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A European vision for hydrological observations and experimentation

Historical and future changes on water resources in the Flumendosa basin, Sardinia.

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In Mediterranean climates during the winter months much of the precipitation recharges sub-surface and surface reservoirs. However, in the late winter and early spring, when vegetation growth conditions are favorable, much of the precipitation can be depleted by transpiration and, furthermore, runoff reduced directly by the increased vegetation cover. In the Mediterranean regions there is the evident effect of climate changes that it is causing several problems on the water resources availability. Several scientists have shown a strong decreasing trend in winter precipitation amounts and an evident shift in how the precipitation is distributed across the winter and spring months. Considering that most of the runoff to surface reservoirs occurs in the winter months and that spring hydrologic response is likely to be influenced strongly by vegetation, these precipitation changes can be considered hydrologically important. Case study is the Flumendosa basin (Sardinia), which is one of the case studies of the ALTOS European project, characterized by a reservoir system that supplies water to the main city of Sardinia, Cagliari. Data are from 42 rain gauges stations (1922-2021 period) over the entire basin and data of runoff are available for the same period. In the Flumendosa reservoir system the average annual input from stream discharge in the latter part of the 20th century was less than half the historic average rate, while the precipitation over the Flumendosa basin has decreased, but not at such a drastic rate as the discharge, suggesting a marked non-linear response of discharge to precipitation changes. We developed and calibrated a distributed hydrological model at basin scale which predicts runoff, soil water storage, evapotranspiration and grass and tree leaf area index (LAI). Hydrometeorological variables provided by the future climate scenarios predicted by Global Climate Model (CMPI-6 MPI-ESM1-2-LR downscaled) have been used as input in the model to predict soil water balance and vegetation dynamics under the future hydrometeorological landcover scenarios. The historical observations highlighted strong negative trends in precipitation series and in the number of wet days (examined using the Mann-Kendall trend test). The results from model application showed that tree dynamics are strongly influenced by the inter-annual variability of atmospheric forcing, with tree density changing according to seasonal rainfall. At the same time the tree dynamics affected the soil water balance. We demonstrated that future warmer scenarios would impact the forest, which could be not able to adapt to the increasing droughts. In addition, future scenarios predict a reduction of the runoff, which is crucial for the dam reservoir recharge. The water resources system planning needs to carefully takes into account the effect of future climate change on water resources and vegetation dynamics.