Agriculture and Food Production

KEY MESSAGE

Climate change stressors are exacerbating an already fragile agricultural sector. Total agricultural product and infrastructure loss from the 2017 hurricanes was over $2 billion.

Agricultural trends in Puerto Rico are largely influenced by the region's vulnerability to external factors such as economic forces (e.g., international trade, food dependence, etc.) and exposure to climatic events. Comas (2009) describes the vulnerability of Puerto Rico's food supply chain as being affected by "a high dependence on imported food, oligopolies in maritime transport logistics, maritime routes coinciding with the hurricane route, and the food reservoir is not clearly defined." The islands' food production is highly vulnerable to climate change because sea level rise may affect prime agricultural lands located in coastal areas; saltwater intrusion may affect aquifers upon which agricultural coastal lands have relied for generations and thus aggravating access to water problems; new pests and introduced species may affect livestock, wildlife, and plants; and farmers do not have the capacity or access to specialized expertise, information or equipment to adapt to climate change (Gould et al., 2015; Gould et al., 2017). Today's agricultural economy often forces farmers to make decisions that may be necessary for the survival of their business but are less protective of soil and water resources.

PRECIPITATION

Agriculture in Puerto Rico is heavily influenced by spatial and temporal rainfall patterns (Harmsen et al., 2008). Yields are reduced whenever a growing crop receives less than or greater than the crop water requirement (i.e., the cumulative potential crop evapotranspiration).

In general, the northwest region and El Yunque Forest receives greater than 2,000 mm of rainfall per year, while the southern coast receives less than 1,000 mm per year. The low rainfall conditions on the southern coast expanded northward between longitudes -66.4 and -66.0 degrees during drought years. The 2015 rainfall distribution (NOAA Advanced Hydrologic Prediction Service; Figure 5) may become the new normal for the region and use of irrigation will spread to areas outside of the current reach of the four irrigation districts if water can be made available.

The rainy season is expected to become wetter and the dry season to become drier between 2000 (average of 1990-2010) and 2090 (average of 2080-2100) (Harmsen et al., 2009). September rainfall is predicted to increase by 73%, 82%, and 95% between 2000 and 2090 at Adjuntas, Mayagüez, and Lajas, respectively (Harmsen et al., 2009). Under current conditions, during the months with the greatest rainfall (Aug, Sep, Oct), western Puerto Rico already experiences unacceptably high levels of soil erosion. Increased soil erosion from extreme rainfall events will further reduce soil fertility, degrade water quality of streams, coastal waters and reefs, and threaten sensitive ecosystems. A potentially positive finding from Harmsen et al. (2009) was that annual aquifer recharge may increase since most recharge occurs during the rainy season. In addition to increasing groundwater supplies, this may have a positive effect on streamflow and quality, since stream base flow would be expected to increase. Potential gains in aquifer recharge may be offset by inadequate water infrastructure and the potential growth/expansion of agriculture.

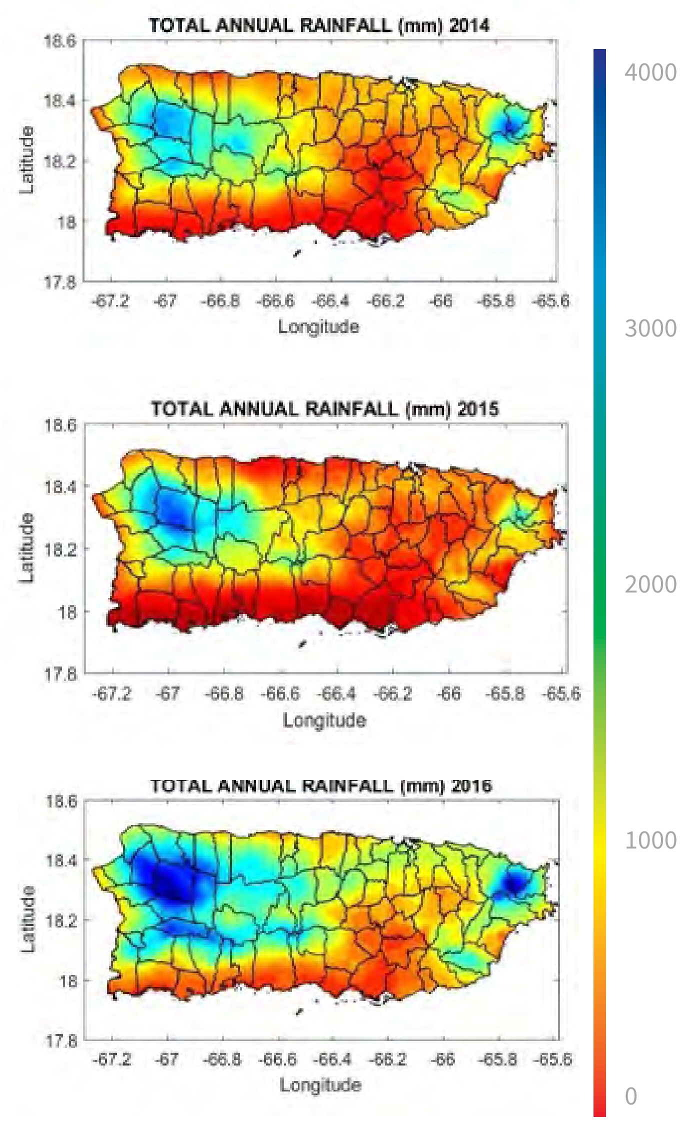
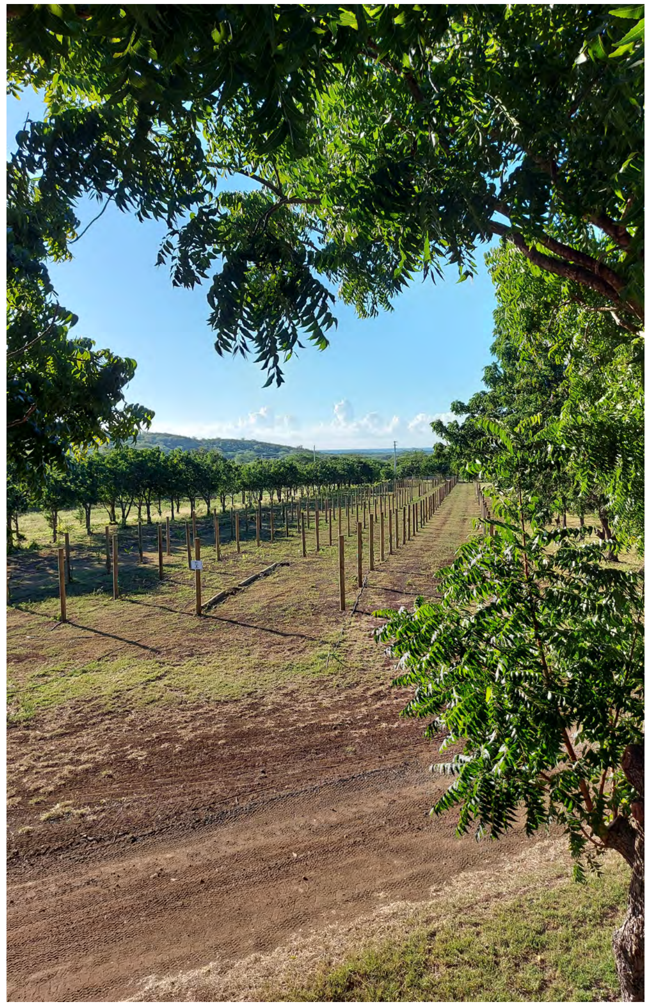


Figure 5. 2014, 2015 and 2016 total rainfall depth for Puerto Rico. Source: NOAA Advanced Hydrologic Prediction Service.

DROUGHTS

Recurrent droughts across the island have highlighted the agricultural vulnerability to these hazards and the increasing need for adaptation mechanisms such as best management practices to support agricultural production. Since 1950, Puerto Rico has experienced seven major periods of meteorological droughts. The drought of 2014-2016 covered 64% of Puerto Rico at its peak and resulted in agricultural losses of over $13.8 million, affecting mainly the livestock and farinaceous sectors, particularly plantains and bananas (Álvarez-Berríos et al., 2018). The Puerto Rico Department of Agriculture reported that in 2015, the drought caused losses of $8.6 million in forage (62.2% of all reported losses) and $750,000 in livestock due to malnutrition or death (5.4%) (Figure 6). Approximately 28% of livestock farms experienced damages and increased costs associated with imported feed to compensate for the reduced availability of hay due to the drought, particularly in 2014 (Gould et al., 2015). Of the total losses, 22% was attributed to plantains, a staple food on the island. The remaining 10% of the losses were attributed to a variety of 21 crops, including farinaceous crops, herbs, fruits, and coffee (Alvarez-Berrios et al., 2018).



Source: Wanda I. Crespo

2015 REPORTED CROP AND LIVESTOCK LOSSES BY AGRICULTURAL REGION (PUERTO RICO DEPARTMENT OF AGRICULTURE 2017)

Figure 6. Drought losses by municipality in 2015 based on Puerto Rico Department of Agriculture data.

TROPICAL CYCLONES

In September 2017, hurricanes Irma and María caused losses of over $2 billion, including crops, ornamental plants, livestock, and other animal products (Puerto Rico Department of Agriculture, 2017). Over 1,016 mm of rainfall were measured from hurricane María, causing flooding on 210.4 km² of farmland. Moreover, about 40% of the poultry production infrastructure and over 90% of dairy industry structures were damaged by the hurricane (ASD, 2018). Agricultural production and infrastructure were also significantly damaged by hurricanes Irma and María, amounting to $1.8 billion in losses. In 2019, the Jacksonville port in Florida, where 90% of Puerto Rico's supplies come from, shut down from September 2 to September 5 due to Hurricane Dorian's path, generating a complicated logistics shift to get vessels in and out of Puerto Rico prior to the shutdown (Caribbean Business, 2019). Hurricane Dorian never arrived at the Jacksonville Port, remaining stationary over the Bahamas for more than 24 hours.

Agricultural advisors interviewed by the USDA Caribbean Climate Hub identified the damage to technology related infrastructure such as power outages (71%), communications (58%) and impassable roads (52%) as devastating to the agricultural sector, exacerbating the direct impact the hurricanes had on agriculture itself (Álvarez-Berríos et al., 2021).

Source: Ricardo Burgos

Table 4. Total agricultural product losses and losses to infrastructure related to 2017 hurricanes Irma and María. (Puerto Rico Department of Agriculture's Office of Agricultural Statistics, 2018).

CATEGORY	AGRICULTURAL PRODUCT LOSSES RELATED TO IRMA AND MARÍA	LOSSES TO INFRASTRUCTURE PER AGRICULTURAL SECTOR
POULTRY AND EGGS	$11,349,473.69	$34,984,001.52
CROPS	$159,099,607.58	$1,030,958,212.13
CATTLE	$16,441,708.51	$694,884,739.54
ORNAMENTALS	$40,715,363.01	-
ANIMAL PRODUCTS	$365,420.70	-
AQUACULTURE	-	$64,903,155.12
GRAND TOTAL	$227,971,573.49	$1,825,730,108.31

Freshwater Resource Management

KEY MESSAGE

Climate change continues to pose challenges for Puerto Rico's freshwater management and sustainable use of water resources and infrastructure.

As previous works detailed in Working Group 1 suggest, Puerto Rico will continue to experience multiple changes on precipitation patterns, temperature, extreme climate events and median sea level; all of which have direct impacts on its freshwater resources. As global changes continue to alter the hydrological cycle trends, Puerto Rico's water resources are expected to be affected in both quantity and quality, and thus are major concerns from an adaptation and resilience-building perspectives (AAA, 2014; DRNA, 2016[a]). The Integrated Water Use Plan has documented and identified several climate-change impacts to freshwater resources including projected reduction in mean precipitation; reduction in superficial freshwater availability; changes in riverine, estuarine and wetland biodiversity; saline intrusion to aquifers; changes in sedimentation loads to reservoirs, rivers and streams; changes in evapotranspiration; and changes in soil humidity (DRNA, 2016[b]).

Source: Wanda I. Crespo

Projected changes in precipitation patterns across Puerto Rico can generate considerable impacts to freshwater resources (Hayhoe, 2013; Van Beusekom et al., 2015; Khalyani et al., 2016). Despite uncertainties associated still embedded into latest downscaled climate models, drier conditions are expected for Puerto Rico and the Caribbean basin. These projections also denote regional and seasonal variability, pointing towards longer dry periods and increased precipitation reductions particularly along the south portion of Puerto Rico.

Reductions in mean precipitation along the southern coast have contributed to affected vulnerable groundwater resources, including aquifer systems that are currently under critical condition. While coastal freshwater resources, such as those of the South coast aquifers, are vulnerable to climate change impacts, intensive groundwater extractions continue to pose a greater threat to these freshwater resources than climatic factors alone (Ferguson & Gleeson, 2012; Unsal et al., 2014). Additional research is needed to better analyze climate change impacts on Puerto Rico's groundwater resources.

Tropical cyclones have brought significant challenges to freshwater resources in Puerto Rico, affecting water quality, natural and built infrastructure conditions, and compromising watershed integrity. Devastation caused by hurricanes Irma and María in 2017 resulted in an estimated 40,000 landslides Island-wide (Bessette-Kirton et al., 2019), severe damages and tree mortality for an estimated 23-31 million trees (Feng et al., 2018), prompting extraordinary sediment discharges to rivers, streams, reservoirs and coastal ecosystems (Miller et al., 2019). In the aftermath of these hurricanes, water quality was severely affected due to high turbidity, high bacteria count, and chlorinated volatile organic compounds (Brown et al., 2018), placing greater environmental and public health concerns.

Runoff along watersheds during hurricane María caused disastrous pluvial flooding, generating casualties, and causing severe infrastructure losses in Puerto Rico. Most notably, flood events along La Plata watershed caused significant damages and deaths on communities in Comerío and Toa Baja (RPRAC, 2018).