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El Niño-Southern Oscillation controls the quality of freshwater lenses under coral atolls in the Pacific Ocean

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The freshwater resources of coral atolls occur mainly as lenses floating on salt water underneath the islands. The size and shape of these lenses are determined by hydrogeologic characteristics, as well as the rainfall recharge rate and its temporal variation, plus abstractions for domestic, industrial or agricultural uses. In the South Pacific, rainfall exhibits seasonal variability, as well as inter-annual cycles, which themselves are related to the El Niño-Southern Oscillation (ENSO). We show an ENSO control on the temporal pattern of the salinity of the lenses. We used electric conductivity measurements from 21 pumped wells (10 years of data) on Tongatapu to reveal the salinity fluctuations. The salinity dynamics depended on the pattern of low rainfall recharge during dry El Niño periods, or dilution throughout wetter La Niña events. These events then determine the quality of the freshwater lenses over the time-scale of several years, independent from seasonal rainfall patterns. We were able to predict the salinity dynamics of the lenses using the Southern Oscillation Index with a lag period of 10 months.