

Guam's Water Resources

How do climate and humans impact freshwater resources, and how can we plan for change?

Where does freshwater come from on Guam?

- Rainfall can infiltrate into the soil and “recharge” the aquifer, run off to streams or the ocean, or return to the atmosphere by way of evaporation and plant transpiration.
- Both groundwater and surface-water supplies depend on adequate rainfall, which averages from 85 to 116 inches a year, mostly falling during the wet season from July through September¹. About 12% of annual rainfall is delivered by typhoons.
- There are two main sources of freshwater on the island of Guam: surface water on the south half of the island (rivers, reservoirs), and groundwater from the Northern Guam Lens Aquifer (NGLA) in the north (pumped wells).
- Groundwater provides about 80% of the drinking water for the island's 160,000 residents and 1 million visitors a year². Groundwater is contained in a freshwater lens that floats on saltwater, separated by a brackish transition zone.
- The Guam Waterworks Authority (GWA) pumps fresh groundwater from the NGLA and surface water from the Ugom River into pipes that provide water to residents and

visitors. The Department of Defense (DoD) obtains water from NGLA wells and the Fena Valley Reservoir. The DoD and GWA have developed projects to manage water resources cooperatively.

Why do we have to manage freshwater differently in the future?

- Up to 50% of total annual rainfall is returned to the atmosphere by evaporation and transpiration and does not recharge the aquifer³. A hotter environment will generally increase that percentage.
- The network of 180 groundwater wells in the NGLA uses energy to pump and distribute drinking water.
 - The NGLA produces about 40 million gallons of freshwater per day⁴. That means that daily per capita consumption is about 250 gallons. The US daily per capita rate is 98 gallons.⁵
 - More pumping requires more energy. Guam already pays 2.5 times more for energy than the mainland US due to the cost of shipping fuel.

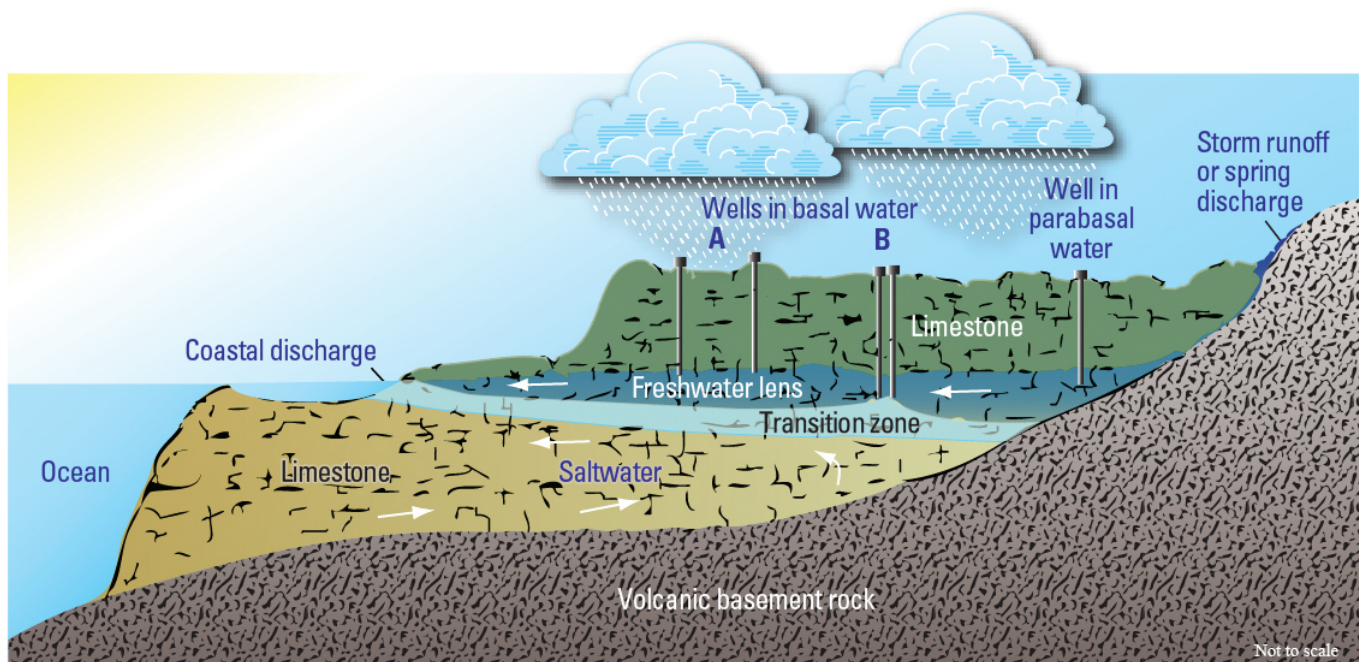


Figure 1: This cross section of the NGLA shows how the freshwater lens is recharged by rain and interacts with the ocean. Wells must be designed carefully to minimize the risk of saltwater contamination. (Gingerich and Jenson, 2010⁶)



Figure 2: The watershed area overlooking the Fena Valley Reservoir (photo by V. Keener).

- If wells are drilled too deeply or pumped too much, the pumped water can become brackish and eventually not suitable for drinking.
- The Fena Valley Reservoir was constructed by the DoD in 1951 and stores water mainly from three gaged streams in southern Guam. When the water level drops due to drought, reservoir managers implement conservation strategies.

How do humans impact drinking-water quality and quantity?

- By overpumping the wells in the NGLA, we can degrade the water quality and make it salty. Chloride concentration is used to measure how salty the water is, and if it is acceptable to drink.
 - The U.S. Environmental Protection Agency Secondary Standard for chloride in drinking water is 250 mg/L.
- When plants are burned or removed and leave bare soil, more sediment washes into streams, reservoirs, and coastal waters.
 - Sediment has pollutants from the land, and can clog water infrastructure. This also increases operating costs of water treatment plants.
- Increased populations put more demand on the water supply, and can cause water from wells to get salty and streamflow to be

diminished.

- Guam hosts about 1 million visitors a year, and is looking to grow its tourism industry. The US military is also planning on moving about 4,000 more Marines to Guam in the next ten years.

How does the climate impact drinking water quality and quantity?

- Freshwater on the island is impacted by warming temperatures, drought, storm and typhoon occurrence, and land use and forest coverage.
- Over the long term, rising sea levels will cause the freshwater lens to rise, bringing salty water closer to wells that supply drinking water. Sea-level rise impacts on the freshwater lens in Guam are expected to be minor⁷.

Using climate information can help managers plan for future changes in supply and demand.

- **Guam is getting warmer.** Higher temperatures increase evaporation and transpiration, as well as the need for more drinking water. This reduces supply and increases demand.
- **Guam is getting drier.** Most rainfall occurs in the wet season, which will be getting less rainfall. This will decrease groundwater recharge and streamflow.
- **Guam will experience fewer, but stronger, typhoons.** Typhoons can shut down the municipal water supply, interrupt power systems, and damage roads and infrastructure.
- **Drought will be more common.** Impacts include more grass fires, dropping water levels in wells, and dying trees.
- **Flooding.** When coupled with high tides and storms, sea-level rise will cause flooding that will increasingly impact coastal communities. Intense storms will cause more severe flooding in southern Guam streams, negatively impacting surface-water quality.
- **Managing surface water and groundwater together provides systemic resilience.** Increasing communication between agencies and sectors that manage freshwater will help create a system more resilient to potential climate or other shocks.

For information on how scientists make these projections about future climate in Guam, and links to articles about the models, please visit www.PacificRISA.org/projects/guam-serdp/.

Endnotes

¹ Gingerich, S.B. Hydrologic Resources of Guam. U.S. Geological Survey Water-Resources Investigations Report 03-4126, 2 Plates, <https://pubs.usgs.gov/wri/wri034126/>.
² U.S. Census Bureau, Census 2010 for Guam.
³ Jenson, J.J. and Taborosi, D. 2014. Professional Field Trip of the Northern Guam Lens Aquifer. WERI, University of Guam. http://north.hydroguam.net/docs/Field_trip_guide.pdf.
⁶ Gingerich, S.B., and Jenson, J.J. 2010, Groundwater availability study for Guam;

goals, approach, products, and schedule of activities: U.S. Geological Survey Fact Sheet 2010-3084, 4 p., <https://doi.org/10.3133/fs20103084>.
⁷ Gingerich, S.B., Johnson, A.G., Rosa, S.N., Marineau, M.D., Wright, S.A., Hay, L.E., Widlansky, M.J., Jenson, J.W., Wong, C.I., Banner, J.L., Keener, V.W., and Finucane, M.L., 2019, Water resources on Guam—Potential impacts of and adaptive response to climate change: U.S. Geological Survey Scientific Investigations Report 2019-5095, XX p., <https://doi.org/10.3133/sir20195095>.

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