Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

backgrounder

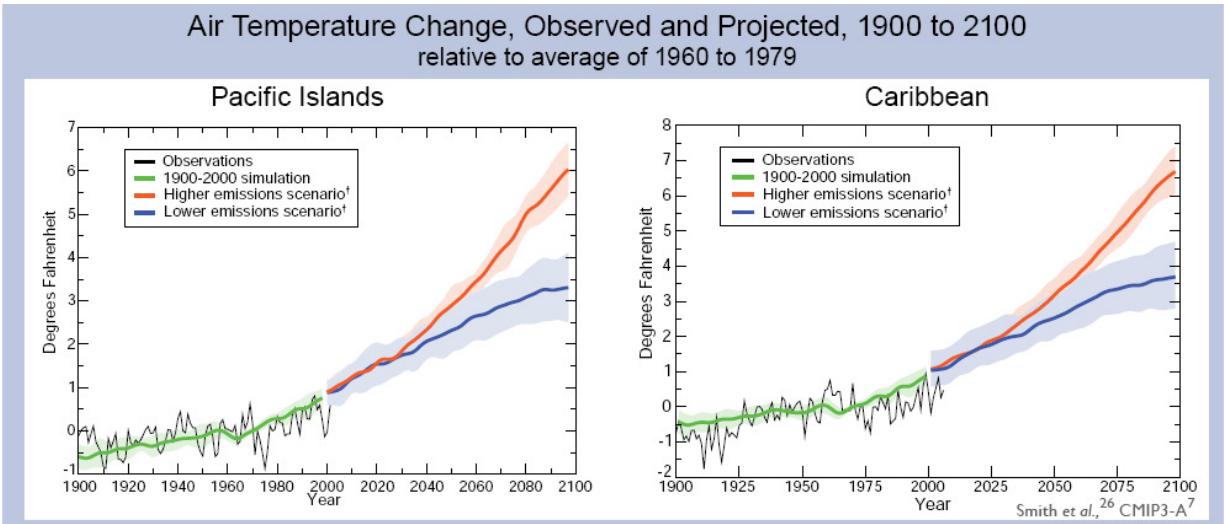
All information in this summary is entirely based on "Global Climate Change Impacts in the United States" (USGCRP, 2009). To enhance clarity, slight modifications were made that maintain the intended meaning of the report.

Islands

Hawaii, Puerto Rico, U.S. Virgin Islands, Palau, the Samoan Islands of Tutuila, Manua, Rose, and Swains; and islands in the Micronesian archipelago, the Carolines, Marshalls, and Marianas

Small islands are considered among the most vulnerable to climate change because extreme events have major impacts on them. Changes in weather patterns and the frequency and intensity of extreme events, sea-level rise, coastal erosion, coral reef bleaching, ocean acidification, and contamination of freshwater resources by salt water are among the impacts small islands face.

Islands have experienced rising temperatures and sea levels in recent decades. Projections for the rest of this century suggest: increases in air and ocean surface temperatures in both the Pacific and Caribbean, an overall decrease in rainfall in the Caribbean. Projections for the Pacific Islands imply a large range of possible levels of increased rainfall during summer months and frequency of heavy downpours.



Air temperatures have increased over the last 100 years in both the Pacific Island and Caribbean regions. Larger increases are projected in the future, with higher emissions scenarios† producing considerably greater increases.

COASTAL RISKS

Island communities, infrastructure, and ecosystems are vulnerable to coastal inundation due to sea-level rise and coastal storms. Flooding will likely become more frequent due to higher storm surges, and coastal land could be permanently lost as the rising sea inundates low- lying areas and the shorelines erode. Loss of land will likely reduce freshwater supplies as saltwater infiltrates further inland in groundwater and estuaries under rising seas and affects living things in coastal ecosystems. For example, the Northwestern Hawaiian Islands, which are low-lying and therefore at great risk from increasing sea level, have a high concentration of endangered and threatened species, some of which exist nowhere else. The loss of nesting and nursing habitat is expected to threaten the survival of already vulnerable species.

A "ghost swamp" in south Louisiana shows the effects of saltwater intrusion.

Photo: , USGS, National Wetlands Research Center

In addition to gradual sea-level rise, extreme high water level events can result from a combination of coastal processes. For example, the harbor in Honolulu, Hawaii, experienced the highest daily average sea level ever recorded in September 2003. This resulted from the combination of long-term sea-level rise, normal seasonal heating (which causes the volume of water to expand and thus the level of the sea to rise), seasonal high tide, and an ocean circulation event which temporarily raised local sea level. The interval between such extreme events has decreased from more than 20 years to approximately 5 years as average sea level has risen.

Hurricanes, typhoons, and other storm events, with their intense precipitation and storm surge, cause major impacts to Pacific and Caribbean island communities, including loss of life, damage to infrastructure and property, and contamination of freshwater supplies. As the climate continues to warm, the peak wind intensities and near-storm precipitation from future tropical cyclones are likely to increase, which, combined with sea-level rise, is expected to cause higher storm surge levels. If such events occur frequently, communities could face challenges in recovering between events, resulting in long-term deterioration of infrastructure, freshwater and agricultural resources, and other impacts.

Critical infrastructure, including homes, airports, and roads, tends to be located along the coast. Flooding related to sea level rise and hurricanes and typhoons negatively impacts port facilities and harbors, and causes closures of roads, airports, and bridges. Long-term infrastructure damage would affect social services such as disaster risk management, health care, education, management of freshwater resources, and economic activity in sectors such as tourism and agriculture.

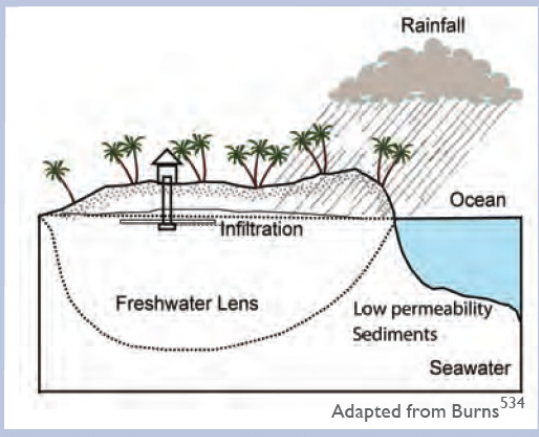
FISHERIES

Fisheries feed local people and island economies. Almost all communities within the Pacific Islands derive over 25 percent of their animal protein from fish, with some deriving up to 69 percent. For island fisheries sustained by healthy coral reef and marine ecosystems, climate change impacts exacerbate stresses such as overfishing, affecting both fisheries and tourism that depend on abundant and diverse reef fish. The loss of live corals results in local extinctions and a reduced number of reef fish species.
Nearly 70 percent of the world's annual tuna harvest, approximately 3.2 million tons, comes from the Pacific Ocean. Climate change is projected to cause a decline in tuna stocks and an eastward shift in their location, affecting the catch of certain countries.

Coral reefs sustain fisheries. Yet these ecosystems are particularly susceptible to the impacts of climate change, as even small increases in water temperature can cause coral bleaching, damaging and killing corals. Ocean acidification due to a rising carbon dioxide concentration poses an additional threat dissolution of calcium carbonate could occur if emission levels continue unabated. Coral reef ecosystems are also especially vulnerable to invasive species. These impacts, combined with changes in the occurrence and intensity of El Niño events, rising sea level, and increasing storm damage, will likely have major negative effects on coral reef ecosystems.

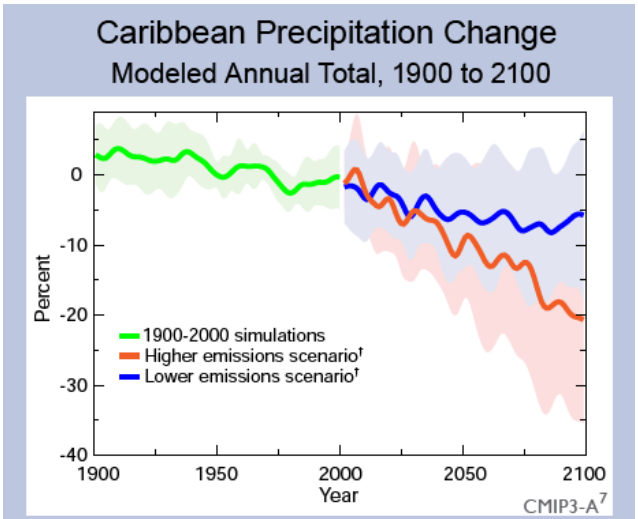
WATER RESOURCES

The availability of freshwater is likely to be reduced, with significant implications for island communities, economies, and resources. Most island communities in the Pacific and the Caribbean have limited sources of the freshwater needed to support unique ecosystems and biodiversity, public health, agriculture, and tourism. Conventional freshwater resources include rainwater collection, groundwater, and surface water. For drinking and bathing, smaller Pacific islands primarily rely on individual rainwater catchment systems, while groundwater from the freshwater lens is used for irrigation. The size of freshwater lenses in atolls is influenced by factors such as rates of recharge (through precipitation), rates of use, and extent of tidal inundation (see Freshwater Lens Figure). Since rainfall triggers the formation of the freshwater lens, changes in precipitation, such as the significant decreases projected for the Caribbean, can significantly affect the availability of water. Because tropical storms replenish water supplies, potential changes in these storms are a great concern.



Many island communities depend on freshwater lenses, which are recharged by precipitation. The amount of water a freshwater lens contains is determined by the size of the island, the amount of rainfall, rates of water withdrawal, the permeability of the rock beneath the island, and salt mixing due to storm- or tide-induced pressure. Freshwater lenses can be as shallow as 4 to 8 inches or as deep as 65 feet.[534]

While it might be seen initially as a benefit, increased rainfall in the Pacific Islands during the summer months is likely to result in increased flooding, which would likely reduce drinking water quality and crop yields. In addition, many islands have weak distribution systems and old infrastructure, which result in significant water leakage, decreasing their ability to use freshwater efficiently. Water pollution (such as from agriculture or sewage), exacerbated by storms and floods, can contaminate the freshwater supply, impacting public health. Sea-level rise also impacts island water supplies by causing salt water to contaminate the freshwater lens and by causing an increased frequency of flooding due to storms occurring during high tides. Finally, a rapidly rising population is straining the limited water resources, as would an increased incidence and/or intensity of storms or periods of prolonged drought.



Precipitation has declined in the Caribbean and climate models project stronger declines in the future, particularly under higher emission scenarios.† Such decreases threaten island communities that rely on rainfall for replenishing their freshwater supplies.

LIVLIHOOD

Climate changes affecting coastal and marine ecosystems will likely have major implications for tourism. Sea-level rise, increasing water temperatures, rising storm intensity, coastal inundation, and flooding from extreme events, beach erosion, ocean acidification, increased incidences of coral disease, and increased invasions by non-native species are among the threats that endanger the ecosystems that provide safety, sustenance, economic viability, and cultural and traditional values to island communities.

Tourism is a vital part of the economy for many islands. In 1999, the Caribbean had tourism-based gross earnings of $17 billion, providing 900,000 jobs and making the Caribbean one of the most tourism dependent regions in the world. In the South Pacific, tourism can contribute as much as 47 percent of gross domestic product. In Hawaii, tourism generated $12.4 billion for the state in 2006, with over 7 million visitors.

Sea-level rise can erode beaches, especially when natural redistribution of beach sediment in response to sea-level rise is inhibited by human infrastructure needs. This along with increasing water temperatures, can destroy or degrade natural resources such as mangroves and coral reef ecosystems that attract tourists. Extreme weather events can affect transportation systems and interrupt communications. The availability of freshwater is critical to sustaining tourism, but is subject to the climate-related impacts described on above. Public health concerns about diseases such as dengue could also negatively affect tourism.

Coral reefs sustain fisheries and tourism, have biodiversity value, scientific and educational value, and form natural protection against wave erosion. For Hawaii alone, net benefits of reefs to the economy are estimated at $360 million annually, and the overall asset value is conservatively estimated to be nearly $10 billion.19 In the Caribbean, coral reefs provide annual net benefits from fisheries, tourism, and shoreline protection services of between $3.1 billion and $4.6 billion. The loss of income by 2015 from degraded reefs is conservatively estimated at several hundred million dollars annually.