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How does evapotranspiration affect streamflow response and shallow water table dynamics? A comparative analysis in two forested catchments in Italy

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The hydrological response of forested catchments is strongly influenced by evapotranspiration. Numerous studies have reported the effect of evapotranspiration on the annual water balance at different spatial scales, but detailed eco-hydrological monitoring at the small catchment scale is still needed to improve the estimation of evapotranspiration fluxes and runoff response by hydrological models.

In this study, we used hydrometeorological data from two small forested catchments in Italy to i) investigate the hydrological response of the two catchments at seasonal and rainfall-runoff event time scale, and ii) analyze the daily fluctuations in streamflow and the shallow water table.

The two catchments are covered by dense mixed broad-leaf forest. The Ressi catchment (0.02 km^2) is located in the Italian pre-Alps and its climate is oceanic, while the Re della Pietra catchment (2.0 km^2) lies in the Northern Apennines and the climate is humid sub-tropical.

Streamflow, rainfall, air temperature and solar radiation were measured continuously in both catchments. In the Ressi catchment, shallow water table was measured in two piezometers installed at a depth of 2.0 and 1.8 m in the riparian zone, while sap flow was monitored in two beech trees located in the riparian zone, and one beech tree and one chestnut tree on the hillslope.

Preliminary results show that during the growing season, rainfall-runoff events had large rainfall intensities, short duration and small stormflow volumes. In the Ressi catchment, runoff coefficients varied between 0.1 and 96% (mean: 17%, n=155, period: August 2012-November 2016), with event runoff coefficients in summer much smaller (mean: 7%, n=66) than during the rest of the year. In the Re della Pietra catchment, event runoff coefficients in the period July-September were also small and varied between 1.2 and 5.1% (n=8).

During dry periods, streamflow tended to decrease in both catchments, but with different dynamics. Strong daily streamflow fluctuations were observed in summer in the Re della Pietra catchment, with minimum streamflow lagging peak solar radiation by 1-3 hours. Conversely, no daily streamflow fluctuations were observed at the end of the growing season, probably due to the reduced impact of evapotranspiration on the catchment storage. In the Ressi catchment, we did not observe clear daily streamflow fluctuations, likely due to the frequent summer storms interrupting the baseflow. However, the shallow water table experienced daily fluctuations. We observed that the minimum water table level lagged peak sap flow by 1-6 hours, implying a role of evapotranspiration on water table variations. Based on these results, further analyses will be carried out to estimate daily and seasonal groundwater recharge and evapotranspiration in both catchments.

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