistic means using the denominated areas of origin as boundaries were calculated based on the climate indices' extreme results (**Figure 2**). A total of two principal component analyses were carried out, with one being dedicated to precipitation indices and the other to temperature indices, both of which were standardized.

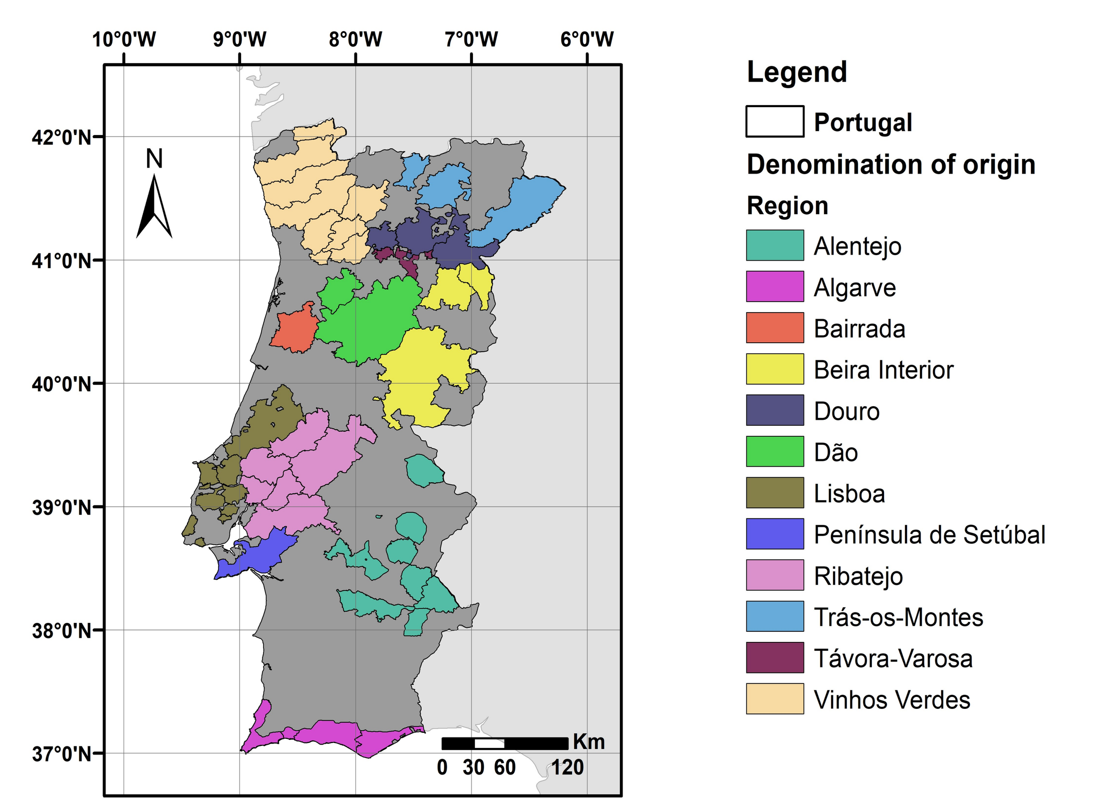

FIGURE 1. Hypsometric map with Portugal mainland location, and denomination of origin regions in mainland Portugal.

RESULTS

The variance explained by the leading principal component for precipitation (ratio between the variance of the principal component and the total variance) was 83%. The distribution (**Figure 3 a,b,c**) shows a positive (red) north-west / south-east spatial pattern of rate and chance of precipitation in the Portuguese wine regions.

The variance explained by the leading principal component for temperature was 77%, and shows (Figure 3 d,e,f) an east-west gradient, where a larger impact on the eastern wine regions of Portugal is likely to occur.

For the Euclidean distance analysis (**Figure 4**), the results show a variation between 0.5 and 8 (distance between each temperature vs precipitation score point), where zero is the lowest susceptibility and eight is the highest. Most of the interior wine sub-regions will witness the greatest impact.

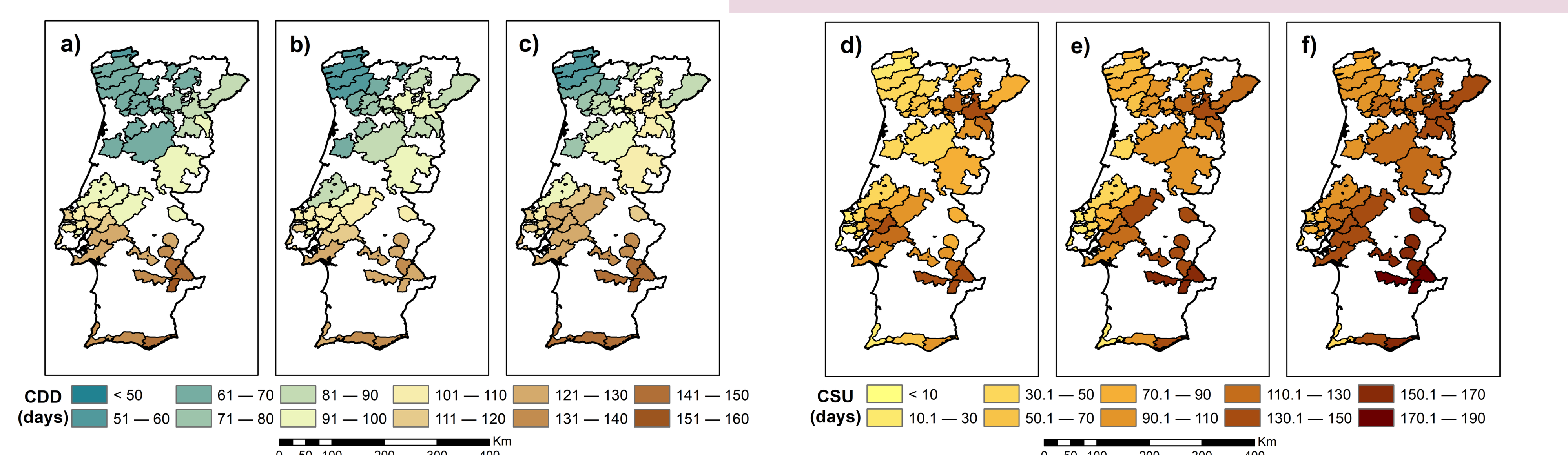

FIGURE 2. Zone statistical mean of **(a, b, c)** CDD – consecutive dry days and **(d, e, f)** CSU – consecutive summer days for the **(a, d)** historical (1981–2010) and future periods **(b, e)** 2041–2070 and **(c, f)** 2071–2100, for the Representative Concentration Pathway 8.5.

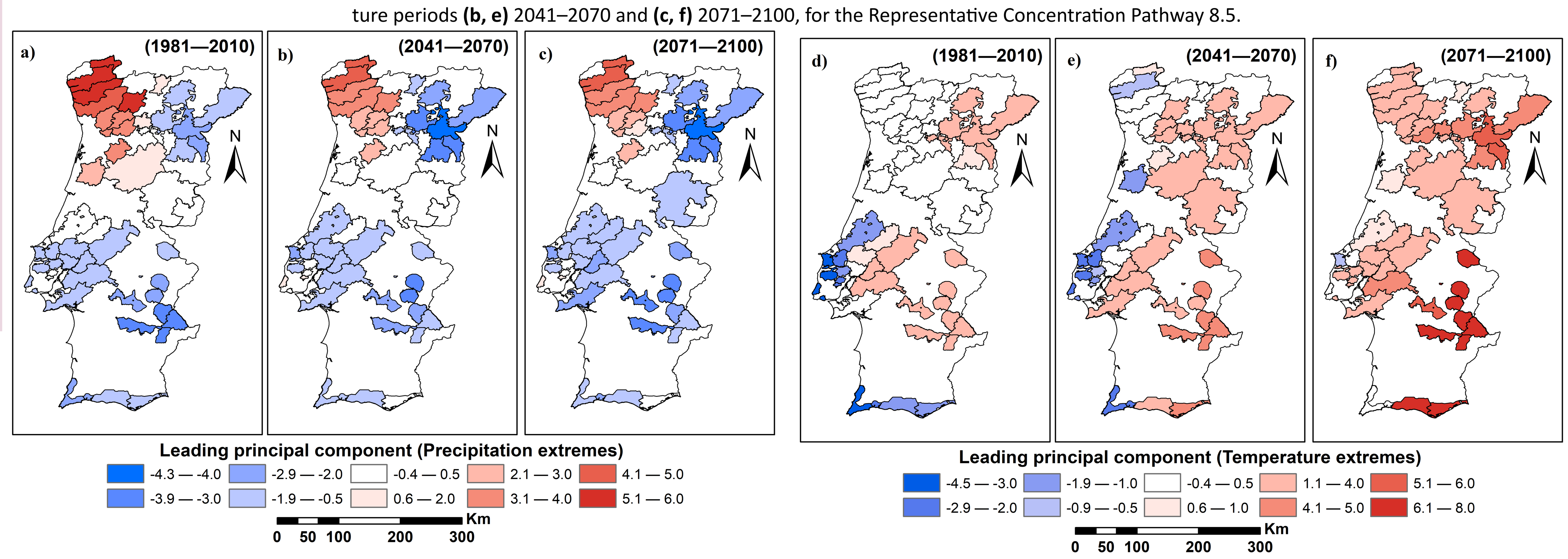

FIGURE 3. Leading principal component values of **(a, b, c)** precipitation extremes and **(d, e, f)** temperature extremes in Portuguese wine-denominated origin sub-regions.

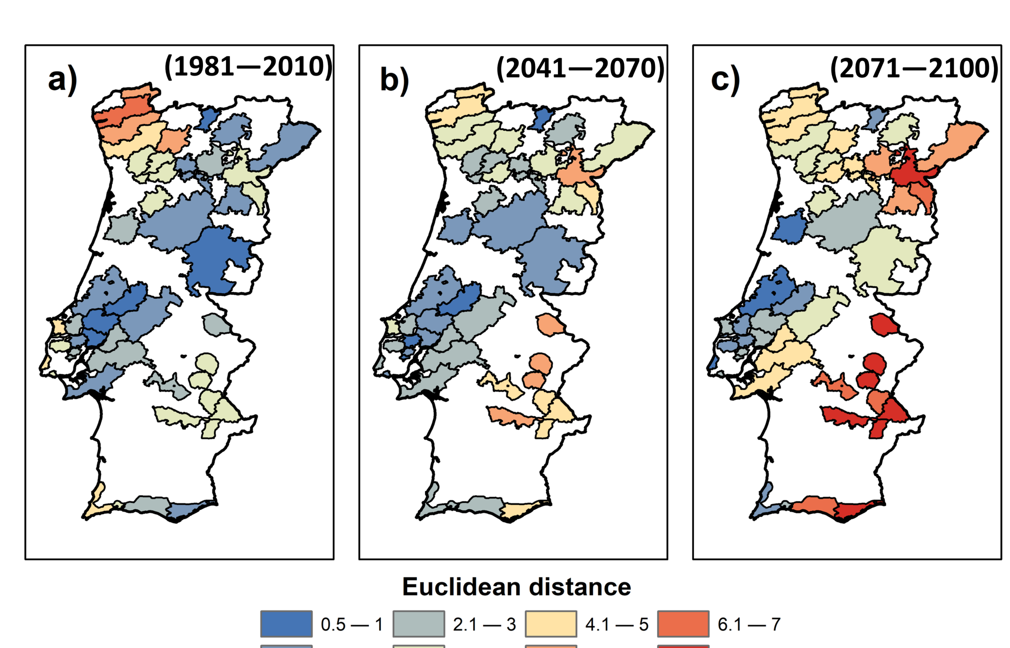

FIGURE 4. The Euclidean distance of the leading principal component scores of both precipitation and temperature extremes of each Portuguese wine sub-region .

REFERENCE

Fonseca A., Fraga H., Santos J.A. 2023

Exposure of Portuguese viticulture to weather extremes under climate change (2023) Climate Services, 30, art. no. 100357. DOI: 10.1016/j.cliser.2023.100357

CONCLUSIONS

Grapevine varieties have high adaptability to various climatic conditions and are relatively resilient to water and heat stresses, their growth and development are still susceptible to the impacts of extreme weather events. Presently, many wine regions in Portugal and across Europe are to be at or near their optimum growing climate thresholds. The results presented in this study suggest that future climate will increase the pressure on Portuguese wine regions, progressively affecting the balanced ripening of the grape of the existing varieties, thus affecting the phenology, development, growth, yields, and ultimately each region typicity. Consequently, some Portuguese wine regions could become more optimal in terms of climate regimes for the production of different cultivars, becoming more advantageous to different grape growing and wine production, more suitable growing climate in northern regions (with more annual precipitation) or western regions (more temperate climate).

ACKNOWLEDGMENTS

Vine & Wine Portugal – Driving Sustainable Growth Through Smart Innovation, PRR – Plano de Recuperação e Resiliência e pelos Fundos Europeus NextGeneration EU, no âmbito das Agendas Mobilizadoras para a Reindustrialização. : Projeto n.º C644866286-011. This research was funded by National Funds by FCT – Portuguese Foundation for Science and Technology, under the project UIDB/04033/2020.

POSTER HERE

PRR Plano de Recuperação e Resiliência

REPÚBLICA PORTUGUESA

Financiado pela União Europeia NextGenerationEU