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Rainfall-runoff relationship at different time scales in a mid-mountainous Mediterranean catchment

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Mediterranean catchments are characterized by high inter-intra annual precipitation variability and summer drought. The hydrological regime is characterized by ephemeral behaviour due to the direct rainfall-runoff relationship. Furthermore, extreme precipitations can generate an amount of rainfall higher than 200 mm in 24 hours with short response time. These events occurred normally under wet soil moisture conditions. The Mediterranean catchment morphology is a favourable factor for flash floods: short catchments with a high gradient slope. Others factor that condition the hydrological regime are the presence of limestone lithology and the impact of human activities on fluvial systems as geomorphological changes in channels and flood plains.

The aim of this study is analyse the hydrological response of five hydrological years (2012-17) in an agricultural headwater catchment (i.e. < 4 km2) at different time scales. Rainfall-runoff relationship was carried out at annual and seasonal scale through the flow duration computation, the variability index, 30/70 ratio, quick flow response ratio and base flow index. The rainfall-runoff relationship at event scale was carried out through a Pearson correlation matrix using different variables extracted from the hyetograph and hydrograph. These variables were placed into two groups: a) antecedent conditions and b) event conditions. The correlation results determined the involved factors in the hydrological response.
At annual scale total flow was present for 42.8% of the time and quick flow was 1.4%. The Variability index value (0.64) was higher than catchments with high dynamics storage (Vi < 0.5). At season scale, winter with 90.6%, showed the highest discharge presence. This highest discharge percentage duration generated a sustained water storage (Vi: 0.55) and increased the soil moisture from autumn getting favourable conditions for runoff generation. Because of that, winter had the highest quick flow duration (3.1%) and also the 30/70 denotes an increase of the flow variability. Autumn and spring had lower percentage of discharge duration than winter, 53% and 41% respectively. Autumn is the season after the dry season when starts again the wet period getting favourable conditions for runoff generation. Spring denotes the importance of the accumulated precipitation contribution of the wet seasons, also indicated for the highest seasonal BFI (0.7). Summer presented flow and quick flow the 0.93% and 0.21% of time respectively.

At event scale, peak discharge, mean discharge, runoff and quick flow showed significant correlations ($p<0.01$) with the total precipitation and correlated with antecedent precipitation of one and three days ($p<0.05$). Baseflow variables correlated with antecedent precipitation until 15 days before flood date. Peak discharge was the unique hydrological variable that correlated with maximum rainfall intensity 30'. That indicated that a shorter period of rainfall intensity (15min) is not enough to generate a response. So, for peak discharge a combination of two mechanisms is needed to generate runoff: a) surface runoff occur when rainfall intensity exceeds infiltration capacity and b) surface runoff is produced by precipitation over the area where water table is at the surface.