Investigating the potential effects of climate change on agricultural water management in two Mediterranean watersheds

V. Pisinaras[1], G. Sismani[1], A. Panagopoulos[1], G. Arampatzis[1]

[1]Soil & Water Resources Institute, Hellenic Agricultural Organization "DEMETER", Sindos, Thessaloniki, 57400, Greece

Keywords: evapotranspiration, irrigation, olive groves, climate change

Presenting author email: vpisinar@gmail.com

Globally, agriculture constitutes the dominant water consumer, accounting for about 80% of the total water demands (Shiklomanov and Rodda, 2003). While on the global scale, irrigation water use from freshwater bodies is estimated at 70%, the corresponding percentage for Mediterranean regions is much higher, especially for its southern and eastern parts. Therefore, viability of the agricultural sector is directly connected to water resources availability. Considering climate change signals, as indicated by projections produced with climate models, the Mediterranean region is expected to face significant water scarcity issues driven by above the average precipitation decrease. Water stress could become acute due to: a) the expected significant air temperature increase which would increase water evaporation and crop evapotranspiration and b) severe drought periods, the frequency of which is expected to be increased.

Considering the above and taking into account the high variability in geomorphological setup, climate conditions and land use, the investigation of potential climate change effects at watershed level is of utmost importance. To this end, the present study aims to investigate the potential effects of climate change on agricultural water management status of two small watersheds located on the island of Crete, Greece. The location of the two watersheds is presented in Figure 1.

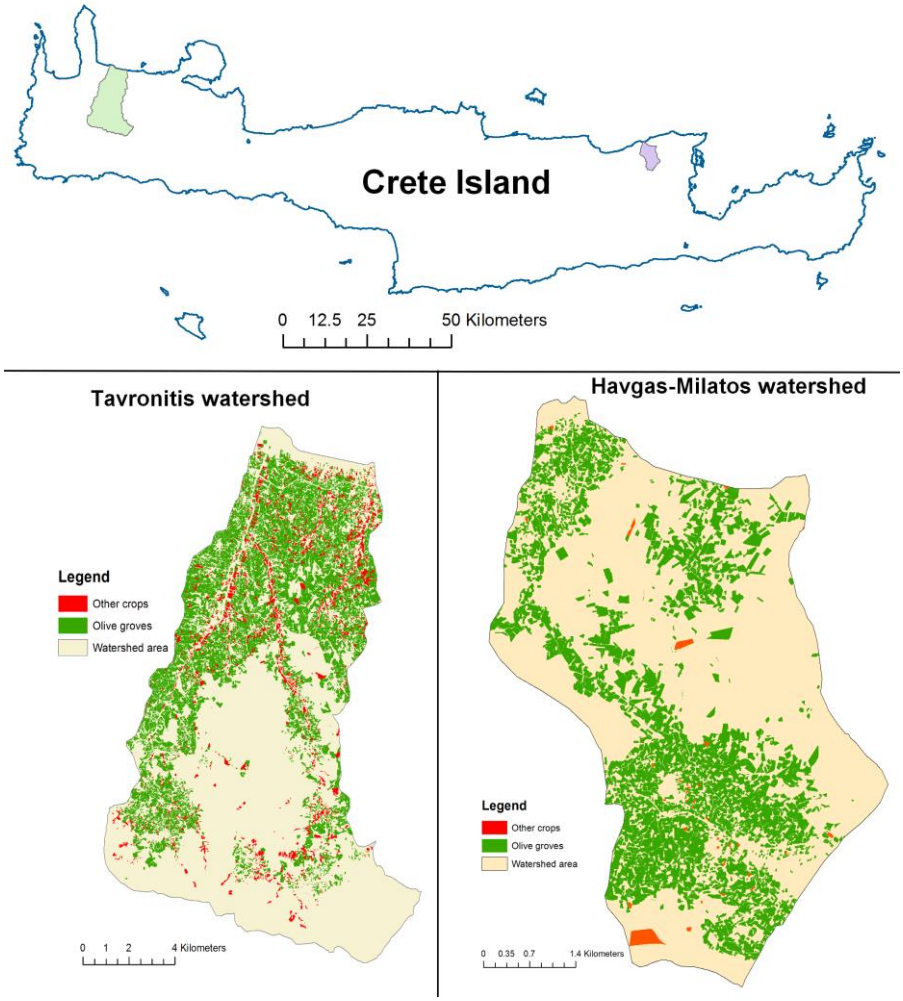

Figure 1. Location map of the two studied watersheds and crop distribution

Agriculture constitutes one of the major land uses in Tavronitis watershed, covering more than 35% of its total spatial extent (165 km^2). The dominant cultivation for Tavronitis watershed is olive groves, covering more than 80% of the total cultivated land. Havgas-Milatos is much smaller compared to Tavronitis watershed, as it counts about 30 km^2 area. Olive groves constitute almost monoculture for Havgas-Milatos watershed, since they cover almost 98% of cultivated land. Except for size, the two watersheds indicate significant differences in terms of received rainfall depth. While the average annual rainfall in Havgas-Milatos watershed is about 800 mm, the corresponding value for Tavronitis is more than 1300 mm (Koutroulis et al., 2011). Therefore, olive groves (most of them rainfed) are almost exclusively found in Havgas-Milatos watershed, while more water consuming crops such as citrus and avocado orchards are found in Tavronitis watershed.

In order to investigate the potential effects of climate change in agricultural water management of the two aforementioned watersheds, the first step was to collect precipitation and air temperature data from an ensemble of state-of-the-art Regional Climate Models (RCMs) under RCP4.5 emissions scenario, which are distributed from the CORDEX Initiative. Then, spatial downscaling of RCM data was performed based on a bilinear interpolation approach, according to Marke et al. (2011). Based on the downscaled data, reference evapotranspiration, crop evapotranspiration, net irrigation requirements and water stress factors were calculated for the agricultural lands of both watersheds for three periods: 1971-2000 (historical period), 2031-2060 (near future) and 2061-2090 (distant future).

The results demonstrate a wide range of variation in all calculated parameters, thus indicating differences in projected climate representations driver by the different RCMs. Nevertheless, the general trend indicates a) significant increase in potential evapotranspiration because of increasing air temperature, b) increase in net irrigation requirements driven by the combined effects of potential evapotranspiration increase and precipitation decrease and c) increase on water stress factor for rainfed olive groves.

Preliminary results from LIFE AgroClimaWater indicate the potential of the good agricultural practices tested in the pilot farms of the project to contribute to water saving and therefore to increase adaptation ability of agriculture in the two watersheds.

Acknowledgements

This work has been elaborated in the framework of the LIFE AgroClimaWater project (LIFE14 CCA/GR/000389) which is gratefully acknowledged. We would also like to acknowledge CORDEX initiative for providing RCM data.

References

Koutroulis, A. G., Vrohidou, A. E. K., & Tsanis, I. K. (2011). Spatiotemporal characteristics of meteorological drought for the Island of Crete. Journal of Hydrometeorology, 12(2), 206-226.

Marke, T., Mauser, W., Pfeiffer, A., & Zängl, G. (2011). A pragmatic approach for the downscaling and bias correction of regional climate simulations: evaluation in hydrological modeling. Geoscientific Model Development, 4(3), 759.

Shiklomanov, I. A., & Rodda, J. C. (2003). World water resources at the be-ginning of the 21st centuryCambridge. UK: UNESCO International Hydrology Series.