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Climate Change And Iowa

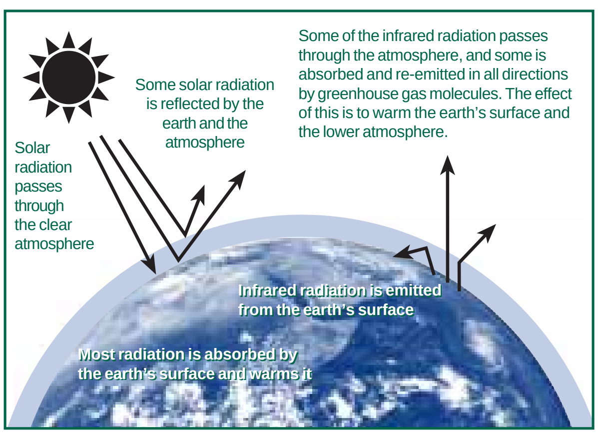
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. 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

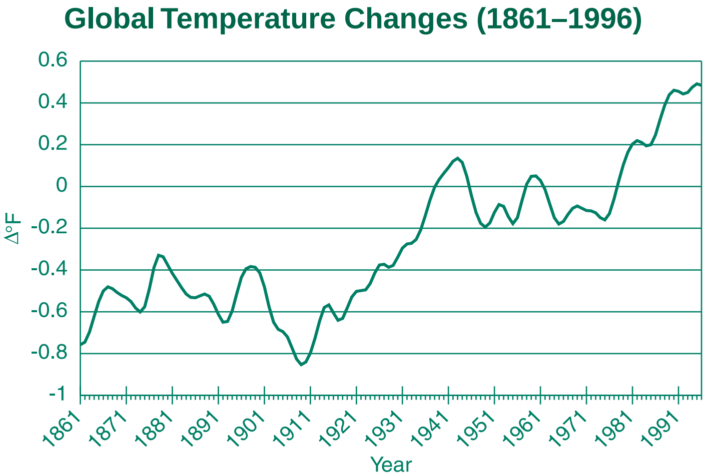
Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate 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 between 1890 and 1996. 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



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.

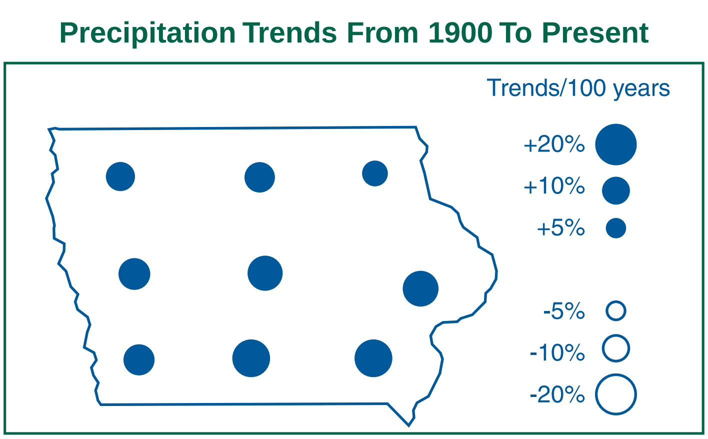
The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level 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, the average temperature near Des Moines, Iowa, has decreased 0.2°F, and precipitation has increased by up to 20% in many parts of the state. These past trends may or may not continue into the future.

Over the next century, climate in Iowa could experience additional changes. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre's climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Iowa could increase by 2°F in summer (with a range of 1-4°F), 3°F in spring (with a range of 1-5°F), and 4°F in fall and winter (with a range of 2-7°F). Precipitation is estimated to increase by 10% in winter and spring (with a range of 5-20%), 15% in fall (with a range of 5-30%), and 20% in summer (with a range of 10-40%). Other climate models may show different results, especially regarding estimated changes in precipitation. The impacts described in the sections that follow take into account estimates from different models. The frequency of extreme hot days in summer would increase because of the general warming trend. It is not clear how the severity of storms might be affected, although an increase in the frequency and intensity of summer thunderstorms is possible.



Source: Karl et al. (1996)

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. The elderly, particularly those living alone, are at greatest risk. These effects have been studied only for populations living in urban areas; however, even those in rural areas may be susceptible.

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. A 2°F warming in the Midwest, with no other change in weather or emissions, could increase concentrations of ozone, a major component of smog, by as much as 8%. Although Iowa is in compliance with current ozone air quality standards, increased temperatures could make remaining in compliance more difficult. Ground-level ozone is associated with respiratory illnesses such as asthma, reduced lung function, and respiratory inflammation. Air pollution also is made worse by increases in natural hydrocarbon emissions such as emissions of terpenes by trees and shrubs during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

Upper and lower respiratory allergies also are influenced by humidity. A 2°F warming and wetter conditions could increase respiratory allergies.

Warming and other climate changes could expand the habitat and infectivity of disease-carrying insects. Infected individuals can bring malaria to places where it does not occur naturally. Also, some mosquitoes in Iowa can carry malaria, and others can carry California encephalitis, which can be lethal or cause neurological damage. If conditions become warmer and wetter, mosquito populations could increase, thus increasing the risk of transmission if these diseases are introduced into the area. Warmer temperatures could increase the incidence of Lyme disease and other tick-borne diseases in Iowa, because populations of ticks, and their rodent hosts, could increase under warmer temperatures and increased vegetation.

Increased runoff from heavy rainfall could increase water-borne diseases such as giardia, cryptosporidia, and viral and bacterial gastroenteritides. Developed countries such as the United States should be able to minimize the impacts of these diseases through existing disease prevention and control methods.

Water Resources

Iowa is bordered on the east by the Mississippi River and on the west by the Missouri River. Roughly two-thirds of the state drains to the Mississippi, and the western third drains to the Missouri. Along the major rivers, the largest water withdrawals are for thermoelectric power generation. In the central and northern parts of the state, groundwater is more important than surface water because these areas contain most of the population, and the principal use of groundwater is for public supply. During most years, precipitation is sufficient to maintain streamflow, recharge aquifers, and preserve sufficient soil moisture to support agriculture (which is primarily rainfed). However, streamflow is highly variable, and during years with less-than-average precipitation, surface water supplies become critically deficient, particularly in the western and south-central areas of the state. This situation could be exacerbated in a warmer climate. Runoff in the state comes largely from rainfall, and to a lesser degree from snowmelt. Warmer winter temperatures would lead to earlier snowmelt and would increase streamflows in winter and spring. In the summer, without large increases in precipitation, higher temperatures and increased evaporation would reduce streamflows, lake levels, and groundwater levels. Lower streamflow and lake levels would limit important uses of the Mississippi and Missouri River reservoirs, including navigation, hydropower generation, recreation, wildlife conservation, and wastewater assimilation. Water availability also would be reduced for offstream uses such as thermoelectric power generation, supply for a growing population, and irrigation demand. In western Iowa, groundwater is used for irrigation during droughts and at critical times in the growing season. Groundwater also is used to water livestock throughout the state. Lower groundwater levels would adversely impact these agricultural uses, as well as public supplies. Lower flows and higher temperatures also could degrade water quality by concentrating pollutant levels and could impair wetlands.

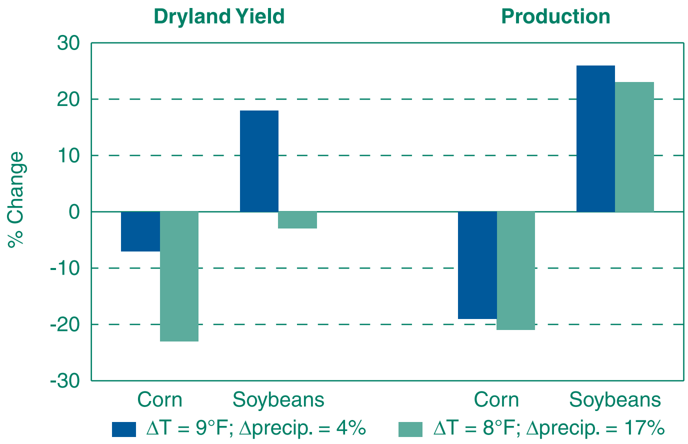
In Iowa, too much rain is as much a concern as too little. Many areas are susceptible to flooding, and the fertile soils in the state are highly erodible. Also, many soils have little permeability, and drainage is a problem. Surface-water quality problems are associated with sedimentation from soil erosion and with high concentrations of nitrates, pesticides, and nutrients from agricultural runoff. Increased rainfall would aggravate these problems, particularly because heavier rains are expected in a warmer climate.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could 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, industry, and other users.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, crop pests, changes in air pollution such as ozone, and adaptation by farmers to changing climate. Including these factors could change modeling results substantially. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

Changes In Agricultural Yield And Production



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

In Iowa, production agriculture is a $10 billion annual industry, 60% of which comes from livestock, mainly cattle. Very few of the farmed acres are irrigated. The major crops in the state are corn and soybeans. Corn yields could fall 7-23%, depending on the extent to which temperature rises beyond the tolerance level of the crop. Soybean yields could fall by 3% or, if changes are less severe, could rise by 18%. Farmed acres could remain fairly constant or could decrease by as much as 8%. Livestock and dairy production may not be affected, unless summer temperatures rise significantly and conditions become significantly drier. Under these conditions, livestock tend to gain less weight and pasture yields decline, limiting forage.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species composition, geographic range, 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 could lead to changes; trees that are better adapted to warmer conditions, such as oaks and southern pines, would prevail. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if the change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

In Iowa, less than 5% of the area is forested, mostly along rivers and streams. With changes in climate, the extent of forested areas in Iowa may change little or could increase by as much as 10-40%, depending on competition from agricultural uses. The uncertainties also depend on many other factors, including whether soils become drier and, if so, how much drier. With hotter, drier weather, southern pines gradually would replace deciduous forests in the southern part of the state, particularly in areas with rich soils. In areas with poorer soils, which are common in some Iowa forests, scrub oaks of little commercial value (e.g., post oak and blackjack oak) could increase. In contrast, warmer, wetter conditions could expand northward the range of oak and pine forests and riparian woodlands.

Ecosystems

Iowa lies in a zone of transition between the forested ecosystems to the east and the Great Plains of the central United States. The natural heritage of the state includes hardwood forests in the south and east, the bluestem prairie in the northwest, and the elm-ash-cottonwood forests of the Mississippi tributaries. The Prairie Pothole Region, which extends into north-central Iowa, is a globally important resource for waterfowl and shorebirds. Millions of migratory birds use the Mississippi River corridor during fall and spring migration, which is critical because of its north-south orientation and its nearly uninterrupted habitat. Desoto National Wildlife Refuge, for example, is a temporary home for hundreds of thousands of snow geese and tens of thousands of ducks. Much of the state is intensively cultivated, and surface water systems receive substantial inputs of nutrients, pesticides, sediments, and pollutants. As a result, populations of fingernail clams, unionid mussels, submersed vegetation, mink, and migratory waterfowl have declined in recent decades. Many waterfowl populations have also declined recently; for example, mallard, blue-winged teal, and northern pintail are at or near their lowest numbers ever recorded. Along one of the reaches of the Mississippi in southern Iowa, peak numbers of lesser scaup have decreased from 300,000-500,000 in the 1970s to fewer than 25,000 today. The oak savannas of the transition zone between the vast treeless prairies and eastern deciduous forests now share equal billing with tallgrass prairie as one of the most threatened plant communities in the Midwest. Historically, they covered large parts of eastern and southern parts of the state, but today they have all but disappeared and are a globally endangered ecosystem. The estimated increases in temperature and changes in precipitation due to climate change could further stress these wildlife and plant resources.

Water and the resulting life that it brings is key to the prairie ecosystem. The abundance of wetlands is closely tied to the yearly variation in weather patterns, including variation in both precipitation and temperature. This has important implications for the shorebird migrants that funnel through the Great Plains. Under drier conditions, wetland feeding areas are not as abundant. As the quantity of suitable habitat declines, artificially high concentrations of waterfowl may lead to increased transmission of avian botulism and large-scale dieoffs. Species of the upland prairie also could face problems in a changing climate. For example, one study showed that all 23 grassland bird species would shift their range and approximately half would decline in range under projected climate change. Sprague's pipit and McCown's longspur could become extinct and chestnut-collared longspur and Baird's sparrow were highly vulnerable.

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, or visit http://www.epa.gov/globalwarming/impacts.