Climate Change and Pacific Islands: Indicators and Impacts

Executive Summary of the 2012 Pacific Islands Regional Climate Assessment (PIRCA)

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This executive summary has been adapted from the full-length report, which can be accessed at www.EastWestCenter.org/PIRCA.

ISLANDPRESS

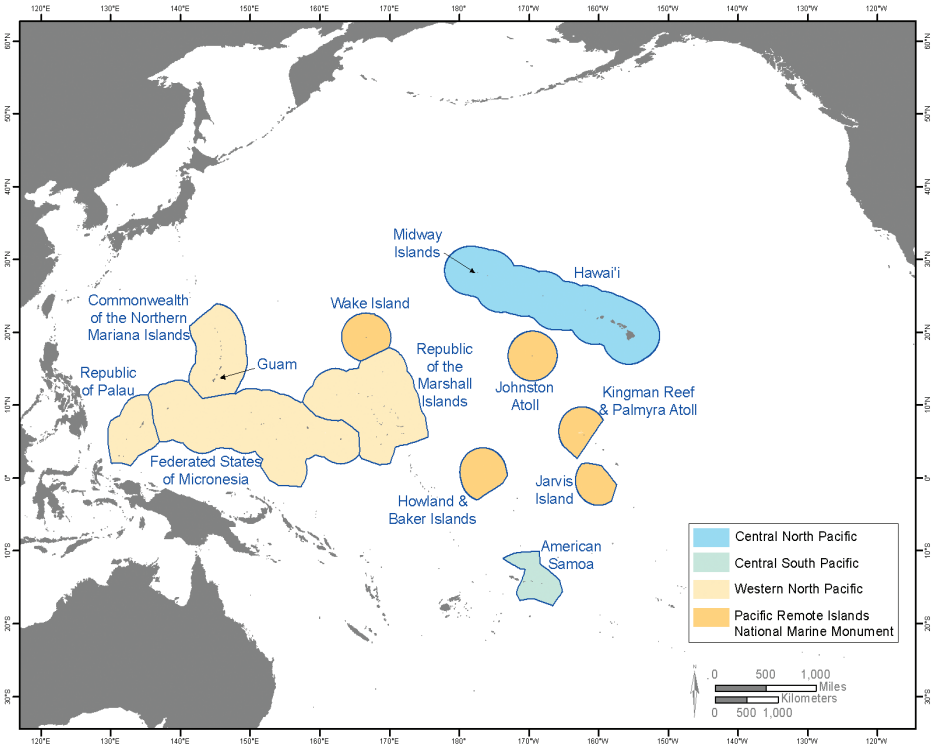
Pacific Islands Regional Climate Assessment (PIRCA)

The Pacific Islands Regional Climate Assessment (PIRCA) is an ongoing process of assessment and information exchange among scientists, natural and cultural resource managers, government agencies, businesses, and communities in the Pacific Islands region. In 2012, PIRCA published a report on the state of climate change knowledge, indicators, impacts, and adaptive capacity in Hawai'i and the US-Affiliated Pacific Islands. PIRCA contributes to the US National Climate Assessment, conducted under the auspices of the US Global Change Research Act of 1990.

Hawai'i and the US-Affiliated Pacific Islands

The Pacific Islands region is spread across millions of square miles of the Pacific Ocean. The Hawaiian archipelago and the US-Affiliated Pacific Islands include more than 2,000 islands with about 1.9 million inhabitants, representing numerous languages and cultures. These islands attract millions of tourists every year and support a large US military presence. The region includes diverse terrestrial and marine ecosystems, ranging from mountainous alpine environments to abyssal environments deep under the ocean. The islands and surrounding ocean are home to some of the most pristine habitat in the world and possess tremendous biodiversity. They are thus of immeasurable value to all people.

Across these islands, the weather and climate are highly variable. El Niño-Southern Oscillation (ENSO), for example, has a large influence on year-to-year changes in rainfall, sea level, and other climate variables. ENSO is a multiyear pattern of shifting atmospheric pressure, wind patterns, and ocean temperatures. In recent decades, scientists have made great improvements in our understanding of ENSO and other climate-related phenomena in the region, but the high level of natural variability makes it difficult to distinguish shorter-term cycles from longer-term trends.



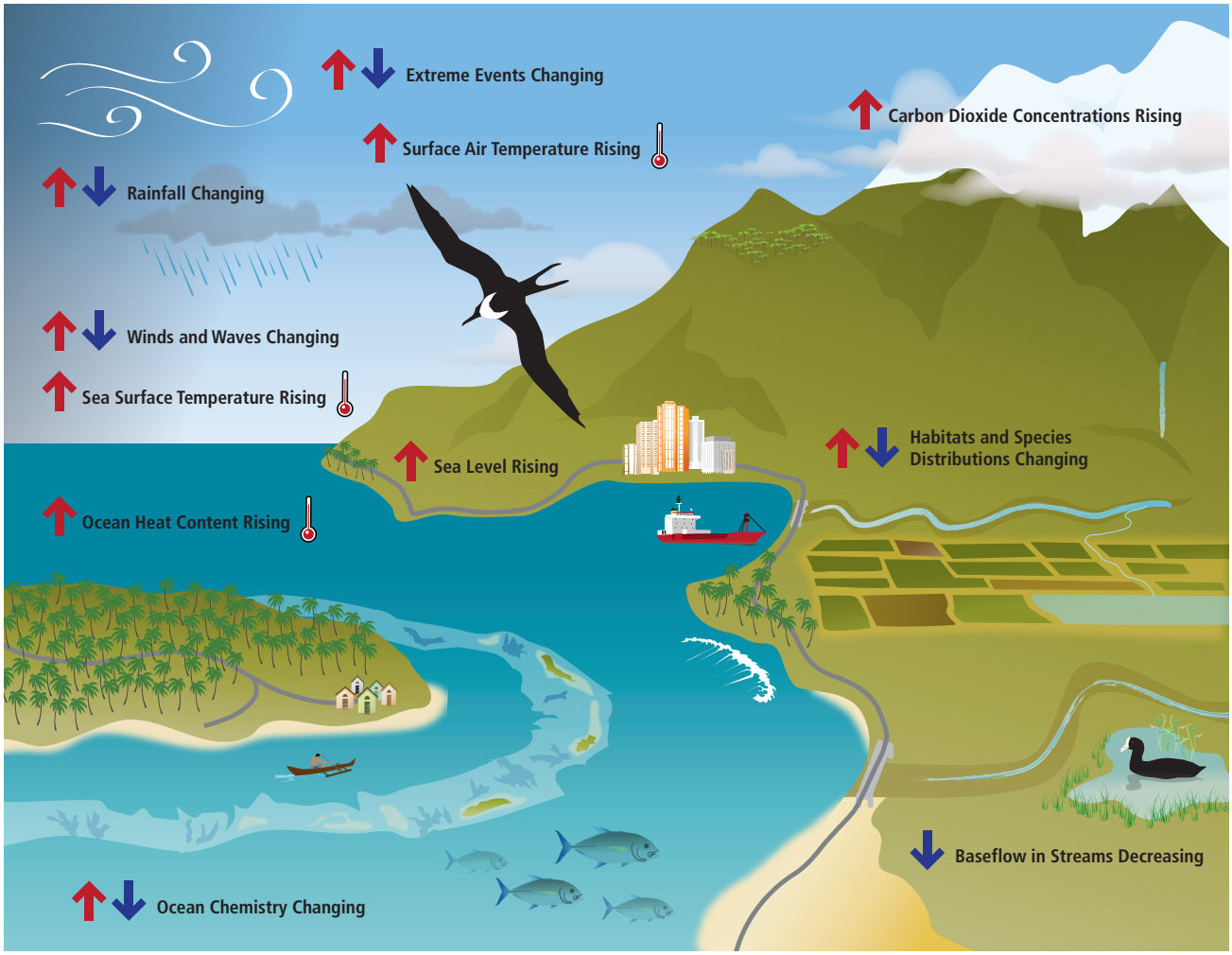
Map of Hawai'i and the US-Affiliated Pacific Islands region and sub-regions. The region includes islands in the Central North Pacific (blue), the Western North Pacific (light orange), the Central South Pacific (light green), and the Pacific Remote Island Marine National Monument (dark orange). Shaded areas indicate each island's exclusive economic zone (EEZ). *Source*: *Miguel Castrence, East-West Center.*

Cover photos: (*Top*) View from Makapu'u Point on the Island of O'ahu in Hawai'i, courtesy of Zena N. Grecni. (*Middle Left*) Tropical Pacific coral reef, Palmyra Atoll National Wildlife Refuge, courtesy of J. Maragos. (*Middle Right*) Pacific fish hook collection, Bishop Museum, Honolulu, Hawai'i, © 2008 Debbie Long, "hooked," used under a Creative Commons Attribution-NonCommercial-ShareAlike license. (*Bottom*) Clouds around Mt. Konahuanui in the Ko'olau Mountain Range, O'ahu, courtesy of Zena N. Grecni.

Climate Change Is a Reality: Key Indicators

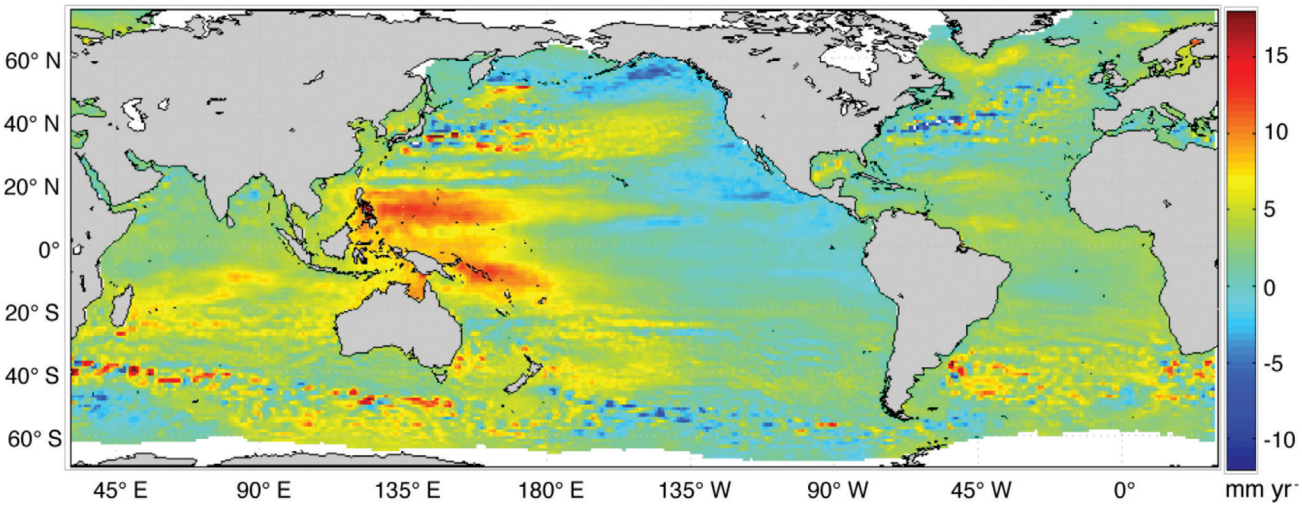
The 2012 Pacific Islands Regional Climate Assessment (PIRCA) identified several important indicators of climate change in the region, such as:

- Average surface air temperatures are rising, with the largest increases found at high altitudes in Hawai'i.
- Over the past century, rainfall has decreased across much of the region. There has been a slight increase in rainfall in the westernmost Micronesian islands.
- In Hawai'i, groundwater discharge to streams has significantly decreased over the past 100 years. This trend indicates a decrease in groundwater storage.
- Mean sea levels are rising, particularly in the Western Pacific.
- Across the region, the frequency and intensity of climatic extremes are changing. Drought has been more frequent and prolonged, and there have been fewer tropical cyclones.
- Pacific Island habitats and species distributions have changed. For example, increasing temperatures are facilitating the upward migration of mosquito-borne diseases that cause mortality in Hawaiian native forest birds.
- Ocean heat content is rising and ocean chemistry is changing.



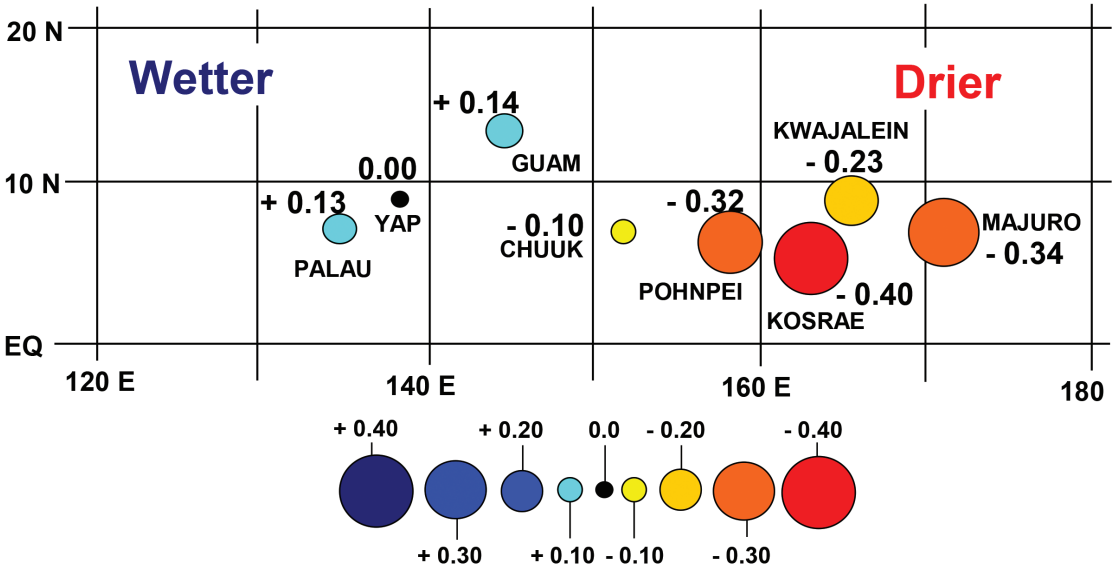
Key indicators of climate change in the Pacific Islands region. *Source*: *Susan Yamamoto, adapted from "Ten Indicators of a Warming World," in NOAA National Climatic Data Center, State of the Climate in 2009 (report).*

Sea Level



Between 1993 and 2010 **global mean sea level rose**, with the highest rise in the Western Pacific. Extreme water levels will occur when sea-level rise related to longer-term climate change combines with seasonal high tides, inter-annual and interdecadal sea-level variations, and surge or high runup associated with storms. *Source*: *Merrifield (2011), by permission of American Meteorological Society.*

Rainfall



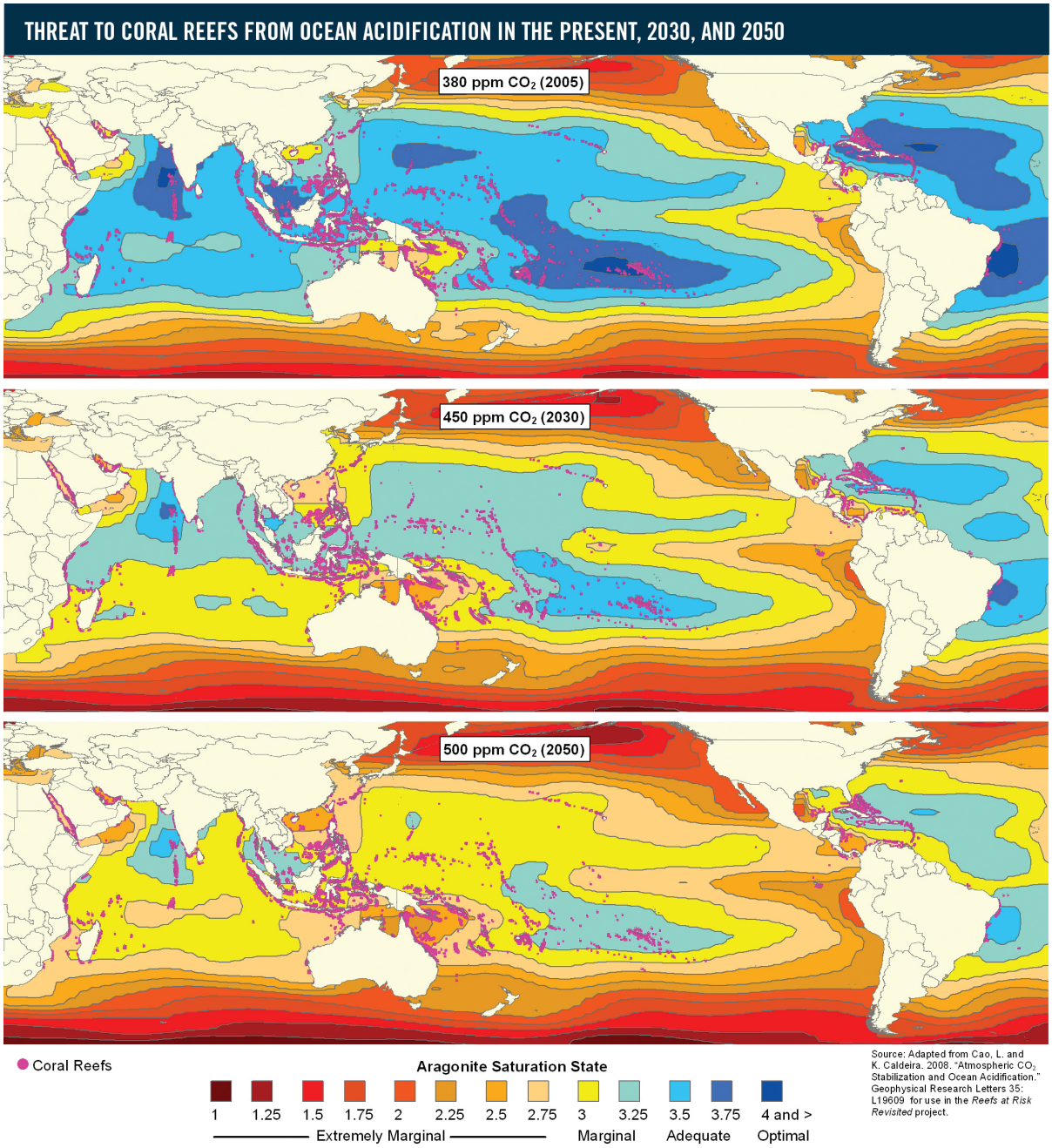
Changes in annual rainfall (inches per month per decade) in the Western North Pacific sub-region from 1950 to 2010 show that **islands in the west are getting slightly more rainfall than in the past, while islands in the east are getting much less. Annual rainfall has decreased also in Hawai'i**, which is even farther to the east (not shown). Darker blue shading indicates that conditions are wetter, while darker red shading indicates drier conditions. The size of the dot is proportional to the size of the trend as per the inset scale. *Source*: *Modified and updated from Lander and Guard, 2003; Lander, 2004.* Decreased rainfall is reflected in groundwater discharge to streams, which has decreased by 20% to 70% at eight out of the nine long-term streamflow gauges in Hawai'i over the past 100 years. This downward trend has **serious implications for health and well-being** because 99% of Hawai'i's drinking water comes from groundwater. *Source*: *Oki, 2004; Bassiouni and Oki, 2012.*

Climate Change Poses Serious Challenges

The indicators of climate change suggest multiple concerns for human and natural communities in the Pacific Islands region.

- Warmer and drier conditions mean that **freshwater supplies will decrease** on some Pacific Islands. Atolls and low-lying islands are especially vulnerable to freshwater shortages due to their small size and limited resources.
- Rising sea levels, exacerbated by storms, will **increase coastal flooding and erosion**, damaging coastal ecosystems and infrastructure and affecting agriculture, tourism, military bases, and other industries.
- Higher sea-surface temperatures will **increase coral bleaching**, leading to a change in coral species composition, coral disease, coral death, and habitat loss.
- Increasing ocean acidification and changing ocean chemistry will have **negative consequences for the entire marine ecosystem**. Although potentially dramatic, the exact nature of the consequences is not yet clear.
- Distribution patterns of coastal and ocean fisheries will be altered, with potential for increased catches in some areas and decreased catches in others. Overall in the long term, **open-ocean fisheries will decline**.
- Rising temperatures, and in some areas reduced rainfall, will stress native Pacific Island plant and animal populations and species, especially in high-elevation ecosystems. This stress, coupled with increased exposure to non-native biological invasions and fire, will **increase the risk of extinctions**.
- Threats to the traditional lifestyles of indigenous communities may include destruction of coastal artifacts and structures, reduced availability of traditional food sources and subsistence fisheries, and the loss of the land base that supports Pacific Island cultures. These losses will **make it difficult for Pacific Island communities to sustain their connection with a defined place and their unique set of customs, beliefs, and languages**.
- Mounting threats to food and water security, infrastructure, and public health and safety will **lead to human migration** from low islands to high islands and continental sites.

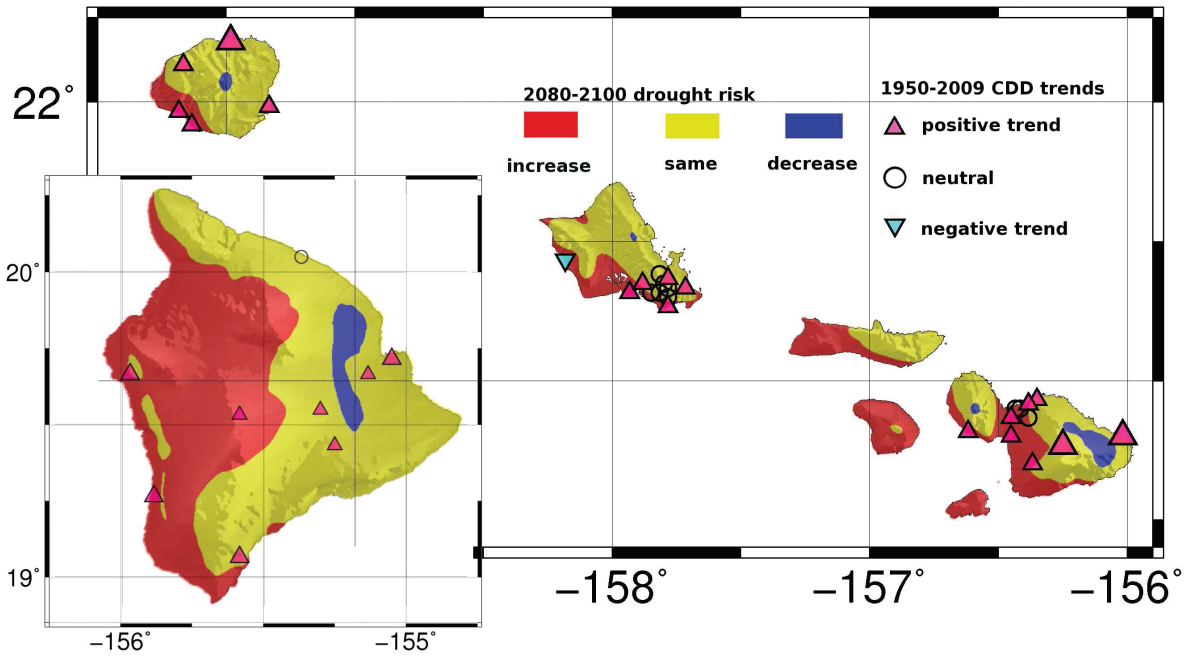
A Hawaiian monk seal (*Monachus schauinslandi*) resting on the North Shore of O'ahu, Hawai'i. Sea-level rise is of critical concern to low-lying islands where **inundation will contribute to loss of terrestrial ecosystems**. Climate influences on erosion and inundation could also **harm key habitats** such as mangroves and coastal wetlands. *Photo source*: *Victoria Keener, East-West Center.*



Ocean acidification reduces the availability of minerals, such as aragonite, which are essential building blocks for corals. If global carbon dioxide emissions continue at current levels, scientists estimate that by 2030, growth conditions for most coral reefs will be marginal at best. By 2050, the situation will be even worse. *Source*: *Burke et al., 2011.*

Projecting Climate Change into the Future

Decision makers often call for projections of climate change over the next few decades to help with planning and management at the island or community level. To generate climate projections at a resolution that encompasses island-level microclimate dynamics and windward versus leeward differences, researchers use a variety of techniques to "downscale" global climate models (GCMs). While downscaling climate models is difficult and computationally challenging, the results are useful for resource managers and policymakers in the Pacific Islands region. For instance, we can compare models of future drought in the Hawaiian Islands with episodes of historical drought already recorded.



All four major Hawaiian Islands (O'ahu, Kaua'i, Maui, and Hawai'i Island) have experienced **more severe winter droughts since the 1950s**, defined by a longer annual number of consecutive dry days. Upward triangles denote increasing drought, while downward triangles denote decreasing drought. Background colors highlight predicted changes in drought risk from 2080 to 2100, measured by the number of low-precipitation months during the wet season (November–April). **The majority of the Hawaiian Islands are predicted to have either similar or increasing levels of drought risk**. *Source*: *Figure courtesy of Oliver Elisen Timm based on data from Chu et al., 2010; Takahashi et al., 2011.*

Climate Information Is Needed to Support Planning and Management

- Many Pacific Islands lack long-term, high-quality data on rainfall, streamflow, waves, and ecosystems. Planners, managers, and researchers all need continuous long-term monitoring of climate variables to understand trends and evaluate projections from downscaled climate models. Yet **throughout the region, monitoring activities are being curtailed**, largely due to insufficient funding.
- **We need to understand how organisms and ecosystems respond to climate change**. Some islands in the region have no human inhabitants and few human impacts, offering a relatively pristine setting in which to assess the impacts of climate change on natural settings.
- Existing biological, geochemical, and physical models need to be integrated to **ensure that natural resource management strategies are based on a comprehensive understanding** of ecological responses to climate change.
- **A comprehensive evaluation of the effectiveness of alternative adaptation strategies** is needed as a basis for planning and management decisions.

Building an outrigger canoe from a breadfruit log in the Republic of the Marshall Islands. Threats from climate change for traditional lifestyles may include the destruction of artifacts, reduced subsistence fisheries and traditional foods, and the loss of a land base that supports Pacific Island cultures. *Photo source*: *Kanchi Hosia, used under a Creative Commons Attribution-NonCommercial-NoDerivs license.*

Adaptation Is Essential

Many of the projected impacts of climate change on Pacific Islands and their communities are now unavoidable, making some degree of adaptation essential. Within the region, **adaptive capacity differs with the availability of socioeconomic and institutional resources**. Informed and timely responses are necessary, especially on low-lying islands and atolls, to improve communities' resilience to the challenges posed by climate change.

Additional research, continued monitoring, a sustained assessment process, and public engagement in the development and sharing of useful information will enhance Pacific Islanders' ability to address the climate challenges they confront. Several regional coordination efforts are facilitating data collection, analysis, and access to information, which contributes to significant progress in developing adaptation plans and policies. Regional communication and collaboration provides a strong foundation for ongoing efforts to build resilience in the face of challenges from a changing climate.

Namdrik Atoll in the Republic of the Marshall Islands has a land area of 1.1 square miles and a maximum elevation of 10 feet. Namdrik and other **low-lying Pacific Islands are the first places that will face the possibility of climate-induced human out-migration as global warming leads to sea-level rise**. *Photo source*: *Darren Nakata.*

Acknowledgments

Primary responsibility for the PIRCA is shared by the Pacific Regional Integrated Sciences and Assessments (RISA) program, funded by the US National Oceanic and Atmospheric Administration (NOAA) and supported through the East-West Center; NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) National Climatic Data Center (NCDC); Pacific Climate Information System (PaCIS); and the Pacific Islands Climate Change Cooperative, funded by the US Fish and Wildlife Service. The editors extend special acknowledgment to the many experts who presented research, discussed findings, and authored or reviewed sections of the full report.

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