



## **Streamflow responses in Chile to megathrust earthquakes in the 20th and 21st centuries**

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Both coseismic static stress and dynamic stresses associated with seismic waves may cause responses in hydrological systems. Such responses include changes in the water level, hydrochemistry and streamflow discharge. Earthquake effects on hydrological systems provide a means to study the interaction between stress changes and regional hydrology, which is otherwise rarely possible. Chile is a country of frequent and large earthquakes and thus provides abundant opportunities to study such interactions and processes.

We analyze streamflow responses in Chile to several megathrust earthquakes, including the 1943 Mw 8.1 Coquimbo, 1950 Mw 8.2 Antofagasta, 1960 Mw 9.5 Valdivia, 1985 Mw 8.0 Valparaiso, 1995 Mw 8.0 Antofagasta, 2010 Mw 8.8 Maule, and the 2014 Mw 8.2 Iquique earthquakes. We use data from 716 stream gauges distributed from the Altiplano in the North to Tierra del Fuego in the South. This network covers the Andes mountain ranges, the central valley, the Coastal Mountain ranges and (mainly in the more southern parts) the Coastal flats. We combine empirical magnitude-distance relationships, machine learning tools, and process-based modeling to characterize responses. We first assess the streamflow anomalies and relate these to topographical, hydro-climatic, geological and earthquake-related (volumetric and dynamic strain) factors using various classifiers. We then apply 1D-groundwater flow modeling to selected catchments in order to test competing hypotheses for the origin of streamflow changes.

We show that the co-seismic responses of streamflow mostly involved increasing discharges. We conclude that enhanced vertical permeability can explain most streamflow responses at the regional scale. The total excess water released by a single earthquake, i.e. the Maule earthquake, yielded up to 1 km<sup>3</sup>. Against the background of megathrust earthquakes frequently hitting Chile, the amount of water released by earthquakes is substantial, particularly for the arid northern areas that depend exclusively on groundwater resources.