Journal of Hydrology
Volume 583, April 2020, 124567

Research papers

Effects of montane watershed development on vulnerability of domestic groundwater supply during drought

Zeno F. Levy [a], Miranda S. Fram [a], Kirsten E. Faulkner [a], Charles N. Alpers [a], Evelyn M. Soltero [b], Kimberly A. Taylor [a]

Show more

https://doi.org/10.1016/j.jhydrol.2020.124567

Highlights

- Recharge to domestic wells in fractured rock is dominated by local precipitation.
- Diverted surface water composes 28% ± 13% of recharge to wells at low elevations.
- Anthropogenic recharge can occur by irrigation or seepage from canals and ditches.
- Wells recharged by surface water had higher levels of nitrate and coliform bacteria.

Abstract

Climate change is expected to reduce recharge to montane aquifers in the western United States, but it is unclear how this will impact groundwater resources in watersheds where intensive surface-water development has disrupted the natural hydrologic regime. To better understand sources of recharge and associated vulnerabilities of groundwater supply in this setting, we made a detailed geochemical survey of domestic wells finished in fractured bedrock throughout the Yuba and Bear River watersheds (Sierra Nevada foothills, northern California) during historic drought (2015–2016). Stable isotopes of water and noble gas recharge temperatures closely tracked atmospheric lapse rates across a broad elevation gradient (100–2000 m), indicating groundwater inputs are dominated by local precipitation that rapidly recharges fractured bedrock during the winter wet-season. However, nearly one-quarter of wells had water isotopes that were fractionated by evaporation and warm recharge temperatures, indicative of mixing with dry-season recharge by surface water. Monte Carlo mixing models suggest evaporation-impacted groundwater samples are mixtures of local rain with an average of 28% ± 13% from diverted surface water that can recharge bedrock aquifers during the dry-season by either irrigation return flow or seepage from extensive distribution infrastructure. Wells that received recharge subsidies from diverted surface water had elevated levels of nitrate and coliform bacteria compared to those replenished exclusively by local precipitation, which are more vulnerable to supply shortage during drought. It is important to consider the impacts of increased surface-water development on the quantity and quality of groundwater recharge in rapidly developing montane watersheds.