

GAO

Testimony

Before the Subcommittee on Energy and  
Environment, Committee on Energy and  
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CLIMATE CHANGE

Observations on Federal  
Efforts to Adapt to a  
Changing Climate

Statement of John Stephenson, Director  
Natural Resources & Environment



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Highlights of [GAO-09-534T](#), a testimony before the Subcommittee on Energy and Environment, Committee on Energy and Commerce, House of Representatives

## Why GAO Did This Study

Changes in the climate attributable to increased concentrations of greenhouse gases may have significant environmental and economic impacts in the United States. For example, climate change could threaten coastal areas with rising sea levels, alter agricultural productivity, and increase the intensity and frequency of floods and storms.

Federal, state, and local agencies are tasked with a wide array of responsibilities that will be affected by a changing climate, such as managing natural resources. Furthermore, climate change could increase the cost of federal programs, such as crop and flood insurance, and place new stresses on infrastructure.

Greenhouse gases already in the atmosphere will continue altering the climate system into the future regardless of emissions control efforts. Therefore, adaptation—defined as adjustments to natural or human systems in response to actual or expected climate change—is an important part of the response to climate change.

Today's testimony summarizes GAO's prior and ongoing work examining (1) actions that federal, state, local, and international authorities are taking to adapt to a changing climate, (2) the challenges that federal, state, and local officials face in their efforts to adapt, and (3) actions that the Congress and federal agencies could take to help address these challenges.

View [GAO-09-534T](#) or key components. For more information, contact John Stephenson, (202) 512-3841, [stephensonj@gao.gov](mailto:stephensonj@gao.gov).

## CLIMATE CHANGE

### Observations on Federal Efforts to Adapt to a Changing Climate

#### What GAO Found

Based on preliminary observations from GAO's ongoing adaptation work for the Select Committee on Energy Independence and Global Warming, certain federal, state, local, and international government authorities are beginning to consider and implement climate change adaptation measures. Some federal programs are already helping officials make decisions in response to a changing climate. For example, the National Oceanic and Atmospheric Administration's Regional Integrated Sciences and Assessments (RISA) program supports climate change research to meet the adaptation-related information needs of decision makers and planners at the regional level. In addition, certain state, local, and international governments are developing and implementing climate change adaptation plans. For example, GAO's recent site visit to Maryland examined the state's comprehensive strategy for reducing vulnerability to climate change focused on sea level rise and coastal storms. As part of ongoing work for the Select Committee, GAO plans to conduct four additional site visits to learn from international, federal, and local adaptation efforts.

Several of GAO's recent reports on climate change examined a number of challenges faced by government officials in their efforts to adapt. First, climate change is one of many priorities competing for attention and resources. Second, a lack of guidance can constrain the ability of officials to consider climate change in management and planning decisions. Third, insufficient site-specific data, including a lack of local projections of expected changes, can reduce the ability of officials to manage the effects of climate change on the resources they oversee. Fourth, officials are struggling to make decisions based on future climate scenarios that may not reflect past conditions. Our ongoing work seeks to identify other challenges warranting the attention of policymakers.

Some of GAO's recent climate change-related reports offer clues on the types of actions federal agencies and the Congress could take to assist states and communities in their efforts to adapt. A recent GAO report on federal land management, for example, recommended that certain agencies develop guidance advising managers how to address the effects of climate change on the resources they manage. Furthermore, a recent GAO report on the economics of climate change identified actions the Congress and federal agencies could take, such as reforming insurance subsidy programs in areas vulnerable to hurricanes or flooding. GAO's current effort for the Select Committee, which focuses more directly on adaptation, will obtain information and perspectives from diverse groups of knowledgeable federal, state, and local officials, and in particular will seek to learn from the experience of practitioners on the front lines working to adapt to a changing climate. This work will be completed by late 2009.

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Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to provide observations on federal efforts to adapt to a changing climate. Changes in the earth's climate attributable to increased concentrations of greenhouse gases may have significant environmental and economic impacts in the United States and internationally.<sup>1</sup> Among other potential impacts, experts agree that climate change could threaten coastal areas with rising sea levels, alter agricultural productivity, and increase the intensity and frequency of floods and tropical storms. Federal, state, and local agencies are tasked with a wide array of responsibilities, such as managing natural resources, that will be affected by a changing climate. Furthermore, climate change has implications for the fiscal health of the federal government, affecting federal crop and flood insurance programs, and placing new stresses on infrastructure. The effects of increases in atmospheric concentrations of greenhouse gases and temperature on ecosystems and economic growth are expected to vary across regions, countries, and economic sectors (see table 1).

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**Table 1: Potential Impacts of Climate Change by Sector**

Sector	Major projected impacts
Agriculture, forestry, and ecosystems	Increased yields in colder environments Decreased yields in warmer environments Increased insect outbreaks Increased danger of wildfires Damage to crops Waterlogging of soils Land degradation Increased livestock deaths Uprooting of trees Damage to coral reefs Salinization of irrigation water, estuaries, and freshwater systems

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<sup>1</sup>Major greenhouse gases include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and synthetic gases (hydrofluorocarbons {HFCs}, perfluorocarbons {PFCs}, and sulfur hexafluoride {SF<sub>6</sub>}).

Sector	Major projected impacts
Water resources	<ul style="list-style-type: none"> <li>Effects on some water resources, such as increased salinization of groundwater and decreased availability of freshwater for humans and ecosystems</li> <li>Increased water demand</li> <li>Water quality problems</li> <li>Adverse effects on quality of surface and groundwater</li> <li>More widespread water scarcity</li> <li>Power outages causing disruption of public water supply</li> <li>Decreased freshwater availability due to saltwater intrusion</li> </ul>
Human health	<ul style="list-style-type: none"> <li>Reduced human mortality from decreased cold exposure</li> <li>Increased risk of heat-related mortality</li> <li>Increased risk of deaths, injuries, and infectious respiratory and skin diseases</li> <li>Increased risk of food and water shortage</li> <li>Increased risk of malnutrition</li> <li>Increased risk of water- and food-borne diseases</li> <li>Increased risk of deaths and injuries by drowning and floods</li> </ul>
Industry, settlement, and society	<ul style="list-style-type: none"> <li>Reduced energy demand for heating</li> <li>Increased energy demand for cooling</li> <li>Declining air quality in cities</li> <li>Reduced disruption to transport due to snow, ice</li> <li>Disruption of settlements, commerce, transport, and societies due to flooding</li> <li>Pressures on urban and rural infrastructures</li> <li>Water shortages for settlements, industry, and societies</li> <li>Reduced hydropower generation potential</li> <li>Potential for population migration</li> <li>Disruption by flood and high winds</li> <li>Withdrawal of risk coverage in vulnerable areas by private insurers</li> <li>Costs of coastal protection versus costs of land use relocation</li> <li>Potential for movement of populations and infrastructure</li> </ul>

Source: IPCC, Working Group III, AR4, Summary for Policymakers

Proposed responses to climate change include reducing greenhouse gas emissions through regulation, the promotion of low-emissions technologies, and adapting to the possible impacts by planning and improving protective infrastructure. Thus far, government attention and resources have been focused on emissions reductions options, climate science research, and technology investment. In recent years, however, climate change adaptation—adjustments to natural or human systems in response to actual or expected climate change—has begun to receive more attention because the greenhouse gases already in the atmosphere are expected to continue altering the climate system into the future regardless of efforts to control emissions.

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Policy makers are increasingly viewing adaptation as a risk-management strategy to protect vulnerable sectors and communities that might be affected by changes in the climate. It may be costly to raise river or coastal dikes to protect communities and resources from sea level rise, build higher bridges, or improve storm water systems. But there is a growing recognition, in the United States and elsewhere, that the cost of inaction could be greater.

My testimony today addresses (1) what actions federal, state, local, and international authorities are taking to adapt to a changing climate, (2) the challenges that federal, state, and local officials face in their efforts to adapt, and (3) actions that the Congress and federal agencies could take to help address these challenges. The information in this testimony is based largely on prior GAO work, including recent reports on climate change on federal lands, federal flood and crop insurance programs, and climate change economics.<sup>2</sup> In addition, certain information in this testimony was gathered through interviews of knowledgeable stakeholders and review of existing adaptation reports as part of our ongoing study of climate change adaptation for the Select Committee on Energy Independence and Global Warming (Select Committee). We conducted our work in accordance with GAO's Quality Assurance Framework, which requires that we plan and perform each engagement to obtain sufficient and appropriate evidence to meet our stated objectives and to discuss any limitations in our work. We believe that the information and data obtained, and the analyses conducted, provided a reasonable basis for the findings and conclusions in these reports.

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## Federal, State, Local, and International Efforts to Adapt to a Changing Climate

Based on preliminary observations from our ongoing adaptation work for the Select Committee, certain federal, state, local, and international government authorities are beginning to consider and implement climate change adaptation measures. A range of federal activities are underway, including efforts to provide information and guidance to decision makers. Certain federal programs are already helping officials make decisions in response to a changing climate. For example, two programs managed by the Department of Commerce's National Oceanic and Atmospheric

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<sup>2</sup>See *Climate Change: Agencies Should Develop Guidance for Addressing the Effects on Federal Land and Water Resources*, [GAO-07-863](#), (Washington, D.C.: Aug. 7, 2007); *Climate Change: Financial Risks to Federal and Private Insurers in Coming Decades Are Potentially Significant*, [GAO-07-285](#), Mar. 16, 2007; and *Climate Change: Expert Opinion on the Economics of Policy Options to Address Climate Change*, [GAO-08-605](#), May 9, 2008.

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Administration (NOAA) help policy makers and managers obtain the information they need to adapt to a changing climate. NOAA's Regional Integrated Sciences and Assessments program supports climate change research to meet the needs of decision makers and policy planners at the regional level. Similarly, NOAA's Sectoral Applications Research Program is designed to help decision makers in different sectors, such as coastal resource managers, use climate information to respond to and plan for climate variability and change, among other goals. Other agencies—including the Department of the Interior's (Interior) U.S. Geological Survey and the National Aeronautics and Space Administration—also manage programs to provide climate information to decision makers.

Federal resource management agencies are also taking steps to adapt to a changing climate. For example, the United States Department of Agriculture's (USDA) Forest Service developed a strategic framework for responding to climate change that recognizes the need to enhance the capacity of forests and grasslands to adapt. In written testimony at a March 3, 2009 hearing before the House Committee on Natural Resources, Subcommittee on National Parks, Forests, and Public Lands, the Chief of the Forest Service stated that dealing with risks and uncertainties introduced or made worse by climate change will need to be a more prominent part of the Forest Service's management decision processes.<sup>3</sup> Similarly, Interior recognized a number of adaptation-related policy options for land managers in reports produced for its Climate Change Task Force.<sup>4</sup> For example, the task force recognized the need to revise management plans to reflect the effects of predicted climate conditions.

Other federal efforts are also attempting to link climate information with the needs of decision makers. The Climate Change Science Program (CCSP)—a multi-agency coordinating group that integrates federal research on climate change—is in the process of developing a series of “building blocks” that outline options for future climate change work, including science to inform adaptation. The adaptation building block includes support and guidance for federal, regional, and local efforts to prepare for and respond to climate change, including characterizing the need for adaptation, and developing, implementing, and evaluating

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<sup>3</sup>Also, on January 16, 2009, the Forest Service issued guidance for addressing climate change considerations in land management planning and project implementation.

<sup>4</sup>For more information about the Department of the Interior Climate Change Task Force, see [http://www.usgs.gov/global\\_change/doi\\_taskforce.asp](http://www.usgs.gov/global_change/doi_taskforce.asp).

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adaptation approaches. In addition, a recent CCSP report described adaptation options for climate-sensitive ecosystems and resources on federally owned and managed lands.<sup>5</sup> Another example of federal efforts to link climate information with the needs of decision makers is the Environmental Protection Agency's (EPA) Climate Ready Estuaries program to develop and implement adaptation strategies in coastal communities.<sup>6</sup>

While adaptation is one of many competing priorities for decision makers, certain state, local, and international governments are nonetheless developing and implementing climate change adaptation plans. For example, we just completed a site visit exploring Maryland's adaptation initiatives. In August 2008, the state issued a comprehensive strategy for reducing its vulnerability to climate change, focusing on sea level rise and coastal storms. The state has completed an extensive mapping effort to identify coastal vulnerability and has begun educating coastal counties about changes that can be made to local ordinances to reduce coastal erosion and increase resilience. Specifically, it provided guidance to three coastal counties recommending changes to planning documents, buildings codes, and local laws to address the risks resulting from sea level rise. Two recent reports by non-government research groups summarize other state and local adaptation planning efforts.<sup>7</sup> As part of our ongoing work for the Select Committee, we plan to further explore the Maryland example and examine additional international, federal, and local adaptation planning and implementation efforts through four more site visits, including the United Kingdom, a federal land management unit, the City of Chicago, and King County, Washington. These site visits will allow us to identify and document how existing adaptation efforts were developed and implemented. Further, site visits will help us identify the

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<sup>5</sup>CCSP, 2008: *Preliminary review of adaptation options for climate-sensitive ecosystems and resources*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Julius, S.H., J.M. West (eds.), J.S. Baron, B. Griffith, L.A. Joyce, P. Kareiva, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA, 873 pp.

<sup>6</sup>Estuaries are places where rivers meet the sea.

<sup>7</sup>See *Adaptation Planning: What U.S. States and Localities are Doing*, Prepared for the Pew Center on Global Climate Change, November 2007 (Updated January 2009), available at <http://www.pewclimate.org/working-papers/adaptation>, and *A Survey of Climate Change Adaptation Planning*, The H. John Heinz III Center for Science, Economics, and the Environment, Washington DC, 2007, available at [http://www.heinzctr.org/publications/meeting\\_reports.shtml](http://www.heinzctr.org/publications/meeting_reports.shtml)

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information and other needs of decision-makers, how the federal government is addressing these needs, and how these efforts can be improved.

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## Challenges in Adapting to Climate Change

Several of our recent reports on climate change illustrate a number of challenges faced by government officials when adapting to a changing climate. Among them, (1) climate change is one of many competing priorities for government officials, (2) a lack of guidance can constrain the ability of officials to consider climate change in management and planning decisions, (3) insufficient site-specific information can reduce the capability of officials to manage the effects of climate change on the resources they oversee, and (4) officials are struggling to make decisions based on projected future climate scenarios that may not reflect past conditions. Our ongoing work for the Select Committee will continue to explore these and other challenges by obtaining information from a broad range of federal, state, and local officials knowledgeable about climate change adaptation.

Competing priorities. Our August 2007 report on climate change on federal lands shows how climate change impacts compete for the attention of decision makers with many more immediate priorities.<sup>8</sup> The federal government manages nearly 30 percent of the land in the United States. Three federal agencies within Interior—the Bureau of Land Management, U.S. Fish and Wildlife Service, and the National Park Service—and USDA’s Forest Service administer over 90 percent of these lands. NOAA administers Marine Protected Areas.<sup>9</sup> These agencies manage their resources for a variety of purposes related to preservation; recreation; and in some cases, resource use, yet each agency has distinct responsibilities for the resources it administers. The agencies are generally authorized to plan and manage for changes in resource conditions, regardless of the cause that brings about the change. As such, federal resource management agencies are generally authorized but not specifically required to address changes in resource conditions resulting from climate change in their actions and planning efforts.

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<sup>8</sup>*Climate Change: Agencies Should Develop Guidance for Addressing the Effects on Federal Land and Water Resources*, [GAO-07-863](#), (Washington, D.C.: Aug. 7, 2007)

<sup>9</sup>Marine Protected Areas are areas of the marine environment that have been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein.



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The same report found that the resource management agencies we reviewed did not at that time make climate change a priority, and that the agencies' strategic plans did not specifically address climate change. Resource managers explained that they had a wide range of responsibilities and that, because none of the agencies designated climate change as a priority, they focused first on near-term activities that they were specifically required to undertake, leaving less time and resources for longer-term issues such as climate change. Resource managers told us that climate change effects were typically not addressed in agency planning activities. Although resource management agencies are now beginning to consider climate change adaptation in planning decisions, this example illustrates how other issues may overshadow climate change adaptation if it is not explicitly designated as a priority.

Lack of guidance. Our August 2007 report also noted that resource managers were constrained by limited guidance about whether or how to address climate change and, therefore, were uncertain about what actions, if any, they should take. In general, resource managers from all of the agencies said that they needed specific guidance to incorporate climate change into their management actions and planning efforts. For example, officials from several federal land and water resource management agencies said that guidance would help resolve differences in their agencies about how to interpret broad resource management authorities with respect to climate change and give them an imperative to take action. While these agencies have started to issue guidance to resource managers, this example shows how a lack of guidance can limit efforts to adapt.

Lack of site-specific information. Our report also demonstrated that resource managers did not have sufficient site-specific information to plan for and manage the effects of climate change on the federal resources they oversee. In particular, the managers lacked computational models for local projections of expected changes. For example, at that time, officials at the Florida Keys National Marine Sanctuary said that they lacked adequate modeling and scientific information to enable managers to predict change on a small scale, such as that occurring within the sanctuary. Without such models, most of the managers' options for dealing with climate change were limited to reacting to already-observed effects on their units, making it difficult to plan for future changes. Furthermore, these resource managers generally lacked detailed inventories and monitoring systems to provide them with an adequate baseline understanding of the plant and animal species that existed on the resources they manage. Without such information, it is difficult to determine whether observed changes are within the normal range of variability.

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Uncertainties in making decisions based on projected future conditions. A recent report by the National Research Council (NRC) shows how officials are struggling to make decisions based on future climate scenarios instead of past climate conditions.<sup>10</sup> According to the report, requested by EPA and NOAA, government agencies, private organizations, and individuals whose futures will be affected by climate change are unprepared both conceptually and practically for meeting the challenges and opportunities it presents. Many of their usual practices and decision rules (for building bridges, implementing zoning rules, using private motor vehicles, and so on) assume a stationary climate—a continuation of past climate conditions, including similar patterns of variation and the same probabilities of extreme events. According to the NRC, that assumption, fundamental to the ways people and organizations make their choices, is no longer valid. Climate change will create a novel and dynamic decision environment.

Our own 2007 climate change-related report on the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program, which insures properties against flooding, and USDA's Federal Crop Insurance Corporation, which insures crops against drought or other weather disasters, reached similar conclusions, highlighting how historical information may no longer be a reliable guide for decision making.<sup>11</sup> Among other things, the report contrasted the experience of public and private insurers. Many major private insurers were incorporating some near-term elements of climate change into their risk management practices. In addition, some private insurers were approaching climate change at a strategic level by publishing reports outlining the potential industry-wide impacts and strategies to proactively address the issue. This more proactive view was recently echoed on March 17, 2009, by the National Association of Insurance Commissioners, which adopted a mandatory requirement that insurance companies disclose to regulators the financial risks they face from climate change, as well as actions the companies are taking to respond to those risks.

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<sup>10</sup>National Research Council (2009), *Informing Decision in a Changing Climate*. Panel on Strategies and Methods for Climate-Related Decision Support, Committee on the Human Dimensions of Global Change, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

<sup>11</sup>*Climate Change: Financial Risks to Federal and Private Insurers in Coming Decades Are Potentially Significant*, GAO-07-285, (Washington, D.C.: Mar. 16, 2007)

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In contrast, our 2007 report noted that the agencies responsible for the nation's key federal insurance programs had done little to develop the kind of information needed to understand their programs' long-term exposure to climate change for a variety of reasons. As a FEMA official explained, the National Flood Insurance Program is designed to assess and insure against current—not future—risks. Unlike the private sector, neither this program nor the Federal Crop Insurance Corporation had conducted an analysis to assess the potential impacts of an increase in the frequency or severity of weather-related events on their operations over the near- or long-term. Both FEMA and USDA have committed to study these issues further and report to the Congress, with USDA estimating completion by December 31, 2009.

Preliminary observations from our interviews with knowledgeable stakeholders and review of existing adaptation reports confirm the challenges discussed above, but also identify additional issues. For example, certain documents we reviewed as part of our ongoing work for the Select Committee identified the lack of public awareness about adaptation as a challenge. Our continuing work will explore this issue further and seek to identify other challenges warranting the attention of policymakers by collecting information from diverse groups of knowledgeable federal, state, and local officials.

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## Potential Adaptation Actions by the Congress and Federal Agencies

Some of our recent climate change-related reports offer clues on the types of actions federal agencies and the Congress could take to assist states and communities in their efforts to adapt to climate change. Our August 2007 report on federal land management, for example, recommended that the Secretaries of Agriculture, Commerce, and the Interior develop guidance that advises resource managers on how to address climate change effects and gather the information needed to do so. Our March 2007 report assessing the financial risks to federal insurance programs found that their exposure to weather-related losses had grown substantially and recommended that the Secretaries of Agriculture and Homeland Security analyze the potential long-term fiscal implications of climate change for the programs and report their findings to the Congress.

Our May 2008 report on the economics of climate change also identified actions that could assist officials in their efforts to adapt to a changing

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climate.<sup>12</sup> Some of the economists surveyed for this report suggested, for example, reforming insurance subsidy programs in areas vulnerable to natural disasters like hurricanes or flooding. Several noted that a clear federal role exists for certain sectors, such as water resource management, which could require additional resources for infrastructure development, research, and managing federal lands.

Our current effort for the Select Committee, focused more directly on climate change adaptation than our prior reports, will provide additional information and insights on the types of actions federal agencies and the Congress could take to assist adaptation efforts. To date, several interviews with knowledgeable stakeholders and evaluation of existing adaptation reports suggested a need for improved coordination among federal agencies and between federal, state, and local governments. Some have also suggested the creation of a centralized government entity to collect and share information about climate change impacts and adaptation. We plan to explore these observations in greater detail by obtaining information and perspectives from a wide range of knowledgeable officials on the front lines of the nation's efforts to adapt to a changing climate. We expect to complete our ongoing work by late 2009.

Mr. Chairman, this concludes my prepared statement. I would be happy to respond to any questions that you or other Members of the Subcommittee may have at this time.

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## Contact and Staff Acknowledgments

Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. For further information about this testimony, please contact John Stephenson, Director, Natural Resources and Environment at (202) 512-3841 or [stephensonj@gao.gov](mailto:stephensonj@gao.gov). Key contributors to this statement were Steven Elstein (Assistant Director), Ben Shouse, and Joe Thompson. Chuck Bausell, Kate Cardamone, Cindy Gilbert, Richard P. Johnson, Kirsten Lauber, Jeanette Soares, and Ruth Solomon also made important contributions.

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<sup>12</sup>*Climate Change: Expert Opinion on the Economics of Policy Options to Address Climate Change*, GAO-08-605, (Washington, D.C.: May 9, 2008)

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