Terrestrial Agriculture and Silviculture

Key Message

Marine heatwaves indirectly impact terrestrial agriculture and silviculture by influencing coastal temperatures, humidity, tornadoes, and hurricanes. High temperatures can lead to crop failures in the summer, though reduced frost risk in the winter may benefit frost-susceptible species. Tornadoes and hurricanes cause extensive damage to agricultural and silvicultural industries that can have lasting impacts.

Overview

Conditions in the ocean can influence conditions on the coast and further inland, especially as it relates to weather that influences local agriculture. The Southeastern U.S. and Caribbean play an important role in U.S. agricultural production. For example, Georgia leads the nation in pecan production, Florida is second in citrus fruit production, and Texas leads the nation in cotton and cattle production (USDA 2024, USDA National Agricultural Statistics Service 2023b and 2024a). Puerto Rico, despite its relatively small size, had $703 million in agricultural production in 2022 (USDA National Agricultural Statistics Service 2024b). U.S. Southeastern states also have substantial silvicultural industries with 40% of the country's timber land producing approximately 60% of the nation's timber harvest (Motha 2011, Oswalt and Smith 2014).

Marine heatwaves are associated with higher temperatures and humidity in coastal regions (see coastal temperature short report). Though agriculture in the Caribbean and Gulf is designed to handle heat, there have been severe reductions in crop yields and loss of forage for livestock (and sometimes deaths) associated with extreme summer temperatures (Shannon and Motha 2015). High temperatures impact crop development. For example, above 32C, *Brassica oleracea* (a group of crops that includes cabbage, broccoli, and brussel sprouts) has compromised leaf expansion, reduction in fresh weight, reduced photosynthetic efficiency, and some subtypes see changes in gas exchange rates at high temperatures (Rodríguez et al. 2015). Soil temperatures above 35C can cause seedling death in soybeans, and air temperatures above 30C can impact wheat germination (Motha 2011). Temperature can also influence crop reproduction. For example, air temperatures above 36C lead to declines in corn pollen viability (Motha 2011). On the other hand, some regional crops are particularly susceptible to freezes (e.g., citrus (Shannon and Motha 2015)) and marine heatwaves in the winter months may help reduce freeze-related losses. High summer temperatures can endanger agricultural workers; U.S. crop workers are 20 times more likely to die of heat-related illnesses than the general civilian workforce (Murbach et al. 2020). There are management adjustments, like increases in rest time, changes in worker effort, and provision of climate-control recovery areas, that can mitigate those risks (Murbach et al. 2020).

Silviculture in the South: States in the Southeastern U.S. have 40% of the nation's timberlands and produce about 60% of the nation's timber harvests. Photo: USDA Forest Service.

Both high temperature and high humidity are associated with fungal plant disease outbreaks globally, with humidity playing an especially important role (Romero et al. 2021). High humidity can also have risks for livestock, including high mortality of chicken embryos, pulmonary

inflammation in lambs, generally high heat stress, and high prevalence and infectivity of some fungal diseases (Xiong et al. 2017). That said, high humidity can reduce transmission for some airborne pathogens — like the flu virus — and can decrease survival for some bacteria, though it increases survival for others (Xiong et al. 2017).

Marine heatwaves are also associated with more frequent and intense thunderstorms and tropical cyclones (see Severe Thunderstorms and Tropical Cyclones/Hurricanes short reports). Tornadoes, which are particularly prevalent in parts of Mississippi and Alabama, can damage forests by damaging tree branches or uprooting trees (Fortuin et al. 2022)). For some hardwood trees in southern Mississippi, one model indicated a more than 50% probability of uprooting within 30 years, around the time when some timber species are harvested in the region (Fortuin et al. 2022). Hurricanes have also led to extensive damage in the region. For example, in addition to killing more than 1,800 people, Hurricane Katrina led to the deaths of millions of chickens, the loss of around $3 million in milk due to electrical outages, and the extreme damage or deaths of 320 million large trees (Motha 2011, Shannon and Motha 2015). Hurricane Floyd was not a powerful hurricane, but the heavy rainfall led to major flooding that killed millions of farm animals and spread pollution from farm waste lagoons and other facilities across eastern North Carolina (Motha 2011). The 2017 and 2018 hurricane seasons cost billions of dollars in agriculture, livestock, and forest industry losses across the Southeastern U.S. and Caribbean (Wiener et al. 2020). Specifically, hurricanes Irma and Maria had devastating impacts on Puerto Rico, with estimates that Maria destroyed more than 80% of Puerto Rico's 2017 agricultural crop value, especially impacting plantain, banana, and coffee harvests. These losses heavily impacted smaller farms — leading to the loss of more than a 50% of farms with fewer than 10 acres when compared to 2012 numbers (Kenner et al. 2023). Recovery is challenging for all, but especially for those farming crops that become more valuable as they age (e.g., pecans, timber (Wiener et al. 2020)). This is not accounting for the long-term impacts of trauma and personal hardship on farming communities in the region.

There are strategies that can help farmers mitigate the economic risks of extreme weather (including hurricanes), like purchasing crop insurance, diversifying to include alternative sources of income, and farming in multiple locations (Shannon and Motha 2015, Wiener et al. 2020). For forestry, strategies like reducing stand rotation length, diversifying stand management styles, and planting wind-resistant species may reduce hurricane damage (Wiener et al. 2020). However, there is limited information on species- or crop-specific mitigation strategies to inform farm management (Wiener et al. 2020).

Storm Damage: Recovery from storm damage is challenging, especially for crops — like timber — that become more valuable as they age. Photo: National Association of State Foresters.

What this means is that, though marine heatwaves may have limited direct impacts on terrestrial agriculture and silviculture, they can increase the likelihood of conditions that are potentially damaging to workers and crops. Specifically increased summer temperatures and increased intensity of thunderstorms and hurricanes can lead to crop, livestock, and timber losses and can impact worker health and well-being.

Temperature Datasets Commonly Used

Analyses primarily rely on air temperature data if looking directly at the relationship between temperature and crops. However, analyses of ENSO-related impacts use a variety of indices, some of which (like the Oceanic Niño Index or ONI) rely on remotely-sensed sea surface temperature anomalies in the tropical Pacific.

Other Relevant MHW Short Reports

- Coastal and Urban Temperature and Humidity
- Severe Thunderstorms
- Tropical Cyclones/Hurricanes

Resources/Communities of Practice

- World Agrometeorological Information Service (USA) (https://wamis.org/wamis/usa/)
- AgroClimate (http://agroclimate.org/)
- USDA NRCS (https://www.nrcs.usda.gov/)

Hurricane Impacts: Maria destroyed more than 80% of Puerto Rico's 2017 agricultural crop value, especially impacting plantain, banana, and coffee harvests. Photo: USDA.

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