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United States Environmental Protection Agency

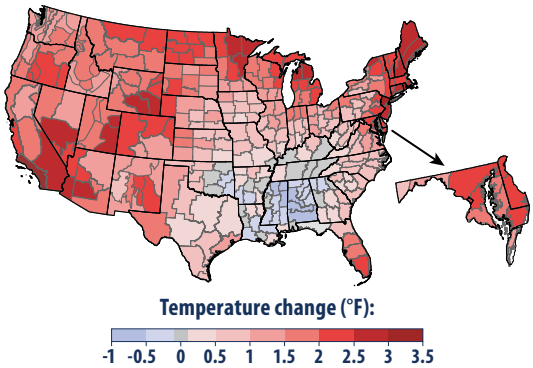
August 2016
EPA 430-F-16-010

What Climate Change *Means for* Delaware

Delaware's climate is changing. The state has warmed two degrees (F) in the last century, heavy rainstorms are more frequent, and the sea is rising about one inch every seven years. Higher water levels are eroding beaches, submerging low lands, exacerbating coastal flooding, and increasing the salinity of estuaries and aquifers. In the coming decades, changing the climate is likely to increase coastal flooding; harm marine, wetland, and inland ecosystems; disrupt farming; and increase some risks to human health.

Our climate is changing because the earth is warming. People have increased the amount of carbon dioxide in the air by 40 percent since the late 1700s. Other heat-trapping greenhouse gases are also increasing. These gases have warmed the surface and lower atmosphere of our planet about one degree during the last 50 years. Evaporation increases as the atmosphere warms, which increases humidity, average rainfall, and the frequency of heavy rainstorms in many places—but contributes to drought in others.

Greenhouse gases are also changing the world's oceans and ice cover. Carbon dioxide reacts with water to form carbonic acid, so the oceans are becoming more acidic. The surface of the ocean has warmed about one degree during the last 80 years. Warming is causing snow to melt earlier in spring, and mountain glaciers are retreating. Even the great ice sheets on Greenland and Antarctica are shrinking. Thus the sea is rising at an increasing rate.



Rising temperatures in the last century. Delaware has warmed more than most of the nation. Source: EPA, Climate Change Indicators in the United States.

Increasing Temperature and Changing Precipitation Patterns

Rising temperatures and shifting rainfall patterns are likely to increase the intensity of both floods and droughts. Average annual precipitation in Delaware has increased a few percent in the last century, and precipitation from extremely heavy storms has increased in the eastern United States by more than 25 percent since 1958. During the next century, annual precipitation and the frequency of heavy downpours are likely to keep rising. Precipitation is likely to increase during winter and spring, but not change significantly during summer and fall. Rising temperatures will melt snow earlier in spring and increase evaporation, and thereby dry the soil during summer and fall. As a result, climate change is likely to intensify flooding during winter and spring, and drought during summer and fall.

Rising Seas and Retreating Shores

Sea level is rising more rapidly along the Delaware coast than in most coastal areas because Delaware is sinking. If the oceans and atmosphere continue to warm, sea level is likely to rise between sixteen inches and four feet along the Delaware coast in the next century.

As sea level rises, the lowest dry lands are submerged and become either tidal wetland or open water. Wetlands can create their own land and keep pace with a slowly rising sea. But if sea level rises three feet or more in the next century, most existing tidal wetlands in Delaware are unlikely to keep pace but will instead become tidal mud flats or shallow open water. Existing tidal flats will generally convert to open water as they are submerged.

Beaches also erode as sea level rises. A higher ocean level makes it more likely that storm waters will wash over a barrier island or open new inlets. The United States Geological Survey estimates that Fenwick Island could be broken up by new inlets or lost to erosion if sea level rises three feet by the year 2100, unless people take measures to reduce erosion. Estuarine beaches may also be eliminated in some areas. Many of Delaware Bay's beaches are narrow, with wetlands immediately inland. Along parts of Delaware Bay and the Delaware River, people have built walls or other shore protection structures that eliminate the beach once the shore erodes up to them.

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Homes and Infrastructure

Towns along the Delaware shore shore will be increasingly vulnerable to storms and erosion as sea level rises. While hurricanes are rare, their wind speeds and rainfall intensities are likely to increase as the climate warms. Rising sea level is likely to increase flood insurance rates, while more frequent storms could increase deductibles for wind damage in homeowner insurance policies. Storms can destroy coastal homes, wash out highways and rail lines, and damage essential communication, energy, and wastewater management infrastructure.

Houses along Broadkill Beach are vulnerable to severe storms, flooding, and coastal erosion. Credit: U.S. Army Corps of Engineers.

Ecosystems

The loss of tidal marshes could harm fish, reptiles, and birds that depend on a marsh for food or shelter. Blue crab, perch, weakfish, flounder, and rockfish rely on the tidal marshes in Delaware Bay to hide from predators and to feed on mussels, fiddler crabs, and other species. Sea turtles and shorebirds feed on some of the species that inhabit these marshes. Great blue herons, black ducks, ospreys, red-winged blackbirds, and several other bird species also use the salt marshes in Delaware Bay. As marshes erode, fish may benefit initially as more tidal channels form, which would make more marsh accessible. But after a point, erosion would make less marsh available, and populations of fish and birds would decline.

The loss of bay beaches and tidal flats would also threaten some species. Delaware Bay is a major stopover area for six species of migratory shorebirds that feed on its beaches and tidal flats, including most of the Western Hemisphere's red knot population. Nearly a million birds feed on the horseshoe crab eggs on the bay's sandy beaches. Diamondback terrapin nest on estuarine beaches along Delaware's inland bays.

Changing temperatures could also disrupt ecosystems. If water temperatures exceed 86°F during summer, eelgrass could be lost, which would remove a key source of food for many fish. Wildflowers and woody perennials are blooming—and migratory birds are arriving—sooner in spring. Not all species adjust in the same way, however, so the food that one species needs may no longer be available when that species arrives on its migration.

Saltwater Intrusion

As sea level rises, salt water can mix farther inland or upstream in bays, rivers, and wetlands. Because water on the surface is connected to ground water, salt water can also intrude into aquifers near the coast. Soils may become too salty for the crops and trees that currently grow in low-lying areas.

Agriculture

Changing the climate will have both harmful and beneficial effects on farming. Hotter summers are likely to reduce yields of corn. But higher concentrations of atmospheric carbon dioxide increase crop yields, and that fertilizing effect is likely to offset the harmful effects of heat on soybeans, assuming that adequate water is available. Although most chickens are raised indoors, warmer temperatures could reduce the productivity of livestock raised outside.

Human Health

Hot days can be unhealthy—even dangerous. Certain people are especially vulnerable, including children, the elderly, the sick, and the poor. High air temperatures can cause heat stroke and dehydration, and affect people's cardiovascular and nervous systems. Warmer temperatures can also increase the formation of ground-level ozone, a key component of smog that can contribute to respiratory problems. Rising temperatures may also increase the length and severity of the pollen season for plants such as ragweed, which has already been observed in other regions.

The risk of some diseases carried by insects may also increase. The ticks that transmit Lyme disease are active when temperatures are above 45°F, so warmer winters could lengthen the season during which ticks can become infected or people can be exposed to the ticks. The number of cases may or may not increase, depending on what people do to control insect populations and avoid insect bites.

As sea level rises, the water table rises as well, which can prevent ordinary septic systems from working properly. The owner of this house in Pickering Beach responded by shifting to a mounds-based system, which provides the required separation between the drain field and the water table. © James G. Titus; used by permission.

The sources of information about climate and the impacts of climate change in this publication are: the national climate assessments by the U.S. Global Change Research Program, synthesis and assessment products by the U.S. Climate Change Science Program, assessment reports by the Intergovernmental Panel on Climate Change, and EPA's *Climate Change Indicators in the United States*. Mention of a particular season, location, species, or any other aspect of an impact does not imply anything about the likelihood or importance of aspects that are not mentioned. For more information about climate change science, impacts, responses, and what you can do, visit EPA's Climate Change website at www.epa.gov/climatechange.

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