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The impact of climate change decrease of winter precipitation on the water use efficiency and sustainability of a Mediterranean forest.

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Over the past century, climate change has been reflected in altered precipitation regimes worldwide. Recently, Montaldo and Sarigu (2017) showed that Sardinia runoff decreased over the 1975-2010 period, with mean annual values 40% lower than the 1922-1974 period.

These trends will have dramatic consequences on basin water resources, therefore forests are frequently exposed to periods characterized by a reduced water availability that influences the evapotranspiration process (ET), the water use efficiency and could be also the main cause of tree mortality or change of tree spatial distribution and density.

The Marganai forest, located in South West Sardinia (Italy), is a Long-Term Ecosystem Research (LTER) Italian site and a European Site of Community Importance (Natura 2000) managed by FORESTAS. The vegetation is mainly composed by Quercus Ilex trees and the soil depth varies between 10 cm and 50 cm. Historical data are from 16 rain stations (1922-2018 period) over the entire area and data of runoff of the Fluminimaggiore basin (area of 83 km^2) are available. From 1922 a persistent decrease trend of winter precipitation in that area (Mann-Kendall t of -0.26) impacted runoff, which decreased of 2.52 mm/y.

Future climate scenarios are selected from IPCC climate change scenarios. From the 12 Atmosphere-Ocean General Circulation Models (AOGCMs) of Flato et al. (2013), we selected theHadGEM2-AO that simulates reasonable approximation of observed past seasonal precipitation and air temperature changes (1976-2004 compared with 1951-1975) in Sardinia.Using a distributed ecohydrologic model and the HADGEM2-AO future climate (rainfall and air temperature) scenarios we predict both hydrologic (soil moisture, runoff, ET) and vegetation dynamic (CO2, biomass, leaf area index and vegetation fraction) outputs.

The model has been successfully calibrated for runoff and ET estimation for the 1922 – 2018 period. Then, the eco-hydrological model, forced with the generated future scenarios, predict a significant change on tree leaf area index, with the reduction of tree density, spatial distribution, forest productivity and runoff. Future scenario predicting further decline is particularly alarming for the Marganai forest, requiring new strategies in both forestal and water resources planning

and management.