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The change of seasonal rainfall distribution with future climate impacts evapotranspiration and water yield in a Mediterranean forest.

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Over the past century, climate change has been reflected in altered precipitation regimes worldwide. In the Mediterranean regions there is a persistent declining trend of precipitation and runoff decrease. Recently, Montaldo and Sarigu (2017) showed that in Sardinia runoff decreased drastically over the 1975-2010 period, with mean annual values 40% lower than the 1922-1974 period. Climate change projections point to an amplification of changes in global precipitation patterns and trends, with further drier trends for the Mediterranean area. These trends will have dramatic consequences on basin water resources. In these conditions, the forests are frequently exposed to periods characterized by a reduced water availability that affects the water balance by influencing the evapotranspiration process (ET), and could be also the main cause of tree mortality or change of tree spatial distribution and density.

The Marganai forest, located in South Ovest Sardinia (Italy), is a Long-Term Ecosystem Research (LTER) Italian site, and an European Site of Community Importance (Natura 2000), that includes five main forest management units 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 (1922-2010 period) over the entire basin and data of runoff of the Fluminimaggiore basin (area of 77 km2) 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 2.6 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 the AOGCM (HadGEM2-AO) that simulates reasonable approximation of observed past seasonal precipitation and air temperature changes (1976-2000 compared with 1951-1975) in Sardinia.

Using a distributed ecohydrologic model and the HADGEM2-AO future climate (rainfall, air temperature and relative humidity) scenarios we predict future water yield, ET, tree biomass, and soil moisture for the 2016-2035, 2046-2065, and 2081-2090 future scenarios. Indeed, the ecohydrological model couples an hydrological model and a vegetation dynamic model, allowing to predict both hydrologic (soil moisture, runoff, ET) and vegetation dynamic (biomass, leaf area index, CO_2) outputs.

The model has been successfully calibrated for runoff and ET estimation for the 1922 – 2010 period. Then, the eco-hydrological model, forced with the generated future scenarios, predict a significant change on tree biomass dynamics and runoff. Although both evapotranspiration and runoff are sensitive to precipitation seasonality, future changes in runoff are related only to changes of winter precipitation, while evapotranspiration changes are related to those of spring and summer precipitation. The effect of future climate change could result in the reduction of the forest productivity or the increase of the risk of plant mortality. Future scenario predicting further decline is particularly alarming for the Marganai forest, requiring new strategies and designs in both forestal and water resources planning and management.