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Climate Change And Louisiana

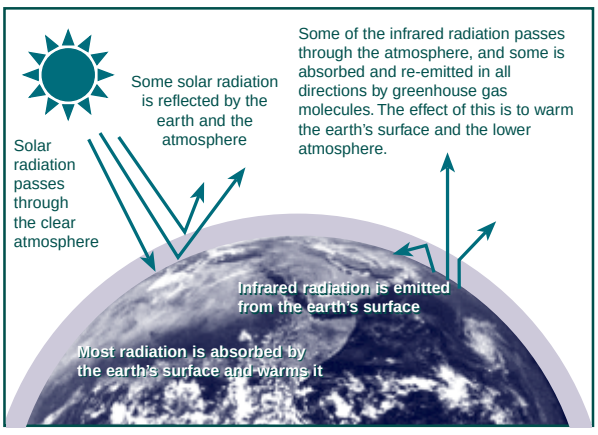
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is ***enhanced*** by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

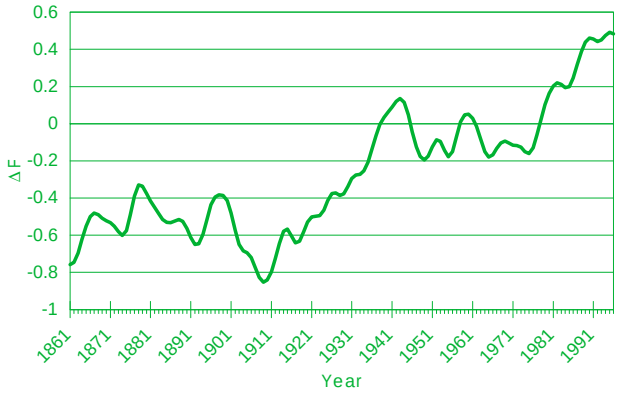
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F since the late 19th century. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that ***"the balance of evidence suggests a discernible human influence on global climate."***

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere's heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, average temperatures in New Orleans, Louisiana, have remained virtually unchanged, but precipitation has increased by 5-20% in some locations of the state.

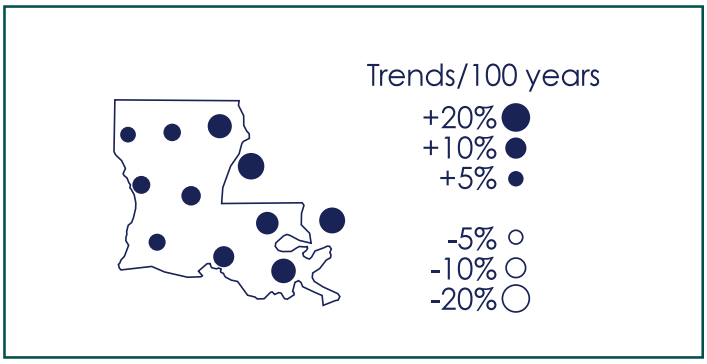
Over the next century, Louisiana's climate may change significantly. Based on projections given by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre's climate model (HadCM2), a model that has accounted for both greenhouse gases and aerosols, it is projected that by 2100, temperatures in Louisiana could increase about 3°F (with a range of 1-5°F) in spring and summer, slightly less in winter, and slightly more in fall. Little change is projected for seasonal precipitation totals in winter and spring, with an increase of around 10% in summer and fall.

The frequency of extreme hot days in summer is expected to increase along with the general warming trend. It is not clear how severe storms such as hurricanes would change.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Human Health

Warming and other climate changes could expand the habitat and infectivity of disease-carrying insects, increasing the potential for transmission of diseases such as malaria and dengue ("break bone") fever. Mosquitoes flourish in Louisiana. Some can carry malaria, while others can carry Eastern equine encephalitis, which can be lethal or cause neurological damage. If conditions become warmer and wetter, mosquitoes could increase, thereby increasing the risk of transmission of these diseases. For example, the lack of a killing frost between 1990 and 1995 caused a proliferation of mosquitoes, cockroaches, and termites in Louisiana.

In addition, warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms. These blooms damage habitat and shellfish nurseries, can be toxic to humans, and can carry bacteria like those causing cholera. Brown algal tides and toxic algal blooms already are prevalent in the Atlantic. Warmer ocean waters could increase their occurrence and persistence. Along Louisiana's coast, viral and bacterial contamination of shellfish has repeatedly caused illness. Warming in the Caribbean may have contributed to these illnesses; future warming combined with local pollution most likely would continue to damage fish and shellfish and thus affect human health.

There is concern that climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Air pollution also is made worse by increases in natural hydrocarbons emissions during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

Increased emissions and higher temperatures could slow progress being made in Louisiana to provide healthy and clear air. Currently, ground-level ozone concentrations in the Baton Rouge and Lake Charles areas exceed the national standards. Ground-level ozone has been shown to aggravate existing respiratory illnesses such as asthma, reduce lung function, and induce respiratory inflammation. In addition, ambient ozone reduces agricultural crop yields and impairs ecosystem health.

Coastal Areas

Sea level rise could lead to flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges. In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding.

At Grand Isle, Louisiana, sea level already is rising by 41 inches per century, and is likely to rise another 55 inches by 2100. Louisiana currently is losing coastal wetlands at a more rapid rate (approximately 50 square miles a year) than any other coastal state or region in the United States. Louisiana's low-lying delta coastal wetlands are a unique case — these wetlands receive large deposits of sediment from the outflow of the Mississippi River. These deposits provide wetlands with a natural defense against the effects of sea level rise. However, because the surface is subsiding faster than sedimentation is occurring, Louisiana wetlands could be flooded extensively even by relatively small changes in sea level. A 1-3 foot increase in sea level over the next century is projected to submerge at least 70% of Louisiana's remaining salt marshes. Even freshwater marshes located far inland may convert to brackish or salt marsh.

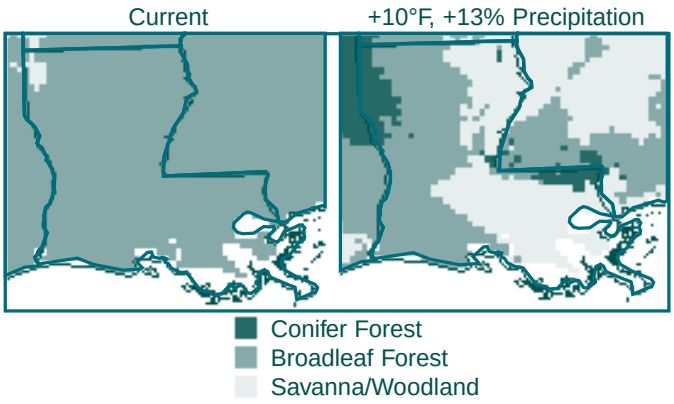
Cumulative costs of sand replenishment to protect Louisiana's coast from a 20-inch sea level rise by 2100 could be $2.6-$6.8 billion.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic extent, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate would lead to changes; trees that are better adapted to these conditions, such as oaks and redwoods, would thrive. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if they are accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent and density of forested areas in Louisiana could change little or decline by 5-15%. Hotter, drier weather could increase wildfires, particularly in the important timber producing regions in the northern part of the state. In some areas, the types of trees dominating Louisiana forests are likely to change. Long-leaf and slash pine densities could

Changes In Forest Cover



Source: VEMAP Participants (1995); Neilson (1995)

increase, as would the extent of cypress and gum dominated forests in southeastern Louisiana. Loblolly and shortleaf pines would continue to thrive over much of the state; however, drier conditions could result in increased areas of grassland and savanna in the western part of the state.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. In addition, more intense precipitation could increase flooding. If streamflow and lake levels drop, groundwater also may be reduced.

Most of Louisiana drains to the lower Mississippi and Red rivers, both of which have headwaters thousands of miles from their mouths. Streamflow in these rivers is affected mostly by conditions outside Louisiana's borders. Because much of the runoff of the Red and Mississippi rivers comes from areas where there is little snowfall, streamflow is affected by changes in precipitation and temperature. Summer flows of these rivers could be reduced by the increased evaporation that would occur in a warmer climate.

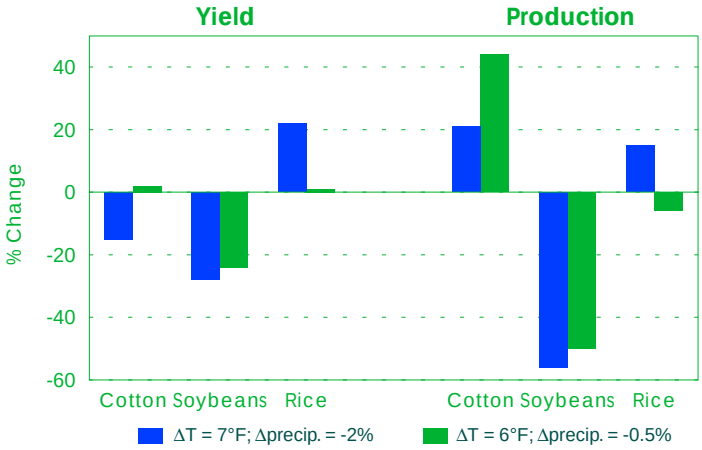
The part of Louisiana that is not in the Red or Mississippi River basins is drained by smaller rivers and streams that flow directly to the Gulf of Mexico. Because of the relatively flat topography, the groundwater and surface water systems are either indistinguishable (e.g., in the bayous) or closely connected. Changes in the flow of these rivers in a warmer climate would depend largely on precipitation changes. However, evaporation probably would increase, which could reduce water levels in freshwater wetlands as well as in groundwater supplies.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns will shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, and other economic sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could substantially change modeling results. Analyses based on changes in average climate and which assume farmers effectively adapt suggest that aggregate U.S. food production will not be harmed, although there may be significant regional changes.

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

In Louisiana, agriculture is about a $2 billion annual industry, one-third of which comes from livestock. About 25% of the acres farmed is irrigated. The principal crops are cotton, soybeans, and rice. Cotton yield under climate change could remain unchanged or fall by 15%. Rice yields could increase, and soybean yields could fall by up to 28%. Acres farmed could fall by 2%, and farm income could be as much as 80% lower. The number of irrigated acres could increase. This could further limit water supplies, and water quality could be further degraded.

Ecosystems

Louisiana's Mississippi River delta contains the largest wetlands in the nation. These coastal wetlands support 30% of national commercial fish and shellfish harvests. They are also the winter home of 20-25% of the ducks that frequent ponds in North America. These wetlands are among the most commercially and ecologically productive in the United States. The coastal marshes in Louisiana, for example, generate over $2 billion worth of commercial species such as oysters, crabs, fish, and shrimp each year. They also are an invaluable buffer against storm surges.

The wetlands of Louisiana are highly vulnerable to climate change effects, particularly sea level rise. Louisiana is already losing many of its wetlands because of levees and other structures along the Mississippi River. Sea level rise most likely will accelerate wetland loss, reducing important habitats for migratory birds, crayfish, sport fish, and other species. Some warm water fish species such as black crappie could lose all of their habitat in Louisiana as a result of the effects of climate change. In addition, spotted sea trout, oyster larvae, pinfish, and flounder would lose much, if not all, of their habitat.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.