Reconstructing 20,000 years of precipitation to constrain a deep groundwater model of the San Diego–Tijuana area, USA and Mexico, and implications for future models

Riley S. Gannon[1] and Wesley R. Danskin[1]
[1]U.S. Geological Survey, California Water Science Center, San Diego, CA, USA

ABSTRACT

Groundwater (GW) is a critically important resource in the western United States where surface water supplies are often scarce. Shallow aquifers containing fresh GW are commonly exploited for their water resources, although studies have shown that this is a finite, declining resource. Some operations are turning to desalination of deep brackish GW to augment their freshwater supplies. Hydrologic models often need to be employed to help characterize this relatively saline source of water, but models need to be properly parameterized to compensate for the very old GW. Lack of precipitation records that span the age of the old brackish GW can be a confounding factor in properly modeling this resource. Here, we have developed a record of reconstructed precipitation for the San Diego—Tijuana region, from the close of the Last Glacial Maximum (LGM; 20,000 years ago) to present, using geochemical proxies and climate models. We use cave speleothem $\delta^{18}O$ records to estimate high-resolution relative precipitation variability, combined with discrete model output of absolute precipitation, to generate the precipitation record. We selected the two closest speleothems to our study area, from regions that have been shown to have similar climatological conditions in the modern era and the LGM. Results from multiple model experiments provide absolute precipitation estimates at four discrete time periods. The model results are scaled proportionally to match historical San Diego precipitation values from 1850-2005, of 500 mm/yr. The other time periods are scaled such that the estimated average precipitation rates are: 500 mm/yr for 1850-2005 CE; 510 mm/yr for 850-1850 CE; 460 mm/yr at 6,000 BP; and 1120 mm/yr at 21,000 BP. The speleothem $\delta^{18}O$ record is then scaled to best fit these modeled precipitation estimates, generating a high-resolution precipitation record from the close of the LGM to present. The resulting precipitation record yields the best possible estimate of precipitation in San Diego from the LGM to present, and generates useful model input for hydrologic simulations of deep groundwater resources.

Contact Information: Riley S. Gannon, U.S. Geological Survey/California Water Science Center, 4165 Spruance Road, Suite 200, San Diego, CA 92101, USA, Phone: 858-598-4165, Email: rgannon@usgs.gov