Drought in the U.S. Affiliated Pacific Islands

Climate change impacts and community resiliency across a diverse landscape

Pacific Islands Climate Adaptation Science Center
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The Pacific Islands region is vast and diverse

The U.S.-Affiliated Pacific Islands (USAPI) includes two U.S. territories (American Samoa and Guam), the Commonwealth of the Northern Mariana Islands, and three independent countries (the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau). Geology of the USAPI varies greatly – from volcanic high islands, to low coral atolls, from young and fertile limestone soils to highly weathered oxisoils of very low fertility. As a result, native ecosystems, agricultural systems, hydrology, and interactions with the ocean are remarkably diverse. These distinctions, especially between high and low islands are also essential for understanding how a changing environment will affect the rich biocultural diversity of the region, and importantly how these small island states and nations will adapt to a changing environment.

East-West Center

The USAPI are experiencing climate change

The USAPI faces important threats from warming, drying, ocean acidification, sea level rise and accompanying salt water intrusions or even large-scale inundation, and increasing storm intensity. The region is particularly sensitive to all of these issues because: nearly all land area occurs as small islands or islets; human communities are highly dependent on supplies of fresh water that are easily impacted by a changing environment; island communities are very isolated, with limited access to resources from neighbors. Enhanced drought poses numerous problems to the region. Most of the USAPI receives what would be considered abundant rainfall, but rainfall is seasonal, periodic El Niño events can be severe, and infrastructure to stabilize water supply is often limited.

Karl Fellenius, Univ. of Hawaii Sea Grant

USAPI communities are resilient and adaptable

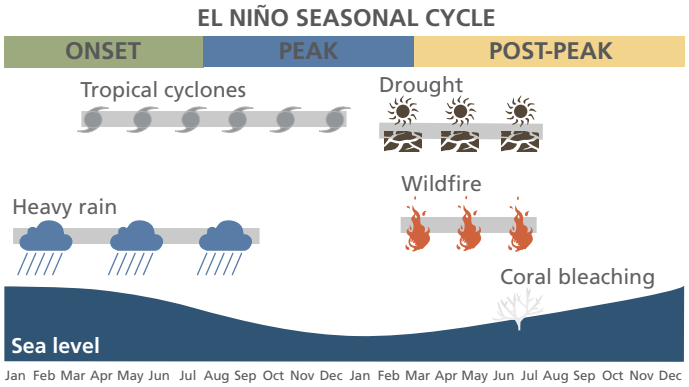
The USAPI is home to diverse resilient cultures that have endured drought for millennia. Isolation has led to development of technological and cultural strategies for responding to drought events and inter-annual variability in rainfall. Historically, settlement patterns, crop diversity, food storage and preservation techniques, and strategies for inter-community cooperation have evolved to cope with drought. Drought exerts impacts from ridge to reef, on upland forests, agricultural systems, human communities, and coastal nearshore areas, requiring holistic, multi-generational approaches to ridge to reef land management.

John Borja, Guam Dept. of Agriculture

The Pacific Islands region is highly susceptible to climate change

High variability is a characteristic feature of the climate in the Pacific Islands region

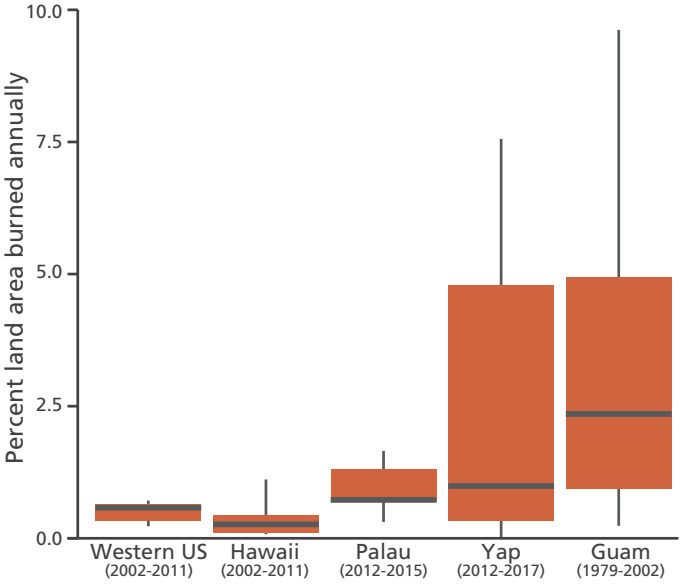
The most prominent driver of interannual climate variability is the El Niño-Southern Oscillation (ENSO). ENSO alternates between warm (El Niño) and cold (La Niña) phases, which impact sea surface temperatures in the Equatorial Pacific, trade winds, and atmospheric circulation, thereby impacting regional rainfall and temperature. Phases recur every three to seven years, and the impacts of ENSO differ across islands. For many islands in the Western Pacific, El Niño typically results in extended drought conditions, which can lead to drinking water shortages and increase the area burned by wildfires, sea level decreases, severe impacts to coral reefs, enhanced risk of damaging tropical cyclones, and possible spread of vector-borne disease and illness. Future climate projections indicate an increased frequency of extreme El Niño events, and more frequent tropical cyclones during El Niño.



The El Niño seasonal cycle experienced within the USAPI Region. The onset of El Niño between Jan-July is characterized by heavy rain and the occurrence of tropical cyclones. This pattern shifts during peak months (Sept-March), resulting in a lower sea level, drought and wildfire.

Climate change may exacerbate fire impacts

Beginning with human arrival 3-4,000 years ago, fire use for land clearing and agriculture greatly expanded the extent of fire-prone grassland and savanna in the USAPI. Contemporary human-caused ignitions, both accidental and intentional, combined with pronounced dry seasons, create annual fire seasons on Palau, Yap, and the Marianas. El Niño-driven drought exacerbates fire risk across the region. An estimated 25% of Pohnpei burned during the 1982-83 El Niño despite rainfall averaging 1 inch per day. In addition to threatening fire-sensitive native forests, fires expose large areas of bare soil, creating opportunities for non-native plant invasions and increasing flood risk and sediment delivery to nearshore reef ecosystems. Fire risk and impacts can be mitigated through public education and watershed management, however, increasing rainfall variability under climate change has potential to increase fuels accumulation and sediment delivery rates during periods of excess rain and increase fire probability during drought.



Comparison of percent land area burned annually for the Western United States and several Pacific Islands. From "Wildfire in the Western Pacific"*, Pacific Fire Exchange Fact Sheet, Feb 2017.*

Drought will impact ecosystem services through cascading socioeconomic effects

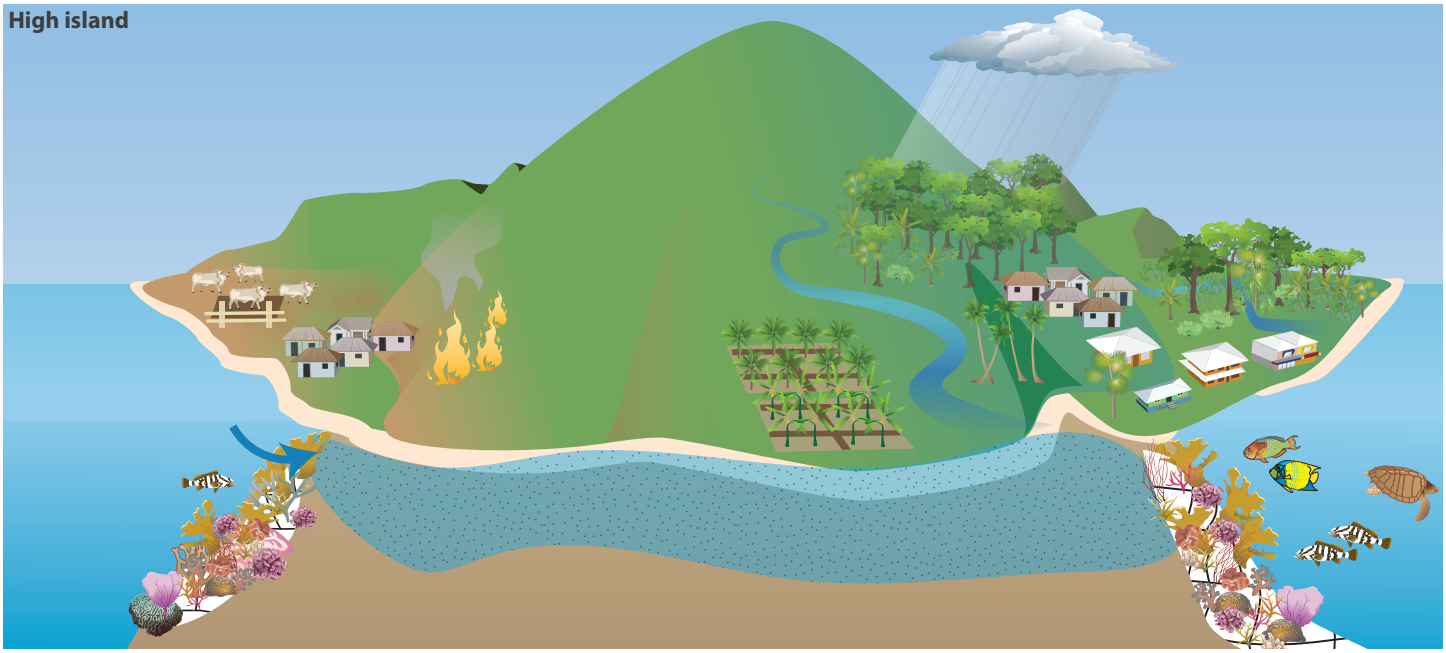
Drought impacts can affect ecosystem services such as food security, the water-energy nexus, tourism and livelihoods, public health, and national security. During El Niño-driven drought, staple crop harvests can decrease by up to 20%, and fish move to cooler waters. At times, drought closes tourist destinations and processing facilities, such as the StarKist cannery in American Samoa, the main employer on the island. It is also associated with higher rates of diarrheal disease and conjunctivitis. During severe droughts, freshwater must be delivered to the islands via aid and U.S. Pacific Command. As an environmental stressor, drought is the most prevalent climate impact felt by Pacific Islanders, and contributes to migration decisions. Severity of impacts varies with the geography and governance system, as atolls and remote islands have fewer resources. To help mitigate socioeconomic impacts, islands can increase communication and planning between different sectors and link weather and climate variables to observed impacts on the ground.

The freshwater storage reservoir on Majuro Atoll. Photo from Majuro Water and Sewer Company via FEMA.

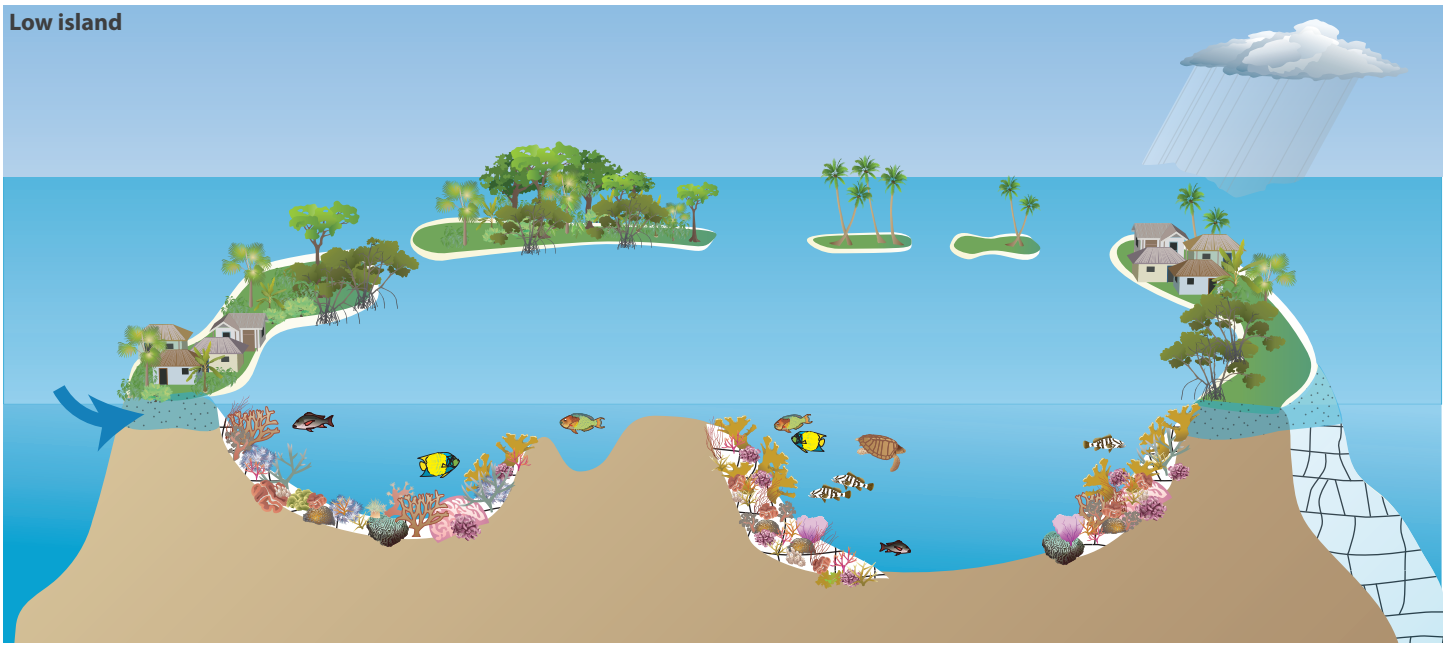
Pacific Island geology and hydrology amplify impacts of drought

Islands within the USAPI can be categorized as either "high islands," which can have peak altitudes as high as 200 feet above sea level, or "low islands," which are no more than a few tens of feet above sea level. The distinction between "high" islands and "low" atoll islands is essential to explain the different climates on islands and the many specialized terrestrial and marine ecosystems that have evolved, as well as the human communities they currently support.

Precipitation is the source of all freshwater on the Pacific Islands. Precipitation runs off land surfaces into the ocean via streams and runoff, returns to the atmosphere through evapotranspiration, or recharges groundwater. Among oceanic islands, fresh groundwater forms a lens-shaped body that overlies denser saltwater from the ocean. Groundwater naturally flows via streams and runoff toward the coast, discharging from lowland springs, streams, and seeps. On average, groundwater recharge is balanced by groundwater discharge, but droughts or unusually wet periods can result in short-term imbalances that cause the freshwater lens to shrink or grow. Climate variation and change affects not only surface-water resources, such as streams and lakes, but also groundwater resources.



High islands are less sensitive to drought because they are typically larger, with larger aquifers that are better buffered against salt water intrusion and drought than low islands. High islands tend to receive higher amounts of total rainfall because of orographic effects. High islands are also more conducive to the formation of freshwater streams, though they are typically ephemeral, especially during severe



Low islands are typically much smaller than High Islands, and as the name implies, often extend just a few meters above sea level at their highest point. They do not generate orographic rainfall, and have limited capacity to naturally store fresh water; aquifers are typically thin and highly sensitive to intrusions of sea water. As a result, low islands are especially prone to drought. Varied coral reef, mangrove, and lagoon habitats support rich marine ecosystems, which are especially important for resilience to changing climate.

Aloha kākou!

Despite our vast geographic distribution, the ocean connects our islands, our cultures, and our communities. Across the U.S.-Affiliated Pacific Islands, as in Hawai'i, fresh water is a precious resource and vital to maintaining our unique biodiversity, wildlife habitats, and resilient communities. We greatly appreciated the opportunity to have hosted an esteemed group of experts to inform us about the climate drivers that result in drought, as well as how such drivers vary widely across the islands. We discussed the ways in which climate variability may increase the risk of wildfires, as well as the direct and cascading impacts of drought on food security, fisheries, and human health; low islands are particularly vulnerable to the effects of drought. The workshop called us to focus our research efforts to better understand and predict the onset and severity of drought throughout the islands, with the goal of developing management strategies so that our communities can continue to be resilient and thrive.

– Janet Cushing and Darren Lerner, Co-Directors, Pacific Islands Climate Adaptation Science Center

The coastline of American Samoa. Photo from Jane Hawkey, UMCES Integration & Application Network.

The Department of the Interior Climate Science Centers (CSCs) and their managing organization, the National Climate Change and Wildlife Science Center at the U.S. Geological Survey, have chosen the emerging climate science field of Ecological Drought as a research focus area. This workshop is part of a series of meetings at each of the nation's eight CSCs aimed at collating our existing knowledge of the ecological impacts, resistance, and recovery from drought. The eight CSCs provide a fantastic opportunity to compare the ecological effects of drought, related research activities, and management options at different regions, spatial scales, and biomes.

Participants at the Ecological drought in the United States Affiliated Pacific Islands workshop held in Honolulu, Hawai'i in August, 2018.

For more information regarding ongoing research and activities at the Pacific Islands Climate Adaptation Science Center, visit pi-casc.soest.hawaii.edu

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