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Climate Change Adaptation by Federal Agencies: An Analysis of Plans and Issues for Congress

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Summary

Though Congress has debated the significance of global climate change and what federal policies, if any, should address them, the Government Accountability Office (GAO) since 2013 has identified the changing climate as one of the 30 most significant risks facing the federal government. President Obama established adaptation as a prominent part of his Climate Action Plan in June 2013. The November 2013 Executive Order 13653, *Preparing the United States for the Impacts of Climate Change*, directed agencies to undertake vulnerability assessments and planning for adaptation. The Administration aimed efforts at reducing agencies' own risks, taking advantage of "no-regrets" adaptation opportunities, and actions that promote resilience to climate changes.

Scope of Report

This report reviews current actions (as of January 2015) of selected federal departments and agencies to adapt their own missions, infrastructure, operations, and personnel to projected climate change. (It does not address federal programs meant primarily to assist others to adapt, although the boundary is often hard to delineate.) This synthesis is not comprehensive. It identifies common approaches among agencies, examples of specific actions, and notable barriers the federal government faces.

As of December 2014, almost 40 federal departments and agencies had, to varying degrees, produced climate change adaptation plans, climate change vulnerability assessments, adaptation milestones, and/or metrics to evaluate adaptation performance. These efforts have identified wide-ranging vulnerabilities to potential climate changes, as well as some opportunities.

Most agencies are in formative stages of their assessments and strategic planning. Some agencies are embarking on more detailed analyses and limited implementation actions. Overall, few examples are apparent of day-to-day agency decisions or actions that are different as a result of their adaptation efforts. Numerous challenges face federal officials in their efforts, including constrained resources, data gaps regarding location-specific climate changes or existing facilities, insufficient personnel training, and—sometimes—low priority among priorities. CRS identified few on-the-ground adaptations and few evaluations, as yet, of the effectiveness and efficiency of alternative adaptation approaches and actions.

It may not be possible to tally budgetary resources associated with federal adaptation efforts. While some are reported in the President's budget proposals, many are indivisible from the activities with which they are associated, reflecting more of a change in how efforts are undertaken than a change in level of effort.

Role of Congress

In light of agencies' risk assessments and adaptation planning, Congress may consider whether agencies have appropriate statutory authorities to take various climate change adaptation actions; how to make data pertinent to adaptation more accessible and usable by federal agencies and the public; the appropriate priority for federal adaptation efforts in the context of agency missions and budgetary constraints; and timeliness of activities. Congress may provide federal agencies direction on how they should organize and fund their adaptation efforts; whether and how to measure and evaluate program performance (e.g., effectiveness at reducing risks to property,

lives, and habitats relative to the federal and private investment of an adaptation measure); and desirable reporting and accountability to Congress and the public. Congress also may assess the role, costs, benefits, and timing of adaptation in the context of discussions regarding climate change mitigation and other broad policy fields such as natural disaster, infrastructure, energy, environmental, agricultural, federal lands, defense, health, tax, and budget policies.

The President's FY2016 budget request and other related administrative announcements roughly concurrent with its release on February 2, 2015, are not addressed in this report. While the President's FY2016 budget request and other recent announcements (e.g., executive order on flooding and proposed FEMA rules) may mention adaptation (or "resilience") to climate change, most pertain to programs outside the narrow scope of this report: assessments and actions that agencies may be undertaking to address *potential risks to their missions, property, operations, and personnel*. For further detail or updates on climate change adaptation plans by individual agencies, the report provides contact information for CRS analysts at the end of each agency section in Part II.

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Purpose, Scope, Method, and Structure¹

For many years, Congress has debated the risks of projected climate change and what, if any, federal action might be appropriate to address those risks.

In 2013, the Government Accountability Office (GAO) identified the changing climate (see **Text Box** below) as one of the 30 most significant risks facing the federal government.² The purpose of this report is to provide background to Congress regarding efforts under way to identify and address through adaptation potential vulnerabilities of federal agencies' resources (lands, facilities, operations, personnel) to projected climate change.³

To date, the executive branch has guided federal agency climate change adaptation planning, although some Members of Congress have introduced bills to promote adaptation.⁴ President Obama established adaptation as a prominent part of his Climate Action Plan, released in June 2013. The November 2013 Executive Order 13653, *Preparing the United States for the Impacts of Climate Change*, continued the Administration's focus on federal climate change preparedness through agency and department adaptation planning. As of December 2014, more than 30 federal departments and agencies had, to varying degrees, produced climate change adaptation plans, vulnerability assessments, adaptation milestones, or adaptation performance metrics to address the potential vulnerabilities of their missions, property, operations, and/or personnel to climate change.⁵ Agency efforts identified wide-ranging vulnerabilities that could result from climate changes, as well as some opportunities.

For Congress, federal adaptation efforts may raise questions of authorization, appropriations, and oversight. For example, some Members of Congress may be concerned that federal agency climate change adaptation planning may divert resources and attention from other, more near-

¹ CRS expresses its appreciation to the research and other contributions to this report of Emily Ann Bruner, a Research Fellow in the Resources, Science, and Industry Division in 2013.

² Government Accountability Office (GAO), "Limiting the Federal Government's Fiscal Exposure by Better Managing Climate Change Risks," in *High-Risk Series: An Update*, GAO-13-283 (Washington, DC, 2013), http://www.gao.gov/highrisk/limiting_federal_government_fiscal_exposure/why_did_study. The most recent GAO list of the most significant risks facing the federal government continued to include climate change. See Government Accountability Office (GAO), "Limiting the Federal Government's Fiscal Exposure by Better Managing Climate Change Risks," in *High-Risk Series: An Update*, GAO-15-290 (Washington, DC, 2015), <http://www.gao.gov/products/GAO-15-290>.

³ This report also does not address the variety of other executive branch actions on climate change, which were outlined in a June 2013 speech by President Obama. See CRS Report R43120, *President Obama's Climate Action Plan*, coordinated by Jane A. Leggett. For example, the EPA proposal to control greenhouse gases is not addressed in this report, but discussed in a separate report, CRS Report R43572, *EPA's Proposed Greenhouse Gas Regulations for Existing Power Plants: Frequently Asked Questions*, by James E. McCarthy et al. Also, for information on EPA funding devoted to climate change activities, see CRS Report R43709, *Environmental Protection Agency (EPA): FY2015 Appropriations*, by Robert Esworthy. For a broader overview of federal climate change funding, see CRS Report R43227, *Federal Climate Change Funding from FY2008 to FY2014*, by Jane A. Leggett, Richard K. Lattanzio, and Emily Bruner.

⁴ In the 113th Congress, see, as examples, the Coastal State Climate Change Planning Act (H.R. 764); Recognizing the disparate impact of climate change on women and the efforts of women globally to address climate change (H.Con.Res. 36); the Climate Protection Act of 2013 (S. 322); the SAFE Act (S. 1202); and the WaterSense Efficiency, Conservation, and Adaptation Act of 2014 (S. 2226).

⁵ Agency adaptation plans are available from many agencies via the following web page at performance.gov (<http://www.performance.gov/node/3406?view=public#supporting-info>). Links to agencies' adaptation web pages are also available in **Table 1**.

term asset management and mission challenges. In contrast, other Members may believe that current federal action to adapt to climate change is insufficient. Key policy issues include determining the level, nature, and mechanisms for investment in federal agency adaptation.

This report aims to synthesize information on the federal government's efforts to adapt itself to a changing climate. It is largely based on a CRS review of the adaptation planning documents released by selected federal departments and agencies as of late 2014, as well as several reviews by other organizations. Part I of the report provides an introduction to federal adaptation efforts and challenges and a synthesis of these efforts. Part II provides summaries of these efforts at the department and/or agency levels.

The report's focus is the state of climate change knowledge and planning *by federal agencies addressing the potential vulnerabilities of their missions, property, operations, and/or personnel* related to projected climate change. The review is not intended to address how agencies and their programs may help or hinder nonfederal entities in adapting to climate change, although the lines between these topics are sometimes blurry. For example, agencies may consider that achieving their core missions may be at risk unless they assist nonfederal entities in addressing climate change-related risks. Programs within the Department of Agriculture (USDA) may consider that they must assist agricultural producers in anticipating and preparing for climate change in order to maintain productivity. Or the Environmental Protection Agency (EPA), which has a mission to help communities finance drinking water infrastructure, may consider that expanding the water utility sector's understanding of climate change risks is important to delivering future water services.

This report is not comprehensive.⁶ Instead, it reviews adaptation plans of selected agencies, aims to illustrate federal actions to prepare and adapt the government to projected climate change, and offers emergent issues and questions for Congress.

⁶ Departments and agencies in Part II have been selected according to availability of CRS resources. The report may be updated, or summaries of additional agencies may be added, depending on congressional interest and as issues evolve. For further information, CRS experts are identified for each selected agency.

What Is the Difference Between Climate and Weather?

“It’s really hot this week; the climate must be warming!” “There haven’t been any major land-falling hurricanes in two years. I guess the climate isn’t changing.” What is flawed in these statements? They, like many people, confuse “weather” with “climate.” Keeping in mind the difference can help decipher meaningful data and statements from misinformation.

“Climate” is the average and variability of meteorological and related conditions in a specific location over a long period of time—typically 30 years, but sometimes measured over a century or even thousands of years. “Weather” is the conditions day to day, or week to week. Compiling and analyzing weather data give a climate measurement. But no day or week may be just like the defined climate. Some people say, “Climate is what you expect; weather is what you get.”

Unusual weather may or may not be an indicator of a changing climate. It takes decades to make a definitive determination. “Normal” weather may occur even when the climate is shifting. Conversely, extreme weather events may within the long-term normal.

Quiz: Which of the following true statements would be good indicators of the climate?

1. The years 2001-2010 were the hottest decade globally since 1891.
2. The global average temperature has not increased since 1998.⁷
3. The trend since 1979 in tropospheric temperatures measured by satellite data is $+0.14 \pm 0.02^\circ$ Celsius per decade.
4. The cumulative loss since 1980 of the mass balance of glaciers globally has been 15.7 meters water equivalent. “The decadal mean annual mass balance was -198 mm w.e. in the 1980s, -382 mm w.e. in the 1990s, and -740 mm w.e. for 2000–10.”⁸

Answer: All of the above are true statements, but only numbers 3 and 4 are indicative of climate and climate change; they describe changes over multidecadal periods. Statements 1 and 2 are about weather, as the time periods are too short to provide definitive information about the climate.

⁷ National Oceanic and Atmospheric Administration (NOAA) National Climate Data Center (NCDC), “Climate at a Glance—Time Series,” global annual temperature data from 1998 to 2013, extracted June 26, 2014.

⁸ Blunden, Jessica, and Derek S. Arndt, “State of the Climate in 2012,” *Bulletin of the American Meteorological Society* 94, no. 8, August 1, 2013, S1-S258, doi:10.1175/2013BAMSStateoftheClimate.1.

Part I: Synthesis and Possible Issues for Congress

Irrespective of driving causes, strong evidence shows that the United States' climate has been changing in recent decades.⁹ Most scientific theory and modeling forecast that climatic variables, such as temperature, precipitation, lengths of seasons, and permafrost patterns, will continue changing and may become less predictable.

GAO concluded that the federal government faces multiple fiscal exposures to climate change

including, but not limited to its role as (1) the owner or operator of extensive infrastructure such as defense facilities and federal property vulnerable to climate impacts, (2) the insurer of property and crops vulnerable to climate impacts, (3) the provider of data and technical assistance to state and local governments responsible for managing the impacts of climate change on their activities, and (4) the provider of aid in response to disasters.¹⁰

Many federal agencies have identified specific ways in which climate change factors, such as altered precipitation patterns, soil moisture, or ocean conditions, bring risks and opportunities. As examples, numerous federally owned and federally supported assets may face increasing flood risk as a result of projected sea-level rise.¹¹ The opening of Arctic waters with less summer sea ice increases opportunities for resource development, tourism, and shipping, while also raising concerns for security, safety, and protection of natural and cultural resources. Similarly, while many factors contribute to the incidence of wildfires, some researchers expect further warming and, in some areas, precipitation changes to increase risks of wildfires on federally owned lands.¹²

Additional researchers have identified highways, railways, and aviation facilities that have experienced failures in recent years due to high temperatures and other extreme weather, which are expected to increase with climate change.¹³ The Department of Defense (DOD) expects that thawing permafrost and rising sea levels will affect military training, installations, and land management in some locations.¹⁴ The Department of Health and Human Services (HHS) considers that climate change will affect the department's mission and strategic goals. USDA's

⁹ This report does not address the causes of multidecadal climate change. For a discussion of climate change science, see National Research Council, *Advancing the Science of Climate Change*, Washington, DC, 2010; and CRS Report R43229, *Climate Change Science: Key Points*, by Jane A. Leggett.

¹⁰ GAO, 2013, op. cit.

¹¹ Department of Transportation (DOT), Federal Highway Administration (FHWA), "Key Findings for Transit Agencies from FHWA Climate Vulnerability Pilots" (no date), http://www.fta.dot.gov/12347_14013.html; Chadwick, Bart, Pei F. Wang, Marris Brand, Reinhard Flick, Adam Young, William O'Reilly, Peter Bromirski, Walter Crampton, Robert Guza, and John Helly, *A Methodology for Assessing the Impact of Sea Level Rise on Representative Military Installations in the Southwestern United States (RC-1703)* (San Diego: Space and Naval Warfare Systems Center Pacific, March 3, 2014).

¹² Westerling, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam, "Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity," *Science* 313, Research Articles, August 18, 2006, pp. 940-943. See also U.S. Global Change Research Program, *Climate Change Impacts in the United States, U.S. National Climate Assessment*, 2014, "Overview," p. 10.

¹³ Meyer, Michael, Emily Rowan, Michael J. Savonis, and Anne Choate, *Integrating Extreme Weather Risk into Transportation Asset Management*, American Association of State Highway and Transportation Officials, November 1, 2012.

¹⁴ See a variety of Department of Defense (DOD) research projects at <http://www.serdp.org/Program-Areas/Resource-Conservation-and-Climate-Change/Climate-Change/Vulnerability-and-Impact-Assessment/%28active%29/no>. Various services within DOD have conducted numerous studies concerning potential climate change impacts.

Animal and Plant Health Inspection Service (APHIS) expects that changing climate conditions will increase demand for genetically engineered crops, resulting in a corresponding increase in numbers of permits, field trials, inspections, and other demands on APHIS resources.¹⁵

Numerous resource managers, engineers, economists, and others have identified benefits of anticipating and preparing for climate change. For example, some analysis suggests that every dollar spent on certain risk mitigation projects to reduce the consequences of natural disasters can generate several times more in monetary benefits.¹⁶ Based on such findings, many researchers and observers believe that anticipating the wide array of likely impacts and reducing risks through adaptation measures would be more efficient than incurring damage, responding to the immediate event, and then adapting reactively. The benefits of adaptation are expected to increase as the climate system moves further and further from historical “climate normals,”¹⁷ and as man-made and natural systems increasingly exceed their thresholds of tolerance and resilience. A range of stakeholders has recommended that federal agencies begin the adaptation process.¹⁸

¹⁵ U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service, *Climate Change Adaptation Plan*, May 31, 2012, p. 25.

¹⁶ Multihazard Mitigation Council, *Natural Mitigation Saves: An Independent Study to Assess Future Savings from Mitigation Activities*, National Institute of Building Sciences, 2005, http://c.y.mcdn.com/sites/www.nibs.org/resource/resmgr/MMC/hms_vol1.pdf.

¹⁷ A “climate normal” is a description of the historical climate over a prescribed area—typically 30 years. The current “climate normal” defined by the National Climate Data Center, for example, describes averages and variability of climate parameters from 1981 to 2010. See <http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html>.

¹⁸ Government Accountability Office, *Climate Change Adaptation: Strategic Federal Planning Could Help Government Officials Make More Informed Decisions*, Washington, DC, October 7, 2009, <http://www.gao.gov/products/GAO-10-113>. See also National Research Council, *Adapting to the Impacts of Climate Change: America’s Climate Choices: Panel on Adapting to the Impacts of Climate Change*, Washington, DC, National Academies Press, 2010; and Smith, Joel B., Jason M. Vogel, Terri L. Cruce, Stephen Seidel, and Heather A. Holsinger, *Adapting to Climate Change: A Call for Federal Leadership*, Arlington VA, Center for Climate and Energy Solutions, April 2010; among others.

Key Definitions Relevant to Adaptation to Climate Change

The terminology used herein is intended to be consistent with the 2014 *Impacts, Adaptation, and Vulnerabilities* report of the Intergovernmental Panel on Climate Change (IPCC):

Adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects

Climate change: “Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: ‘a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.’ The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.”

In addition, the National Research Council’s report *America’s Climate Choices* provides additional definitions:

Preparedness: Actions taken to plan, organize, equip, train, and exercise to build, apply, and sustain the capabilities necessary to prevent, protect against, ameliorate the effects of, respond to, and recover from climate change-related damages to life, health, property, livelihoods, ecosystems, and national security.

Resilience: A capability to anticipate, prepare for, respond to, and recover from significant multihazard threats with minimum damage to social well-being, the economy, and the environment.

Risk: A combination of the magnitude of the potential consequence(s) of climate change impact(s) and the likelihood that the consequence(s) will occur.

Vulnerabilities: The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change including climate variability and extremes. EPA, for example, applies this definition to its adaptation planning as “Challenges resulting from a changing environment due to climate change that may inhibit the Agency’s ability to fulfill its mission are referred to as vulnerabilities. Vulnerabilities can be a physical change in the environment ... or that may relate to programmatic processes or tools that may need to be adapted as a result of a changing environment.” Every EPA office examines vulnerabilities of its programs, policies, rules, and operations to ensure they remain effective in meeting its statutory, regulatory, and programmatic requirements.

Sources: Field, Christopher, et al., “Summary for Policy-Makers,” in *Climate Change 2014: Impacts, Adaptation, and Vulnerability*, Intergovernmental Panel on Climate Change, March 2014. Box SPM.2; Interagency Climate Change Adaptation Task Force, *Federal Actions for Climate Resilient Nation: Progress Report of the Interagency Climate Change Adaptation Task Force*, October 28, 2011, p. 2; EPA, *Climate Change Adaptation Plan*, June 29, 2012, p. 12. See also <http://www.epa.gov/climatechange/impacts-adaptation/fed-programs.html#adaptInteragency>.

What is meant by “adaptation” to ongoing and expected climate change varies widely. For some, adaptation may be development of new varieties of plants that will grow optimally in the expected climate. For others, it may mean new investments to address opportunities and risks associated with the opening of sea routes in the Arctic, or to protect or replace infrastructure at risk (e.g., from flooding with more extreme rainfall or from higher temperatures). For others, it may entail examining assumptions built into decision-support models—for example, for projecting electric load demand by consumers for heating and cooling, and then planning future capacity needs on that basis.

Background on Climate Change

The federal agency climate change adaptation plans discussed in this report aimed to use a common set of projected changes in temperature and precipitation for the continental United States. The following four figures illustrate some of the ranges of projections that agencies used when identifying potential impacts of climate changes and plans to adapt to them. These projections are no longer the most recent projections, but are provided in this report because they are those used by most agencies in their existing adaptation plans. They are not dramatically different from updated modeling.

Source and Note Material for Figures 1 Through 4

Source: The Coupled Model Inter-comparison Project version 3 (CMIP3). Gridded data downloaded in November 2013 from the U.S. Geological Survey at <http://cida.usgs.gov/climate/derivative/>; documentation available in Hayhoe, Katherine, et al., *Development and Dissemination of a High-Resolution National Climate Change Dataset*, Texas Tech University, March 22, 2013. A newer version of this inter-comparison project, CMIP5, is available at <http://cmip-pcmdi.llnl.gov/cmip5/>.

Notes: The maps show the National Climate Assessment's climate change scenarios to 2099. According to the CMIP3 documentation, these maps rely on a statistical "downscaling" method that combines high-resolution observations of climate with outputs from 16 global climate models, based on four future greenhouse gas scenarios from the 2001 Special Report on Emissions Scenarios (SRES) of the IPCC. The downscaled data sets were quality-controlled with observations from more than 10,000 long-term weather stations and projections generated for each of those stations. The High scenarios rely on greenhouse gas emissions (GHGs) associated with the "A2" scenario, representing a regionalized global economy and high population growth, low economic growth, slower technology improvements and diffusion, and other factors that contribute to high emissions and lower adaptive capacity (e.g., low per capita wealth). The Low scenarios uses the IPCC "B1" scenario, with more globalization, lower population growth, higher incomes, more efficient energy systems used globally, and other conditions that yield slower growth of GHG emissions and concentrations. See <http://scenarios.globalchange.gov/content/scenarios>.

These maps overlay congressional districts (in black lines) to help locate projected climate changes.

Figure 1. Range of Projected Mid-Century Surface Air Temperature Changes for the Continental United States

Change calculated using averages for the period 2040-2069, relative to the period 1971-2000

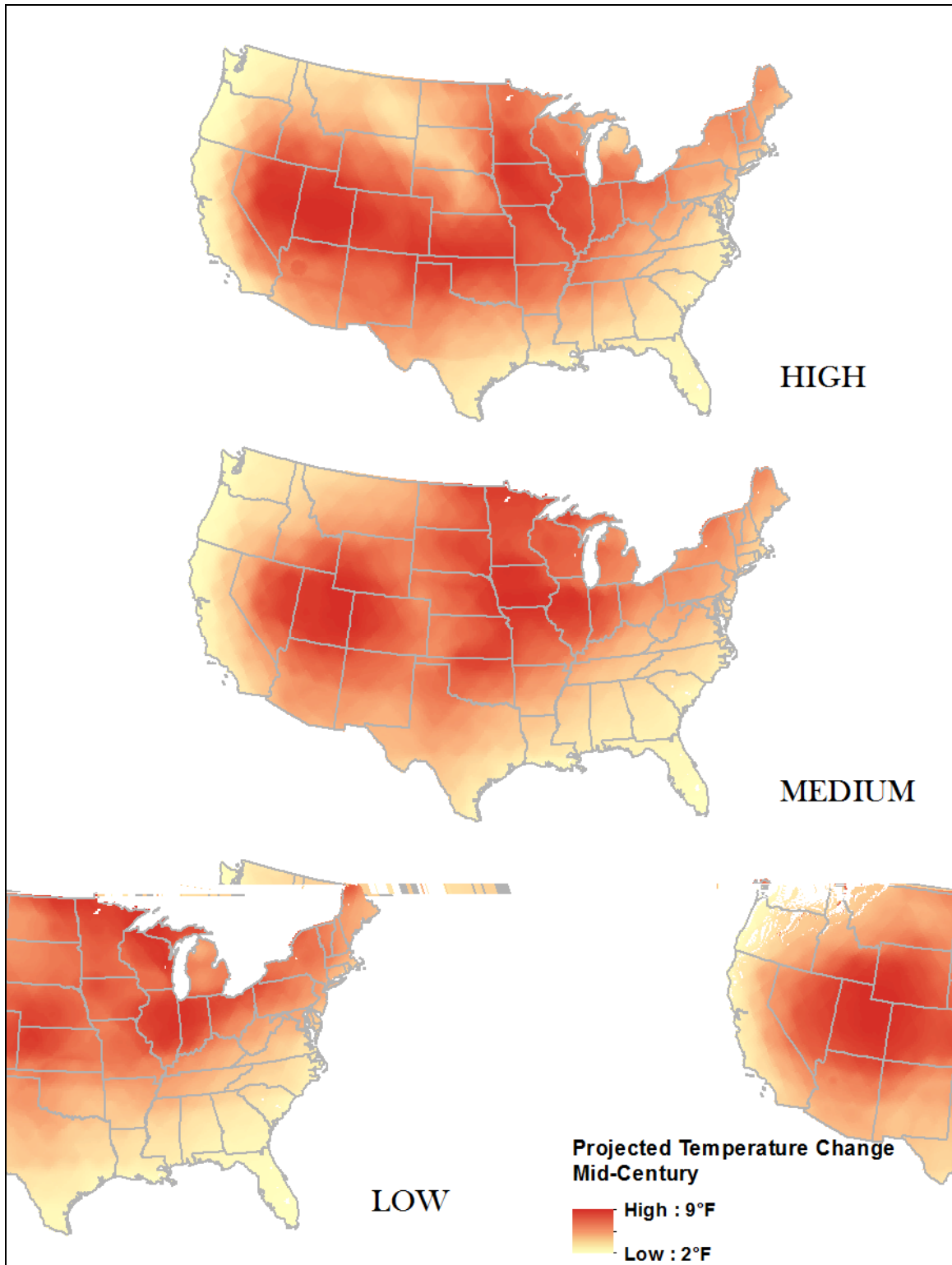


Figure 2. Range of Projected Late-Century Surface Air Temperature Changes for the Continental United States

Change calculated using averages for the period 2070-2099, relative to the period 1971-2000

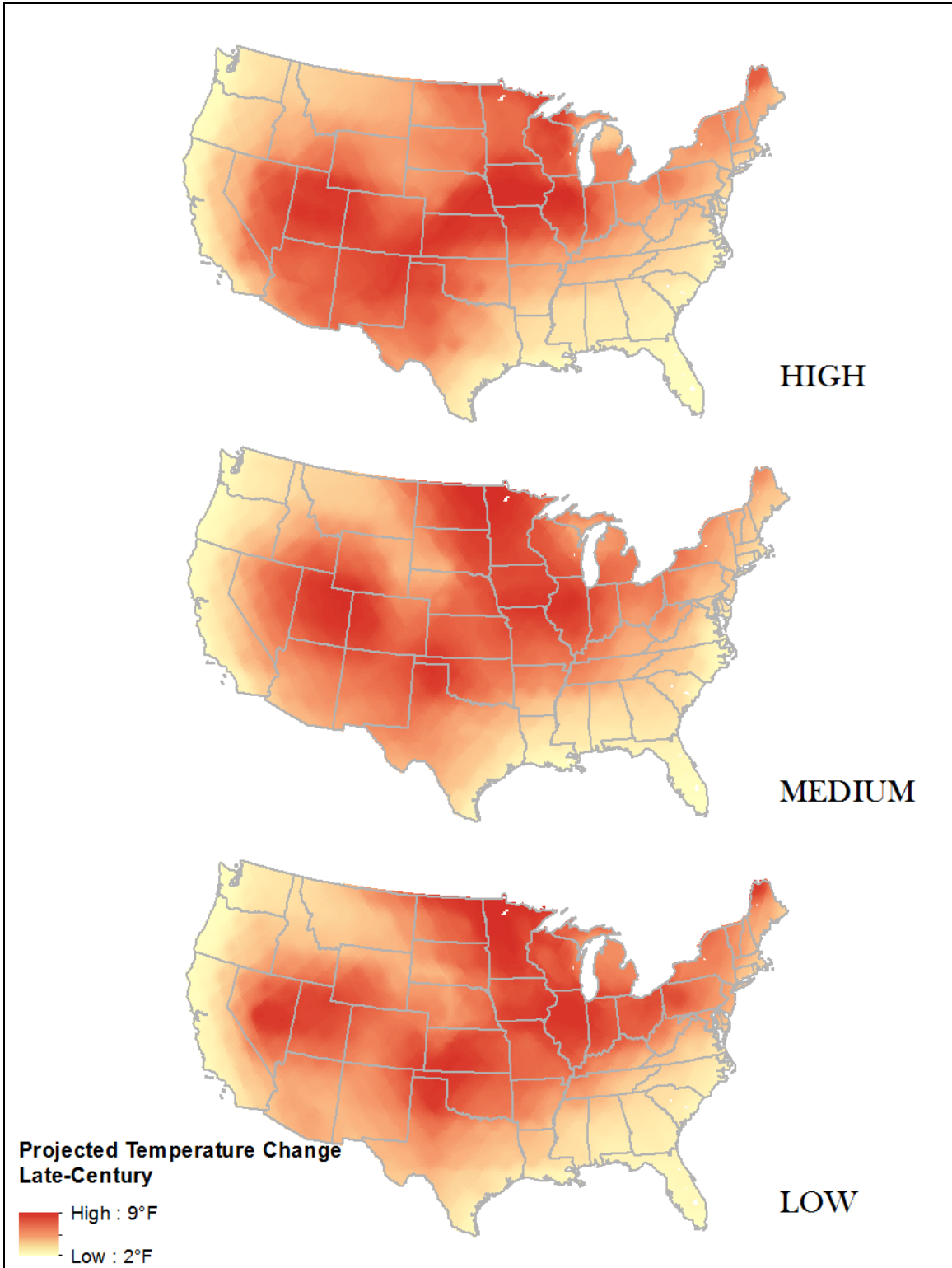


Figure 3. Range of Projected Mid-Century Precipitation Changes for the Continental United States

Percentage change calculated using averages for the period 2070-2099, relative to the period 1971-2000

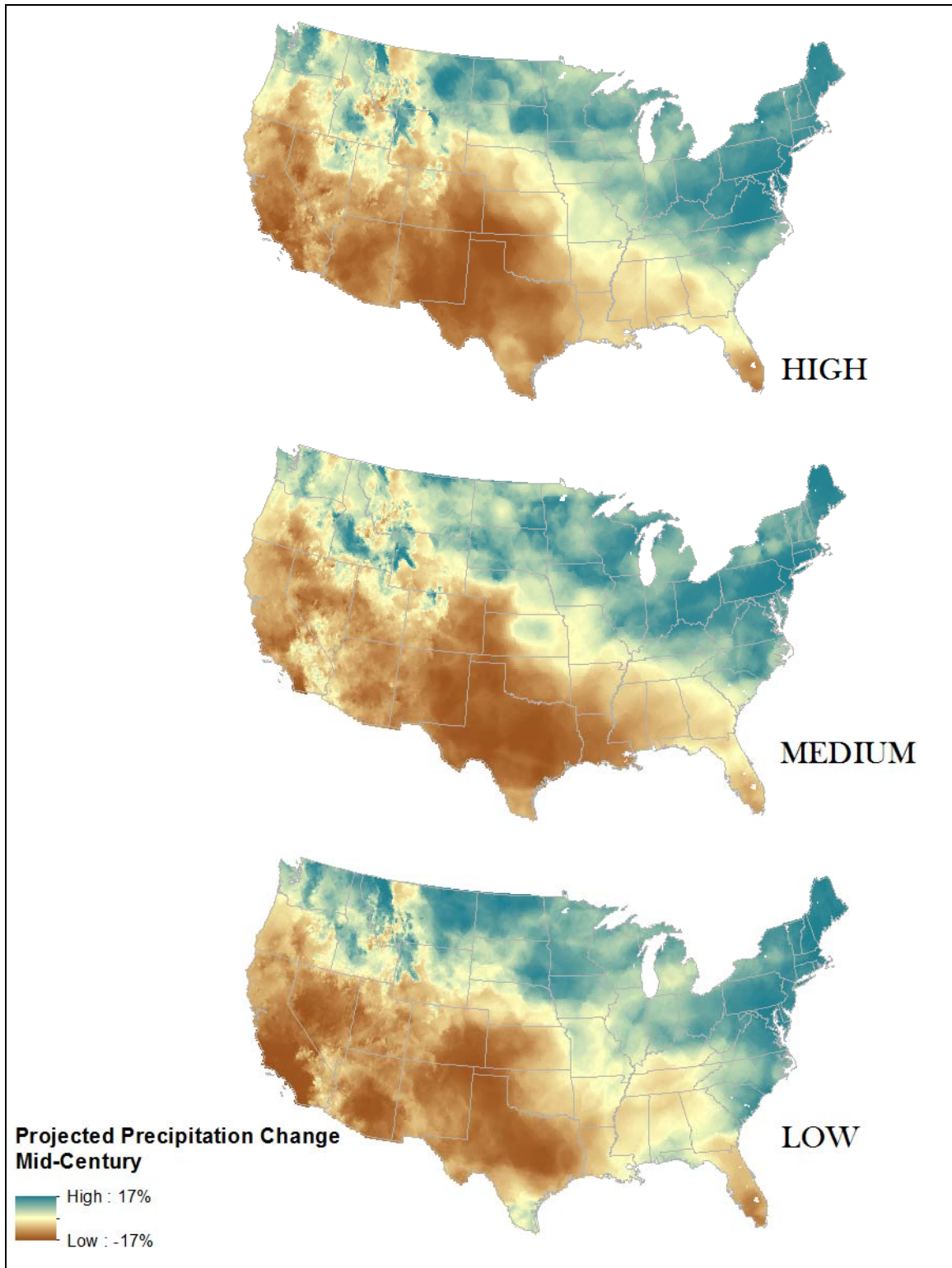
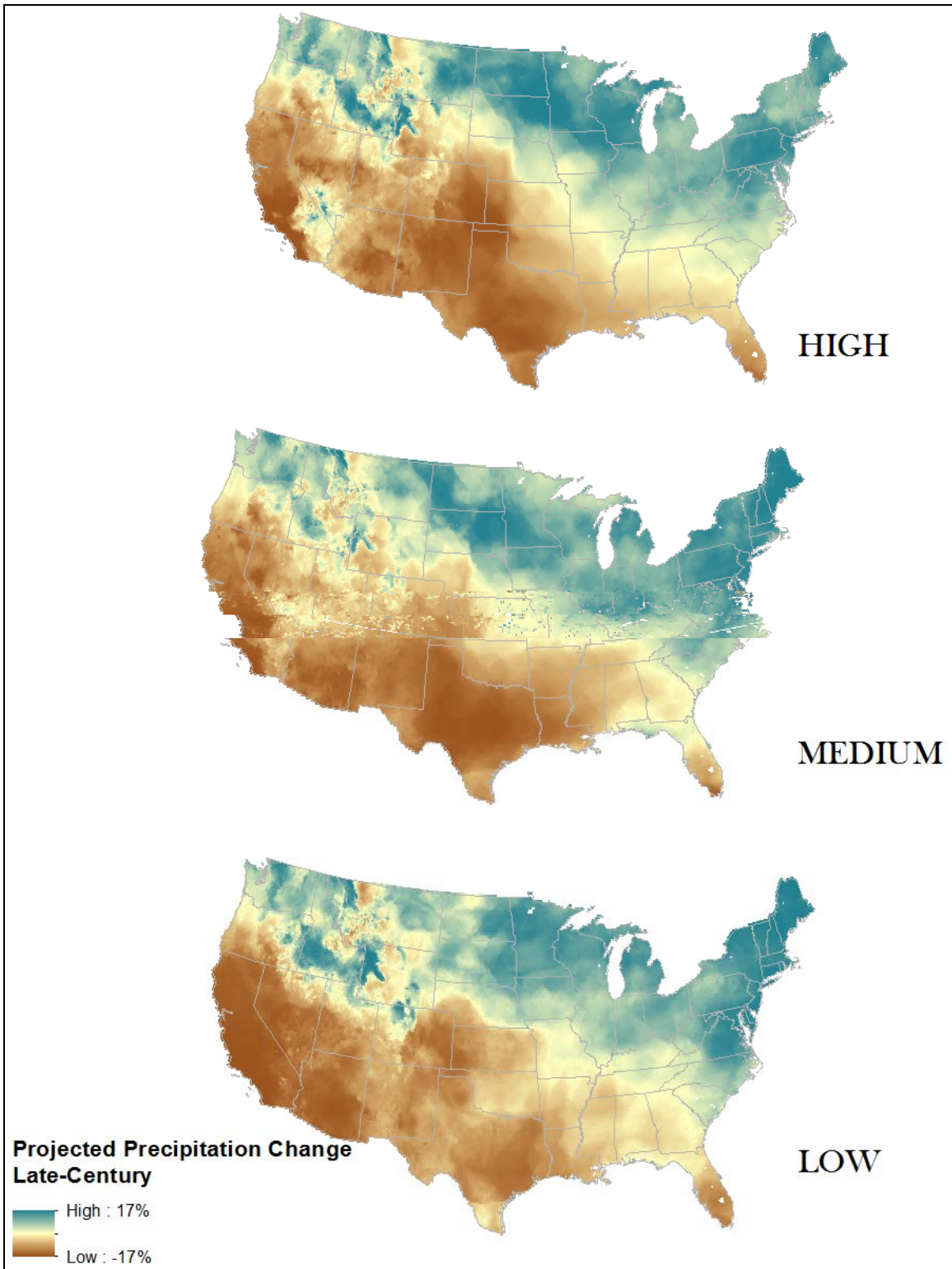


Figure 4. Range of Projected Late-Century Precipitation Changes for the Continental United States

Percentage change calculated using averages for the period 2070-2099, relative to the period 1971-2000



Overarching Federal Policy and Processes

In recent years, the executive branch has increased the federal government's planning efforts to adapt to projected impacts of a changing climate. Two recent cross-agency initiatives, the Climate Data Initiative and the Climate Resilience Fund (both discussed later), may support agencies' own efforts as well as the assistance they provide to the public and state and local governments.

For several decades, some agencies have invested in relatively small amounts of research to support adaptation to climate change.¹⁹ However, few if any agencies have comprehensively assessed how climate change may affect their abilities to achieve their authorized missions and abilities to safeguard their properties and personnel. Since 2009, Obama Administration initiatives have generally increased the priority, number of participants, and specificity of products and actions aimed at federal adaptation to climate change.

Executive Orders and High-Level Bodies

Executive Order (E.O.) 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, in October 2009,²⁰ directed agencies to begin a formal process of Strategic Sustainability Performance Planning that included steps to develop agency climate change adaptation plans. Section 8(i) of the executive order requires that each federal agency evaluate agency climate change risks and vulnerabilities to manage both the short- and long-term effects of climate change on the agency's mission and operations.

On November 1, 2013, President Obama strengthened existing directives with E.O. 13653, *Preparing the United States for the Impacts of Climate Change*.²¹ The executive order reshuffled and upgraded preceding organizational arrangements. Notably, it sunset and built on the work of the Interagency Climate Change Adaptation Task Force (CCATF), begun in 2009 (discussed later). In its place, E.O. 13653 established a higher-level coordinating Council on Climate Preparedness and Resilience (the Council), chaired by the White House and drawing on at least 33 White House offices and federal agencies, to be represented at the Deputy Secretary level. The Council's administration was provided by the Council on Environmental Quality (CEQ). The executive order also added, as a co-chair of the Council, the Assistant to the President for Homeland Security and Counterterrorism, apparently to improve coordination.

Among the mandates to the Council were preparation of an interagency inventory and assessment of changes to land- and water-related policies, programs, and regulations necessary to make watersheds, natural resources, and ecosystems—and the communities and economies that depend

¹⁹ For example, from the 1980s or earlier, USDA was researching potential impacts on forestry and food supply; the Department of Energy (DOE) began looking at impacts on heating and cooling demand; the Environmental Protection Agency (EPA) researched sea-level rise, water supply, and other topics; the National Oceanic and Atmospheric Administration (NOAA) examined potential impacts on fisheries and Great Lakes water supplies; among other efforts. The total research on impacts and adaptation has been a very small share of all research related to climate change.

²⁰ Executive Office of the President, *Executive Order 13514: Federal Leadership in Environmental, Energy, and Economic Performance*, October 5, 2009, 74 *Federal Register* 52117, <https://www.federalregister.gov/articles/2009/10/08/E9-24518/federal-leadership-in-environmental-energy-and-economic-performance>.

²¹ Executive Office of the President, *Executive Order 13653: Preparing the United States for the Impacts of Climate Change*, November 1, 2013, 78 *Federal Register* 66817, <https://www.federalregister.gov/articles/2013/11/06/2013-26785/preparing-the-united-states-for-the-impacts-of-climate-change>.

on them—more resilient to a changing climate.²² E.O. 13653 also required agencies to track their implementation of federal high-priority adaptation actions.

E.O. 13653 also created a State, Local, and Tribal Leaders Task Force on Climate Preparedness and Resilience composed of invited elected officials including 8 governors, 16 county and local officials, and 2 tribal leaders.²³ At its final meeting on July 16, 2014, the Task Force provided recommendations to the Council. In response, the Administration announced additional efforts to support nonfederal climate preparedness such as assistance to tribes²⁴ and investing in the rural electric system. (As these are outside the scope of this report, the announced initiatives are not discussed further here.)

In October 2014, the Council published “Priority Agenda: Enhancing the Climate Resilience of America’s Natural Resources.”²⁵ It reports the initial inventory, assessment, and plan called for in Section 3 of E.O. 13653, compiled by a Climate and Natural Resource Working Group (CNRWG) composed of the Departments of Defense, Interior, and Agriculture, EPA, NOAA, the Federal Emergency Management Agency (FEMA), and the U.S. Army Corps of Engineers (USACE or the Corps). The report, or “Agenda,” identifies four priority strategies to make U.S. natural resources more resilient to a changing climate:

1. foster climate-resilient lands and waters;
2. manage and enhance U.S. carbon sinks;
3. enhance community preparedness and resilience by utilizing and sustaining natural resources; and
4. modernize federal programs, investments, and delivery of services to build resilience and enhance sequestration of biological carbon.

Under the direction of the interagency Council on Climate Preparedness and Resilience, the CNRWG will track the implementation of this Priority Agenda in coordination with the existing efforts to implement the National Ocean Policy; the National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate; and the National Fish, Wildlife and Plants Climate Adaptation Strategy. In 2015, federal agencies will conduct a 12-month appraisal of implementation.

²² Section 3 of E.O. 13653 specifically directs the Departments of Defense, Interior, and Agriculture, EPA, NOAA, the Army Corps of Engineers (USACE or the Corps), and the Federal Emergency Management Agency (FEMA) to complete this inventory assessment of policies and regulations.

²³ For a listing of Task Force members, see White House, “FACT SHEET: Executive Order on Climate Preparedness,” November 1, 2013, <http://www.whitehouse.gov/the-press-office/2013/11/01/fact-sheet-executive-order-climate-preparedness>.

²⁴ <http://www.doi.gov/news/pressreleases/secretary-jewell-announces-new-tribal-climate-resilience-program.cfm>.

²⁵ Climate and Natural Resource Working Group (CNRWG), *Priority Agenda: Enhancing the Climate Resilience of America’s Natural Resources*, Washington, DC, Council on Climate Preparedness and Resilience, October 2014, http://www.whitehouse.gov/sites/default/files/docs/enhancing_climate_resilience_of_americas_natural_resources.pdf.

Executive Guidance to Agencies

Pursuant to E.O. 13514, a set of 2011 Implementing Instructions directed that

[t]hrough adaptation planning, each agency will identify aspects of climate change that are likely to impact the agency's ability to achieve its mission and sustain its operations and respond strategically. Adaptation planning will help an agency reduce the negative effects and take advantage of new opportunities that climate change may bring. Integration of climate change adaptation planning into the operations, policies, and programs of the Federal Government will ensure that resources are invested wisely and that Federal services and operations remain effective in current and future climate conditions.²⁶

Implementing Instructions relied on common planning steps identified by the CCATF for federal agencies:

- set a mandate to adapt with clear objectives and metrics;
- understand how climate is changing;
- apply understanding to assess implications for agency mission and operations;
- develop, prioritize, and implement actions;
- evaluate and learn; and
- build awareness and skills.²⁷

Presumably, the magnitudes of each of these steps are not equal. For example, much effort would be entailed in the step of development, prioritization, and implementation of actions.

The CCATF also offered two guiding principles for agencies' efforts to build federal resilience to a changing climate; agencies should ensure that

- “[f]ederal resources are invested wisely,” and
- the federal government's operations and services remain effective in a changing climate.²⁸

In many cases, government agencies were expected to seek efficient decisions, for example, by selecting options in which the benefits of adaptation to climate change would exceed the costs. In practice, formal cost-benefit analyses may be difficult to produce or have wide ranges of certainty.

The 2013 E.O. 13653 in some ways promoted “mainstreaming” of climate change efforts into existing processes and operations, rather than establishing adjunct offices and separate sets of activities. E.O. 13653 Section 2(c) charged a variety of interagency working groups with ensuring

²⁶ Council on Environmental Quality (CEQ), *Federal Agency Climate Change Adaptation Planning: Implementing Instructions*, March 11, 2011, http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_final_implementing_instructions_3_3.pdf.

²⁷ See Interagency Adaptation Planning Efforts at FedCenter.gov, https://www.fedcenter.gov/_kd/go.cfm?destination=Page&Pge_ID=3868.

²⁸ Interagency Climate Change Adaptation Task Force, “Federal Actions for Climate Resilient Nation: Progress Report of the Interagency Climate Change Adaptation Task Force,” October 28, 2011, p. 1.

that climate change risk considerations were incorporated into their processes. Those groups included the Steering Committee on Federal Infrastructure Permitting, the Task Force on Ports, the Interagency Working Group on Coordination of Domestic Energy Development and Permitting, and the Federal Interagency Working Group on Environmental Justice. Many observers would consider more mainstreaming a positive and important objective. Some instances of mainstreaming adaptation efforts in agencies are identified in a later section of this report.

On December 18, 2014, CEQ issued updated draft guidance for review and public comment on when and how federal agencies should consider the effects of GHG emissions and climate change in their evaluations of proposed federal actions under the National Environmental Policy Act (NEPA).²⁹ The draft guidance “counsels agencies to use the information developed during the [NEPA] review to consider alternatives that are more resilient to the effects of a changing climate....”³⁰ The draft guidance would apply to all proposed federal actions including site-specific actions, grants for or funding of small-scale or broad-scale activities, rulemakings, and land and resource management decisions. It does not cover actions over which agencies have no discretion or control, including actions carrying out congressional directions.³¹ To illustrate some ways in which climate changes may be relevant, the guidance provides the following description:

For example, a proposed action may require water from a stream that has diminishing quantities of available water because of decreased snow pack in the mountains, or add heat to a water body that is exposed to increasing atmospheric temperatures. Such considerations are squarely within the realm of NEPA, informing decisions on whether to proceed with and how to design the proposed action so as to minimize impacts on the environment, as well as informing possible adaptation measures to address these impacts, ultimately enabling the selection of smarter, more resilient actions.³²

The temporal bounds for considering climate change risks to a project under NEPA review would be determined by the life span of the proposed project, so that this guidance might be most relevant to long-lived projects including infrastructure that may have a useful life of several decades or more. The guidance, among other recommendations, suggests that agencies periodically engage their environmental justice experts, and potentially the Federal Interagency Working Group on Environmental Justice, to identify approaches to mitigate potential adverse effects on vulnerable communities including minority and low-income populations.

Interagency Coordination

Effective coordination across agencies and programs has been a concern expressed by some stakeholders. Overarching coordination occurs through the Council on Climate Preparedness and Resilience established by E.O. 13653, described above. The Council convened a Climate and Natural Resources Working Group (CNRWG), which published in October 2014 a “Priority Agenda: Enhancing the Climate Resilience of America’s Natural Resources,”³³ identifying federal and nongovernmental actions aimed at

²⁹ Council on Environmental Quality, *Draft published for public review and comment Dec. 2014*, available at http://www.whitehouse.gov/sites/default/files/docs/nepa_revised_draft_ghg_guidance.pdf.

³⁰ *Ibid.*, p. 4.

³¹ CRS has not researched to what degree adaptation to climate change has yet been considered under NEPA reviews.

³² *Ibid.*, p. 22.

³³ Council on Climate Preparedness and Resilience, *Priority Agenda: Enhancing the Climate Resilience of America’s* (continued...)

protecting important landscapes and developing new science, planning and tools to foster climate-resilient lands and waters; enhancing U.S. carbon sinks such as forests, grasslands, wetlands and coastal areas; promoting innovative 21st century infrastructure that integrates natural systems into community development, including green stormwater infrastructure; and modernizing Federal programs, investments, and services to build resilience and enhance carbon storage.

The Priority Agenda outlined further interagency monitoring and evaluation of these efforts:

Under the direction of the interagency Council on Climate Preparedness and Resilience, the CNRWG will track the implementation of this Priority Agenda in coordination with the existing efforts to implement the National Ocean Policy, the National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate, and the National Fish, Wildlife and Plants Climate Adaptation Strategy. In 2015, Federal agencies will conduct a 12 month appraisal of implementation.³⁴

There exist additional mechanisms for information sharing such as through FedCenter.gov and an Interagency Forum on Climate Change Impacts and Adaptations.³⁵ The latter appears to have limited participation. To facilitate agency adaptation planning, the Administration has supported cross-agency data exchange efforts such as the Climate Data Initiative, described below, and announcements to officials from FedCenter.gov, “the Federal government’s home for comprehensive environmental stewardship and compliance assistance information for Federal facility managers and their agencies.”³⁶

Within some departments such as the Department of the Interior, coordination among agencies appears to be strong and substantive. In others, coordination mechanisms among subagency programs are less evident, though they may operate effectively through informal practices rather than through formal bodies.

Mainstreaming Climate Change Considerations into Line Operations of Agencies

Overall, there have been growing efforts in many agencies to increase attention to potential climate changes and consideration of how future changes may affect their mainline missions and operations. This is often referred to as “mainstreaming.”

Numerous federal policies and programs exist that may reduce agencies’ vulnerabilities to climate change, but are not labeled as “adaptation” projects or do not have explicit mandates to support adaptation to climate change. Because they are not directly tied to climate change adaptation in mission or title, it may be difficult to identify them. For example, the requirement in E.O. 13514, “Federal Leadership in Environmental, Energy, and Economic Performance,” that agencies reduce their potable water intensity by 2% annually through FY2020, would likely improve

(...continued)

Natural Resources, Washington, DC, October 2014, http://www.whitehouse.gov/sites/default/files/docs/enhancing_climate_resilience_of_americas_natural_resources.pdf.

³⁴ Ibid., p. 6.

³⁵ <https://www.fedcenter.gov/programs/greenhouse/ccforum/>.

³⁶ FedCenter.gov.

agencies' resilience to climate-induced shortages, but are not expressly categorized as climate change adaptation programs. In some instances, programs closely related to adaptation might be more effectively employed rather than if agencies created separate climate change adaptation tasks.

The Climate Data Initiative

In March 2014, President Obama announced a new Climate Data Initiative, at <http://climate.data.gov>, to provide “resources to help companies, communities, and citizens understand and prepare for the impacts of coastal flooding and sea-level rise. Over time, this community will expand to include more datasets.”³⁷ The web portal provides access to federal climate change-related statistics and information. This portal may help alleviate some of the data accessibility issues that federal agencies identified (discussed later in this report). The data sets available at this portal may help agencies with their own climate vulnerability assessments and planning efforts, and may help to identify gaps and redundancies in the data available, as well as to evaluate the data's quality and relevance.

Synthesis of Agency Adaptation Plans and Example Actions

Almost 40 Federal Agencies Have Identified Adaptation Efforts

As of December 1, 2014, 38 federal departments and agencies had produced

- initial (2012) Climate Change Adaptation Plans and, in most cases, second-round (2014) Plans;³⁸
- vulnerability assessments;
- adaptation plans with milestones; and/or
- metrics to evaluate adaptation performance.

Few, if any, departments or agencies have prepared comprehensive, quantitative assessments of the vulnerabilities of their missions and programs to projected climate change.³⁹ DOD is perhaps the farthest along in assessing its vulnerabilities; Secretary Hagel stated in October 2014 that the department had nearly completed a baseline survey of its nearly 7,000 bases, installations, and other facilities that would be used to integrate climate change considerations into planning, operations, and training.⁴⁰ Most agencies' assessments have been at a “high level”—broad views with generalized information, though some have been preparing detailed assessments for locations that appear to have mission-critical vulnerabilities. Many agencies remain primarily in stages of “fact-finding,” initial analysis, and broad planning, and sometimes outreach and training for personnel.⁴¹

³⁷ <http://www.data.gov/climate/>.

³⁸ Available at <http://www.performance.gov/node/3406/view?view=public#supporting-info>.

³⁹ Environmental Protection Agency, *Climate Change Adaptation Plan (draft)*, Washington, DC, June 2012, p. 7.

⁴⁰ Department of Defense, “Military Must Be Ready for Climate Change, Hagel Says,” *DoD News*, October 13, 2014, <http://www.defense.gov/news/newsarticle.aspx?id=123399>.

⁴¹ Bierbaum, Rosina, Joel B. Smith, Arthur Lee, Maria Blair, Lynne Carter, F. Stuart Chapin III, Paul Fleming et al., “A (continued...)”

Some agencies appeared in late 2014 to be in early stages; they appear to have done little thus far to assess the potential risks of climate change specifically to their property, operations, or personnel, though they may conduct scientific research or produce data or decision-making tools to serve their customers (e.g., the public, state and local agencies, etc.). For example, the Departments of Energy and Health and Human Services (HHS), and the Tennessee Valley Authority (TVA), among others, released climate change adaptation plans dated in 2014 that do not contain evidence of having conducted the vulnerability assessments or adaptation planning required by Section 5, “Federal Agency Planning for Climate Change Related Risk,” of E.O. 13653. Their “plans” may contain many pages of descriptions in general terms of potential climate change impacts, but do not evidence the location- and event-specific analysis displayed by many other agencies. In some cases, it is also apparent that little updating occurred in the 2014 releases of planned actions identified in the 2012 documents. Acknowledgements of the modicum of current information on adaptation planning in these agencies, and explanations of the reasons (e.g., other pressing priorities, greater priority to serving the agencies’ customers, lack of financial or expert resources, etc.) might be more useful to Congress and other readers than the generalized and outdated presentations provided.

CRS found few specific adaptation actions, either planned or taken, that tangibly alter federal vulnerabilities at this point in time. Certainly, selected actions resulting in risk reductions are apparent in some agencies. Some may provide significant risk reductions over time. This seems especially likely where agencies have identified mission-critical infrastructure that may be vulnerable to certain aspects of climate change, or secondary effects that may result from, say, outages or overload of electricity supply during extreme events. These examples appear to represent the leading edge rather than the norm. The challenge in identifying on-the-ground adaptation actions may reflect the high level of aggregation of most agency-level reporting. It is likely that some federal programs are acting to reduce their vulnerabilities to climate in ways that may not be captured in agency-level planning processes. Also, some agencies have begun pilot activities that, pending positive evaluations, may be propagated more broadly for risk reductions.

Agencies Are Adopting Common Approaches

CRS found that federal agencies are largely using a set of common approaches in their climate change adaptation efforts. These include the following:

- researching, assessing, and planning (which are the main focus and deliverables of current relevant executive orders);
- implementing initial actions that are obvious, easy, and offer low- to no-regret⁴² options;
- developing general options and “decision tools” transferable to other situations;

(...continued)

Comprehensive Review of Climate Adaptation in the United States: More than Before, but Less than Needed,” *Mitigation and Adaptation Strategies for Global Change* 18, no. 3, March 1, 2013, pp. 361-406, doi:10.1007/s11027-012-9423-1. See also Archie, Kelli M., Lisa Dilling, Jana B. Milford, and Fred C. Pampel, “Climate Change and Western Public Lands: A Survey of U.S. Federal Land Managers on the Status of Adaptation Efforts,” *Ecology and Society* 17, no. 4, 2012, doi:10.5751/ES-05187-170420.

⁴² “No regrets” is a term used to describe actions that may be carried out with no or very low cost, or that provide ancillary benefits, so they would have little adverse impact even if they do not provide expected primary results.

- demonstrating response measures or pilot programs that, if successful, could be disseminated within an agency or by partner organizations; and
- arranging outreach and training to federal personnel and contractors.

Some Agencies Are Mainstreaming Consideration of Climate Change Risks

Climate change has long been addressed adjunct to the line missions of agencies. That is, in most agencies, climate change has been researched and analyzed in specialized staff offices that were not generally integral to the mission-oriented “line” operations of the agency. As federal efforts to prepare for climate change have expanded, some observers expressed concerns that adaptation efforts might evolve as parallel, side-lined, or redundant efforts, rather than integrated into agency operations. The November 2013 E.O. 13653 encouraged agencies to “mainstream” consideration of future climate changes into their line operations.

CRS found that some agencies have moved beyond general awareness-building and broad policy statements, and some have transitioned from stand-alone climate change teams and efforts (producing primarily reports) toward “mainstreaming” climate change data and considerations into programmatic decisions and actions. An official from DOD voiced this approach as follows: “... [T]he crux of this report is, rather than creating a stovepipe within the DOD organizational structure to deal with climate change, we are going to integrate climate change considerations into the normal processes, the day-to-day jobs of everybody.”⁴³

A few active examples include the following:

- The Northwoods Climate Change Response Framework of the U.S. Forest Service in northern Wisconsin. It encompasses a team of land management agencies, private forest owners, conservation organizations, and others to share information and experience, develop tools to factor climate change into decision making, and implement those new tools.⁴⁴
- The Exotic Plant Management Teams of the National Park Service (NPS) identify, control, and manage plant species that are new to, and may have substantial impacts on, park resources. Such efforts may help protect parks from invasive species whose ranges shift because of climate change, although the teams’ mandate is broader than, and not formally part of, NPS’s climate adaptation framework.⁴⁵
- A 2012 National Aeronautics and Space Administration (NASA) Facilities Design Guide incorporated climate change-related principles that “could be used by NASA facilities project managers when determining design requirements and writing statements of work, and by Architect-Engineer firms who might have

⁴³ John Conger, Acting Deputy Undersecretary of Defense for Installations and Environment, as quoted by DOD, “DOD Wraps Climate Change Response into Master Plans,” *DoD News*, November 26, 2013, <http://www.defense.gov/news/newsarticle.aspx?id=121237>.

⁴⁴ U.S. Forest Service, Northern Institute of Applied Climate Science, *Northwoods Climate Change Response Framework*, <http://www.nrs.fs.fed.us/niacs/climate/northwoods/>.

⁴⁵ For more on the National Park Service’s (NPS’s) Exotic Plant Management Teams, see http://www.nature.nps.gov/biology/invasivespecies/EPMT_teams.cfm.

limited experience working with NASA.”⁴⁶ This guidance is limited to principles and references to requirements and standards, and is a step toward considering what design modifications might be merited in a particular project.

- The Army Corps of Engineers (USACE or the Corps) has launched the Comprehensive Evaluation of Projects with Respect to Sea Level Change (SLC) (CESL) to screen and provide an initial assessment of the vulnerability of its coastal projects to sea-level change in the 50- and 100-year planning horizons.⁴⁷ It is a web-based tool that allows users to enter data, view project information, view SLC curves for tidal gauges at or near project sites, view Extreme Water Level information, and view projects on a map interface.
- DOD has identified the Hampton Roads, VA, region, which houses the largest concentration of U.S. military sites in the world, as experiencing recurrent flooding today. The department has begun to address a projected sea-level rise there of 1.5 feet over the next 20 to 50 years.⁴⁸

Maintaining Hydropower Efficiency and Flexibility: Hoover Dam Example

Extended drought conditions over the last decade have decreased levels at Lake Mead behind Hoover Dam on the Colorado River, operated by the Department of the Interior (DOI) Bureau of Reclamation. The low water levels reduced electricity generation and increased turbine operations in zones of high wear and tear (i.e., rough zones). The Bureau of Reclamation currently is investing in “wide head turbine runners,” increasing the generating units’ ability to operate efficiently and generate power over a wider range of lake levels. The first wide-range turbine at Hoover Dam became operational in June 2012, and future additional installations are planned through FY2015.

These investments illustrate how modifications to existing facilities can improve the flexibility and efficiency of operations of multipurpose infrastructure under different water management conditions, including potentially future drier conditions. The challenges to western states’ water resources infrastructure management are shaped not only by climate conditions, but also by land use, agricultural activities, municipal and industrial demands, and species protections. Since its creation in 1902, the Bureau of Reclamation has attempted to harness the intermittent precipitation in the West for socially and economically productive uses. The region’s precipitation patterns have been at the heart of its mission and its challenges since the agency’s inception.

Congress, in Section 9505 of P.L. 111-11, required the Secretary of Energy to assess the vulnerability of federal hydroelectric power production to water supply risks posed by global climate change. This assessment, along with ongoing efforts by the Bureau of Reclamation (e.g., its follow-up to a December 2012 Colorado River Supply and Demand Study) and other federal hydropower operators, may help to identify federal hydropower facilities at risk from climate variability and change.

While CRS identified these examples, CRS was not able to identify widespread changes in federal decision making, management, or operations associated with adaptation to projected climate change. A recent academic survey of four federal land management agencies concluded that “These adaptation efforts within agencies, however, all represent initiatives promulgated at the headquarters level. Ultimately, to be considered effective, these policies must result in

⁴⁶ National Aeronautics and Space Administration (NASA), Facilities Engineering Division, *NASA Facilities Design Guide*, August 2012, http://www.hq.nasa.gov/office/codej/codejx/Assets/Docs/NASA_Facilities_Design_Guide_Final_Submittal_-_8_8_124.pdf.

⁴⁷ Army Corps of Engineers, “Climate Change Adaptation—Comprehensive Evaluation of Projects with Respect to Sea-Level Change,” web page at <http://www.corpsclimate.us/ccacesl.cfm>.

⁴⁸ Department of Defense, *FY 2014 Climate Change Adaptation Roadmap*, October 13, 2014, in “Foreword,” <http://www.acq.osd.mil/ie/download/CCARprint.pdf>.

changes to decision making practices ‘on the ground’ by agency resource managers connected with the resource in question.”⁴⁹

Many Agencies Have Identified Climate Change Risks to Their Operations

To date, many agencies have invested the majority of their efforts in understanding their vulnerabilities to, or benefits from, climate change. Agency officials and observers have identified a number of ways in which climate shifts may affect agencies’ operations and assets, including the following examples:

- Arctic sea ice melting allows increased activity in the Far North, prompting the U.S. Coast Guard and DOD to increase attention to an evolving Arctic Strategy for safety, security, resource development, and environmental protection.⁵⁰
- DOD, in its *FY 2014 Climate Change Adaptation Roadmap*, concluded that “A changing climate will have real impacts on our military and the way it executes its missions. The military could be called upon more often to support civil authorities, and provide humanitarian assistance and disaster relief in the face of more frequent and more intense natural disasters. Our coastal installations are vulnerable to rising sea levels and increased flooding, while droughts, wildfires, and more extreme temperatures could threaten many of our training activities. Our supply chains could be impacted, and we will need to ensure our critical equipment works under more extreme weather conditions. Weather has always affected military operations, and as the climate changes, the way we execute operations may be altered or constrained.”⁵¹ The report further noted that climate change-related effects have been observed at DOD facilities.
- “The Department of Agriculture estimates an increase of as much as 100 percent in the number of acres burned by wildfires annually by 2050, putting residents and firefighting employees at greater risk, further impacting the agency’s budget and resources, and reducing its capacity to provide other critical services. Fire suppression funding has already grown from 16 percent in 1995 to 42 percent of the U.S. Forest Service’s budget.”⁵²
- USDA’s Farm Service Agency (FSA) is evaluating whether its commodity crop programs encourage adaptation to a changing climate or the status quo.⁵³
- Many NASA facilities have been damaged or closed temporarily in recent years by tornadoes, hurricanes, flooding, and wildfires. An agency-wide assessment

⁴⁹ Archie, Kelli M., Lisa Dilling, Jana B. Milford, and Fred C. Pampel, “Climate Change and Western Public Lands: A Survey of U.S. Federal Land Managers on the Status of Adaptation Efforts,” *Ecology and Society* 17, no. 4, 2012, doi:10.5751/ES-05187-170420.

⁵⁰ White House, *National Strategy for the Arctic Region*, May 2013, http://www.whitehouse.gov/sites/default/files/docs/nat_arctic_strategy.pdf.

⁵¹ DOD, *FY 2014 Climate Change Adaptation Roadmap*, October 13, 2014, <http://www.acq.osd.mil/ie/download/CCARprint.pdf>.

⁵² CEQ, “Obama Administration Releases Federal Agency Climate Plans on Fifth Anniversary of Presidential Sustainability Initiative,” the White House, October 31, 2014, http://www.whitehouse.gov/administration/eop/ceq/Press_Releases/_October_31_2014.

⁵³ Farm Service Agency (FSA), *USDA Farm Service Agency: Climate Change Adaptation Strategy*, USDA, February 2013, p. 39.

noted that more than two-thirds of its infrastructure property value—assets worth about \$20 billion—are within 16 vertical feet of current sea level and at risk from sea-level rise (see **Figure 5**) alone.⁵⁴ The assessment found that “changing climate will impact facility operations (e.g., water management, energy demands), natural resources (e.g., tidal marsh habitat and increase in invasive species, increase in pest species), infrastructure that is vital to mission success (e.g., flooded buildings and launch assets, buildings too hot to work in), quality of life in the community (e.g., increased number of hot days), and the region’s economy (e.g., increased percentage of public funds for utility costs, firefighting, and flood control).”⁵⁵ NASA identified climate-related vulnerabilities to its missions including launch capabilities, space operations, ground systems, and training and test facilities. NASA is pursuing detailed analysis and planning at a minimum of eight facilities.⁵⁶

- NPS found that “The widespread nature of climate change effects amplifies ongoing resource impacts such as habitat fragmentation, water scarcity, pollution, invasive species, etc.” It plans to “mainstream” climate change adaptation at a policy level; it is proposing that its fundamental mission of preserving lands in their historical condition may need to be rethought in an era of shifting climates and habitats.⁵⁷ NPS is also analyzing specific park and facility issues associated with climate change.
- EPA plans to examine how climate change may put at risk more contaminant releases due to severe weather, flooding, or sea-level rise at Corrective Action sites, Superfund sites, Brownfield sites, chemical storage facilities, or landfills. Saltwater intrusion and increased ground water salinity in coastal aquifers may also increase the permeability of clay liners installed at waste sites such as landfills, allowing contaminants to spread to nearby properties. Contaminant releases may increase the risk of adverse health and environmental impacts.⁵⁸

The **Text Box** above describes an action at Hoover Dam that could help improve an agency’s resilience to a changing climate, though it is not an adaptation to projected climate change per se. The likelihood of complementary benefits of actions that improve the resilience of agencies to climate changes and that provide other benefits may make it difficult to discern and evaluate, now

⁵⁴ National Aeronautics and Space Administration, *NASA Climate Risk Management Plan and Report*, 2012. See also Dominguez, Olga, and Deborah Feng, “Risk to Resilience: NASA’s Framework for Addressing Climate Change Impacts & Adaptation,” presented at the Resilience and Adaptation to Climate Change Risks Symposium, Ames Research Center, 2011, <http://environment.arc.nasa.gov/symposium2011/symposium/OlgaDominguez-symposium-1.pdf>.

⁵⁵ National Aeronautics and Space Administration, Facilities Engineering Division, *NASA Facilities Design Guide*, August 2012, http://www.hq.nasa.gov/office/codej/codejx/Assets/Docs/NASA_Facilities_Design_Guide_Final_Submittal_-_8_8_124.pdf.

⁵⁶ National Aeronautics and Space Administration, Facilities Engineering Division, op. cit.

⁵⁷ National Park Service, *Climate Change Response Program Adaptation Brief*, U.S. Department of the Interior (DOI), <http://www.nps.gov/subjects/climatechange/upload/AdaptationBriefv-4.pdf>; National Park System Advisory Board, *Revisiting Leopold: Resource Stewardship in the National Parks*, August 25, 2012, at http://www.nps.gov/calltoaction/PDF/LeopoldReport_2012.pdf.

⁵⁸ Office of Solid Waste and Emergency Response, *Climate Change Adaptation Implementation Plan—Draft*, Environmental Protection Agency, June 2013, <http://epa.gov/climatechange/Downloads/impacts-adaptation/office-of-solid-waste-and-emergency-response-plan.pdf>.

and in the future, the degree to which agencies are making adaptations and what effect they may have.

Figure 5. NASA's Wallops Island Facilities Near Current Sea Level



Source: NASA, from Dominguez, Olga, and Deborah Feng, "Risk to Resilience: NASA's Framework for Addressing Climate Change Impacts & Adaptation," presented at the Resilience and Adaptation to Climate Change Risks Symposium, Ames Research Center, 2011.

Most agencies and multiagency consortia are regionalizing their approaches to climate change adaptation. This facilitates their assessments according to physically linked locations. Looking more broadly, this is also a complicating factor as definitions of regions often differ across programs and agencies. They often are not consistent with the eight geographic regions used under the United States Global Change Research Program (USGCRP) and the nine plus Alaska and Hawaii used by the National Climatic Data Center (NCDC) for science and climate monitoring purposes. (See **Figure 6.**)

- DOI uses Landscape Conservation Cooperatives (LCCs) and Climate Science Centers (CSCs) as geographic coordinating units.
- The Bureau of Land Management (BLM) further uses regions for Rapid Ecological Assessments (REAs) to support vulnerability and adaptation assessments.

- NOAA relies on centers of Regional Integrated Science and Assessments (RISAs), in addition to NCDC's regions.
- EPA uses the USGCRP regions and adds a "Montane" region in the Intermountain West, though these do not correspond with EPA's organizational Regional Offices.

The different definitions of regions present a challenge within and across agencies, as well as to stakeholders, in accessing relevant information and understanding climate change impacts and related programs.

Figure 6 illustrates some of the major federal regional schemes used by various agencies, and also overlays state and congressional district boundaries. The different regional schemes are tied to the agencies' varying missions and resources; however practical, the differences also pose challenges for sharing and interpreting information across agencies and with the public. (This is discussed later in this report.) (A URL below **Figure 6** provides access to an interactive PDF version of this map that allows the user to turn on and off map layers to facilitate viewing and comparing of different boundary definitions.)

In sum, most agencies have planning efforts under way to identify the vulnerabilities and opportunities of their missions, assets, and personnel to climate change. Much of the current adaptation planning appears confined to information gathering and analysis at a high level. A number of agencies focus almost exclusively on how they may help their clients (e.g., states, businesses, specific populations, etc.) understand risks and understand adaptation planning, but have done little to understand the vulnerabilities or opportunities to the federal agency itself. Among those agencies that have begun implementation, measures to adapt appear mostly as pilot or demonstration efforts. A number of agencies acknowledge that they have not moved substantially into implementing adaptation actions.⁵⁹ A few federal entities, including DOD, EPA,⁶⁰ NASA,⁶¹ and the Department of Transportation (DOT),⁶² appear to be among the more advanced in preparing their assets, programs, and operations for climate change. (Other agencies may have focused their attention primarily on assisting their clients to anticipate and prepare for climate change.)

⁵⁹ For example, the Department of Health and Human Services' (HHS's) 2013 sustainability performance plan states that "While HHS has made significant progress since 2010, the Department recognizes a gap between the conceptualization of its Sustainability and Climate Adaptation Plans and the actual implementation of those plans within health and human service programs." HHS is not alone at this stage.

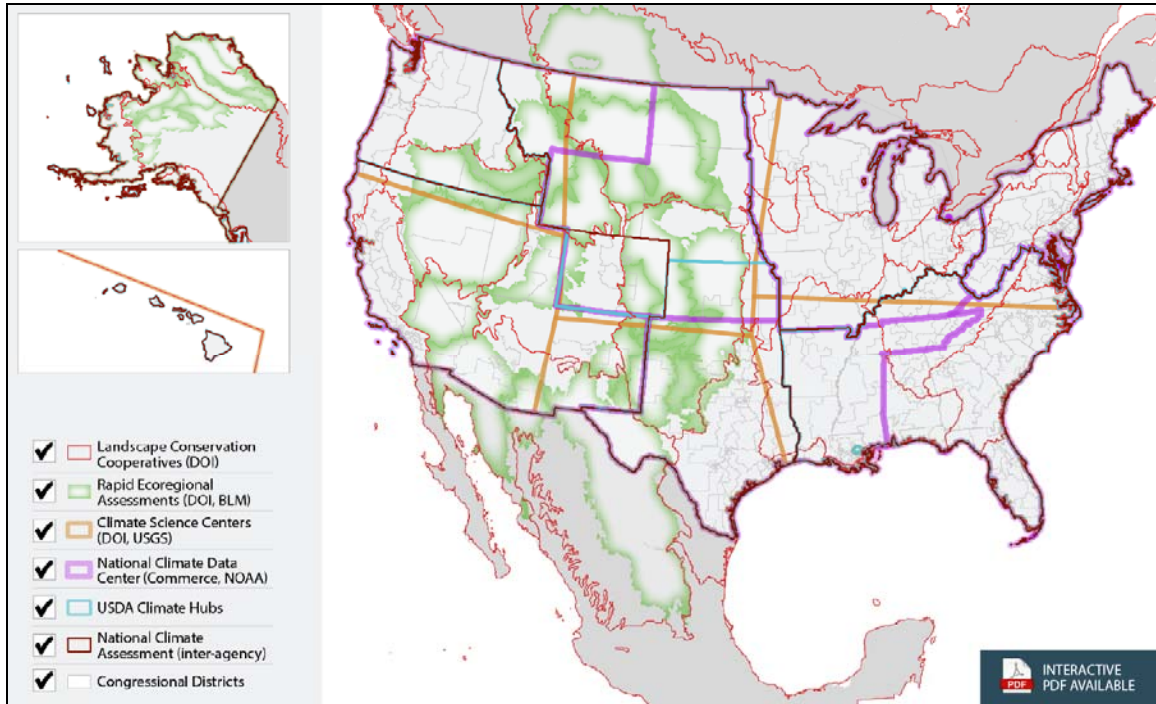
⁶⁰ EPA has, office by office, released Climate Change Adaptation Implementation Plans for public review and comment, at <http://epa.gov/climatechange/impacts-adaptation/fed-programs/EPA-impl-plans.html>. These draft plans identify specific vulnerabilities in each program, as well as actions that the offices propose to take to reduce agency vulnerabilities. For example, the Office of Chemical Safety and Pollution Prevention noted that potentially toxic chemicals may be stored in low-lying areas and could be at risk of release in the event of major weather events or flooding; the office may need to investigate the locations of such chemical facilities and evaluate this uncertain risk.

⁶¹ National Aeronautics and Space Administration, *NASA Climate Risk Management Plan and Report*, op. cit.

⁶² Department of Transportation, "DOT Transportation and Climate Change Clearinghouse," accessed March 24, 2014, <http://climate.dot.gov/impacts-adaptations/planning.html>. DOT's Federal Highway Administration (FHWA) has as part of its adaptation efforts supported nonfederal "climate resilience pilots" in 16 states. For more on FHWA's climate adaptation efforts, see https://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/summary/index.cfm. Its recent efforts have been research to analyze adaptation options to increase resiliency (e.g., enlarging culverts, raising bridges, using more heat-resistant materials) and the integration of climate resilience into FHWA programs (e.g., updated engineering circulars). Its next steps are aimed at developing tools and information for states to assess their vulnerabilities.

Figure 6. Federal Agencies Use Different Regional Definitions for Climate Adaptation Work

Selected federal regional schemes shown relative to state and congressional district boundaries



Interactive Version of Map: An interactive PDF version of this map is available at <http://www.crs.gov/products/map/pdf/MAPI0000.pdf>. In the PDF version, the viewer may clear all boundaries by clicking the “CLEAR ALL” icon, or may turn on and off individual “layers” by clicking the checkboxes in the legend.

Sources: CRS map from geographic information provided by various federal agencies. National Climate Assessment regions defined at <http://www.globalchange.gov>; National Climate Data Center’s (NCDC’s) U.S. Climate Regions are defined at <http://www.ncdc.noaa.gov/monitoring-references/maps/us-climate-regions.php>; Department of the Interior’s (DOI’s) Regional Climate Science Centers are defined at <http://www.doi.gov/csc/index.cfm>; the Landscape Conservation Cooperative’s regions are at <http://lccnetwork.org/Find>.

Agencies Have Identified Some Specific Benefits of Adaptation

A number of agency action plans have identified some of the benefits that could arise from planning for climate change adaptation. Examples include the following:

- identifying actions that have no cost or would have net benefits regardless of the magnitude of future climate change impacts (e.g., EPA/OPPTS, identifying where toxic chemicals are stored in existing flood zones);
- limiting federal financial liability for disaster losses and encouraging efficient risk management by private decision makers (e.g., increasing community preparedness for extreme weather events);
- modifying infrastructure specifications or considering locations for new facilities to be compatible with uncertain future climate conditions (e.g., NASA’s review and re-specification of building requirements);

- making assets and operations robust to potential disruptions of water or energy supplies (e.g., making arrangements for national laboratories to maintain essential operations when water supplies become extremely low);
- facilitating more rapid and efficient responses to acute weather events where and when they occur; and
- identifying potential emerging opportunities with climate change such as increasing accessibility of Arctic resources or lengthening growing seasons in some locations.

Most of these benefits are abstract, as relatively few adaptation activities have yet been carried out. Evaluations may be planned to develop empirical, and possibly quantitative, information about the effectiveness, costs, and benefits of various adaptation measures.

Agencies Face Adaptation Challenges

Most reports on climate change adaptation identify “barriers” to effective adaptation. For example, a 2009 GAO review of the status of federal adaptation efforts concluded the following:

The challenges faced by federal, state, and local officials in their efforts to adapt fell into three categories, based on our analysis of questionnaire results, site visits, and available studies. First, available attention and resources are focused on more immediate needs, making it difficult for adaptation efforts to compete for limited funds. Second, insufficient site-specific data, such as local projections of expected changes, makes it hard to predict the impacts of climate change, and thus hard for officials to justify the current costs of adaptation efforts for potentially less certain future benefits. Third, adaptation efforts are constrained by a lack of clear roles and responsibilities among federal, state, and local agencies.⁶³

Evidently, the attention to vulnerabilities and adaptation at the White House level has resulted in a great deal of effort at communication and report-writing in most agencies. Beyond reports, there remain challenges of sharing useful information, making programmatic decisions, and carrying out first-priority measures that reduce agency vulnerabilities. Three of the most frequently cited challenges are funding, information management and use, and uncertainty. Each is discussed below.

Funding

Adaptation competes with other agency priorities and missions. Recent reports have cited “lack of funding” as a primary challenge to adaptation.⁶⁴ Resources for fact-finding, assessment, and

⁶³ Government Accountability Office, *Climate Change Adaptation: Strategic Federal Planning Could Help Government Officials Make More Informed Decisions*, Washington, DC, October 7, 2009, p. 31. See also Bierbaum, Rosina, Joel B. Smith, Arthur Lee, Maria Blair, Lynne Carter, F. Stuart Chapin III, Paul Fleming et al., “A Comprehensive Review of Climate Adaptation in the United States: More than Before, but Less than Needed,” *Mitigation and Adaptation Strategies for Global Change* 18, no. 3, March 1, 2013, pp. 361-406, doi:10.1007/s11027-012-9423-1.

⁶⁴ See, for example, Archie, op cit.; Bierbaum, op. cit.; Federal Highway Administration, “Assessment of the Body of Knowledge on Incorporating Climate Change Adaptation Measures into Transportation Projects—Overcoming Barriers,” web page, January 14, 2014, http://www.fhwa.dot.gov/environment/climate_change/adaptation/resources_and_publications/transportation_projects/page06.cfm; GAO, *Climate Change: Federal Efforts Under Way to* (continued...)

decision-making resources may be most readily identifiable. In contrast, adaptations may take place as actions incremental to and obscured within existing program efforts. For example, adaptation plans may call for updating climate data in decision models or operational plans, or may require changing the types of materials or locations for infrastructure projects. The costs of such adaptation efforts may be difficult to estimate or identify in agency budget requests. Only a few agencies specifically requested appropriations in the FY2016 or earlier budget requests for adaptation activities.⁶⁵ Current budget constraints and federal budget scrutiny may not permit greater financial resources for federal adaptation actions.

While the President's FY2016 budget request and other recent announcements (e.g., executive order on flooding and proposed FEMA rules) may mention adaptation (or "resilience") to climate change, most pertain to programs outside the narrow scope of this report: assessments and actions that agencies may be undertaking to address *potential risks to their missions, property, operations, and personnel*. For further detail or updates on climate change adaptation plans by individual agencies, the report provides contact information for CRS analysts at the end of each agency section in Part II.

Information Management and Use

Multiple federal agencies, as well as nonfederal entities, readily acknowledge that finding and accessing the climate and related data they need—and having the right skill sets to use those data—remain important obstacles to preparing for climate change. For example, federal officials often lack information applicable to their particular agencies, programs, or localities, especially regarding climate data (recent and projected). Agencies identified challenges in acquiring information on projections of demographic, economic, technological, and other factors that might influence choices among options. For example, a number of agencies identified lack of information on facilities and other built infrastructure (e.g., dams, roadways, railways, etc.) as a key need to further develop their adaptation plans under E.O. 13514 and E.O.13653.⁶⁶

Acquiring information to inform adaptation decisions is not solely a lack of precise information, but also its disarray or difficulty to use from a user's perspective.⁶⁷ In response, the Obama Administration initiated an Internet portal (<http://www.data.gov/climate/>) intended to provide eventually a one-stop shop for climate-related data and tools. The website provides data sets, mapping tools, and "challenges" to nonfederal entities to help address specific problems by

(...continued)

Assess Water Infrastructure Vulnerabilities and Address Adaptation Challenges, Washington, DC, December 13, 2013.

⁶⁵ CRS Report R43227, *Federal Climate Change Funding from FY2008 to FY2014*, by Jane A. Leggett, Richard K. Lattanzio, and Emily Bruner.

⁶⁶ Seyller, Emily A., "Overview of Research and Information Needs from the 2012 Agency Adaptation Plans," presented at the 2013 White House Council on Environmental Quality GreenGov Workshop on Climate Science and Adaptation, August 2, 2013.

⁶⁷ See example studies: Kirchhoff, Christine J., Maria Carmen Lemos, and Suraje Dessai, "Actionable Knowledge for Environmental Decision Making: Broadening the Usability of Climate Science," *Annual Review of Environment and Resources* 38, no. 1, 2013, pp. 393-414; McNie, Elizabeth C., "Delivering Climate Services: Organizational Strategies and Approaches for Producing Useful Climate-Science Information," *Weather, Climate, and Society* 5, no. 1, January 2013, pp. 14-26, doi:10.1175/WCAS-D-11-00034.1; Lackstrom, Kirsten, Nathan P. Kettle, Benjamin Haywood, and Kirstin Dow, "Climate-sensitive Decisions and Time Frames: a Cross-sectoral Analysis of Information Pathways in the Carolinas," *Weather, Climate, and Society*, November 11, 2013.

developing applications (i.e., apps) or other solutions. Its initial phases incorporated agency information related to coastal flooding, resilience of food supply, and ecosystems.

Some agencies are also tackling this access problem. The U.S. Geological Survey (USGS), for example, sees among its functions the responsibility to provide climate change information to other agencies within DOI (and to nonfederal entities) to assist them in adaptation assessment. It, along with DOD, DHS, and the National Geospatial Intelligence Agency, provides data sets containing mapping information on infrastructure and geographical features that can assist federal and nonfederal organizations with climate preparedness.⁶⁸

There are several data portals in various agencies with climate-related data, and the location and distinctions among them may not be clear to most potential users. President Obama, in June 2013 and again in March 2014, announced a “climate data initiative” to make relevant data more easily accessible (discussed earlier).⁶⁹ One effort to make climate projections more easily available is a publicly available archive of high-resolution (“downscaled”) results from the latest phase of global climate modeling (CMIP5).⁷⁰ Another is the USGCRP’s MATCH portal, a Metadata Access Tool for Climate and Health, which offers centralized access to thousands of government-held data sets related to health, the environment, and climate science.⁷¹

The ability of organizations to take advantage of climate change-related information is also critical. A number of reports suggest that improving in-house expertise to use such information may be important, as well as institutional flexibility to adapt to new information.⁷²

Uncertainty

Planning and decision making in the face of uncertainty are a challenge in many fields. For adaptation action, the wide range of uncertainty in global climate projections increases over time, and increases as regional and local trends and impacts are protected.⁷³ Uncertainties also are

⁶⁸ Data.gov (<https://www.data.gov/climate/>).

⁶⁹ Executive Office of the President, “The President’s Climate Action Plan,” June 2013; White House, “FACT SHEET: The President’s Climate Data Initiative: Empowering America’s Communities to Prepare for the Effects of Climate Change,” March 19, 2014, <http://www.whitehouse.gov/the-press-office/2014/03/19/fact-sheet-president-s-climate-data-initiative-empowering-america-s-comm>.

⁷⁰ Maurer, E.P., L. Brekke, T. Pruitt, B. Thrasher, J. Long, P. Duffy, M. Dettinger, D. Cayan, and J. Arnold, “An Enhanced Archive Facilitating Climate Impacts and Adaptation Analysis,” *Bulletin of the American Meteorological Society*, November 18, 2013. The archive is available through Lawrence Livermore National Laboratory: http://gdo-dcp.ucllnl.org/downscaled_cmip_projections.

⁷¹ <http://match.globalchange.gov/geoportal/catalog/main/home.page>.

⁷² See, for example, Bolson, Jessica, and Kenneth Broad, “Early Adoption of Climate Information: Lessons Learned from South Florida Water Resource Management,” *Weather, Climate, and Society* 5, no. 3, July 2013, pp. 266-281, doi:10.1175/WCAS-D-12-00002.1. The experience of the South Florida Management District may be helpful to understanding the challenges of federal agencies.

⁷³ The core climate change scenarios are produced by global-scale models that provide output with resolution typically at 100 to 200 kilometers square (62 miles to 124 miles square). Because of ongoing uncertainty in modeling approaches and the underlying variability in climate, models run “ensembles”—or many computer runs—of each scenario and then provide ensemble averages, which are then averaged with the ensembles of other models. These provide ranges of uncertainty and other statistics that analysts may use to consider how future climate may differ from historical patterns in specific locations. However, the resolution of global models is typically too coarse for local analyses, so the data are “downscaled” with regional models or statistical techniques to finer resolutions, such as 12-kilometer and sometimes 800-meter resolutions (7.5 miles and 0.5 mile, respectively). For an example of very recent downscaling, see Bureau of Reclamation, *Downscaled CMIP3 and CMIP5 Climate and Hydrology Projections: Release of Downscaled CMIP5* (continued...)

greater for variables other than annual average surface-air temperature (e.g., precipitation, runoff) and for more regional or local precision.

The federal adaptation planner is tasked with acquiring and using future climate scenarios and meshing those projections and their uncertainties with local and historical information and science relevant to federal missions, property, personnel, and/or operations. Planning for climate change means trying to discern when that change may become important and how—when it may exceed the weather or environmental variability to which the existing assets or operations may already be adapted. Statistical methods become important to making robust decisions, and determining which statistical measures to use is an element of ongoing research. (See **Text Box** below.) A question of particular concern for planning adaptation regards the existence and timing of potential “tipping points,” at which climate change exceeds the tolerance of existing climate-related systems and may change abruptly, and in possibly unexpected ways.

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Climate Projections, Comparison with preceding Information, and Summary of User Needs, prepared by DOI, Bureau of Reclamation, Technical Services Center, Denver, CO, 2013.

When Does Local Climate Change Become Evident? Assistance from Statistics

For decades, scientists and engineers have used statistical evidence to discern the strength of a measurement compared to underlying variability, or “noise.” In recent climate research and adaptation planning, such “signal to noise ratios” helps analysts to understand how significant climate changes may be relative to the variability to which systems are accustomed. To facilitate federal preparations for climate change, the General Services Administration (GSA) recently issued a request for information on service providers that might provide critical statistical analyses. GSA defined climate impacts as changes in variations in mean state and other aspects of climate over time, and the time at which the “signal” of climate change may emerge from the “noise” of natural climate variability. Below are examples of some of these statistical metrics and their significance in addressing adaptation efforts.

Time of Emergence/Time of Departure. Statistics to examine when a warming or otherwise changing climate will be outside the range of natural climate variability—that is, outside of what current systems have been exposed to in the past. The significance of these estimates lies in helping to identify populations and ecosystems that may be most susceptible to the nearest-term impacts and may require accelerated adaptation planning.

Mitigation Signal. Estimates of the time when a detectable signal of mitigation arises from ongoing and future reductions of greenhouse gas emissions. The complexities of feedbacks between greenhouse gas forcing and the internal variability of the climate system may prove to mask or delay reductions in warming expected from mitigation scenarios. The significance of these estimates lies in helping to identify when climate benefits from mitigation efforts may be detected, and could provide key inputs to cost-benefit analyses employed in adaptation planning efforts.

Climate Fingerprint. Estimates to detect the signals of various anthropogenic and natural external factors (the fingerprints) from amid the noise of historical climate variability. These statistics help to assess confidence in the diagnoses of climate change and in designing effective policies that focus on the “right” causes and related projections of change.

While subtle changes in methodology and historical time period selected can affect regional and temporal predictions, improvement and consistency in calculation of these and similar statistical analyses are important in designing relevant and cost-effective policy strategies.

Sources: Deser et al., “Communication of the role of natural variability in future North American climate,” *Nature Climate Change*, October 2012; GSA, RFI XZ003-XZ988-3, “Services to Support Federal Climate Change Adaptation Activities,” September 26, 2013; Hasselmann, “On the signal-to-noise problem in atmospheric response studies,” *Meteorology of Tropical Oceans*, 1979; Hawkins and Sutton, “Time of emergence of climate signals,” *Geophysical Research Letters*, January 2012; Mahlstein et al., “Early onset of significant local warming in low latitude countries,” *Environmental Research Letters*, 2011; Mora et al., “The projected timing of climate departure from recent variability,” *Nature*, October 2013; Santer, B.D., et al., “Separating signal and noise in atmospheric temperature changes: The importance of timescale,” *J. Geophysical Research*, November 2011; Santer et al., “Identifying human influences in atmospheric temperature,” *PNAS*, January 2013; Tebaldi and Friedlingstein, “Delayed detection of climate mitigation benefits due to climate inertia and variability,” *PNAS*, September 2013.

Issues for Congress

To date, the White House has guided federal agency climate change adaptation planning. As agencies continue their planning efforts, Congress may opt to oversee adaptation efforts, consider responses to third parties' recent and past recommendations regarding federal adaptation,⁷⁴ and provide advice or statutory direction to the executive branch or specific agencies, as well as consider the funding and data used to support these efforts. Congress may consider the following:

- reviewing the significance and nature of the climate change risks to the federal government (including the distribution and timing of those risks);
- evaluating which, if any, preparations and adaptations are cost-beneficial and feasible; and
- assessing whether to alter specific agencies' existing authorities.⁷⁵

Congress may act to provide federal agencies direction on whether and how adaptation efforts are to be organized and funded, and their performance measured and evaluated (e.g., effectiveness at reducing damage to property, lives, and habitat relative to the federal and private investment of an adaptation measure). Congress may decide to review the accessibility of adaptation-relevant information and the strategies under way to improve it, and consider options for authorities, directions, and resources to overcome data management and accessibility challenges.

Congress may consider the role, costs, and benefits of adapting federal agencies to projected climate change. Considerations may arise in the broader context of whether and how to address climate change, as well as in other public policy concerns such as policies affecting natural disaster preparedness; ocean, energy, environmental, agricultural, and federal lands management; national and international security; public health; and public finance and budgets. There are complementarities and trade-offs among major adaptation approaches and actions in these broader fields of policy. Congress may seek improved information and analysis to support examination of the socioeconomic, distributional, political, and moral dimensions of various adaptation approaches, of making policy choices under uncertainty, and of appropriate federal and nonfederal roles and responsibilities.⁷⁶

⁷⁴ GAO, among others, has provided recommendations in the past regarding federal adaptation activities. As examples, see Government Accountability Office, *Climate Change Adaptation: Strategic Federal Planning Could Help Government Officials Make More Informed Decisions*, Washington, DC, October 7, 2009, <http://www.gao.gov/products/GAO-10-113>; GAO, *Climate Change: Various Adaptation Efforts Are Under Way at Key Natural Resource Management Agencies*, GAO-13-253, Washington, DC, May 31, 2013; and Bierbaum, Rosina, et al., "A Comprehensive Review of Climate Adaptation in the United States: More Than Before, but Less Than Needed," *Mitigation and Adaptation Strategies for Global Change* 18, no. 3, March 1, 2013, pp. 361-406.

⁷⁵ One review commissioned to inform the National Climate Assessment recommends that "regulations, laws, and agency missions should be reevaluated with climate change in mind" (Bierbaum, Rosina, et al. "A Comprehensive Review of Climate Adaptation in the United States: More Than Before, but Less Than Needed," *Mitigation and Adaptation Strategies for Global Change* 18, no. 3, March 1, 2013, pp. 361-406, doi:10.1007/s11027-012-9423-1. See also CRS Report R42613, *Climate Change and Existing Law: A Survey of Legal Issues Past, Present, and Future*, by Robert Meltz.

⁷⁶ See CRS Report R41973, *Climate Change: Conceptual Approaches and Policy Tools*, by Jane A. Leggett. See also Congressional Budget Office, *Uncertainty in Analyzing Climate Change: Policy Implications*, January 2005.

Part II: Summaries of Adaptation Plans in Some Federal Departments and Agencies

More than 30 federal departments and agencies have produced reports on their climate change adaptation efforts. Agencies' adaptation plans are available from many agencies as appendixes to their 2012 and 2014 sustainability performance plans. CRS has researched materials beyond what is included in these documents, but has not comprehensively identified or reviewed information from all agencies regarding their climate change adaptation efforts. Additional agencies and updates may be added to the summaries in this section, subject to congressional interest.

FY2016 Budget Request

The President's FY2016 budget request and other related administrative announcements roughly concurrent with its release on February 2, 2015, are not addressed in this report. While the President's FY2016 budget request and other recent announcements (e.g., executive order on flooding and proposed FEMA rules) may mention adaptation (or "resilience") to climate change, most pertain to programs outside the narrow scope of this report: assessments and actions that agencies may be undertaking to address *potential risks to their missions, property, operations, and personnel*. For further detail or updates on climate change adaptation plans by individual agencies, the report provides contact information for CRS analysts at the end of each agency section in Part II.

For further information on specific departments and agencies, each section that follows identifies relevant CRS experts.

Table I. Selected Departments and Agencies with Adaptation Plans

Links to the full set of agencies' adaptation plans are available at <http://www.performance.gov/node/3406/view?view=public#supporting-info>

Selected Departments/Agencies	Latest Plan Posted
Department of Agriculture (USDA)	June 2014
U.S. Forest Service (USFS)	October 2014
Department of Commerce (DOC)	June 2014
National Oceanic and Atmospheric Administration (NOAA)	
Department of Defense (DOD)	October 2014
Army Corps of Engineers (USACE or the Corps)	June 2014
Environmental Protection Agency (EPA)	October 2014
Federal Emergency Management Agency (FEMA), as part of the Department of Homeland Security (DHS) Addendum to its Adaptation Plan of 2012	June 2014
Department of Health and Human Services (HHS)	July 2014
Department of the Interior (DOI)	October 2014
Bureau of Land Management (BLM)	
Bureau of Reclamation (Reclamation)	
National Park Service (NPS)	
Fish and Wildlife Service (FWS)	
U.S. Geological Survey (USGS)	
Department of State (DOS)	October 2014
Agency for International Development (USAID)	October 2014

Source: CRS, from various federal websites.

Department of Agriculture

The Department of Agriculture (USDA) is responsible for the management of 193 million acres of national forests and grasslands in the National Forest System, and provides assistance in managing the nation's 1.3 billion acres of farm, ranch, and private forest lands through public and private partnerships.⁷⁷ Studies have suggested that climate change will have a varying impact on agricultural production.⁷⁸ The overall impact to agricultural production depends partly on the direction, magnitude, and rate of changes in temperature and precipitation.⁷⁹ Producers have, and continue to, adapt to these changes; however, the long-term response to climate change may require new management techniques and technologies.⁸⁰

Similarly, some research indicates that climate variability is reshaping forest landscapes by altering the frequency, intensity, and timing of disturbance events (e.g., wildfires, precipitation events, and insect and disease infestations) that influence the structure, composition, and function of the forest and grassland ecosystems.⁸¹ Forest ecosystems have inherent characteristics that enhance their capacity to survive disturbance events (resistance) or facilitate recovery after disturbance (resilience). Despite this inherent capacity, current thinking suggests that the rapid pace and magnitude of climate change may exceed the resistance and resilience capacity of many forests.⁸²

Forest ecosystems and agricultural land also play a role in mitigating against rising carbon levels: growing vegetation removes carbon from the atmosphere and stores (“sequesters”) it in wood and soil. Carbon is released back into the atmosphere during some disturbance events (e.g., a forest fire). Thus, appropriate management of disturbances may be critical for avoiding potential future releases of large amounts of carbon.

In June 2011, USDA issued Departmental Regulation 1070-001, establishing USDA's Official Policy Statement on Climate Change Adaptation within the Office of the Chief Economist.⁸³ This policy recognized the Climate Change Program Office (CCPO) as the point of contact for development of the Adaptation Plan required by Executive Order 13514, and called for department-wide integration of climate change adaptation planning and actions. The department's Adaptation Plan was updated in 2014 in response to E.O. 13653.⁸⁴ In addition to climate change

⁷⁷ U.S. Department of Agriculture, *FY2014 Budget Summary and Annual Performance Plan*, 2013, <http://www.obpa.usda.gov/budsum/FY14budsum.pdf>.

⁷⁸ Scott Malcolm, Elizabeth Marshall, and Marcel Aillery, et al., *Agricultural Adaptation to a Changing Climate: Economic and Environmental Implications Vary by U.S. Region*, U.S. Department of Agriculture, Economic Research Service, ERR-136, July 2012, <http://www.ers.usda.gov/media/848748/err136.pdf>.

⁷⁹ Ibid.

⁸⁰ Jerry Hatfield, Gene Takle, and Richard Grotjahn et al., *Climate Change Impacts in the United States: The Third National Climate Assessment*, U.S. Global Research Program, Chapter 6: Agriculture, May 6, 2014, <http://nca2014.globalchange.gov/report/sectors/agriculture>.

⁸¹ James M. Vose, David L. Peterson, and Toral Patel-Weynard, *Effects of Climate Variability and Change on Forest Ecosystems: a Comprehensive Science Synthesis for the U.S.*, Forest Service, PNW-GTR-870, Portland, OR, 2012, <http://www.treesearch.fs.fed.us/pubs/42610>.

⁸² Ibid.

⁸³ U.S. Department of Agriculture, *Policy Statement on Climate Change Adaptation*, Departmental Regulation 1070-001, Washington, DC, June 3, 2011, <http://www.ocio.usda.gov/sites/default/files/docs/2012/DR1070-001.pdf>.

⁸⁴ U.S. Department of Agriculture, *US Department of Agriculture Climate Change Adaptation Plan*, June 2014, http://www.usda.gov/oce/climate_change/adaptation/USDA_Climate_Change_Adaptation_Plan_FULL.pdf.

adaptation activities, the CCPO represents USDA to the U.S. Global Change Research Program (USGCRP), chairs the USDA Global Change Task Force, oversees departmental greenhouse gas accounting capabilities and responsibilities, and directs international climate change initiatives.⁸⁵

Under the direction of the CCPO, USDA offices and agencies provided input for the USDA Climate Change Adaptation Plan in addition to identifying vulnerabilities to key agency resources and mission areas. The USDA Climate Change Adaptation Report includes specific plans from the following USDA agencies and offices: Agricultural Research Service (ARS), Animal and Plant Health Inspection Service (APHIS), CCPO, Farm Service Agency (FSA), Foreign Agricultural Service (FAS), Forest Service (FS), Grain Inspection Packers and Stockyards Administration (GIPSA), National Agricultural Statistics Service (NASS), National Institute of Food and Agriculture (NIFA), Natural Resources Conservation Service (NRCS), Risk Management Agency (RMA), and Rural Development (RD). Each agency identified specific actions related to climate change adaptation, and provided timelines, performance metrics, and agency leads in a tabular format as appendixes to individual plan documents. The full plan and individual sections can be found on USDA's climate change website, http://www.usda.gov/oce/climate_change/adaptation/adaptation_plan.htm.

Adaptation-Related Activities

Of USDA's four overall strategic goals in its strategic plan for FY2010-FY2015, one is specifically related to climate adaptation; Goal 2 states that USDA will "ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources."⁸⁶ While other strategic goals allude to varying challenges associated with climate change adaptation, this goal is reflected throughout the annual budget request, adaptation plan, and office and specific agency activities. Although a full accounting of department-wide adaptation activities is beyond the scope of this report, a brief description of activities is provided below regarding the department overall, followed by selected offices and agencies.

Department-Level Activities

As previously stated, the department's Climate Change Program Office has primary responsibility for coordinating and leading USDA's response to climate change, including the following:

- analysis, planning, and research coordination;
- development of climate change response strategies;
- providing liaison with other federal agencies;
- informing department leadership of related scientific developments and policy issues; and

⁸⁵ U.S. Department of Agriculture, Climate Change Program Office, *The Climate Change Program Office*, Fact Sheet, http://usda.gov/oce/climate_change/fact_sheets/CCPO_FactSheet.pdf.

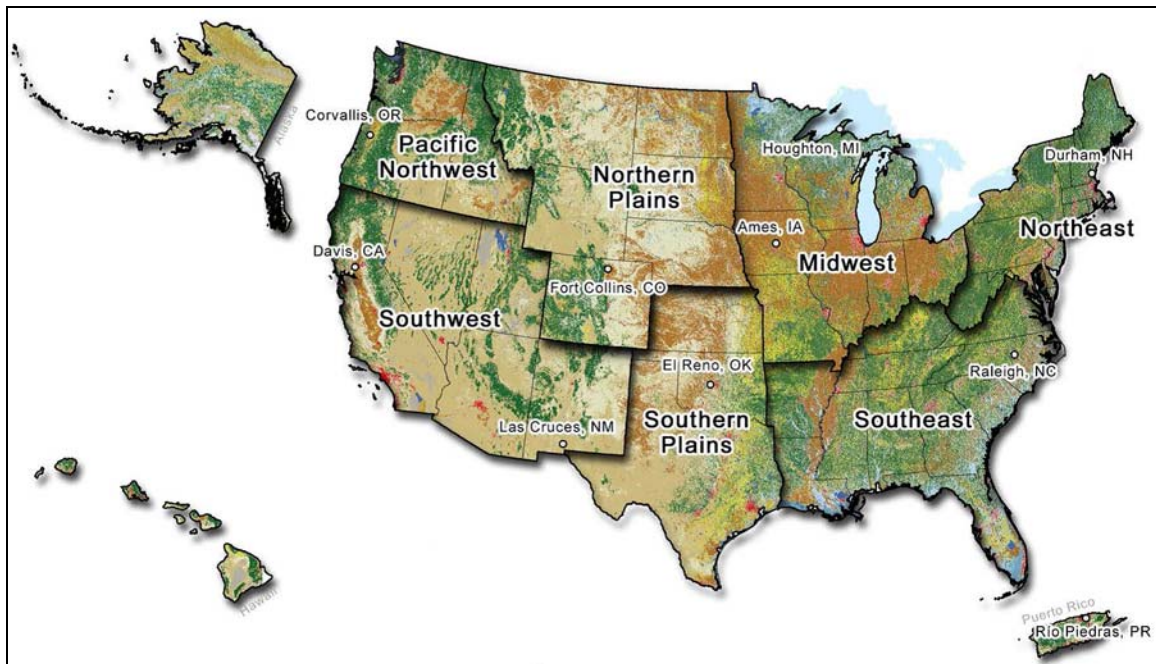
⁸⁶ U.S. Department of Agriculture, *Strategic Plan FY 2010-2015*, <http://www.ocfo.usda.gov/usdasp/sp2010/sp2010.pdf>.

- ensuring climate change concerns are fully integrated into USDA's research, planning, and decision-making processes.⁸⁷

At the department level, USDA participates in a number of interagency efforts including the Council on Climate Preparedness and Resilience, U.S. Global Change Research Program, National Climate Assessment, National Fish, Wildlife and Plants Climate Adaptation Strategy Implementation Team, Agricultural Air Quality Task Force, Joint Fire Science Program, and the National Interagency Fire Center.⁸⁸

In February 2014, USDA announced the creation of regional hubs for risk adaption and mitigation to climate change. These hubs are based on existing statutory authorities within USDA, and do not require additional resources. Hub locations were chosen through a competitive, internal application process among USDA facilities (see **Figure 7**). The purpose of these hubs is to (1) provide technical support for agricultural producers and landowners responding to climate change, (2) assess and monitor the risk to agricultural production, and (3) conduct research and education to the department's clients about the effect of climate change on agriculture and forests.⁸⁹

Figure 7. USDA Climate Hubs for Risk Adaption and Mitigation to Climate Change



Source: USDA Climate Hub Regions, http://www.usda.gov/oce/climate_change/hubs/Hub_PPT_11182014.pdf.

⁸⁷ U.S. Department of Agriculture, CCPO Presentation, December 5, 2013.

⁸⁸ A detailed description of USDA's involvement in these activities may be found in USDA's 2014 Adaptation Plan: http://www.usda.gov/oce/climate_change/adaptation/USDA_Climate_Change_Adaptation_Plan_FULLL.pdf.

⁸⁹ U.S. Department of Agriculture, *Charter of the Executive Committee of the Regional Hubs for Risk Adaption and Mitigation to Climate Change*, USDA ARS-NRCS-Forest Service-NIFA-FSA-RMA-RD-CCPO, Washington, DC, January 31, 2014, http://www.usda.gov/oce/climate_change/hubs/RegionalHubCharter.pdf.

Forest Service

The U.S. Forest Service (FS) is an agency within USDA with a mission to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations. FS is responsible for managing national forests and grasslands, conducting forestry research, and providing assistance to state, private, and international forestry agencies. Each of these FS mission areas has activities related to the effects of climate variability and change on forest ecosystems. While the CCPO has primary responsibility for organizing and leading USDA climate change activities, FS's mission increases its presence in climate change activities above those of most other agencies at USDA.

In fulfilling the FS mission, the agency has identified several intertwined roles regarding climate change management including federal land management, research, and engagement and outreach with other forestry managers. As a land manager, FS addresses climate change through strategic planning and policy initiatives regarding the management of the National Forest System. FS also is responsible for responding to active wildfires on federal lands and on nonfederal lands by request.⁹⁰

In the FS Research and Development office, climate change research is one of five priority areas for emphasis, and the Global Change Research Strategy 2009-2019 includes research on adaptation, mitigation, and decision-support strategies. Through the State and Private Forestry office, FS provides technical and financial assistance to states and private forest landowners, including a program to fund restoration and other forest health management projects. Several of the USDA Regional Climate Hubs (see **Figure 7**) are operated in partnership with both Research and Development and State and Private Forestry activities. FS also conducts a regular forest inventory and analysis program that provides both a baseline on ecosystem composition and monitoring of changes across time. In addition, FS addresses climate change in international forestry issues through policy engagement and technical cooperation to develop capacity and strengthen existing institutions related to forest governance and management worldwide.

The Climate Change Resource Center is a compilation of FS's related research, outreach, and management activities.⁹¹ This resource provides land managers and other decision makers—private and public—with information, research, decision-support models, maps, and simulations. These tools may be used to incorporate climate change management activities into planning and project management.

FS developed several policy initiatives in accordance with E.O. 13514 and E.O. 13653.⁹² The agency published the Strategic Framework for Responding to Climate Change, which set forth seven goals as the overarching structure for agency strategies, priorities, policy decisions, and resource allocations for responding to climate change.⁹³ To implement the strategic framework,

⁹⁰ Federal responsibility for wildfire suppression is to protect lives, property, and resources on federal lands. For more information, see CRS Report R41858, *Federal Assistance for Wildfire Response and Recovery*, by Katie Hoover.

⁹¹ For more information, see <http://www.fs.fed.us/ccrc>.

⁹² USDA, *Climate Change Adaptation Plan 2014: Forest Service*, http://www.usda.gov/oce/climate_change/adaptation/adaptation_plan.htm.

⁹³ Forest Service, *Forest Service Strategic Framework for Responding to Climate Change*, October 2008, <http://www.fs.fed.us/climatechange/documents/strategic-framework-climate-change-1-0.pdf>.

FS published the National Roadmap for Responding to Climate Change in 2011.⁹⁴ The roadmap describes three interconnected modes of action for FS response:

- assessing current risks, vulnerabilities, policies, and gaps in knowledge;
- engaging employees and stakeholders to seek solutions; and
- managing for resilience through adaptation and mitigation strategies.

From the action items in the roadmap, FS developed a performance scorecard to measure progress, with the goal of each national forest and grassland achieving 7 out of 10 of the scorecard's benchmarks by 2015. A 2011 baseline measurement found that 16% of the national forests already achieved the performance goals. In 2013, 49% of the national forests were in compliance.⁹⁵

For the national forests, the National Roadmap for Responding to Climate Change outlined how the agency plans to address major stressors from climate variability and provide direction for landscape restoration goals. FS is establishing a restoration and resilience policy to provide a foundational policy for sustainable management of the national forests.⁹⁶ As part of the policy, the agency is focusing on restoration strategies aimed to improve the capacity of the ecosystem to withstand stressors and return to specified desired conditions post-disturbance. The desired conditions are to be determined at the landscape level by assessing the adaptive capacity and enhancing the resistance and resilience of forest ecosystems. The FS 2012 Planning Rule, through which the agency makes land use decisions for the national forests as directed by the National Forest Management Act,⁹⁷ provides an adaptive framework for incorporating resilience goals into land management planning and decision making. The adaptive framework includes an expanded inventory and monitoring system as part of the planning process to assess progress toward the restoration goals and refocus efforts as necessary. FS also has several programs to accelerate restoration activities in the national forests, including the Collaborative Forest Landscape Restoration Program, which leverages local resources to encourage large-scale, long-term restoration projects.

Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) has primary responsibility for assisting private landowners with addressing natural resource concerns. In addition to providing technical assistance related to soil and water, the agency also administers a number of financial incentive programs that pay farmers and ranchers to alter production practices to achieve environmental benefits. NRCS conducted an internal examination of these programs and technical resources, and found that conservation practices prescribed within these programs were effective at both mitigation of greenhouse gases (GHGs) and climate change adaptation.⁹⁸ Existing practices such

⁹⁴ Forest Service, *National Roadmap for Responding to Climate Change*, <http://www.fs.fed.us/climatechange/pdf/Roadmapfinal.pdf>.

⁹⁵ Forest Service, *Fiscal Year 2015 Budget Justification*, March 2014, pp. 1-4, <http://www.fs.fed.us/aboutus/budget/>.

⁹⁶ USDA, *Climate Change Adaptation Plan 2014: Forest Service*, http://www.usda.gov/oce/climate_change/adaptation/adaptation_plan.htm.

⁹⁷ 16 U.S.C. §1600 et seq.

⁹⁸ USDA, NRCS, *Climate Change Vulnerability Assessment and Adaptation Plan 2014*, http://www.usda.gov/oce/climate_change/adaptation/Natural%20Resources%20Conservation%20Service.pdf.

as residue management, forest stand improvement, cover crops, and prescribed grazing may make agricultural systems more resilient to changes in climate.

The NRCS adaptation report⁹⁹ makes few action recommendations that would require congressional action. The report states that integrating adaptation to changes in climate can be developed within the current NRCS conservation structure. Adjustments to traditional conservation planning approaches will be required in order to focus on a more holistic approach to conservation delivery that includes flexibilities for producers to adapt to changing climate conditions.

Agricultural Research Service

The Agricultural Research Service (ARS) is the in-house research agency at USDA. The agency is organized into “National Programs” that coordinate the research carried out by ARS. Under the National Climate Change, Soils, and Emissions program (NP #212), ARS works “to improve the quality of atmosphere and soil resources affected by, and having an effect on agriculture and to understand the effects of, and prepare agriculture for, adaptation to climate change.”¹⁰⁰ ARS research activities within NP# 212 support a number of soil and atmospheric research projects, including mechanisms for enabling agriculture to adapt to climate change.¹⁰¹ As part of this effort, ARS is also co-leading the collaborative research project known as the Agricultural Model Intercomparison and Improvement Project (AgMIP), with a goal to improve the characterization of risk of hunger and world food security due to climate change, and to enhance adaptation capacity in developing and developed countries.

Risk Management Agency

The Risk Management Agency (RMA) offers federal crop insurance and other production risk management products through a network of private-sector entities.¹⁰² RMA also funds partnerships with state departments of agriculture, universities, and other public or private organizations to develop risk management tools to assist producers in minimizing their risks and adapting to increased risks from climate change, drought, and other weather-related conditions. In 2010, RMA released a report on the potential effects of climate change on crop insurance. The report found that the effects will vary greatly across the country, with production in the South and Southeast more negatively impacted than production in the West.¹⁰³ Another such collaboration is with Oregon State University to build PRISM—a climate and weather web portal that houses

⁹⁹ Ibid.

¹⁰⁰ USDA, ARS, *National Program 212: Climate Change Soils, and Emission*, website, http://www.ars.usda.gov/research/programs/programs.htm?NP_CODE=212.

¹⁰¹ Examples of related activities may be found in the USDA ARS *FY2012 Annual Report*, National Program 212—Climate Change, Soils, and Air Emissions, <https://www.ars.usda.gov/SP2UserFiles/Program/212/NP%20212%20FY%202012%20Annual%20Rpt.pdf>.

¹⁰² For additional information on RMA and USDA’s production risk management programs, see CRS Report R40532, *Federal Crop Insurance: Background*, by Dennis A. Shields, and CRS Report R42759, *Farm Safety Net Provisions in a 2013 Farm Bill: S. 954 and H.R. 2642*, by Dennis A. Shields and Randy Schnepf.

¹⁰³ Robert H. Beach, Chen Zhen, and Allison Thomson et al., *Climate Change Impacts on Crop Insurance*, RTI International for USDA Risk Management Agency, RTI Project Number 2011911, Research Triangle Park, NC, May 2010, http://www.usda.gov/oce/climate_change/files/ImpactsCropInsurance062010.pdf.

USDA's climatological data.¹⁰⁴ The agency is also changing program implementation procedures including the establishment of emergency adjustment procedures for catastrophic loss events to ensure that the crop insurance program reflects changes in the climate and agronomics for crops currently covered; the expansion of programs to ensure that crop insurance coverage is available to new areas where crops are grown due to changes in the climate; the development and maintenance of maps for identification of at-risk areas; and the development of special provisions to address unique crop or regional conditions that pose potential program vulnerabilities.¹⁰⁵

Congress has shifted risk management for agriculture away from ad hoc disaster payments and toward more permanent disaster support programs and federal crop insurance, as authorized in the 2014 farm bill (P.L. 113-79, §1501 and Title XI of P.L. 113-79). As RMA adapts these risk management programs to a changing climate, shifts in traditional production and the continued use of historical crop yield data could prove to be a challenge. Extreme weather events and possible increased production damage could prove costly to the current system.

National Institute of Food and Agriculture

The National Institute of Food and Agriculture (NIFA) supports research, education, and extension programs in the Land-Grant University System and other organizations. The agency does not perform research, education, or extension, but rather provides funds and national leadership in these areas.¹⁰⁶ Climate change is a “priority science area” at NIFA. Projects are administered through the Institute of Bioenergy, Climate, and Environment (IBCE), a division of NIFA that manages programs to help agricultural, forest, and range production systems adapt to climate variables.¹⁰⁷ Most NIFA-funded grants that are focused on climate change are multimillion-dollar, integrated, transdisciplinary projects that address the adaptation of food, feed, and fiber production systems to changing climates and the goal of reducing greenhouse gas emissions and increasing carbon sequestration in the agriculture and forestry sectors. According to NIFA's adaptation report, the agency anticipates the need to balance an increasing demand for scientific research, modeling, educational programs, and extension activities in order to address climate change issues with other research, education, and extension needs for agriculture.¹⁰⁸ For example, investigations of climate stressors and tipping points could become more important to climate adaptation science research, and would have to be balanced with susceptible areas of crop and livestock production research and formal and informal state educational programs.¹⁰⁹

¹⁰⁴ PRISM stands for Parameter-elevation Regressions on Independent Slopes Model. Additional information may be found at <http://prism.oregonstate.edu/>.

¹⁰⁵ USDA, RMA, *Climate Adaptation Plan*, http://www.usda.gov/oce/climate_change/adaptation/Risk%20Management%20Agency.pdf.

¹⁰⁶ For additional information, see CRS Report R40819, *USDA's Research, Education, and Economics (REE) Mission Area: Issues and Background*.

¹⁰⁷ USDA, NIFA, *Institute of Bioenergy, Climate, and Environment*, Institute Fact Sheet IBCE R7, December 11, 2012, http://www.csrees.usda.gov/about/pdfs/fact_sheets/inst_fs_ibce.pdf.

¹⁰⁸ USDA, NIFA, *USDA National Institute of Food and Agriculture—Agency Climate Change Adaption Plan*, 2012, http://www.usda.gov/oce/climate_change/adaptation/National%20Institute%20of%20Food%20and%20Agriculture.pdf.

¹⁰⁹ *Ibid.*

Animal and Plant Health Inspection Service

The Animal and Plant Health Inspection Service (APHIS) is tasked with protecting and promoting the health of U.S. agriculture and natural resources. As climate changes, pests and diseases can pose increased threats to the agricultural industry. The primary role of APHIS in USDA's climate change response is to analyze and anticipate changes in these threats. APHIS focuses on plant health response programs, early-warning systems for and management of vector-borne diseases—diseases spread by insects—in livestock and wild animal populations, trade regulations and management in regard to international disease outbreaks, emergency preparedness for both pest and disease emergencies as well as natural disasters and biosecurity hazards, and collaboration with federal, state, local, academic, and business community partners, and other stakeholders.¹¹⁰ According to the APHIS adaptation report, the agency does not anticipate that climate change will require a modification of its statutory authority. The agency plans to continue to adopt regulations and policies to address new or shifting pest and disease scenarios.¹¹¹

Farm Service Agency

The Farm Service Agency (FSA) administers a number of financial incentives for farmers and ranchers through farm loans and commodity, disaster, and conservation programs. FSA identified three climate change adaptation actions in the USDA adaptation report, including amending policy to facilitate adaptation, providing outreach to producers through the existing FSA service center structure and USDA's new climate change hubs, and conducting a “continuity of operations” exercise to prepare for an increase in large-scale crop failures resulting from climate change. With the passage of the Agricultural Act of 2014 (P.L. 113-79, the 2014 farm bill), Congress reauthorized a number of the existing programs FSA cited as necessary for its response to climate change (e.g., the Conservation Reserve Program, the Conservation Reserve Enhancement Program, loan programs, and disaster programs).¹¹² Congress did not, however, amend these existing programs to specifically change the agency's current limited use for adaptation. In most cases, the agency's use of these programs has continued relatively unchanged since the issuance of the adaptation plan.

Issues for Congress

Agriculture and forestry face a number of challenges (e.g., weather, disease, pests) that could be substantially affected by a changing climate. As the federal entity tasked with providing “leadership on food, agriculture, natural resources, rural development, nutrition, and related issues based on sound public policy, the best available science, and efficient management,” USDA could play an integral role in assisting U.S. producers with climate adaptation. A number of challenges related to climate change and its role in agricultural and forestry adaptation remain for USDA.

¹¹⁰ USDA, APHIS, *Animal and Plant Health Inspection Service and Climate Change*, Fact Sheet, http://www.usda.gov/oce/climate_change/fact_sheets/APHIS_Climate_Change_Fact_Sheet.pdf.

¹¹¹ USDA, APHIS, *USDA Animal and Plant Health Inspection Service*, Climate Change Adaptation Plan, June 2014, http://www.usda.gov/oce/climate_change/adaptation/Risk%20Management%20Agency.pdf.

¹¹² For information on the changes made by the Agricultural Act of 2014, see CRS Report R43076, *The 2014 Farm Bill (P.L. 113-79): Summary and Side-by-Side*, coordinated by Ralph M. Chite.

First, existing federal policies both help and hinder adaptation-related activities. For example, many of USDA's programs rely on voluntary participation by producers. This could slow the application of adaptation-related activities and reduce the agriculture industry's ability to adapt to climate change in the long term. Producers are not required to adopt practices recommended by USDA, or, if paid to do so, are not required to maintain practices beyond the period for which payment is received. Similarly, FS technical and financial assistance programs also rely on voluntary participation by nonfederal forest landowners.

Second, federal funding for research, conservation, outreach, and other adaptation-related activities has declined in recent years. While some private-sector funding has increased over time to fill some of the gap in public spending—namely in research and conservation—there is growing concern among some that private-sector funding focuses primarily on taking existing technologies to market (i.e., more applied research), and does not focus on basic problems and/or longer-term challenges that the agricultural and forestry sectors may face in the future, such as adaptation to climate variability. The rising cost of suppressing wildfires—both on federal and nonfederal land—is another funding concern.

Finally, while there is recognition at the department level that a coordinated response to climate adaptation may be most effective, agency-level actions appear to diverge in some respects. A number of USDA agencies have developed adaptation plans, but the diversity of agency mission areas has resulted in an inconsistent application of those plans. Some USDA agencies have recognized the need to adapt current programs to potential effects of climate change, and have carried out adaptation measures with tangible results, such as RMA's expansion of program coverage to new areas in which crops are grown due to changes in the climate and agronomics. Other USDA agencies have identified the need for adaptation, but lack the program flexibility or funding to act, such as the cost to fully implement FS's restoration strategy for the national forests.

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Department of Commerce

The Department of Commerce (DOC) is composed of 12 bureaus with a wide range of responsibilities. DOC focuses on five basic missions:

- promoting the development of U.S. business and increasing foreign trade;
- improving the nation's technological competitiveness;
- encouraging economic development;
- fostering environmental stewardship and assessment; and
- compiling, analyzing, and disseminating statistical information on the U.S. economy and population.

On August 31, 2011, in response to E.O. 13514, the Secretary of Commerce signed Departmental Administrative Order (DAO) 216-18,¹¹³ which states that “it is the policy of the Department to undertake comprehensive climate change adaptation planning in order to ensure that the Department fulfills its mission and maintains its programs and operations in a changing climate.”

The DAO established a Climate Coordinating Committee to develop DOC's Climate Change Adaptation Strategy (CCAS). In June 2012, the strategy was released as an appendix to the 2012 update of DOC's Strategic Sustainability Performance Plan.¹¹⁴ In June 2014, the CCAS was updated to reflect lessons learned since the first strategy was released, and to incorporate guidance provided by the Council on Environmental Quality (CEQ) on implementing E.O. 13653.¹¹⁵

The CCAS identifies key climate change vulnerabilities and outlines the department's approach to addressing these vulnerabilities. Climate change vulnerabilities also were linked to priority adaptation actions that were updated for FY2014. The key climate change vulnerabilities and priority adaptation actions are organized by the following strategic themes: economic growth, science and information, environmental stewardship, and infrastructure, facilities, and operations management.¹¹⁶ Each of these themes is discussed below in more detail. The CCAS also presents five-year strategic goals for adaptation planning, describes how interagency coordination can be supported, addresses barriers to federal climate resilience investment, and identifies opportunities to support climate resilient investments by states, local communities, and tribes.¹¹⁷

¹¹³ Secretary of Commerce, *Climate Change Adaptation Planning*, Department of Commerce, Number: DAO 216-18, Washington, DC, August 31, 2011, http://www.osec.doc.gov/opog/dmp/daos/dao216_18.html.

¹¹⁴ U.S. Department of Commerce, *United States Department of Commerce Strategic Sustainability Plan*, Washington, DC, June 22, 1012.

¹¹⁵ Department of Commerce, *Department of Commerce Climate Change Adaptation Strategy*, Washington, DC, June 2014, hereinafter cited as the Climate change Adaptation Strategy 2014.

¹¹⁶ Climate Change Adaptation Strategy 2014.

¹¹⁷ Climate Change Adaptation Strategy 2014.

Economic Growth

Most of DOC's bureaus¹¹⁸ support economic growth by developing the tools, systems, policies, and technologies that foster U.S. competitiveness, improve efficiency, and facilitate the development of new businesses. Climate change may present challenges to U.S. businesses by interfering with their ability to produce, transport, and deliver goods and services. Sea-level rise and extreme weather events influenced by climate change could damage infrastructure and harm natural resource-dependent industries such as forestry, fishing, and agriculture. Businesses may be challenged to develop new technologies and processes to help themselves or others adapt.

Climate change challenges may also present opportunities for businesses that satisfy the demand for clean energy and climate-friendly technologies. According to the CCAS, DOC will need to ensure it is positioned to assist companies to turn innovative products such as climate-friendly technologies into a competitive advantage for the U.S. economy. Moreover, the CCAS states that the department will need to enhance efforts to promote trade, economic and business development, innovation, entrepreneurship, supply chain information, best practices, and standards that consider climate change.¹¹⁹ In the CCAS, DOC identified the following adaptation actions to address economic growth in FY2014, and identified lead offices for each action within DOC:

- Factor in resiliency (including resiliency to the effects of climate change) into economic development investments.
Lead Office /Bureau—Economic Development Administration (EDA)
- Help businesses capitalize on an increased demand for green technologies sparked by a changing climate.
Lead Office/Bureau—International Trade Administration (ITA)
- Improve the ability to process patent application filings for climate change adaptation-related technologies in a timely manner.
Lead Office/Bureau—U.S. Patent and Trademark Office (USPTO)

Science and Information

DOC science and information agencies¹²⁰ enhance scientific knowledge and provide information to stakeholders to improve innovation and technology, support economic growth, and improve public safety. Climate change is anticipated to increase the need for climate, weather, economic, ecological, and demographic data in the private and public sectors. These data are needed to model and assess physical, biological, and social processes that may be altered by climate change; much of this data is significant to adaptation efforts of other federal agencies and departments. Enhancing understanding of climate-related changes to the U.S. economy, society, and the

¹¹⁸ Bureaus identified in the department strategic plan under the economic growth theme include the International Trade Administration (ITA), National Institute of Standards and Technology (NIST), U.S. Patent and Trademark Office (USPTO), Economic Development Administration (EDA), Bureau of Industry and Security (BIS), National Telecommunications and Information Administration (NTIA), and Minority Business Development Agency (MBDA).

¹¹⁹ Climate Change Adaptation Strategy 2014.

¹²⁰ Bureaus identified in the department's strategic plan under the science and information theme are the Economics and Statistics Administration (ESA), which includes the Census Bureau and the Bureau of Economic Analysis (BEA), National Institute of Standards and Technology (NIST), and the National Oceanic and Atmospheric Administration (NOAA).

environment can improve decision making broadly. For example, buildings, infrastructure, and communities may suffer losses associated with climatic events such as drought, hurricanes, floods, and wildfires. By improving understanding of climate change, standards and practices can be developed to minimize risks to public safety and economic losses. DOC agencies will need to enhance information collection, scientific knowhow, and services capabilities to meet the data and knowledge needs of federal partners, state and local government, nongovernmental organizations, and businesses that are vulnerable to changing climate. DOC identified the following adaptation actions to address federal vulnerabilities related to science and information in FY2014:

- Continue coordinating climate and related ecological research and services partnerships within the department and with department partners to better understand climate variability and change and how climate variability and change may affect communities and ecological processes.
Lead Office/Bureau—National Oceanic and Atmospheric Administration (NOAA)
- Develop frameworks and tools to help coral reef managers incorporate climate change information into effective decision making that minimizes their risks to climate change.
Lead Office/Bureau—National Oceanic and Atmospheric Administration (NOAA)
- Develop performance-based standards and tools for new and retrofit building designs resistant to extremes of wind, storm surge, and fire and that prevent or mitigate collapse.
Lead Office/Bureau—National Institute of Standards and Technology (NIST)
- Understand and prepare for ocean acidification.
Lead Office/Bureau—National Oceanic and Atmospheric Administration (NOAA)
- Support adaptation decisions through the National Integrated Drought Information System (NIDIS).
Lead Office/Bureau—National Oceanic and Atmospheric Administration (NOAA)
- Support adaptation decisions with climate data, forecasts, and tools in order for the nation to better respond to extreme weather and water events.
Lead Office/Bureau—National Oceanic and Atmospheric Administration (NOAA)
- Develop climate change adaptation decision-support information for the Arctic region.
Lead Office/Bureau—National Oceanic and Atmospheric Administration (NOAA)

Environmental Stewardship

Within DOC, the National Oceanic and Atmospheric Administration's (NOAA's) mission is to understand and predict changes in climate, weather, oceans, and coasts; to share that knowledge and information with others (including other federal entities); and to conserve and manage coastal

and marine ecosystems and resources.¹²¹ Climate adaptation is a central element of NOAA’s mission and its future vision of resilient ecosystems, communities, and economies. In many cases, existing approaches to natural resource management assume relatively static conditions.¹²² One of NOAA’s tasks is modify management systems to increase resilience to rising sea level (and associated coastal flooding), higher air and water temperatures, ocean acidification, and droughts. For example, climate change may allow pathogens, parasites, and invasive species to live in new areas, which may affect the health of coastal and ocean ecosystems and species. Moreover, the distribution and abundance of fish stocks, protected species, and other marine organisms may shift with changing ocean conditions. According to the CCAS, NOAA will need to incorporate climate considerations into natural resource and coastal planning to maintain healthy and resilient coastal communities. DOC identified the following adaptation actions to address vulnerabilities related to environmental stewardship for which NOAA is the lead office:

- Continue developing networks of “sentinel sites”¹²³ to coordinate assets and efforts to increase understanding of, and improve response to, sea-level change impacts on coastal ecosystems and adjacent communities.
- Track and assess climate-related impacts on U.S. marine ecosystems and the distribution of major fish stocks.
- Assess the climate vulnerability and resilience of fish stocks and fishing communities.
- Increase understanding of current and future climate impacts on living marine resources.
- Provide training to coastal communities to build their capacity to adapt to climate change.
- Enhance climate resilience of endangered corals.
- Develop climate-ready protection and recovery of Pacific Northwest salmon and other riverine-dependent species—projecting climate impacts and designing resilient salmon restoration projects.
- Inform and advance the use of natural and nature-based infrastructure for coastal resilience, including through increased understanding of the value of the ecosystem services and benefits provided.

Infrastructure, Facilities, and Operations Management

Climate change could affect DOC’s performance and its ability to deliver its services effectively and efficiently. Climate change may affect DOC’s facilities and infrastructure and impede its ability to carry out its missions and operations. DOC identified the following adaptation actions to address vulnerabilities related to infrastructure, facilities, and operations management in FY2014:

¹²¹ Office of Program Planning, *NOAA’s Next-Generation Strategic Plan*, National Oceanic and Atmospheric Administration, Silver Spring, MD, December 2010, http://www.ppi.noaa.gov/wp-content/uploads/NOAA_NGSP.pdf.

¹²² Climate Change Adaptation Strategy 2012, p. 11.

¹²³ NOAA, NOAA Sentinel Site Program, September 30, 2011, <http://oceanservice.noaa.gov/sentinelsites/pdf/Sentinel-Site-Program.pdf>.

- Assess the vulnerability of the department's leased facilities to climate change.
Lead Office/Bureau—Chief Financial Officer/Assistant Secretary for Administration
- Continue to work with the General Services Agency (GSA) to assess and analyze climate change vulnerabilities for real property assets GSA has assigned to the Department of Commerce.
Lead Office/Bureau—Chief Financial Officer/Assistant Secretary for Administration

Issues for Congress

One of many challenges to implementing both short- and long-term actions related to climate change in ocean and marine areas is the need for coordination among federal agencies and other governmental entities. For example, elevated levels of carbon dioxide, warming oceans, and sea-level rise are expected to affect marine ecosystems, coastal infrastructure, and marine-related activities. Actions needed to meet these challenges will depend on many different federal, state, and local authorities. For broad regional and global changes, coordination is especially important for avoiding gaps or duplication in efforts related to climate change adaptation. Effective communication is also needed to ensure the free flow of information among agencies including state and local governments.

According to the U.S. Commission on Ocean Policy, at the federal level, 11 of 15 Cabinet-level departments and 4 independent agencies play important roles in the development of ocean and coastal policy.¹²⁴ Although the Administration has developed a national ocean policy, it remains an open question whether Congress will provide new authorities to improve coordination of efforts to mitigate, increase resilience to, and adapt to cross-cutting ocean issues, such as climate change.

For More Department of Commerce Information

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¹²⁴ U.S. Commission on Ocean Policy, *An Ocean Blueprint for the 21st Century*, Final Report, Washington, DC, September 2004, http://govinfo.library.unt.edu/oceancommission/documents/full_color_rpt/000_ocean_full_report.pdf.

Department of Defense

The Department of Defense (DOD) can be affected by climate change in several areas including potential impacts on geopolitics and national security interests that could result in military operations, risks to existing military infrastructure, and hindrances to readiness and the ability to execute missions.¹²⁵ For example, the Air Force has found that the combination of thawing permafrost, decreasing sea ice, and rising sea levels on the Alaskan coast has increased coastal erosion at several Air Force radar early-warning and communication installations.¹²⁶

The U.S. Army Corps of Engineers (USACE or the Corps) is an agency in DOD with both military and civilian responsibilities. The Corps' civil works activities associated with domestic water resources are discussed separately in a later section.

Congressional Action and DOD Response

In the National Defense Authorization Act for Fiscal Year 2008 (P.L. 110-181), Congress required the first national security strategy and first national defense strategy¹²⁷ prepared after January 2008 to

include guidance for military planners to assess the risks of projected climate change to current and future mission of the armed forces; to update defense plans based on these assessments, including working with allies and partners to incorporate climate mitigation strategies, capacity building, and relevant research and development; and to develop the capabilities needed to reduce future impacts.¹²⁸

Congress also required DOD to include in the first Quadrennial Defense Review (QDR) prepared after 2008 an analysis of “the capabilities of the armed forces to respond to the consequences of climate change, in particular, preparedness for natural disasters from extreme weather events and other missions the armed forces may be asked to support inside the United States and overseas.”¹²⁹

Subsequently, DOD included a discussion of climate change (and energy) in the 2010 QDR, and the Administration included a discussion of climate change in the 2010 national security strategy

¹²⁵ U.S. Congress, Senate Committee on Appropriations, Subcommittee on Department of Defense, *The National Security Implications of Climate Change*, Written Statement of Dr. Daniel Chiu, Deputy Assistant Secretary of Defense for Strategy and Force Development, 113th Cong., 2nd sess., May 21, 2014, p. 13.

¹²⁶ GAO, *Climate Change Adaptation: DOD Can Improve Infrastructure Planning and Processes to Better Account for Potential Impacts*, Washington, DC, May 30, 2014, <http://www.gao.gov/products/GAO-14-446>.

¹²⁷ The President's national security strategy, the Secretary of Defense's national defense strategy and its associated Quadrennial Defense Review report, and the Chairman of the Joint Chiefs of Staff's national military strategy (NMS) are core national security strategic guidance documents. In theory, these documents and review exercises are all “nested” with each other, such that guidance issued at higher levels of the executive branch, for example by the President, informs guidance issued at lower levels, for example by the Secretary of Defense, whose guidance, in turn, informs that issued by the Chairman of the Joint Chiefs of Staff (CJCS). For more information on these and other strategy documents, see CRS Report R43174, *National Security Strategy: Mandates, Execution to Date, and Issues for Congress*, by Catherine Dale.

¹²⁸ §951.

¹²⁹ The Quadrennial Defense Review is a statutorily mandated strategic review process (P.L. 104-201) conducted by DOD every four years. The review process generates an unclassified report whose contents are also specified in law.

(the first of either documents published after 2008).¹³⁰ According to DOD, the 2010 QDR is the foundation for the department's strategic policy on climate change adaptation.¹³¹ In 2012, pursuant to Executive Order 13514, DOD published a nine-page *FY 2012 Climate Change Adaptation Roadmap*, which laid out in broad strokes the challenges of climate change and the initial steps being taken by DOD.¹³²

While these initial efforts were mandated by Congress and the President, DOD has continued to address the issue and is working to develop a more robust approach for managing the risks posed by climate change. DOD issued a brief FY2013 update to the *Climate Change Adaptation Roadmap*¹³³ and a more robust *Climate Change Adaptation Roadmap* in FY2014, and included a discussion on climate change in the 2014 QDR,¹³⁴ even though there was no legislative or executive dictate to do so.

DOD Risks from Climate Change

DOD considers climate change to pose two broad categories of risk:¹³⁵

1. Climate change could affect the type, scope, frequency, tactics, and location of military operations worldwide.
2. Climate change could impact the force structure and the effectiveness and configuration of bases, training facilities, and other infrastructure that DOD relies upon to execute its mission.

1. Effect of Climate Change on Military Operations

Climate change can serve as a catalyst for conflict between nations, instability within nations, and more severe or frequent natural disasters and humanitarian crises.¹³⁶ The military may be called upon to respond to these scenarios, potentially affecting the type, scope, frequency, and location of military operations. Climate change can also alter the physical environment within which DOD must operate. For example, sea-level rise could affect amphibious landings, and weather pattern changes could alter operational timing and intelligence-gathering capabilities from airborne platforms.

¹³⁰ P.L. 110-81 §951.

¹³¹ Department of Defense, *Climate Change Adaption Roadmap*, FY2012, http://www.acq.osd.mil/ie/download/green_energy/dod_sustainability/2012/Appendix%20A%20-%20DoD%20Climate%20Change%20Adaption%20Roadmap_20120918.pdf.

¹³² Ibid.

¹³³ See Department of Defense, *Sustainability Performance Report*, FY2013, August 14, 2013, Appendix C. The update is two pages.

¹³⁴ Department of Defense, *Quadrennial Defense Review, 2014*, pp. 84-88, as well as mentions in other sections of the document.

¹³⁵ Department of Defense, *Climate Change Adaption Roadmap*, FY2012, p. 1; U.S. Congress, Senate Committee on Appropriations, Subcommittee on Department of Defense, *The National Security Implications of Climate Change*, Written Statement, 113th Cong., 2nd sess., May 21, 2014, p. 1.

¹³⁶ *FY 2014 Climate Change Adaption Roadmap*, p. 4.

Exacerbating Conflict and Instability

Climate change can serve as “an accelerant of instability or conflict.”¹³⁷ Rising sea levels, rising temperatures, changing precipitation patterns, and competition for water, among other factors, could have significant geopolitical impacts contributing to “poverty, environmental degradation, the weakening of fragile governments and food and water scarcity.”¹³⁸ The 2014 National Intelligence Strategy stated the following:

Many governments will face challenges to meet even the basic needs of their people as they confront demographic change, resource constraints, effects of climate change, and risks of global infectious disease outbreaks. These effects are threat multipliers that will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions—conditions that can enable terrorist activity and other forms of violence. The risk of conflict and mass atrocities may increase.¹³⁹

According to news reports, the National Intelligence Council reportedly found that Sub-Saharan Africa, the Middle East, and Central and Southeast Asia are most vulnerable to climate change-related drought, flooding, extreme weather, and resulting food insecurity.¹⁴⁰ DOD may be called upon to respond to climate change-related conflict or instability, thereby impacting the roles and missions of the military.

Nonconflict Operations

DOD has an established mission to conduct humanitarian assistance/disaster relief, and has long played a role in U.S. efforts to assist foreign populations, militaries, and governments.¹⁴¹ The historical DOD role in providing assistance and support to foreign nations can be regarded as serving three purposes:

1. responding to humanitarian and basic needs,
2. building foreign military capacity and capabilities, and
3. strengthening foreign governments’ ability to deal with internal and international threats through state-building measures.¹⁴²

¹³⁷ Department of Defense, *Quadrennial Defense Review, 2014*, p. 85; Department of Defense, *Climate Change Adaption Roadmap*, FY2012, p. 1; Department of Defense, *FY 2014 Climate Change Adaption Roadmap*, “Foreword.”

¹³⁸ Department of Defense, “Quadrennial Defense Review, 2010,” p. 85. This theme was echoed in the 2014 QDR.

¹³⁹ Office of the Director of National Intelligence, *The National Intelligence Strategy of the United States of America*, 2014, September 2014, p. 5. A 2012 report coordinated by the intelligence community predicted that “during the next 10 years, water problems will contribute to instability in states important to U.S. national security interests ... [A]s water shortages become more acute beyond the next 10 years, water in shared basins will increasingly be used as leverage; the use of water as a weapon or to further terrorist objectives also will become more likely beyond 10 years.” Office of the Director of National Intelligence, *Global Water Security*, Intelligence Community Assessment, February 2, 2012, p. iii, http://www.dni.gov/files/documents/Special%20Report_ICA%20Global%20Water%20Security.pdf.

¹⁴⁰ Gjeltel, Tom. “Intel Report Eyes Climate Change-Security Link,” NPR, June 23, 2008, <http://www.npr.org/templates/story/story.php?storyId=91819098>. Referring to National Intelligence Council 2008, National Security Implications of Global Climate Change Through 2030.

¹⁴¹ According to officials, DOD does not structure the force specifically for humanitarian assistance or disaster relief.

¹⁴² For a detailed discussion of the role of DOD in foreign assistance, see CRS Report RL34639, *The Department of Defense Role in Foreign Assistance: Background, Major Issues, and Options for Congress*, coordinated by Nina M. Serafino.

The use of DOD to provide foreign assistance stems in general from the perception that DOD can contribute unique or vital capabilities and resources because it possesses the manpower, materiel, and organizational assets to respond to international needs.¹⁴³ The United States may have a significant interest in having the military conduct selected nonconflict operations (such as training and capacity building) as a means of preempting conflict, instability, or humanitarian crises that could otherwise emerge.

DOD has unique capabilities to address climate-related challenges. For example, a nuclear-powered aircraft carrier can produce more than 400,000 gallons of drinking water from sea water per day, thereby providing fresh water to remote seacoast populations in times of crisis.¹⁴⁴ The Army Corps of Engineers possesses the capability to assist nations in developing the infrastructure necessary to manage critical government services such as water access and allocation.

2. Installations, Readiness, and Mission Assurance

DOD maintains more than 555,000 facilities at more than 5,000 locations worldwide, covering 28 million acres. DOD installations are found in all 50 states, 7 U.S. territories, and 40 foreign countries.¹⁴⁵ The total value of its buildings and structures is estimated at approximately \$874 billion.¹⁴⁶ Given the extent of the DOD infrastructure, adapting to climate change impacts that affect installations and facilities worldwide could require significant financial investments.

DOD's operational readiness and capabilities depend on continued and reliable access to functioning installations (including ports and bases), and training and testing facilities.¹⁴⁷ DOD's portfolio of installations faces direct risks from some impacts of climate change.¹⁴⁸ Some of these risks include the following:¹⁴⁹

- sea-level rise, storm surge risks, and storm runoff at coastal installations;
- drought and competition for water resources with local populations;
- extreme heat and severe flooding; and

¹⁴³ *FY 2014 Climate Change Adaption Roadmap*, p. 2.

¹⁴⁴ <http://navylive.dodlive.mil/2013/11/14/the-aircraft-carrier-more-than-a-warship/>.

¹⁴⁵ Deputy Under Secretary of Defense (Installations and Environment), *Base Structure Report*, Fiscal Year 2013 Baseline, pp. 2, 7. Installations are defined as buildings and structures; see http://www.acq.osd.mil/ie/download/bsr/Base%20Structure%20Report%202013_Baseline%2030%20Sept%202012%20Submission.pdf.

¹⁴⁶ DOD categorizes buildings (valued at \$567B), structures (\$141B), and linear structures (\$119B) separately. See Deputy Under Secretary of Defense (Installations and Environment), *Base Structure Report*, Fiscal Year 2013 Baseline, pp. 8, 10, and 12. For a definition of the different categories, see p. 4, http://www.acq.osd.mil/ie/download/bsr/Base%20Structure%20Report%202013_Baseline%2030%20Sept%202012%20Submission.pdf.

¹⁴⁷ Department of Defense, "Quadrennial Defense Review, 2010," p. 85, <http://www.defense.gov/qdr/qdr%20as%20of%2026jan10%200700.pdf>.

¹⁴⁸ The National Intelligence Council reportedly estimated in a 2008 report that more than 30 coastal military installations in the continental United States were facing threats from sea-level rise; about 10% of DOD coastal installations are at or near sea level. Department of Defense, Strategic Environmental Research and Development Program, "Assessing Impacts of Climate Change on Coastal Military Installations: Policy Implications," January 2013, p. 5, referring to National Intelligence Council, 2008, National Security Implications of Global Climate Change Through 2030.

¹⁴⁹ Office of the Deputy Undersecretary of Defense (Installations and Environment), "Climate Change Adaptation and the Department of Defense," presentation, March 8, 2012, p. 9.

- changes in weather conditions that make training facilities unusable for their intended purpose (for example, a facility dedicated to alpine training may not be useable if warming temperatures result in insufficient snow depths).¹⁵⁰

Climate change-related effects are already being observed at military installations worldwide.¹⁵¹ As the Strategic Environmental Research and Development Program found, “Climate-related effects already are being observed at DOD installations in every region of the United States and its coastal waters. The direction, degree, and rate of these changes will differ by region, as will the impacts to the military’s infrastructure and capabilities.”¹⁵²

These impacts could increase the cost of maintaining installations and critical infrastructure, as well as impact the ability of the installations to support operations.

DOD installations often rely on non-DOD infrastructure. Bases may rely on local towns or cities for food, housing, local workforce, and infrastructure (such as the maintenance of surrounding roads). Climate changes that affect these towns or cities could adversely affect the functionality of military installations located nearby.

¹⁵⁰ Similarly, extreme heat or drought could also impact an installation’s effectiveness. Extremely dry conditions could raise the risk of wildfires, thereby limiting the days that live-fire exercises or artillery practice could be conducted.

¹⁵¹ See *FY 2014 Climate Change Adaptation Roadmap*, p. 2; U.S. Government Accountability Office, *Climate Change Adaptation: DOD can Improve Infrastructure Planning and Processes to Better Account for Potential Impacts*, GAO-14-446, May 30, 2014, pp. 11-14.

¹⁵² SERDP website, <http://www.serdp.org/Program-Areas/Resource-Conservation-and-Climate-Change>. See also U.S. Congress, Senate Committee on Appropriations, Subcommittee on Department of Defense, *The National Security Implications of Climate Change*, Written Statement, 113th Cong., 2nd sess., May 21, 2014, pp. 2-3.

The Arctic: A Case Study

The Arctic region highlights some of the challenges climate change can pose to the military. As discussed in the Navy's 2009 Arctic roadmap, the Arctic region is warming twice as rapidly as the rest of the world and may experience "nearly ice-free summers sometime in the 2030's." At some point in the future, the changing Arctic environment may lead to increased resource development, tourism, development, and shipping in the region, which will offer opportunities for either peaceful cooperation or increased tensions.

The opening of the Arctic may require the military to respond to a range of future scenarios. As shipping and transportation in the region increase, the military services may be called upon to ensure access to the global commons or to conduct rescue operations. According to a Navy official, the Navy does not maintain assets north of the Arctic circle and does not currently possess the topographical knowledge, logistical support, or fleet structure necessary to effectively execute a full range of surface fleet operations in the region. DOD may need to develop a more robust infrastructure in the Arctic to support future operations.

According to DOD officials, the Coast Guard manages most of the current Arctic-region operational requirements. Given the pace of climate change, DOD does not foresee a near-term gap in capabilities, and is focusing its efforts on long-term operational requirements. In 2009, the Navy's Task Force Climate Change released the first *U.S. Navy Arctic Roadmap*. In November 2013, DOD issued its first *Arctic Strategy*, a 14-page document outlining the overarching strategic approach in the region. In February 2014, the Navy issued a more detailed roadmap for the Arctic entitled *U.S. Navy Arctic Roadmap: 2014-2030*, which is intended to be an implementation plan, complete with required actions and reporting requirements.

For an in-depth discussion on the Arctic, including national security issues, see CRS Report R41153, *Changes in the Arctic: Background and Issues for Congress*, coordinated by Ronald O'Rourke.

DOD Adaptation Plan and Other Actions

In October 2014, DOD released its *FY 2014 Climate Change Adaptation Roadmap*.¹⁵³ The roadmap outlines three broad goals for addressing climate change:

1. identifying and assessing the effects of climate change,
2. managing risks associated with climate change by integrating climate change considerations into department planning and policy, and
3. collaborating with other agencies, foreign governments, international organizations, and industry to meet the challenges of climate change.¹⁵⁴

DOD is already incorporating climate change considerations into installation and training plans, and is beginning to include the science and strategic implications of climate change in formal military training and education.¹⁵⁵ In recent testimony, Dr. Daniel Chiu, Deputy Assistant Secretary of Defense for Strategy and Force Development stated, "the Department initiated in 2013 a review of existing directives, policies, manuals, and associated guidance document and criteria to identify which ones should incorporate considerations of a changing climate. The initial screen reviewed 58 documents and identified 28 policies, programs and procedures for update; five have already been updated, all dealing with installations."¹⁵⁶

¹⁵³ Department of Defense, *FY 2014 Climate Change Adaptation Roadmap*, June 2014. While the report was released to the public in October (see <http://www.defense.gov/Releases/Release.aspx?ReleaseID=16976>), the report is dated June 2014 (see back cover of report).

¹⁵⁴ *Ibid.*; see p. 1 and the detailed discussion of each goal within the report.

¹⁵⁵ *Ibid.*, p. 9.

¹⁵⁶ U.S. Congress, Senate Committee on Appropriations, Subcommittee on Department of Defense, *The National Security Implications of Climate Change*, Written Statement, 113th Cong., 2nd sess., May 21, 2014.

In addition to DOD's climate change adaptation roadmap, DOD also established goals related to the reduction of energy, water, and fuel use, as well as the reduction of greenhouse gas emissions and more sustainable practices as part of its strategic sustainability plan.¹⁵⁷ Meeting these goals may contribute to more climate-resilient installations and activities.

DOD Research on the Impact of Climate Change

According to DOD, "more comprehensive and region/installation-specific vulnerability assessments are needed to determine which adaptive responses are appropriate."¹⁵⁸ Given the pace of climate change, many of its potential effects on DOD could take time to develop. In addition to the efforts currently under way (as described above), DOD intends to research climate system modeling, environmental process models, and assessment and adaptation methods.¹⁵⁹ This effort could help inform a strategic approach to managing the risks of climate change.

Regarding DOD's efforts to collect and analyze data regarding the vulnerabilities of its installations to climate change, GAO concluded that "[w]ithout a plan, including interim milestones to gauge progress, DOD may not finish its assessments in a timely and complete manner."¹⁶⁰ GAO recommended that DOD develop a plan with milestones, and provide further information to installation planners, clarifying actions that should be taken to account for climate change in planning documents, and clarify the processes used to compare military construction projects for funding to include consideration of potential climate change impacts. DOD concurred with GAO's recommendations and explained how they will be implemented.

Much of the research is conducted by DOD in partnership with DOE and EPA under DOD's Strategic Environmental Research and Development Program (SERDP). SERDP, established in 1990 to coordinate environmental research across military services, has been tasked with developing climate change assessment tools for DOD installations. Under this program, DOD is producing several reports focusing on adaptation science and vulnerability and impact assessment (see **Table 2**).

¹⁵⁷ Department of Defense, *FY2012 Strategic Sustainability Plan*, September 2012, p. II-2-II-3, http://ww.acq.osd.mil/ie/download/green_energy/dod_sustainability/2012/DoD%20SSPP%20FY12-FINAL.PDF.

¹⁵⁸ Department of Defense, *FY 2012 Climate Change Adaptation Roadmap*, September, 2012, p. 2.

¹⁵⁹ Department of Defense, "The Department of Defense and Climate Change: Initiating the Dialogue," January 2012, Proceedings of a workshop convened July 19-21, 2011.

¹⁶⁰ GAO, 2014, op. cit. Highlights.

Table 2. Selected SERDP Research Relevant to Climate Change DOD Adaptation

Research Number	Title	
RC-1699	Integrated Climate Change and Threatened Bird Population Modeling to Mitigate Operations Risks	Completed
RC-1700	Effects of Near-Term Sea-Level Rise on Coastal Infrastructure	Completed
RC-1703	A Methodology for Assessing the Impact of Sea Level Rise on Representative Military Installations in the Southwestern United States	Completed
RC-1701	Risk Quantification for Sustaining Coastal Military Installation Assets and Mission Capabilities	
RC-1702	Shoreline Evolution and Coastal Resiliency at Three Military Installations: Investigating the Potential for and Impacts of Loss of Protecting Barriers	
RC-2110	Addressing the Impacts of Climate Change on U.S. Army Alaska with Decision Support Tools Developed Through Field Work and Modeling	
RC-2204	Decision Scaling: A Decision Framework for DOD Climate Risk Assessment and Adaptation Planning	
RC-2205	Assessing Climate Change Impacts for DOD Installations in the Southwest United States during the Warm Season	
RC-2206	Understanding Data Needs for Vulnerability Assessment and Decision Making to Manage Vulnerability of DOD Installations to Climate Change	
RC-2232	Climate Change Impacts and Adaptation on Southwestern DOD Facilities	
RC-2242	Climate Change Impacts to Department of Defense Installations	
RC-2245	Defense Coastal / Estuarine Research Program	
RC-2334	The Impact of Sea-Level Rise and Climate Change on Department of Defense Installations on Atolls in the Pacific Ocean	
RC-2335	Advancing Best Practices for the Formulation of Localized Sea Level Rise/Coastal Inundation “Extremes” Scenarios for Military Installations in the Pacific Islands	
RC-2336	Impacts of Changing Climate on Pacific Island-Based Defense Installations	
RC-2340	Water Resources on Guam: Potential Impacts and Adaptive Response to Climate Change for Department of Defense Installations	
RC-2436	Improving Design Methodologies and Assessment Tools for Building on Permafrost in a Warming Climate	

Source: SERDP, <http://www.serdp.org/Program-Areas/Resource-Conservation-and-Climate-Change/Climate-Change/%28list%29/1/>.

Note: Data as of May 2014.

Military Department Adaptation Activities

The Under Secretary of Defense for Acquisition, Technology, and Logistics is the Senior Sustainability Official responsible for implementing E.O. 13514 and overseeing climate change adaptation. The Deputy Under Secretary of Defense (Installations and Environment) is responsible for overseeing implementation of DOD climate change adaptation efforts, and published the *FY 2014 Climate Change Adaptation Roadmap*.

In addition, each military department is undertaking climate change adaptation activities. The Army has formed a climate change working group, which is working on incorporating climate change considerations into policies, guidance, and plans; assessing vulnerabilities across locations and missions; and performing pilot demonstrations at two locations to include climate change concerns in installation plans. To support these efforts, the Army Science Board issued a report, *Planning for Climate Change: Actions for the Army to Better Adapt to the Effects of Climate Change in 2030* (November 2013),¹⁶¹ and the Office of the Assistant Secretary of the Army (Installations, Energy, and Environment) released a report, *High-level Climate Change Vulnerability Assessment* (December 2013), which “provides an overview of potential Army installation vulnerabilities to climate change.”¹⁶²

The Air Force’s 2010-2030 Strategic Environment Assessment includes climate change as a strategic consideration. The Air Force is also developing installation management plans that include climate change impacts for two coastal installations.¹⁶³

The Navy’s climate change adaptation activities appear to be the most fully developed within DOD. The Navy’s Task Force Climate Change was established in May 2009, earlier than the other military services or establishment of the DOD-wide task force.¹⁶⁴ **Figure 8** shows an example of facility-specific assessments that have been initiated. The Navy released its first Arctic Roadmap in 2009 (four years before the DOD-wide Arctic Strategy was released) and a Climate Change Roadmap in April 2010 (three years before the DOD-wide roadmap was released). The Navy does not intend to issue an updated climate change roadmap, as all the military services now work within the DOD-wide task force and roadmap.¹⁶⁵

¹⁶¹ Army Science Board, *Planning for Climate Change: Actions for the Army to Better Adapt to the Effects of Climate Change in 2030*, FY2013 Summer Study, Washington, DC, November 2013.

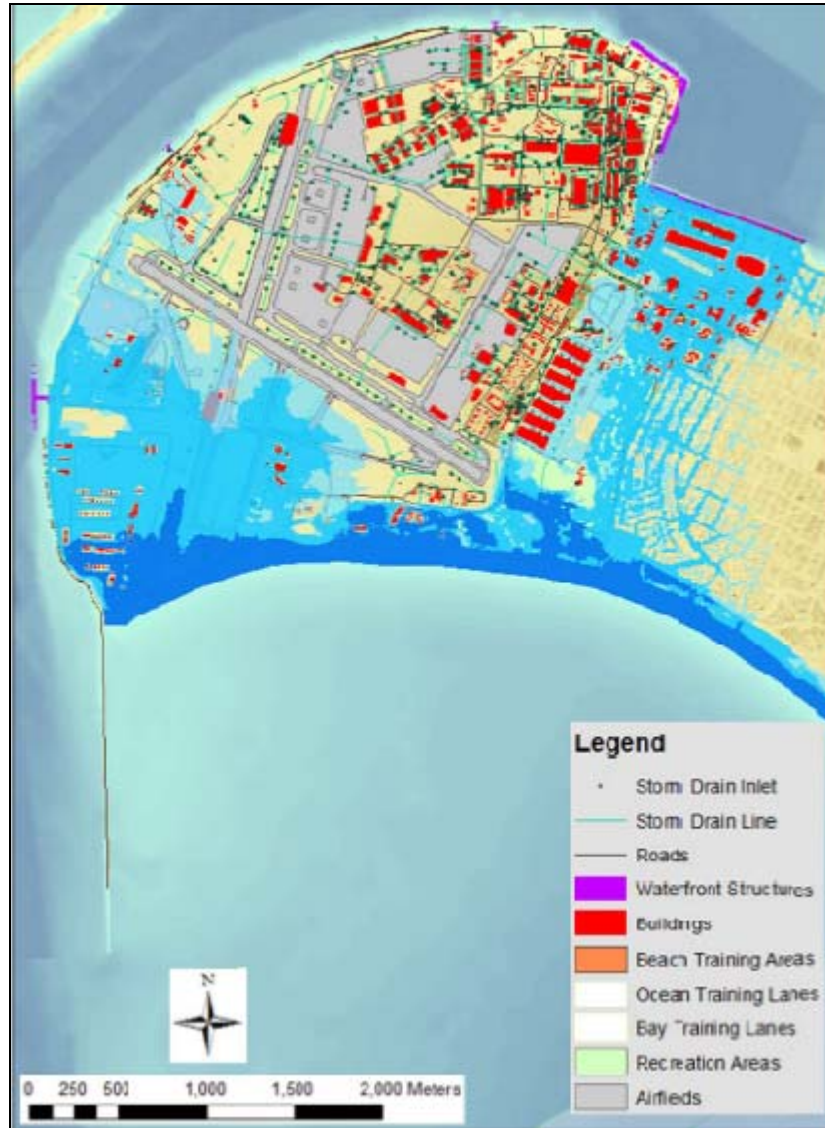
¹⁶² Department of the Army, *High-level Climate Change Vulnerability Assessment*, December 2013, p. 2.

¹⁶³ Department of Defense, Strategic Environmental Research and Development Program, “Assessing Impacts of Climate Change on Coastal Military Installations: Policy Implications,” January 2013, p. 6; Department of Defense, *FY 2012 Climate Change Adaptation Roadmap*, September 2012, p. 7.

¹⁶⁴ The Army Climate Change Work Group was established in 2011. See Department of the Army, *High-level Climate Change Vulnerability Assessment*, December 2013, p. 1.

¹⁶⁵ Based on discussion with Navy official, May 30, 2014. The Navy intends to continue many of its efforts spelled out in the 2010 roadmap, including incorporating climate change into the educational curriculum. CRS has been provided with a list of educational classes containing discussions on climate change that are taught at various Navy institutions.

Figure 8. Example Results of One Assessment of Vulnerability of Coastal Military Installations



Source: Chadwick, Bart, *A Methodology for Assessing the Impact of Sea Level Rise on Representative Military Installations in the Southwestern United States*. Submitted to the Strategic Environmental Research and Development Program, March 2014 (Figure 5-93).

Notes: Results for projected flooding with 1 meter of sea-level rise at Naval Air Station North Island, San Diego, CA. Return periods for floods are represented by dark-blue (weekly), medium-blue (yearly), and light-blue (100-year) shading.

Issues for Congress

The Arctic and Beyond

According to the November 2013 Department of Defense Arctic Strategy,

Fiscal constraints may delay or deny needed investment in Arctic capabilities, and may curtail Arctic training and operations. As the Department downsizes to meet budgetary targets, it will have to prioritize engagements for the resulting smaller force. There is also a risk that desired investments in Arctic capabilities may not compete successfully against other requirements in the Department's budgetary priorities.¹⁶⁶

As such, DOD's approach is to monitor changes in the Arctic and the geostrategic situation to "determine the appropriate timing for future capability investment."¹⁶⁷ Given the fiscal environment and DOD's acknowledgement that it may not prioritize Arctic investment, Congress may consider where climate change should rank in the list of DOD priorities, and to what extent DOD should dedicate limited resources to the potential risks posed by climate change generally, and to the evolving arctic climate specifically.

In addition to the Arctic, Congress may consider the extent to which DOD is preparing now for the potential effects that climate change may have globally. Congress may examine the extent to which DOD is

1. identifying regions of the world most vulnerable to climate change,
2. incorporating climate change impacts into plans, operations, and infrastructure maintenance in these regions, and
3. dedicating sufficient resources to mitigate climate change risks in these regions.

Industrial Base

Congress may also consider whether and to what extent DOD should examine the potential risks climate change poses to the industrial base supporting DOD. As discussed above, climate-related effects are already being observed at numerous DOD installations. DOD and the services are working to develop predictive models, evaluate the impact of climate change, and incorporate climate change into installation management. It is unclear whether DOD plans to take a similar systematic approach to determine what impact, if any, climate change may have on critical industrial base facilities, such as shipyards, or whether DOD plans to evaluate the extent to which contractors are adequately preparing for potential environmental change.

For More DOD Information

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¹⁶⁶ Department of Defense. *Arctic Strategy*. November 2013. http://www.defense.gov/pubs/2013_Arctic_Strategy.pdf. p. 12.

¹⁶⁷ Ibid.

U.S. Army Corps of Engineers (Civil Works)

The Army Corps of Engineers (USACE or the Corps) is an agency in DOD with both military and civilian responsibilities. Under its civil works program, the Corps plans, builds, operates, and maintains a wide range of water resources facilities (e.g., dams, levees, navigational channels) throughout the country. These facilities are sensitive to changes in climate, in particular changes in hydrologic (e.g., droughts, floods, runoff) and coastal processes (e.g., storms, sea-level rise, sediment transport).¹⁶⁸ Climate change is expected to affect all Corps mission areas and activities such as its responsibilities for navigation, flood control, hydropower, and ecosystem restoration. The effects of altered climate are of particular concern where Corps projects have documented vulnerabilities due to flooding (e.g., flood control projects in the Sacramento area or in Greater New Orleans), drought (e.g., water supply projects on the Apalachicola-Chattahoochee-Flint River), and wetland degradation/sea-level rise (e.g., ecosystem restoration projects in coastal Louisiana and the Florida Everglades). A complete assessment of the vulnerability of Corps projects has yet to be completed.

The Corps has outlined its role in responding to climate change as (1) characterizing and understanding potential threats to its missions and operations, and (2) engineering and deploying adaptation strategies and policies that reduce these threats.¹⁶⁹ While the Corps is itself a user of actionable climate science knowledge, it considers the conduct of climate science to be outside of its primary mission.

Efforts to respond to climate change may not directly affect the decision making of nonfederal entities. However, many nonfederal entities rely on infrastructure operated or built by the Corps, and are thus affected by its policies (e.g., operations of reservoirs, planning standards for levees, etc.). Additionally, many of the issues encountered by the Corps are common to managers of nonfederal water resources infrastructure; thus Corps adaptation strategies may be translatable to other agencies and decision makers.

Adaptation-Related Activities

The Corps conducts its climate change planning under the Obama Administration's broader climate change policy framework. In 2012 the Corps prepared and submitted a *Climate Change Adaptation Plan and Report* in accordance with Executive Order 13514.¹⁷⁰ The Corps is a member of the federal Climate Change and Water Working Group (CCAWWG), an interagency working group that provides engineering and scientific collaborations in support of water management. The Corps also sits on the Water Resources Working Group, one of five interagency working groups established by the Council on Environmental Quality (CEQ) to develop a

¹⁶⁸ The foundational document outlining the Corps perspective on climate change and variability to its projects is USGS Circular 1331. See Brekke et al., "Climate Change and Water Resources Management: A Federal Perspective," USGS Circular 1331, 2009, <http://pubs.usgs.gov/circ/1331/>. Hereinafter "USGS Circular 1331."

¹⁶⁹ *U.S. Army Corps of Engineers*, "USACE 2012 Climate Change Adaptation Plan and Report," p. 1, http://www.corpsclimate.us/docs/2012_USACE_Adaptation_Plan_and_Report_23_June_2012%20final.pdf. Hereinafter "2012 USACE Adaptation Report."

¹⁷⁰ This report was issued as an appendix to the USACE FY2012 Sustainability Plan. See U.S. Army Corps of Engineers, "2012 Sustainability Plan," November 2012, http://www.usace.army.mil/Portals/2/docs/Sustainability/Performance_Plans/USACE_Sustainability_Plan_2012_Public_w_Appendices_20121116.pdf.

national strategy for adapting to climate change. These efforts inform other climate change-related work by the Corps at the agency level.

The Corps carries out climate adaptation-related activities in accordance with its 2011 Climate Change Adaptation Policy Statement.¹⁷¹ According to this statement, it is Corps policy to integrate climate change planning and adaptation into agency missions, operations, programs, and projects, and to consider climate change adaptation at every step of the project development process. The policy established the USACE Climate Change Adaptation Steering Committee (ASC), chaired by the Chief of Engineers, to oversee and coordinate implementation of this policy.

The Corps established a program in 2010, the Responses to Climate Change (RCC) program, to develop methods, policies, and processes to reduce the vulnerability of Corps facilities to climate change.¹⁷² To date, some of the primary activities under the Responses to Climate Change program have focused on the creation of assessment frameworks and tools to help characterize vulnerabilities of Corps projects. Future efforts are expected to further incorporate these changes into its planning. For example, in 2011 the Corps developed an Engineering Circular with the help of NOAA and USGS, which established guidance for assessing the effect of sea-level change impacts on coastal projects.¹⁷³ The Corps also developed tools for project managers to understand these effects, including a web-based calculator to aid in assessing sea-level rise potential at Corps projects.¹⁷⁴ The Corps is currently developing a screening process to assess the vulnerability of its projects to sea-level change, and is formulating additional guidance for developing and evaluating alternatives to address these changes at the project level.

For areas in which less actionable science is available, the RCC program has focused largely on characterizing known needs and potential impacts. Through its work on the CCAWWG, the Corps has contributed to multiple interagency reports and forums identifying needed supporting information for water management decisions.¹⁷⁵ For instance, in 2011 and 2013 the Corps and other agencies produced reports identifying needs for long-term and short-term water resources planning and management, respectively.¹⁷⁶ Additionally, the Corps has coordinated workshops to familiarize water managers with changing assumptions due to climate change in project planning, design, and operations such as those related to potential changes in hydrologic extremes. In the future, it plans to build on this work to provide more specific guidance on incorporating these assumptions into project-level climate change impact assessments.

¹⁷¹ U.S. Army Corps of Engineers, "USACE Climate Change Adaptation Policy Statement," June 2011, <http://www.corpsclimate.us/docs/USACEAdaptationPolicy3June2011.pdf>.

¹⁷² Program information is available at <http://corpsclimate.us/rcc.cfm>.

¹⁷³ U.S. Army Corps of Engineers, "Sea-Level Change Considerations for Civil Works Programs," Engineering Regulation No. 1165-2-212, October 1, 2011, http://publications.usace.army.mil/publications/eng-circulars/EC_1165-2-212.pdf.

¹⁷⁴ The calculator is available at <http://www.corpsclimate.us/ccaceslcurves.cfm>.

¹⁷⁵ These efforts build off of a 2009 interagency report with the USGS and other agencies. See USGS Circular 1331.

¹⁷⁶ Brekke, Levi D., et al., *Addressing Climate Change in Long-Term Water Resources Planning: User Needs for Improving Tools and Information*, U.S. Army Corps of Engineers and U.S. Bureau of Reclamation, CWTS-10-02, Washington, DC, January 2011, http://www.ccawwg.us/docs/Long_Term_Addressing_Climate_Change.pdf; and David Raff et al., *Short-Term Water Management Decisions: User Needs for Improved Climate, Weather, and Hydrologic Information*, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, National Oceanic and Atmospheric Administration, CWTS 2013-1, Washington, DC, January 2013, http://www.ccawwg.us/docs/Short-Term_Water_Management_Decisions_Final_3_Jan_2013.pdf.

The Corps is also conducting limited regional impact assessments and pilot studies under its RCC program. It is conducting regional climate impact assessments in specific areas such as Alaska, the Pacific Islands, eastern regions, and the Caribbean Basin. The Corps has also conducted pilot studies at specific locations to better understand the potential effects of climate change at Corps facilities throughout the nation.¹⁷⁷

Issues for Congress

Issues for Congress may include whether available information provides an actionable basis for changes to Corps project development and management, the extent to which the Corps and other water resources managers have the authority and capability (including funding) to implement alterations, and the extent to which Congress agrees with the specifics of these plans. If implemented, alterations to Corps projects may affect the established distribution of Corps project benefits (e.g., altered reservoir operations may provide more water for some purposes and less for others), and could thus prove controversial. Finally, Congress may also weigh in on the status and priority of information “gaps” identified in previous water resources planning forums, including the relative priority and adequacy of various research efforts.

There are significant connections between the adaptation activities of the Corps and other federal agencies, both in the early stages of climate change planning and in day-to-day operations of water resources facilities.¹⁷⁸ Congress may consider these connections as it provides further direction for Corps adaptation activities. In addition to its relationship with other federal agencies, Congress may also provide further guidance and direction for Corps work with nonfederal entities. For instance, Congress may weigh in on the Corps role in facilitating adaptation work related to levees that were constructed by the Corps but operated by nonfederal partners.

For More Army Corps of Engineers Information

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¹⁷⁷ U.S. Army Corps of Engineers, *Climate Change Adaptation Pilots*, September 2012, http://www.corpsclimate.us/docs/RCC_Pilots_Sept_2012_highres.pdf.

¹⁷⁸ For instance, in preparing and implementing its efforts to respond to climate change, the Corps relies heavily on external agencies such as USGS and NOAA to produce actionable science, and works with other water resources management agencies, such as the Bureau of Reclamation, to address similar issues in planning and implementing management actions.

Environmental Protection Agency

The Administrator of the Environmental Protection Agency (EPA), in a June 2011 Policy Statement on Climate Change Adaptation, declared that to fulfill EPA’s mission of protecting human health and the environment,¹⁷⁹ the agency must adapt to climate change. Much of EPA’s work is organized by medium—preventing or reducing pollution in air, soils, and water. EPA also regulates certain chemicals (e.g., pesticides), works to prevent environmental emergencies such as unexpected pollution releases, and responds to releases including those associated with homeland security incidents. The Administrator at that time cautioned that EPA, its partners, and the regulated community may no longer reliably predict future accomplishments when assuming historical climate conditions.

EPA enumerated ways in which its mission may be vulnerable to a changing climate, but has not conducted a detailed, quantitative assessment of the vulnerability of its mission to climate change. Among the potential vulnerabilities, EPA noted that projected higher air temperatures and more stagnant air masses may make it more difficult to achieve health-based standards for smog in some regions, with potentially adverse effects on health and regulatory compliance. Projected increases in flooding, prolonged drought, wildfires, and associated losses of vegetation increase risks of contamination of water and reduced ecosystem services such as water supply and filtration. More heavy rainfall events may increase fertilizer runoff from lands and augment harmful algal blooms in lakes and oceans. Flooding and sea-level rise could lead to contaminant releases from facilities that manage wastes or store hazardous materials, and/or disrupt access in waste management systems. Chemicals, such as pesticides and herbicides, may be used with different frequencies or in different ways. The report further noted that increasingly extreme weather events could divert EPA’s resources to emergency responses and away from day-to-day responsibilities.

EPA reports that the nation’s water resources and infrastructure may be particularly susceptible to climate change. Variable climate conditions, including changes in precipitation (amount, timing, form, and location), changes in the intensity and frequency of extreme weather events, and sea-level rise can result in increased coastal and inland flooding, shoreline erosion, saltwater infiltration into groundwater resources, and diminished supplies of freshwater resources. These events can threaten water utilities’ ability to serve their essential functions; and can alter the quality and function of lakes, estuaries, and other water resources and aquatic ecosystems.

For the most part, EPA’s adaptation plan concerns potential effects of climate change on achieving EPA’s mission. The agency also stated that it has begun to assess “the safety of its personnel, the safe and continued operation of its buildings and other critical assets (e.g., vehicles), and the integrity of its grants and procurement systems” to changes in the climate. Elements of risks to EPA’s infrastructure, personnel, and operations are visible in some of the National Program Offices’ and Regional Offices’ Implementation Plans.

¹⁷⁹ The agency lacks an organic statute establishing an overriding “mission;” rather, a collection of environmental statutes variously require or authorize specific regulatory actions aimed at protecting human health and/or the environment. See Reorganization Plan No. 3 of 1970, 42 U.S.C. §4321 note.

EPA's Adaptation-Related Activities

EPA released an updated Climate Change Adaptation Plan in October 2014. EPA's adaptation-related efforts were also evident in the agency's budget request for FY2015.¹⁸⁰ In its Congressional Justification for FY2014, the agency set three Strategic Measures for climate adaptation activities, to achieve by 2015,¹⁸¹ with performance metrics to measure agency-wide integration of climate change vulnerability assessments and plans:

- integration of science trend and scenario information into five scientific models and/or decision-support tools used in implementing agency environmental management programs, consistent with existing authorities;
- integration of science trend and scenario information into five rulemaking processes to further EPA's mission, consistent with existing authorities; and
- consideration of impacts and adaptive measures into five major grant, loan, contract, or technical assistance programs, consistent with existing authorities.

These adaptation-related performance metrics did not appear in EPA's FY2015 Congressional Justification.

EPA was among the first federal agencies to release implementation plans across all of its programs and geographic regions to facilitate their adaptation to climate change.¹⁸² In most cases, these implementation plans identify program- and location-specific vulnerabilities and needs for further assessment, though they also identify some concrete actions and timetables.¹⁸³ Common actions across offices include the following:

- increased training of staff on science, engineering, risks, and options to anticipate, monitor, and respond to emerging climate challenges;
- consideration of options for greater reliance on distributed energy to reduce vulnerabilities of EPA offices and operations—especially of emergency response resources—to grid and telecommunication interruptions possible with extreme events or high cooling demand for electricity; and
- enhancing priority of EPA facilities' water conservation in drought-susceptible areas.

¹⁸⁰ EPA, *Fiscal Year 2015: Justification of Appropriation Estimates for the Committee on Appropriations*, EPA-190-R-14-002. March 2014. <http://www.epa.gov/ocfo>.

¹⁸¹ EPA, *Fiscal Year 2014: Justification of Appropriation Estimates for the Committee on Appropriations*, EPA-190-R-13-003. April 2013, <http://www.epa.gov/ocfo>, pp. 882-883.

¹⁸² See EPA Adaptation Implementation Plans at <http://www.epa.gov/climatechange/impacts-adaptation/fed-programs/EPA-impl-plans.html>.

¹⁸³ The EPA adaptation plans build on three decades of investment in research and several partnerships to identify and address health and environmental risks linked to extreme weather events and climate change. See, as examples, Hoffman, J.S., Keyes, D., and Titus, J.G., *Projecting future sea level rise: methodology, estimates to the year 2100, and research needs*, EPA Technical Report EPA-230-09-007, October 24, 1983; EPA Office of Water, *Climate Ready Water Utilities*, <http://water.epa.gov/infrastructure/watersecurity/climate/>; EPA, Office of Water, *Explore Climate Ready Estuaries*. <http://water.epa.gov/type/oceb/cre/explore.cfm/>.

EPA's climate adaptation policy¹⁸⁴ gives emphasis to developing external partnerships, and has a goal of mitigating impacts on the nation's most vulnerable populations including children and the elderly, and minority, low-income, and indigenous populations. In many cases, EPA's documents reflect the agency's view that it occupies one niche in a broader societal response to climate changes. For example, EPA Region 6's adaptation implementation plan notes that "[i]n some cases, market forces will continue to push desired outcomes even without the Agency's involvement.... The federal government has an important and unique role in climate change adaptation, but is only one part of a broader effort that must include public and private partners throughout the country and internationally."¹⁸⁵

Likewise, the Office of Solid Waste and Emergency Response explicitly asked, "Does EPA have a unique or lead role or technical expertise ... ?,"¹⁸⁶ as it evaluated opportunities and set priorities in a resource-constrained environment.

EPA's Adaptation Implementation Plans lay out actions to be undertaken in its own programs and through work with partners in the private sector and with public agencies at the federal, state, local, and international levels.¹⁸⁷ For example, the agency is assisting selected communities, states, and businesses to revise design guidelines for water treatment systems, develop extreme heat warning systems with selected cities, and help coastal communities prepare for sea-level rise. EPA appears to have reduced some of its early adaptation activities as other agencies have expanded related efforts such as in urban heat warning systems and coastal zone analysis.¹⁸⁸ These supplement ongoing EPA observational and research activities related to climate change.

Some highlights of EPA's adaptation plans for individual office operations are identified below.¹⁸⁹

Office of Administration and Resource Management (OARM). EPA will consider enhancing the resilience of existing agency facilities in coastal areas to protect them from severe weather, flood damage, and sea-level rise, and work with the General Services Administration (GSA) to account for climate change in design and construction of new or leased facilities. A particular example is incorporation of considering resilience to climate change into GreenCheck, OARM's process to evaluate building projects. The effort aims to ensure that EPA laboratories—which need water for experiments and building cooling—are prepared to respond in drought or adverse water quality events. Likewise, facilities will prepare to reduce reliance on the electrical grid, which may suffer interruption with weather events and rising temperatures. Also, the agency may

¹⁸⁴ EPA, *FY 2011-2015 EPA Strategic Plan: Achieving Our Vision*, September 30, 2010, p. 7.

¹⁸⁵ EPA Region 6, Climate Change Adaptation Implementation Plan, DRAFT, September 18, 2013, p. 9.

¹⁸⁶ EPA/OSWER, Climate Change Adaptation Implementation Plan, DRAFT, June 2013, p. 9.

¹⁸⁷ Some of EPA's programs to assist partners to adapt to climate change include the Heat Island Reduction Program; Climate Ready Water Utilities; Smart Growth for Coastal and Waterfront Communities, with NOAA; and participation in the interagency Partnership for Sustainable Communities.

¹⁸⁸ See NOAA's *National Weather Service's Heat/Health Watch Warning System: Improving Forecasts and Warning for Excessive Heat*, January 11, 2005, for an announcement of NOAA's increased efforts on programs pioneered with EPA's assistance, <http://www.nws.noaa.gov/pa/fstories/2005/0105/fs11jan2005a.php>. NOAA's and other organizations' efforts to prepare for sea-level rise are not widespread, but grew from seminal EPA efforts in the 1980s. (See, among others, Titus, James G., "Planning for sea level rise before and after a coastal disaster," *Greenhouse Effect and Sea Level Rise: A Challenge for This Generation*. New York: Van Nostrand Reinhold Company (1984).)

¹⁸⁹ EPA's Adaptation Implementation Plans for its program and Regional Offices, released in late 2013, are available at <http://epa.gov/climatechange/impacts-adaptation/fed-programs/EPA-impl-plans.html>.

need to redirect personnel to assist emergency management, assess environmental damage, or test sites for contamination following severe weather or other climate-related events.

Office of Air and Radiation (OAR). OAR plans to review and revise information regarding the potential impacts of climate change on concentrations of criteria air pollutants (such as ozone and particulate matter) as well as indoor air quality. Better understanding of climate change on air pollution may inform outreach to citizens as well as guidance and tools for partners. OAR will consider whether research indicates that the office needs to modify the analytical tools and models used for developing and implementing regulations.

Office of Chemical Safety and Pollution Prevention (OCSPP). EPA is concerned that changes in the climate could affect exposures to chemicals by altering environmental patterns or use patterns. The office intends to ensure that its tools and methods reasonably reflect environmental changes, including climate changes, and how these may affect assessments of the rate, timing and/or frequency of chemical uses, or alter disease or invasive species distributions. Historical weather data sets may be updated. The office will consider new pathways and changes in chemical behavior that may result from a changing climate. In addition, the office may acquire better data on the locations of existing facilities such as chemical storage in low-lying areas that may be susceptible to flooding. The agency notes that it has not assessed potential changes to exposures for some kinds of chemicals, such as lead or asbestos used in buildings, and how they may be altered by any changes in fires, high winds, or flooding.

Office of Water. The Office of Water strategy is to “integrate climate change considerations and awareness into day-to-day management decisions for clean water and drinking water programs at national, Regional, State, Tribe, and local levels.”¹⁹⁰ Program areas covered by adaptation initiatives include water infrastructure, watersheds and wetlands, coastal and ocean waters, and water quality. Priority adaptation initiatives include, among others, (1) encouraging climate change consideration in managing the Clean Water and Drinking Water State Revolving Loan Fund programs, (2) developing screening criteria to identify water sector utilities in coastal areas that may be at risk of inundation from storm surges, (3) building state and local capacity to protect watersheds, (4) expanding WaterSense partners and products, (5) identifying ways to integrate climate change considerations into water quality management planning, and (6) promoting the use of an Extreme Events Workshop Planner for water utilities. EPA also integrated climate change into wetland program grants. Under the Climate Ready Water Utilities (CRWU) Initiative, EPA has developed a climate change risk assessment tool (Climate Resilience Evaluation and Awareness Tool, or CREAT).¹⁹¹ In FY2015, EPA plans to promote climate change adaptation by water, wastewater and stormwater systems by increasing the role of the CRWU Initiative in emergency response and preparedness efforts. EPA proposes to use funds realigned from the water security program for this purpose and to develop and distribute a more robust climate resilience evaluation tool that incorporates sea-level rise and storm surge components, and allows mapping of facilities.¹⁹²

¹⁹⁰ U.S. Environmental Protection Agency, *Office of Water Climate Change Adaptation Implementation Plan, Draft*, Office of Water, September 2013, p. 12, <http://epa.gov/climatechange/Downloads/impacts-adaptation/office-of-water-plan.pdf>.

¹⁹¹ In April 2014, EPA issued its fifth progress report summarizing its water program’s climate change accomplishments. See U.S. Environmental Protection Agency, *2013 Highlights of Progress: Responses to Climate Change by the National Water Program*, EPA-850-R-14-002, April, 24, 2014, <http://www.epa.gov/water/climatechange>.

¹⁹² U.S. Environmental Protection Agency, *Fiscal Year 2015, Justification of Appropriation Estimates for the* (continued...)

Office of Solid Waste and Emergency Response (OSWER). Among 23 OSWER priority actions over three years, several will increase outreach and informational tools to prepare to manage possible surges in waste and debris from the impacts of extreme climate-related events. This would entail cooperation with the Department of Homeland Security (DHS). Efforts to prevent contamination from chemical releases will involve enhanced inspector training and guidelines. Regarding waste cleanup, OSWER offices will gather further information, increase outreach, and in some cases require grantees to consider potentially changing climate conditions when evaluating alternative measures. In addition, the agency has begun to apply screening analysis mapping to identify the sites most likely to be vulnerable to climate change.

Office of Research and Development (ORD). ORD will work with OARM to identify and reduce vulnerabilities of laboratory assets, and identify particular facilities that may be most vulnerable to severe weather or flooding. ORD will also need to safeguard and maintain continuity of other research assets such as field experiments, equipment, archived samples, and personnel from extreme temperature and precipitation. ORD reports it has incorporated criteria for climate change adaptation in grant development.¹⁹³

Office of Enforcement and Compliance Assistance (OECA). Federal laws broadly hold federal facilities to the same standards of environmental compliance as others in the regulated community.¹⁹⁴ In some instances, OECA will inspect facilities that manage hazardous wastes, oil, toxic chemicals, and/or discharge stormwater in FEMA flood zones to determine environmental compliance and recommend best management practices to avoid unexpected releases.

Beyond the actions of program offices highlighted above, EPA Regional Offices have undertaken additional types of actions. One example is working with the National Response Framework and the National Disaster Recovery Framework to incorporate climate adaptations into post-disaster redevelopment plans. Another is developing methods to identify the most vulnerable populations within regions. Some regions are developing plans to alert schools and other susceptible populations to air quality emergencies that may increase with climate change, such as wildfire pollution episodes.

EPA's adaptation plan also emphasizes that climate change impacts may be most severe on certain already vulnerable populations, including the elderly and low-income communities, as well as tribes. The agency has established a principle to give priority to addressing the vulnerabilities to climate change of these people and communities.

Reports on Accomplishments

EPA has not prepared comprehensive quantitative assessments of the vulnerability of health and environmental protection to climate change.¹⁹⁵ Some limited studies are available.¹⁹⁶ Though the

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Committee on Appropriations, EPA-190-R-14-002, March 2014, p. 114.

¹⁹³ Scheraga, J.D. and B.S. Binder, "Incorporating Climate Change Adaptation Considerations into Applicable Assistance Agreement Competitive Funding Opportunity Announcements," Memo to Grants Customer Relations Council and Agency Senior Resource Officials, October 18, 2011.

¹⁹⁴ See, e.g., Clean Air Act §118, 42 U.S.C. §7418.

¹⁹⁵ EPA, *Climate Change Adaptation Plan (draft)*, Washington, DC, June 2012, p. 7.

¹⁹⁶ See a summary of available information from EPA at <http://www.epa.gov/climatechange/impacts-adaptation/> (continued...)

agency set three quantitative Strategic Measures to achieve by 2015—to incorporate consideration of climate change into decision tools, grants or assistance, and rulemakings (see above)—the October 2014 report included little specific discussion of progress toward achieving those quantitative measures. It cited only inclusion of a Climate Assessment Tool within the broader watershed and water quality analysis tool, BASINS, available to help regional, state, and local agencies assess water resource and management issues.

Often in cooperation with other federal agencies or state or local governments, EPA has produced a number of resources intended to assist the agency in helping others (communities, tribes, private companies, etc.) anticipate and respond to climate change. One of EPA's earliest efforts, with the Centers for Disease Control and Prevention (CDC), the National Weather Service (NWS), and nongovernmental organizations, was support for development of Heat Health Watch/Warning Systems to reduce deaths related to extreme heat events that may increase with climate change. For example, EPA helped the Philadelphia Department of Public Health develop a heat warning system that one study estimated saved 117 lives between 1995 and 1998, with benefits that greatly exceeded the costs of the system.¹⁹⁷ The approach has been replicated and tailored to numerous other localities.

Issues for Congress

As Congress oversees EPA operations and considers related budget proposals and priorities, there are multiple issues it may consider with regard to climate change adaptation:

- Does EPA's research and that of other agencies and institutions meet the needs of EPA's programs for reliable climate change-related data and models, in order to identify potential risks and their locations? Through what mechanisms are EPA's information needs identified? Are climate change data accessible to the regulated community and the public?
- Are there specific questions of authority that may arise as EPA pursues adaptation measures? For example, EPA noted in its 2012 Adaptation Plan that it may need to determine the extent of its authorities to consider climate change impacts in setting standards or issuing permits.¹⁹⁸ Similarly, relationships between EPA's statutory authorities and various expenditures for climate initiatives may be of oversight interest.
- Could metrics of adaptation *outcomes* (rather than agency activities) for health and the environment be quantified in budget justifications?¹⁹⁹ What may be the challenges? Could quantitative metrics related to effectiveness of adaptation activities be meaningful and effective?

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society.html. The Office of Water has perhaps the longest-standing and most comprehensive effort on adaptation to climate change within the agency. This may explain why there is more information regarding accomplishments than for other offices.

¹⁹⁷ Ebi, Kristie L., et al., "Heat Watch Warning Systems Save Lives: Estimated Costs and Benefits for Philadelphia, 1995-1998," *Epidemiology*, September 2003.

¹⁹⁸ See discussion in EPA, *Climate Change Adaptation Plan (draft)*, Washington, DC, June 2012, pp. 37-38.

¹⁹⁹ EPA, <http://www2.epa.gov/sites/production/files/documents/cjfy14.pdf#page=1110>.

- In the water sector, many EPA adaptation activities are compatible with, but may fall outside, the core statutory responsibilities. It may be difficult to discern the level of resources allocated to climate change adaptation activities separately from spending on core mission activities, or to determine whether focus on climate change may have an effect on implementation of core statutory missions. Is the allocation of resources allotted to adaptation planning and initiatives in this or other programs adversely affecting congressionally required functions?

For More EPA Information

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Federal Emergency Management Agency

The Department of Homeland Security's (DHS's) Federal Emergency Management Agency (FEMA) has the primary mission to reduce the loss of life and property from all hazards, including man-made and natural disasters. FEMA accomplishes this mission by leading and supporting the nation in a risk-based, comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation.²⁰⁰ Through this mission, FEMA has a lead role in guiding nationwide adaptation to the impacts of climate change related to extreme weather events. Scientific research organizations have highlighted the potential impact of climate change as it relates to the frequency, and potential severity, of extreme weather events.²⁰¹ FEMA expects that climate change will adjust the likelihood and magnitude of certain extreme weather events, but not create novel threats.

Therefore, FEMA expects that the nation will experience more natural disasters of certain types—namely meteorological phenomena such as heavy precipitation events, flooding, heat waves, and droughts—that may also produce greater damages when they strike communities. When the prospective change in likelihood and severity of threats is accounted for, it may result in new risk²⁰² for communities across the nation. Not all changes to risks will have negative outcomes for the nation or individual communities. It is possible, for instance, that the likelihood of certain extreme weather events will decrease in a particular region with changing climate conditions such as a lower likelihood of drought in a region. Changes to risk are also unlikely to be consistent across geographic regions of the nation.²⁰³ Further, future risk to extreme weather events may be offset or exacerbated by other correlated or uncorrelated factors. For example, enhanced building design or other technological advancements may reduce physical vulnerability to a particular extreme weather event. As these types of natural disasters already threaten the nation, FEMA is primarily working to integrate climate change adaptation into existing programs and policies that mitigate these threats, as opposed to developing additional, climate change-specific programs/policies.²⁰⁴

²⁰⁰ For a full description of FEMA's mission and authorities, see 6 U.S.C. §§314-315, which are §§503 and 504 of the Homeland Security Act of 2002, as amended. See also the Robert T. Stafford Disaster Relief and Emergency Assistance Act (P.L. 93-288, as amended); Title V of the Homeland Security Act of 2002 (P.L. 107-296, 6 U.S.C. §§311-321, as amended); and the Post-Katrina Emergency Management Reform Act of 2006 (P.L. 109-295, 6 U.S.C. §§700-797).

²⁰¹ For examples, see the following:

- Key messages 5-10 in Jerry Hatfield, Gene Takle, and Richard Grotjahn et al., *Climate Change Impacts in the United States: The Third National Climate Assessment*, U.S. Global Research Program, "Chapter 2: Our Changing Climate," May 6, 2014, <http://nca2014.globalchange.gov/>;
- National Research Council, *Adapting to Impacts of Climate Change*, 2010, pp. 29-61, at http://www.nap.edu/catalog.php?record_id=12783;
- National Research Council, *Climate and Social Stress: Implications for Security Analysis*, 2012, at http://www.nap.edu/catalog.php?record_id=14682;
- U.S. Government Accountability Office, *High Risk Series: An Update*, GAO-13-283, February 2013, pp. 61-75, <http://www.gao.gov/products/GAO-13-283>; *Global Climate Change Impacts in the United States*, ed. Karl, Thomas R., Melillo, Jerry M., and Peterson, Thomas C. (Cambridge University Press, 2009), at <http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf>; and
- Intergovernmental Panel on Climate Change, *Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, Summary for Policymakers, New York City, NY, 2012, http://ipcc-wg2.gov/SREX/images/uploads/SREX-SPMbrochure_FINAL.pdf.

²⁰² Department of Homeland Security, *DHS Risk Lexicon: 2010 Edition*, September 2010, p. 27, at <http://www.dhs.gov/dhs-risk-lexicon>. Risk is defined as the "potential for an unwanted outcome resulting from an incident, event, or (continued...)"

FEMA's Adaptation-Related Activities

In a strategic plan, FEMA has identified climate change as a key “driver” of future needs for emergency management.²⁰⁵ In a supporting assessment of this driver of future needs, the agency noted that the implications of climate change on emergency management may be exacerbated by other projected changes including aging infrastructure, forecasts of lower government budgets, and increasing demographic concentration in cities and coastal areas.²⁰⁶ In review of these strategic assessments, FEMA has identified actions to integrate climate change adaptation planning into its existing programs, policies, and operations.

In addition to its agency-specific work, FEMA, as a component of DHS, has led a DHS Task Force set up to evaluate the risks of climate change effects to DHS missions and operations.²⁰⁷ Working in conjunction with other components of DHS such as the U.S. Coast Guard and U.S. Customs and Border Protection (CBP), FEMA has contributed to the development of several DHS-wide policy documents on climate change adaptation, including a

- 2010 *Climate Change Adaptation Report*,²⁰⁸
- 2012 *Climate Change Adaptation Roadmap*,²⁰⁹
- 2013 *DHS Climate Action Plan*,²¹⁰ and
- 2014 “Addendum” to the *DHS Climate Action Plan*.²¹¹

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occurrence, as determined by its likelihood and the associated consequences.”

²⁰³ For summary evaluations of possible changing risks for United States Census Regions, see Jerry Hatfield, Gene Takle, and Richard Grotjahn et al., *Climate Change Impacts in the United States: The Third National Climate Assessment*, U.S. Global Research Program, “Chapter 1: Overview and Findings,” May 6, 2014, p. 11, <http://nca2014.globalchange.gov/>; and National Research Council, *Adapting to Impacts of Climate Change*, 2010, Table 2.1, p. 38, at http://www.nap.edu/catalog.php?record_id=12783.

²⁰⁴ Federal Emergency Management Agency, *Climate Change Adaptation Policy Statement*, 2011-OPPA-01, 2011, at <http://www.fema.gov/media-library/assets/documents/33082>.

²⁰⁵ Federal Emergency Management Agency, *FEMA Strategic Plan, Fiscal Years 2011-2014*, FEMA P-806, February 2011, p. 4, at http://www.fema.gov/pdf/about/strategic_plan11.pdf. See also Federal Emergency Management Agency, *Crisis Response and Disaster Resilience 2030: Forging Strategic Action in an Age of Uncertainty*, Washington, DC, January 2012, <http://www.fema.gov/media-library/assets/documents/24174>.

²⁰⁶ Federal Emergency Management Agency, Strategic Foresight Initiative, *Climate Change: Long Term Trends and their Implications for Emergency Management*, August 2011, http://www.fema.gov/pdf/about/programs/oppa/climate_change_paper.pdf.

²⁰⁷ Department of Homeland Security, *Congressional Budget Justification FY2012*, p. 2395 (FEMA Management and Administration, p. 78), <http://www.dhs.gov/xlibrary/assets/dhs-congressional-budget-justification-fy2012.pdf>.

²⁰⁸ Department of Homeland Security, *Climate Change Adaptation Report*, October 2010.

²⁰⁹ Department of Homeland Security, *Climate Change Adaptation Roadmap*, June 2012, at http://www.dhs.gov/sites/default/files/publications/Appendix%20A%20DHS%20FY2012%20Climate%20Change%20Adaptation%20Plan_0.pdf.

²¹⁰ Department of Homeland Security, *Climate Change Action Plan*, September 2013, at <http://www.dhs.gov/sites/default/files/publications/DHS%20Climate%20Action%20Plan.pdf>.

²¹¹ Department of Homeland Security, “Addendum” to *Climate Change Action Plan*, June 2014, at [http://www.dhs.gov/sites/default/files/publications/Climate%20Action%20Plan%20Addendum%20June%202014%20\(508%20Compliant\).pdf](http://www.dhs.gov/sites/default/files/publications/Climate%20Action%20Plan%20Addendum%20June%202014%20(508%20Compliant).pdf).

These documents comply with adaptation planning requirements initiated under E.O. 13514.²¹² FEMA was also one of the seven departments and agencies²¹³ specifically identified in E.O. 13653 that were directed to “complete an inventory and assessment of proposed and completed changes to their land- and water-related policies, programs, and regulations” to make U.S. natural resources more resilient to a changing climate.²¹⁴ To fulfill this requirement, FEMA was a participating agency in the Climate and Natural Resource Working Group (CNRWG), which published in October 2014 a “Priority Agenda: Enhancing the Climate Resilience of America’s Natural Resources.”²¹⁵

Analyzing the array of policy documents noted above, FEMA has committed to fulfilling a broad set of actions related to climate change adaptation, such as (but not limited to)

- increasing its internal training and communications for FEMA emergency management staff on the connections between climate change and emergency management programs and functions;²¹⁶
- improving its existing cost-benefit analysis methods for post-disaster assistance programs provided through the Stafford Act, such as the Public Assistance and Hazard Mitigation Grant Program, to incorporate future flood risks (e.g., sea-level rise) and other climate factors;²¹⁷
- updating risk assessment models that FEMA currently provides to accurately account for possible increases in risk due to climate change, including the Threat Hazard Identification Risk Assessment;²¹⁸ and
- advance and participate in intergovernmental and “whole of community” partnerships to address specific extreme weather events that may increase in frequency and intensity with climate change, such as through the National Cohesive Wildland Fire Management Strategy and the National Drought Resilience Partnerships.²¹⁹

²¹² See Section 16 of Executive Order 13514, “Federal Leadership in Environmental, Energy, and Economic Performance,” 74 *Federal Register* 52117, October 8, 2009. The Climate Change Adaptation Task Force has been replaced by the Council on Climate Preparedness and Resilience.

²¹³ The other six agencies are the Departments of Defense, the Interior, and Agriculture, the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, and the Army Corps of Engineers.

²¹⁴ See Section 3 of Executive Order 13653, “Preparing the United States for the Impacts of Climate Change,” 78 *Federal Register* 66819, November 6, 2013.

²¹⁵ Climate and Natural Resource Working Group (CNRWG), *Priority Agenda: Enhancing the Climate Resilience of America’s Natural Resources*, Washington, DC: Council on Climate Preparedness and Resilience, October 2014, http://www.whitehouse.gov/sites/default/files/docs/enhancing_climate_resilience_of_americas_natural_resources.pdf.

²¹⁶ See p. 11 of the DHS *Climate Change Action Plan*, and p. 6 of the “Addendum” to the DHS *Climate Change Action Plan*.

²¹⁷ See p. 24 of the DHS *Climate Change Action Plan*, and p. 17 of the “Addendum” to the DHS *Climate Change Action Plan*.

²¹⁸ See p. 24 of the DHS *Climate Change Action Plan*, and p. 18 of the “Addendum” to the DHS *Climate Change Action Plan*.

²¹⁹ See p. 36 of the “Priority Agenda: Enhancing the Climate Resilience of America’s Natural Resources” document, and p. 17 of the “Addendum” to the DHS *Climate Change Action Plan*.

Prior to its FY2015 budget request, the Administration did not request or receive funding specifically related to climate change adaptation activities for FEMA. However, the strategic planning activities of FEMA's Office of Policy and Program Analysis related to climate change have been cited in past budget justification documents.²²⁰ In the FY2015 supplemental budget request, labeled the "Opportunity, Growth, and Security Initiative," the Administration requested \$400 million for the Pre-Disaster Mitigation (PDM) grant program.²²¹ If appropriated by Congress for FY2015 or in other future fiscal years,²²² this type of funding could be used by communities to adapt to extreme weather events exacerbated by climate change, in addition to other types of disasters.²²³ A general lack of specific funding for climate change adaptation may reflect FEMA's objective to integrate adaptation activities into existing programs, thus making it difficult to specifically identify funding for adaptation activities in appropriated resources for current programs. Arguably, any funding directed toward the general goal of emergency preparedness may assist the nation as it adapts to changing likelihoods of extreme weather events, in addition to other disasters.

For More FEMA Information

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²²⁰ See, for example, Department of Homeland Security, *Congressional Budget Justification FY2012*, p. 2395 (FEMA Management and Administration, p. 78), <http://www.dhs.gov/xlibrary/assets/dhs-congressional-budget-justification-fy2012.pdf>.

²²¹ Section 203 of the Stafford Act, 42 U.S.C. §5133.

²²² As of mid-January 2015, appropriations for FEMA were not complete.

²²³ Department of Homeland Security, *Budget-in-Brief, Fiscal Year 2015*, p. 131, at <http://www.dhs.gov/publication/fy-2015-budget-brief>.

Department of Health and Human Services

HHS is the lead federal agency responsible for researching and responding to the health effects of climate change. According to the most recent version of the HHS climate adaptation plan,²²⁴ the Office of the Assistant Secretary for Health (OASH) within HHS is the lead office on climate adaptation. OASH works closely with the “Office of the Assistant Secretary for Administration (ASA), Office of the Assistant Secretary for Preparedness and Response (ASPR), Centers for Disease Control and Prevention (CDC), and the National Institutes of Health (NIH).”²²⁵

Adaptation-Related Activities

Activities to address climate change within HHS are multipronged and in different stages of development. For example, some activities are an extension of ongoing work, led by ASPR, to prevent, prepare for, and respond to public health emergencies and disasters. As noted in the HHS plan, “ASPR has a major role in identifying communities and at-risk individuals most vulnerable to disasters as climate change progresses.”²²⁶ Other activities, led by the CDC and NIH, involve collecting data and creating mapping tools to track the effects of climate change and assess potential health impacts.²²⁷ Many of these efforts are preliminary, focused on establishing the infrastructure necessary to ameliorate the potential impacts of climate change (e.g., identifying key personnel, programs, and policies that need updating or replacement; assessing facilities and infrastructure). One of these efforts is expected to produce a special report²²⁸ that “will be an evidence-based, quantitative assessment of the observed and projected climate change impacts on human health in the United States.”²²⁹ A draft of the report is expected in early 2015.

The 2014 climate adaptation plan presents vulnerability assessments for populations and HHS missions. It identifies climate-related health risks affecting the U.S. population, including

- deaths and illnesses from heat stress;
- injuries and illnesses due to extreme weather events (e.g., severe storms, heat waves);
- respiratory and cardiovascular illness and deaths caused by smoke from heat-related and drought-related wildfires, as well as changes in air pollution, particularly ozone smog;
- allergic illnesses from elevated pollen levels, caused by more vigorous weed growth and longer pollen seasons;

²²⁴ *HHS Climate Adaptation Plan*, Department of Health and Human Services, July 3, 2014, <http://www.hhs.gov/about/sustainability/2014-climate-change.pdf>.

²²⁵ *Ibid.*

²²⁶ *HHS Climate Adaptation Plan*, Department of Health and Human Services, July 3, 2014, <http://www.hhs.gov/about/sustainability/2014-climate-change.pdf>. (Hereinafter HHS Adaptation Plan.)

²²⁷ *Ibid.*

²²⁸ Proposed Rule, “Request for Public Engagement in the Interagency Special Report on the Impacts of Climate Change on Human Health in the United States,” U.S. Environmental Protection Agency, <https://www.federalregister.gov/articles/2014/02/07/2014-02304/request-for-public-engagement-in-the-interagency-special-report-on-the-impacts-of-climate-change-on>.

²²⁹ *Ibid.*

- changing rates and ranges of infectious diseases carried by insects or in food and water;
- threats to the safety and availability of food and water supplies; and
- greater levels of mental and emotional stress in response to climate change and extreme weather-related emergencies.²³⁰

According to the plan, those most vulnerable in general—children, the elderly, those living in poverty, those with underlying health conditions, and those living in certain geographic areas—are also at increased health risk from the effects of climate change.

The HHS plan also includes (1) NIH efforts to identify and protect vulnerable populations, (2) CDC programs to help state and local governments prepare for the potential impacts of climate change on populations within their jurisdictions, and (3) work by the Substance Abuse and Mental Health Services Administration to help states, territories, tribes, and local governments respond to the behavioral health impacts of climate change. HHS has not conducted a formal risk assessment of climate change on its brick-and-mortar facilities; however, the adaptation plan notes that HHS intends to partner with the General Services Administration to “address the vulnerabilities of these sites and facilities to incremental climate change and variability.”²³¹

Issues for the 114th Congress

Adapting the health care and public health sectors to respond to climate change generally involves infrastructure and activities already in place; however, to optimally address climate change concerns, such activities may need to be expanded. As Congress considers the issues associated with the HHS climate adaptation plan, Members may assess the extent to which the existing public health preparedness and disaster response infrastructure is sufficient to handle the anticipated impacts of climate change over different periods of time—the next 1 to 5 years, the next 5 to 10 years, and beyond. Congress may also want to get a better sense of the level of current and projected HHS spending for the various initiatives included in its climate adaptation plan.

For More HHS Information

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²³⁰ Centers for Disease Control and Prevention (CDC), “Building Resilience Against Climate Effects (BRACE) Framework,” August 2012, <http://www.cdc.gov/climateandhealth/BRACE.htm>.

²³¹ Ibid.

Department of the Interior

The Department of the Interior (DOI) has a wide range of responsibilities primarily related to managing lands and resources throughout the nation. For example, DOI houses three of the four major federal land management agencies. Together, these agencies—the Bureau of Land Management (BLM), the Fish and Wildlife Service (FWS), and the National Park Service (NPS)—manage approximately 20% of the nation’s lands and related cultural and natural resources, as shown in **Figure 9**.²³² The department also manages 35,000 miles of coastline and 1.76 billion acres of the Outer Continental Shelf,²³³ and has considerable responsibilities for water and power resources. Among the properties managed by DOI are the nation’s national parks, monuments, and recreation areas; national wildlife refuges; other public lands and resources including forested lands and rangelands; lands held in trust for Native American Indians; and more than 300 dams and reservoirs owned and operated by the Bureau of Reclamation (Reclamation). DOI facilities provide large quantities of water and produce considerable hydroelectric power for communities and farmers in the 17 western states. The department is also responsible for managing energy and mineral resources located below ground and offshore. This includes oil and gas leasing, as well as leasing for certain renewable resource development. It also provides financial and technical to U.S. territories.

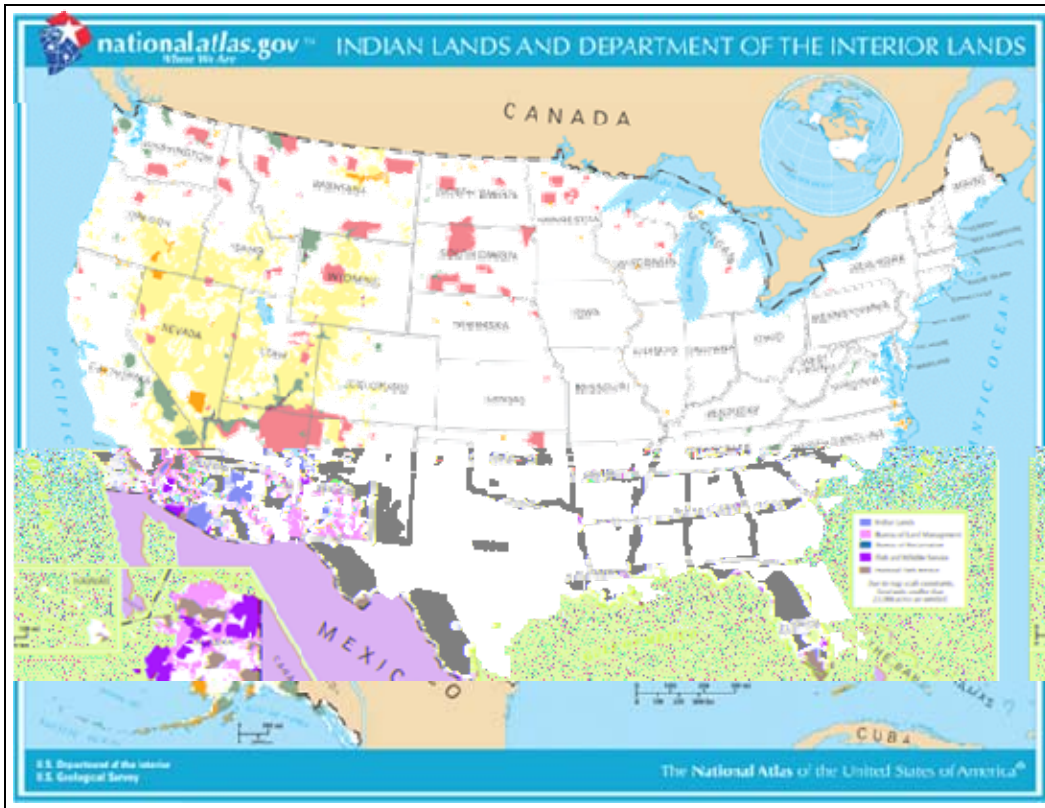
Through its agencies, DOI manages and monitors species and their habitats, as well as ecosystems. In addition to its cultural and natural resource stewardship role, the department plays an important role in providing scientific information to other federal agencies, states, local and tribal governments, and other nonfederal entities. For example, DOI’s U.S. Geological Survey (USGS) and other agencies play a large role in measuring and monitoring resources and developing science-based tools for land and water resource managers nationwide. The department also is involved in numerous private-public partnerships involving monitoring, research, and resource management.

Because of DOI’s widespread land and resource management responsibilities, including protection of threatened and endangered species, its operations and missions are particularly sensitive to climate conditions, whether they are due to naturally occurring climate variability or the predicted intermediate and long-term effects of climate change. Multiple climate factors affect DOI’s ongoing operations; among the likely key climate change effects for the department are changing soil and air temperatures, precipitation patterns, streamflow and runoff, sea-level rise, habitat conditions, and extreme events such as storms, floods, and droughts. For example, climate conditions can affect the health and well-being of fish and wildlife; they also can expand or restrict access to and development of natural resources and infrastructure upon which many communities and industries depend. More detailed examples are discussed below in the individual summaries of agency climate adaptation plans.

Issues for Congress regarding DOI agency climate change adaptation activities are discussed at the end of this DOI overview section, due to overlap among many of the issues at the agency level.

²³² For more information on these agencies, see CRS Report R42346, *Federal Land Ownership: Overview and Data*, by Carol Hardy Vincent, Laura A. Hanson, and Jerome P. Bjelopera.

²³³ <http://www.doi.gov/whatwedo/climate/index.cfm>.

Figure 9. Department of the Interior and Indian Lands

Source: National Atlas, http://nationalatlas.gov/printable/printableViewer.htm?imgF=images/preview/fedlands/DOI_ALL_2.gif&imgW=588&imgH=450.

DOI Adaptation-Related Activities

DOI has undertaken numerous activities related to climate change adaptation. In accordance with E.O. 13514, the department has issued Strategic Sustainability Performance Plans since FY2010, and more recently, Climate Change Adaptation Plans. The 2014 Climate Change Adaptation Plan (2014 CCAP) includes a brief summary of DOI's Climate Change Adaptation policy, a brief assessment of DOI climate-related vulnerabilities, and a description of current and planned climate change adaptation implementation strategies.²³⁴ The department's focus through the 2014 Climate Change Adaptation Plan is to increase the resilience of DOI facilities and resources in the face of climate vulnerability.²³⁵ DOI also issued a climate change adaptation plan for FY2013,²³⁶ and on December 20, 2012, issued a *Departmental Manual for Climate Change Policy*.²³⁷

²³⁴ Department of the Interior, *Department of the Interior Climate Change Adaptation Plan 2014*, http://www.doi.gov/greening/sustainability_plan/upload/2014_DOI_Climate_Change_Adaptation_Plan.pdf. (Hereinafter referred to as 2014 CCAP.)

²³⁵ 2014 CCAP, p. 2.

²³⁶ See http://www.doi.gov/greening/sustainability_plan/upload/DOI_Climate_Adaptation_Plan_for_FY2013_for_release.pdf.

²³⁷ See http://www.fws.gov/mountain-prairie/science/documents/Climate%20Change%20Policy_DM_523.pdf.

These DOI plans and policies apply to all DOI agencies. Many of these actions build upon DOI's 20-year history of increasingly ecologically based—or landscape scale—management, and incorporate several different programs and activities undertaken by the department under various initiatives of different names in the past. For example, to address the growing need for collaboration, to streamline funding, and to reduce duplicative efforts among agencies, several interagency science committees, initiatives, programs, and projects (CIPPs) have been created within DOI—all of which may play a role in the department's and broader federal agency climate science and adaptation.²³⁸ DOI also plays a role in the President's Climate Action Plan through activities such as accelerating clean energy permits and conserving land and water resources through a variety of mechanisms including grants and private-public partnerships.

DOI also addresses climate change impacts through department-wide secretarial orders. Secretarial Order (S.O.) 3289, issued in September 2009 and amended in February 2010, provides the primary guidance for DOI agencies, and established “a Department-wide approach for applying scientific tools to increase understanding of climate change and to coordinate an effective response to its impacts on tribes and on the land, water, ocean, fish and wildlife, and cultural heritage resources that the Department manages.”²³⁹ Pursuant to S.O. 3289, DOI has created or reorganized several different department-wide initiatives. Major initiatives include the establishment of a Climate Change Response Council and the creation and renaming of eight regional Climate Service Centers, the National Climate Change and Wildlife Science Center, and Landscape Conservation Centers. These initiatives are briefly described below. Another secretarial order, S.O. 3297, addresses water resources management. Activities under S.O. 3297 are discussed in the USGS and Bureau of Reclamation sections below.

DOI Climate Change Adaptation Plan for 2014

The DOI Climate Change Adaptation Plan (CCAP) for 2014 describes department-wide vulnerabilities to climate change in three key mission areas: natural and cultural resources, people and communities, and infrastructure and equipment. The plan also includes “guiding principles” covering a range of natural and cultural resource factors, and states that “[I]t is the policy of the Department to effectively and efficiently adapt to the challenges posed by climate change to its mission, programs, operations, and personnel.” The guiding principles are organized into eleven areas: (1) Science; (2) Ecosystem-Based Management; (3) Ecosystems and Wildlife; (4) Energy, Mining, and Water; (5) Cultural and Heritage Resources; (6) Minority Populations and Low Income Populations; (7) American Indians, Alaska Natives, and Insular Areas; (8) Coordination and Partnerships; (9) Human Health and Safety; (10) Public Use and Enjoyment; and (11) Infrastructure and Equipment.²⁴⁰ A summary of current and planned agency climate change adaptation strategies is also included in the 2014 CCAP. The 2013 CCAP also included implementation direction and discussed “near-term actions.” According to the department, the 2013 CCAP focused on assessing climate change vulnerabilities, whereas, the 2014 CCAP

²³⁸ For example, the department established a Cooperative Ecosystem Studies Units Network (CESU) for research on biological, physical, social, and cultural sciences. The CESU program was established by the National Parks Omnibus Act of 1998 (P.L. 105-391 §203); the CESU Council and Network was established in 1999 through a memorandum of understanding (MOU). This MOU directs the CESU Council to establish the broad policies of the Network.

²³⁹ U.S. Department of the Interior, Secretarial Order No. 3289, *Addressing the Impacts of Climate Change on American's Water, Land, and Other Natural and Cultural Resources*, issued September 14, 2009, by Secretary of the Interior Ken Salazar, <http://www.doi.gov/whatwedo/climate/cop15/upload/SecOrder3289.pdf>.

²⁴⁰ 2014 CCAP, pp. 19-26.

focuses on “addressing” climate change adaptation through secretarial orders and other policy guidance.²⁴¹

DOI’s Energy and Climate Council is responsible for implementing the CCAP. The Energy and Climate Council was established under S.O. 3289. DOI activities also are likely to receive funding from the Administration’s Climate Resilience Fund.²⁴² DOI also produces annual Strategic Sustainability Performance Plans pursuant to Executive Order 13514, which include numerous goals ranging from greenhouse gas emissions reduction to climate change resilience.²⁴³

Other DOI-Wide Adaptation Initiatives

- **Climate Change Response Council.** DOI’s Climate Change Response Council—created pursuant to S.O. 3289 in 2009—is charged with coordinating a department-wide strategy to increase scientific understanding and develop tools to address the impacts of climate change on natural and cultural resources. The Council is in the Office of the Secretary, where the Secretary serves as the Chair, the Deputy Secretary as the Vice-Chair, and the Counselor to the Secretary as a second Vice-Chair; other members include the Assistant Secretaries, agency Directors, and the Solicitor. The Council coordinates all climate change activities with all relevant federal departments and agencies, including the Council on Environmental Quality, the Office of Energy and Climate Change, the Office of Science and Technology Policy, the National Science and Technology Council, the Department of Agriculture, the Department of Commerce, the Department of Defense, and the Environmental Protection Agency.
- **National Climate Change and Wildlife Science Center (NCCWSC) and DOI Climate Science Centers (CSCs).**²⁴⁴ These eight regional centers support research, assessment, and synthesis of global change data for use at regional levels, including undertaking research relevant to on-the-ground managers. (See **Figure 10.**) The NCCWSC is located at the USGS headquarters in Reston, VA. S.O. 3289 broadened the missions of the CSCs, which were once known as “regional hubs” of the NCCWSC; their missions now encompass other climate change impacts on DOI’s resources.²⁴⁵ The CSCs were established to evaluate global climate change models to scales appropriate for natural resource managers, identify science priorities, and facilitate departmental data integration and outreach to collaborators and stakeholders including other federal agencies.²⁴⁶ Further, in FY2013, DOI required these centers to incorporate

²⁴¹ 2014 CCAP, p. 2.

²⁴² See <http://www.doi.gov/news/pressreleases/president-proposes-11-9-billion-fy2015-budget-for-interior.cfm>.

²⁴³ See http://www.doi.gov/greening/sustainability_plan/index.cfm.

²⁴⁴ These centers were authorized in the Department of the Interior, Environment, and Related Agencies Appropriations Act, 2008 (P.L. 110-161). Eight regional centers cover regions named: Alaska, Northeast, Southeast, Southwest, Northwest, North Central, South Central, and the Pacific Islands.

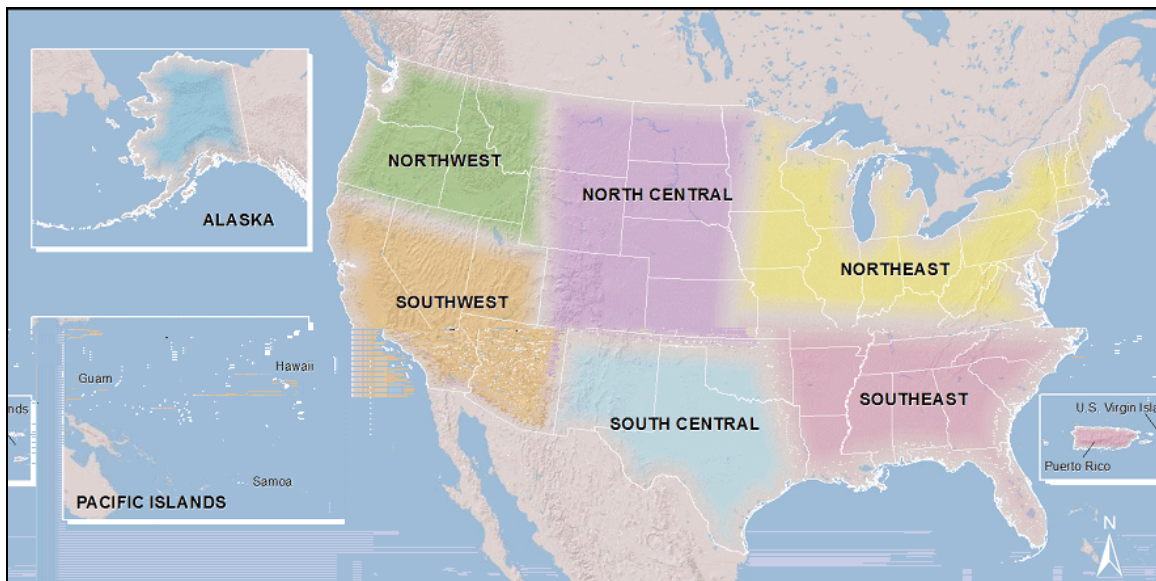
²⁴⁵ Secretarial Order 3289, signed on September 14, 2009, directed the renaming of the “regional hubs” as “Regional Climate Change Response Centers.” However, when S.O. 3289 was amended on February 22, 2010 (S.O. 3289A1), the “regional hubs” were renamed again, and directed to be called “DOI Climate Science Centers.” For consistency and clarity, the term DOI “Climate Science Center,” or “CSC,” is used throughout this report when discussing these centers, except in instances such as this, when a quote is used.

²⁴⁶ <http://www.doi.gov/whatwedo/climate/index.cfm>.

climate change adaptation into their policies, studies, and programs. For FY2014, the Administration proposed to use the centers to conduct adaptation planning for issues such as sea-level rise and drought, work with tribal communities, and create a system for facilitating adaptation coordination among DOI agencies. USGS manages and maintains the centers.

- **Landscape Conservation Cooperatives (LCCs).** These centers were created in 2009 under S.O. 3289, and are part of a network designed to ameliorate the effects of climate change on land and water resources.²⁴⁷ The LCCs are an amalgam of research institutions, federal resource managers and scientists, and cover lands managed by agencies at various levels of government. Each has a focus on one of 22 specific regions of the United States. Other than the offices of individual LCC coordinators, an LCC may be a virtual organization without a physical presence at a specific location. (See further discussion under the “Fish and Wildlife Service,” including **Figure 12.**)

Figure 10. Department of the Interior’s Climate Science Centers



Source: Department of the Interior, <http://www.doi.gov/csc/index.cfm>.

Note: According to DOI Climate Science Center (CSC) officials, boundaries of the CSCs are not precise; some Center activities may extend beyond the boundaries roughly indicated above.

²⁴⁷ FWS provides links to many of its climate programs at <http://www.fws.gov/home/climatechange/adaptation.html>.

Issues for Congress

A prominent issue for Congress is one of potential overlap and duplication among DOI agencies and other federal agencies. It appears that DOI agencies have expanded their emphasis on global climate change in recent years per secretarial and presidential guidance, which may raise questions of overlap, duplication, and even gaps in agency science and adaptation portfolios. Others may be concerned that what appears like more attention to climate change science may be simply repackaging of existing efforts. Thus, it is difficult to tell without in-depth analysis what is duplication due to similar names or confusing agency or program histories.

Additionally, the relationship among some DOI programs is unclear, as their missions seem similar. Even so, the differing cultures and missions of DOI agencies may lead to differing views on science and data needs. Constraints on reducing any duplication or gaps could be statutory, budgetary, or cultural. Another issue for DOI could be the effectiveness of adaptation measures, considering the uncertainties surrounding climate change and its effects on resources. Reliable metrics for adaptation effectiveness and progress are difficult to develop or obtain. For example, the Fish and Wildlife Service (FWS) notes in its 2015 budget justification that its LCC program has supplied 46 “decision-support tools ... to conservation managers to inform management plans/decisions and [Endangered Species Act] Recovery Plans” in FY2013, and noted 15 “conservation delivery strategies and actions evaluated for effectiveness.”²⁴⁸ The meaning of these descriptions and their metrics is somewhat unclear; further reporting might clarify the results of efforts at adaptation. Thus, an oversight issue may be how best to assess or measure the effectiveness of adaptation programs and activities, given the varying climatic conditions nationwide, and changing conditions at the regional level.

Other issues relate to agency budgets and appropriations for climate change adaptation activities. For example, issues may include congressional interest in the related appropriations levels for individual DOI agency activities and programs, efforts to expand or restrict ongoing monitoring programs, or initiatives to alter DOI agency participation in the multitude of cooperative programs related to climate in which DOI agencies participate.

For More Information on DOI Department-Wide Efforts

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Related CRS Reports

CRS Report R42346, *Federal Land Ownership: Overview and Data*, by Carol Hardy Vincent, Laura A. Hanson, and Jerome P. Bjelopera.

CRS Report R43429, *Federal Lands and Natural Resources: Overview and Selected Issues for the 113th Congress*, coordinated by Katie Hoover.

²⁴⁸ Fish and Wildlife Service, *Budget Justification and Performance Information Fiscal Year 2015*, p. CLC-9. Projections for the same programs for FY2014 are 74 and 24, respectively.

Bureau of Land Management²⁴⁹

DOI's Bureau of Land Management (BLM) administers more onshore federal lands than any other agency—247.3 million acres. BLM lands are heavily concentrated (99.8%) in 12 western states.²⁵⁰ Nearly half of the total acreage is in two states—Alaska (29%) and Nevada (19%). BLM lands, officially designated the National System of Public Lands, include grasslands, forests, high mountains, Arctic tundra, and deserts. BLM lands often are intermingled with other federal or private lands, and the agency has authority to acquire, dispose of, and exchange lands under various authorities.²⁵¹

BLM generally manages its lands to provide for sustained yields of multiple uses including recreation, grazing, energy and mineral development, timber, watershed, wildlife and fish habitat, and conservation.²⁵² Some lands are withdrawn (restricted) from one or more uses, or managed for a predominant use. The agency inventories its lands and resources, and develops land use plans for its land units. The public uses BLM lands for their diverse attributes and opportunities.

Climate change has been cited by DOI as a contributing factor to changes in western lands and resources.²⁵³ One example is the desertification of public lands, which may result in part from increased temperature and reduced precipitation. This could contribute to a decrease in the productivity of rangelands. Changing climate also may increase the vulnerability of BLM forested lands to damage from insects and disease. As temperatures rise, in some locations there also may be an increase in the size and frequency of wildfires and an expansion of noxious weeds and invasive species. Another potential change is the increased melting of glaciers and permafrost in Alaska, perhaps contributing to erosion and a loss of soil stability.

Adaptation-Related Activities

BLM is focused on two efforts in part to adapt to climate change: a landscape approach to managing lands and rapid ecoregional assessments (REAs). The goal is to help BLM managers understand land conditions and trends, as well as influences and opportunities for land use, from a broader perspective that may not be apparent when focusing on smaller areas. The landscape approach looks at large, connected geographic areas defined by their similar ecological characteristics, such as the Sonoran Desert or Colorado Plateau. In conducting REAs, BLM uses landscape classification known as “ecoregions.”²⁵⁴ The ecoregions span land ownerships,

²⁴⁹ Information in this section is drawn primarily from the following: <http://www.blm.gov/wo/st/en/prog/more/climatechange.html>; http://www.blm.gov/wo/st/en/prog/more/Landscape_Approach.html; and the U.S. Department of the Interior, Bureau of Land Management, *Budget Justifications and Performance Information, Fiscal Year 2014*, on the DOI website at http://www.doi.gov/budget/appropriations/2014/upload/FY2014_BLM_Greenbook.pdf.

²⁵⁰ The 12 western states are Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

²⁵¹ See, e.g., 43 U.S.C. §§1713, 1715, 1716.

²⁵² BLM management responsibilities are defined in the Federal Land Policy and Management Act of 1976 (FLPMA), 43 U.S.C. §§1701 et seq.

²⁵³ See, for example, the BLM website at <http://www.blm.gov/wo/st/en/prog/more/climatechange.html>, and 2009 testimony of Thomas R. Armstrong, U.S. Geological Survey, Department of the Interior, p. 5, at <http://naturalresources.house.gov/uploadedfiles/armstrongtestimony03.03.09.pdf>. These sources address the issues in this paragraph.

²⁵⁴ More specifically, BLM states that it “is using Level III ecoregions, which have been classified by the Commission for Environmental Cooperation and the Environmental Protection Agency as fundamental geographic units for resource (continued...)”

including both federal and nonfederal land, and they range in size from about 11 million to 160 million acres. The assessments are called “rapid” because they use existing information and generally are to be completed within 18 months. They are prepared in cooperation with other federal and state land management agencies. They seek to synthesize scientific information about natural resource conditions and trends, highlight and map areas of high ecological value, and gauge the potential risks from climate change and other environmental challenges. They also intend to identify areas of high energy development potential and relatively low ecological value.

BLM anticipates completing 15 REAs. Several have been completed, with others expected in 2015 and beyond.²⁵⁵ **Figure 11** shows the 15 REA areas, which will cover more than 800 million acres of public and nonpublic lands. The information from the REAs will be used to plan for, and respond to, the effects of climate and other environmental changes to public lands, and will generally help BLM to identify and coordinate resource conservation, rehabilitation, and development priorities over the long term. BLM is working with DOI Climate Science Centers and Landscape Conservation Cooperatives, as well as other partners, to develop management strategies for the ecoregions covered by several REAs.²⁵⁶ REAs also may be helpful to the various landowners in the region, according to BLM. REAs can be updated as new information becomes available.

BLM is completing agency-specific guidance to implement departmental direction on climate change. The agency anticipates completing its guidance in 2015.²⁵⁷

(...continued)

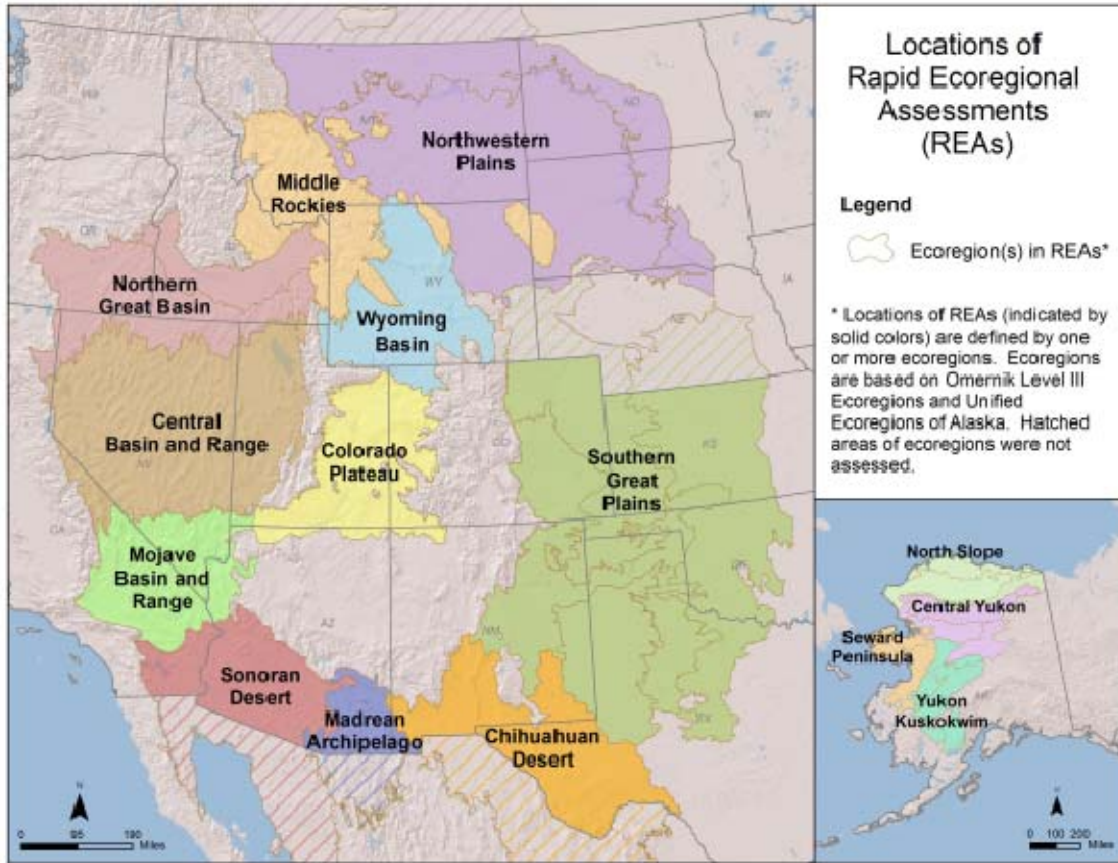
assessment and management.” See the BLM website at http://www.blm.gov/wo/st/en/prog/more/Landscape_Approach/landscapequestions.html#howdef.

²⁵⁵ BLM issued its first REA, for the Colorado Plateau, on February 26, 2013. The documents released to date for the various REAs are on the BLM website at http://www.blm.gov/wo/st/en/prog/more/Landscape_Approach/reas/docs.html.

²⁵⁶ According to BLM, DOI’s Landscape Conservation Cooperatives and BLM’s REAs are “complementary processes that will become more fully integrated as they progress. The BLM will be providing the data and results of its REAs to the LCCS, which may assist in “stepping down” the results of the REAs into specific management actions.” See the BLM website at http://www.blm.gov/wo/st/en/prog/more/Landscape_Approach/reas/assessmentsqa.html#LCC. For additional information on Landscape Conservation Cooperatives, as well as DOI Climate Science Centers, see the section of this report, above, on Interior’s department-wide initiatives.

²⁵⁷ This information was provided to CRS by the BLM Office of Legislative Affairs on January 12, 2015. For additional information on BLM adaptation to climate change, see GAO, *Climate Change: Various Adaptation Efforts Are Under Way at Key Natural Resource Management Agencies*, Washington, DC, May 31, 2013.

Figure 11. Location of BLM's Rapid Ecoregional Assessments (REAs)



Source: This map was prepared by BLM, and provided to CRS on December 12, 2013.

For More BLM Information

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Bureau of Reclamation

DOI's Bureau of Reclamation (Reclamation) manages water resource projects primarily in 17 western states.²⁵⁸ Reclamation's mission is to "manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public."²⁵⁹ Reclamation built and manages most of the large federal dams in the West, in addition to hundreds of other dams and diversion projects; it now operates more than 300 storage reservoirs and 58 hydropower plants serving approximately 30 million people.

As the nation's largest wholesale distributor of water and the second-largest hydropower producer in the West, Reclamation's considerable infrastructure and mission could be at risk under projected climate change. Key impacts of concerns include changes to soil and air temperature, precipitation, seasonal runoff, long-term stream flow, and extreme events.²⁶⁰ Since most of the surface water "stored" in the West is stored in snowpack, changes that reduce snowpack or accelerate or change the timing of runoff may result in less effective reservoir storage and major changes in reservoir and river operations. Extreme events—long periods of lower-than-normal precipitation and/or hot weather and mega-storms—pose additional risks. Because much of the West, particularly the Southwest, is naturally semiarid and arid, and has experienced periods of decades-long drought in the past millennia, some observers have noted that if climate change predictions prevail, the Southwest may face a "double-whammy" impact on water supplies due to recurrent mega-drought and climate change.²⁶¹ Irrigated agriculture, hydropower production, municipal water deliveries, and aquatic species that rely on the Lower Colorado River and the Rio Grande may especially be at risk.²⁶² Planning for such potential conditions is difficult, particularly for the Colorado River Basin, which has multiple storage reservoirs across a wide geographic area—some parts of which may see less precipitation, and others the same or more, according to different climate models.²⁶³

Reclamation facility operations are closely intertwined with myriad stakeholders including other federal agencies, states, Indian tribes, local water and irrigation districts, and other nongovernmental organizations. Although Reclamation built, owns, and continues to operate much of its infrastructure, local sponsors play a large role in system operations and maintenance, and are obligated to reimburse the federal government for a portion of construction costs. Thus,

²⁵⁸ Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming.

²⁵⁹ See <http://www.usbr.gov/main/about/mission.html> (accessed May 15, 2013).

²⁶⁰ For example, temperature, precipitation, and runoff conditions in the Western United States are expected to change if the projected effects of global climate change are realized. Such changes may affect Reclamation's ability to reliably deliver water to project users, and affect hydropower production, species habitat, and recreation in areas projected to receive less precipitation and runoff or experience severe weather events.

²⁶¹ Reed D. Benson, "Federal Water Law and the 'Double Whammy': How the Bureau of Reclamation Can Help the West Adapt to Drought and Climate Change," *Ecology Law Quarterly*, vol. 39, no. 4 (2012), p. 1050, quoting testimony of University of Arizona climate scientist Dr. Jonathan Overpeck before the Senate Committee on Energy and Natural Resources (field hearing), April 27, 2011, available at <http://www.energy.senate.gov/public/index.cfm/hearings-and-business-meetings?ID=4b915a8-f802-02-02d0bd1d-9515713e419a> (accessed May 12, 2013).

²⁶² *Ibid.*

²⁶³ One Reclamation study notes that there appears to be "climate model consensus agreement" on temperature increases; however, there is less model agreement on precipitation changes. Additionally, such changes vary geographically, which makes predictions for large river basins with multiple storage reservoirs, such as the Colorado and Missouri, especially difficult. (See *SECURE Water Act Section 9503(c)—Reclamation Climate Change and Water2011*, available at <http://www.usbr.gov/climate>. Hereinafter *2011 SECURE Water report*), pp vii -viii.

many stakeholders are likely to play a role in ensuring Reclamation's facilities continue to provide water, power, and ecosystem services into the future under varying climatic conditions.

Adaptation-Related Activities

Reclamation is carrying out climate change adaptation-related activities pursuant to DOI's adaptation plan as described in S.O. 3289, and a related DOI secretarial order on the department's WaterSMART program, which is designed to implement the 2009 SECURE Water Act (P.L. 111-11, Subtitle F, §§9501-9510).²⁶⁴ The SECURE Water Act directed Reclamation to undertake numerous climate-related research and adaptation activities. The resultant WaterSMART program focuses on the long-term sustainability of water resources (including the embedded energy use in water supplies).

The WaterSMART program includes both adaptation activities and research and development. Key research and adaptation activities include a Basin Studies program, in which Reclamation collaborates with partners to assess water supply and demand imbalances within individual basins, and to develop strategies to adapt to these imbalances.²⁶⁵ Reclamation also provides funding for WaterSMART grants to develop climate analysis tools and improve water and energy efficiency and systems operations and water treatment options.²⁶⁶ The WaterSMART program also now includes among its suite of activities Reclamation's 20-year-old water reuse program, known as Title XVI of P.L. 102-575.²⁶⁷

Reclamation's climate change adaptation activities include assessing broad-scale climate change risks on land and water resources through "West-Wide Climate Impact Assessments," identifying climate change water-related research needs of water resource managers, compiling climate data for water managers, and developing adaptation tools for water resource managers. Reclamation has produced numerous reports in these areas, largely since 2009, and works closely to coordinate its adaptation research and actions with other DOI agencies such as USGS and FWS, and other federal agencies such as the U.S. Army Corps of Engineers, NOAA, and DOE.²⁶⁸ Reclamation also participates in larger DOI-wide and government-wide efforts, including the Landscape Conservation Cooperatives, Climate Science Centers, and various task forces and work groups.

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²⁶⁴ Department of the Interior, Secretarial Order No. 3297, *Department of the Interior WaterSMART Program—Sustain and Manage America's Resources for Tomorrow*, signed February 22, 2010. Available at <http://www.usbr.gov/climate/docs/so3297.pdf>.

²⁶⁵ See <http://www.usbr.gov/WaterSMART/bsp/>.

²⁶⁶ See <http://www.usbr.gov/WaterSMART/grants.html>.

²⁶⁷ See [usbr.gov/WaterSMART/title/index.html](http://www.usbr.gov/WaterSMART/title/index.html) (accessed May 15, 2013).

²⁶⁸ Recent publications can be found at <http://www.usbr.gov/climate/>.

National Park Service

The 405 units of the National Park System (NPS) face a diverse array of potential impacts from climate change. Warming temperatures, precipitation changes, streamflow changes, sea-level rise, wildfire, invasive species, and wildlife migration, among other changes, all have the potential to significantly alter park resources (depending on their location and vulnerability) and to affect tourism and recreation in the parks.²⁶⁹ Some natural resource changes have attracted particular public attention, such as ongoing glacial melting in Glacier National Park (MT), rising temperatures that may eventually drive the Joshua trees from Joshua Tree National Park (CA), and sea-level rise that could damage or submerge parts of Everglades and Biscayne National Parks (FL).²⁷⁰ Attention has also focused on potential impacts of climate-related events to the iconic cultural resources administered by the NPS, such as the Statue of Liberty in New York.²⁷¹

NPS is addressing climate change through research, education, and adaptive management, as well as through efforts to reduce its own carbon footprint. Some have suggested that managing the parks for adaptation requires a fundamental rethinking of the NPS mission, from one that has historically focused on preserving lands in an unimpaired state to one that would “steward NPS resources for continuous change that is not yet fully understood.”²⁷² For example, one study discusses Point Reyes National Seashore in California, where preservation of the shoreline and intertidal wetlands are important goals. The study suggests that, in the future, it may be most effective for park managers to facilitate these goals by guiding the inland migration of these features, rather than attempting to resist sea-level rise, as would be called for under traditional management strategies.²⁷³

²⁶⁹ A recent study found evidence of warming temperatures in almost all national park units studied, with extreme warming in some parks, including Mojave National Preserve (CA), Lake Mead National Recreation Area (AZ and NV), Mammoth Cave National Park (KY), Cape Lookout National Seashore (NC), and Niobrara National Scenic River (NE), among others. The study found less uniformity with respect to changes in precipitation. William B. Monahan and Nicholas A. Fisichelli, “Climate Exposure of U.S. National Parks in a New Era of Change,” *PLoS ONE*, vol. 9, no. 7 (July 2014), at <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.01101302>; hereinafter referred to as Monahan and Fisichelli, “Climate Exposure.”

²⁷⁰ See, for example, NPS, “Climate Change: Effects in Parks,” at <http://www.nps.gov/subjects/climatechange/effectsinparks.htm>; NPS Regional Climate Change Talking Points, at <http://www.nps.gov/subjects/climatechange/resources.htm>; and reports on park-specific climate change impacts by the Rocky Mountain Climate Organization and the Natural Resources Defense Council, at http://www.rockymountainclimate.org/programs_7.htm.

²⁷¹ See, for example, Union of Concerned Scientists, *National Landmarks at Risk: How Rising Seas, Floods, and Wildfires Are Threatening the United States’ Most Cherished Historic Sites*, May 2014, at http://www.ucsusa.org/assets/documents/global_warming/National-Landmarks-at-Risk-Full-Report.pdf.

²⁷² National Park System Advisory Board, *Revisiting Leopold: Resource Stewardship in the National Parks*, August 25, 2012, p. 11, at http://www.nps.gov/calltoaction/PDF/LeopoldReport_2012.pdf.

²⁷³ Monahan and Fisichelli, “Climate Exposure.”

Gray Wolves at Isle Royale National Park: Rethinking NPS Intervention in an Era of Climate Change

Foundational to the NPS mission is the mandate to preserve the resources of the National Park System “unimpaired” for future generations (16 U.S.C. 1). Traditionally, NPS has aimed to fulfill this mission by allowing natural processes to unfold in parks, where possible, without human intervention. Should this policy apply if the natural processes are themselves shaped by human-induced climate change? NPS scientists and managers are confronting this question at Isle Royale National Park. This park also is a congressionally designated wilderness area, where “the earth and its community of life” are to remain “untrammelled by man” (16 U.S.C. §1131).

Isle Royale, an island in Michigan’s Lake Superior, has supported a population of gray wolves since the 1940s. The wolves crossed from the mainland to the island via a natural ice bridge that historically formed in most winters. Recently, however, owing to warmer temperatures, the ice bridge has formed less often. At the same time, the wolf population on the island has become increasingly inbred, and has shrunk to fewer than a dozen. Biologists have found genetic deformities due to inbreeding in the wolves, and are concerned about the long-term viability of the remaining population. With fewer ice bridges in recent years, there is less chance that wolves from the mainland will augment the population. Warming has also affected the wolves’ prey, the moose that inhabit Isle Royale. Moose numbers have declined in part because of higher temperatures, which, for example, have brought infestations of winter ticks.

Park managers are exploring whether to introduce new wolves to the island, an action that would contravene the traditional NPS policy of nonintervention. There is disagreement about whether the role of climate change in the animals’ decline justifies such a step. Many factors over the years have caused the island populations of wolves and moose to fluctuate significantly, and scientists’ role thus far has been to monitor the changes. Some question whether the current decline is so singular as to warrant more aggressive action. Stakeholders also point out that the near-term effects of a changing climate on the Isle Royale ice bridges may be unclear—while warming temperatures could reduce the likelihood of bridges forming in winter, severe winter weather events could increase the formation of bridges. During the severe winter of 2013-2014, an ice bridge formed for only the second time in 17 years.

Others contend that an intervention is justified to prevent an extinction that could have severe impacts for the entire island ecosystem. They have argued for a “new meaning of wilderness,” as a “place where concern for ecosystem health is paramount, even if human action is required to maintain it.” One park manager summarized the issue: “We have a policy ... where you let natural processes rule and dictate the changes on the landscape, and we also have a policy that says when people have caused the dramatic change within a park, then you should do what you can to rectify it.... So what do you do when the change that human beings have wrought is so broad-based?”²⁷⁴

Adaptation-Related Activities²⁷⁵

NPS released its *Climate Change Response Strategy* in September 2010, focusing on four types of actions: science, adaptation, mitigation, and communication.²⁷⁶ It followed this with a *Climate Change Action Plan* in November 2012, emphasizing the same four response areas and detailing

²⁷⁴ See John A. Vucetich, Michael P. Nelson, and Rolf O. Peterson, “Should Isle Royale Wolves Be Reintroduced? A Case Study on Wilderness Management in a Changing World,” *The George Wright Forum*, vol. 29, no. 1, pp. 126-147 (2012), at http://isleroyalewolf.org/sites/default/files/tech_pubs_files/Vucetich%20et%20al%202012%20GW%20Forum.pdf; Wolves and Moose of Isle Royale, “About the Project: Overview,” at http://isleroyalewolf.org/overview/overview/at_a_glance.html; Elizabeth Harball, “Warming Raises Life-or-Death Questions on an Island Once a Wolf’s Paradise,” *ClimateWire*, December 3, 2013, at <http://www.eenews.net/climatewire/2013/12/03/stories/1059991159>; John A. Vucetich et al., “Predator and Prey, a Delicate Dance,” *New York Times*, May 8, 2013, at http://www.nytimes.com/2013/05/09/opinion/save-the-wolves-of-isle-royale-national-park.html?_r=0.

²⁷⁵ A recent report by GAO contains a more detailed account of NPS climate change adaptation activities, as well as a case study of efforts at Montana’s Glacier National Park. See GAO, *Climate Change: Various Adaptation Efforts Are Under Way at Key Natural Resource Management Agencies*, GAO-13-253, May 2013, at <http://www.gao.gov/assets/660/654991.pdf>.

²⁷⁶ National Park Service, *Climate Change Response Strategy*, September 2010, at http://www.nature.nps.gov/climatechange/docs/NPS_CCRS.pdf.

over 50 immediate actions to incorporate climate change considerations into NPS operations.²⁷⁷ The actions, some of which have been implemented, include training park personnel on climate change issues,²⁷⁸ assessing park management plans and project plans for climate considerations, partnering with universities to research park-specific climate trends, developing a “risk screening tool” to assess the vulnerability of park facilities to erosion and sea-level rise, creating interpretive exhibits for park visitors on climate effects, and initiating youth outreach programs, among others.²⁷⁹ The agency sees itself as having a unique role as an “extraordinary educational institution where millions of people learn about the environment.”²⁸⁰ Thus, raising public awareness of climate change and potential responses is a key aspect of NPS’s strategy.²⁸¹

DOI’s *Climate Change Adaptation Plan*, released in October 2014, identified similar goals for NPS, focusing especially on adaptation planning and communication. It identified NPS’s climate adaptation priorities as (1) developing guidance for incorporating climate change science into park and strategic plans, and implementing them at the field level; (2) building workforce capacity to apply climate-smart conservation practices; (3) improving infrastructure resilience and sustainability; (4) communicating climate science, potential impacts, and strategies to 300 million park visitors annually; and (5) implementing a comprehensive risk evaluation approach and prioritizing adaptation actions to protect facilities and cultural and historic resources.

Some of NPS’s ongoing programs and activities specifically support the agency’s climate change strategy. For example, NPS maintains a Climate Change Response Program, and participates in DOI’s climate change efforts, including Landscape Conservation Cooperatives and Climate Science Centers. Other agency activities, although not explicitly targeted toward climate change, also play a role in NPS’s adaptation efforts—for example, the geographic information systems (GIS) program, exotic plant management teams, the wildlife health team, the acoustic monitoring program, and others.²⁸²

Despite these initiatives at the agency management level, it is not clear to what extent the planning efforts have translated into adaptation actions at individual park units. A 2012 study of climate change adaptation on public lands in Colorado, Utah, and Wyoming found that 78% of surveyed NPS unit managers and staff reported either that no adaptation planning was taking place at their unit, or that they did not know whether such planning was occurring. Staff cited

²⁷⁷ National Park Service, *Climate Change Action Plan 2012-2014*, November 2012, at http://www.nature.nps.gov/climatechange/docs/NPS_CCActionPlan.pdf.

²⁷⁸ In addition to training programs that have already been implemented, the White House’s *Priority Agenda: Enhancing the Climate Resilience of America’s Natural Resources*, October 2014, p. 77, http://www.whitehouse.gov/sites/default/files/docs/enhancing_climate_resilience_of_americas_natural_resources.pdf, calls for NPS to “complete development of a Natural Resource Career Field Academy online climate change module to help resource professionals understand key climate change related issues and explore adaption and planning options.”

²⁷⁹ For updates on NPS implementation of climate change response actions, see the quarterly *Climate Change Response Program Newsletters*, available at <http://www.nps.gov/subjects/climatechange/resources.htm>.

²⁸⁰ National Park Service Director Jonathan B. Jarvis, in NPS, *Climate Change Response Strategy*, September 2010, at http://www.nature.nps.gov/climatechange/docs/NPS_CCRS.pdf.

²⁸¹ See, for example, White House Office of Science and Technology Policy, “FACT SHEET: Lifting America’s Game in Climate Education, Literacy, and Training,” December 3, 2014, at <http://www.whitehouse.gov/sites/default/files/microsites/ostp/climateed-dec-3-2014.pdf>, which describes the Administration’s Climate Education and Literacy Initiative. Among several Administration commitments is to equip NPS employees with climate-relevant resources, in order to support park interpreters “in the creation and delivery of effective climate-change messages in the programs and exhibits across all National Parks” (p. 2).

²⁸² See discussions of these programs in recent NPS budget justifications, at <http://www.nps.gov/aboutus/budget.htm>.

budget constraints, lack of information at a relevant scale, and uncertainty of available information as barriers to adaptation planning.²⁸³ Recent research has aimed to address some of these issues by translating large-scale climate change effects to the individual park level.²⁸⁴

For More NPS Information

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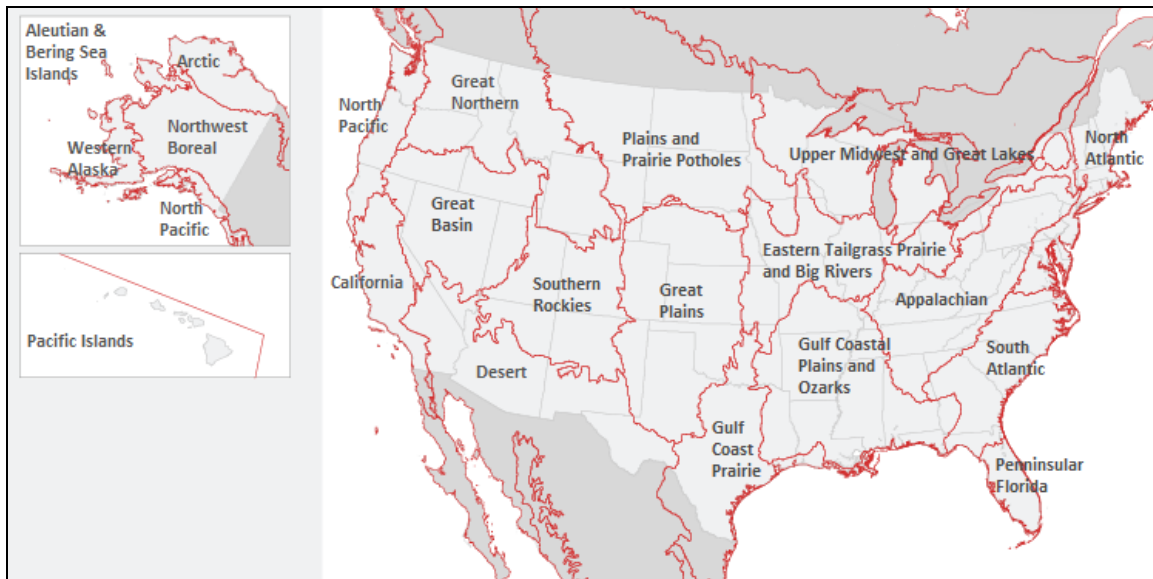
²⁸³ K. M. Archie et al., “Climate Change and Western Public Lands: A Survey of U.S. Federal Land Managers on the Status of Adaptation Efforts,” *Ecology and Society*, vol. 17, no. 4 (2012), p. 20, <http://dx.doi.org/10.5751/ES-05187-170420>. For an earlier study that similarly assessed barriers to adaptation at the individual park level, see L. C. Jantarasami et al., “Institutional Barriers to Climate Change Adaptation in U.S. National Parks and Forests,” *Ecology and Society*, vol. 15, no. 4 (2010), p. 33.

²⁸⁴ See, e.g., Andrew J. Hansen et al., “Exposure of U.S. National Parks to Land Use and Climate Change, 1900-2100,” *Ecological Applications*, 24(3), 2014, pp. 484-502; U.S. Geological Survey, “Vulnerability of U.S. National Parks to Sea-Level Rise and Coastal Change,” September 2012, at <http://www.cakex.org/sites/default/files/NPS%20Sea%20Level%20Rise.pdf>; and the reports cited in footnote 283.

Fish and Wildlife Service

The official mission of DOI's Fish and Wildlife Service (FWS) is "working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people."²⁸⁵ With this mission, climate change and its effects on wildlife and refuge resources pervades most agency activities and can be difficult to separate from its general programs. As species from oak trees to alligators find habitat in their current range too hot, too dry, too wet, too variable, or otherwise unsuited to their needs, FWS is a leader in determining the nature of the threat and, second, in working with partners at federal, state, tribal, and local levels to develop strategies to address climate impacts on wildlife at local and regional scales and relevant adaptation strategies. FWS administers a wide range of statutes and programs, many of which need to address climate adaptation in some way. These include endangered species, coastal programs, migratory bird management, refuge management, various international programs and grants, fish and hatchery management, construction, land acquisition, grants to states and tribes, and others.

Figure 12. Landscape Conservation Cooperatives



Source: <http://www.doi.gov/lcc/index.cfm>.

Notes: Landscape Conservation Cooperatives (LCCs) were established under DOI's 2009 Secretarial Order 3289, to establish "a network of public-private partnerships that provide shared science to ensure the sustainability of America's land, water, wildlife and cultural resources."

FWS Activities Related to Climate Adaptation

According to FWS, its climate adaptation goals include (1) participating in the development of a National Fish, Wildlife, and Plants Climate Adaptation Strategy, (2) partnering to create a National Biological Inventory and Monitoring Partnership for sharing monitoring data across a wide variety of sources, and (3) sharing information with many partners through a network of

²⁸⁵ This official mission statement was adopted on June 15, 1999; see http://www.fws.gov/policy/npi99_01.html.

Landscape Conservation Cooperatives (LCCs) to ameliorate the effects of climate change.²⁸⁶ (See **Figure 12.**)

The Endangered Species Act of 1973 (ESA; 16 U.S.C. §1531 et seq.) plays a role in FWS activities in climate change adaptation, and—equally important—adaptation plays a role in endangered species conservation. The additional pressure on habitat from climate change, along with other stressors, is likely to lead to more species being listed under the ESA.²⁸⁷ For listed species, adaptation efforts may include safeguarding corridors linking populations of listed species. FWS also attempts to reduce genetic isolation and inbreeding that may result from loss of habitat due to climate change. As a result of these and similar measures, the strong protections available under the ESA could lead to more environmental protection and thereby indirectly alleviate the effects of climate change on multiple species, including those that are not listed and those that are game species. The ESA’s role in federal climate change adaptation may therefore be indirect as well as direct. However, FWS has explicitly avoided any efforts to use the ESA as a means whereby plaintiffs could seek to prevent or control general threats to the global climate system.²⁸⁸

Because of climate change, managers of the National Wildlife Refuge System (NWRS) and other FWS lands and waters face many decisions daily on a range of practical issues. These include which plants to select in a re-vegetation project, what lands deserve priority for acquisition in the face of rising sea levels, and how to manage a coastal refuge whose land base is slowly disappearing. More frequent fires, heavy precipitation, and storm surges also affect refuge operations. Examples may include repair or replacement of roofs, docks, boats, roads, walkways, and other facilities. Were the frequency of extreme weather events to increase, many coastal refuges would play an increasing role in protecting areas farther inland, while simultaneously being eroded by rising ocean levels.²⁸⁹ The NWRS is a key player in providing the linkage of natural areas (whether owned by FWS or other federal, state, or local agencies or private parties) to allow species to move more freely to suitable habitats. FWS has also compiled a variety of tools and information resources on climate change for its resource managers.²⁹⁰

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²⁸⁶ FWS provides links to many of its climate programs at <http://www.fws.gov/home/climatechange/adaptation.html>.

²⁸⁷ Examples of species listed, or proposed for listing, under the ESA, due in part to changing climate include polar bears, walrus, and ringed seals (for loss of Arctic ice), and elkhorn and staghorn corals (for elevated sea surface temperatures). For more data on listed species, see <http://www.fws.gov/endangered/>.

²⁸⁸ There were, for example, concerns that listing of polar bears as threatened under the ESA could allow the ESA to be used as a tool to limit the burning of fossil fuels. However, regulations issued when the polar bear was listed in 2008 as a threatened species (50 C.F.R. §17.40(q)(4)) restrict lawsuits claiming incidental takes of polar bears to instances where the incidental take occurs in the state of Alaska.

²⁸⁹ No single storm can be attributed to climate change. P.L. 113-2 provided \$68.2 million for FWS to address one storm’s effects on eastern coastal refuges. Projects such as those cited above were funded.

²⁹⁰ See <http://www.fws.gov/home/climatechange/climatechangeupdate.html>.

U.S. Geological Survey

The mission of DOI's United States Geological Survey (USGS) is to provide reliable scientific information to describe and understand the geological processes of the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect the nation's quality of life.²⁹¹ USGS has eight interdisciplinary program areas that include (1) water resources, (2) climate and land use change, (3) energy and minerals and environmental health, (4) natural hazards, (5) core science systems, (6) ecosystems, (7) administrative and enterprise information, and (8) facilities. Much of the work relevant to climate change adaptation is done through the climate and land use change program area; portions of several other program areas also relate to climate change adaptation.

USGS is primarily a science agency. Unlike other DOI agencies, USGS does not manage large tracts of lands, or construct infrastructure or modify waterways or habitat. Further, the agency does not have regulatory authority under any laws. Consequently, USGS addresses climate change adaptation through conducting scientific studies; collecting and analyzing data related to climatic variables; modeling and predicting the effects of climate variability on natural resources, natural processes (e.g., natural hazards), wildlife, and ecosystems; and monitoring resources such as water flows, habitat changes, and wildlife. For example, USGS provides data on natural resources and scientific analysis to support adaptive management strategies implemented by DOI land management agencies (as well as for other federal agencies, state and local governments, and others) that address climate change adaptation. DOI agencies rely on USGS for scientific data and interpretations to inform their land management decisions. Memorandums of understanding (MOUs) and scientific agreements between USGS and other federal and state agencies allow USGS to provide research results on climate change processes and impacts, as well as data for making decisions on specific geographic areas.

Climate Change Adaptation-Related Activities

USGS is still evaluating the vulnerability and adaptation to the potential effects of climate change on its facilities.²⁹² USGS evaluates facility projects through a capital planning and investment review process. An Investment Review Board analyzes agreements and the costs and benefits of actions related to facilities. Beyond that effort, USGS is conducting several scientific and monitoring activities that directly and indirectly relate to climate change adaptation. This section provides an overview of some of these activities.²⁹³

National Climate Change and Wildlife Science Center and DOI Climate Science Centers.²⁹⁴

As noted above, one of the primary functions of the Climate and Land Use Change Program under USGS is the implementation and maintenance of the National Climate Change and Wildlife Science Center (NCCWSC) and its regional entities—referred to as the DOI Climate Science

²⁹¹ Department of the Interior, *Fiscal Year 2014, The Interior Budget in Brief, April 2013*, Department of the Interior, April 2013, pp. BH-51.

²⁹² Communication from the USGS Congressional Liaison Office with CRS on January 16, 2015.

²⁹³ Information taken, in part, from USGS Office of Budget, Planning, and Integration, *Adapting to a Changing Climate*, U.S. Geological Survey, April 2013, pp. 1-3, http://www.usgs.gov/budget/2014/docs/FY14_budget_climate.pdf.

²⁹⁴ These centers were authorized in an appropriations law, the DOI, Environment, and Related Agencies Appropriations Act, 2008 (P.L. 110-161).

Centers (CSCs). These centers support research, assessment, and synthesis of global change data for use at regional levels. The CSCs aim to evaluate global climate change models to scales that are appropriate for research managers of species and habitats, and facilitate data integration and outreach to collaborators and stakeholders including federal agencies.

Climate Change Research and Development. One of the objectives of USGS's climate change research and development is to understand regional responses to climate change and estimate how climate change might affect future scenarios or processes. Two areas of research under this program include understanding the effects of sea-level rise on coastal communities and infrastructure, and studying the long-term effects of drought. Under both lines of research, USGS plans to provide insight into how various stakeholders in the country can adapt to these changes.

Biological Carbon Sequestration. USGS is in the process of conducting a quantitative assessment of the carbon released and stored in the ecosystems of the United States. This work is intended to help quantify interactions between carbon storage, land use, and climate change, which can inform land management policies and practices.

Data Collection and Monitoring. USGS collects data and monitors natural processes that are relevant to climate change adaptation. For example, The National Streamflow Information Program, along with the Cooperative Water Program, monitors streamgages throughout the country that collect data on stream flow. These data can be analyzed to determine changes in water flows and water quality over time, and can be used in projecting future flows under various climate scenarios. Anticipating how climate change may influence the timing and levels of flows in the future could inform federal land managers, federal infrastructure investments and preparedness, and nonfederal decision making.

Collaborative Efforts to Address Adaptation. USGS collaborates with several other agencies to address climate change adaptation. The agency generally provides scientific analysis and data resources for these efforts. For example, USGS participated with the Army Corps of Engineers, Bureau of Reclamation, and NOAA to create a strategy for addressing water management needs in a changing climate.²⁹⁵ The strategy concluded that several water management or system operational changes may be considered to facilitate adaptive management to address a changing climate.

Issues for Congress

A potential issue for USGS is how to include climate variability in its scientific studies. For example, efforts to model long-term changes in ecosystems could require an understanding of how climate variability might affect ecosystem processes.

Another issue associated with USGS work relevant to climate change adaptation is the potential for duplicating other federal (or nonfederal) activities. To temper this possibility, USGS is attempting to coordinate its climate change adaptation activities with other federal agencies, especially within DOI, as described earlier.

²⁹⁵ Levi D. Brekke et al., *Climate Change and Water Resources Management: A Federal Perspective*, U.S. Geological Survey, Circular 1331, 2009, p. 65.

Specifically related to the Climate Change Program within USGS, some question whether the CSCs and the NCCWSC are fulfilling their mission of providing natural resource managers with the tools and information they need to develop and execute strategies for successfully adapting to and mitigating the impacts of climate change. Addressing this concern might be difficult, considering the short length of time data have been collected.

For More USGS Information

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Department of State²⁹⁶

The Department of State (DOS) considers climate change to be a threat multiplier that potentially puts at risk not only the department's facilities and personnel but also its mission to "create a more secure, democratic, and prosperous world for the benefit of the American people and the international community."²⁹⁷ State's 2010 Quadrennial Diplomacy and Development Review (QDDR) highlights climate change as one of six development areas targeted for action.²⁹⁸

While it accepts that "specific impacts of climate change on conflict, migration, terrorism and complex disasters are still uncertain,"²⁹⁹ the department recognizes that a number of its more than 275 posts worldwide are located in areas vulnerable to potential climate change impacts that could adversely affect its ability to carry out its mission. For example, DOS forecasts that

- rising temperatures in most regions will impact its energy use and building infrastructures as demand for cooling grows;
- extreme weather events, such as heavy precipitation events, could damage local infrastructure on which U.S. diplomatic facilities rely;
- storm surges and rising sea levels could directly impact U.S. facilities in coastal areas;
- deteriorating air quality could result in increased risks to the health of DOS personnel; and
- destabilization, in part caused by the effects of climate change, of a country in which the department operates could adversely impact DOS operations.

The department's strategy to address these challenges is outlined in its FY2014 *Climate Change Adaptation Plan*, published in June 2014, as required by E.O. 13514.³⁰⁰ To address the risks of climate change to both its operations and its mission, the department's *Adaptation Plan* outlines three broad goals: (1) using reporting, planning, and training to integrate adaptation policies in

²⁹⁶ This section was contributed by Ryan Caldwell, Fellow, and Alex Tiersky, Analyst in Foreign Affairs, atiersky@crs.loc.gov, 7-7367.

²⁹⁷ As noted on the State Department website, <http://www.state.gov/s/d/rm/rls/dosstrat/2004/23503.htm>. Accessed on June 20, 2013.

²⁹⁸ *Leading through Civilian Power: The First Quadrennial Diplomacy and Development Review, 2010*, available at <http://www.state.gov/qddr>, accessed on June 20, 2013. The other five areas for development are as follows: food security, global health, sustainable economic growth, democracy and governance, and humanitarian assistance. In remarks launching the 2014 QDDR process, Secretary of State Kerry referred twice to climate change, including the statement that "this new QDDR will enable us to take advantage of this unique moment in history, one where new tools, technologies, and partnerships are redefining what's possible, and where we have to address real opportunities and challenges we will face—the challenge of climate change and performance in fragile states and conflict-affected settings." See John Kerry, Secretary of State, "Remarks at the Quadrennial Diplomacy and Development Review (QDDR) Launch," April 22, 2014, <http://www.state.gov/secretary/remarks/2014/04/225050.htm>.

²⁹⁹ U.S. Department of State 2014 Climate Change Adaptation Plan, available at <http://www.state.gov/documents/organization/233779.pdf>. The FY2014 plan appears significantly more ambitious than the FY2013 plan (available at <http://www.state.gov/documents/organization/203934.pdf>), for instance in asserting the department's intent to convene partners and disseminate adaptation solutions worldwide, rather than the earlier-stated goals of simply helping to enhance understanding of climate change risks and strengthening capacity to build resilience to climate change impacts.

³⁰⁰ U.S. Department of State 2014 *Climate Change Adaptation Plan*, available at <http://www.state.gov/documents/organization/233779.pdf>. The U.S. Agency for International Development (USAID) has completed a separate Action Plan, available at http://www.usaid.gov/sites/default/files/documents/1865/USAIDAgencyAdaptationPlan_FY15.pdf.

both domestic and international operations; (2) promoting integration of adaptation policies into “at risk” sectors such as agriculture and disaster risk management, while also implementing policies for adaptation internationally; and (3) encouraging multilateral entities to pursue adaptation strategies.³⁰¹

Addressing Operational Challenges

The department plans to minimize climate change impacts on its operations overseas through building and maintaining awareness of potential impacts, building relevant expertise among its employees, and in particular educating and advising its facilities managers and engineers on how to identify natural hazard risks in their planning and design of DOS facilities, both domestically and overseas.

For example, the Bureau of Administration, which manages all domestic facilities, seeks to minimize the impact of department facilities on the environment, and identify threats to those facilities from extreme weather events. Further, it seeks to better understand and address vulnerabilities to the department’s procurement supply chain. The Bureau of Overseas Building Operations (OBO) has also increasingly emphasized sustainable design criteria for new facilities overseas. The annual Greening Activities Inventory, a sustainability survey of posts conducted since 2010, provides an assessment of climate change risks and potential impacts on operations that OBO uses to provide guidance to posts regarding steps to improve resilience to climate change impacts.

The department also states that it will, where appropriate, integrate climate change considerations into its Natural Hazards Program. This initiative, launched in 2005, seeks to identify measures that could save lives and reduce damage to diplomatic facilities from naturally occurring events such as tsunamis, floods, hurricanes, or volcanoes, and trains department facilities managers and engineers on climate change considerations.³⁰² Under the program, posts are encouraged to report potential threats, which may be matched with budgeted mitigation funds.

The department reports that while it considers opportunities for climate impact mitigation at its facilities, specific posts are already taking adaptation measures independently, sometimes through “green teams” operating at more than 150 locations. In one example, Embassy Canberra has installed solar panels on government-owned residences in order to reduce energy consumption and provide backup energy supply.

Among its longer-term goals, the department reports that it plans to expand training for its foreign service officers on sustainability issues, initially focusing on entry-level personnel but in future years expanding to include mid- and senior-level officers. DOS plans to deepen partnerships with other federal agencies on these issues—for example, through collaboration with EPA to monitor air quality in diplomatic facilities overseas, and by joining DOD-led efforts to develop vulnerability assessment tools based on regional scenarios. By FY2016-2017, the department

³⁰¹ Responsibility for the development, implementation, and evaluation of the *Adaptation Plan* falls to the department’s Office of Management Policy, Rightsizing, and Innovation (M/PRI); the Bureau of Oceans and International Environmental and Scientific Affairs, Office of Global Change (OES/EGC); and the Special Envoy for Climate Change (SECC).

³⁰² The Natural Hazards Program is managed by the Civil/Structural Engineering Division of the Office of Design and Engineering. U.S. Department of State 2014 *Climate Change Adaptation Plan*.

seeks to develop climate adaptation criteria for evaluating global operational decisions ranging from energy procurement to processes for evaluating relocation priorities of existing facilities.

*Diplomatic and Programmatic Activities*³⁰³

As the primary function of the department is diplomatic, the FY2014 Climate Change Adaptation Plan details policies and activities in support of adaptation actions within foreign countries.³⁰⁴ To this end, DOS and the U.S. Agency for International Development (USAID) issued a *Joint Strategic Plan*³⁰⁵ in spring 2014 that set forth a number of priorities for both organizations in the coming years. These include the following:

- promoting the transition to a low-emission, climate-resilient world while expanding global access to sustainable energy;
- enhancing U.S. leadership on global climate change;
- advancing scientific understanding on climate change impacts and adaptation actions; and
- coordinating with other federal agencies, such as USAID, NOAA, EPA, DOI, USDA, and the Treasury, and partnering with other countries, to advance climate change policy through various multilateral fora such as the United Nations Framework Convention on Climate Change, the Intergovernmental Panel on Climate Change, and the Global Environment Facility, as well as other international financial institutions and organizations that support adaptation activities in developing countries.

Under the Obama Administration, international development assistance for adaptation actions has been articulated primarily as the Global Climate Change Initiative (GCCCI), a platform within the President's 2010 Policy Directive on Global Development. The GCCCI aims to integrate climate change considerations into U.S. foreign assistance through a full range of bilateral, multilateral, and private-sector mechanisms to foster low-carbon growth, reduce emissions from deforestation and land degradation, and promote sustainable and climate-resilient societies in each partner country. The GCCCI is implemented through programs at three "core" agencies—the Departments of State, Treasury, and USAID—and related funding is requested by the Administration through its International Affairs activities (Budget Function 150).

Adaptation-related programs in the GCCCI aim to assist low-income countries with reducing their vulnerability to climate change impacts and building climate resilience. Most adaptation-related activities at USAID are implemented through the agency's bilateral development assistance programs. State and Treasury funding is generally channeled through international organizations (e.g., the United Nations) or multilateral financial institutions (e.g., the World Bank). Multilateral activities aim to leverage international donor and private-sector contributions in order to coordinate and finance large-scale infrastructure projects. Initiatives supported by DOS include the Least Developed Country Fund and the Special Climate Change Fund, which focus on climate

³⁰³ This section was contributed by Richard K. Lattanzio, Analyst in Environmental Policy, rlattanzio@crs.loc.gov, 7-1754.

³⁰⁴ U.S. Department of State 2014 Climate Change Adaptation Plan, "Policy," pp. 11-18.

³⁰⁵ U.S. Department of State and U.S. Agency for International Development, "Strategic Plan, FY 2014-2017," March 17, 2014, <http://www.state.gov/documents/organization/223997.pdf>.

resilience and food security provisions in countries with the greatest needs. The department also supports adaptation activities through its contributions to the United Nations Framework Convention on Climate Change (including the work of the Adaptation Task Force) and to the Energy and Climate Partnership of the Americas. Multilateral initiatives supported by the Department of the Treasury include the World Bank's Strategic Climate Fund: Pilot Program for Climate Resilience, which is tasked with coordinating comprehensive strategies in several of the most vulnerable countries to support actions that respond to the potential risks of a changing climate.

Issues for Congress

Congress plays an important role in authorizing, funding, and overseeing the department's operations. As it considers the challenges of climate change on U.S. diplomatic facilities and personnel, and on the department's ability to carry out its mission (including assistance of U.S. citizens abroad), Congress may consider issues such as the relative priority of climate change adaptation efforts in the department's overseas facility construction and maintenance programs, and mechanisms for the monitoring and evaluation of those programs. Another potential concern may be the effectiveness of interagency coordination between DOS and the dozens of agencies represented abroad—in particular DOD—which is required to understand and respond to climate change, including questions of cost sharing at posts overseas. U.S. reliance on host nations to address climate-related risks to and consequences for U.S. facilities overseas could also be of interest.

Further, Congress is responsible for several aspects of foreign development assistance including authorizing periodic appropriations for federal agency programs and multilateral fund contributions, enacting those appropriations, providing guidance to the implementing agencies, and overseeing U.S. interests in the programs and multilateral funds. As Congress considers potential authorizations and/or appropriations for activities administered through the GCCCI, it may have questions concerning the cost, purpose, direction, efficiency, and effectiveness of these programs, as well as the GCCCI's relationship to U.S. industries, investments, humanitarian efforts, national security, and international leadership.

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Related CRS Report

CRS Report R41845, *The Global Climate Change Initiative (GCCCI): Budget Authority and Request, FY2010-FY2016*, by Richard K. Lattanzio.

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