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Modelling the impact of climatic variability on groundwater and surface flows from a mountainous catchment in the Chilean Andes

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Abstract This study aims to simulate the relationship between climate forcing and the dynamics of both water table levels and runoff from the upper Elqui catchment (5660 km^2, Chile). Simulations are performed with a daily conceptual model that takes into account: (i) a shallow reservoir supplied by precipitation and feeding evapotranspiration, surface/sub-surface runoff and infiltration, and (ii) a deep reservoir fed by infiltration and generating the baseflow. A third reservoir, in which fluxes are controlled by temperature, has been introduced to account for the snowmelt regime of the catchment. A nearly 30-year period (1977–2008) was chosen to capture long-term hydro-climatic variability due to alternating ENSO and LNSO events. Calibration and validation were performed on the basis of a multi-objective function that aggregates a variety of goodness-of-fit criteria. The model correctly reproduces the observed discharge at the basin outlet, for either lumped or semi-distributed applications. Nash coefficients are about 0.9 over the calibration period (1979–1990) and 0.75 over the validation period (1991–2008). The volume error between observation and simulation is lower than 11% over the whole period studied. The dynamics of both the water level in the deep conceptual reservoir and the water table in a piezometer at the basin outlet are also in good agreement. The model thus provides encouraging simulations of groundwater and surface flows when applied to various climatic conditions. However, improvements are still needed before forecasting water availability using medium-term climatic scenarios.

Key words hydro-climatic variability; hydrological modelling; snowmelt regime; groundwater/surface exchanges; River Elqui, Chile