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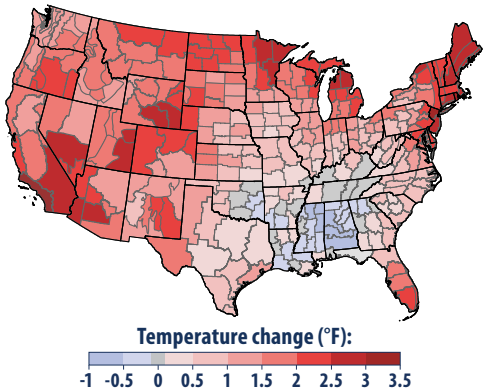
What Climate Change *Means for* Pennsylvania

Pennsylvania's climate is changing. The commonwealth has warmed more than half a degree (F) in the last century, heavy rainstorms are more frequent, and the tidal portion of the Delaware River is rising about one inch every eight years. In the coming decades, changing the climate is likely to increase flooding, harm 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.

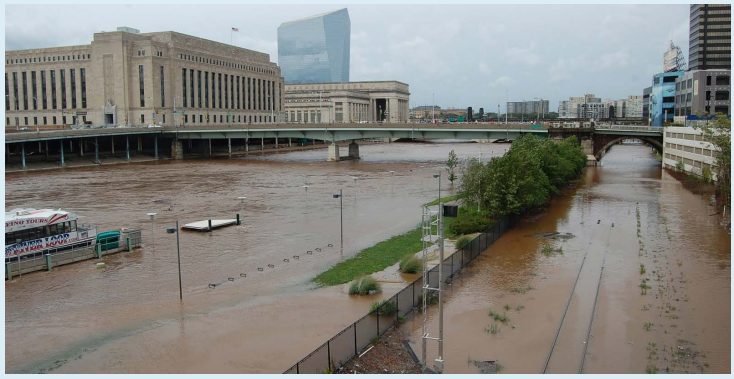
Greenhouse gases are also changing the world's oceans and ice cover. Carbon dioxide reacts with water to form carbonic acid, so the oceans are becoming more acidic. The surface of the ocean has warmed about one degree during the last 80 years. Warming is causing snow to melt earlier in spring, and mountain 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. All regions of Pennsylvania have warmed. Source: EPA, Climate Change Indicators in the United States.

Increasing Temperature and Changing Precipitation

Rising temperatures and shifting rainfall patterns are likely to increase the intensity of both floods and droughts. Average annual precipitation in Pennsylvania has increased 5 to 10 percent in the last century, and precipitation from extremely heavy storms has increased 70 percent in the Northeast 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, changing the climate is likely to intensify flooding during winter and spring, and drought during summer and fall.



In 2011, Hurricane Irene caused the Schuylkill River to overflow its banks, flooding a rail line, bike path, and other infrastructure in Philadelphia. Credit: Sarah Clark Stuart, Bicycle Coalition of Greater Philadelphia.

Higher Tides Along the Delaware River

Sea level is rising more rapidly along Pennsylvania's shoreline than in most coastal areas because the Delaware Valley is sinking. If the oceans and atmosphere continue to warm, the tidal portion of the Delaware River is likely to rise one to four feet in the next century. Parts of Philadelphia International Airport and neighborhoods to the north are within two or three feet above the average high tide on the Delaware River. In downtown Philadelphia, Penn's Landing and the Northeast Corridor railroad tracks at 30th Street Station are currently in the 100-year floodplain. Along the Delaware and Schuylkill rivers, a higher sea level could increase the extent of flooding caused by either coastal storms or severe rainstorms, unless communities take measures to hold back the rising rivers.

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Tidal marshes like this one at Tinicum are vulnerable to destruction and saltwater intrusion as sea level rises. Credit: Partnership for the Delaware Estuary.

The tidal freshwater wetlands along the Delaware River are likely to capture enough sediment for their land surfaces to keep pace with rising sea level. But both rising sea level and increasing drought enable salt water to mix farther up the Delaware River, which could kill wetland plants. In places where that occurs, wetlands might be replaced by either salt-tolerant wetland plants or shallow waters. Higher salinity could also create problems for Philadelphia's water supply during droughts, if salty water moves upstream to the city's drinking water intake at Torresdale.

Inland Waters

Extraordinarily high river flows occasionally cause problems for commercial navigation along the Ohio and Allegheny rivers, and riverfront communities along the Susquehanna River and smaller tributaries occasionally flood. Heavier storms and greater river flows could make these problems worse. In 2011, heavy rainfall caused record flooding on the Susquehanna and the evacuations of Wilkes-Barre. Conversely, lower summer rainfall and higher evaporation could leave some rivers too shallow for navigaton during droughts.

One advantage of climate change is that warmer winters reduce the number of days that ice prevents navigation on rivers and in the Great Lakes. Between 1994 and 2011, reduced ice cover lengthened the shipping season on the Great Lakes by eight additional days. The Great Lakes are likely to warm another 3° to 7°F in the next 70 years, which will further extend the shipping season. The impact of climate change on water quality is less likely to be beneficial. Warmer temperatures tend to cause more algal blooms, which can be unsightly, harm fish, and degrade water quality. Severe storms also increase the amount of pollutants that run off from the land into the water, further increasing the risk of algal blooms.

Ecosystems

Changing the climate threatens ecosystems by disrupting the existing relationships between species. 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. As a result, for example birds in western Pennsylvania have had lower body weights during warm years. Warmer temperatures allow deer populations to increase, leading to a loss of forest underbrush, which, in turn, makes some animals more vulnerable to predators. Rising temperatures also enable invasive species to move into areas that were previously too cold.

Agriculture

Changing climate will have both beneficial and harmful effects on farming, but the net effect is unknown. Longer frost-free growing seasons and higher concentrations of atmospheric carbon dioxide would increase yields for many crops during an average year, notably soybeans. But increasingly hot summers are likely to reduce yields of corn, Pennsylvania's most important crop. The earlier arrival of spring may increase populations of major crop pests, such as the corn earworm and aggressive weeds. Higher temperatures cause cows to eat less and produce less milk, so a warming climate could reduce the output of milk and beef, which together account for more than one-third of the commonwealth's farm revenues.

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.

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. Higher temperatures would also expand the area that is warm enough for the Asian tiger mosquito, a common carrier of West Nile virus. The number of cases may or may not increase, depending on what people do to control insect populations and avoid insect bites.

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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