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

D. Ruelland¹, H. Jourde², N. Brisset², R. Rochette², R. Oyarzun³, CEAZA, Centro de Estudio Avanzado en Zonas Aridas, Colina El Pino, La Serena, Chile; ULS, Universidad La Serena, La Serena, Chile

This study aims to simulate the relationship between climate forcing and dynamics of both water table levels and runoff from the upper Elqui catchment (5600 km², Chile) that has undergone significant hydro-climatic variability due to alternating ENSO and LNSO events. Simulations are performed with a daily, conceptual model that takes into account (i) a shallow reservoir supplied by rainfall and feeding evapotranspiration, surface/subsurface 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 snow regime of the catchment. A nearly 30-year period (1977-2008) was chosen to capture long-term hydro-climatic variability. After a warm-up period, calibration and validation were performed on the basis of a multi-objective function that aggregates a variety of goodness-of-fit indices. The model correctly reproduces the observed discharge at the outlet of the catchment, 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 cumulated volume error between observation and simulation is lower than 7% over the whole period studied. In the case of the lumped simulation, the dynamics of both the water level in the deep conceptual reservoir and the water table in piezometers are in good agreement. As a result, the model could be used to forecast future water availability using mid-term climatic scenarios in the basin since it correctly represents surface and groundwater flows when applied to various climatic conditions.