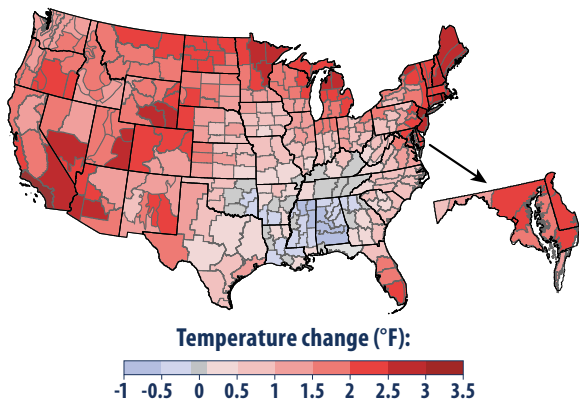


What Climate Change Means for Maryland

Maryland's climate is changing. Most of the state has warmed one to two degrees (F) in the last century, heavy rainstorms are more frequent, and the sea is rising about one inch every seven to eight 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 and inland flooding; harm marine, wetland, and inland ecosystems; disrupt fishing and 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. Except for western Maryland, the state 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 Maryland has increased about 5 percent in the last century, but precipitation from extremely heavy storms has increased in the eastern United States by more than 25 percent since 1958. During the next century, average annual precipitation and the frequency of heavy downpours are likely to keep rising. Average 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, changing the climate 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 in Maryland than in most coastal areas because the land is sinking. If the oceans and atmosphere continue to warm, sea level along the Maryland coast is likely to rise sixteen inches to four feet in the next century.

As sea level rises, the lowest dry lands are submerged and become either tidal wetland or open water. The freshwater wetlands in the upper tidal portions of the Potomac, Patuxent, Choptank, and Nanticoke rivers build their own land by capturing floating sediments, and they are likely to keep pace with the rising sea during the next century. But most salt marshes elsewhere in the state are unlikely to keep pace if sea level rises three feet. The wetlands along the Eastern Shore south of the Bay Bridge are even more vulnerable, and likely to be lost if the sea rises two feet. Wetlands in Dorchester County are already being submerged by rising sea level.

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 Assateague Island is likely to be broken up by new inlets or lost to erosion if sea level rises two feet by the year 2100. Eroding beaches along Chesapeake Bay and its tributaries are likely to be squeezed between the advancing water and stone revetments erected to protect development along the shore. Even towns with "Beach" in their names are seeing their beaches replaced with hard shore protection structures.



Sea level rise threatens coastal wetlands like this marsh at Blackwater Wildlife Refuge, along with the ecosystems and fisheries they support. © James G. Titus; used by permission.

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.

Homes and Infrastructure

Storms can destroy coastal homes, wash out highways and rail lines, and damage essential communication, energy, and wastewater management infrastructure. In 2003, the storm surge in Chesapeake Bay from Hurricane Isabel flooded downtown Annapolis, North Beach, and several communities on the Eastern Shore, causing about \$400 million in damages. While recent hurricanes have had minimal impacts on Ocean City, about 25 percent of its structures are vulnerable to flooding. On the lower Eastern Shore, communities like Hooper's Island, Smith Island, and parts of Crisfield are so low that water in ditches along the streets rises and falls with the tides. These towns will become more vulnerable to storms and erosion as sea level rises.

Although hurricanes are rare, their wind speeds and rainfall rates are likely to increase as the climate continues to warm. Rising sea level is likely to increase flood insurance rates, while more frequent storms could increase the deductible for wind damage in homeowner insurance policies.



Downtown Annapolis the day after Hurricane Isabel struck the Atlantic coast on September 18, 2003. © James G. Titus; used by permission.

Ecosystems

The loss of tidal marshes could harm fish and birds that depend on a marsh for food or shelter. Small insects and marine organisms that feed in the marsh are a key source of food for crabs, rockfish, and other commercially important fisheries. Striped bass, bluefish, sea trout, and summer flounder also move into and out of the marsh for feeding and shelter. The most vulnerable marshes along Chesapeake Bay are inhabited by great blue heron, bald eagle, American black duck, and snowy egret. The marshes near Ocean City and Assateague Island provide forage for shorebirds, such as sandpipers and plovers, and several species of ducks and geese spend the winter in these marshes.

The loss of bay beaches would remove key habitat for diamondback terrapin that nest on these beaches. Other species that depend on bay beaches include horseshoe crabs, tiger beetles, sand fleas, snails, and several crab species. The loss of those species would remove important sources of food for birds.

Changing temperatures could also disrupt ecosystems. If water temperatures exceed 86°F during summer, eelgrass could be lost. Blue crabs would lose an important hiding place during spring when they are changing shells and vulnerable to predators, and the sea turtles that feed on those crabs in the eelgrass might lose that food source. 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.

Fishing and Farms

Parts of Maryland's fishing and agriculture sectors may suffer as the climate changes. Blue crabs and other shellfish are vulnerable to increased acidity in the water, especially during early life stages when acidity impairs their ability to build shells. As sea level rises, the Chesapeake Bay region is expected to lose some of the wetlands that fish and shellfish depend on for nursery grounds. Warmer waters are expected to increase harmful algae, lower oxygen levels, and change the mix of species that thrive in the bay.

Climate change may also pose challenges for agriculture: some farms may be harmed if more hot days and droughts reduce crop yields, or if more flooding and wetter springs delay their planting dates. Other farms may benefit from a longer growing season and the fertilizing effect of carbon dioxide.

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 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.