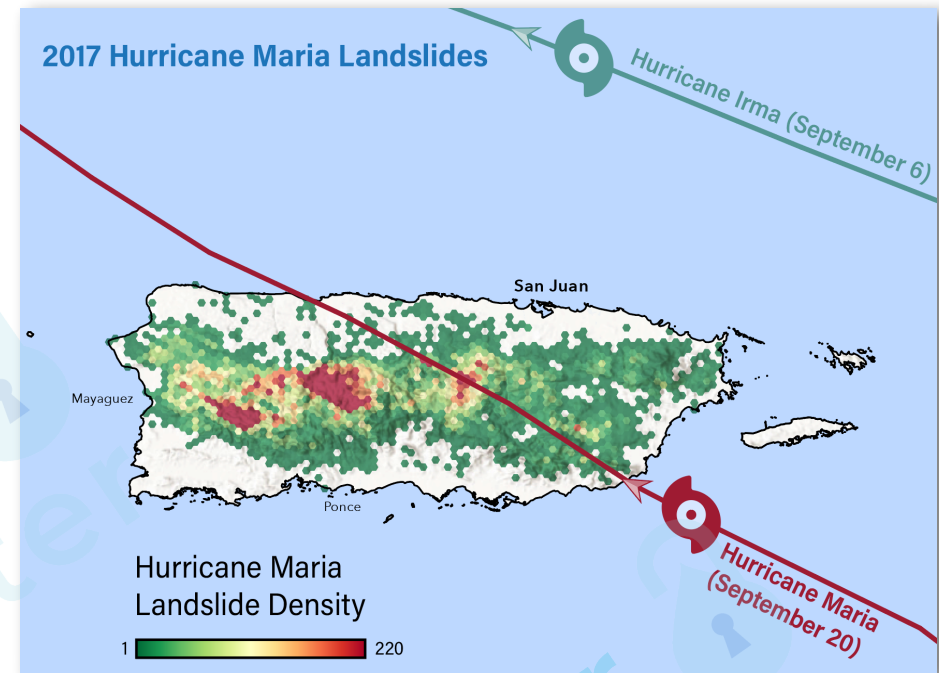


Recurrent extreme events have hobbled Puerto Rico, which some research considers the **most affected place by weather events from 1999-2018, trailed by Myanmar and Haiti**. Cyclones caused the most damage and are **expected to become more intense**.

In September 2017 Puerto Rico experienced two major hurricanes within two weeks. While Irma (Cat 5) only grazed the island, Maria (Cat 5, 4) struck the island directly. **Damages were estimated at \$132 billion**.

- **40,000 landslides were triggered** over ¾ of the island, particularly mountainous areas. Soils were already saturated from up to 550 mm of Irma rainfall.
- **The storms caused significant loss of life**, but the death toll is contested. The PR government figure is 2,975, while research found there to be 4,645 excess deaths.
- The **hurricanes caused catastrophic damage to infrastructure**.
 - They **decimated the power grid**—both transmission and distribution systems collapsed, leaving some **residents without electricity for almost a year**.
 - This **loss of power left water treatment, pumping, and wastewater treatment stations inoperable**. Eight months after the storms, household water was intermittent and quality was uncertain. Cases of the waterborne illness leptospirosis spiked, 26 deaths occurred.
 - **Infrastructure recovery is still ongoing**.
 - **Outmigration to the continental US increased after Maria**. Puerto Rico's population has declined by 600,000 people since 2003 because of economic contraction. Maria led to an additional population decline from of 130,000-475,000 people. **The remaining population is aging and largely impoverished (43%)**.



Flooding (NBC News, 2020)



Landslides (AB Forces News Collection, 2017)

Puerto Rico experiences more than 2,000 registered earthquakes per year. Most of these earthquakes are magnitude of 3.0 or lower. People typically don't feel earthquakes of magnitude 2.0 or lower.

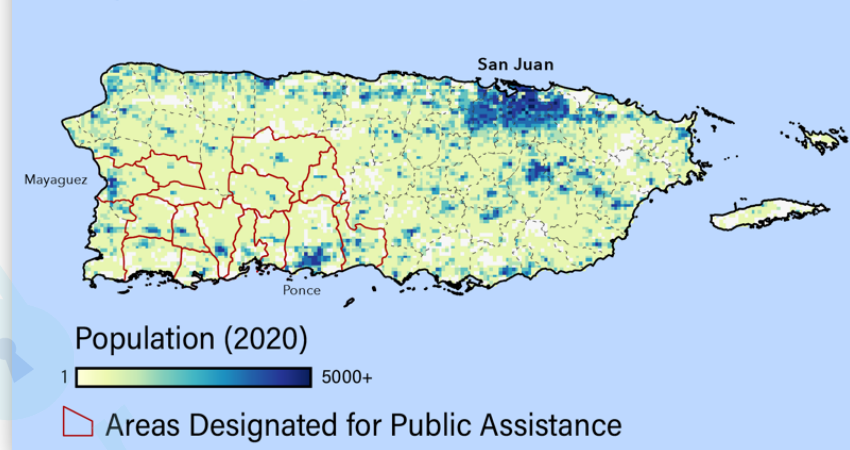
Earthquake

- In January 2020, a series of earthquakes ranging from a **magnitude 5.0 to 6.4** hit southwest Puerto Rico, the strongest earthquakes in this region since 1918.
- Unsafe housing caused more than **8,000 people to be displaced**. However, that number only accounts for those documented at relief shelters. Sources say there are likely **thousands more sleeping on the streets**.
- According to the US Geological Survey, **Puerto Rico still has a 50% chance of experiencing at least one magnitude 5.0 or higher earthquake per year until 2030**.

Compounded Damage

- The **2020 earthquakes destroyed the Costa Sur Power Plant that supplies roughly a third of the island's power**. Costa Sur had already suffered damage from the 2017 hurricanes.
- Canvas tents were quickly erected as relief centers by different aid agencies. **These housed only 8,000 people, less than 20% of the total displaced**.
- Fear of continued earthquakes, hurricanes, displacement, and lack of relief have caused a **major mental health crisis** among Puerto Ricans.

January 2020 Earthquake



Population density and designated areas for public assistance after the earthquakes in January 2020

Relief centers
(New York Times, 2021)



Structural damages
(Washington Post, 2020)

Projected changes leave Puerto Rico with a hotter and drier climate. This likely means less water available for all users, including drinking water, irrigation, and industry.

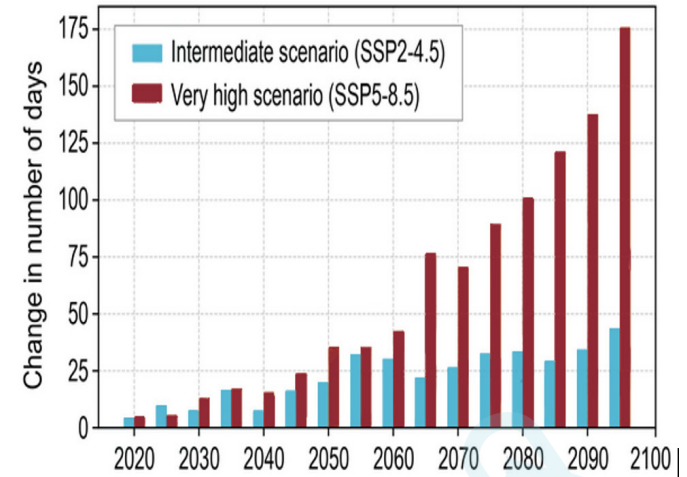
Increasing temperatures will likely stress people and plants, leading to **adverse public health outcomes and decreased agricultural productivity.**

The **already-stressed power grid will struggle to meet energy demands** for cooling homes, schools, and businesses.

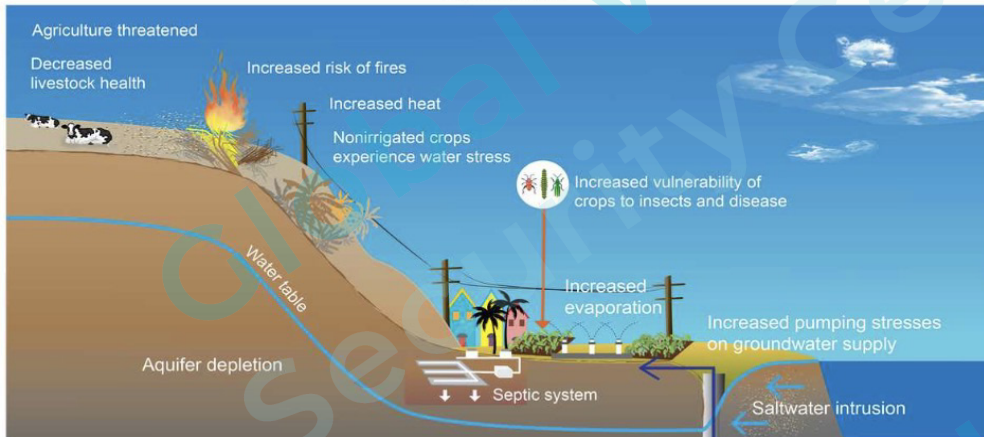
Increasingly cyclones intensity could take more lives and cost more money to recover.

Ocean acidification will damage coral reefs, potentially **harming tourism on the island currently valued at \$8.9 billion dollars**

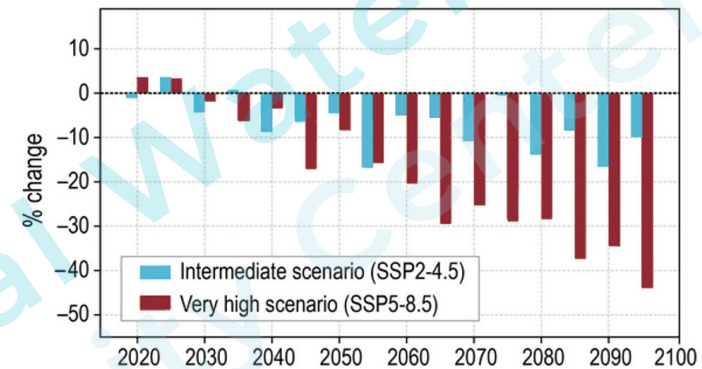
Projected change in maximum number of consecutive dry days (wet season: May–October)



Dry scenario



Projected change in annual average precipitation

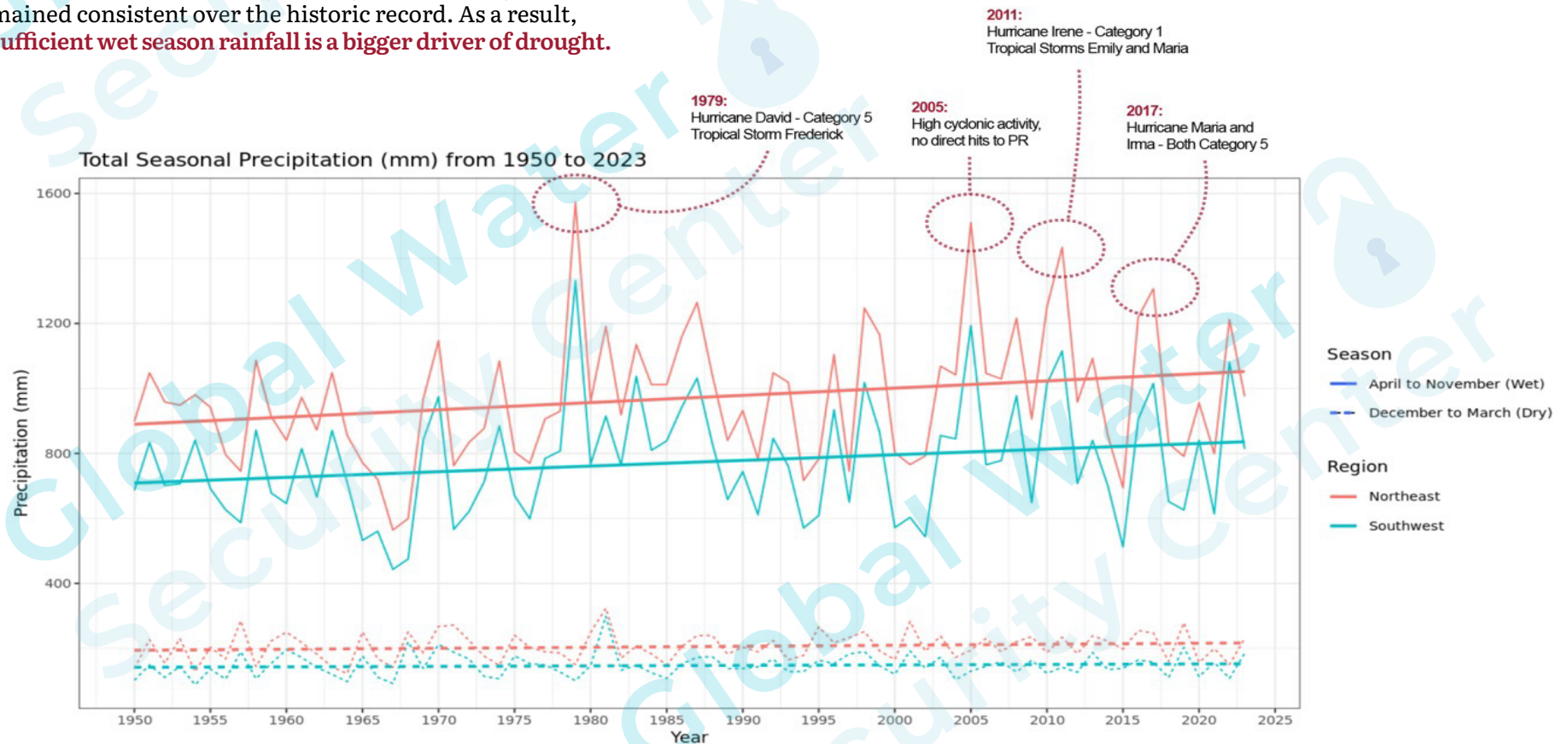


Historic Temperature and Precipitation Record (1950-2023)

- Increase in mean temperature by 0.6 degrees Celsius since 1990. Puerto Rico appears to be warming more slowly than the global average of 1 degree C in that time period
- **Precipitation has increased slightly** over the historical time period, about 2mm per year, with **increasing variability in the wet season mixed with more frequent extreme events.**
- Dry-season rainfall has low year-to-year variability and has remained consistent over the historic record. As a result, **insufficient wet season rainfall is a bigger driver of drought.**

Moving Forward

- **Water management will be even more vital and will become more difficult** for handling the variability in rainfall—managing for both floods and droughts.



Years of disinvestment and deferred maintenance have weakened critical water infrastructure.

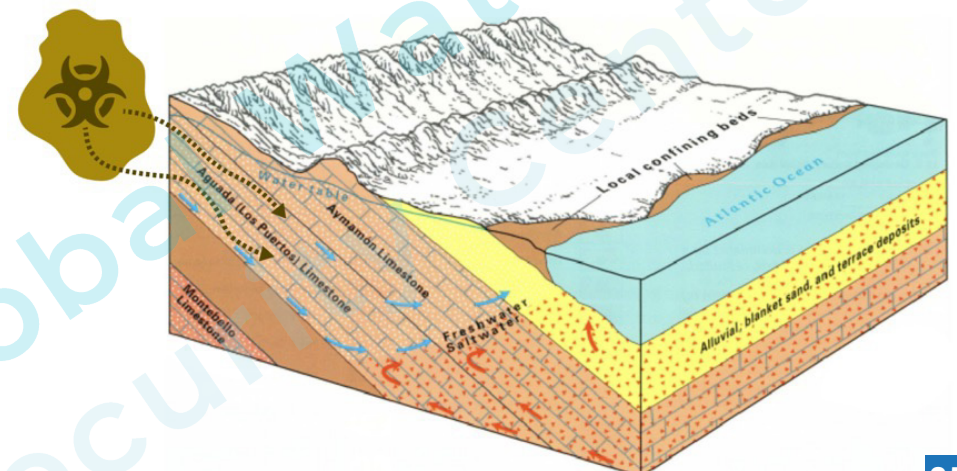
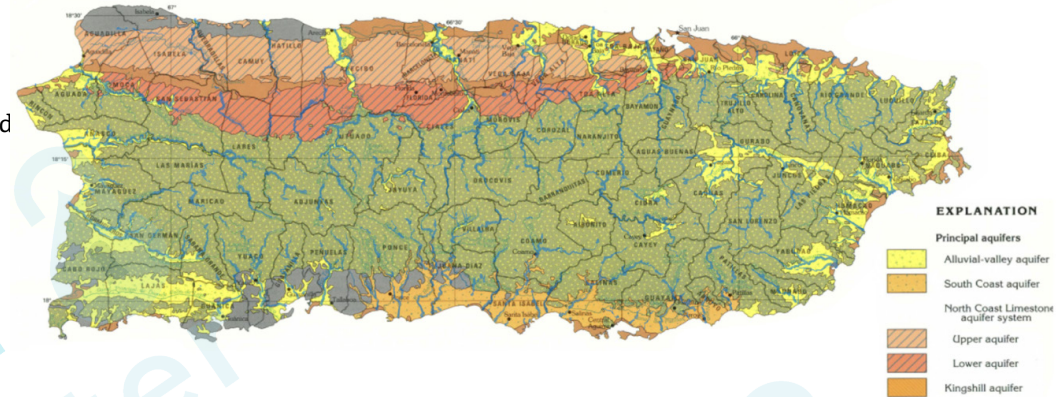
Poor Municipal Water Management & Infrastructure

- Microbially induced **pipe corrosion undermines structural integrity**. Stormwater systems are undersized and degraded. **Reservoirs have high sedimentation, which degrades flood and drought protection.**
- In 2007, PR Aqueduct & Sewer found municipal **water losses to be 60%** but had no information of where or why the losses occurred.
- After the 2015 PR debt default, budget constraints **suspended all capital improvements.**
- In 2022, a PR government news release cited the same 60% water loss figure which had not been updated or remediated.
- **Raw sewage contaminates freshwater.** Over 27,000 sewage overflows occur annually. Over 40% of the population is not connected to sewerage, and an estimated half of that population uses poorly functioning septic systems.
- **Toxic industrial waste** from legacy superfund sites, current effluent and landfill runoff is **transported directly into the highly porous and transmissive karst aquifers.** This has caused the **most violations of the Safe Drinking Water Act by any state or territory.** Groundwater provides 20% of PR's water supply.

Water Service Relies on Power

- **During storms, power fails.** Most power generation takes place in the south, where aging fossil fuel power plants send electricity through precarious transmission lines that span across ravines and mountains.
- Since Maria, habitual **brownouts and power surges are the norm.**
- In 2022, Category 1 Hurricane Fiona again triggered **extended power and water outages as backup generators had not been secured in the 5 years since Maria.** Puerto Ricans again experienced **waterborne bacterial diseases.**
- Diesel shortages often occur after cyclones, as PR imports all fossil fuels.

Aquifers and Surface Water



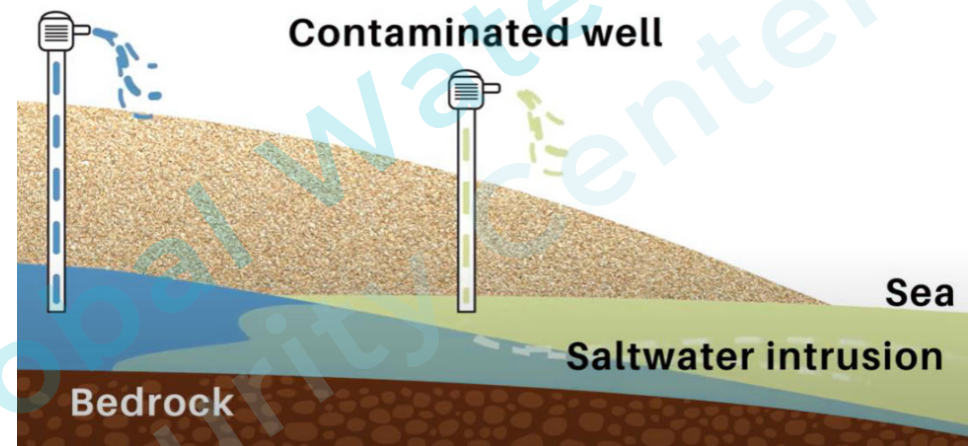
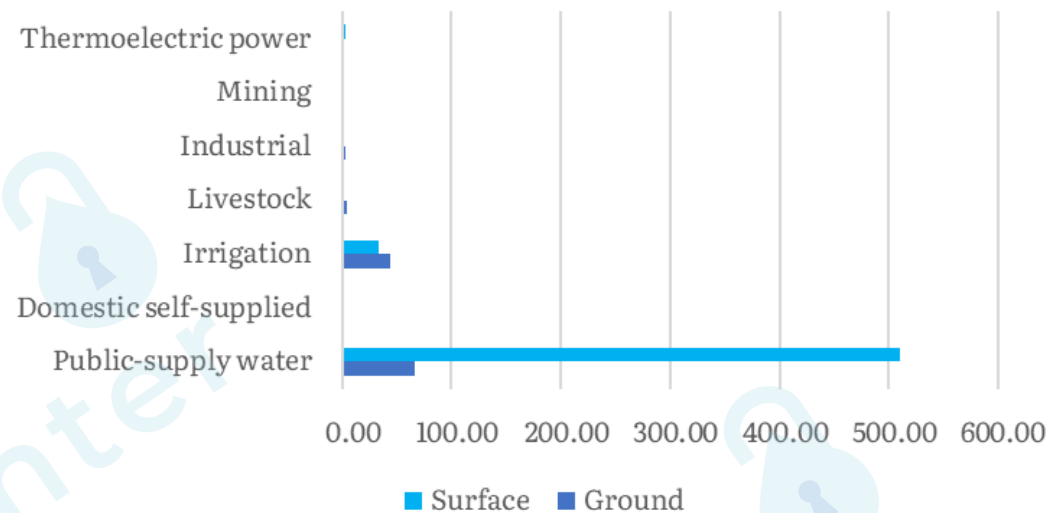
Water Use (2015)

- **Public water supply accounts for 86% of total freshwater** withdrawals, with 20% sourced from groundwater and 80% from rivers and reservoirs. This water use declined by 14% since 2010, likely attributed to population decline.
- **Irrigation accounts for 12% of freshwater use**, an increase of more than 100% since 2010. Since Hurricane Maria, small-scale farming has seen a resurgence.
- Altogether, withdrawals for **livestock, industrial, mining, and thermoelectric power accounted for 2% of all freshwater** withdrawals, 71% of this from groundwater. This water usage declined by 9% since 2010.
- **Saltwater intrusion can be a problem** in areas of large withdrawals, particularly in alluvial aquifers adjacent to the ocean.

Food Security

- Agriculture in Puerto Rico declined drastically post-WWII as focus shifted to industry. **Puerto Rico currently imports 85% of its food supply and exports 15% of its agricultural production.** Only 1% of the workforce is employed in agriculture.
- The **US is the main provider of agricultural imports**, followed by the European Union, Canada, and the Dominican Republic.

Water Withdrawals by Category (Mgal/d)



(FEMA)

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