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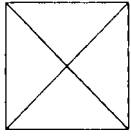
National Assessment of Climate Change Press Guidance (October 5)

Background:

The first National Assessment of the potential consequences of climate change for the United States--mandated by Congress and tasked to the National Science and Technology Council (NSTC)---is in the final stages of revision after 3 years of workshops, research, and analyses. Senator James Inhofe, Representatives Joseph Knollenburg and Jo Ann Emerson, and a group of conservative interest groups have filed a lawsuit against President Clinton and Neal Lane (Assistant to the President for Science and Technology). The suit seeks to prevent publication of the report by charging that the assessment activity has violated various aspects of the FACA and the US Global Change Research Act of 1990 (the authorizing legislation of the U.S. Global Change Research Program). The suit will be announced today at a 1:30 p.m. press conference in the Capitol. The assessment report was developed by the National Assessment Synthesis Team, an independent team of government, academic, and private sector experts chartered under the Federal Advisory Committee Act by NSF.

Talking Points

- The National Assessment report has been prepared by a team of authors that includes industry, government, environmental, and academic scientists chartered under the auspices of the Federal Advisory Committee Act. **The entire process has been open to the public.**
- Climate change poses challenges and opportunities for our nation. The national assessment process was undertaken to identify and analyze the potential consequences of climate change for our country.
- The assessment is taking place under the U.S. Global Change Research Program (USGCRP), which is mandated by the Global Change Research Act of 1990 to undertake scientific assessment of the potential consequences of global change.
- The major product of the assessment will be a report titled *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*, which will draw together regional and sectoral analyses of the potential consequences of change to provide a national picture.
- All materials have been publicly available during the preparation of the report, meetings have been open to the public, and there have been numerous opportunities for participation and comment by interested parties, including the 60-day public comment period requested by the Congress.
- The nation's leading climate scientists and many concerned citizens and stakeholders have taken part in the assessment process. An Independent "Blue Ribbon Panel" that includes several Nobel Laureates has overseen the entire process. They approved the assessment plans and have monitored the scientific integrity of the process, including assuring the responsiveness of the authors to comments received.
- The report has been through multiple levels of review over the last 12 months, including scientific peer-review and technical review by USGCRP agencies. Over **300 sets of comments** totaling about **850 pages** were received in the two rounds of technical review. The National Assessment Synthesis Team made major revisions to the draft in response.
- From June 12 – August 11, the document was posted for a 60-day public comment period, as requested by Congress. The posting was announced in the *Federal Register*, with the document available over the Web. Over 33,000 different users accessed the document during the formal 60-day review period. About 300 sets of comments (about 200 pages) were received.
- Copies of all comments and the author's responses are publicly available from the National Science Foundation.
- The report is undergoing final revisions, after which it will be reviewed one last time by agencies before being submitted to the President and the Congress.



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For Immediate Release,
June 12, 2000

**DRAFT REPORT EXAMINES POTENTIAL IMPACTS
OF CLIMATE CHANGE ON U.S.
National Assessment Posted for Public Comment**

The U.S. Global Change Research Program today released for public comment a draft report analyzing the potential impacts of global climate change on the United States. The report, to be presented to the President and Congress following final review, was prepared by a team of scientists from government, academia and the private sector.

The report, *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*, provides the most detailed look ever at the possible impacts of global warming on the United States over the next 100 years.

Among its key findings, the draft report indicates that continued growth in worldwide emissions is likely to increase average temperatures across the United States by 5-10 degrees Fahrenheit by 2100; impacts such as heavier precipitation and increased drought will vary widely from region to region; some natural ecosystems are likely to disappear entirely and others may be severely disrupted; changes in rain and snowfall patterns could affect the availability of fresh water; and crop productivity is likely to rise nationally, although regional cropping patterns may change significantly.

"Our work clearly indicates that climate change is a serious issue for the United States," said ecologist Anthony Janetos of the World Resources Institute, a co-chair of the scientific team that led the analysis. "One of the things that makes this assessment unique is the extensive public participation in defining issues of concern. We hope that many more people will take advantage of the review period to take a close look at our findings and conclusions."

Regions examined in the draft report are the Northeast, Southeast, Midwest, Great Plains, West, Pacific Northwest, Alaska, Native Homelands, and Islands. Specific sectors examined are Agriculture, Human Health, Forests, Coastal Zones, and Water Resources.

“One of our most important findings is that, in many cases, regional and local level impacts are much more pronounced than those at the national level” said team co-chair Thomas Karl, director of National Oceanic and Atmospheric Administration’s National Climatic Data Center. “And the nature of the impacts on a resource can change over time. For example, forest productivity is likely to increase in the short term, while over the longer term, changes in processes such as fire, insects, drought, and disease will possibly decrease forest productivity.”

The USGCRP was authorized by Congress in 1990 to coordinate research among agencies of the federal government, and was directed by Congress to conduct periodic assessments of the effects of global change on the United States. To prepare the draft report, USGCRP assembled a National Assessment Synthesis Team made up of leading scientists from federal agencies, major universities, the private sector, and non-governmental organizations. The team conducted its own analyses and drew on hundreds of published scientific reports. Hundreds of leading climate scientists and thousands of stakeholders participated in the assessment process, which included 20 regional workshops to identify important questions and issues of concern.

The draft report was extensively peer-reviewed by independent scientists, and underwent a detailed technical review by federal agencies. The writing and review of the report was overseen by an independent review board appointed by the President’s Committee of Advisors on Science and Technology.

The draft report will be posted on the Web for a 60-day public comment period. After the public comment period is completed, the report will undergo final revision before publication and submittal to the President and Congress later this year.

The draft report can be viewed on the Web at
<http://www.gcric.org/NationalAssessment/>.

The authors noted that the report is being released in draft form, as required by Congress, and that its conclusions and analyses may be refined or modified based on input received as part of the public.

Key Findings

1. Increased warming: Assuming continued growth in world greenhouse gas emissions, the climate models used in this Assessment project that temperatures in the US will rise 5-10°F (3-6°C) on average in the next 100 years.

2. Differing regional impacts: Climate change will vary widely across the U.S. Temperature increases will vary somewhat from one region to the next. Heavy and extreme precipitation events are likely to become more frequent, yet some regions will get drier. The potential impacts of climate change will also vary widely across the nation.

3. Vulnerable ecosystems: Ecosystems are highly vulnerable to the projected rate and magnitude of climate change. A few, such as alpine meadows in the Rocky Mountains and some barrier islands, are likely to disappear entirely, while others, such as forests of the Southeast, are likely to experience major species shifts or break up. The goods and services lost through the disappearance or fragmentation of certain ecosystems are likely to be costly or impossible to replace.

4. Widespread water concerns: Water is an issue in every region, but the nature of the vulnerabilities varies, with different nuances in each. Drought is an important concern in every region. Floods and water quality are concerns in many regions. Snowpack changes are especially important in the West, Pacific Northwest, and Alaska.

5. Secure food supply: At the national level, the agriculture sector is likely to be able to adapt to climate change. Overall, U.S. crop productivity is very likely to increase over the next few decades, but the gains will not be uniform across the nation. Falling prices and competitive pressures are very likely to stress some farmers.

6. Near-term increase in forest growth: Forest productivity is likely to increase over the next several decades in some areas as trees respond to higher carbon dioxide levels. Over the longer term, changes in larger-scale processes such as fire, insects, droughts, and disease will possibly decrease forest productivity. In addition, climate change will cause long-term shifts in forest species, such as sugar maples moving north out of the U.S.

7. Increased damage in coastal and permafrost areas: Climate change and the resulting rise in sea level are likely to exacerbate threats to buildings, roads, powerlines, and other infrastructure in climatically sensitive places, such as low-lying coastlines and the permafrost regions of Alaska.

8. Other stresses magnified by climate change: Climate change will very likely magnify the cumulative impacts of other stresses, such as air and water pollution and habitat destruction due to human development patterns. For some systems, such as coral reefs, the combined effects of climate change and other stresses are very likely to exceed a critical threshold, bringing large, possibly irreversible impacts.

9. Surprises expected: It is very likely that some aspects and impacts of climate change will be totally unanticipated as complex systems respond to ongoing climate change in unforeseeable ways.

10. Uncertainties remain: Significant uncertainties remain in the science underlying climate-change impacts. Further research would improve understanding and predictive ability about societal and ecosystem impacts, and provide the public with useful information about adaptation strategies.

- more -

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Supporting Activities in Regions and Sectors

The USGCRP is funding more detailed analyses of 16 regions and 5 sectors as part of the overall assessment process. The regional reports are being prepared by academic institutions with USGCRP funding. Teams that are co-chaired by agency and academic experts are preparing the sectoral reports. Each regional and sectoral team has independent authority over the content of and the review processes for its report.

- Three regional assessment reports – Pacific NW, Alaska, and the Mid-Atlantic – have been published. Regional reports from the Great Lakes, Great Plains and Southwest are expected in the next few months. Other reports are still being drafted.
- The executive summary of the Human Health sector report was published in the April issue of *Environmental Health Perspectives*. The Agriculture, Coastal/Marine, Water Resources, and Forest sector reports are still undergoing review.

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WARMING'S EFFECTS TO BE WIDESPREAD

Significant Changes for U.S.,
Good and Ill, Seen in Study

By ANDREW C. REVKIN

A warming of the global climate is likely to have substantial consequences — for better and worse — around the United States in coming decades, including bumper crops in the heartland, chronic erosion of coasts, summer water shortages and winter floods in the West and a future New York City that steams in summer like present-day Atlanta.

These are a few of the predictions made in the first thorough federal assessment of the possible effect on the country, region by region, of a warming trend that many scientists expect will characterize coming decades.

Increasingly, mainstream scientists are concluding that a buildup of heat-trapping gases like carbon dioxide in the atmosphere has contributed to warming in the last 100 years, and they say the trend is likely to carry well into the new century.

Some of the growth in these so-called greenhouse gases, scientists say, is caused by the burning of fossil fuels, destruction of forests and other human activities.

Temperatures nationwide rose about one degree in the 20th century, and the report estimated the potential effects of further warming by using a "business as usual" assumption.

Continued on Page A25

Warming's Effects to Be Widespread, Study Says

Continued From Page A1

tion, in which carbon dioxide levels continued to grow at the rate of recent years. At this pace, the average temperature in the country would rise 5 to 10 degrees in the next century, although the authors stressed that this was only one possibility. To put that in perspective, the world is 5 to 9 degrees warmer than in the last ice age, 18,000 to 20,000 years ago.

The study, which is to be released today by the Clinton administration for 60 days of public review, was ordered by Congress in 1990 to help lawmakers identify vulnerabilities and potential benefits of the warming trend. But it kicked into high gear only three years ago, when computer models grew sophisticated enough to analyze links between the atmosphere and oceans and local systems like crops and forests.

The assessment includes an illustrated summary and a series of technical analyses of the effect of a warmer world on forestry, fresh water, farming, coasts and human health. The report will be on the Internet at www.nacc.usgcrp.gov.

The report forecasts some profound changes, with many regions of the country seeing conditions shift to those of their present-day neighbors to the south.

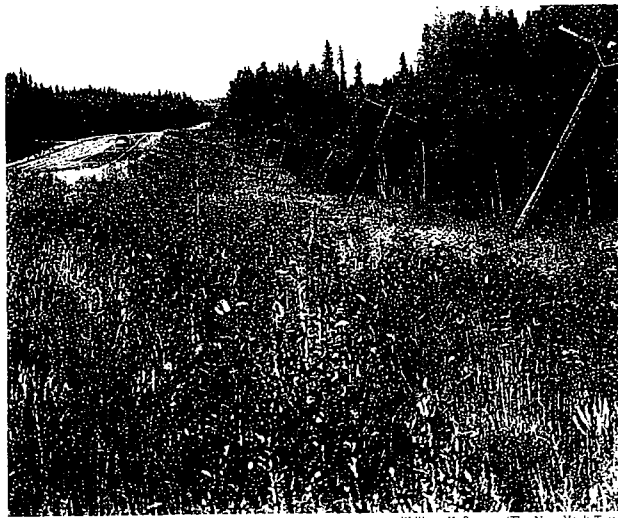
In the mountains of the Pacific Northwest, rising stream temperatures are very likely to harm migrating salmon, the report said.

In California, less snow in winter would lead to less runoff from melting snow in the late spring, reducing water supplies during the summer growing season. The Southwest would see rising precipitation that could cause shrubby forests to overtake desert landscapes.

The study says one of the most likely of all consequences from continued warming would be coastal erosion and destructive storm surges as sea level steadily rises.

In Eastern cities, the summer heat index, combining humidity and temperature, is likely to rise, so that as New York City takes on Southern steaminess, Atlanta will see hot spells more typical of Houston.

The biggest benefits are likely to come from the positive effect of rising carbon dioxide concentrations on plants, which rely on the gas for photosynthesis. Using computer models of climate, crops and forest health, the study found that the country could see rising yields and falling prices for food and timber. The falling prices would be good for consumers but could hurt some timber companies and farmers as already tenu-



William K. Stevens/The New York Times

The effects of warming have already been felt in Alaska. On the road to Fairbanks, leaning telephone poles in thawing ground are common.

ous profit margins shrink.

But scientists who conducted the study cautioned that the benefits would not be uniform. For example, while farmers in the Northern plains could see gains, those in Southern states could see losses because of increased risk of droughts and damaging floods as more rain falls in drenching downpours.

The good news should be tempered, too, because the study did not calculate possible agricultural losses because of flourishing weeds or migrating insect pests, its authors said.

And the composition of wild forests is likely to change, with some species that are considered hallmarks of particular regions disappearing. For example, the sugar maple, the New York state tree and an important species for tourism, is likely to vanish from all but the most northern parts of the state as its preferred colder climatic zone moves north.

The warming is likely to keep shipping lanes in Alaska and the Great Lakes free of ice longer, easing the movement of oil and other goods.

But other effects could negate any savings, the study concluded. Water levels in the Great Lakes are expected to drop, increasing the need for costly dredging of channels.

In Alaska, the effects of the warming have already been felt and are requiring costly adjustments, with roads and air strips requiring constant repair as underlying permafrost thaws and buckles, scientists

said. Native Alaskans, who rely on ice-dwelling seals for food, are finding it more difficult to hunt, said Gunter Weller, a climatologist at the University of Alaska Fairbanks, who is participating in the project.

"For the native community or the oil industry or the fishing industry, this is no longer some nebulous global thing coming in 100 years," Dr. Weller said. "These are real things in real time that are really occurring."

Scientists from dozens of government agencies, universities, private groups and industries conducted the studies and more than 300 independent reviewers offered comments, the authors said. The overview's three principal authors were Dr. Thomas R. Karl, director of the National Climatic Data Center in Asheville, N.C.; Anthony Janetos of the World Resources Institute in Washington; and Dr. Jerry M. Melillo of the Marine Biological Laboratory in Woods Hole, Mass.

As the overview moved from early to final drafts in the last few months, the politics of climate intruded, with intense tugs of war being felt by some scientists involved in the work over how to word conclusions.

Indeed, in recent weeks the emphasis changed, participants said, with the focus shifting somewhat toward the positive consequences for agriculture, for example.

Also, the 145-page overview was released even though not all the underlying regional studies are complete, a decision that drew criticism

from scientists from both ends of the political spectrum.

"There's been pressure all along that the synthesis had to come out first because of the election," said a scientist who shares the Clinton administration position that global warming is a serious problem, but who is still involved in the report and thus spoke only on condition of anonymity. "It's unfortunate, because the whole process would have been stronger if you did it the right way. Then the critics wouldn't have anything to say."

Over the weekend, officials at the White House said the summary was released ahead of time only because the final work on some of the underlying studies had been delayed.

Apart from the timing, a variety of experts involved in preparing the document, including people from industry and advocacy groups, say it represents a real consensus and that its findings are significant.

Thomas F. Cecich, vice president for environmental safety at the drug company Glaxo Wellcome and a member of the team that wrote the national overview, called the report a first look at a dizzyingly complicated system. He said that everyone involved tried to filter out politics and preconceptions. "I think it's been a fair and open and scientifically valid process," he said.

In particular, many scientists said, the effort, if continued and refined, could offer the first opportunity for the country to incorporate long-term climate projections into its planning for everything from bridge building to crop planting.

The report concludes that society, for the most part, will probably be able to adapt to many of the coming shifts, but that some natural systems — alpine meadows, coral reefs, mangrove swamps and the like — will be damaged or disappear because they are either hemmed in by man-made structures or geography or simply cannot keep pace with the rate of temperature change.

The authors stressed that the consequences described in the study — like the visions of Scrooge's future in "A Christmas Carol" — mainly represent developments that may be, not things that must be.

And there will always be surprises, said Dr. Karl, one of the main authors. "There are a lot of uncertainties with respect to interactions between natural systems, human systems and climate."

Even if the surprises are good news, he said, humans will not necessarily be able to exploit them. "Usually, if something is not anticipated, you can't take advantage of it."

Drastic Climate Changes Forecast

Global Warming Likely to Cause Droughts, Coastal Erosion in U.S., Report Says

By CURT SUPLEE
Washington Post Staff Writer

Global warming in the 21st century will likely cause drastic changes in the climate of the United States, including potentially severe droughts, increased risk of flood, mass migrations of species, substantial shifts in agriculture and widespread erosion of coastal zones, a new federal report says.

Yet "for the nation as a whole, direct economic impacts are likely to be modest," concludes the report, which is based on computer models and historical data, and "American society would likely be able to adapt to most of the impacts," although "particular strategies and costs [are] not known."

"Climate Change Impacts on the United States," scheduled for public release today after four years of preparation, has an ample array of ominous projections:

■ Average temperatures will probably rise 5 to 10 degrees Fahrenheit—nearly twice the projected warming for the planet as a whole—prompting more summer urban heat waves and gentler winters across the nation.

■ Agricultural production will likely surge, and forests will probably flourish, thanks to the fertilizing effect of more carbon dioxide in the air. But many long-suffering ecosystems, such as alpine meadows, coral reefs, coastal wetlands and Alaskan permafrost, will likely deteriorate further. Some may disappear altogether.

■ Snowpack will probably diminish by 50 percent on average, while winter rains are likely to increase, bringing 60 to 100 percent more showers to much of Southern California and the parched Southwest.

■ Total precipitation nationwide, which rose 5 to 10 percent during the 20th century, will probably increase another 10 percent by 2100, chiefly in the form of extreme storms, exacerbating runoff pollution in the Chesapeake Bay and other sensitive areas.

Paradoxically, however, the threat of drought—especially in the western Kansas-eastern Colorado breadbasket—will rise because hotter conditions enhance evaporation. For the same reason, water levels could drop as much as

five feet in the Great Lakes.

As for health effects, the report projects doubling or tripling of heat-related deaths in Minneapolis, Chicago and other cities that rarely experience extreme high temperatures. The July heat index is likely to rise by 10 to 20 degrees in the mid-Atlantic region.

Warming may also cause substantial shifts in the habitats of disease-bearing mosquitoes and other animal sources of disease. But the authors conclude that "not enough is known about our adaptive capabilities to say whether or not climate changes will make us more vulnerable to health problems."

The report, known as the "national assessment," was ordered by Congress in 1990 and assembled by the U.S. Global Change Research Program, an executive branch initiative incorporating projects in nine federal agencies and the Smithsonian Institution. The first such comprehensive ef-

inch rise, the authors say, would eliminate about 4,000 square miles of coastal wetlands in addition to the nearly 2,000 square miles lost in the past half-century.

The analysis is based largely on two computer simulations of future climate (from the Canadian Meteorological Centre and the Hadley Centre in the United Kingdom) that often produce very different or even antithetical results.

For example, climate-change skeptic S. Fred Singer of the Science & Environmental Policy Project in Fairfax said, "look at North Dakota. One [model] turns it into a desert, the other into a swamp. Neither will probably happen." Central Kansas shows an increase in soil moisture of 25 percent in one projection; in the other, it loses 50 percent. North and South Carolina have dramatic rainfall increases in one model, and decreases of up to 10 percent in the other.

Such discrepancies are common among sophisticated computer cli-

direction it's in."

Several environmental groups hailed the report as a timely warning. "America's alarm bells should go off today," said Jennifer Morgan of the World Wildlife Fund.

But numerous skeptics contend that the language is strongly biased toward negative conclusions. That was also the initial reaction of some staff and external reviewers.

"I think we have fixed most of that problem," Janetos said. "We've made an enormous effort to be balanced."

Not everyone will agree. For example, in the forestry section, the analysis indicates that even in the Southeast, where the likelihood of drought stress during the next century is considered fairly high, timber stands will increase by 8 percent to 25 percent depending on species. Yet the strong emphasis in the text is on the threat of reduced producer profits as more trees bring prices down.

Similarly, the section on agriculture projects 15 to 50 percent yield increases for nearly all commercial crops, including wheat, rice, barley, oats, potatoes and most vegetables. That would entail the use of 5 to 20 percent more pesticides, the report suggests, and would raise the threat of more nitrogen-fertilizer runoff into bays and estuaries. But the net effect would be extraordinary.

Moreover, the analysis suggests that a warmer, accelerated growing season and increased rainfall nationally will probably reduce the need for crop irrigation 30 to 40 percent by the end of the 21st century. That would be a huge change in a nation where more than 80 percent of all fresh water now goes to agricultural uses.

Yet the text notes laconically that climate change probably "will not imperil the ability of the U.S. to feed its population and to export foodstuffs."

Janetos is looking forward to hearing all comments. "This is a serious issue. It's not ideological," he said. "There is a wide range of changes coming around the country, and we have to start thinking about that. My hope is that [millions of Americans] will take a look at this assessment. I'd love for this Web site to set new records."

"People have to start thinking hard about what they might want to do."

— Anthony Janetos,
World Resources Institute

fort by any country, it will be available for public review at <http://www.usgcrp.gov> and elsewhere as part of a long-term effort to understand and plan for the effects of climate change.

"We're not making a specific prediction about what the future will be like. It would be farcical to try to do that," said Anthony Janetos of the World Resources Institute, co-chairman of the 14-member panel that wrote the 145-page overview. (An additional 700-page "foundation document" provides scientific details.) Instead, "given our current understanding, these are reasonable scenarios of how the future might play out."

The report employs conventional assumptions, such as an annual increase of 1 percent in the amount of greenhouse gases in the atmosphere. It assumes that sea levels—which have risen four to eight inches globally over the past century—will rise an additional five to 35 inches by 2100. A 20-

mate models, each of which represents the interactions among heat, air, water, cloud and land somewhat differently. The smaller the geographic scale, the larger the disparities can be.

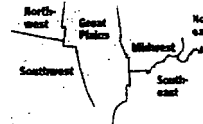
"But we can't just say, 'Well, this is hard. Therefore we can't say anything,'" Janetos said. "There are a lot of local and regional decisions that have to be made now—not just federal policies—and people have to start thinking hard about what they might want to do."

The model contradictions are enough to "make you tear your hair out," said Tom Wigley of the National Center for Atmospheric Research, who was not involved in the report. "At the regional level, there's a tremendous amount of uncertainty." Nonetheless, he said, even "model results that are radically different" serve to notify residents that "there's a good chance that we're in for a big change in the future, but we don't know what

From the Report

Among the likely effects of warming over the next century

Northeast: Winter nights will be as much as 9 degrees warmer, and annual precipitation is likely to increase. With higher sea levels, storm surges will threaten beaches in New Jersey and imperil bridges and other transportation system elements.



Southeast: In one model, it dries considerably, forests gradual turn to savannah, and heat waves and drought scourge the region. In the other, rainfall increases as much as 25 percent, forests thrive (especially hardwoods) and crop yields rise, while the risk of flood damage increases substantially.

Midwest/Great Plains: Risk of drought is substantial. A projected increase of 10 to 30 percent in rainfall is expected to be more than offset by evaporation and loss of soil moisture. Depending on the model, Illinois in 2100 will have a summer climate equivalent to that now seen in Oklahoma or North Carolina. Fish populations will shift to warm-water species.

California/Southwest: Temperatures rise, but rainfall may double with grasslands and even forests forming in parts of Nevada and Arizona. That could be of enormous importance to the region, where population is rising fast.

Northwest: Snowpack is projected to decline from 10 to 70 percent in parts of Oregon, Idaho, Montana and Wyoming, with like increases in soil moisture for parts of Oregon and Idaho.

Effects on environment

Affected regions

Forests

The composition of tree species changes, altering animal habitats. In the Southeast, woodlands and grasslands displace forests if the climate becomes drier.



Grasslands

Invasive, nonnative species increasingly thrive. In the West, woodlands and forest displace grasslands if the climate becomes wetter.



Freshwater

A rise in water temperature and changes in the timing and amount of runoff alter habitats in rivers and lakes.



Coastal and marine

Rising sea levels reduce coastal wetlands. Changes in quantity and quality of fresh water entering streams and bays alter habitats. In Alaska, ice changes affect habitats.



SOURCE: U.S. Global Change Research Program

National Assessment of Climate Change Press Guidance (October 5)

Background:

The first National Assessment of the potential consequences of climate change for the United States--mandated by Congress and tasked to the National Science and Technology Council (NSTC)---is in the final stages of revision after 3 years of workshops, research, and analyses. On October 3, Senator James Inhofe, Representatives Joseph Knollenburg and Jo Ann Emerson, and a group of conservative interest groups filed a lawsuit against President Clinton and Neal Lane (Assistant to the President for Science and Technology). The suit seeks to prevent publication of the report by charging that the assessment activity has violated various aspects of the FACA and the US Global Change Research Act of 1990 (the authorizing legislation of the U.S. Global Change Research Program). The suit will be announced today at a 1:30 p.m. press conference in the Capitol. The assessment report was developed by the National Assessment Synthesis Team, an independent team of government, academic, and private sector experts chartered under the Federal Advisory Committee Act by NSF.

Talking Points

- The National Assessment report has been prepared by a team of authors that includes industry, government, environmental, and academic scientists charted under the auspices of the Federal Advisory Committee Act. **The entire process has been open to the public.**
- Climate change poses challenges and opportunities for our nation. The national assessment process was undertaken to identify and analyze the potential consequences of climate change for our country.
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Questions and Answers:

What is your response to the complaint in the lawsuit?

Refer to Justice Dept.
~~We have reviewed the complaint and fully expect it to be dismissed.~~

Isn't the Administration trying to gain support for its climate change policy agenda by scaring people with this assessment?

No. Conducting assessments of the potential impacts of global change, including climate change, is mandated in the authorizing legislation of the U.S. Global Change research program. The purpose of this assessment is to begin to identify the potential vulnerabilities of the U.S to climate change, to identify possible options for coping with change, and to determine where further research can help answer important questions.

What is the relationship between this National Assessment and activities related to implementing the Kyoto Protocol?

These are separate activities. The National Assessment is looking at *potential impacts* of climate change on various regions of the US, the possible vulnerability of US agriculture, coastal zones, forests, human health, and water resources, and at strategies to cope with change. The Kyoto Protocol is primarily concerned with *mitigation* of climate change through emissions reductions.

CLIMATE CHANGE IMPACTS ON THE UNITED STATES

The Potential Consequences of Climate Variability and Change

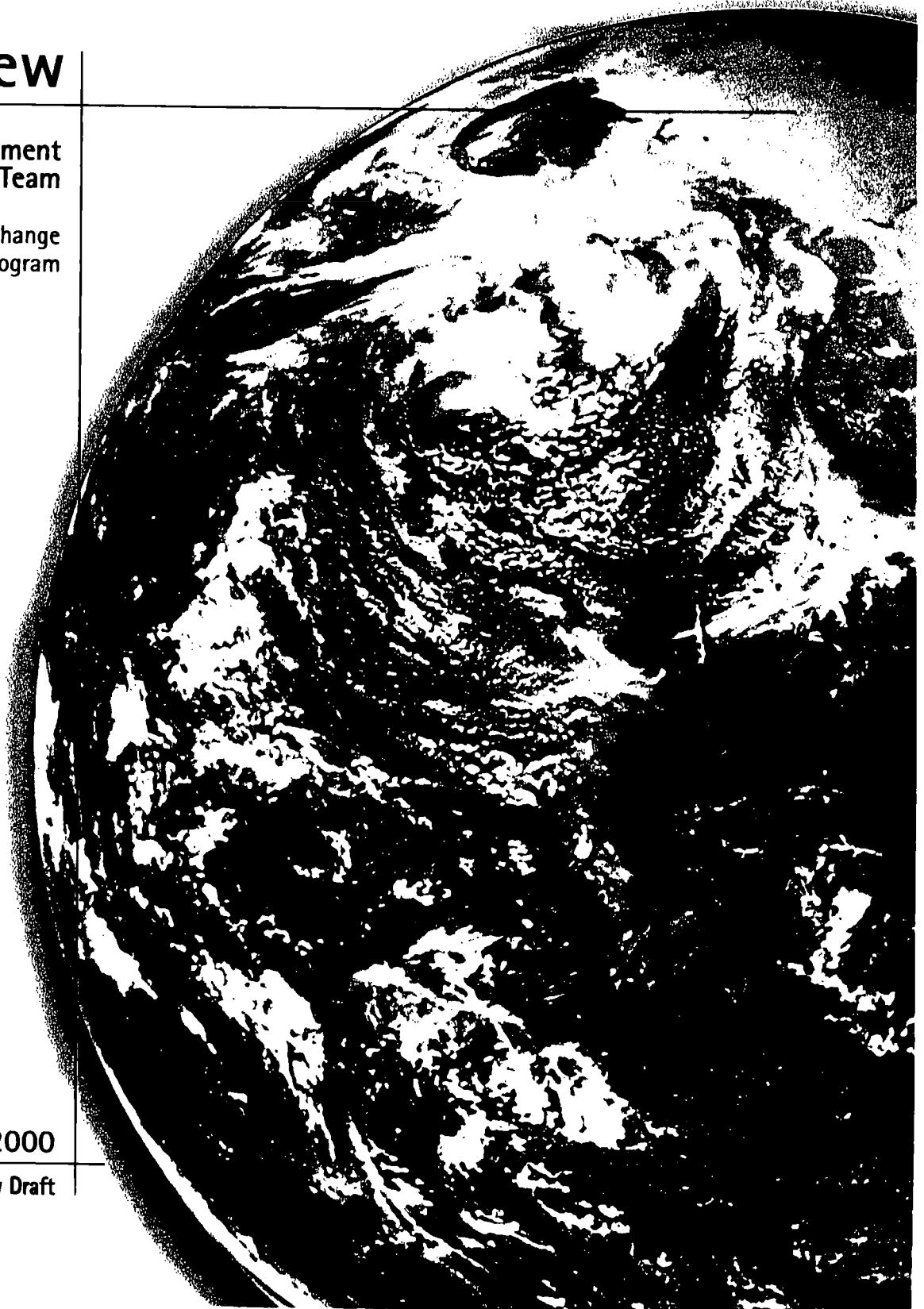
Overview

National Assessment
Synthesis Team

US Global Change
Research Program

June 2000

Public Review Draft



CLIMATE CHANGE IMPACTS ON THE UNITED STATES

The Potential Consequences of Climate Variability and Change

Overview

Humanity's influence on the global climate will grow in the coming century. Increasingly, there will be significant climate-related changes that will affect each one of us.

We must begin now to consider our responses, as the actions taken today will affect the quality of life for us and future generations.

A Report of the
National Assessment
Synthesis Team

US Global Change
Research Program

An Investment in Science
for the Nation's Future

June 2000

Public Review Draft

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This report is also based on the work of hundreds of individuals and organizations participating in regional and sector activities across the country without whose input, support, and expertise, it would not have been possible. In addition, many reviewers provided comments on drafts of the report. Additional credits and acknowledgements can be found in the appendix.

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EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY

WASHINGTON, D.C. 20502

Month 2000

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Sincerely,

Neal Lane
Director

ABOUT THIS DOCUMENT

What is this Assessment?

The National Assessment of Potential Consequences of Climate Variability and Change is a landmark in the major ongoing effort to understand what climate change means for the US. Climate science is developing rapidly and scientists are able to begin projecting some changes at the regional scale, identifying regional vulnerabilities, and assessing potential regional impacts. Science increasingly indicates that the Earth's climate has changed in the past and continues to change, and that climate change is very likely to accelerate in the 21st century. This Assessment has begun a national process of research, analysis, and dialogue about the coming changes in climate, their impacts, and what Americans can do to adapt to an uncertain and continuously changing climate. This Assessment is built on a solid foundation of science conducted as part of the United States Global Change Research Program (USGCRP).

What is this document and who is the NAST?

This document is the Assessment Overview, written by the National Assessment Synthesis Team (NAST). The NAST is a committee of experts drawn from governments, universities, industry, and non-governmental organizations. It has been responsible for broad oversight of the Assessment, with the Federal agencies of the USGCRP. This Overview is based on a longer, referenced "Foundation" report, written by the NAST in cooperation with independent regional and sector assessment teams. These two national-level, peer-reviewed documents synthesize results from studies conducted by regional and sector teams, and from the broader scientific literature.

Why was this Assessment undertaken?

The Assessment was called for by a 1990 law, and has been conducted under the USGCRP in response to a request from the President's Science Advisor. The NAST developed the Assessment's plan, which was then approved by the National Science and Technology Council, the cabinet-level body of agencies responsible for scientific research, including global change research, in the US government.

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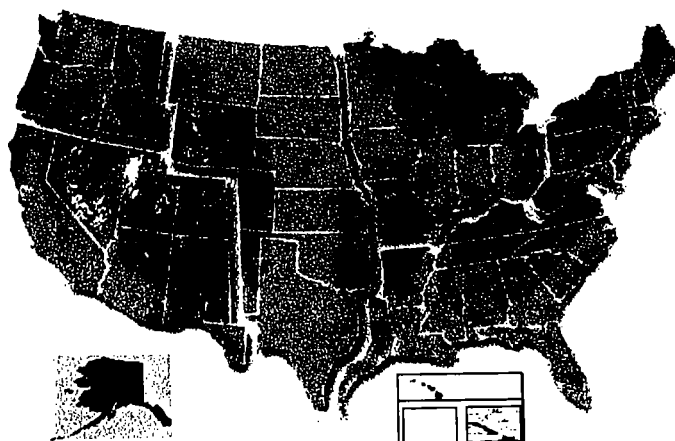
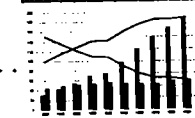
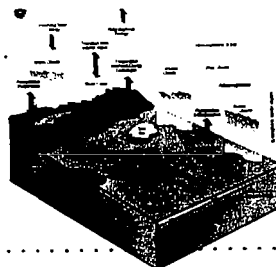
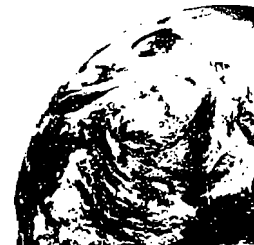
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ABOUT THE ASSESSMENT PROCESS

The Assessment's purpose is to synthesize, evaluate, and report on what we presently know about the potential consequences of climate variability and change for the US in the 21st century. It has sought to identify key climatic vulnerabilities of particular regions and sectors, in the context of other changes in the nation's environment, resources, and economy. It has also sought to identify potential measures to adapt to climate variability and change. Finally, because present knowledge is limited, the Assessment has sought to identify the highest priority uncertainties about which we must know more to understand climate impacts, vulnerabilities, and our ability to adapt.

This first National Assessment involved both stakeholders and scientific experts. The stakeholders from different regions and sectors began the Assessment by articulating their concerns in a series of workshops about climate change impacts in the context of the other major issues they face. In the workshops and subsequent consultations, stakeholders identified priority regional and sector concerns, mobilized specialized expertise, identified potential adaptation options, and provided useful information for decision-makers. The Assessment also involved many scientific experts using advanced methods, models, and results. Further, it has stimulated new scientific research in many areas and identified priority needs for further research.

Although global change embraces many interrelated issues, this first National Assessment has examined only climate change and variability, with a primary focus on specific regions and sectors. In some cases, regional and sector analyses intersect and complement each other. For example, the Forest sector and the Pacific Northwest have both provided insights into climate impacts on Northwest forests.

The regions cover the nation. Impacts outside the US are considered only briefly, with particular emphasis on potential linkages to the US. Sector teams examined Water, Agriculture, Human Health, Forests, and Coastal Areas and Marine Resources. This first Assessment could not attempt to be comprehensive: the choice of these five sectors reflected an expectation that they were likely to be both important and particularly informative, and that relevant data and analytic tools were available – not a conclusion that they are the only important domains of climate impact. Among the sectors considered, there was a continuum in the amount of information available to support the Assessment, with some being at far earlier stages of development. Future assessments should consider other potentially important issues, such as Energy, Transportation, Urban Areas, and Wildlife.

Each regional and sector team is publishing a separate report of its own analyses, some of which are still continuing. The Overview and Foundation reports consequently represent a snapshot of our understanding at the present time.

Responses to climate change can be of two broad types. One type involves adaptation measures to reduce the harms and risks, and maximize the benefits and opportunities, of climate change, whatever its cause. The other type involves mitigation measures to reduce human contributions to climate change. After identifying potential impacts, this Assessment sought to identify potential adaptation measures for each region and sector studied. While this was an important first step, it was not possible at this stage to evaluate the practicality, effectiveness, or costs of the potential adaptation measures. Both mitigation and adaptation measures are necessary elements of a coherent and integrated response to climate change. Mitigation measures were not included in this Assessment, but are being assessed in other bodies such as the United Nations Intergovernmental Panel on Climate Change (IPCC).

No. An integrated climate policy will combine mitigation and adaptation measures as appropriate. If future world emissions of greenhouse gases are lower than currently projected, for whatever reason, including intentional mitigation, then the rate of climate change, the associated impacts, and the cost and difficulty of adapting will all be reduced. If emissions are higher than expected, then the rate of change, the impacts, and the

difficulty of adapting will be increased. But no matter how aggressively emissions are reduced, the world will still experience at least a century of climate change. This will happen because the elevated concentrations of greenhouse gases already in the atmosphere will remain for many decades, and because the climate system responds to changes in human inputs only very slowly. Consequently, even if the world takes mitigation measures, we must still adapt to a changing climate. Similarly, even if we take adaptation measures, future emissions will have to be curbed to stabilize climate. Neither type of response can completely supplant the other.

State-of-the-art climate models have been used to generate climate change scenarios. These scenarios are not predictions of the future. Rather, they are plausible, quantitative representations of climate change over the next century. The model-based scenarios used in this Assessment are grounded in our best current understanding of the complex processes at play in the atmosphere, oceans, land, and human society. Climate models have uncertainties, but they are the best tools available for thinking systematically about climate change. Computer models of ecological systems, hydrological systems, and various socioeconomic systems have also been used in the Assessment to study response of these systems to the scenarios generated by climate models.

In addition to models, the Assessment has used two other ways to think about potential future climate. First, the Assessment has used historical climate records to evaluate sensitivities of regions and sectors to climate variability and extremes that have occurred in the 20th century. Looking at real historical climate events, their impacts, and how people have adapted, gives valuable insights into potential future impacts that complement those provided by model projections. In addition, the Assessment has used "what if" analyses, which ask how, and how much, the climate would have to change to bring major impacts on particular regions or sectors. For example, how much would temperature have to increase in the South before agricultural crops such as soybeans would be negatively affected? What would be the result for forest productivity of continued increases in temperature and leveling off of the CO₂ fertilization effect?

This Overview and the underlying Foundation document have had three levels of review. More than 300 scientific and technical experts have provided peer review on part or all of the report. A panel of distinguished experts convened

by the President's Council of Advisors on Science and Technology has provided broad oversight, and monitored the authors' response to reviews. Finally, the report was reviewed by federal agencies, under the guidance of the Office of Science and Technology Policy (OSTP).

This report identifies scientific uncertainties throughout and where present knowledge permits, describes how sensitive its results are to these uncertainties. To describe uncertainties, the report uses a consistent set of terms that denote various levels of confidence, similar to those used in weather forecasting. The level of confidence ascribed to each result is based on the expert judgment of the NAST. If there is less than a 10% chance of an event, it is either not mentioned or described as "little chance" or "very unlikely." A 10-33% chance is referred to as "unlikely" or "some chance." A 34-66% chance is "possible," while a 67-90% chance is "likely" or "probable." If there is more than a 90% chance, the event is called "very likely" or "very probable."

Common Language

Probability Range

"little chance" or "very unlikely"	< 10%
"unlikely" or "some chance"	10-33%
"possible"	34-66%
"likely" or "probable"	67-90%
"very likely" or "very probable"	> 90%

SUMMARY

CLIMATE CHANGE AND OUR NATION

Natural ecosystems, which are our life support system in many important ways, appear to be the most vulnerable to the harmful effects of climate change...

Long-term observations confirm that our climate is now changing at a rapid rate. Over the 20th century, the average annual US temperature has risen by almost 1°F (0.6°C) and precipitation has increased nationally by 5 to 10%, mostly due to increases in heavy downpours. These trends are most apparent over the past few decades. The science indicates that the warming in the 21st century will be significantly larger than in the 20th century. Scenarios examined in this Assessment, which assume no major interventions to reduce continued growth of world greenhouse gas emissions, indicate that temperatures in the US will rise by about 5-10°F (3-6°C) on average in the next 100 years, which is more than the projected global increase. This rise is very likely to be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions.

This Assessment reveals a number of national-level impacts of climate variability and change including impacts to natural ecosystems and water resources. Natural ecosystems appear to be the most vulnerable to the harmful effects of climate change as there is often little that can be done to help them adapt to the projected speed and amount of change. Some ecosystems that are already constrained by climate, such as alpine meadows in the Rocky Mountains, are likely to face extreme stress, and may disappear entirely. It is likely that other more widespread ecosystems will also be vulnerable to climate change. One of the climate scenarios used in this Assessment suggests the potential for the forests of the Southeast to break up into a mosaic of forests, savannas, and grasslands. Several of the climate scenarios suggest possible changes in the species composition of the Northeast forests, including the loss of sugar maples. Major alterations to natural ecosystems due to climate change could possibly have negative consequences for our economy, which depends in part on the sustained bounty of our nation's lands, waters, and native plant and animal communities.

A unique contribution of this first US Assessment is that it combines national-scale analysis with an examination of the potential impacts of climate change on different regions of the US. For example, sea-level rise will very likely cause further loss of coastal wetlands (ecosystems that provide vital nurseries and habitats for many fish species) and put coastal communities at greater risk of storm surges, especially in the Southeast. Reduction in snowpack will very likely alter the timing and amount of water supplies, potentially exacerbating water shortages and conflicts, particularly throughout the western US. The melting of glaciers in the high-elevation West and in Alaska represents the loss or diminishment of unique national treasures of the American landscape. Large increases in the heat index (which combines temperature and humidity) and increases in the frequency of heat waves are very likely. These changes will, at minimum, increase discomfort, particularly in cities. It is very probable that continued thawing of permafrost and melting of sea ice in Alaska will further damage forests, buildings, roads, and economies, and harm subsistence livelihoods. In various parts of the nation, cold-weather recreation such as skiing will very likely be reduced, and air conditioning use will very likely increase.

Highly managed ecosystems appear more robust and some potential benefits have been identified. Crop and forest productivity is likely to increase in some areas for the next few decades due to increased carbon dioxide in the atmosphere and an extended growing season. It is possible that some US food exports could increase, depending on impacts in other food-growing regions around the world. It is also possible that a rise in crop production in fertile areas could cause prices to fall, benefiting consumers. Other benefits that are possible include extended seasons for construction and warm weather recreation, reduced heating requirements, and reduced cold-weather mortality.

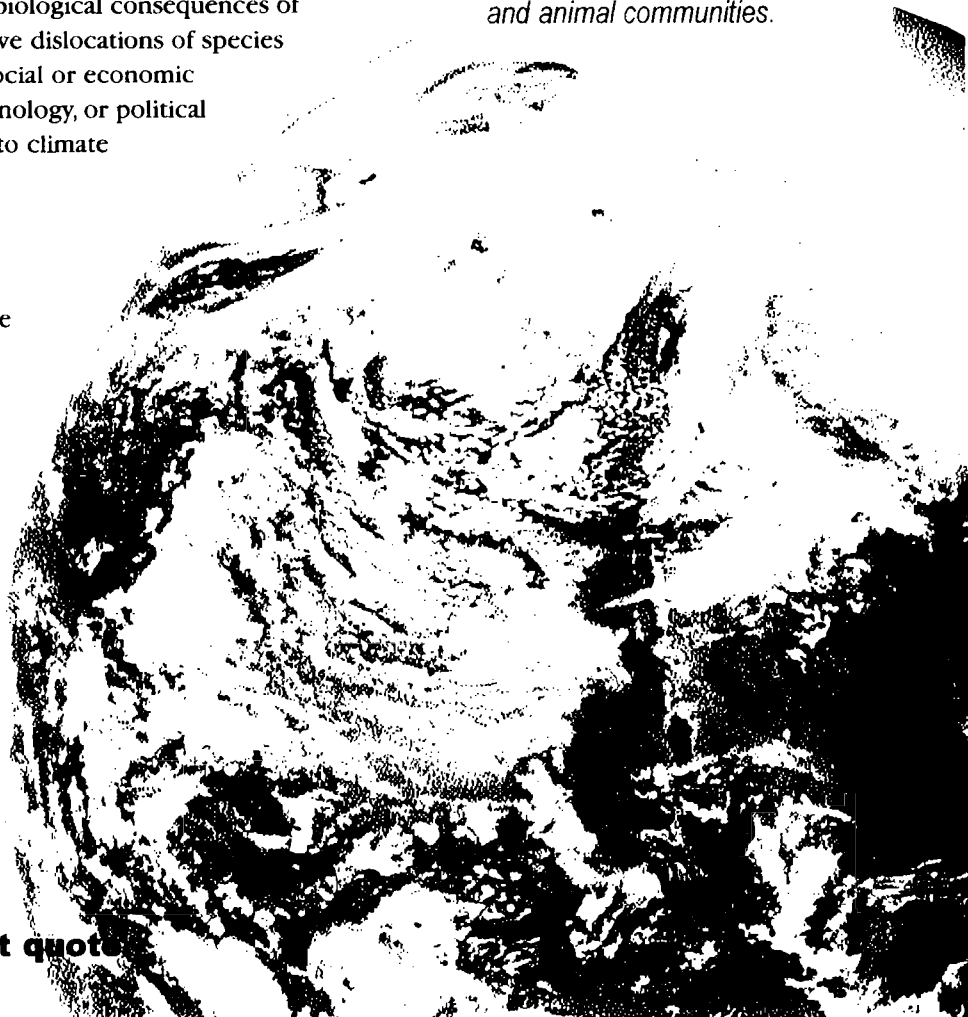
Climate variability and change will interact with other environmental stresses and socioeconomic changes. Air and water pollution, habitat fragmentation, wetland loss, coastal erosion, and reductions in fisheries are likely to be compounded by climate-related stresses. An aging populace nationally, and rapidly growing populations in cities, coastal areas, and across the South and West are social factors that interact with and alter sensitivity to climate variability and change.

There are also very likely to be unanticipated impacts of climate change during the next century. Such "surprises" may stem from unforeseen changes in the physical climate system, such as major alterations in ocean circulation, cloud formation, or storms; and unpredicted biological consequences of these physical climate changes, such as massive dislocations of species or pest outbreaks. In addition, unexpected social or economic change, including major shifts in wealth, technology, or political priorities, could affect our ability to respond to climate change.

Greenhouse gas emissions lower than those assumed in this Assessment would result in reduced impacts. The signatory nations of the Framework Convention on Climate Change are negotiating the path they will ultimately take. Even with such reductions, however, the planet and the nation are already committed to more than a century of climate change, due to the long lifetimes of greenhouse gases already in the atmosphere and the momentum of the climate system. Adapting to a changed climate is consequently a necessary component of our response strategy.

Climate-induced changes in the frequency and magnitude of ecologically important processes such as wildfires, floods, droughts, and disease and pest outbreaks are likely to have greater impacts on our nation's ecosystems than changes in average temperature and precipitation.

Major alteration of natural ecosystems due to a changing climate is particularly significant because our lives and economy depend on the sustained bounty of our nation's lands, waters, and native plant and animal communities.



SUMMARY

CLIMATE CHANGE AND OUR NATION

The magnitude of climate change impacts depends on time period and geographic scale. Short-term impacts differ from long-term impacts and regional and local level impacts are much more pronounced than those at the national level.

For the nation as a whole, direct economic impacts are likely to be modest, while in some places, economic losses or gains are likely to be large. While crop yields are likely to increase at the national scale over the next few decades, large increases or decreases in yields of specific crops in particular places are likely.

Through time, climate change will possibly affect the same resource in opposite ways. Forest productivity is likely to increase in the short term, while over the longer term, changes in processes such as fire, insects, drought, and disease will possibly decrease forest productivity.

Adaptation measures can, in many cases, reduce the magnitude of harmful impacts, or take advantage of beneficial impacts. For example, in agriculture, many farmers will probably be able to alter cropping and management practices. Roads, bridges, buildings, and other long-lived infrastructure can be designed taking projected climate change into account. Adaptations, however, can involve trade-offs, and do involve costs. For example, the benefits of building sea walls to prevent sea-level rise from disrupting human coastal communities will need to be weighed against the economic and ecological costs of seawall construction. The ecological costs could be high as seawalls prevent the inland shifting of coastal wetlands in response to sea-level rise, resulting in the loss of vital fish and bird habitat and other wetland functions, such as protecting shorelines from damage due to storm surges. Protecting against any increased risk of water-borne and insect-borne diseases will require diligent maintenance of our public health system. Many adaptations, notably those that seek to reduce other environmental stresses such as pollution and habitat fragmentation, will have beneficial effects beyond those related to climate change.

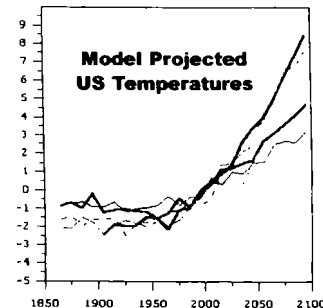
Another outcome of this Assessment is the renewed realization that the US cannot, in the end, consider its own vulnerabilities to climate variability and change without also considering the consequences of changes in other parts of the world. The US is inextricably linked to the fates of other nations, and both our vulnerabilities and our potential responses will likely depend in part on impacts and responses in other nations. For example, conflicts or mass migrations resulting from resource limits, health, and environmental stresses in more vulnerable nations could possibly pose challenges for global security and US policy. Effects of climate variability and change on US agriculture will depend critically on changes in agricultural productivity elsewhere, which can shift international patterns of food supply and demand. Climate-induced changes in water resources available for power generation, transportation, cities, and agriculture are likely to raise potentially delicate diplomatic issues with both Canada and Mexico.

This Assessment has identified many remaining uncertainties that limit our ability to fully understand the spectrum of potential consequences of climate change for our nation. To address these uncertainties, future research needs include better regional-scale climate projections. Additional research is also needed to improve understanding of ecological processes that are sensitive to climate, and of the economic costs and benefits of a changing climate to Americans. Results from these research efforts will inform future assessments that will continue the process of building our understanding of humanity's impacts on climate, and climate's impacts on us.

KEY FINDINGS

1. Increased warming

Assuming continued growth in world greenhouse gas emissions, the climate models used in this Assessment project that temperatures in the US will rise 5-10°F (3-6°C) on average in the next 100 years.



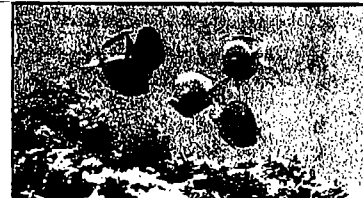
2. Differing regional impacts

Climate change will vary widely across the US. Temperature increases will vary somewhat from one region to the next. Heavy and extreme precipitation events are likely to become more frequent, yet some regions will get drier. The potential impacts of climate change will also vary widely across the nation.



3. Vulnerable ecosystems

Ecosystems are highly vulnerable to the projected rate and magnitude of climate change. A few, such as alpine meadows in the Rocky Mountains and some barrier islands, are likely to disappear entirely, while others, such as forests of the Southeast, are likely to experience major species shifts or break up. The goods and services lost through the disappearance or fragmentation of certain ecosystems are likely to be costly or impossible to replace.



4. Widespread water concerns

Water is an issue in every region, but the nature of the vulnerabilities varies, with different nuances in each. Drought is an important concern in every region. Floods and water quality are concerns in many regions. Snowpack changes are especially important in the West, Pacific Northwest, and Alaska.



5. Secure food supply

At the national level, the agriculture sector is likely to be able to adapt to climate change. Overall, US crop productivity is very likely to increase over the next few decades, but the gains will not be uniform across the nation. Falling prices and competitive pressures are very likely to stress some farmers.



6. Near-term increase in forest growth

Forest productivity is likely to increase over the next several decades in some areas as trees respond to higher carbon dioxide levels. Over the longer term, changes in larger-scale processes such as fire, insects, droughts, and disease will possibly decrease forest productivity. In addition, climate change will cause long-term shifts in forest species, such as sugar maples moving north out of the US.



7. Increased damage in coastal and permafrost areas

Climate change and the resulting rise in sea level are likely to exacerbate threats to buildings, roads, powerlines, and other infrastructure in climatically sensitive places, such as low-lying coastlines and the permafrost regions of Alaska.



8. Other stresses magnified by climate change

Climate change will very likely magnify the cumulative impacts of other stresses, such as air and water pollution and habitat destruction due to human development patterns. For some systems, such as coral reefs, the combined effects of climate change and other stresses are very likely to exceed a critical threshold, bringing large, possibly irreversible impacts.



9. Surprises expected

It is very likely that some aspects and impacts of climate change will be totally unanticipated as complex systems respond to ongoing climate change in unforeseeable ways.



10. Uncertainties remain

Significant uncertainties remain in the science underlying climate-change impacts. Further research would improve understanding and predictive ability about societal and ecosystem impacts, and provide the public with useful information about adaptation strategies.



IMPACTS OF CLIMATE CHANGE

It is very likely that the US will get substantially warmer. Temperatures are projected to rise more rapidly in the next one hundred years than in the last 10,000 years. It is also very likely that there will be more precipitation overall, with more of it coming in heavy downpours. In spite of this, some areas are likely to get drier as increased evaporation due to higher temperatures outpaces increased precipitation. Droughts and flash floods are likely to become more frequent and intense.

PERMAFROST AREAS

It is very probable that rising temperatures will cause further permafrost thawing, damaging roads, buildings, and forests in Alaska.



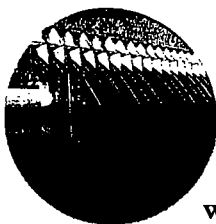
FORESTRY

Timber inventories are likely to increase over the 21st century. Hardwood productivity is likely to increase more than softwood productivity in some regions, including the Southeast.



SPECIES DIVERSITY

While it is possible that some species will adapt to changes in climate by shifting their ranges, human and geographic barriers, and the presence of invasive non-native species will limit the degree of adaptation that can occur. Losses in local biodiversity are likely to accelerate towards the end of the 21st century.



WATER SUPPLY

Reduced summer runoff, increased winter runoff, and increased demands are likely to compound current stresses on water supplies and flood management, especially in the western US.

ISLANDS

Sea-level rise and storm surges will very likely threaten public health and safety and possibly reduce the availability of fresh water.



CORAL REEFS

Increased CO₂ and ocean temperatures, especially combined with other stresses, are very likely to exacerbate coral reef bleaching and die-off.



FRESHWATER ECOSYSTEMS

Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands.



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FOREST ECOSYSTEMS

Forest growth is likely to increase in many regions, at least over the next several decades. Over the next century, tree and animal species' ranges will probably shift in response to the changing climate. Some forests are likely to become more susceptible to fire and pests.



AGRICULTURE

The Nation's food supply is likely to remain secure. The profit margin for food producers is likely to continue to drop.



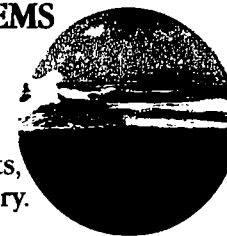
URBAN POPULATIONS

Heat waves are very likely to increase in frequency, resulting in more heat-related stresses. Milder winters are likely to reduce cold-related stresses in some areas.



COASTAL ECOSYSTEMS

Sea-level rise is very likely to cause the loss of some barrier beaches, islands, marshes, and coastal forests, throughout the 21st century.



EXTREME EVENTS

It is very likely that more rain will come in heavy downpours, increasing the risk of flash floods.



COASTAL COMMUNITIES AND INFRASTRUCTURE

Coastal inundation from storm surges combined with rising sea level will very likely increase threats to water and sewer systems, transportation and communication systems, homes, and other buildings.



RARE ECOSYSTEMS

Alpine meadows, mangroves, and tropical mountain forests in some locations are likely to disappear because the new local climate will not support them or there are barriers to their movement.



There are substantial opportunities to minimize the negative impacts and maximize the benefits of climate change through adaptation. Examples include cultivating varieties of crops, trees, and livestock that are better suited to hotter conditions. This report includes an initial identification of potential adaptation strategies, but an analysis of their effectiveness, practicality, and costs was not considered in this Assessment.