

Highlights of a
FORUM

*Convened by the Comptroller General of the United States
Report to Congressional Addressees*

**Preparing for Climate-Related Risks:
Lessons from the Private Sector**



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Why GAO Convened This Forum

According to the National Climate Assessment, climate-related impacts can present wide-ranging and sometimes cascading risks across the economy and at all levels of government. This assessment and a study by the Center for Climate and Energy Solutions—a nonpartisan, nonprofit organization—reported that climate-related risks can affect businesses in a variety of ways. In addition, GAO has previously found that the federal government faces fiscal exposure from climate-related risks and that building in resilience to protect against future damage is one strategy to help manage these risks.

On July 21, 2015, GAO convened a group of leaders to discuss: (1) businesses' climate-related risks, actions to identify and manage them, and justification of resilience efforts; (2) interdependencies of business and government entities and implications for building resilience; and (3) challenges and opportunities for businesses and governments in addressing climate-related risks and building resilience.

The participants, selected with assistance from the National Academies, included representatives from businesses, federal agencies, local governments, academia, and nongovernmental organizations. This report summarizes the discussion by forum participants. Comments expressed in the report do not necessarily represent the views of all participants, their organizations, or GAO. Participants reviewed a draft of this report, and GAO incorporated their comments, as appropriate.

View [GAO-16-126SP](#). For more information, contact J. Alfredo Gómez at (202) 512-3841 or gomezj@gao.gov

HIGHLIGHTS OF A FORUM

Preparing for Climate-Related Risks: Lessons from the Private Sector

What Participants Said

During the GAO-sponsored forum, participants discussed the following topics:

Businesses' Climate-Related Risks, Actions to Identify and Manage Them, and Justification of Resilience Efforts

Forum participants representing businesses across a variety of industries described climate-related risks to their operations, infrastructure, and supply chains. Participants also discussed their businesses' actions to identify and manage climate-related risks, such as better understanding and quantifying these risks, taking physical actions to build resilience, and embedding resilience into business processes and plans. Several business participants also described how their businesses place a value on resilience in order to justify actions to build resilience.

Interdependencies and Implications for Building Resilience

Forum participants discussed public and private sector interdependencies—areas in which various entities rely upon one another for support and services—that exist between and within the sectors, such as infrastructure, supply chains, and data and tools. Participants also discussed the implications of these interdependencies for building resilience, including the importance of

- establishing partnerships to leverage information and resources,
- examining the resilience of all components of a system, and
- pursuing a collective effort that engages all stakeholders.

Key Challenges and Opportunities

Forum participants discussed challenges and opportunities for businesses and governments in the following three key areas:

- **Identifying climate-related risks and developing actions to build resilience:** Several participants said they face challenges in finding and accessing sufficient data to identify risks; needing more tools and technical assistance to develop actions to build resilience; and having limited internal expertise for such efforts. Several participants described opportunities to address these challenges, such as by sharing existing information, providing tools and technical assistance, and building expertise through partnerships.
- **Providing incentives for resilience:** Several participants described challenges, including inadequate pricing of risks and limited policies and guidance on placing a value on resilience. Several participants discussed opportunities to address these challenges, including developing metrics and standards for resilience, providing better incentives and removing disincentives, and better using existing policies to encourage resilience.
- **Addressing interdependencies across sectors:** Some participants discussed challenges with unclear leadership roles and communicating across sectors. Several participants described opportunities to enhance leadership and coordinate efforts within and across sectors, engage communities early in the process, and assess current resources and needs for resilience efforts across sectors.

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November 19, 2015

Congressional Addressees

Climate-related impacts are considered by many to pose risks to various environmental and economic systems—including agriculture, infrastructure, ecosystems, and human health—and can present financial risks to various sectors, including businesses and the federal government. According to the U.S. Global Change Research Program’s National Climate Assessment and the National Research Council of the National Academies, the physical impacts from a changing climate are already evident in many sectors and are expected to become increasingly disruptive throughout this century and beyond.¹ Impacts may include inundation of land and coastal areas from rising sea levels, altered agricultural productivity due to different temperature or precipitation patterns, and increased intensity and frequency of severe weather events.

According to the National Climate Assessment, climate-related impacts can present wide-ranging and sometimes cascading risks across the economy and at the federal, state, and local government levels. As reported in the National Climate Assessment and by the Center for Climate and Energy Solutions,² within the private sector, such climate-related risks can include property damage, supply chain disruptions, commodity price volatility, and changes in resource availability.³ In our

¹Jerry M. Melillo, Terese (T.C.) Richmond, and Gary W. Yohe, eds., *Climate Change Impacts in the United States: The Third National Climate Assessment*, U.S. Global Change Research Program (Washington, D.C.: U.S. Government Printing Office, May 2014). National Research Council of the National Academies, *America’s Climate Choices: Panel on Adapting to the Impacts of Climate Change, Adapting to the Impacts of Climate Change* (Washington, D.C.: 2010).

²Center for Climate and Energy Solutions, *Adapting to Climate Change: A Business Approach* (Arlington, VA: April 2008). Center for Climate and Energy Solutions, *Weathering the Storm: Building Business Resilience to Climate Change* (Arlington, VA: July 2013). The Center for Climate and Energy Solutions is an independent, nonpartisan, nonprofit organization that works to address climate and energy challenges.

³For the purposes of this report, we define climate-related risks as vulnerabilities of natural and human systems, such as environmental and economic systems, due to changes in the earth’s climate—including higher temperatures, changes in precipitation, rising sea levels, and increases in the severity and frequency of severe weather events.

February 2015 high-risk update, we found that the federal government faces fiscal exposure from climate-related risks in various areas, including in its role as the owner or operator of extensive infrastructure and as the insurer of property and crops vulnerable to climate-related impacts.⁴ In addition, according to the President's 2012 *National Strategy for Global Supply Chain Security*, the global competitiveness of the United States depends in part on managing supply chain risks, which include climate-related risks.⁵ Finally, state and local governments face climate-related risks to infrastructure, such as transportation networks and water and wastewater systems, that can also increase risks to the private sector.

We have previously reported that building in resilience to protect against future damage is one strategy to help manage climate-related risks, as well as risks from other natural disasters.⁶ The National Academies define resilience as the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.⁷ According to a 2013 Center for Climate and Energy Solutions report, within the private sector, some companies have considered these risks within their overall risk management frameworks and have begun taking actions to build resilience.⁸ In a 2015 report, the Center for Climate and Energy Solutions

⁴Every 2 years at the start of a new Congress, GAO calls attention to agencies and program areas that are high risk due to their vulnerabilities to fraud, waste, abuse, and mismanagement, or are most in need of transformation. GAO, *High-Risk Series: An Update*, [GAO-15-290](#) (Washington, D.C.: Feb. 11, 2015).

⁵The White House, *National Strategy for Global Supply Chain Security* (Washington, D.C.: January 2012).

⁶GAO, *Disaster Resilience: Actions Are Underway, but Federal Fiscal Exposure Highlights the Need for Continued Attention to Longstanding Challenges*, [GAO-14-603T](#) (Washington, D.C.: May 14, 2014).

⁷The National Academies, Committee on Increasing National Resilience to Hazards and Disasters; Committee on Science, Engineering, and Public Policy; *Disaster Resilience: A National Imperative* (Washington, D.C.: 2012). As reported by the National Research Council of the National Academies, no one-size-fits-all solution exists to the challenges of adapting to climate change impacts, as options will differ depending on context, regional vulnerabilities, available resources, and scale. When discussing climate change, the term adaptation—defined as adjustments to natural or human systems in response to actual or expected climate change—is synonymous with enhancing resilience. Adaptation is a risk-management strategy to help protect vulnerable infrastructure and communities that might be affected by changes in the climate.

⁸Center for Climate and Energy Solutions, *Weathering the Storm: Building Business Resilience to Climate Change* (Arlington, VA: July 2013).

found that business continuity and risk management plans remain the most common ways companies address weather and climate-related risks, but many plans only include historical risk and not a consideration of how climate change will alter those risks.⁹

On July 21, 2015, GAO convened a group of 24 leaders for a forum focusing on lessons from the private sector on preparing for climate-related risks. The participants included representatives from businesses, federal government agencies, and local governments; subject matter experts from nongovernmental organizations and academia; and moderators from GAO and the National Academies. See appendix I for a list of forum participants and their affiliations. With assistance from the National Academies, we selected participants to include business representatives from a range of industries facing a variety of climate-related risks whose businesses have taken actions to build resilience to those risks, officials from federal agencies well positioned to engage with the private sector on issues related to preparing for climate-related risks, local government officials from communities of different sizes facing a variety of climate-related risks, and subject matter experts on climate-related risks faced by the private sector or on building resilience. The forum consisted of three discussion sessions and a closing session. The three discussion sessions focused on (1) businesses' climate-related risks, actions to identify and manage them, and justification of resilience efforts; (2) interdependencies of business and government entities and implications for building resilience; and (3) challenges and opportunities for businesses and governments in addressing climate-related risks and building resilience.

This report summarizes the discussion by forum participants, highlighting the ideas and themes that emerged during each of the discussion sessions.¹⁰ The information presented in this summary does not

⁹Center for Climate and Energy Solutions, *Weathering the Next Storm: A Closer Look at Business Resilience* (Arlington, VA: September 2015). This report examined companies listed in the Standard and Poor's Global 100 Index.

¹⁰Throughout the report, we use modifiers to quantify forum participants' views as follows: "some" represents two to three participants, and "several" represents four to seven participants. Also, we use the general term "participants" when we refer to a set of participants that includes various participant groups—business representatives, federal government representatives, local government representatives, and subject matter experts. Otherwise, we specify the type of participant who made the statement.

necessarily represent the views of all participants or the views of their organizations, including GAO. We structured the forum so that participants could openly comment on issues, although not all participants commented on all topics. We provided an opportunity for the participants to comment on a draft of this report.

We conducted our work from August 2014 to November 2015 as part of our ongoing body of work on climate-related issues and in accordance with all sections of GAO's Quality Assurance Framework that are relevant to our objectives. The framework requires that we plan and perform the engagement to obtain sufficient, appropriate evidence to meet our stated objectives and to discuss any limitations in our work. We believe that the information and data obtained, and the analysis conducted, provide a reasonable basis for any findings and conclusions in this product.

This report is available at no charge on the GAO website at <http://www.gao.gov>. If you or your staff have any questions about this report, please contact J. Alfredo Gómez at (202) 512-3841 or gomezj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions are listed in appendix IV.

I wish to thank all of the participants for their thoughtful contributions to the forum discussion. The discussion enhanced understanding of issues related to preparing for climate-related risks, and we will all benefit from these insights as we carry out our work on these issues.



Gene L. Dodaro
Comptroller General of the United States

Businesses' Climate-Related Risks, Actions to Identify and Manage Them, and Justification of Resilience Efforts

Forum participants representing seven businesses that have taken actions to build resilience to climate-related risks described their businesses' climate-related risks, the actions taken to identify and manage these risks, and how their businesses justify those actions.

Businesses' Climate-Related Risks

The business participants described climate-related risks faced by their businesses in three areas: operations, infrastructure, and supply chains. Some of these participants said that, in many cases, climate change amplifies risks already faced by their businesses.

- **Operational risks:** Several business participants said their businesses face climate-related risks to operations from extreme weather events, water stress, and wildfires. For example, some business participants said their companies had experienced operational disruptions due to severe thunderstorms or hurricanes. Some other business participants said that their companies' operations had been affected by water stress. One of these participants said that more than 50 percent of the company's manufacturing facilities were experiencing some effects on production due to water stress. Another said that water stress in the form of reduced snowpack had affected the company by decreasing its ability to generate hydroelectric power. This same business participant said the company was also affected by electrical outages as a result of an increase in the intensity and frequency of wildfires.
- **Infrastructure risks:** Some business participants said their businesses face climate-related risks to infrastructure from extreme weather events, rising temperatures, rising sea levels, and wildfires. For example, some business participants discussed risks to their companies' infrastructure from extreme events. One business participant said that the company's infrastructure, in various locations across the country, has experienced significant damage in recent years from extreme weather events—including Hurricane Sandy, blizzards, and tornados. Another business participant said that Hurricane Katrina cost the company \$1.5 billion in damages to infrastructure and forced one of its subsidiaries into bankruptcy. After Katrina and other hurricanes, including Ike and Gustav, the company recognized the need to analyze the potential effects of future storms

and better manage these risks, rather than enhancing resilience after the fact. Yet another business participant said that increased electricity demand from higher temperatures has strained the company's infrastructure, and wildfires and sea level rise have directly affected the company's infrastructure.

- **Supply chain risks:** Some business participants said their businesses face climate-related risks to their supply chains from extreme weather events, water stress, and rising temperatures.¹¹ For example, one business participant said that the 2011 floods in Thailand had affected the company's supply chain, and the information technology industry as a whole, by affecting suppliers in that country. Another business participant said that water stress and rising temperatures had affected the company's agricultural supply chain and had contributed to commodity price fluctuations.

Businesses' Actions to Identify and Manage Climate-Related Risks

Business participants reported that their businesses have taken various actions to identify and manage their businesses' climate-related risks, including actions to:

- **Better understand and quantify climate-related risks:** Several business participants described various strategies their businesses have used to better understand climate-related risks, such as developing internal expertise; quantifying risks to assets; mapping supply chains to identify potential risks; and modeling potential agricultural impacts, supply chain impacts, or future water conditions. For example, some business participants said their companies now had scientists on staff to help research and identify climate-related risks. Another business participant said the company now maps its supply chain, by identifying its suppliers and where they are located, in order to evaluate the effects of various scenarios of climate-related risks. Yet another business participant described the company's effort to quantify potential changes in land area suitable for growing barley under different scenarios of rising temperatures in Kenya—barley is a key ingredient for the company's beer production in that country. According to the participant, this information has informed the company's long-term strategy for sourcing barley in Kenya.

¹¹According to the U.S. Global Change Research Program, water stress occurs when demand for water by people and ecosystems exceeds available supply.

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- **Take physical actions to build resilience:** Several of the business participants described physical actions their businesses have taken to build resilience, such as making infrastructure stronger, diversifying power supplies and installing backup power, increasing the height of infrastructure, and managing vegetation to reduce effects from wildfires. For example, one business participant said the company had strengthened its infrastructure after its power generator and information technology systems broke down during Hurricane Sandy, and the company now serves as a resilience center for the community. Another business participant said that the company developed a renewable source of energy at one of its plants, which has resulted in fewer operational disruptions due to electrical grid outages during storms. Another business participant said the company started actively managing the vegetation around its distribution infrastructure in 2008 and has since experienced a 50 percent reduction in the frequency of outages resulting from wildfires.
 - **Embed resilience into business processes and plans:** Several business participants discussed how their businesses have embedded considerations of climate-related risks and resilience into some of their regular processes and plans. For example, some business participants said their companies have integrated considerations of climate-related risks into their enterprise risk management process, which companies use to identify and proactively manage risks from a variety of hazards. Another business participant said that the company has incorporated climate-related resilience considerations into its process for selecting suppliers and is now using more local suppliers to minimize the effects of extreme weather on its supply chain. Yet another business participant said that the company has changed its business process at some facilities in water-stressed areas to improve water efficiency and that it has developed facility-specific business continuity plans to minimize disruptions during extreme events.
 - **Engage the community for broader resilience:** Some business participants said that their businesses worked with local communities to make the communities more resilient, which ultimately makes the businesses' facilities and its customers more resilient. For example, one business participant described how the company engaged with communities through meetings to identify collective risks and discuss how everyone could work together to mitigate losses during extreme events. These meetings have helped the company prioritize its investments and complement the actions of others in the community.

Another business participant characterized such efforts as addressing “beyond the fence line” climate-related risks to the company.

Businesses’ Justification of Resilience Efforts

Several business participants described different ways in which their businesses place a value on resilience to justify to management, shareholders, or regulators the costs of efforts to build resilience. For example, one business participant said that the company has placed a dollar value on building resilience. Specifically, the company determined that every dollar the company invested in resilience efforts could prevent \$5 in potential losses. Other participants described their companies’ resilience efforts as not necessarily financially driven, but rather intended to help improve the community or to be a “responsible neighbor.” Finally, other business participants said their companies justified resilience efforts as helping to meet customer expectations for business continuity and to maintain levels of service over the long-term. For example, one business participant said that resilience efforts helped the company to ensure continuity of its services during extreme events, which the company can use as a selling point to its customers.

Interdependencies of Business and Government Entities and Implications for Building Resilience

Forum participants discussed various private and public sector interdependencies—areas in which various entities rely upon one another for support and services—that exist between and within the business and government sectors, and provided examples based on their own experiences. The participants also discussed the implications of these interdependencies from lessons learned during their experiences with efforts to build resilience.

Interdependencies of Business and Government Entities

Forum participants described interdependencies that exist between and within the private and public sectors and within sectors, such as between two or more businesses or between different levels of government. The participants described interdependencies in various areas, including:

- **Interdependencies related to infrastructure:** Several forum participants said that the operations of businesses, local governments, and federal agencies are interdependent through various types of infrastructure—such as energy, transportation, water, and telecommunications systems—that are owned or operated by other businesses and government entities. Business participants

representing several different industries described interdependencies their companies have with energy companies, since they rely on energy from the electric grid and fossil fuels to power their operations. With regard to transportation infrastructure, one federal government participant explained that damage to transportation networks from extreme weather events, such as Hurricanes Katrina and Sandy, prevented some of the workforce from reaching their work facilities, and resulted in operational disruptions for days or weeks even though these facilities did not sustain damage. Additionally, one federal government participant described how some of the workforce on military bases often resides in local communities, and thus is dependent upon local roads being passable to reach the bases. Government participants also identified federal government interdependencies with local water infrastructure. For example, a local government participant described how a military facility relies on community water and wastewater systems. With regard to telecommunications, one local government participant described interdependencies that the town has with the private sector and the federal government. The participant explained that the local telecommunications system consists of private networks located on federal government-owned towers, so that when flooding affected the towers, it affected the town's telecommunications capabilities.

- **Interdependencies related to supply chains:** Some business participants said that businesses and governments have interdependencies through supply chains although, at times, businesses and governments do not have sufficient knowledge of who their suppliers are and where they are located to fully understand the extent to which the resilience of their supply chains may be affected by climate-related events in particular locations. For example, a business participant said that the company's leaders initially thought that the business was unaffected by the tsunami that struck Japan in 2011, but later found that their supply chain was disrupted due to damage sustained by a lower-level supplier that they were not aware was a component of their supply chain. Another business participant discussed how businesses and the U.S. military might have suppliers using the same vulnerable highway, without realizing they share a common risk if the highway is flooded. The participant explained that identifying common suppliers and supply routes would help in determining interdependence within the economy and could help with building resilience in the supply chain and in the region.
- **Interdependencies related to data and tools:** Several forum participants identified ways in which businesses and governments are

interdependent through their reliance on each other's data and tools for identifying climate-related risks and building resilience. For example, one federal government participant said that insurers, reinsurers, and risk modeling agencies rely on the National Oceanic and Atmospheric Administration (NOAA) to facilitate the sharing of data and to ensure that the best data are made available. A subject matter participant discussed the insurance industry's reliance on data from NOAA and the United States Geological Survey for its catastrophic loss models. With regard to tools, another subject matter participant estimated that 40 percent of companies that model climate-related risks rely on the World Resources Institute's Aqueduct Tool.¹² Additionally, a business participant discussed water utilities' use of the Environmental Protection Agency's Climate Resilience and Evaluation Tool, which is a software tool to help water and wastewater utility owners understand and assess climate-related risks at their individual utilities.

Implications for Building Resilience

Given these interdependencies, several forum participants identified implications for building resilience, such as the importance of:

- **Establishing partnerships to leverage information and resources:** Several forum participants discussed the importance of establishing partnerships among stakeholders facing similar risks in order to share information and leverage resources for building resilience to climate-related risks. A federal participant described how the Department of Energy's Energy Sector Climate Resilience Partnership, which has 18 members and is continuing to grow, allows for sharing information. The participant explained that the Department of Energy recognized the private sector was undertaking efforts to address climate-related risks, but the pace, scale, and scope of those efforts needed to increase. As a result, it created the partnership to share best practices and provide user-friendly climate data, decision tools, and methods to assess vulnerabilities and the costs and benefits of climate resilience actions to make the business case for investments in resilience. Another federal participant discussed how partnering allowed a

¹²The World Resources Institute is a nonprofit, global research organization focused on sustaining natural resources. With the support of a diverse group of partners, the World Resources Institute built Aqueduct to help companies, investors, governments, and communities better understand where and how water risks are emerging around the world.

federal agency and a private company to leverage their resources. The participant explained that the United States Department of Agriculture and a private company were able to share the costs of vegetation management near electric transmission lines to reduce wildfire risk.

- **Considering all components of a system:** Several business and government participants identified the importance of examining the resilience of all components of a system. A federal government participant provided an example of building flood walls around tunnels to make the tunnels resilient to flooding, but not considering flooding risks to other parts of the system, such as the roads leading to the tunnels. If the roads leading to the tunnels were to flood, no one would be able to reach the tunnels even if they were not flooded. A local government participant provided an example showing the need to consider all components of an entire system or region when evaluating or assessing resilience. The participant explained that houses built on the side of a mountain were located above the floodplain, and by that measure, were considered to be resilient. However, during a recent flood, these houses collapsed because flood waters undercut the slopes upon which the houses were built.
- **Pursuing a collective effort:** Several forum participants emphasized that building resilience to climate-related risks requires pursuing a collective effort that engages all stakeholders, since no single stakeholder has or controls all of the solutions. To illustrate the important roles of various stakeholders, several participants discussed examples of collective efforts, including local governments managing climate-related risks through building codes, the federal government providing direction and tools for managing risks, and businesses supporting community resilience efforts. A business participant noted that communities will succeed or fail in building resilience together and that all stakeholders need to understand and build upon each other's work to attain their common goal. A federal government participant emphasized the need to engage with those stakeholders that are often left out of discussions about building resilience, such as individuals who do not own homes and small business owners. A local government participant said that the resilience of small businesses is very important to the community as a whole.

Key Challenges and Opportunities for Businesses and Governments in Addressing Climate-Related Risks and Building Resilience

Forum participants discussed a variety of challenges and opportunities for businesses and governments in addressing climate-related risks and building resilience. Specifically, participants discussed key challenges and opportunities for businesses and governments in identifying and assessing climate-related risks and developing actions to build resilience, providing incentives and making a business case for resilience, and addressing interdependencies across sectors.

Challenges and Opportunities in Identifying Climate-Related Risks and Developing Actions to Build Resilience

Many business and government participants said they face challenges in identifying and assessing climate-related risks and developing actions to build resilience, including:

- **Difficulty identifying and accessing reliable data:** Several business and government participants said they face challenges in identifying and accessing reliable data—particularly at a local level—that are available in a format they can use to identify climate-related risks and develop actions to build resilience. For example, one business participant said site-specific data are very important for the company in addressing client concerns about potential site disruptions and how long it could take to return to typical operations. One federal government participant said that all sectors would benefit from having an agreed-upon set of down-scaled predictive climate change and impact scenarios available for local or regional use. The participant said that the federal government should work toward producing this core information but recognized the challenges in doing so, including the uncertainties associated with climate change projections. Other federal government participants noted that reliable projections of precipitation, hydrology, and wind remain limited.
- **Insufficient tools and technical assistance:** Several business and government participants said they need more tools and technical assistance to develop actions to build resilience, while some federal government participants said stakeholders may not know about existing tools and technical assistance. One subject matter participant noted that the federal government regularly provides climate data sets, but technical assistance is needed to understand and integrate the various data sets. Another subject matter participant said businesses struggle to calculate their risks, in part, because they may not have a generally accepted methodology or standardized metrics

to do so. A business participant said the company was aware of resources such as maps that show vulnerability to flooding in particular areas, but would need assistance in using the maps to identify specific flooding risks. Some federal government participants discussed a publicly available tool that has helped them assess vulnerabilities to climate-related risks, but, when asked, no other participants said they were aware of this existing resource. Moreover, several participants said that some organizations—including small or medium-sized companies or small towns—face challenges because they have limited internal expertise to interpret and apply data to analyze climate-related risks.

Several business and government participants described various opportunities to help address these challenges, including:

- **Sharing existing data and information:** Several participants described opportunities for sharing existing information. For example, some federal government participants stated that federal agencies could better publicize and share existing federal sources of data and climate information. One federal government participant said that federal agencies have invested in assessments of climate-related vulnerabilities for locations important to their missions. The participant explained that this type of information should be shared with and used by local communities and businesses to develop their own actions to build resilience. One subject matter participant said it would be helpful if federal data were located centrally so that it would be easier to find the data. A business participant noted that aggregating weather and climate data with economic and social data could provide greater insights into climate-related risks than would the individual data sets. Another business participant said that businesses also have valuable data to share and described how one company donated formerly proprietary data on water stress to a nonprofit organization that, in turn, used the data to develop publicly available maps on global water risks. This participant went on to say that this resource has since become an industry standard for assessing vulnerabilities from water stress.
- **Providing tools and technical assistance:** Some business and government participants described opportunities to provide tools and technical assistance to help guide resilience efforts. For example, one business participant said a federal agency is working with Internet

cloud providers to offer a tool that could conduct metadata searches to help identify resources to help build resilience.¹³ A subject matter participant said the actuarial community has been partnering with climate scientists to develop a climate risk index based on climate change projections. When complete, companies could use this tool to help identify projected changes in climate-related risks. A federal government participant noted that some federal efforts are underway to provide technical assistance. For instance, the participant said that the Department of Energy is currently developing technical guidance to assist electric utilities in assessing climate change vulnerabilities and developing cost-effective resilience solutions.

- **Building expertise through partnerships:** Some participants described opportunities for organizations to develop the internal expertise to identify climate-related risks and build resilience by working with other stakeholders. For example, one business participant noted that various industries in the private sector have communities of practice where members can exchange information and ideas to help develop expertise. Another business participant said that the water sector could benefit from sharing best practices through partnerships like the Department of Energy's Energy Sector Climate Resilience Partnership. One subject matter participant said that some research suggests that those who partner more in identifying and managing climate-related risks tend to have the ability to accomplish more over time.
- **Initiating pilot programs:** Some business and government participants stated that initiating pilot programs would provide opportunities to try different approaches to building resilience. One federal government participant noted that the agency could share some promising practices identified through its experience with three pilot projects. Another federal government participant suggested that governments and businesses could learn a lot from undertaking a pilot that, for example, might include 10 cities and involve the private sector and local, state, and federal governments jointly assessing available data, identifying interrelated systems, and discussing how actions to build resilience today may change the cities' future climate-

¹³According to the National Institute for Standards and Technology, cloud computing is a means for enabling convenient, on-demand network access to a shared pool of computing resources, which can be rapidly provisioned and released with minimal management effort or service provider interaction.

related risks. A local government participant suggested that such a pilot program should also include and assess the needs and resources of different-sized communities.

Challenges and Opportunities in Providing Incentives and Building a Business Case for Resilience

Several business and government participants described challenges in providing incentives and building a business case for resilience. In particular, participants said that inadequate pricing of risks through insurance, as well as local codes that promote building in vulnerable areas, can often establish disincentives to building resilience. In addition, business and local government participants said there are limited policies and guidance available to help define and place a value on resilience, which would help in making a business case for resilience efforts. For example, one federal government participant said that there are limited policies and guidance to help utilities make a business case for investments in resilience to investors or, in the case of regulated utilities, regulators.

Several participants described opportunities to address these challenges, including:

- **Developing generally accepted metrics and standards:** Some business and government participants said that having generally accepted metrics and standards for resilience could help organizations place a value on their resilience efforts which, in turn, could help in justifying such efforts to investors or regulators. A business participant said that historical losses during extreme weather events can often be attributed to weak building standards. The participant said that many of these losses could be avoided if more consumers were informed about more resilient standards through programs such as the Department of Homeland Security's (DHS) Resilience STARTM initiative. According to the participant, this initiative informs consumers on how to build a home that meets standards developed by the Insurance Institute for Business and Home Safety, such as by placing waterproof tape under shingles to keep water out of the house if shingles are torn off in a storm.¹⁴ A local government

¹⁴According to the DHS website, the Resilience STARTM Home Pilot Project is a government-led, public-private initiative to engage homeowners, builders, and contractors in communities at high risk for certain natural disasters to identify proactive steps to enhance the resilience of homes. This initiative utilizes standards developed by the Institute for Business and Home Safety, which is an independent, nonprofit, scientific research and communications organization supported by property insurers and reinsurers.

participant provided an example of how new standards for resilience could create value and help make a case for resilience. According to this participant, homes in the community that were built 3 feet above the floodplain—in accordance with a resilience standard implemented by the community—tended to sell faster than other comparable homes.

- **Providing better incentives for resilience:** Some participants said that the public and private sectors could more adequately price risk through insurance products and provide better incentives for resilience through actions such as creating consumer demand for resilient products. For example, a subject matter participant said that pricing insurance in a manner that adequately reflects risks could help inform homeowners and enable them to better manage risks for their own homes. Also, a federal government participant said that the DHS Resilience STAR™ program could help create consumer demand for resilient products, similar to what the Environmental Protection Agency’s ENERGY STAR program has done to create consumer demand for energy-efficient appliances.¹⁵
- **Better using existing policies:** Some business and government participants said that existing policies could be more effectively used to help encourage resilience. One federal government participant cited some federal policies and programs that could be used more broadly to require communities to consider future climate-related risks. For example, the participant noted that the Stafford Act contains a provision that requires state, local, or tribal governments to plan for future risks to qualify for increased disaster aid.¹⁶ The participant also said that the government could act as an influencer of markets, under the SAFETY Act.¹⁷ A subject matter participant emphasized the

¹⁵According to the ENERGY STAR website, ENERGY STAR is an Environmental Protection Agency voluntary program to identify and promote energy-efficient products and buildings through labeling of products and buildings that meet the highest energy efficiency standards.

¹⁶The Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended, defines the federal government’s role during the response and recovery after a major disaster and establishes the programs and process through which the federal government provides disaster assistance to state and local governments, tribes, certain nonprofit organizations, and individuals. 42 U.S.C. §§ 5121 et seq.

¹⁷The SAFETY Act provides legal protections for providers of antiterrorism technologies, encouraging the development and deployment of such technologies.

importance of incorporating future climate-related risks into these policies, noting that businesses rely on community services to maintain business continuity during extreme events. One business participant said that the federal government could create incentives for resilience by making planning for resilience a condition of eligibility for a federal loan or grant. This participant also said that the federal government could remove some disincentives to building resilience that exist in current policies, such as tax disincentives for public-private partnerships and limitations on eligibility for certain low interest loans.

Challenges and Opportunities Addressing Interdependencies Across Sectors

Business and government participants discussed challenges in addressing interdependencies across sectors including:

- **Unclear leadership roles:** Some business and government participants said each sector has been looking to other sectors to take a leadership role in developing promising practices to address climate-related risks. Further, several business and government participants noted that, in some cases, key stakeholders may not be aware of various efforts taking place, making it difficult to coordinate efforts and identify leadership. For example, one local government participant said the community could benefit from more coordination and leadership around building resilient infrastructure. In one particular instance, the community faced challenges coordinating with the region's power marketing administration to install fiber connections on the only existing transmission towers so the community's broadband capabilities would be more resilient to future floods.¹⁸ According to the participant, the power marketing administration said its charter does not allow the town to use private lines on these towers, despite the community's desire to enhance the resilience of its infrastructure.
- **Challenges engaging and communicating:** Some government and business participants discussed challenges in engaging and communicating across sectors. For example, some government and business participants indicated that establishing public-private partnerships can be challenging due to constraints such as the inability to share proprietary or sensitive information about particular

¹⁸Four power marketing administrations exist within the Department of Energy. The role of these administrations is to market wholesale electricity from multiuse water projects.

vulnerabilities. A federal government participant said that agencies may not know how to discuss potential public-private partnerships with businesses while, at the same time, complying with laws intended to prevent inappropriate influence on federal policies.¹⁹ Finally, a local government participant said that businesses are sometimes not engaged with government resilience efforts until it is too late to consider their input. For example, a business might provide feedback on a building code after it has already been enacted.

Several business and government participants discussed opportunities to address some of these challenges, which they said could be a key step in building resilience. Such opportunities include:

- **Leading and coordinating efforts within and across sectors:** Several participants discussed various opportunities to enhance leadership and coordination within and across sectors. For example, a business participant encouraged the federal government to lead by example, and noted that GAO highlighted the importance of federal leadership by placing “Limiting the Federal Government’s Fiscal Exposure by Better Managing Climate Change Risks” on its high-risk list. Several participants noted that sharing information through, for example, forums such as this one could help sectors communicate with one another.
- **Engaging across sectors and regions:** The local government participants said that engaging across sectors early in the process of building resilience could help inform communities about the best actions to take. One local government participant suggested developing regional partnerships based on, for example, a watershed rather than jurisdictional boundaries, since climate-related risks may extend beyond jurisdictions. Another local government participant explained that, in particular, small businesses may not have the internal expertise and resources to manage climate-related risks on their own and would benefit from sharing knowledge and promising practices with large businesses.

¹⁹In 1972, Congress passed the Federal Advisory Committee Act upon finding, among other things, that standard and uniform procedures should govern the establishment, operation, administration, and duration of advisory committees. The act states that Congress advisory committees should be established only when they are essential and their number should be kept to the minimum necessary.

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- **Conducting gap analyses:** Some participants said that gap analyses should be performed across sectors to assess the status of existing resilience efforts and current resource levels. One subject matter participant said gap analyses could help governments and businesses understand what is known about resilience and what information is still needed. A federal government participant said gap analyses could also help governments and businesses understand what resources they have available and what resources they still need. Another subject matter participant added that a gap analysis could also help identify potential overlap in resilience efforts.

List of Congressional Addressees

The Honorable Maria Cantwell
Ranking Member
Committee on Energy and Natural Resources
United States Senate

The Honorable Sheldon Whitehouse
Ranking Member
Subcommittee on Fisheries, Water, and Wildlife
Committee on Environment and Public Works
United States Senate

The Honorable Matthew Cartwright
House of Representatives

Appendix I: List of Participants and Their Affiliations

Comptroller General Forum on Preparing for Climate-Related Risks: Lessons from the Private Sector

Participant Roster

Moderators

Mark Gaffigan	Managing Director, Natural Resources & Environment, GAO
J. Alfredo Gómez	Director, Natural Resources & Environment, GAO
Timothy M. Persons	Chief Scientist, GAO
Poornima Madhavan	Director, Board on Human-Systems Integration, Division of Behavioral and Social Sciences and Education, The National Academies

Business Representatives

Roberta Barbieri	Global Environmental Director, Diageo
James Chelius	Director of Engineering Asset Planning, American Water
Carl Hedde	Senior Vice President, Head of Risk Accumulation, Munich Re America
Diane Ross-Leech	Director of Environmental Policy, Pacific Gas & Electric Company
David Tulauskas	Director of Sustainability, General Motors
Steve Tullos	Senior Manager, Environmental Strategy & Policy, Entergy
Kathrin Winkler	Chief Sustainability Officer, EMC Corporation

Federal Agency Officials

Michael Culp	Team Leader, Sustainable Transportation and Climate Change, Federal Highway Administration
Patrick Holmes	Senior Advisor to the Under Secretary, Natural Resources and Environment, Department of Agriculture

Kevin Kampschroer¹	Chief Sustainability Officer, General Services Administration
Samantha Medlock²	Deputy Associate Director for Climate Preparedness, Council on Environmental Quality
Maureen Sullivan	Director, Environment, Safety, and Occupational Health, Department of Defense
Roy E. Wright³	Deputy Associate Administrator for Insurance and Mitigation, Federal Emergency Management Agency
Craig Zamuda	Senior Policy Advisor, Office of Energy Policy and Systems Analysis, Department of Energy

Local Government Officials

Frank Lancaster	Town Administrator, Estes Park, Colorado
Christine Morris	Chief Resilience Officer, Norfolk, Virginia

Subject Matter Experts

Shawna Ackerman	Vice President, Casualty Practice Council, American Academy of Actuaries
Rosina Bierbaum	Professor of Natural Resources and Environmental Policy, University of Michigan
Janet Peace	Senior Vice President, Policy and Business Strategies, Center for Climate and Energy Solutions

¹During parts of the forum, Ann Kosmal, Architect, Office of Federal High-Performance Green Buildings, represented the General Services Administration.

²During parts of the forum, Marissa McInnis, Senior Program Manager, Office of Federal Sustainability, represented the Council on Environmental Quality.

³During parts of the forum, Michael Kangior, Supervisory Emergency Management Specialist, represented the Federal Emergency Management Agency.

Appendix II: Forum Agenda

**Comptroller General Forum on Preparing for Climate-Related Risks:
Lessons from the Private Sector
July 21, 2015**

Agenda

- 8:00 a.m. Registration starts/Continental breakfast
- 8:30 a.m. **Welcome**
- Opening remarks
 - Introductions
 - Overview of the agenda
- 9:00 a.m. **Session I: Actions by businesses to build resilience to climate-related risks**
- How have extreme weather events and/or climate phenomena directly or indirectly—such as through supply changes or infrastructure—affected your business, and how might climate-related risks affect your business in the future?
 - What actions has your company taken to build resilience to climate-related risks?
 - How has your company justified such actions from a business perspective?
- Featured Speakers:* Presentations from business participants (5-10 minutes each)
- Roberta Barbieri – Diageo
 - James Chelius – American Water
 - Carl Hedde- Munich Re America
 - Diane Ross-Leech – Pacific Gas & Electric Company
 - David Tulauskas – General Motors
 - Steve Tullos – Entergy
 - Kathrin Winkler – EMC Corporation
- Group discussion among all forum participants
- 10:30 a.m. **Coffee Break**

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- 10:45 a.m. **Session II: Interdependency of business and government resilience**
- In what key ways are the business and government sectors dependent upon one another for building resilience to climate-related risks?
 - In what key ways have businesses and government partnered to build resilience, including through sharing tools and information?
 - What are some key lessons that have been learned from partnering?
- Featured speakers:*
- Samantha Medlock – Council on Environmental Quality (15 minutes)
 - Frank Lancaster – Estes Park, Colorado (5 minutes)
 - Christine Morris – Norfolk, Virginia (5 minutes)
- Group discussion among all forum participants
- 12:30 p.m. **Lunch Distributed**
- 1:00 p.m. **Working Lunch/Session III: Challenges and opportunities for businesses and government to better build resilience to climate-related risks**
- What are some key challenges businesses and government face in building resilience to climate-related risks?
 - What are some key opportunities for businesses and government to address these key challenges?
 - What steps are needed to pursue these opportunities?
- Group discussion among all forum participants
- 2:30 p.m. **Coffee Break**
- 2:45 p.m. **Session III Continued**
- 3:15 p.m. **Forum Wrap-Up: Group Discussion of Next Steps**
- 4:00 p.m. **Adjournment**

Appendix III: Issue Briefs Sent to Participants Prior to the Forum

Climate-related impacts are considered by many to pose risks to various environmental and economic systems—including agriculture, infrastructure, ecosystems, and human health—and to pose financial risks to various sectors, including businesses. According to the U.S. Global Change Research Program National Climate Assessment and the National Research Council of the National Academies, the physical impacts from a changing climate are already evident in many sectors and are expected to become increasingly disruptive throughout this century and beyond.¹ For example, these impacts include inundation from rising sea levels, altered agricultural productivity due to different temperature or precipitation patterns, and increased intensity and frequency of severe weather events.

According to the National Climate Assessment, climate-related impacts can present wide-ranging and sometimes cascading risks across the economy and at the federal, state, and local government levels.² As reported in the National Climate Assessment and by the Center for Climate and Energy Solutions, within the business sector such climate-related risks can include property damage, supply chain disruptions, commodity price volatility, and changes in resource availability.³ Similarly, in its February 2015 high risk update, GAO found that the federal government faces fiscal exposure from climate-related risks in its role as

¹Jerry M. Melillo, Terese (T.C.) Richmond, and Gary W. Yohe, eds., *Climate Change Impacts in the United States: The Third National Climate Assessment*, U.S. Global Change Research Program (Washington, D.C.: U.S. Government Printing Office, May 2014). National Research Council of the National Academies, *America's Climate Choices: Panel on Adapting to the Impacts of Climate Change, Adapting to the Impacts of Climate Change* (Washington, D.C.: 2010). The U.S. Global Change Research Program coordinates and integrates the activities of 13 federal agencies that conduct research on changes in the global environment and their implications for society. Participating agencies include the Departments of Agriculture, Commerce, Defense, Energy, Interior, Health and Human Services, State, and Transportation; the U.S. Agency for International Development; the Environmental Protection Agency; the National Aeronautics and Space Administration; the National Science Foundation; and the Smithsonian Institution.

²We define climate-related risks as vulnerabilities of natural and human systems, such as environmental and economic systems, due to changes in the earth's climate—including higher temperatures, changes in precipitation, rising sea levels, and increases in the severity and frequency of severe weather events.

³Center for Climate and Energy Solutions, *Adapting to Climate Change: A Business Approach* (Arlington, VA: April, 2008). Center for Climate and Energy Solutions, *Weathering the Storm: Building Business Resilience to Climate Change* (Arlington, VA: July, 2013).

the owner or operator of extensive infrastructure and as the insurer of property and crops vulnerable to climate-related impacts, among other areas (see attachment for additional information on federal fiscal exposure).⁴ In addition, according to the President's 2012 *National Strategy for Global Supply Chain Security*, the global competitiveness of the United States depends in part on managing supply chain risks, which include climate-related risks.⁵ Finally, state and local governments face climate-related risks to infrastructure, such as transportation networks and water and wastewater systems, which can increase risks to the private sector.

GAO has previously reported that building resilience to protect against future damage is one strategy to help manage climate-related risks, as well as risks from other natural disasters.⁶ The National Academies define resilience as the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.⁷ According to a Center for Climate and Energy Solutions report, within the private sector some companies have considered these risks within their overall risk management frameworks and have begun taking actions to build resilience.⁸ To explore such actions and advance the national dialogue on

⁴Every two years at the start of a new Congress, GAO calls attention to agencies and program areas that are high risk due to their vulnerabilities to fraud, waste, abuse, and mismanagement, or are most in need of transformation. GAO, *High-Risk Series: An Update*, [GAO-15-290](#) (Washington, D.C.: Feb. 11, 2015).

⁵The White House, *National Strategy for Global Supply Chain Security* (Washington, D.C.: January, 2012).

⁶GAO, *Disaster Resilience: Actions Are Underway, but Federal Fiscal Exposure Highlights the Need for Continued Attention to Longstanding Challenges*, [GAO-14-603T](#) (Washington, D.C.: May 14, 2014).

⁷The National Academies, Committee on Increasing National Resilience to Hazards and Disasters; Committee on Science, Engineering, and Public Policy; *Disaster Resilience: A National Imperative* (Washington, D.C.: 2012). When discussing climate change, the term adaptation—defined as adjustments to natural or human systems in response to actual or expected climate change—is synonymous with enhancing resilience. Adaptation is a risk-management strategy to help protect vulnerable infrastructure and communities that might be affected by changes in the climate.

⁸Center for Climate and Energy Solutions, *Weathering the Storm: Building Business Resilience to Climate Change* (Arlington, VA: July, 2013). As reported by the National Research Council of the National Academies, no one-size fits all solution exists to the challenges of adapting to climate change impacts, as options will differ depending on context, regional vulnerabilities, available resources, and scale.

preparing for climate-related risks, the Comptroller General will convene a forum of leaders from business, government, and other sectors to discuss the following questions:

- What key steps are businesses taking to build resilience to climate-related risks, and how have they justified such actions from a business perspective?
- In what key ways do the business and government sectors face interdependent climate-related risks, and how have they collaborated to build resilience?
- What challenges and opportunities exist for businesses and government to better build resilience to climate-related risks?

The following issue briefs provide background information for these questions.

Issue 1: Private Sector Climate-Related Risks and Efforts to Build Resilience

The goal of the forum's first discussion session is to explore actions taken by businesses across various sectors to identify climate-related risks and build resilience. This discussion session will focus on how extreme weather events or climate phenomena, such as sea level rise, have affected or could affect businesses in various industries; the actions these businesses have taken to build resilience; and how businesses have justified such actions from a business perspective.

Many businesses have experienced impacts from climate-related risks or could face risks from such impacts in the future, according to reports by private sector and nonprofit entities. For example, potential risks to the core operations of a business could include damage to physical assets from sea level rise and increased storm surges, interruptions to business operations due to extreme weather, unsafe conditions for the workforce due to high temperatures, or water scarcity due to drought conditions. As reported by private sector, nonprofit, and government entities, businesses may also face risks due to potential disruptions in their supply chains, changes or delays in services provided by public and private electricity and water utilities, and decreased availability of raw materials. In addition, many sectors are interconnected, meaning that risks to one may trigger risks to others. For example, in January 2014, GAO found that climate-

related risks in the nation's energy system could have wide-ranging implications for energy production and use.⁹ This could ultimately affect transportation, industrial, agricultural, and other critical sectors of the economy that require reliable supplies of energy.

Climate-related risks to businesses vary by geographic region and sector of the economy. The location of a company's operations is often the greatest factor determining direct economic exposure to such risks because each region of the country has a different risk profile and a different ability to manage that risk, according to a report by the Risky Business Project.¹⁰ For example, as reported in 2008 by the Center for Climate and Energy Solutions, risks are not evenly spread across geographic regions, and companies with core operations, customers, or critical supply chain components in the most vulnerable locations may face greater risks.¹¹ In addition, various sectors of the economy face different climate-related risks. According to the 2008 report by the Center for Climate and Energy Solutions, the companies most at risk include: (1) those facing decisions about long-term capital investments, such as infrastructure or equipment; (2) those where weather and climate are integral components of production, including agriculture or construction; (3) industries that rely heavily on transport and other infrastructure in their supply and demand chains; and (4) those that assume the risks of other companies, such as the insurance industry.¹²

Many businesses have experienced climate-related impacts, but, as reported by private sector and nonprofit entities, relatively few companies have undertaken efforts to systematically incorporate resilience into their planning and operations. According to a 2013 Center for Climate and Energy Solutions report, some companies have evaluated their climate-related risks and determined that the risks are either relatively minimal, too distant in time to be of concern, too difficult to quantify, or too

⁹GAO, *Climate Change: Energy Infrastructure Risks and Adaptation Efforts*, [GAO-14-74](#) (Washington, D.C.: Jan. 31, 2014).

¹⁰The Risky Business Project, *Risky Business: The Economic Risks of Climate Change in the United States* (June 2014).

¹¹Center for Climate and Energy Solutions, *Adapting to Climate Change: A Business Approach* (Arlington, VA: April, 2008).

¹²Center for Climate and Energy Solutions, *Adapting to Climate Change: A Business Approach* (Arlington, VA: April, 2008).

uncertain to support business decisions for building resilience.¹³ However, this report stated that other companies are taking steps to reduce climate-related risks where they see significant opportunities and a clear business case to become more efficient, reduce costs, or provide greater value to customers by reducing the risks. Many of these companies invest in climate resilience in order to respond quickly and recover readily to events beyond their control, maintain a competitive advantage, or preserve or create value, while other companies simply view resilience as a business imperative, according to the Center for Climate and Energy Solutions report and others. As some of these reports state, the type and level of a company's response typically depends on factors such as experience with climate-related disruptions to business infrastructure or operations, and whether it is responding to direct risks to its core operations, or indirect risks relating to supply chain or other dependencies. According to the 2013 Center for Climate and Energy Solutions report, the process commonly used by proactive companies to understand and manage climate-related risks to build resilience includes:

- Collecting information and building knowledge about climate-related risks;
- Assessing and prioritizing climate-related risks using corporate risk management frameworks;
- Developing plans and guidance that inform management decisions to build resilience which may include actions such as modifying planning and operations, fortifying infrastructure, managing supply chain risks, or adjusting insurance coverage; and
- Incorporating risk factors into an ongoing, iterative review process to fine-tune resilience strategies.

¹³Center for Climate and Energy Solutions, *Weathering the Storm: Building Business Resilience to Climate Change* (Arlington, VA: July, 2013).

Issue 2: Interdependency of Business and Government Climate- Related Risks and Resilience

The forum's second discussion session will focus on how the business and government sectors depend on one another to build resilience to climate-related risks; the ways in which businesses and government have partnered to build resilience, including through sharing tools and information; and key lessons learned from these partnerships.

Business and Government Sector Interdependencies and Risks

Business and government sectors are interdependent because they are linked through infrastructure, services, supplies, and support. As a result, climate-related risks in one sector can increase risks in other sectors. For example, in its February 2015 high-risk update, GAO found that state, local, and private sector decision makers can increase federal climate-related fiscal exposures because they are responsible for planning, constructing, and maintaining certain types of vulnerable infrastructure. This infrastructure is paid for with federal funds, insured by federal programs, eligible for federal disaster assistance, or relied upon by federal agencies to achieve their missions. In addition, climate-related risks may also disrupt private sector supply chains that provide the food, medicine, energy, and products that support the U.S. economic system. The federal government relies on such supply chains to provide these goods and services. Examples of interdependent climate-related risks include those related to:

- **Roads and bridges:** As GAO reported in 2014, the federal government invests billions of dollars annually in infrastructure projects, such as roads and bridges that state and local governments prioritize and supervise.¹⁴ The private sector relies on this infrastructure to maintain business operations and continuity. For example, Louisiana State Highway 1 provides the only road access to Port Fourchon, which services virtually all deep-sea oil operations in the Gulf of Mexico. According to the National Oceanic and Atmospheric Administration (NOAA), this region has experienced one of the highest rates of relative sea level rise in the world, and the highway is closed an average of 3.5 days annually due to inundation. NOAA estimates that, within 15 years, sea level rise will inundate this

¹⁴GAO, *Extreme Weather Events: Limiting Federal Fiscal Exposure and Increasing the Nation's Resilience*, [GAO-14-364T](#) (Washington, D.C.: Feb. 12, 2014).

highway an average of 30 times annually, effectively closing the port each time.

- **Telecommunications and data center services:** According to the General Services Administration (GSA), the telecommunications and data center service sectors provide mission critical services to federal agencies.¹⁵ A study commissioned by GSA identified the impacts that extreme weather has had on these sectors. For example, in 2012, damage from the storm surge associated with Hurricane Sandy cost Verizon \$1 billion. GSA expects that the costs suppliers incur to recover from climate-related events will be passed along to their customers. Therefore, any proactive steps that can be taken today to minimize these risks can help manage the rise of future costs.

Federal Efforts to Help Build Resilience: Partnerships and Tools

The federal government released the President's June 2013 Climate Action Plan and has issued various executive orders and initiated related activities to help build resilience and address climate-related risks across various sectors. Examples of some federal efforts to help build resilience in cooperation with other levels of government and the private sector include the following:

- The Federal Highway Administration (FHWA) partnered with state and local transportation agencies in Connecticut, New Jersey, and New York, to leverage lessons learned from Hurricane Sandy and other recent storms, and develop feasible, cost-effective strategies to enhance the resiliency of the region's transportation system to extreme weather and climate-related impacts.
- Through the Department of Energy's (DOE) *Partnership for Energy Sector Climate Resilience* initiative, DOE partners with energy companies to develop resources to facilitate risk-based decision making and pursue cost-effective strategies for more climate resilient energy infrastructure. As GAO found in 2014, enhancing the resilience of energy infrastructure is primarily accomplished through planning

¹⁵GSA provides centralized procurement for the federal government, offering products, services, and facilities that federal agencies need to serve the public, and as such, needs to understand and mitigate risks to vital services.

and investment decisions made by private companies that own the infrastructure.¹⁶

In addition, the federal government provides tools and technical assistance to state, local, and private sector decision makers to help them build resilience. For example:

- The U.S. Department of Agriculture established its climate hubs in February 2014 to deliver science-based knowledge and practical information, and support climate-informed decision making in light of the increased risks and vulnerabilities associated with a changing climate. These hubs deliver information to farmers, ranchers, and forest landowners to help them adapt to climate and weather variability.¹⁷
- The U.S. Department of Transportation (DOT) conducted a comprehensive, multiphased study of the Central Gulf Coast region to better understand climate-related impacts on transportation infrastructure and identify potential adaptation strategies.¹⁸ The project resulted in findings on the region's transportation vulnerability, as well as approaches for using climate data in transportation vulnerability assessments, methods for evaluating vulnerability and adaptation options, and tools and resources to assist others in conducting similar work.
- Through an effort coordinated by the White House Office of Science and Technology Policy and Council on Environmental Quality, NOAA led a partnership of other federal agencies and organizations to develop the U.S. Climate Resilience Toolkit. This toolkit provides scientific tools, information, and expertise to help communities, businesses, and policy leaders at all levels of government, among

¹⁶[GAO-14-74](#).

¹⁷More information on the U.S. Department of Agriculture regional hubs can be found [here](#).

¹⁸U.S. Department of Transportation: Center for Climate Change and Environmental Forecasting. *Assessing Transportation Vulnerability to Climate Change: Synthesis of Lessons Learned and Methods Applied*. Impacts of Climate Change and Variability on Transportation Systems and Infrastructure – The Gulf Coast Study Phase 2. (Washington, D.C.: October 2014). FHWA-HEP-15-007.

others, manage their climate-related risks, and improve their resilience to extreme events.¹⁹

Issue 3: Challenges and Opportunities for the Private and Public Sectors

During the forum's third discussion session, we will facilitate a dialogue among forum participants to identify key challenges faced by businesses and government in building resilience to climate-related risks and explore key opportunities for businesses and government to collaborate to address these challenges.

Several businesses and federal agencies have taken steps to build resilience to climate-related risks, but face challenges in these efforts. Based on GAO's prior work, a literature review, and background interviews with business representatives, some examples of key challenges that federal agencies and businesses have faced in taking steps to build resilience include those identified in the list below. During the forum, we will ask participants to identify what they view as the most important challenges, either from this list or additional challenges not included here.

- *Availability of data and tools* – Some business representatives we interviewed indicated a need for relevant data (for example, industry-specific or at a more local level) to help inform their decisions regarding building resilience. In addition, one business representative said it would be helpful if business had access to a tool that helped them assess risk and identify resilience activities.
- *Incorporating forward-looking information into existing processes* – Certain types of extreme weather events have become more frequent or intense, according to the U.S. Global Change Research Program. However, some representatives we interviewed said their businesses primarily use historical data, not projections, to make decisions about adaptation planning. Moreover, according to representatives we interviewed and our literature review, time horizons for business planning cycles and investment decisions do not necessarily align with longer-term climate-related risks. Similarly, in 2013, GAO found that most local infrastructure planning processes and their associated funding cycles occur on time horizons poorly matched to the longer

¹⁹More information on the *Climate Resilience Toolkit* may be found [here](#).

view sometimes required to discern climate-related impacts and identify the benefits of building resilience.

- *Interdependency of resilience* – For example, one representative we interviewed said the ability for his business to return to typical operations after severe weather events has been limited by damage to local infrastructure that prevented employees and customers from returning to their homes or traveling to work. Moreover, although the business’s operations were resilient after Hurricane Ike in 2008, one of its major customers was severely impacted by the storm and could not buy its service for 4 weeks.
- *Internal expertise* – Federal agencies and businesses do not always have the internal expertise to support management decisions to build resilience. Instead, they may need to rely on external climate science experts to, for example, project climate-related risks to infrastructure.
- *Resource constraints* – Efforts to build resilience may compete for resources with other objectives or priorities that could produce more immediate results or benefits, and studies to estimate climate-related risks can require significant investments. In one instance, a business spent about \$4 million to estimate its potential loss of assets due to flooding, wind damage, and storm surge, according to a representative we interviewed.
- *Uncertainty in long-term climate change projections* – Long-term changes in severe weather events are difficult to predict, so federal agencies and businesses may face challenges justifying the funds to build resilience for future conditions.

During the forum, we will also ask participants to identify key opportunities for businesses and federal agencies to address key challenges and better build resilience. Based on a literature review and background interviews with business representatives, such opportunities may include those on the following list or additional opportunities not included here:

- collaborating to identify or share relevant data sources or develop analysis tools;
- sharing knowledge about managing climate-related risks and resilience efforts; and
- leveraging resources through, for example, public-private partnerships.

**Appendix III: Issue Briefs Sent to Participants
Prior to the Forum**

In addition, during the forum's third discussion, we will ask participants to discuss the steps needed to pursue the key opportunities.

Attachment: Climate-Related Risks Present Financial Risks to the Federal Government

GAO is convening this forum in conjunction with its work related to limiting the federal government's fiscal exposure by better managing climate-related risks. This attachment provides additional information about this work.

GAO's past work has identified a variety of federal fiscal exposures—responsibilities, programs, and activities that may either legally commit the federal government to future spending or create the expectation for future spending.²⁰ For example, weather-related events have cost the nation tens of billions of dollars over the past decade, and fiscal exposure from weather-related events increases with the increased frequency and severity of these events.²¹ The U.S. Global Change Research Program concluded that the impacts and costs of extreme weather events—those resulting from floods, droughts, and other events—will increase in significance as what have been considered “rare” events become more common and intense due to climate change.²² It is not possible to link any individual weather event to climate change; however, these events provide insight into potential climate-related risks the United States faces. Because of these risks, in February 2013, GAO added the area of *Limiting the Federal Government's Fiscal Exposure by Better Managing Climate Change Risks* to its High Risk List.²³ In February 2015, GAO released its High Risk biannual update and once again included this area on the list.²⁴ GAO work also has identified five areas where government-wide improvement is needed to reduce its fiscal exposure, including the federal government's role as:

²⁰Additional information on GAO's work related to fiscal exposures may be found on GAO's website, click [here](#).

²¹GAO, *Fiscal Exposures: Improving Cost Recognition in the Federal Budget*, [GAO-14-28](#) (Washington, D.C.: Oct. 29, 2013).

²²Jerry M. Melillo, Terese (T.C.) Richmond, and Gary W. Yohe, eds., *Climate Change Impacts in the United States: The Third National Climate Assessment*, U.S. Global Change Research Program (Washington, D.C.: U.S. Government Printing Office, May 2014).

²³GAO, *High-Risk Series: An Update*, [GAO-13-283](#) (Washington, D.C.: Feb. 14, 2013).

²⁴[GAO-15-290](#). In addition, the Office of Management and Budget reported in the *Fiscal Year 2016 Budget of the U.S. Government, Analytical Perspectives* volume, that the federal government has broad exposure to escalating costs and lost revenue as a direct or indirect result of a changing climate. For additional information, click [here](#).

1. **Leader of national strategic plan:** The federal government is not well organized to address the fiscal exposure presented by climate-related risks, partly because of the inherently complicated, crosscutting nature of the issue. The federal government would be better positioned to respond to the risks posed if federal efforts were more coordinated and were directed toward common goals. While the federal government has recently initiated many climate-related strategic planning activities, existing strategic planning efforts generally do not address the roles, responsibilities, and working relationships among federal, state, and local entities; identify how such efforts will be funded and staffed over time; or establish mechanisms to track and monitor progress.
2. **Owner and operator of extensive infrastructure:** The federal government owns and operates hundreds of thousands of facilities that climate-related risks could affect. For example, the Department of Defense (DOD) manages a global real-estate portfolio that includes more than 555,000 facilities and 28 million acres of land with a replacement value of close to \$850 billion. This infrastructure is vulnerable to flooding and extreme weather events. For example, in August 2013, a military base in the desert Southwest experienced a rain event in which the amount of rain normally received in 1 year fell in 80 minutes. Flooding from this event resulted in an estimated \$64 million in damages to more than 160 facilities, eight roads, one bridge, and 11,000 linear feet of fencing.²⁵
3. **Insurer of property and crop insurance:** Two important federal insurance efforts—the National Flood Insurance Program (NFIP), and the Federal Crop Insurance Corporation—face climate-related risks and other fundamental challenges. Previously, GAO assessed the financial risks to the National Flood Insurance Program and the United States Department of Agriculture’s Federal Crop Insurance Corporation and found that their exposure to weather-related losses had grown substantially.²⁶ For example:
 - The NFIP is a key component of the federal government’s efforts to limit the damage and financial cost of floods. However, it likely

²⁵GAO, *Climate Change Adaptation: DOD Can Improve Infrastructure Planning and Processes to Better Account for Potential Impacts*, [GAO-14-446](#) (Washington, D.C.: May 30, 2014).

²⁶GAO, *Climate Change: Financial Risks to Federal and Private Insurers in Coming Decades Are Potentially Significant*, [GAO-07-285](#) (Washington, D.C.: Mar. 16, 2007).

will not generate sufficient revenues to repay the billions of dollars borrowed from the Department of the Treasury to cover claims from the 2005 and 2012 hurricanes or potential claims related to future catastrophic losses. The flood insurance program is intentionally not actuarially sound because, among other things, Congress authorized subsidized insurance rates to be made available for policies covering certain structures. As of December 31, 2014, the Federal Emergency Management Agency (FEMA) owed the Treasury \$23 billion, up from \$20 billion as of November 2012. FEMA made a \$1 billion principal repayment at the end of December 2014—FEMA's first such payment since 2010.²⁷

- The cost of the federal crop insurance program grew significantly from 2003 to 2012. The cost averaged \$3.4 billion a year for fiscal years 2003 through 2007, but it increased to \$8.4 billion a year for fiscal years 2008 through 2012. Federally subsidized crop insurance has become one of the most important programs to help farmers manage the risks inherent to farming.²⁸

4. **Provider of technical assistance to decision makers:** Climate-related risks have the potential to directly affect a wide range of federal services, operations, programs, assets, and national security, increasing federal fiscal exposure in many ways. State, local, and private sector decision makers can also increase federal climate-related fiscal exposures because they are responsible for planning, constructing, and maintaining certain types of vulnerable infrastructure paid for with federal funds, insured by federal programs, or eligible for federal disaster assistance. Federal efforts are beginning to focus on providing information to these decision makers so they can make more informed choices about how to manage the risks posed by potential climate impacts. However, federal, state, local, and private sector decision makers may be unaware that this information exists or may be unable to use what is available.
5. **Provider of aid in response to disasters:** Multiple factors, including increased federal disaster declarations, climate-related risks, and insufficient premiums under the NFIP, increase federal fiscal exposure. Extreme weather events have cost the nation tens of

²⁷GAO-15-290.

²⁸GAO, *Crop Insurance: Considerations in Reducing Federal Premium Subsidies*, GAO-14-700 (Washington, D.C.: Aug. 8, 2014).

billions of dollars in damages over the past decade. For example, from 2004 through 2013, FEMA obligated more than \$95 billion in federal disaster assistance.²⁹ Among other things, this assistance provides for the necessary expenses and serious needs of disaster victims that cannot be met through insurance, as well as assistance with housing, crisis counseling, unemployment, or legal expenses incurred as a result of a disaster.

²⁹GAO, *Budgeting for Disasters: Approaches to Budgeting for Disasters in Selected States*, [GAO-15-424](#) (Washington, D.C.: March 26, 2015).

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

J. Alfredo Gómez, (202) 512-3841 or gomezj@gao.gov

Staff Acknowledgments

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