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The contribution of runoff to recharge rates in a semiarid to subhumid carbonated aquifer. A case study from the Sierra de Gador, SE Spain.

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Two general pathways exist for recharge in carbonated aquifers: i) diffuse percolation from the base of the soil profile and ii) concentrated infiltration of surface water in favourable zones such as ephemeral stream beds and widened cracks in partly dissolved limestone. It has been shown that for large semi arid regions diffuse percolation can be assessed from the water balance i.e. the difference in precipitation and evapotranspiration. Recently, methods have been developed to assess the water balance at the regional scale based on the spatial distribution of rainfall and vegetation indices, the latter as a proxy for evapotranspiration. Concentration of surface water occurs during moderate to heavy rainfall events as a result of runoff generation from impermeable or low permeable areas, or partially controlled by slope when permeable rock outcrops. It has been shown that the large carbonate aquifer system of the Sierra de Gador, underlayered by the Campo de Dalias coastal plain, is fed preferentially during storms with a return period of more than 1-5 years. However, as a result of the volume of the aquifer, its unknown response time and the infrequent occurrence of such events, no evaluation of the relative contribution of diffuse versus concentrated recharge can be made. Therefore, different methodological approaches are applied to assess the role that both type of recharge mechanisms (diffuse and concentrated) have on the water yield of a single semiarid catchment which is drained by a regional spring of Celin. The study catchment covers a surface of c.26 km^2 ranging from the footslopes at 580 m a.s.l. to the summit of the Sierra de Gador at 2200 m a.s.l. The average potential recharge varies from more than 250 mm/year in summit areas to less than 50 mm/year in the bottom of the range. Runoff will be calculated using a spatially distributed rainfall/runoff model that was calibrated on water harvesting systems draining the representative combination of vegetation, rock outcrop and soil types within the Sierra de Gador. An altitudinal gradient of runoff to concavities and stream beds will be calculated for moderate storms (return period 1 year) under wet, normal and dry antecedent moisture conditions in order to estimate concentrated recharge. Furthermore, gradients as a result of diffuse recharge based on the spatial modelling of the water balance will be calculated based on the method of Contreras et al. (2008). Both gradients will be checked with those obtained by isotopic techniques, focussed to know the source of recharge, and by conservative chemical balances to quantify diffuse recharge rates in local springs at several altitudes. Under steady-state conditions, the bulk solutes mass discharged in Celin spring integrates flow mass derived from diffuse recharge by rainfall at several altitudes plus mass flow from concentrated recharge by runoff. These results give more insights about the relative contribution of both pathways to recharge in semiarid carbonate aquifers. An understanding of the relative contribution of these pathways along altitude is essential for implementing measures to increase recharge artificially.