Climate Change Impacts
on the MED-Agro-Food Chain

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Future projections of climatic indices relevant to agriculture in the Aegean region

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The Aegean islands are characterized by strong relief and low vegetation cover and are listed as a region of high desertification risk (Giorgi, 2006; Zanis et al., 2008). The impacts of climate change such as decreased rainfall, temperature increases and extreme weather phenomena, are expected to affect significantly agricultural production, biodiversity, soil structure, and, as a result, local economic activities (JRC, 2014). For millennia terraces allowed the cultivation of island areas with poor and dry soils, reducing soil erosion and wildfire risk. For identifying the most vulnerable regions and prioritize future interventions in the Aegean area, potential future climate changes are examined using projections derived from state-of-the-art Regional Climate Model (RCM) simulations, developed within the framework of EURO-CORDEX (Coordinated Regional Climate Downscaling Experiment). Changes in climate indices, which directly or indirectly affect agriculture in the examined areas, are studied for control and future periods and examined under two new IPCC (2013) emissions scenarios (the medium mitigation scenario and the high emission scenario with no climate mitigation policies). This work aims to provide information on the use of drystone terraces as green infrastructures resilient to climate change impacts, in order to improve agricultural ecosystem resilience, support a modern, extensive and climate smart agricultural sector for the Mediterranean islands, with benefits for local societies.

Future projections of climatic indices relevant to agriculture in the Aegean region

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1. Introduction

Climate change is expected to strongly affect agriculture, as it directly depends on climatic factors such as temperature, sunlight and precipitation for its viability. In the Mediterranean region the negative impacts of climate change include reduced crop yields due to high temperatures, increased water demand for irrigation and reduced water availability due to prolonged periods of droughts and water scarcity which will in turn affect significantly the local economic activities (JRC, 2014). The Aegean islands are characterised by strong relief and low vegetation cover and are listed as a region of high desertification risk (Giorgi, 2006; Zanis et al., 2008). This work is a part of the LIFETERRACESCAPE project which will take advantage of the Land Stewardship practices and their climate adaptation features to improve agricultural ecosystem resilience, support a modern, extensive and climate smart agricultural sector for the Aegean island of Andros (Greece) and the Mediterranean islands, with benefits for local societies. For millennia terraces allowed the cultivation of island areas with poor and dry soils, reducing soil erosion and favoring local biodiversity and local farming communities. In this study, projections derived from state-of-the-art Regional Climate Model (RCM) -within the framework of EURO-CORDEX- are used to examine the potential future climate changes in Andros island and in the Aegean region for identifying the most vulnerable areas and prioritize future interventions.

2. Data and Methods

The RCA4 regional climate model SMHI (Collins et al., 2011; Martin et al., 2010) with boundary conditions from the global HadGEM- ES model of the Met Office Hadley Centre (MOHC) was found to give the best results for the Andros island (fine-resolution projections) and Aegean region (coarse-resolution projections) following detailed evaluation (Fig.1). In order to depict future climate changes in climatic indices relevant to agriculture, time series analysis of future projections in Andros and geographical maps for the Aegean area were constructed based on model simulations at a horizontal resolution of approximately 12km. The selected climatic indices which directly or indirectly affect agriculture in the examined areas, are: mean maximum (Tmax) or minimum (Tmin) temperatures; Number of days with: Tmax>30ºC (hot days), Tmax> 35ºC (heatwaves), Tmin> 20ºC (tropical nights) ;Total Precipitation (PR); Maximum length of dry spell (consecutive days with PR<1mm). Results are presented for the control period (1971-2000) and the near- and distant future periods (2031-2060 and 2071-2100, respectively). Two new IPCC emissions scenarios are implemented in the future simulations, the weak climate change mitigation scenario (RCP4.5) and the non-mitigation business as usual scenario with high emissions (RCP8.5).

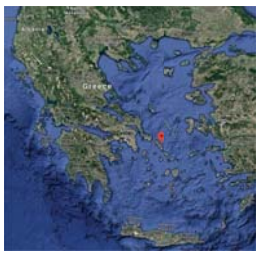

Fig. 1. Map of Greece, Andros Island (Aegean) is noted with red color.

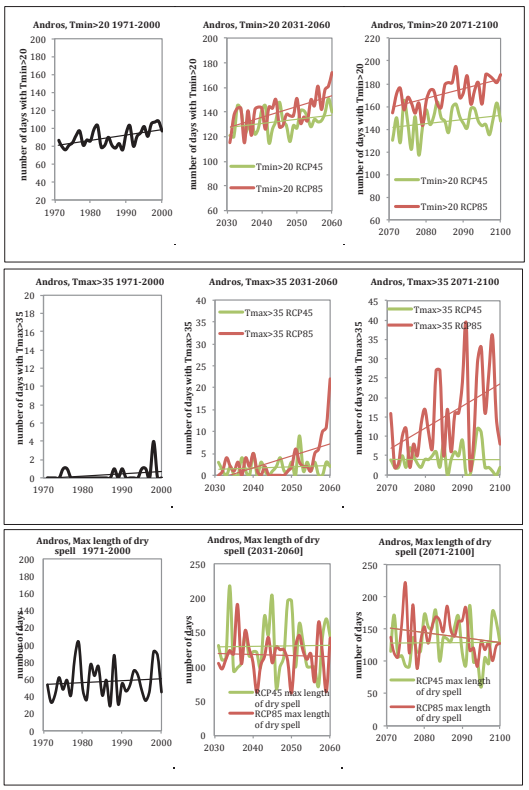

Fig. 2. Average annual number of days with: minimum temperature higher than 20ºC (tropical nights), maximum temperature higher than 35ºC (heatwaves), and precipitation less than 1mm (dry spells) for Andros during the historical period 1971-2000 (black line, left coloumn), the near future period 2031-2060 (middle column)and the distant future period 2071-2100 (right column), under the future scenarios RCP4.5 (green line) and RCP8.5 (red line)

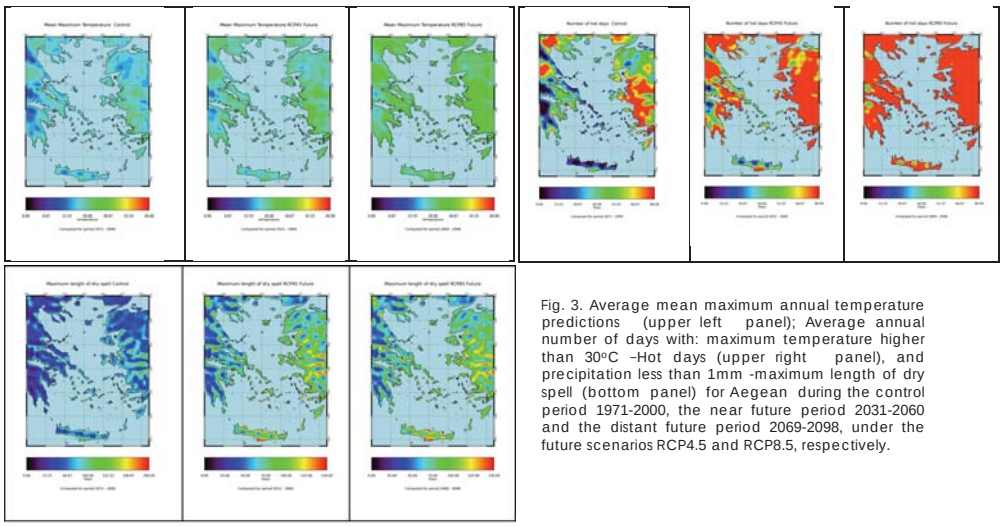

Fig. 3. Average mean maximum annual temperature predictions (upper left panel); Average annual number of days with: maximum temperature higher than 30ºC –Hot days (upper right panel), and precipitation less than 1mm -maximum length of dry spell (bottom panel) for Aegean during the control period 1971-2000, the near future period 2031-2060 and the distant future period 2069-2098, under the future scenarios RCP4.5 and RCP8.5, respectively.

3. Results

Model output of daily temperature and daily total precipitation for the closest model grid point to the study region of Andros Island were extracted. The mean maximum temperature Tmax increases in the near future, to 22.3 ° C and 22.8 ° C while in the distant future it is 23.3 °C and 25 ° C for the RCP4.5 and RCP8.5 scenarios, respectively (Fig. 3). Hot days (Tmax>30ºC) increase from 10 days/year to 30-40 days/year in the near future and 50-80 days/year in the distant future (Fig. 2). Tropical nights (Tmin>20ºC) increase from 85 days/year to 132-140 days/year in the near future and 140-170 days/year in the distant future (Fig 2). Future simulations show large increases in the maximum length of dry spells (PR < 1mm). The maximum annual length of a dry spell was on average 59 days over the control period, increasing to 130 (RCP 4.5) – 110 (RCP 8.5) days in the near future and 135 (RCP 4.5) - 140 (RCP 8.5) days in the distant future (Fig. 2).

Coarse-resolution simulation results show similar climate change trends as the fine- resolution study of Andros Island. The annual averaged Tmax and Tmin temperatures show increases in the range of 4-6ºC in the near- and distant future, especially under the RCP8.5 climate change scenario. Hot days (Tmax>30ºC) are projected to increase considerably in the future, counting up to 75-80 days/year in the E-N Aegean (Fig. 3) and heatwaves show also large increases in the distant future, reaching 60 days/year for Dodecanese & North Aegean. Tropical nights (Tmin >20 ºC) are to double and triple in the near- to distant future for all Aegean islands (Fig.3). Total annual PR decreases significantly in the distant future, by 15-25%, while the maximum length of dry spells shows large increases across the Aegean under both RCP scenarios (Fig.3).

4. Conclusions

The results of these study generally are in agreement with studies focusing on changes in temperature and PR extremes (e.g. Diffenbaugh et al., 2007; Giannakopoulos et al.,2009). The future vegetation cover and composition is likely to change under influence of the declining annual PR and the increasing length of dry spells. This work aims to provide information on the use of drystone terraces as green infrastructures resilient to climate change impacts, in order to improve agricultural ecosystem resilience, support a modern, extensive and climate smart agricultural sector for the Mediterranean islands, with benefits for local societies.

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