



Driving factors of non-linearity rainfall-runoff relationships at different time scales in small Mediterranean-climate catchments

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The complexity of Mediterranean fluvial systems is caused by the multiple temporal and spatial heterogeneity in the relationships between the natural and human-induced abiotic and biotic variables. Accordingly, Mediterranean rivers are characterized by a large heterogeneity in hydrological regimes promoting significant temporal and spatial differences in the hydrological response.

This research investigates the non-linearity in the rainfall-runoff relationship at multiple temporal scales to achieve a better understanding of the hydrological response in representative small Mediterranean-climate catchments (i.e., < 10 km²). Rainfall-runoff was evaluated at annual and event scales. At annual scale, data from 43 catchments were collected to assess the influence of lithology on runoff response. At event scale, 203 events from 12 catchments were classified according to (a) seasonal occurrence (autumn, winter, spring or summer), (b) pervious or impervious lithology and (c) main land use (agricultural, agroforestry, forest or shrub). Besides, the inter- and intra-annual variability of the rainfall-runoff and the temporal downscaling (i.e., annual to event scale) was studied in Es Fangar Creek catchment (3.35 km²; Mallorca, Spain) during five hydrological years (2012-2017).

The assessment of rainfall-runoff relationships at annual scale in small Mediterranean-climate catchments showed a strong linearity in the hydrological response due to the importance of the annual rainfall amount. However, lithology effects on runoff generation explained an increase of the scattering in these relationships because pervious and impervious materials triggered larger and lower runoff contribution respectively. Although the significant correlation between rainfall and runoff, Es Fangar Creek dataset illustrated a huge intra-annual variability of the rainfall-runoff relationship as seasonal rainfall and evapotranspiration dynamics controlled the runoff response. These dynamics were observed in the average seasonal runoff coefficients, decreasing from winter to summer. These differences should be considered as a starting point of the non-linearity generation in the rainfall-runoff relationships at event scale.

At event scale, lineal and non-lineal performances were observed in the rainfall-runoff relationships in small Mediterranean-climate catchments suggesting that different factors conditioned the runoff response. Total rainfall was the most significant driver factor although the interaction between seasonality and the spatial diversity of lithology and land uses at catchment scale also played an important role on runoff generation. Thus, the highest correlations at seasonal scale were observed in those events occurred in winter and spring when the highest water reserves favoured the runoff response. Lithology caused higher dispersion in rainfall-runoff relationships at event scale in the set of small Mediterranean-climate catchments because pervious materials required higher antecedent wetness conditions. Agricultural land uses promoted the highest runoff generation.

These findings will improve the comprehension of hydrological processes as the temporal downscaling of rainfall-runoff linked to the driven factors with the linearity and non-linearity knowledge is needed for accuracy and precision into hydrological modelling at event scale.

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