

Climate change in Hawaii and U.S. tropical islands

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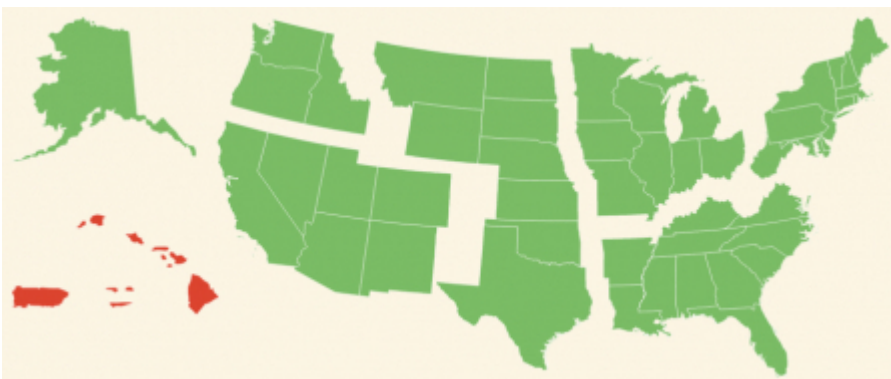
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A sea turtle is seen swimming above a reef near the Hawaiian islands. Climate change has major impacts on ocean ecosystems and communities living on islands. Photo: Pixabay/public domain.

Overview



The U.S. tropical islands include Puerto Rico and the U.S. Virgin Islands in the Caribbean, and Hawaii, Guam, the Northern Mariana Islands, and American Samoa in the Pacific. Many islands are especially vulnerable to the risks of climate change because of their small size, low

elevation, remote geographical location, and concentration of infrastructure along coastlines. Islands are also home to unique ecosystems, including coral reefs, mangrove forests, and diverse populations of native species found nowhere else in the world. Island ecosystems are already stressed from human development and pollution, making them particularly sensitive to additional stresses from climate change.

Islands are experiencing rising air temperatures and sea levels, and warmer, more acidic coastal waters. Temperatures are expected to increase into the future, but will vary in the extent of warming that occurs based on location, elevation, and changes in ocean conditions. In Hawaii and the Central North Pacific, temperatures are projected to rise by 1.5 degrees Fahrenheit to 3.5 degrees F by mid-century, while in Guam and Northern Mariana Islands, increases of 1.9 degrees F to 2.6 degrees F are projected. In the Caribbean, Puerto Rico is projected to warm by 2 degrees F to 5 degrees F by the end of this century.

Changes in precipitation are also being observed. The Pacific Islands are highly influenced by El Niño and La Niña events, which create annual variability in storms and precipitation. Despite this variability, a trend for decreasing precipitation has been observed in Hawaii, while a small increase has been measured in the Northern Mariana Islands and in Guam. Future precipitation patterns are less certain, but for Hawaii, projections suggest a small decrease in precipitation during the wet season and a small increase during the dry season. Some parts of the Caribbean are experiencing reduced precipitation while other areas have seen increases. Continued variation in trends is expected in the future, but on average, precipitation is expected to decrease across the Caribbean. In Puerto Rico, an increasing amount of rain has been falling in the form of heavy downpours in recent history. Limited information for American Samoa shows no significant change in precipitation.

Water Resources

Climate change is expected to affect the availability of water on some islands, particularly on small islands and atolls. On islands where precipitation decreases, ground and surface water supplies may not be recharged, resulting in less freshwater availability. This can impact both drinking water supplies and irrigation water for crops. Sea level rise and coastal erosion may also reduce water availability by inundating land with saltwater, contaminating freshwater, and preventing recharge of the freshwater supply. Increased temperatures coinciding with reduced precipitation are also expected to increase the likelihood of drought.

In contrast, some islands are expected to receive heavier downpours, which can cause flooding, overload water infrastructure systems, and result in sewage contamination and public health concerns. On islands where populations are growing or where infrastructure is old or poorly maintained, the impacts on water supplies may be especially severe.

Communities And Agriculture

Climate change will have far-reaching effects on local island culture, health, and livelihoods, altering traditional lifestyles on the islands. Cultural structures may be lost to rising seas while availability of traditional foods may decline because of coral reef losses, drought, or saltwater inundation of agricultural lands. Residents in coastal areas may need to relocate if climate-related damages become too extreme.

Climate change is also expected to negatively impact human health. The incidence of some diseases, such as dengue fever, are likely to increase in the Pacific Islands. In the Caribbean, diseases already present, including malaria and dengue and yellow fevers, could increase with warming temperatures.

Coastal agriculture is also affected by climate change. Sea level rise can lead to saltwater inundation, causing soils to become saltier and less fertile on some islands. Water supplies can suffer as a result of reductions in rainfall or from saltwater intrusion, reducing both drinking water and irrigation water availability.

Infrastructure And Economy

Island infrastructure and economic development are at greater risk due to climate change. Island settlements, social and leisure events, and economic activity tend to be concentrated close to the coasts, especially on smaller islands. This makes them especially vulnerable to climate change impacts from sea level rise, coastal inundation, storm surge, flooding, and shoreline erosion.



Higher sea levels, inundation, flooding, and shoreline and beach erosion are expected to affect critical transportation, energy, and water infrastructure, including airports, roads, ports, and wastewater systems. Because of their geographic remoteness, islands largely rely on imported food, fuel, and materials, making damage to airports or ports especially critical to the well-being of island residents. The impacts of sea level rise are already being felt. In Rincón, Puerto Rico, sea level rise is currently eroding the coastline at a rate of about three feet per year.

Climate change will affect tourism, an important source of revenue for islands. Sea level rise, warming water temperatures, increasing storm intensity, beach erosion, and ocean acidification could pose risks to beaches and threaten coastal activities, such as coral reef exploration, boating, and fishing. Closures to island beaches due to damage or harmful algal blooms could have large economic impacts, particularly on the tourism sector. In Puerto Rico,

3.5 million tourists spent \$3.5 billion in 2009. Tourism accounts for 26% of the state income in Hawai'i. The loss of the Waikiki Beach in Hawai'i alone could reduce the state annual income by \$2 billion.

Ecosystems

Islands are home to unique ecosystems and species that provide economic opportunities, safety, and cultural value to island communities. Rising sea levels, temperatures, and ocean acidification of coastal waters are threatening the stability and functioning of these ecosystems.

Coral reefs serve as an important habitat for many fish and marine organisms. They also provide shoreline protection, valuable fisheries, and revenue through tourism. In Hawai'i, the goods and services provided by coral reefs are estimated to bring in approximately \$385 million each year. In the Caribbean, income losses associated with degraded reefs are conservatively estimated to be several hundred million dollars each year.

Reef ecosystems are stressed by coastal development, pollution, and invasive species. Warmer, more acidic coastal waters further stress reefs, and coral disease outbreaks and bleaching events tend to coincide with warming waters. As the oceans warm, coral cover is expected to decline greatly.

Oceans are also becoming more acidic. This occurs as the higher levels of carbon dioxide in the atmosphere react with sea water to produce carbonic acid. Since the Industrial Revolution, ocean acidity has increased by 30%, a rate that is approximately 50 times faster than the known historical change prior to this period. Acidity is projected to increase by an additional 37% to 50% above present levels by the end of the century.

Increases in ocean acidity (measured by lower pH values) changes the balance of minerals in the water. This change makes it more difficult for corals, some types of plankton, and other organisms to produce calcium carbonate, which makes up and strengthens the marine organisms' hard skeletons and shells.



As climate change alters coral reefs, reduction in fish populations that inhabit these ecosystems is expected. Many island communities depend on local fisheries for survival and economic development. Changes in ocean temperatures can also damage fish habitats and cause shifts in the reproduction or migration behaviors of certain fish species, including tuna. These impacts may exacerbate existing stresses on fisheries, such as those from pollution and overfishing, and may ultimately lead to a decline in the abundance and health of fishery populations.

Sea level rise will result in flooding or loss of tidal marshes, swamps, and other coastal habitats. These ecosystems provide important habitat for birds and aquatic organisms, and losses will exacerbate existing stresses on vulnerable species. In the Caribbean, forests are retreating from the coastlines. Mangrove forests, which help to protect shorelines, are expanding in some parts of the Caribbean, but are shrinking in parts of the Pacific.



Plants and animals are increasingly stressed by high temperatures and, on some islands, reduced rainfall. High-elevation ecosystems are especially vulnerable because they have limited ability to find suitable habitat. Climate change is also providing conditions that increase the spread of invasive species, pathogens, and diseases, which will affect populations of native plants, birds, and freshwater organisms.

Quiz

- 1 Read the selection from the section "Ecosystems."

Sea level rise will result in flooding or loss of tidal marshes, swamps, and other coastal habitats. These ecosystems provide important habitat for birds and aquatic organisms, and losses will exacerbate existing stresses on vulnerable species.

Which conclusion can be drawn from the information above?

- (A) Ecosystems that support the most vulnerable species will have additional protection from climate change.
 - (B) Results of climate change will have additional damaging effects on species that are already struggling.
 - (C) Coastal habitats may see increased populations of species that depend on elevated sea levels.
 - (D) Climate change and sea level rise will only affect the species that were already likely to become extinct.
- 2 Which of the following subjects is NOT thoroughly addressed by the article?
- (A) the ways in which climate change could negatively alter everyday life for island communities
 - (B) the characteristics of islands that make them especially vulnerable to the effects of climate change
 - (C) the specific strategies that can be used to protect islands from the effects of climate change
 - (D) the current evidence supporting predictions regarding the effects of climate change

- 3 Which of the following options BEST describes two central ideas of the article?
- (A) Many islands are especially vulnerable to the risks of climate change because of their geography and coastal infrastructure; climate change will have far-reaching effects on island lifestyles, economies, and ecosystems.
 - (B) Many islands are especially vulnerable to the risks of climate change because of their geography and coastal infrastructure; agriculture will suffer as a result of reduced fresh water from rain and increased saltwater from sea levels.
 - (C) Climate change is expected to negatively affect human health as the spread of diseases from high temperatures increases; sea level rise will result in flooding or loss of tidal marshes, swamps, and other coastal habitats.
 - (D) Climate change is expected to negatively affect human health as the spread of diseases from high temperatures increases; islands are home to unique ecosystems and species that draw many tourists.
- 4 Which of the following statements would be MOST appropriate to include in an accurate and objective summary of the article?
- (A) Mounting evidence of the negative effects of climate change on island environments is a frightening cause for alarm.
 - (B) Island communities and ecosystems face many unique challenges resulting from the negative effects of climate change.
 - (C) Island communities must take responsibility for protecting island ecosystems from the negative effects of climate change.
 - (D) People who live in island communities do not know they are at increased risk of being negatively affected by climate change.