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Hydrological characterization of livestock watering ponds in semi-arid rangelands of the southwestern Iberian Peninsula

Ubaldo Marín-Comitre, Susanne Schnabel, and Manuel Pulido-Fernández

GeoEnvironmental Research Group, University of Extremadura, Cáceres, Spain

Watering ponds are the main source of drinking water supply for livestock in the rangelands of the SW Iberian Peninsula. Most of these ponds consist of small earth dams which collect surface runoff from intermittent streams, with pond sizes rarely exceeding 1 ha. Understanding the hydrological functioning of this type of infrastructures is crucial for an efficient water management in extensive livestock farms, especially in semi-arid areas, where water resources are often scarce.

In this line, we have analysed the temporal patterns of water availability in a sample of representative livestock watering ponds in the SW Iberian Peninsula, being the objectives (1) to determine the influence of temporal rainfall variability on water availability in the ponds; (2) to examine the influence of factors such as pond size and catchment area on the effectiveness of the ponds, understood as their capacity to keep water during dry periods; and (3) to suggest minimum values for those factors, which can serve as a guide for the design of watering ponds in comparable rangeland areas. The applied methodology was primarily based on the analysis of aerial photographs and rainfall data available from public sources, requiring only few field measurements, and could therefore be used in areas with data scarcity.

High correlation coefficients were obtained between the water availability observed in the ponds and the antecedent rainfall at several time scales, evidencing the principal role of precipitation in the hydrological dynamics of these infrastructures in the study area. The accumulation periods (AP) of antecedent rainfall that best explained the hydrological response of the ponds depended largely on pond size. In those ponds whose maximum flooded area (A_{\max}) was less than 2000 m², water availability in the ponds was greatly influenced by AP between 2 and 5 months, while for the ponds larger than 2000 m², the best correlations were obtained for AP greater than 6 months. These results highlight the key role of the size of the ponds in their effectiveness. Thus, since the dry season usually lasts in the study area for 3-4 months, the large ponds ($A_{\max} > 2000$ m²) could remain operational throughout the summer, if it rains enough during the wet season and if their watersheds are large enough to allow a sufficiently high pond water level to be reached at the end of the wet season. In relation to the latter, the analyses carried out led us to suggest, for the study area, a minimum value of the catchment-area/pond-capacity ratio around 100 m⁻¹.

Moreover, the analysis of the water availability observed in the ponds under drought conditions (i.e., with an antecedent rainfall substantially lower than normal for the corresponding time of year) revealed a high vulnerability to droughts in most of the ponds, which limits their use as the

sole source of water supply in many farms.