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Bioclimatic modelling in the Holocene and in future warming scenarios in *Arbutus unedo* L.

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PURPOSE OF THE STUDY

Questions

Which are the ecological niche changes in the past and in two future global warming scenarios, RCP 4.5 and 8.5 , in 2050 and 2070 ?

What are the species' environmental tolerances ?

RESULTS

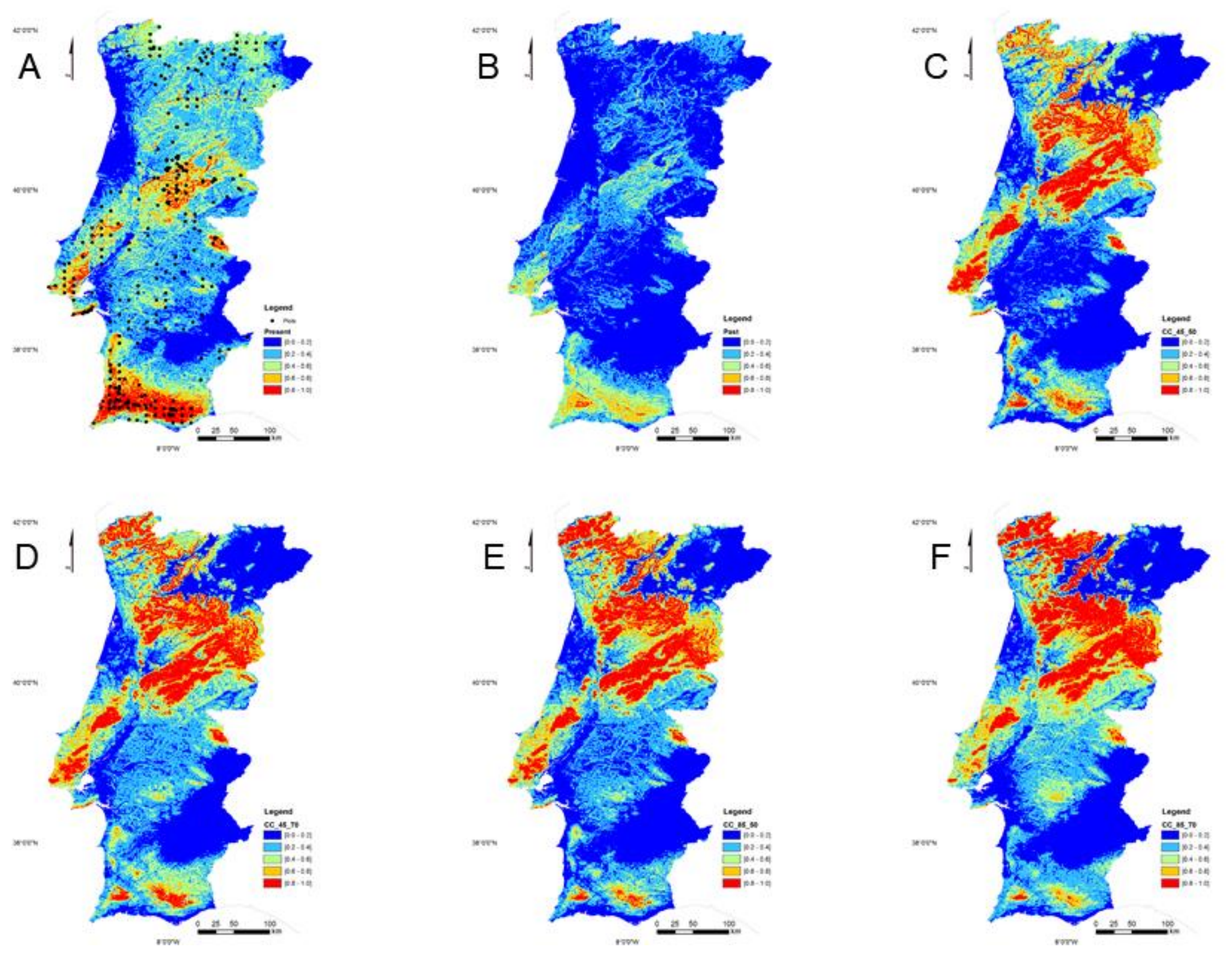

Fig. 2 Representation of the Maxent models for the *A. unedo* habitat suitability predictions. Warmer colors show areas with better predicted conditions. (A) Present (current climate conditions). (B) Past 6,000 BP. (C) Future 2050, RCP 4.5. (D) Future 2070, RCP 4.5. (E) Future 2050, RCP 8.5. (F) Future 2070, RCP 8.5.

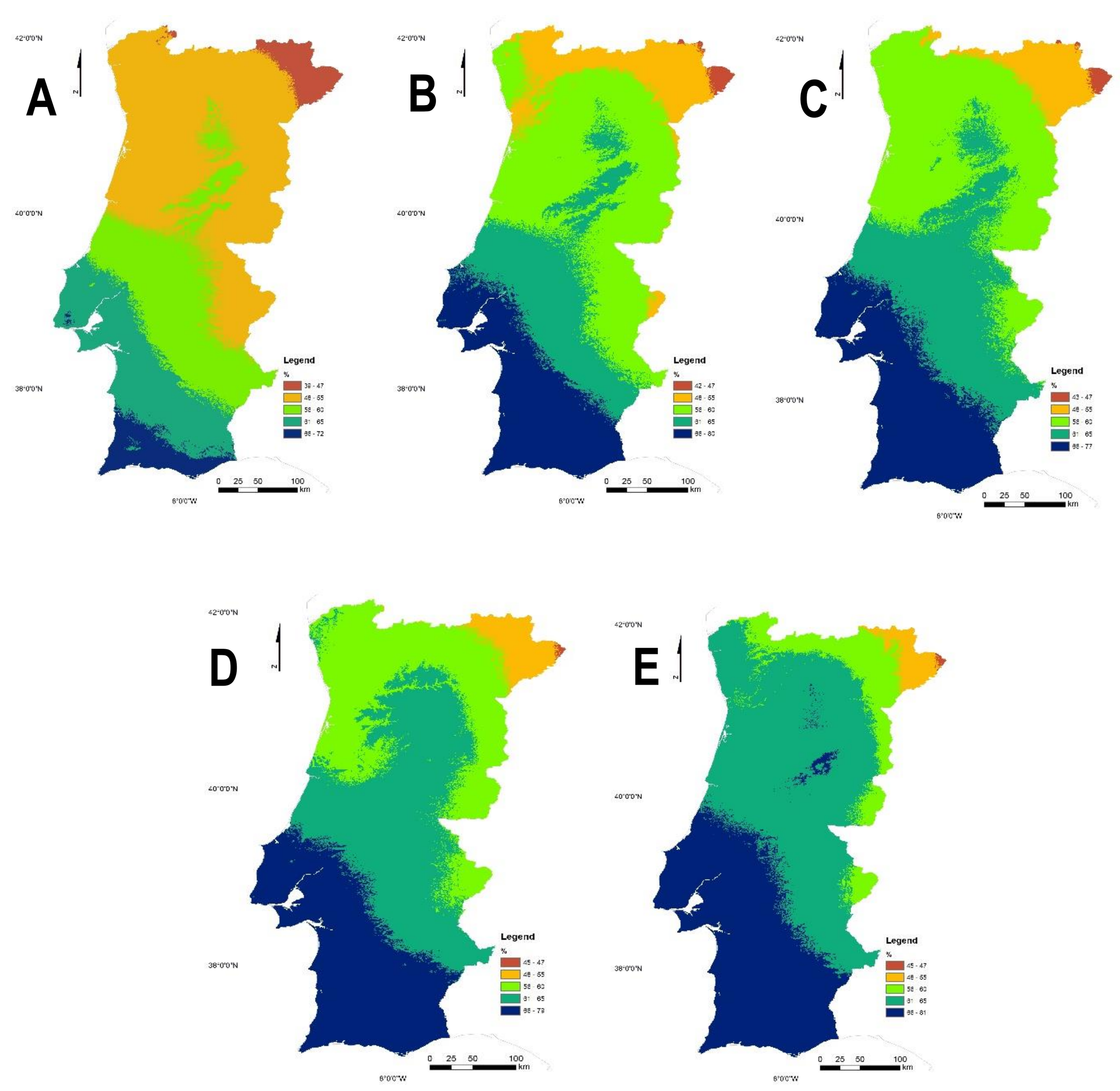

Fig 3. Representation of BIO15 variable, the precipitation seasonality in %, that has highest contribution for the *A. unedo* habitat suitability predictions in the Maxent. (A) Present (current climate conditions). (B) Future 2050, RCP 4.5. (C) Future 2070, RCP 4.5. (D) Future 2050, RCP 8.5. (E) Future 2070, RCP 8.5.

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MATERIAL AND METHODS

- **90,425 plots (1-Km grid level)**
- **318 plots with the species (presence) dataset, including 25 % of testing points (Fig. 1)**
- **Seven bioclimate attributes were chose as the best predictor variables, selected using a Bayesian network methodology with the software BayesiaLab v6.0.7, and 2 additional topographical variables (slope and altitude)**
- **Current, past (6000 BP), future 2050 (RCP 4.5 and RCP 8.5), and future 2070 (RCP 4.5. and RCP 8.5.; +1.4 and +2.0 ºC) climate conditions.**
- **Modelling in the MaxEnt software (100 bootstraps)**

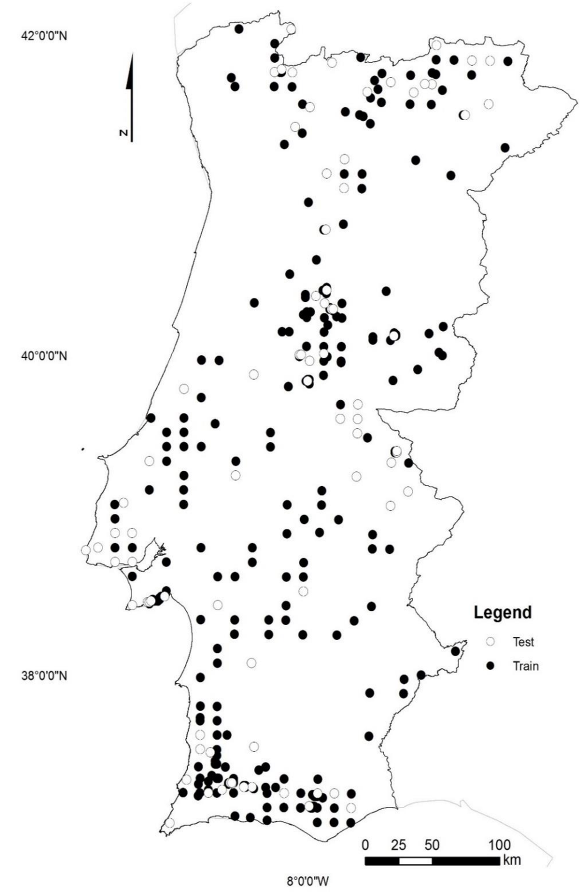

Fig. 1 Black dots show the presence locations used for training, while white dots show test locations.

Table 1. Variables used in modelling, extracted from WorldClim, after a network using a Bayesian methodology to detect the best predictor variables of the species presence, with additional topographical variables, and relative contributions to the Maxent model predictions.

Code	Variable	Unities	%
BIO15	Precipitation seasonality (coefficient of variation)	%	40
Slope	Tangent of the angle of the surface to the horizontal	%	32
Altitude	Mean height above sea level (Digital Elevation Model)	m	8
BIO2	Mean diurnal range (mean of monthly (max temp - min temp))	°C * 10	6
t_{min}	Monthly average minimum temperature	°C * 10	5
t_{max}	Monthly average maximum temperature	°C * 10	4
BIO5	Max. temperature of warmest month	°C * 10	3
BIO9	Mean temperature of driest quarter	°C * 10	1
BIO1	Annual mean temperature	°C * 10	1

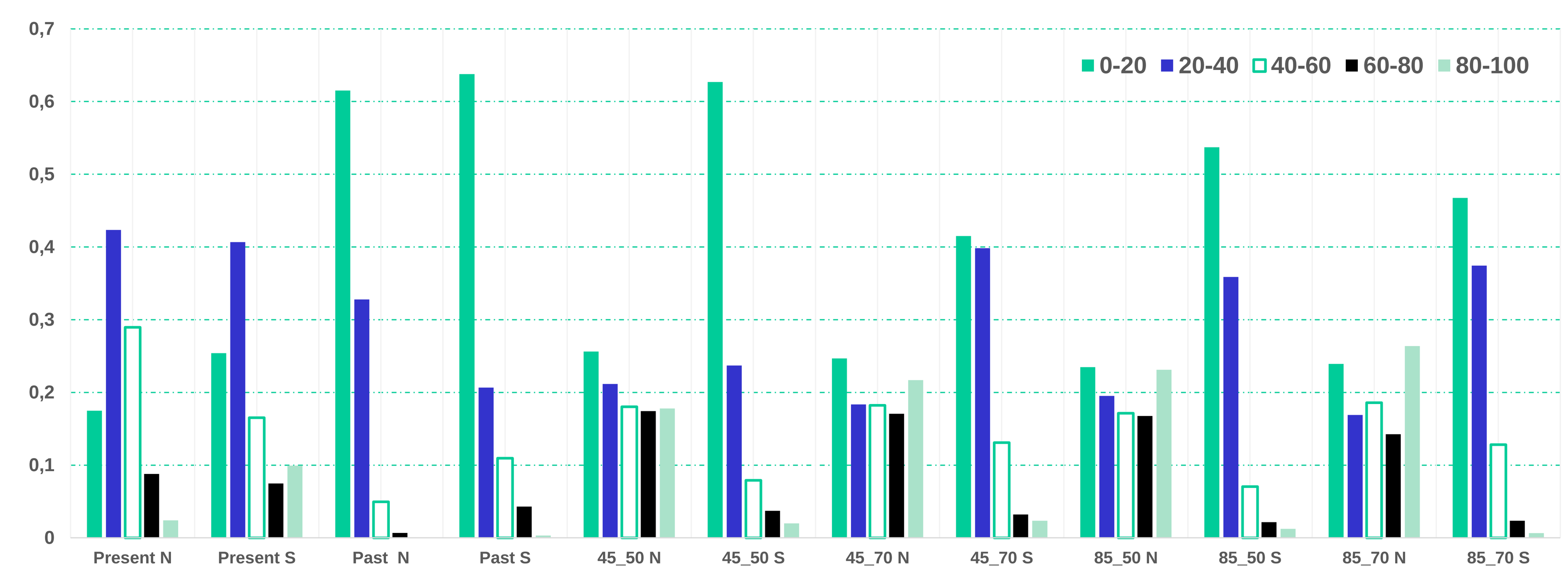

Fig. 4 Territorial evolution in percentage (area) of the present, past, future 2050 (RCP 4.5 and RCP 8.5), and future 2070 (RCP 4.5. and RCP 8.5.) climate conditions, for the different classes of probability of presence of the species predicted conditions, in the North (N) and in the South (S) of the Tagus river.

DISCUSSION

The evaluation of the impact of climate change on the forest in Portugal suggest the strawberry tree migration from south to north and to mountain areas (Fig. 2 C-F) in futures scenarios. Moreover, the species may disappear from the presently drier area in the south of the country (Fig. 2 A and 4).

Changes in precipitation seasonality were predicted to progressively increase in the 2050 and 2070 warming scenarios (RCP 4.5 and 8.5) (Fig. 3 A-E). Strawberry tree seems to develop better in medium precipitation variability (Fig. 3 A), which suggests that this species may have high sensitiveness to high variation in precipitation and, thus, disadvantaged within the seasonality precipitation increase predictions.

The results obtained in the current study for the best scenario projection RCP 4.5 to 2050s, intensified for the RCP 8.5 scenario considering both time slices, show a strong decrease in the species presence in the southern Tagus river's bank, which leads to a potential risk for the species' natural habitat, particularly when considered as a putative refuge (Serra de Monchique) (Fig 2 C-E and Fig. 4).

The distribution of the species in the Middle Holocene (Fig. 2 B) agrees with previous genetic and fossils studies in the region, which supported two putative refuges for the species since the LGM and a cryptic refugia in the East-Central mountain region.

Suitable area reduction in the South and potential competition with agriculture occupation seem to constitute a main concern to the future maintenance of the strawberry tree formations in nature. Forest policies and management should consider the impact of climate change on the usable areas for forestry, seeing a case-study species particularly adapted to the Mediterranean regions and wildfires, such as strawberry tree.