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Water harvesting potential in function of hillslope characteristics: A case study from the Sierra de Gador (Almeria province, south-east Spain)

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Abstract

Surface water in limestone and dolomite mountain ranges in semi-arid regions is very rare. Therefore, water harvesting systems, collecting the runoff from hillslopes, can be found at regular distances to supply water points for grazing animals. The hydrological behaviour of a range of hillslopes and small catchments can thus be studied by monitoring the rainfall and runoff for such water harvesting systems. The number of runoff events collected in four of such systems ranged from 2 to 22 per year during a 7-year period in the Sierra de Gador (Almería province, Spain). The large variation in runoff response can be attributed to the distribution of the rainfall (long-term average 400 mm) and the characteristics of the catchment areas. Rainfall–runoff behaviour was far more erratic than reported for plot studies and rainfall simulations in other semi-arid regions, demonstrating that plot scale results cannot be extrapolated to design water harvesting systems. The aim of this study was to determine thresholds for the production of runoff on hillslopes and zero-order catchments reaching the water harvesting reservoirs at the footslopes. Multiple logistic regressions showed that the rainfall depth per event and the antecedent precipitation index over 20 days (API20) are the main parameters to explain the occurrence of runoff in the reservoirs connected to the four catchments. The hillslopes show a systematic pattern of rock outcrops on the crest and shoulders to a colluvial mantle at the footslopes, where the cisterns are dug out. The rainfall and API threshold of the four catchments, required to produce runoff in the reservoirs, are lowest for hillslopes with a short distance from the rock outcrops to the reservoirs and a low vegetation cover. It was demonstrated that (i) re-infiltration of runoff frequently occurs (56 events not reaching the reservoirs against 14 events with continuous runoff) even within the unlined channel connecting the cistern to the hillslope, and that (ii) the 80% probability of runoff occurrence, calculated using the logistic regression, can be used as a proxy for the total annual runoff to be collected.

Keywords: Connectivity; Hillslope; Runoff; Semi-arid areas; Spain; Thresholds; Water harvesting

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