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The damping capacity of the water balance of salt flats subjected to brine pumping: The Salar de Atacama example

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The Salar de Atacama was used as a case study to analyse the effect of lithium-rich brine pumping on the natural hydrodynamics and water balance of salt flats. A three-dimensional groundwater flow model calibrated with experimental data was used to quantify coupled natural (evaporation and recharge) and anthropogenic processes (brine pumping). Important changes in the dynamics of the water table between the pre-operational period (1986-1994) and operational period (1994-2015) were observed. During the pre-operational period, the water table showed a gradual drawdown because the evaporation was greater than the recharge for most of the time. This negative balance was counteracted by some sharp rises that were produced by direct rainfall events on the salt flat. The deep lateral recharge that arrived from the mountains did not produce abrupt changes in the water table because the rain events in the mountains were damped by the distance of the recharge zone and great thickness of the unsaturated zone.

During the operational period, the natural evolution of the water table was modified by the intensive brine pumping in the south-western area. As evaporation depends on the water table depth, the drawdown of the water table caused by pumping resulted in an evaporation reduction that partially compensated for the pumped brine in the water balance of the basin. This effect is defined as the damping capacity of salt flats. Thus, salt flats have a high capacity for dampening oscillations in their water table in response to both natural and anthropogenic disturbances which is of great importance for the management of lake and wetland ecosystems and brine exploitation. The limit of the dampening capacity of salt flats is defined by the evaporation extinction depth, which is in the range of 0.5-2 m.