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Relative contribution of groundwater and surface water fluxes in response to climate variability over a mountainous catchment in the Chilean Andes

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Abstract In the semi-arid region of Norte Chico (Chile), climate variability, mainly controlled by ENSO and LNSO events, generates a high variability of both surface water and groundwater fluxes. Taking the upper Elqui catchment as an example, this study found that, during LNSO events, the abnormally high values (>200%) of the runoff coefficient may be the consequence of a groundwater contribution to surface water flow. During ENSO events, however, the lower values (<100%) of the runoff coefficient and the dynamics of the water table level highlight the recharge of the subsurface compartment. For the hydrological years characterized by a high Pluviometric Index during the 1977–2008 period, three dynamics of interaction between groundwater and surface water are identified: (i) the water table increases before the river discharge, and its logarithmic increase highlights a rapid recharge related to the concomitance of snowmelt and rainfall events; (ii) the water table increases after the river discharge and its exponential increase shows a progressive intensification of the recharge over time; and (iii) the water table and the river discharge increase are concomitant. Dynamics (i) and (ii) are observed during the ENSO events, when precipitation occurs over a long period; dynamic (iii) is observed during the neutral years, when high intensity precipitations occur over short periods. Accordingly, if the present climate trend marked by an increased frequency of El Niño events in recent decades (IPCC, 2007) persists, this should favour dynamics (i) and (ii), and thus enhances the relative importance of the groundwater resource with respect to surface water resource. However, both the present positive trend in temperature and the difference of trends at the scale of the catchment may favour the less efficient of these two dynamics in terms of groundwater recharge.

Key words hydro-climatic variability; water resource; surface/subsurface interactions; snowmelt; Río Elqui, North-Central Chile