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Findings of the IPCC Fourth Assessment Report

Climate Change Impacts

The summary of the second policy-relevant report published in 2007 by the Intergovernmental Panel on Climate Change (IPCC) describes the impacts of global warming on society and the natural environment, as well as some of the options for adapting. Released in April 2007—six years after the prior assessment by the IPCC—the Working Group II Summary for Policymakers is titled *Climate Change 2007: Impacts, Adaptation and Vulnerability*.[1]

The other components include the Working Group I report summary *The Physical Science Basis* and the Working Group III report summary *Mitigation of Climate Change*. This report is one component of the full IPCC Fourth Assessment Report, which includes the input of more than 1,200 authors and 2,500 scientific expert reviewers from more than 130 countries.[2]

Highlights from Working Group I

The IPCC reported in February 2007 that it is "very likely" (>90 percent) that heat-trapping emissions from human activities have caused "most of the observed increase in globally averaged temperatures since the mid-20th century." The IPCC based its projections of further climate change on six scenarios that assume various increases in concentrations of heat-trapping gases in the atmosphere. IPCC projects temperature increases by the end of the century in the range of ~2°F (1.1°C) to ~11.5°F (6.4°C).[3]

Effects of Warming Are Apparent Worldwide

Human-induced warming over recent decades is already affecting many physical and biological processes on every continent. Nearly 90 percent of the 29,000 observational data series examined revealed changes consistent with the expected response to global warming, and the observed physical and biological responses have been greatest in the regions that warmed the most. This conclusion is further supported by recent advances in studies that compare observed changes with simulations that explicitly separate natural and human-induced factors affecting climate. This enables researchers to calculate how much of an observed change is attributable to human-induced warming. Challenges remain over the influence of other factors such as local pollution, invasive species, and land-use change.

The IPCC expects additional substantial effects on human society and natural environments around the world. One reason is that ~1 degree Fahrenheit (°F), or 0.6 degree Celsius (°C), of additional warming is already unavoidable due to past emissions. Further emissions would cause additional warming and thus additional impacts. The IPCC summary often does not explicitly predict the magnitude and timing of these consequences because they depend on the amount and rate of warming and, in some cases, on society's ability to adapt.

Changes in Water Resources

Hundreds of millions of people face water shortages that will worsen as temperatures rise. Most at risk are current drought-affected regions, areas with heavily used water resources, and areas that get their water from glaciers and snowpack (including the western U.S.).**

The land area affected by drought is expected to increase and water resources in affected areas could decline as much as 30 percent by mid-century. U.S. crops that are already near the upper end of their temperature tolerance range or depend on heavily used water resources could suffer with further warming.**

More than one-sixth of the world's population currently lives near rivers that derive their water from glaciers and snow cover; these communities can expect to see their water resources decline over this century.** The IPCC expects many Latin American glaciers to disappear entirely over the next couple of decades,** and

IPCC Terminology

Projections described in the text of this document are marked with asterisks that reflect the degree of confidence assigned to that conclusion by the IPCC:

- Very high confidence*** = At least a 9 out of 10 chance
- High confidence** = About an 8 out of 10 chance
- Medium confidence* = About a 5 out of 10 chance

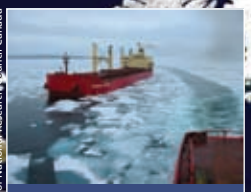
Likelihood of occurrence:

- Very likely = Greater than 90% probability
- Likely = Greater than 66% probability

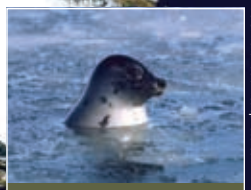
Impacts of Warming on North America


Lapdong Guo

Rising seas, retreating sea ice, and thawing permafrost erode coastlines


Courtesy of National Research Council Canada

Sea routes become increasingly navigable


B&C Alexander/Arcticphoto.com

Retreating sea ice reduces seal and polar bear habitat


Gary Braasch

Communities forced to relocate, with associated high costs


B&C Alexander/Arcticphoto.com

Rapid changes threaten traditional ways of life


Ashley Cooper/Picimpact/Corbis

Thawing permafrost destabilizes infrastructure


Courtesy of USDA

Forest pests and diseases increase


Courtesy of USDA

Altered distribution of insects and rodents that transmit disease


Photos.com

Summer river flow decreases


Courtesy of NPS

Glaciers melt


Jodi Hilton

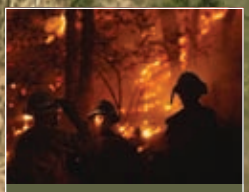
Winter recreation and tourism suffer


Associated Press

Heat waves increase in number, intensity, and duration


Courtesy of USDA

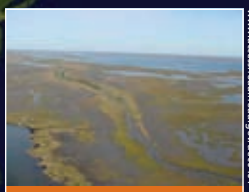
Water supply from mountain snowpack declines


AP Photo/Ajang Chadwick Williams

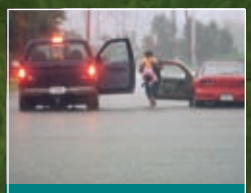
Wildfire season lengthens; more forest area burns


Picturequest

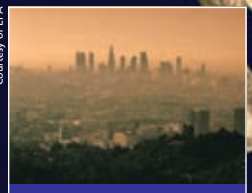
Agricultural yields increase with small temperature increases, but further warming decreases yields


www.accessnoaa.noaa.gov/dec0401

Coastal land is lost, including species-rich wetlands


Associated Press

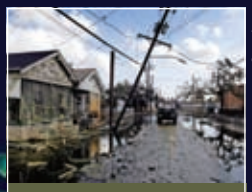
Heavy precipitation increases flood risk


Courtesy of EPA

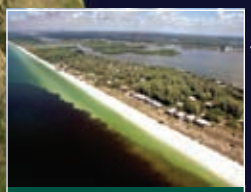
Rising temperatures increase smog-related health risks


Courtesy of USDA

Extent and duration of droughts increase


Getty Images

Intense hurricanes increase


Courtesy of NOAA

Risk of harmful algal blooms increases


Courtesy of USGS

Rising water temperatures and acidification kill corals

Although IPCC has a global focus, this map highlights some of the impacts for North America. Most of these impacts are already underway and are expected to increase with further warming.

Map courtesy of NASA

water resource competition to increase in western North America when decreased snowpack in the mountains reduces summer river flow.*** Many rivers that derive their water from melting glaciers or snow will have earlier peak runoff in spring and an overall increase in runoff, at least in the short term.** Such a temporary increase in water flow would not always be welcome; for example, melting glaciers in the Himalayas would increase flooding and rockslide risks, while flash flood risks could increase in Northern, Central, and Eastern Europe.

Changes in Food Production

The IPCC expects food production to decline in low-latitude regions (near the equator), particularly in the seasonally dry tropics, as even small temperature increases decrease crop yields in these areas.

The IPCC projections show drought-prone areas of Africa to be particularly vulnerable to food shortages due to a reduction in the land area suitable for agriculture; some rain-fed crop yields could decline as much as 50 percent by 2020.** The likely degradation of African coral reefs and mangroves would have negative consequences for fisheries. Rising lake temperatures in Africa combined with overfishing may also decrease fish supplies. Several developing countries in Asia face a continued very high risk of food shortages from a combination of projected declines in crop production, rapid population growth, and urbanization.

Under local average temperature increases of ~2 to ~5°F (1 to 3°C), regions such as Northern Europe, North America, New Zealand, and parts of Latin America could benefit from increased growing season length, more precipitation, and/or less frost, depending on the crop. However, these regions can also expect more flooding, and if local average temperatures rise beyond this range, crop yields could decline in some of these areas.* Note that these higher-latitude regions warm at a faster rate than the global average.

The populations most vulnerable to climate change-induced food shortages are those that depend on climate-sensitive food and water supplies and also lack the economic resources and government support to plan for or recover from extreme events such as floods or prolonged droughts.

Species in Peril

Up to 30 percent of plant and animal species could face extinction if the global average temperature rises more than ~3 to ~5°F (1.5 to 2.5°C)[4] relative to the 1980–1999 period.* Many projections suggest the low end of this temperature range could be reached by mid-century.

NOAA

Many species have already shifted their ranges to higher latitudes (toward the poles) and higher elevations over the past several decades. Spring has been arriving earlier during this time, influencing the timing of bird and fish migration, egg laying, leaf unfolding, and spring planting for agriculture and forestry in the high northern latitudes.*** Satellite records since the early 1980s confirm that increased temperatures have produced longer growing seasons.**

Scientists expect the magnitude of these changes to increase along with temperatures over this century. Many species and ecosystems may not be able to adapt as the effects of global warming and its associated disturbances (including floods, drought, wildfire, and insects) are compounded by other stresses such as pollution and resource exploitation.** Polar and alpine species are especially vulnerable to the effects of climate change, as their unique habitats could shrink due to warming.

Acidification of the oceans due to increasing atmospheric carbon dioxide negatively affects marine shell-forming organisms such as corals and some plankton (and the species that depend upon them). Warming ocean waters represent another threat to corals; if they are unable to adapt to projected sea surface temperature increases of ~2 to ~5°F (1 to 3°C), corals could lose the algae that nourish and give them color, and many would die.*** Scientists expect coral reefs and mangroves in Africa to be degraded to the point that fisheries and tourism suffer.

Some areas, such as the national parks of Australia and New Zealand and many parts of tropical Latin America are likely to experience a significant loss of biodiversity. The Great Barrier Reef could experience such a loss by 2020.* By mid-century, tropical forests in the eastern Amazon Basin could be gradually replaced by less species-rich savanna because of rising temperatures and decreasing soil moisture.**

Escalating Hazards for Coasts

Flooding caused by sea-level rise is expected to affect millions of additional people every year by the end of this century, with small islands and the crowded delta regions around large Asian rivers (such as the Ganges-Brahmaputra) facing the highest risk.

Sea-level rise exposes coasts to higher risks of flooding and erosion, which would be exacerbated by growing population, increased human infrastructure within flood-prone areas, and human activities that increase erosion or local subsidence.*** Regions especially at risk are low-lying areas of North America, Latin America, Africa, populous coastal cities of Europe, crowded delta regions of Asia that face flood risks from both large rivers and ocean storms, and many small islands whose very existence is threatened by rising seas. In North America, current preparedness for rising seas, more frequent severe weather, and higher storm surges is low.

The Greenland and West Antarctic ice sheets face substantial melting if the global average temperature rises more than ~2 to ~7°F (1 to 4°C) relative to the period 1990–2000—eventually contributing to an additional sea-level rise of ~13 to ~20 feet (4 to 6 meters) or more.* This would result in the inundation of low-lying coastal areas, including parts of many major cities.

More Extreme Weather

The IPCC expects extreme weather and weather-related events to become more frequent and/or intense, with serious consequences for human health and well-being.

Scientists expect heat waves, droughts, wildfires, floods, severe storms, and dust transported between continents to cause

locally severe economic damage and substantial social and cultural disruption. The IPCC projects an extended fire season for North America as well as increased threats from pests and disease (which could significantly enlarge the area burned in a fire).*** Moreover, because fires release the carbon stored in trees, an increase in wildfires would further worsen global warming.


Associated Press

Increases in the frequency of droughts and floods would negatively affect local food production, and communities in mountain regions would face an increased risk of floods caused by melting glaciers. In addition, the risk of flood-induced illness and death from diarrheal diseases could rise in South and Southeast Asia. A region's vulnerability to such extreme events depends both on how much the climate changes and whether or not nations develop effective responses to potential threats.

Threats to Human Health

The IPCC expects heat waves, floods, storms, fires, and droughts related to global warming to contribute to increased rates of death, disease, and injuries for millions around the world.

U.S. cities that currently experience heat waves can expect increases in the number, intensity, and duration of heat waves over the course of the century. Scientists project an increase in the incidence of cardio-respiratory diseases caused by the higher concentrations of ground-level ozone (smog) that may accompany higher air temperatures. Some infectious diseases, such as those carried by insects and rodents, may also become more common in regions where those diseases are not currently prevalent.

Developing countries, many of which are already under stress, could experience increases in the incidence of diarrheal diseases and malnutrition and consequent disorders, affecting child growth and development. The populations most vulnerable to harsh living conditions in any nation—the elderly, children, and poor—may be unable to cope with further climate change.

The Warming We Can and Can't Avoid

We need adaptation strategies to cope with those consequences of global warming that are already unavoidable due to past emissions. Many additional consequences *can* be avoided, minimized, or delayed by reducing our emissions.

Many of the unavoidable near-term consequences of global warming can be addressed through adaptation strategies such as building levees and restoring wetlands to protect coasts, altering farm practices to grow crops that can survive higher temperatures, building infrastructure that can withstand extreme weather, and implementing public health programs to help people in cities survive brutal heat waves. However, the options for successful adaptation diminish and the associated costs increase as temperatures continue to rise. One of the IPCC's fundamental conclusions is that both adaptation and mitigation (in the form of emission reductions) are required to cope with climate change over the short and long term. These two broad categories of policy options are complementary tools in a policy portfolio designed with the ultimate goal of reducing climate risks as much as possible.

Some near-term adaptation strategies may increase local vulnerability in the long run (for example, where coastal levees encourage development in vulnerable regions, or where population grows in response to temporarily increased water resources from glacier-fed rivers that will ultimately disappear). In contrast, development can be planned in a way that reduces our vulnerability to climate change such as not building in flood plains. However, even responsible development could be overwhelmed by the impacts of climate change unless we also slow the rate of global warming.

Options for curbing climate change by reducing our heat-trapping emissions are explored in the IPCC Working Group III report to be published in May 2007.

ENDNOTES

1. Whenever practical, the exact language from the Working Group II Summary for Policymakers is used throughout this document. To enhance clarity, slight modifications were made that maintain the intended meaning of the report. The full text of the Summary for Policymakers is available at *www.ipcc.ch*.
2. For more background on IPCC history and process, visit *www.ucsusa.org/global_warming/science/the-ipcc.html*.
3. The "~" indicates where temperatures have been rounded to whole numbers after being converted from Celsius to Fahrenheit. The range is partly a function of the uncertainty in how sensitive the global climate is to increasing levels of heat-trapping emissions, and partly a function of societal decisions affecting the timing and amount of future emissions. Source: IPCC Working Group I, *Climate Change 2007: The Physical Science Basis*—Summary for Policymakers. Available at *www.ipcc.ch*.
4. Increases in global average temperature represent the increase above the global average during the period 1980–1999. The 1980–1999 average is 0.5°C above the 1850–1899 average, and the average today is around 0.8°C above the 1850–1899 average.

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The Union of Concerned Scientists is the leading science-based nonprofit working for a healthy environment and a safer world.

Also available at *www.ucsusa.org/global_warming/science/ipcc-highlights2.html*