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Climate Change And Idaho

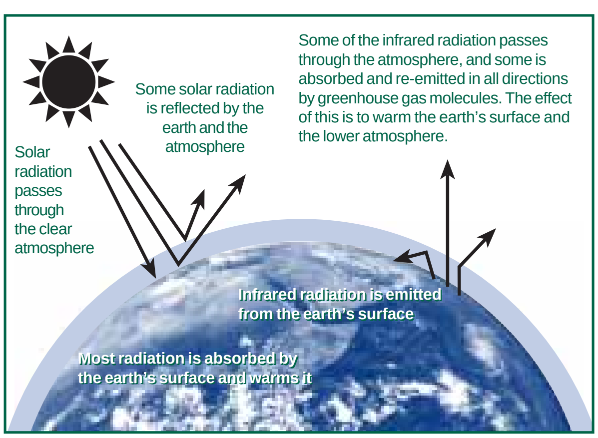
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed.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

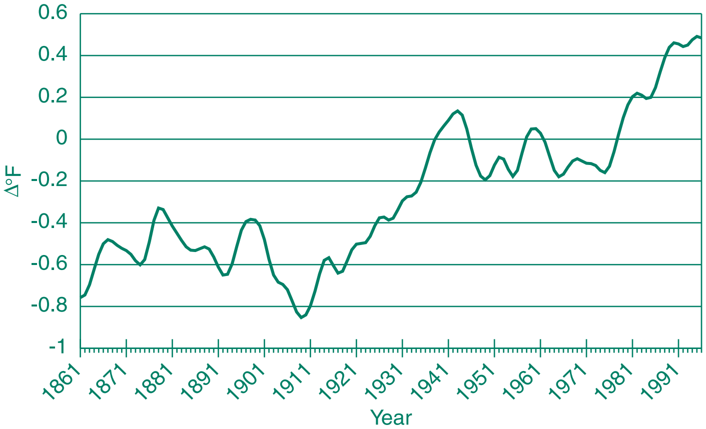
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and 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

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.

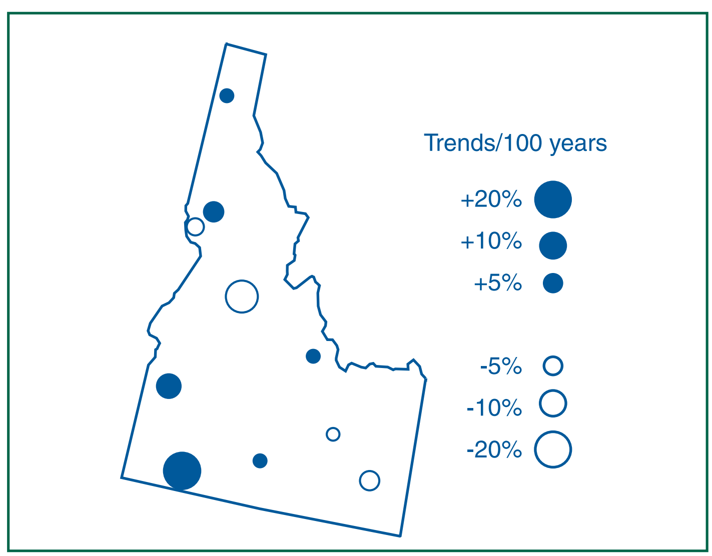
Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency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

Local Climate Changes

Over the last century, the average temperature near Boise, Idaho, has increased nearly 1°F, and precipitation has increased by nearly 20% in many parts of the state, and has declined in other parts of the state by more than 10%. These past trends may or may not continue into the future.

Over the next century, climate in Idaho may 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 Idaho could increase by 5°F (with a range of 2-9°F) in winter and summer and 4°F (with a range of 2-7°F) in spring and fall. Precipitation is estimated to change little in summer, to increase by 10% in spring and fall (with a range of 5-20%), and to increase by 20% in winter (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 amount of precipitation on extreme wet or snowy days in winter is likely to increase. 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 winter storms is possible.

Precipitation Trends From 1900 To Present



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. Although Idaho 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 could increase.

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

Warming and other climate changes could expand the habitat and infectivity of disease-carrying insects. Mosquitoes in Idaho can carry malaria, and some can carry western equine 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 this and other diseases are introduced into the area. Warmer temperatures could increase the incidence of Lyme disease and other tick-borne diseases in Idaho, 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

Idaho relies primarily on surface, but groundwater is also an important source of supply. Most of Idaho is drained by tributaries to the Columbia River, including the Spokane, Pend Oreille, Kootenai, and Snake rivers. These rivers are regulated by dams and reservoirs to reduce spring flooding and augment summer flows. Runoff in the state is strongly affected by winter snow accumulation and spring snowmelt. A warmer climate could mean less snowfall, more winter rain, and a faster, earlier snowmelt. This could result in lower reservoirs and water supplies in the summer and fall. Additionally, without increases in precipitation, higher summer temperatures and increased evaporation also would contribute to lower streamflows and lake levels in the summer.

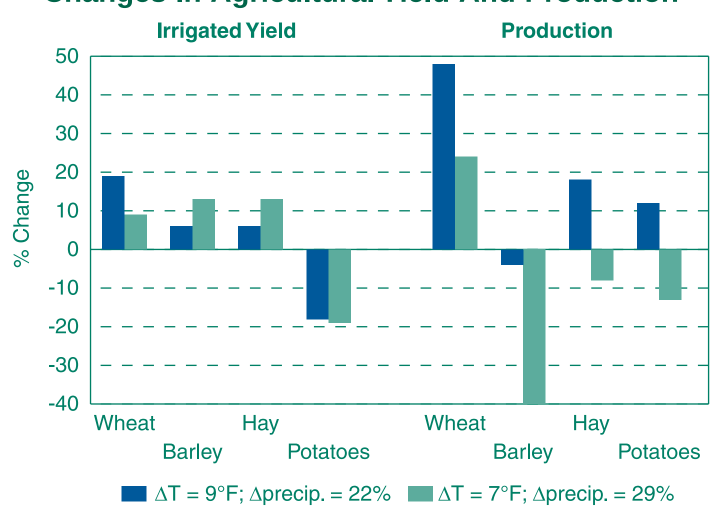
Drier summer conditions would intensify competition for water among the diverse and growing demands in Idaho. Traditionally, the largest water withdrawals have been for irrigated agriculture, and hydroelectric power production has been an important instream user of water. Recently, water demands to support manufacturing and tourism have increased. Higher instream flows are now required to augment flows in the lower Snake and Columbia rivers to improve conditions for threatened and endangered salmon. The public has demanded improved recreational opportunities, and tribal water rights also must be satisfied. In areas such as the Snake River Plain aquifer, groundwater levels are declining because of increased pumpage, changes in irrigation practices, and a prolonged drought (1987-1994). Lower streamflows and runoff could reduce rates of groundwater recharge and exacerbate water supply problems. Lower flows and increased temperatures could impair water quality by reducing the assimilation of wastes and concentrating pollutants from irrigation return flows, mine tailings, and municipal and industrial wastes.

Wetter conditions could benefit hydropower production and ease competition for water, but they could also increase flooding in some areas. In snow-dominated river basins such as the Columbia, less snow accumulation could reduce the risk of spring floods. However, more rain during the traditional flood season could increase the frequency of flooding at lower elevations. In a warmer climate, storm intensity could increase. Near Boise, intense storms and warm rain on snowpack cause severe flooding and mud and debris flows. More intense rains could increase other hazards associated with high flows in Idaho, such as landslides on steep roadcuts, erosion and stream sedimentation, levels of pesticides and fertilizers in runoff from agricultural lands, and pollution in runoff from urban lands.

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.

Changes In Agricultural Yield And Production



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

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.

In Idaho, production agriculture is a $2.8 billion annual industry, 60% of which comes from crops. Almost 70% of the farmed acres are irrigated. The major crops in the state are wheat, hay, barley, and potatoes. Climate change could increase wheat yields by 9-18%. Barley and hay could increase by 12%, and potato yields could fall by 18% under severe conditions where temperatures rise beyond the tolerance levels of the crop. Farmed acres could rise or fall by 10%, depending on how climate changes.

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 these conditions, such as fir and spruce, would thrive. 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.

With changes in climate, the extent of forested areas in Idaho may change little or could decline by as much as 15-30%. The uncertainties depend on many factors, including whether soils become drier and, if so, how much drier. Hotter, drier weather could increase the frequency and intensity of wildfires, threatening both property and forests. Drier conditions would reduce the range and health of lodgepole and Douglas fir forests, and increase their susceptibility to fire. With increases in rainfall, however, these effects could be less severe. Grass and rangeland could expand into previously forested areas along the eastern slope of the Rocky Mountains and into some of the western valleys. Warmer conditions could increase the elevation of the timberline, resulting in a reduction or the disappearance of alpine tundra and its unique (and in some cases already endangered) species. Milder winters could increase the likelihood of insect outbreaks and of subsequent wildfires in the dead fuel left after such an outbreak. These changes would significantly affect the character of Idaho forests and the activities that depend on them.

Ecosystems

Idaho is very rich in ecological diversity. Major forest ecosystems include grand fir-Douglas fir forest, cedar-hemlock-pine forest, Douglas fir forest, western ponderosa pine forest, and western spruce-fir forest. While the northern part of the state is dominated by forests, most of the southern part of the state is covered by sagebrush steppe, interspersed with islands of desert and saltbush-greasewood shrublands. Many areas in the state are nearly pristine and include some of the largest areas in the United States without paved roads. Significant fish resources include salmon and steelhead. Fire plays an important role in several ecosystems, including sagebrush steppe, western juniper woodlands, and ponderosa and lodgepole pine. In many of these ecosystems, fire suppression and other land use policies have resulted in significant changes in forest composition and structure. In sagebrush steppe, a greater frequency of fires in the last 50 years has resulted in invasion by annual grasses such as cheatgrass and medusahead. In western juniper woodlands, continued grazing and 50 years of attempted fire exclusion have allowed juniper expansion to continue unchecked. Historically, frequent, low-intensity surface fires perpetuated park-like conditions in ponderosa pine stands. Today, after 60 years of fire suppression, many of these forests, along with lodgepole pine forests, have high densities of trees, are plagued by epidemics of insects and diseases, and are subject to severe stand-destroying fires. Significant changes are also occurring in whitebark pine populations of high-elevation forests. In northern Idaho, stands have decreased by anywhere between 50 and 100%, due in part to fire suppression and white pine blister rust, a non-native fungus that has defied control. Fewer than 1 in 10,000 trees is resistant. Loss of this forest type may be catastrophic for grizzlies. Even a modest warming and drying could reduce whitebark pine habitat by up to 90%. Whitebark pine nuts and the army cutworm moth caterpillars found in southeastern forests provide vital food for grizzly bears. Yellowstone National Park is the most famous of the region's protected areas. Its intact grizzly bear habitat, rangelands for buffalo, elk, and moose, and spectacular hot springs and geysers attract millions of visitors per year.

Climate change could exacerbate many of the problems facing ecosystems in Idaho. Although wildfires are a natural and necessary part of the ecology of western forests, changes in fire regimes under climate change have significant implications.

Climate change poses a threat to high alpine systems, and could lead to their significant decline. Local extinctions of alpine species such as arctic gentian, alpine chaenactis, rosy finch and water pipit have resulted from habitat loss and fragmentation, both of which could worsen under climate change. Whitebark pine forest could be replaced with Douglas fir. On the lower slopes, forests would give way to treeless landscapes dominated by sagebrush, Idaho fescue, and bluebunch wheatgrass.

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.