September 17, 2025

MEMO TO: ADEPT-1(10)

F R O M: Gabe Johnson, Chair
Agriculture, Diversification, Environment, and Public Transportation Committee

SUBJECT: **TRANSMITTAL OF INFORMATIONAL DOCUMENT RELATING TO CLIMATE CHANGE IMPACTS ON MAUI COUNTY** (ADEPT-1(10))

The attached informational document pertains to Item 1(10) on the Committee's agenda.

adept:ltr:001(10)afile02:ebm

Attachment

COUNTY OF MAUI, HAWAI'I

Climate and Community Trends Primer

Prepared by the Geos Institute (Climate Change Data and Models) and Sustainable Pacific (Community Characteristics)

May 2022

GEOS INSTITUTE

SUSTAINABLE PACIFIC

OFFICE OF CLIMATE CHANGE, RESILIENCY, & SUSTAINABILITY
Resilient MAUI NUI
County of Maui • Office of the Mayor

COUNTY OF MAUI
STATE OF HAWAII

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Introduction

While climate change is a global phenomenon, the impacts and opportunities for action occur locally. All communities in Maui County need to take action to protect people, property, indigenous Kanaka Maoli (Hawaiian) culture, and nature from climate-related risks. The actions that Maui County takes in the next decade will help to determine long term resilience.

This primer is intended as a starting point for identifying climate change vulnerabilities and associated adaptation strategies throughout Maui County. It includes both information about current and future climate trends as well as community characteristics.

The trends and projections in this primer are based on the latest available scientific information. They include observed changes in Maui County as well as projected future changes based on two scenarios — one in which the world carries on with business as usual in terms of greenhouse gas emissions and the other in which aggressive reductions in emissions are realized.

Community characteristics include demographic information about the residents of Maui County as well as the current state of its community systems. This section includes information about the local economy, natural systems, human health, infrastructure, emergency management, and vulnerable populations.

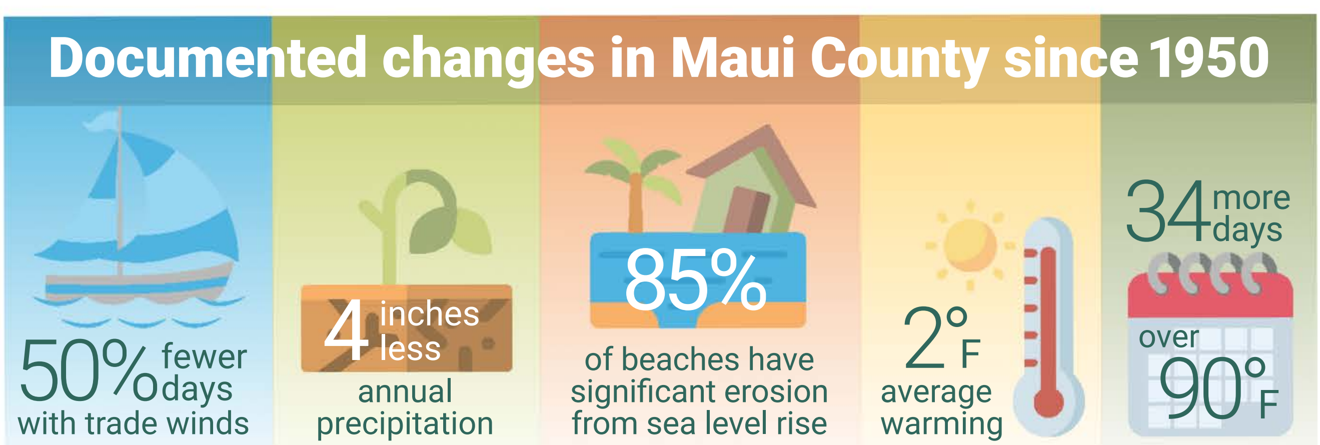
The climate trends and community characteristics are combined with local knowledge and cultural context, as well as the expertise of those responsible for designing and maintaining the various community systems. This provides the background necessary to complete a countywide vulnerability assessment, which will inform the larger Climate Action and Resiliency Plan for the County of Maui.

Climate Change and Maui County

Maui County includes the islands of Maui, Molokaʻi, Lānaʻi, and Kahoʻolawe. The islands of Maui County exhibit beautiful landscapes, diverse cultures and traditions, and rich natural resources. All islands except Kahoʻolawe are inhabited by people.

The islands of Maui County are deeply rooted in Hawaiian traditions, including nā hana lawaiʻa (fishing), nā hana mahiʻai (farming), ʻŌlelo Hawaiʻi (Hawaiian language), hula, and heʻe nalu (surfing). These traditions promote sustainability, resilience, and connection to the land and ocean while fostering interdependence between humans and the natural world. From this beginning, new cultures were introduced during the missionary, whaling, and plantation eras, which led to a decline in the Native Hawaiian population and its cultural practices. However, many of these cultural practices continue to this day and provide a solid foundation upon which Maui County can begin to reclaim a sense of sustainability. Practices such as mahi loʻi kalo (wetland taro cultivation) are known to reduce stream sedimentation and protect nearshore coral reefs, providing abundance both on land and in the sea. There is still much we can learn from Native Hawaiian practices and the relationships they encourage to live sustainably on these islands.

Each of Maui County's four islands is unique, with abundant natural resources creating a vibrant setting for residents, caretakers, and visitors. A key part of this vibrance comes from its ideal climate, which is changing over time as global climate change accelerates. Increased development, tourism, and environmental impacts exacerbate community, cultural, and environmental challenges. This primer provides an overview of existing community characteristics and historical and future trends associated with climate change across Maui County.



Projected Trends for Maui County	Mid-century (2050s)	Late-century (2080s)
Average temperature[5]	↑ +2 to +6°F	↑ +3 to +9°F
Number of days with extreme heat[9]	↑↑	↑↑↑
Percent change in wet season precipitation[7]	↓ −15%	↓ −23%
Percent change in dry season precipitation[7]	↓ −37%	↓ −52%
Drought severity and frequency[3,9]	↑	↑↑
Frequency of heavy rains and flooding	↑	↑↑
Northeasterly tradewinds[10]	↓↓	↓↓↓
Sea level rise (global average)[2]	↑ ~1 foot	↑ 2 to 3 feet
Ocean temperature (global average)[16]	—	↑ +5°F by 2100
Frequency of coral bleaching events[16]	↑ yearly	—
Declines in ocean fishery productivity[16]	↓ −15%	↓ −50%

Climate Change Data and Models

The Earth's climate is regulated by a layer of gases commonly referred to as greenhouse gases for their role in trapping heat and keeping the Earth at a livable temperature. These gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and water vapor (H_2O). CO_2 plays an especially large role due to its long residence time and relative abundance. The concentration of CO_2 in the atmosphere has risen from 280 to over 410 parts per million (ppm) in the past century, driven largely by fossil fuel combustion, with smaller contributions by deforestation and other human activity. CO_2 levels are about 40% higher now than prior to the industrial revolution.[2]

Information from ice cores provides us a glimpse into CO_2 levels over hundreds of thousands of years. This data shows us that CO_2 has fluctuated between about 175 and 300ppm over the last 800,000 years. The current level of 410 ppm is far above anything detected in the ice core analyses. As CO_2 has fluctuated in the past, it has tracked closely with changes in temperature, and we can expect this relationship to hold in the future as CO_2 and other greenhouse gases continue to rise.

The Intergovernmental Panel on Climate Change (IPCC), which is made up of thousands of leading scientists from around the world, has compiled a suite of more than 25 global climate models (GCMs) from different institutions with which to assess future trends. These models were created independently and vary substantially in their output. In addition, there are different potential "pathways" for future greenhouse gas concentrations (called Regional Concentration Pathways, or RCPs), which assume different levels of emissions.

All models have uncertainty because complex processes are simplified, and assumptions are made about how the earth's processes work. Thus, different models show different trajectories for a future climate, creating uncertainty in the projections. The uncertainty is similar to that associated with other types of models that we use every day to make decisions about the future, including economic models, population growth models, and environmental models. In the case of climate change, however, most uncertainty stems from human behavior related to reducing emissions, rather than the modeling process itself.

Results shown in this primer include those using the “business-as-usual” RCP8.5 trajectory, which results from continued higher emissions, and a lower RCP4.5 trajectory, which results from immediate and substantial global emissions reductions. While not shown here, the RCP2.6 trajectory, based on drastic cuts as well as active carbon sequestration in soils and forests, would achieve even greater emissions reductions.

When assessing climate risks based on model projections, it is important to consider the level of uncertainty associated with the projections. Temperature projections have fairly high certainty (agreement among many models) because all models show continued warming over the next few decades and beyond. Precipitation projections are more uncertain, however, with some projecting wetter conditions and others projecting drier conditions. Similarly, near-term projections have less uncertainty than longer-term projections, making near-term planning more reliable.

Global Climate Trends

Observed Trends – Global climate trends indicate an urgency to act at the local level to address greenhouse gas emissions. The hottest year on record was 2016, at 1.8°F above the 20th century average. 2020 was the second hottest. In fact, all years from 2015-2020 fall within the top 6 hottest years.

Projected Trends – Models project continued average global warming of 3-9°F (1.5° to 6°C) by the end of this century and continued warming up to 23°F over the next two centuries if business-as-usual emissions continue (Fig. 1; RCP8.5). The international community of leading scientists and policy-makers has determined that warming over 3°F (1.5°C) is unsafe for the continued well-being of people worldwide and the natural resources we rely on.

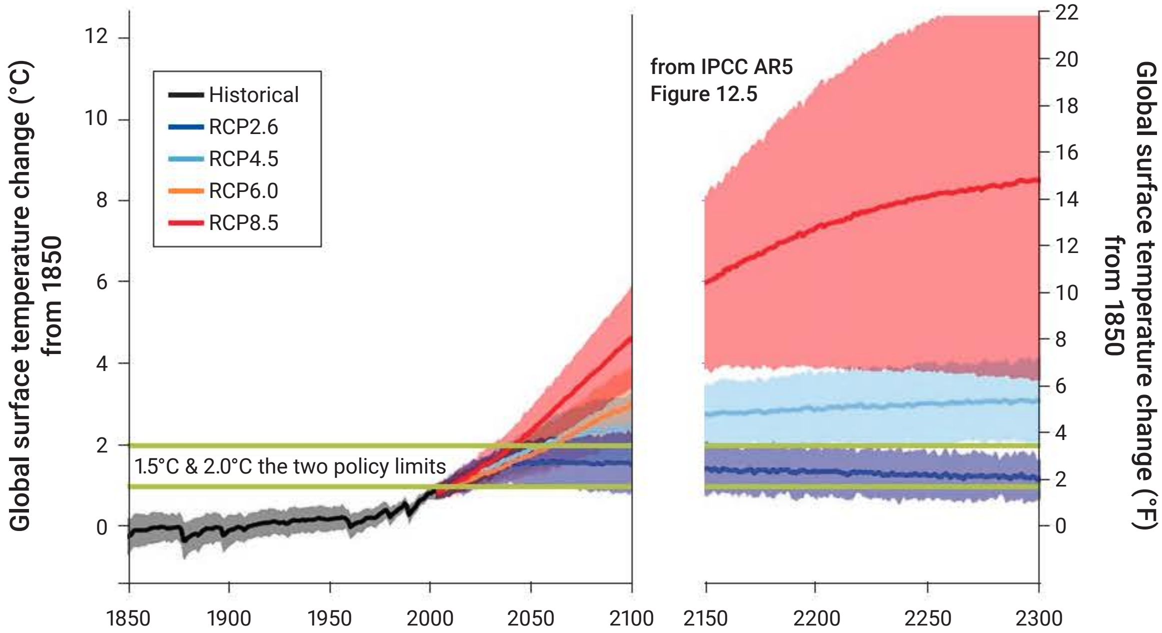


Figure 1. Global annual mean temperature anomalies (difference from historical average) from 1850 to 2300. Modeled values are CMIP5 multi-model means (solid lines) and 5 to 95% averages (shaded) based on different trajectories for future GHG concentrations. Graph adapted from IPCC 2014.

Hawaiʻi Climate Trends

Temperature

Observed Trends – Climate shifts have been documented across the state of Hawaiʻi, where the annual average temperature has risen about 2°F since 1950.[3] Higher elevations are warming fastest (about 1°F every 20 years).[4]

Average temperature at the Kahului Airport has risen 2°F since 1955 (Fig. 2), with 2019 and 2020 the hottest on record. Other locations around Maui County have less complete datasets, but show similar warming trends (Fig. 3).

The number of days above 90°F has also risen in Kahului, spiking in recent years as high as 162 days in 2019 (Fig. 2). From 1955-1964, the average was only 6 days/year, whereas the average reached almost 40 days/year in the last decade.

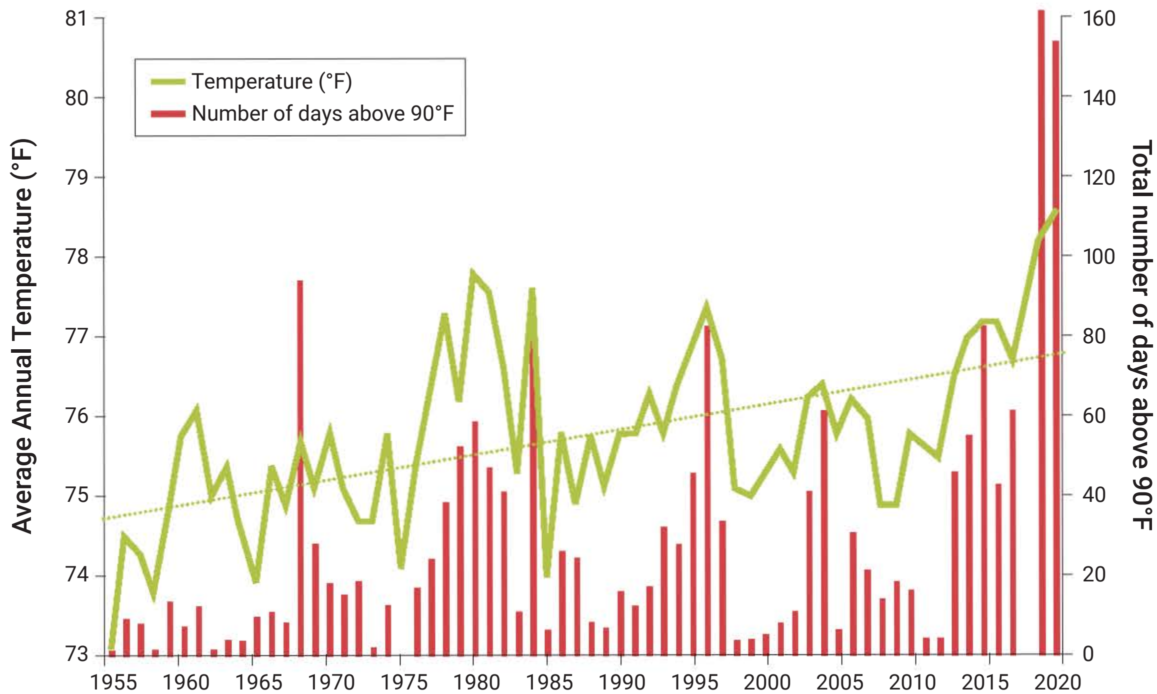


Figure 2. Average annual temperature at the Kahului Airport and the number of days above 90°F in Kahului from 1955–2020.

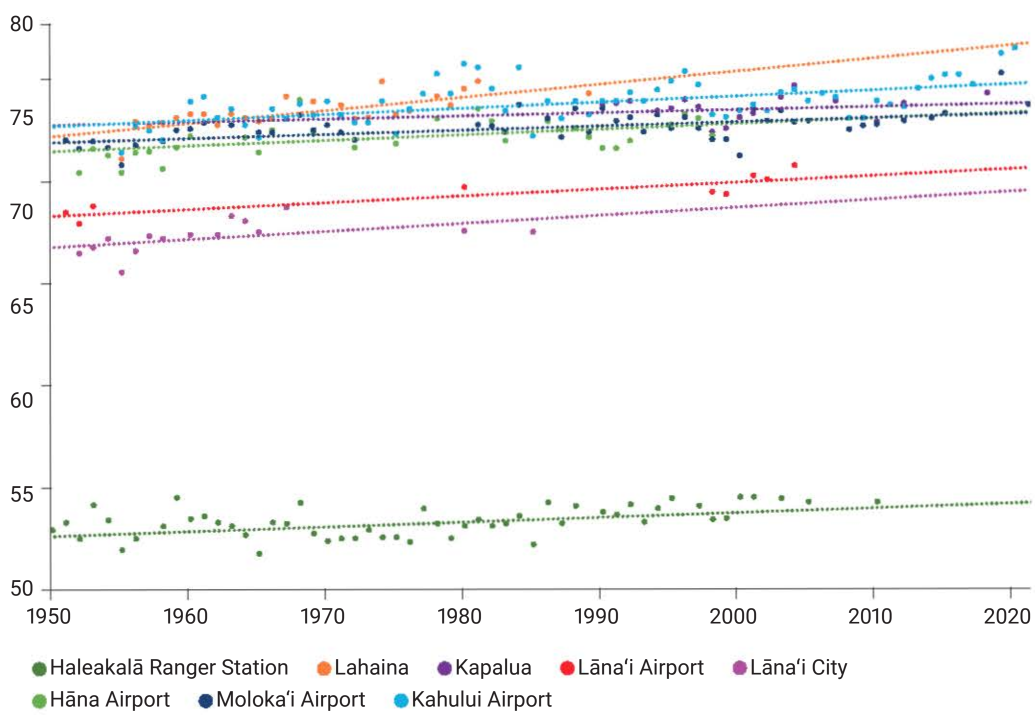


Figure 3. Trends in average annual temperature from 1950 to 2021 at eight different weather stations across Maui County. All datasets of varying geographic locations, time frames and number of data points show similar warming trends.

Projected Trends – Across the state, warming of up to 10°F is projected to continue through the end of this century (Fig. 4), if emissions continue unabated (RCP8.5). If emissions are reduced aggressively at a global scale, warming could level off at a few degrees.

Temperatures across Maui County are expected to continue to rise (Fig. 5). Models project 1° to 4°F warming by mid-century (2041-70) and up to 5°F by late century (2071-99) if emissions are reduced globally (RCP4.5). If emissions continue unabated, temperatures are expected to increase 2° to 6°F by mid-century and 3° to 9°F by late-century.[5]

Observed and Projected Temperature Change

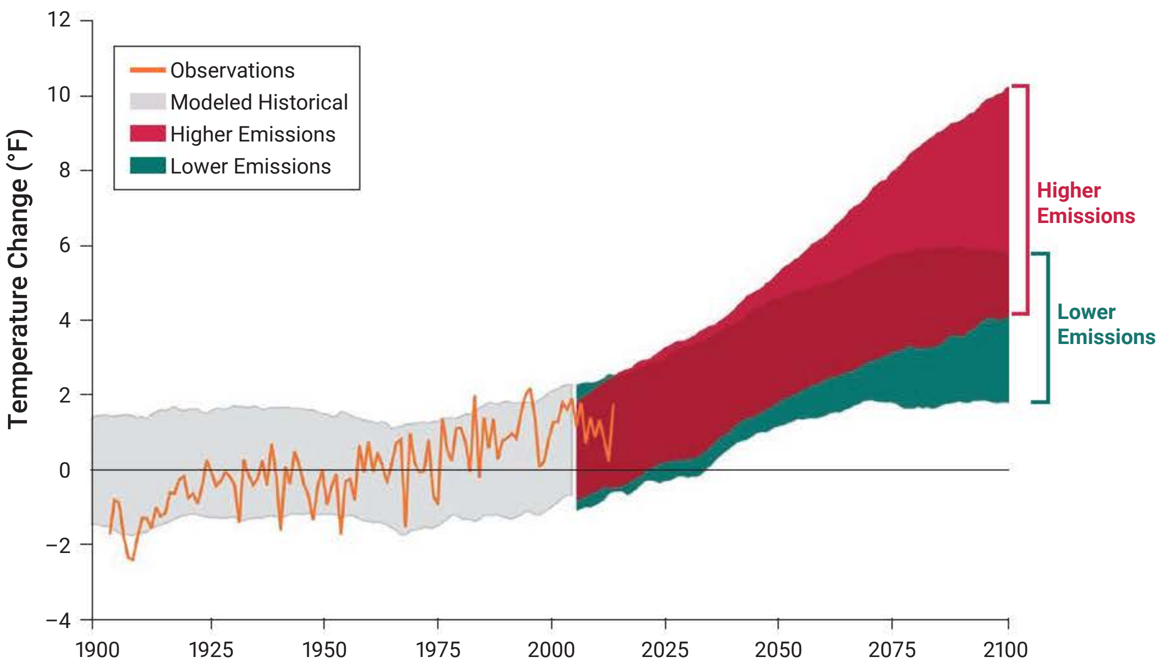


Figure 4. Observed and projected temperature change in Hawai'i, compared to 1951–1980. The higher emissions pathway is RCP8.5 while the lower emissions pathway is RCP4.5. Source: CICS-NC and NOAA NCEI.

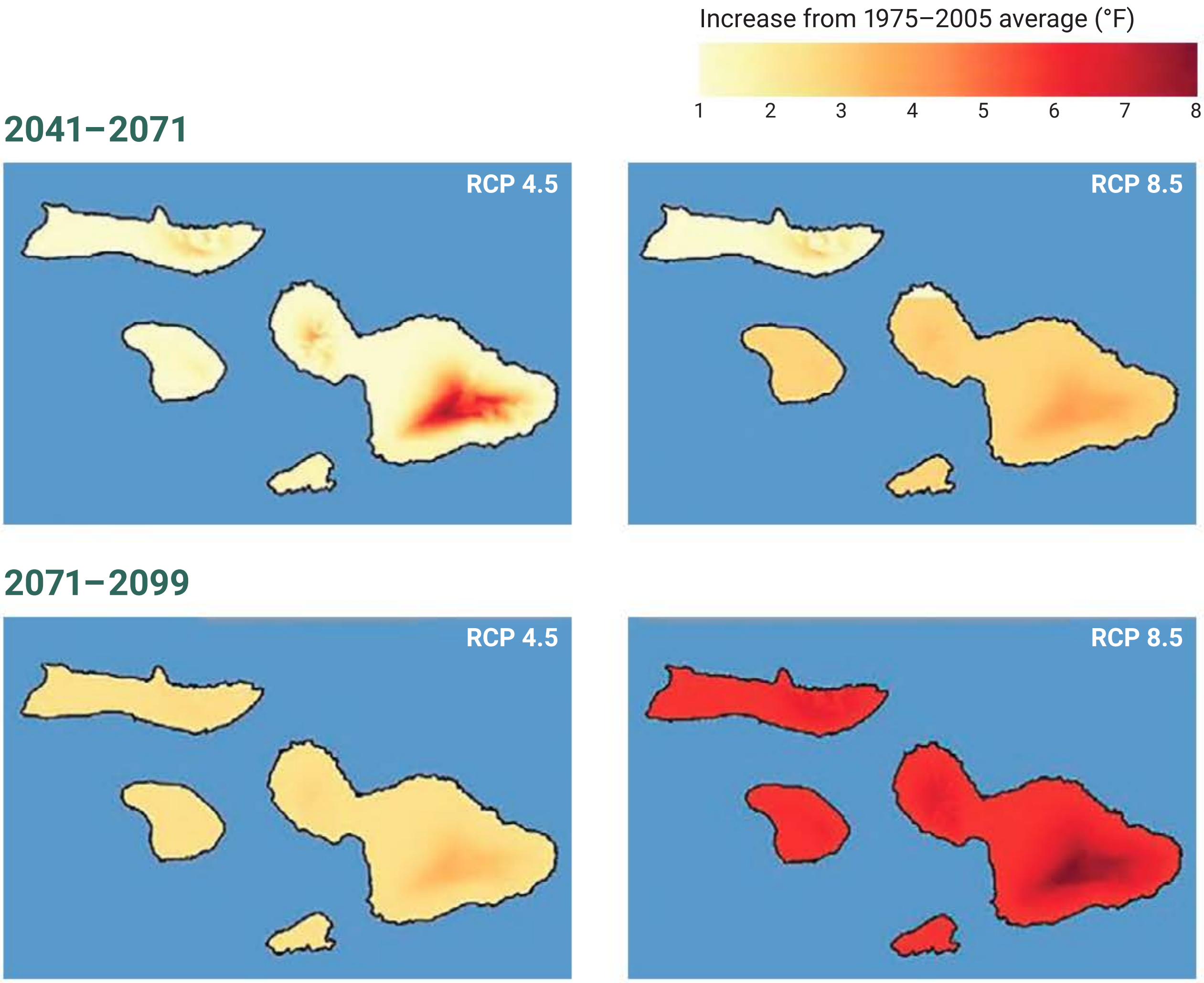


Figure 5. Average temperature is expected to continue to increase across Maui County. If global emissions are reduced (RCP 4.5) warming can be limited to about 1° to 5°F (3°F average) by late century. If global emissions continue on the business-as-usual trajectory, Maui County is expected to warm 3° to 9°F (6°F average).[5]

Precipitation

Observed Trends – Precipitation varies substantially from year to year. Annual rainfall has decreased state-wide since 1950. Dry-season precipitation has declined for most areas of Maui County except Molokaʻi. Wet-season precipitation decline has been significant as well, with declines of 1 inch per decade from 1920-2012.[6]

At the Kahului airport on Maui, average annual precipitation declined by about 4 inches from 1955 to 2020. Similar declines were observed across all weather stations, except the Hāna Airport (Fig. 6). At Kahului, the number of days per year with more than an inch of precipitation declined slightly from 1955 to 2020. The number of days per year without any rainfall increased slightly.

Projected Trends – Precipitation across Maui County is expected to continue to decline in coming decades (range from –1% to –45% by mid-century and +1% to –70% by late-century with continued higher emissions). Average

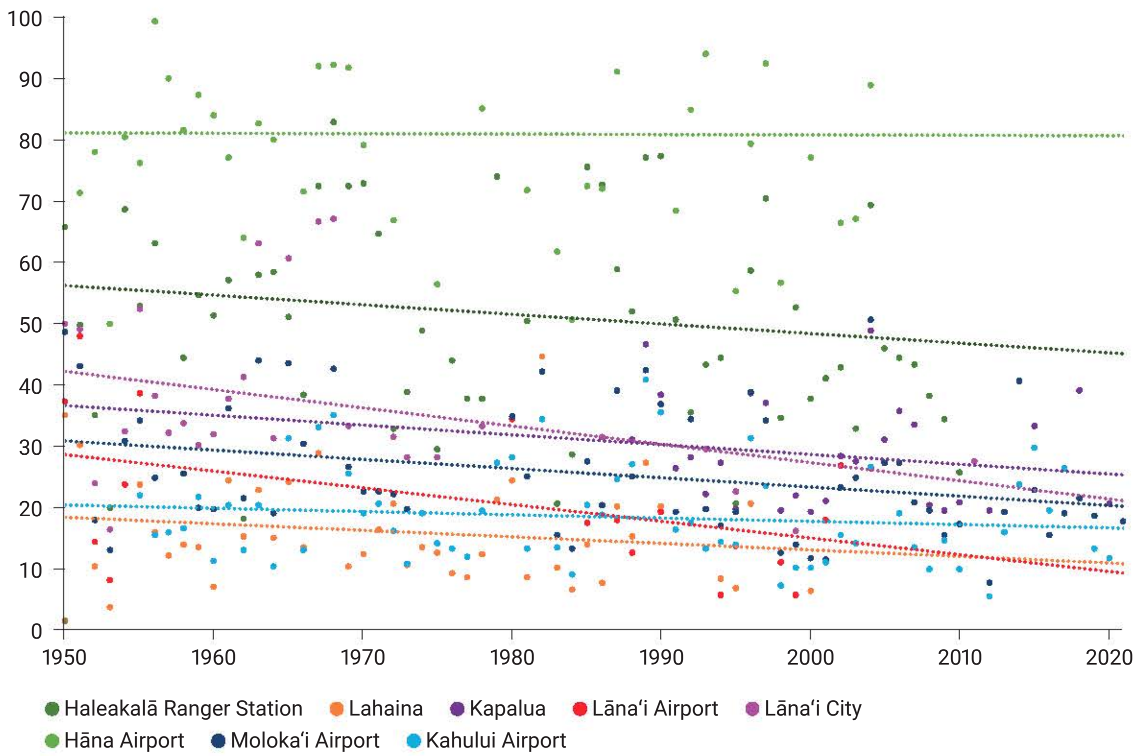


Figure 6. Trends in average annual precipitation from 1950 to 2021 at eight different weather stations across Maui County. All datasets of varying geographic locations, time frames and number of data points show declining trends in precipitation, except the one collected at the Hāna Airport.

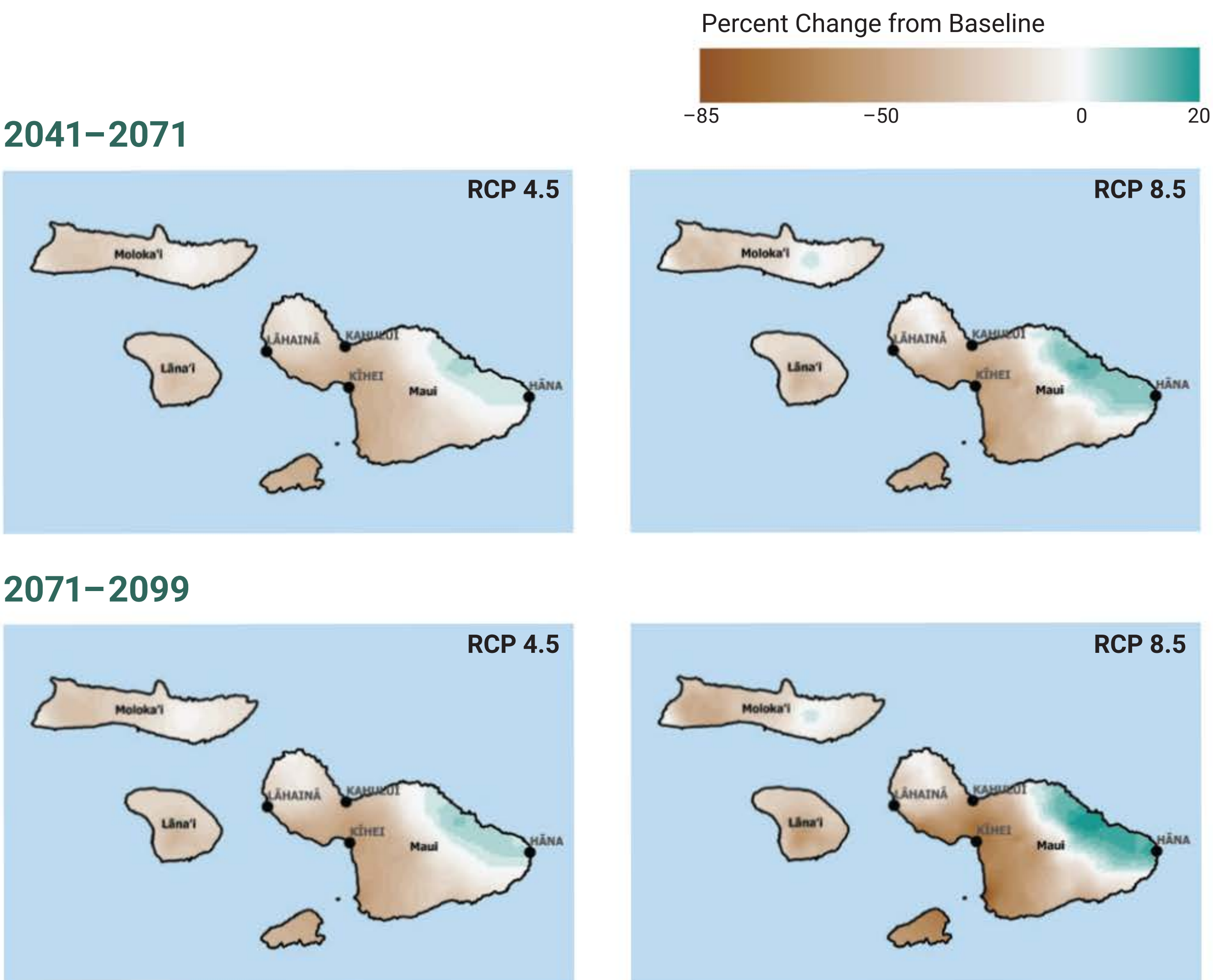


Figure 7. Percent change in precipitation during the wet season across Maui County. Downscaled CMIP5 [7] data accessed from http://apdrc.soest.hawaii.edu/projects/SD/.

change is projected to be around –52% during the dry season and –23% during the wet season, but projections vary substantially (from +6% to –96%). The dry side of the islands is expected to become drier, while projections for the wet side range from 14% wetter to 27% drier.[7] See Figure 7.

Hawaiʻi straddles the transition between wetter conditions in the tropics and drier conditions in the subtropics, making precipitation projections particularly challenging. It is likely that the currently wet windward sides of the major islands will see an increase in rainfall, while the currently dry leeward sides will experience a decrease in rainfall.

Drought

Drought events have increased in duration across all islands since the 1950s.[8] Continued changes in major weather patterns such as El Niño Southern Oscillation (ENSO) are likely to increase drought severity and frequency in future decades. More frequent El Niño conditions, which are associated with lower rainfall, are increasingly likely as climate change intensifies.[9] Low- and mid-elevation leeward areas are most at risk of declining soil moisture and increasing drought. Higher temperatures will increase the rate of loss of soil moisture during dry periods, leading to increased intensity of droughts, even if precipitation rates do not change.[3]

Heat waves

Maui is already experiencing more days of extreme heat (Fig. 2). The heat waves of 2020 were exacerbated by warmer ocean temperatures, a lack of wind associated with El Niño weather patterns, and urban development. Ocean temperatures as high as 86°F have been measured off the coast.

More frequent and intense extreme heat days are expected as climate change intensifies,[9] with extensive impacts to natural systems and human health, including increased mortality.

Wind

Hawai'i's historical climate was characterized by incredibly reliable winds that moved warm tropical air from the equator to the north and south, in high-altitude jet streams. Cooler air from the northeast was then pulled in to replace the hot air, collecting moisture and creating trade winds that kept Hawai'i's climate so blissful and provided reliable rainfall. From 1973 to 2019, winds in Hawai'i shifted from northeast to east, with northeast trade winds declining from 291 days/year to 150 days/year (from 80% to 41% of the year).[10] A shift from northeast to east trade winds has brought more heat and drought to the region. The shift has been called "really alarming" by State Climatologist Pao-Shin Chu, and is expected to continue to worsen as climate change accelerates.

Baldwin Beach Remnant Cesspool Summer Erosion (2016)

Heidi Sherman / Used with permission

Sea Level Rise

Global mean sea level is rising primarily from (1) thermal expansion of ocean waters with higher water temperature, and (2) melting of land-based glaciers and ice sheets. Since 1880, global sea level has risen by about 8 inches.[3] Sea level across the state is projected to rise another 1–3 feet by the end of the 21st century (Table 1), but could occur as early as mid-century, and higher levels are also possible (as high as 6-9 feet).[2] The threat of 3 feet or more sea level rise in this century is real and unlikely to diminish given emissions already released and the overall trend in higher and more rapid projections.[2]

Sea level rise has already caused severe impacts to Maui County's coastlines. At the Kahului Harbor, mean sea level has risen about 0.9 inches/decade (Fig. 8). Continued sea level rise of 1-3 feet will lead to more areas affected (Fig. 9).

Eighty-five percent of Maui's beaches have already been eroded over the past century, with more than 13 miles (11%) of beaches completely lost.[1] Coastal armoring also contributes to beach loss, with 4 miles of Maui's beaches lost in

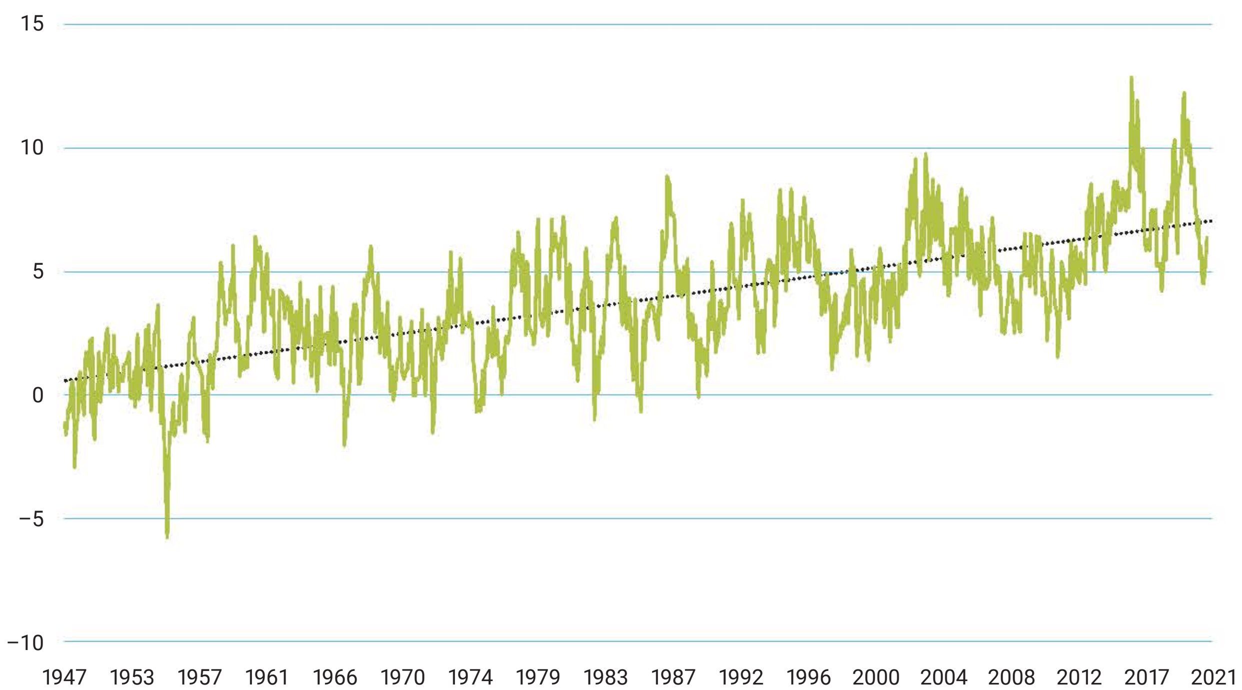


Figure 8. Mean sea level rise (in inches) at the Kahului Harbor since 1947, with the average seasonal cycle removed, as compared to the 1947–1976 average.

King Tide Flooding Honoapiʻilani Highway (2017)

Asa Ellison / Used with permission

front of seawalls and other armoring. If more armoring is allowed, many more miles could be lost. These trends are calculated from about 100 years of historical shorelines from the 1900s to the early 2000s.

Extreme events in Hawaiʻi (from a combination of sea level rise, high tides, and storms) have increased in frequency from every 20 years to every 5 years.[11] Sea level rise continues to present major challenges to coastal resources and populations, due to erosion and inundation. Sea level rise leads to impacts in three primary ways, as depicted in the Hawai'i Sea Level

Rise Viewer — passive flooding (high tide flooding), annual high wave flooding, and erosion (land loss).[12]

Some of the impacts associated with sea level rise include marine flooding, drainage problems, salt-water intrusion, changes in waves dynamics with greater wave power at the shore, increased beach and coastal erosion, and higher storm surges, tides, eddies, and waves. Significant flooding already occurs during especially high tides and storms. Periodic flooding is expected to increase in frequency and severity as climate change accelerates.

Table 1. Global mean sea level rise projections relative to the 1986-2005 average, based on IPCC RCP 8.5 (continued higher emissions).[14]

Year	Projections
2030	0.3–0.6 feet
2050	0.6–1.0 feet
2075	1.1–2.0 feet
2100	1.7–3.0 feet

Lahaina **Kahului**

Figure 9. Sea level rise is projected to affect the coastlines across Maui County. If sea level rise is limited to 1:1 feet, inundation and associated impacts will be reduced. GIS Data from Tetra Tech, Inc. and University of Hawaiʻi Coastal Geology Group. 2017. Sea Level Rise – Exposure Area. http://www.hawaiisealevelriseviewer.org.

SLR Exposure Area

Sea level rise will also affect Hawai'i's coastal water management system and could cause extensive economic damage through ecosystem damage and losses in property, tourism, and agriculture.

Many coastal resilience initiatives and tools have been developed, including the State of Hawai'i's Sea Level Rise and Adaptation Vulnerability Report,[2] the Sea Level Rise Viewer[12] and the West Maui Community Plan for Climate Change and Sea Level Rise.[13] The Sea Level Rise viewer allows visualization and site assessment of impacts associated with passive flooding, annual high wave flooding, and erosion.

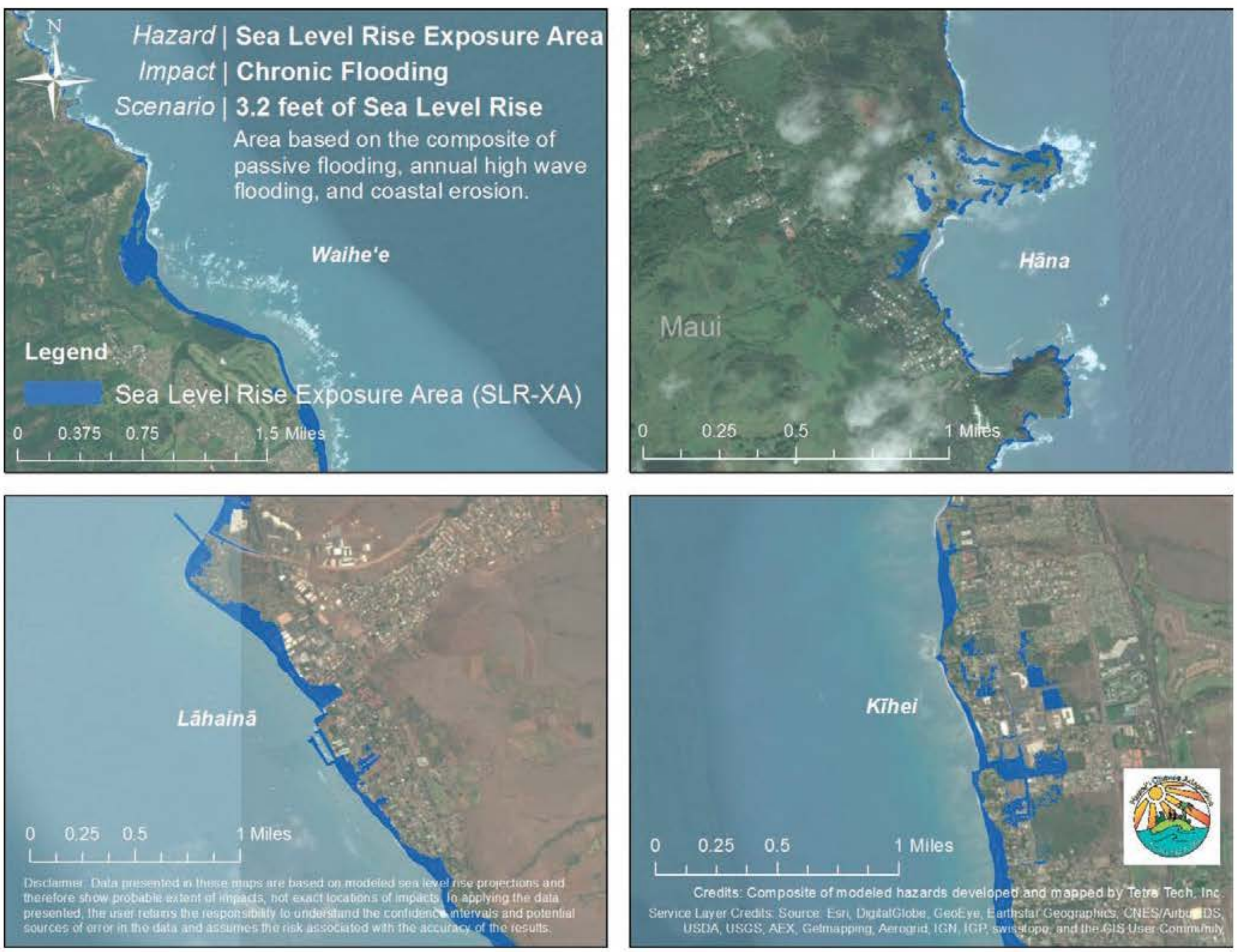


Figure 10. Potential chronic flooding with 3.2 feet of sea level rise in four areas on Maui. From Hawai'i Climate Change Mitigation and Adaptation Commission 2017 report.[2]

Valkyrie Pierce / CC0

Ocean Temperature and pH

Average global sea surface temperatures have increased by approximately 1.5°F over the past century. Sea surface temperatures closely follow air temperature and large-scale climate variability events such as the El Niño Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). Ocean temperatures are projected to continue to increase up to 5°F by 2100. Ocean temperatures are closely linked to the health of aquatic ecosystems, including corals and fisheries.

Oceans have absorbed approximately 1/3 of global CO_2 emissions since the industrial revolution, corresponding to a 26% increase in acidity.[15] This trend is expected to continue, with ocean acidity continuing to increase as more CO_2 is absorbed over time.

Increased ocean acidity leads to a lack of available carbonate for corals and shells. This can disrupt corals, phytoplankton, lobsters, clams, and a variety of other species.

Coral reef ecosystems are vitally important for local subsistence, tourism, and coastal protection. Coral reefs inject $364 million dollars in goods and services each year into Hawai'i's local economy. Widespread coral bleaching has become more common, with mass events in 2014, 2015, and to a lesser extent 2019. By mid-century, these events are projected to occur every year.[16]

Hawai'i's open oceans support sea turtles, sea birds, marine mammals, and economically valuable fisheries of tuna and other pelagic fishes. Declines in oceanic fishery productivity are expected to reach 15% by mid-century and 50% by late-century, if emissions continue unabated.[16]

Major Weather Patterns

Winds vary significantly based on ENSO and PDO phases. El Niño events can cause sea levels to rise an additional 6-21 inches above mean conditions. A doubling in the occurrence of El Niño events has been projected.[17] These events can also sustain more tropical cyclone activity and associated wave action, flooding and erosion.

Wildfire

The area burned by wildfire in Hawai'i has increased 4-fold within the last century.[18] The proportion of land area affected is comparable to the Western U.S. The combination of non-native grasses, more frequent drought, frequent high winds, and human-caused ignition create favorable conditions for wildfire. Natural wildfire ignition is largely absent in Hawai'i, except during volcanic eruptions, so wildfire and ignition patterns are closely linked (Fig. 11).

Increasing temperatures and drought, combined with a growing human population and expanding invasive grass cover, are likely to continue the increase in wildfire occurrence that has been observed since the beginning of the 20th century.[3]

Between 1999 and 2019, there were 80 wildfires that impacted Maui County. The number of wildfire events increased over the decades with 16 fire events occurring in 2019 compared to the average of four per year. The Leeward areas of Maui County are drier, more likely to experience drought conditions, and are at higher risk for wildfires.

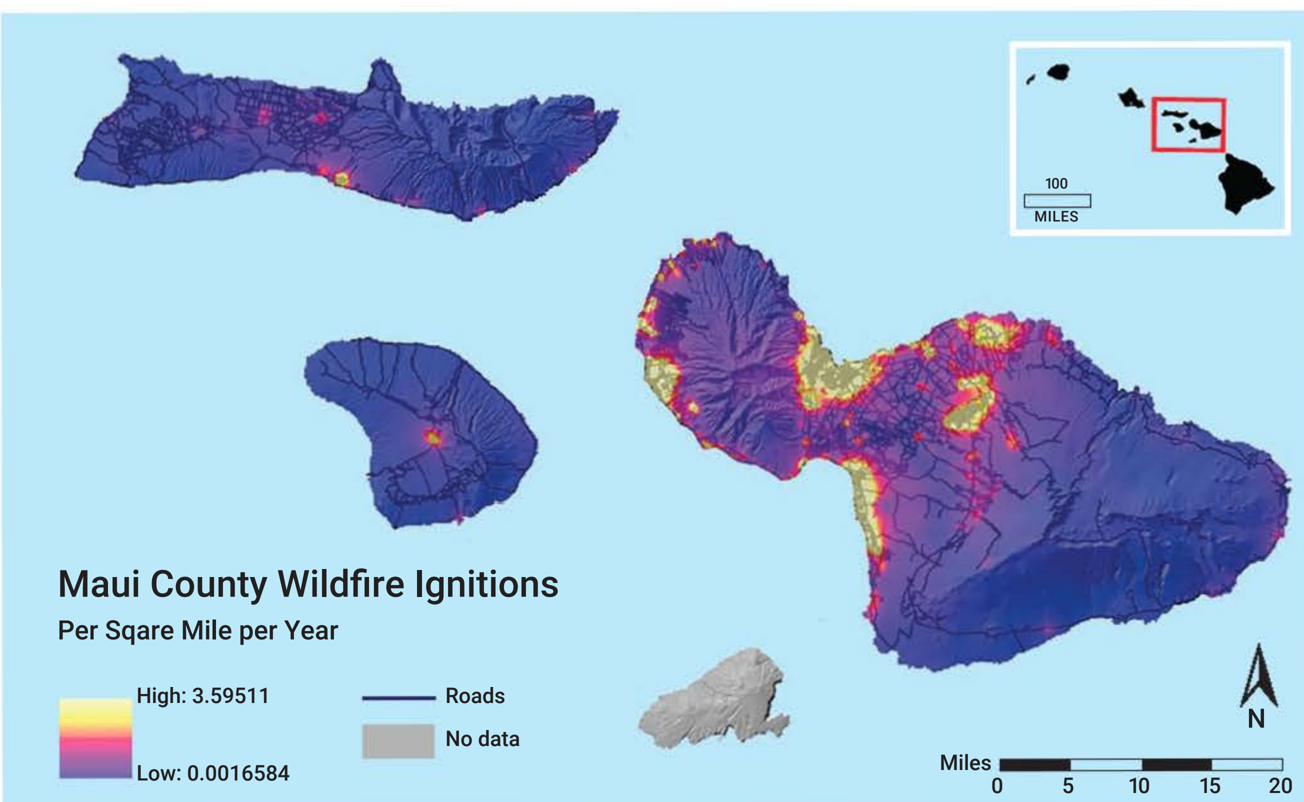


Figure 11. Wildfire ignition density in Maui County, based on data from 2000–2012. Map from Trauernicht and Lucas 2016.[19]

Natural Habitats and Services

A 2018 vulnerability assessment for Maui County (Maui, Molokaʻi, and Lānaʻi) ranked Maui's natural systems by their overall vulnerability to climate change, based on exposure, sensitivity, and adaptive capacity.[20] This assessment revealed that most habitats and services are moderately to highly vulnerable. The most vulnerable habitats and services included:

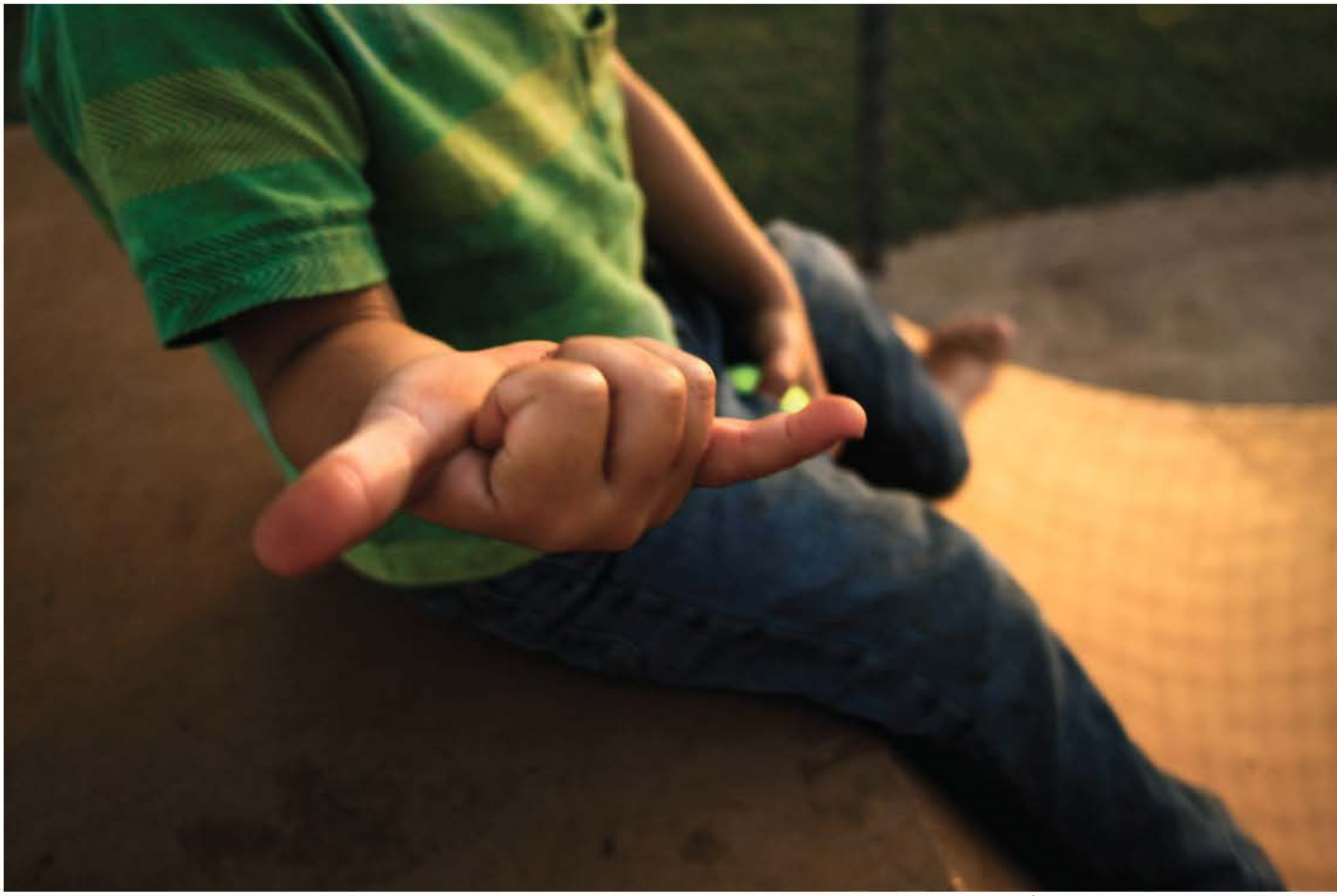
- Coastal beaches (due to erosion and inundation)
- Anchialine pools (due to salinity and water depth changes)
- Dry forest (due to changes in precipitation and soil moisture)
- Cultural knowledge and heritage (due to the potential loss of native ecosystems and species, and inundation of cultural sites)
- Flood and erosion control (due to flash floods, drought, and wildfire)
- Freshwater supply (due to more drought, changing precipitation, and sea level rise).

Many natural habitats and services are already impacted by human development and disturbance. For example, over 90% of Maui's dry forest area has already been lost and the remaining area is fragmented and at risk. Similarly, indigenous Hawaiian knowledge and heritage is still affected by colonialism, as well as a lack of societal recognition and support. Strategies for reducing vulnerability will need to address ongoing stressors as well as climate change impacts.

Curt Smith / CC BY 2.0

Community Characteristics

The impact of changing climate conditions on any particular area is influenced heavily by the characteristics of that landscape and the human communities that inhabit it. Considerations such as population demographics, how the community has developed the landscape, how it responds to natural disasters, what drives the local economy, and who in the community is already vulnerable due to low income or historic inequities, have considerable influence on the magnitude of threat posed by climate impacts. These characteristics also affect how residents will experience those impacts. The Community Characteristics section of this primer provides information regarding the current state of various community systems within Maui County.



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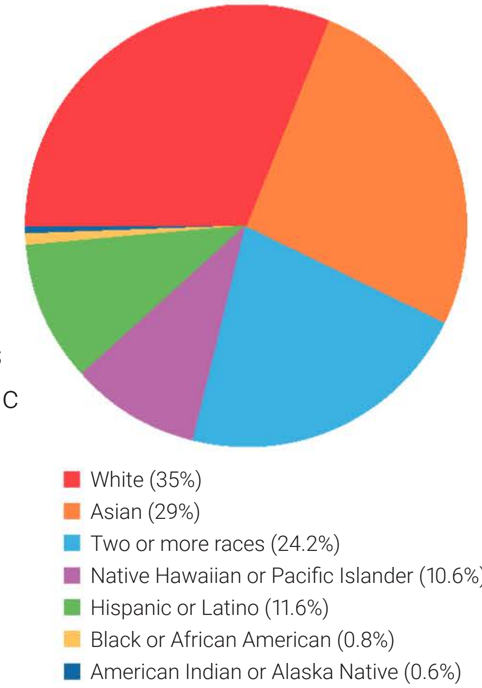
Demographics



Population Trends

Maui County's population is 168,307 (2021), a slight increase of 0.3% from 2020. The population grew approximately 8% from 2010-2020. About 35% of the population identifies as White, 29% as Asian, 24.2% as two or more races, 10.6% as Native Hawaiian or Pacific Islander, 11.6% as Hispanic or Latino, 0.8% as Black or African American, and 0.6% as American Indian or Alaska Native. The County has a large population age 65 and above (19%) and under 18 years of age (21.6%).[21]

Income and Housing

Income and housing disparities are a growing concern in Maui County. The median household income was $80,948, and per capita income was $35,241 in 2019. About 10.7% of the population was under the poverty level in 2019. The median value of home prices was $1.1 million in 2021, a 19.3% increase compared to the year prior,[22] while median household income only trended toward a 5% increase per year.[23] During the pandemic in 2020, unemployment increased from 2% to over 32%.

Natural Systems

From its first inhabitants to the present day, the worship and protection of natural systems has been embedded in Hawaiian society. Resources are intrinsically limited on most island communities, and in Hawai'i, the first early arrivers adopted an "island worldview" upheld by certain kapu (a set of rules and prohibitions for everyday life). The "island worldview" recognized natural systems and resources as bounded and precious, seeking to preserve the sanctity of mana (an expression of supernatural power). The kapu were established through mindful observation and communal interdependence and ensured that resources were harvested at proper times and at appropriate quantities to ensure the long-term sustainability of the community.[24]

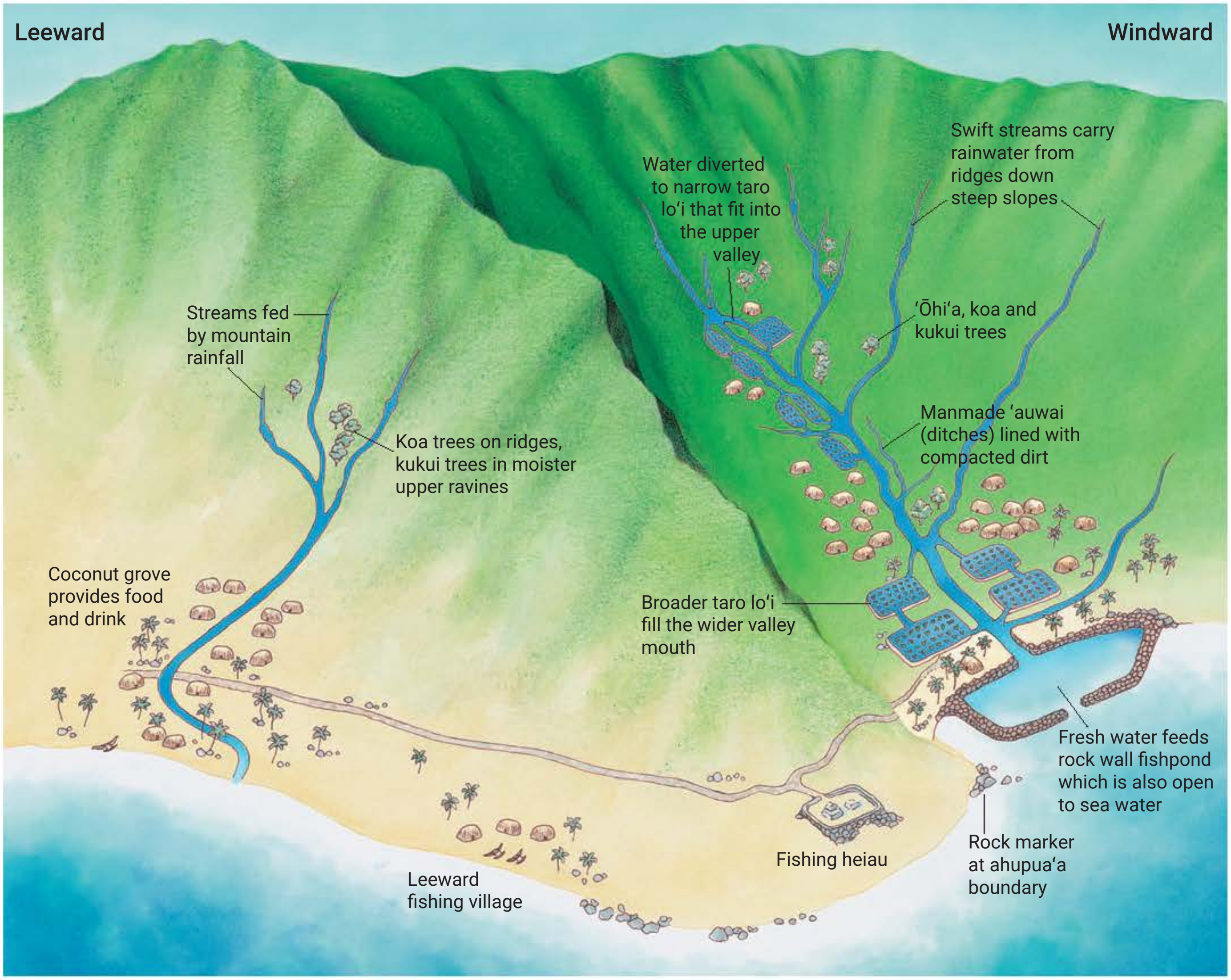


Figure 12. An illustration of ahupuaʻa system. From http://www.hawaiihistory.com

Prior to the arrival of Europeans in 1778, the communal interdependence of the Native Hawaiians became the seed that established Hawaiʻi's primary land divisions. Each island was subdivided into districts or moku, which radiated downward from the summit of the mountain to the ocean. Each moku was divided into ahupuaʻa, which included a section from mauka (mountain) to makai (ocean).[25] Each ahupuaʻa supported all of the material needs of each community (Fig. 12). The island of Maui has over 200 ahupuaʻa within twelve moku. Each community developed intimate knowledge of the ʻāina (land) and a deep understanding of how to maximize yield with limited island resources. The ʻāina and its natural resources remain a core element in the identity and prosperity of the Hawaiian community.

Maui County experiences many microclimates. The islands of Hawaiʻi are split into windward and leeward sides. The windward sides are north and east-facing and typically wet and rainy. The leeward sides are south and west-facing and are dry, receiving little to no rain. The Island of Maui is home to many microclimates varying from hot and semi-arid to tropical monsoon. On the island of Maui, Haʻikū gets the most rainfall with over 55 inches of rain annually,[26] while Wailea/Kīhei receives the least with seven inches annually. Maui County has 210 miles of coastline: Maui island has 120, Lānaʻi has 47, Molokaʻi has 88, and Kahoʻolawe has 29.[26] The tallest summit in Maui County is Haleakalā's Puʻu ʻUlaʻula ("Red Hill") at 10,028 feet.[26]

Infrastructure

Hawaiʻi is the most remote landmass in the world. While Hawaiʻi was completely self-sustaining prior to the arrival of European and Western influences, it has since become dependent on the rest of the world for its resources. For instance, over 80% of its food is imported and over 70% of its energy sources are imported as fossil fuels.

Energy

The State of Hawaiʻi currently generates about 35% of its electricity from renewable resources. Due to its remote location and dependence on fossil fuels from abroad, Hawaiʻi set a goal to generate 100% of its energy from clean energy sources by 2045. Maui County reached 50% in its renewable portfolio standard (RPS) in 2021. Renewable sources include solar, wind, and biofuels. The future plan includes an additional 175 MW of new solar-storage hybrid power plants over the next three years.[27] This is expected to be enough power to supply Maui Electric's 70,000 customers without using conventional generation for many hours of the year.

Water

Maui County has eight community planning districts: Hāna, Kīhei-Makena, Lānaʻi, Makawao- Pukalani-Kula, Molokaʻi, Pāʻia-Haʻikū, Wailuku-Kahului, and West Maui. Hāna and Molokaʻi use groundwater. Kīhei-Makena and Wailuku-Kahului use groundwater from the ʻĪao Aquifer under the West Maui Mountains. That water is naturally filtered by lava rocks, disinfected, and delivered. West Maui uses a mix of surface water and groundwater. The water treatment facilities for West Maui are located above Lahainaluna School and near the Kapalua Airport. Haʻikū mostly uses well water from wells or water treatment facilities, and Makawao- Pukalani-Kula receives surface water from the streams in East Maui. It is treated and disinfected at one of three water treatment facilities before it's delivered.[28]

Maui County, especially the island of Maui, is well-known for its waterfalls. Major named waterfalls include Honokōhau, discharging an average of 26 million gallons of water per day; Waimoku, discharging an average of 37 million gallons of water per day; and Waihiʻumalu, which has an unknown amount of water discharge.[26]

Roads & Transportation

Coastal Maui County roads are vulnerable to changing climate trends, especially due to sea level rise. Across the County, 13.6 miles of roads are at risk of flooding from sea level rise (Fig. 13). Hawai‘i officials have proposed moving parts of a Maui coastal highway to higher elevations. The State Department of Transportation plans to spend $90 million moving 4.5 miles of Honoapi’ilani highway further inland.[29]

King Tide Flooding Honoapi‘ilani Highway (2017)

Asa Ellison / Used with permission

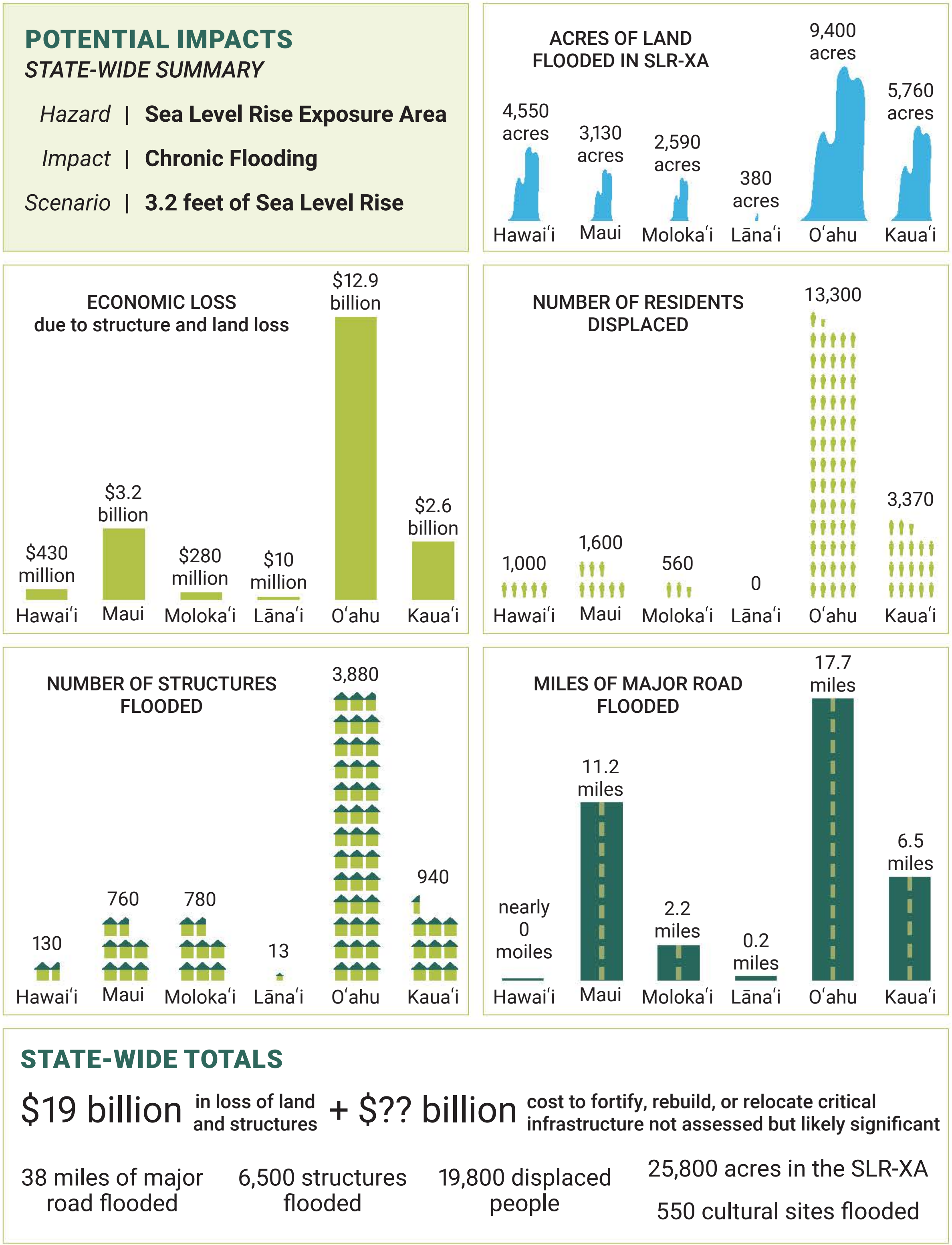


Figure 13. Summary of potential impacts in the SLR-XA with 3.2 feet of sea level rise (chronic flooding) in Hawaiʻi.[2]

Emergency Management

Flood Risk

Heavy rains often occur in Maui County from October through April. Flooding also regularly occurs due to the following types of storms[30]:

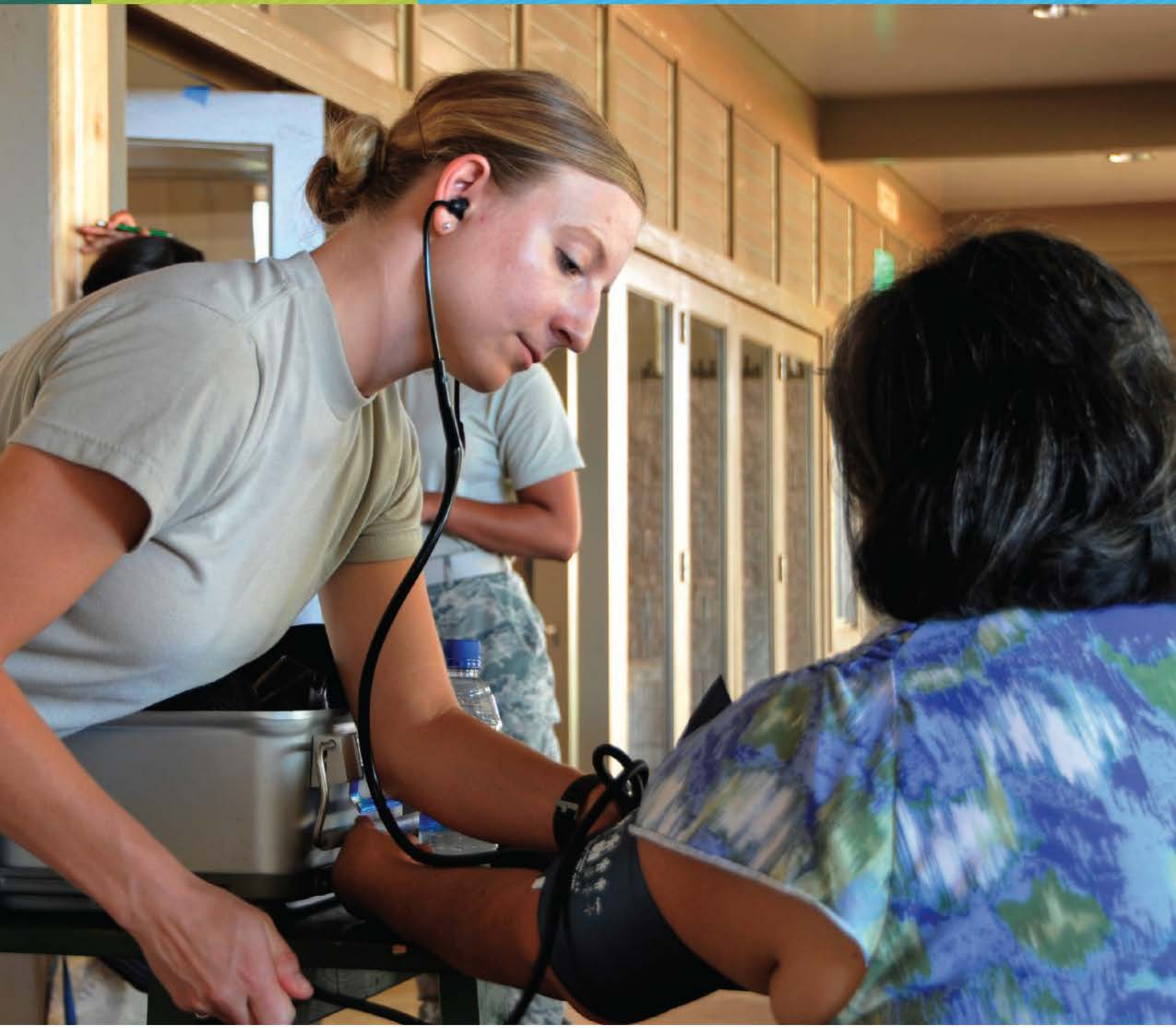
1. **Kona Storms:** These occur during the wettest period of the year from November to April. The potential combination of high winds and heavy rains can cause coastal and inland flooding over large geographic areas.
2. **Frontal Storms:** These usually occur from December through March and originate as a result of the intersection of polar and tropical air masses and move eastward over the islands. Low-lying areas with poor drainage are prone to landslides and flash floods during these storms.
3. **Upper Level Lows:** These can occur any time of the year. In many instances, upper level lows have little or no effect on the lower levels of the atmosphere.
4. **Tropical Hurricanes:** These storms pass near the Hawaiian Islands and can cause heavy rains, storm surge, high winds, and surf.

Natural Disasters

Hurricanes and tropical storms can impact all of the islands in Maui County. The most populated areas of Maui Island—Kahului, coastal areas of Wailuku, and Kīhei—are all within potential storm surge locations. On the Island of Molokaʻi, Kaunakakai is the island's most populous town and is mostly within estimated storm surge areas.[31]

Inland flooding, not as common on Molokaʻi and Lānaʻi since they are sheltered from northwest swells, has had the most wide-ranging impacts on Maui. The mountains and valleys on the eastern side of Maui are younger and less developed, cutting down to a narrow coastline. The north shore and Hāna coastlines have the most flooding histories, experiencing regular road closures due to flash floods and mudslides. Major floods occur about once a decade from Iao Valley into the urban centers of Kahului and Wailuku. The Kīhei and Lahaina regions are more prone to extreme drought, which can make them vulnerable to standing surface water flooding after intense rainfalls due to inadequate drainage from poor soil permeability and development of these areas.

Over the last 220 years, there were 61 tsunami events reported. Maui County's tsunami hazard potential has a "likely" probability of a 1% to 10% annual chance. Damaging tsunami events are less frequent. The 1946 tsunami was the deadliest in Maui's recorded history, with a total of 14 reported deaths, while the March 2011 tsunami was the costliest, with almost $6.4 million in reported damages. Recently, Maui County adopted an emergency alert system[32] that includes a three-minute tone to alert the island in the event of an emergency. A monthly test siren is conducted on the first State workday of every month.



Physical and Mental Health

Mental Health and the Covid-19 Pandemic

The COVID-19 pandemic created a significant mental health stressor in the Maui County community. Maui Behavioral Health Resources cited an overall increase in anxiety, depression, substance abuse, insomnia, weight gain, and other conditions throughout the pandemic.[33] Additionally, adult crisis calls increased each month during this time period. February and March 2021 had the highest rates of calls in 4 years.

Health Inequities

Health disparities are closely linked with social, economic, and/or environmental disadvantage.The County of Maui has experienced a shortage of health-care professionals, and certain communities in the County report much higher shortages than others, minimizing access to health care.

Having a primary care provider is associated with better health outcomes. Between 2008-2010, 13.4% of adults in Hawaiʻi did not have a primary health care provider, and Pacific Islanders were the most affected with 27% not having a provider.[34] The east side of Maui and the island of Molokaʻi have significant primary care and dental professional shortages, deeming these areas as "Health Professional Shortage Areas" (HSPA).[35]

A core element of overall health is having access to healthy food. Within the County of Maui, Lānaʻi and Molokaʻi islands have lower access to healthy food. Both are considered Low Income and Low Access (LILA) regions due to low income level, distance to supermarkets, and low vehicle access. Both islands also have higher prevalence of subsistence hunting, fishing, and farming. The State of Hawaiʻi had 101 registered farmer's markets in 2017 with 99% located on the island of Maui and 1% on Molokaʻi. About 16% were located within a food desert tract.[36]

Marissa Rodriguez / CC0

Economy and Jobs

Tourism is the largest economic driver in Maui County. The tourism industry is the core driver to the economic engines of Maui, Lāna‘i, and Moloka‘i with approximately 80% of every dollar generated directly or indirectly by the visitor industry.[37] The following industries had the highest GDP for the County.[38]

- Accommodation and food services – 25%
- Real estate and rental leasing – 22%
- Retail trade – 12%
- Government – 11.3%
- Health care and social assistance – 8.7%

The COVID-19 pandemic led to a wave of relocation for Maui residents. Many service workers left Hawai‘i, while many remote workers moved to Hawai‘i. The tourism and hospitality industries are still recovering from job losses due to the loss of service workers and many businesses remain understaffed.

Smith Major on unsplash

Vulnerable Populations

Vulnerable populations in Maui County include residents that live in low-lying coastal areas, Pacific Islanders, older residents, the homeless population, and residents facing health disparities.

Maui County's Social Vulnerability Index (SVI) was used in the County's 2020 Hazard Mitigation Plan[30], and identified communities that are socially vulnerable due to socioeconomic and household characteristics and access. The SVI found the island of Molokaʻi to be "very high" on the index scale, making this planning zone the most vulnerable in the County due to household composition and socioeconomic status. Second to Molokaʻi is the Wailuku-Kahului area, identified as vulnerable for the same reasons.

Kona Low event in Kīhei (2021)

Shane Tegarden, County of Maui / Used with permission

Conclusion and Next Steps

This Climate Change and Community Trends Primer is the first step in identifying the specific climate change vulnerabilities across the County of Maui. The information in this report provides a common understanding of current climate and community conditions and how climate conditions are expected to change over time. Using this information, the County can prepare and build greater resilience to protect both the people and natural resources that call these islands home.

The next step in this process is to compile a Vulnerability Assessment building from the department level vulnerability assessments that are already underway. With the assistance of residents and local experts on the natural, built, human, economic, and cultural systems, the County will move through a whole community resilience process aimed at identifying specific vulnerabilities from the current and future climate impacts identified in this report. The resulting Vulnerability Assessment will be used to identify and develop strategies that build climate resilience in alignment with local needs and values.

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