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Investigating young water fractions in different hydrological compartments of a small Mediterranean mountain catchment: Mountain catchments may release large young water fractions.

Francesc Gallart (1), María Valiente (2), Pilar LLorens (1), Carles Cayuela (1), Matthias Sprenger (1,3), and Jérôme latron (1)

(1) IDAEA, CSIC, Barcelona, Spain (francesc.gallart@idaea.csic.es), (2) Geodynamics Department, University of the Basque Country, Leioa, Spain (maria.valiente@ehu.eus), (3) Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, USA (mspreng@ncsu.edu)

The young water fraction, defined as the proportion of water in storage or flux that is younger than 2-3 months, was investigated in soil, ground and stream waters in the 0.56 Km2 sub-humid Can Vila catchment (Vallcebre Research Catchments). Rain water was sampled at 5-mm rainfall intervals, soil water and groundwater were sampled fortnightly, using suction lysimeters (composite samples between 50 and 100 cm depth) and in two shallow (down to 3 metres deep) wells, respectively. Stream water was sampled at variable time intervals (30 minutes to 1 week) depending on flow. A total of 1529 oxygen-18 determinations obtained during 58 months were used for this study.

Results show that soil waters exhibited rather large young water fractions (44%), while in ground and stream, young water fractions were strongly related to water table and discharge variations respectively, decreasing to zero for both low water table and discharge levels. Level-weighting and flow-weighting oxygen-18 concentrations in ground and stream waters, respectively, resulted in young water fraction values (F*yw) respectively twice and nearly 4 times larger than the corresponding time-weighted values (Fyw). This indicates that young water fractions tended to be larger when the catchment was wet and discharge was correspondingly higher.

However, for stream water, the high ratio between flow and time weighted estimates reflected not only a marked increase in young water fractions with increasing flows, but also the low representativeness of time-weighting estimates in this catchment, due to the highly skewed flow duration curve. Indeed, the highest discharges that represent 25% of the total flow had a Fyw close to unity but occurred during only 0.6% of time. Using all the data, the flow-averaged F*yw was 29.6%, while 50% of flows occurred during 4.8% of time, whereas the time-averaged Fyw was just 7.9%, while 50% of the time cumulated 95% of flows. Limiting the analysis to a weekly sampling strategy, F*yw decreased to 12.7% and Fyw decreased to 6.6%.

These results support the warnings claimed by several authors about the dependence of young water fraction on the sampling rate and show the advantages of flow-weighted F*yw over time-weighted Fyw. Yet, young water fraction determinations in mountain catchments may be more sensitive to sampling rate than those in flat areas, because of the more pronounced flashy flow regimes.