Vulnerability of the main rainfed agroforestry species in southern Portugal under climate change scenarios RCP 4.5 and RCP 8.5

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Abstract

Mediterranean ecosystems will be the most affected by water scarcity magnified by climate changes in the near future. We examine the evolution of the distribution of the main agroforestry species in southern Portugal in response to a mild (RCP 4.5) and a harsher and more probable (RCP 8.5) climate change scenario.

To do so, the Geographically Weighted Regression (GWR) was used to model the kernel density of *Quercus suber*, *Quercus ilex* and *Pinus pinea* (Fig.1A) to climate drivers. Climate variables and drought indexes were derived from temperature and precipitation of the European daily gridded observational dataset E-Obs from the EU-FP6 project ENSEMBLES, covering the historical period 1971-2000.

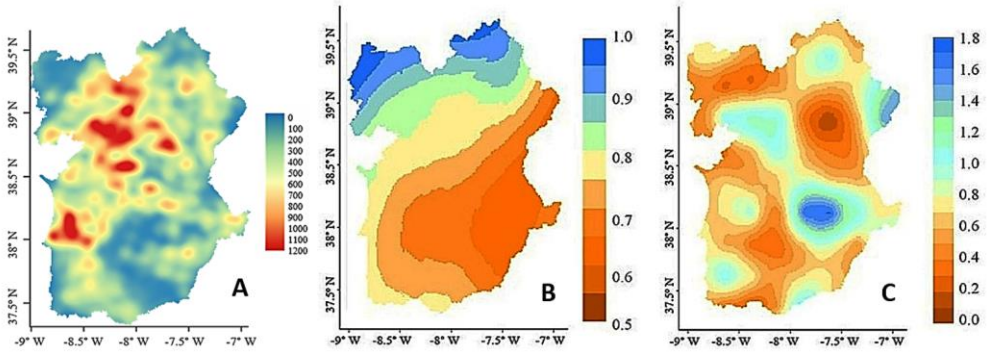

Figure 1. (**A)** Kernel density of Quercus suber, Q. ilex and Pinus pinea in the Alentejo region in southern Portugal. Aridity index **(B)** and Ombrothermic index **(C)** for the historical period 1971-2000.

The best climate predictor was found to be a combination of the Aridity index (AI) based on the potential evapotranspiration using Hargreaves equation [1, 2] and the Ombrothermic index (IOS) of the period March, June, July and August [3]. Both AI and IOS indexes were calculated as averages of the historical period 1971-2000 (Fig.1B, C). The resulting performance of the model was high with a quasi-global R^2=0.997.

Climate indexes AI and IOS for the period 2011-2040, 2041-2070 and 2071-2099 were computed using precipitation and temperature simulated by a multi-model Ensemble of 12 models of the EUCORDEX network under the Representative Concentration Pathways RCP 4.5 and 8.5. Model performance was assessed according to a combination of the performance criteria RMSE, Yule-Kendall Skewness and Willmott-D scores [4]. To predict AI and IOS, the EUCORDEX models showing the best performance were KNMI2 and KNMI1 while SMHI4 and MPI showed the worse results. There was an overall good agreement between observations and simulations of AI and IOS for he historical period 1971-2000, with higher uncertainties spotted in the littoral and northern area of the studied region. Those were explained by the precipitation difference between Eobs observations and the Ensemble simulation of the historical period 1971-2000.

AI dropped respectively 8, 16 and 15% under scenario RCP4.5 along the periods 2011-2040, 2041-2070 and 2071-2099 and 12, 22, 33% under RCP8.5 for the same respective periods. The Alentejo region in southern Portugal progressively shifts from mostly sub-humid to mostly semi-arid, with a few areas becoming arid at the end of the century under RCP8.5 (Figure 2A) and according to the UNEP climate classification [5]. IOS values showed steeper decreasing trends, dropping 21 to 42% under scenario RCP4.5 and 30 to 58% under RCP8.5 (Figure 2B).

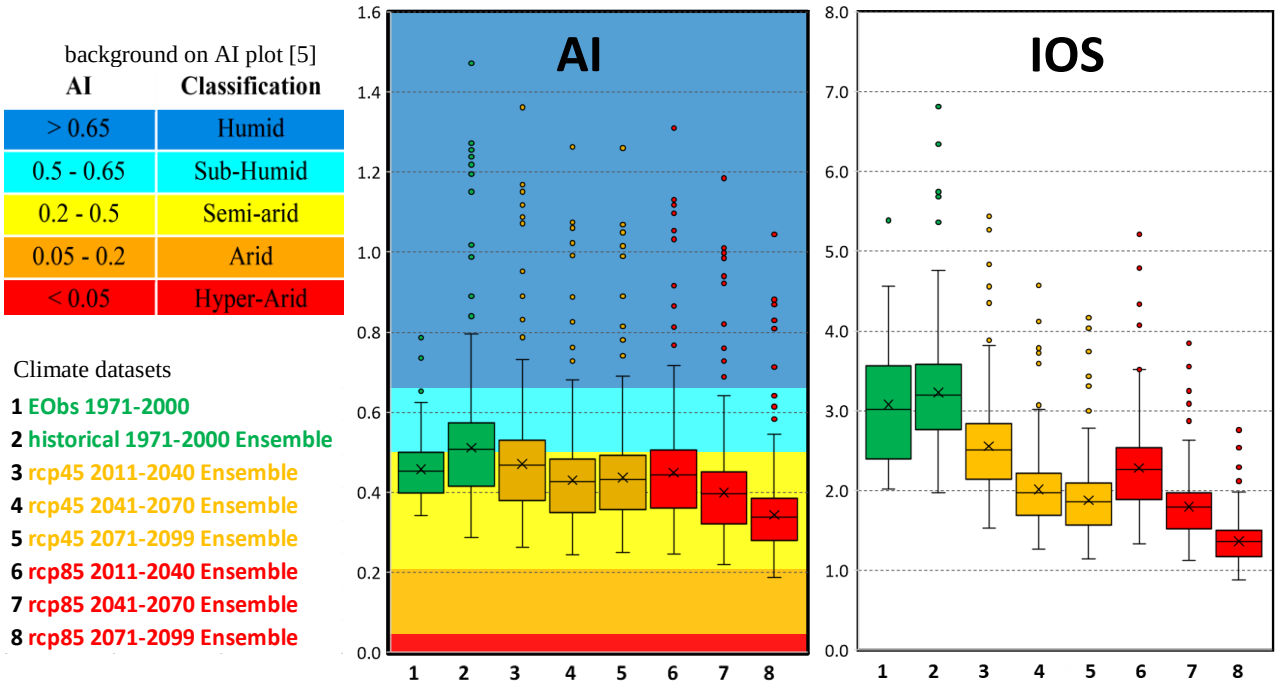

Figure 2. Evolution of the Aridity index (A) and the ombrothermic index (B) values in Alentejo region of southern Portugal in reference to EObs observations and EUROCORDEX Ensemble simulations of the historical period 1971-2000 (1, 2) and for the EUCORDEX multi-model Ensemble simulations for the future periods 2011-2040, 2041-2070 and 2071-2099 under RCP 4.5 (3 to 5) and RCP 8.5 (6 to 8).

Eventually the impact of climate change on the distribution (Kernel density) of the main agroforestry species of southern Portugal until 2100 under RCP 4.5 and 8.5, currently being computed, will be presented. An analysis of the reduction of the Kernel distribution will highlight the most vulnerable areas that will priority need adaptation measures to mitigate the adverse effects of increasing aridity predicted in the studied region, for the future periods 2011-2040, 2041-2070 and 2071-2099.

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