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Impacts of precipitation and temperature trends on different time scales on the water cycle and water resource availability in mountainous Mediterranean catchments.

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Climatology trends, precipitation and temperature variations condition the hydrological evolution of the river flow response at basin and sub-basin scales. The link between both climate and flow trends is crucial in mountainous areas, where small variations in temperature can produce significant impacts on precipitation (occurrence as rainfall or snowfall), snowmelt and evaporation, and consequently very different flow signatures. This importance is greater in semiarid regions, where the high variability of the climatic annual and seasonal regimes usually amplifies this impact on river flow. The Sierra Nevada National Park (Southern Spain), with altitudes ranging from 2000 to 3500 m.a.s.l., is part of the global climate change observatories network and a clear example of snow regions in a semiarid environment. This mountain range is head of different catchments, being the Guadalfeo River Basin one of the most influenced by the snow regime.

This study shows the observed 55-year (1961-2015) trends of annual precipitation and daily mean temperature, and the associated impacts on snowfall and snow persistence, and the resulting trend of the annual river flow in the Guadalfeo River Basin (Southern Spain), a semiarid abrupt mountainous area (up to 3450 m a.s.l.) facing the Mediterranean Sea where the Alpine and Mediterranean climates coexist in a domain highly influenced by the snow regime, and a significant seasonality in the flow regime.

The annual precipitation and annual daily mean temperature experimented a decreasing trend of 2.05 mm/year and an increasing trend of 0.037 ºC/year, respectively, during the study period, with a high variability on a decadal basis. However, the torrential precipitation events are more frequent in the last few years of the study period, with an apparently increasing associated dispersion. The estimated annual snowfall trend shows a decreasing trend of 0.24 mm/year, associated to the decrease of precipitation rather than to temperature increase. From the analyses of river flow observations and hydrological modelling, these trends result in an estimated decreasing annual trend of the mean river inflow to reservoirs of 0.091 m3/s, which is equivalent to a mean loss of 2.87 hm3/year during the study period. Nonetheless, these results are associated to a high variability of both extreme values and the annual and decadal values. Moreover, the decrease of the annual inflow is approximately a 25% higher than the loss of precipitation, due to the impact on the different water fluxes from the snowpack associated to the enhanced torrential behaviour of both snowfall/rainfall occurrence and snow persistence.

The results show the complexity of hydrological processes in Mediterranean regions, especially under the snow influence, and point out to a significant shift in the precipitation and temperature regime, and thus on the snow-affected hydrological variables in the study area, with a decrease of the available water resource volume in the medium and long term. However, on an annual basis, years with an intense snowfall regime but mild and longer dry periods result in a significant increase of the annual river flow and water storage. Reservoir operation criteria and water allocation should undergo a revision based on hydrological modelling of the snow regions and scenario analysis.