

Disaster Resilience Framework

Principles for Analyzing Federal Efforts to Facilitate and Promote Resilience to Natural Disasters



INFORMATION

INTEGRATION

INCENTIVES

Disaster Resilience Framework

GAO created the Disaster Resilience Framework to serve as a guide for analysis of federal actions to facilitate and promote resilience to natural disasters.

This Framework is organized around three broad overlapping principles and a series of questions that those who provide oversight or management of federal efforts can consider when analyzing opportunities to enhance their contribution to national disaster resilience.

Principle:



Information

Accessing information that is authoritative and understandable can help decision makers to identify current and future risk and the impact of risk-reduction strategies.

Provide reliable and authoritative information about current and future risk

- To what extent could federal efforts:
- Enhance the validity and reliability of the disaster risk information produced?
 - Generate and share additional information that would help decision makers understand their disaster risk?
 - Reduce the complexity of and translate risk information for non-technical audiences?
 - Help leverage and synthesize disaster risk information from other partners across agencies, governments, and sectors?
 - Promote consensus around the reliability of the sources and methods that produce disaster risk information?

Improve the ability to assess alternatives to address risk

- To what extent could federal efforts:
- Help decision makers identify and select among disaster risk-reduction alternatives?
 - Provide technical assistance to help build capacity of nonfederal partners?
 - Contribute to an understanding of approaches for estimating returns on investment?
 - Help decision makers identify and combine available funding sources and innovative methods for meeting disaster risk-reduction needs?

Strengthen the ability to assess status and report progress

- To what extent could federal efforts:
- Advance methodologies or processes to measure the current state of nationwide resilience?
 - Promote monitoring of progress toward resilience on a programmatic basis?



Integration

Integrated analysis and planning can help decision makers take coherent and coordinated resilience actions.

Build an overarching strategic vision and goals

- To what extent could federal efforts:
- Help to establish overarching strategies that guide national resilience efforts?
 - Ensure that resilience goals are incorporated into relevant national strategies?
 - Prioritize resilience goals that reflect the most pressing resilience challenges?

Promote coordination across missions and sectors

- To what extent could federal efforts:
- Ensure consistent and complementary policies, procedures, and timing across relevant federal funding mechanisms?
 - Convene stakeholders with different perspectives and interests to create whole systems solutions?
 - Encourage governance mechanisms that foster coordination and integrated decision making within and across levels of government?
 - Engage non-government partners in disaster risk reduction?

Recognize relationships among infrastructure and ecosystems

- To what extent could federal efforts:
- Promote better understanding and awareness of the interactions among infrastructure components and ecosystems in disaster resilience actions?
 - Assist decision makers in determining what combination of ecosystem and built infrastructure solutions will best suit their needs within their constraints?
 - Assist in ensuring that projects undertaken under different programs and by different actors do not conflict?
 - Facilitate planning across jurisdictions and sectors to avoid or respond to cascading failure?



Incentives

Incentives can help to make long-term, forward-looking risk-reduction investments more viable and attractive among competing priorities.

Provide financial and nonfinancial incentives

- To what extent could federal efforts:
- Make risk-reduction measures more viable and attractive?
 - Incorporate disaster risk-reduction measures in infrastructure and ecosystem management financial assistance?
 - Require disaster risk-reduction measures for government-owned or -operated infrastructure and for federally funded projects?

Reduce disincentives

- To what extent could federal efforts:
- Alleviate unnecessary administrative burden?
 - Streamline review processes?
 - Improve program design to motivate risk-reduction actions?

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Why We Created This Framework

GAO has identified the rising number of natural disasters and increasing reliance on federal assistance as a significant source of federal fiscal exposure.¹ In the last 3 years alone, there have been about \$183 billion in select supplemental appropriations for disaster assistance to multiple federal agencies and annual appropriations to the Disaster Relief Fund.² Since 1980, the U.S. has experienced 254 climate and weather disasters causing more than \$1 billion in damage each and totaling over \$1.7 trillion, according to the National Oceanic and Atmospheric Administration. The U.S. Global Change Research Program (USGCRP) projects increases in the severity and frequency of certain extreme weather and climate-related events, which will have negative economic impacts across the nation.³

GAO created the Disaster Resilience Framework to support analysis of federal opportunities to facilitate and promote resilience to natural hazards.⁴ Recognizing the gravity of the effect of natural disasters on the American people and the fiscal exposure it creates, this Framework provides a set of high-level principles to help those who have responsibility for oversight and management of federal efforts to consider actions they might take to increase resilience to natural hazards.

The federal government has a variety of roles in managing disaster impacts, including as: (1) insurer of property and crops; (2) provider of disaster aid; (3) owner or operator of infrastructure; (4) convener of stakeholders and coordinator of efforts at the federal, state, local, and private-sector levels; and (5) provider of data and technical assistance to decision makers. Since 2013, in recognition of these unique roles and the federal government's significant stake in managing climate-related disaster impacts, GAO has included "Limiting the Federal Government's Fiscal Exposure by Better Managing Climate Change Risks" in its High Risk List.⁵

Investments in disaster resilience are a promising avenue to address the federal fiscal exposure because such investments offer the opportunity to reduce the overall impact of disasters. For example, we reported that elevating homes and strengthening building codes in Texas and Florida prevented greater damages during the 2017 hurricane season.⁶ In addition, the National Institute of Building Sciences (NIBS) concludes that disaster resilience investments can save from \$3 to \$11 per dollar invested, depending on the circumstances and type of hazard.⁷



In 2011 tropical storm Irene caved in many roads after dropping more than 11 inches of rain. This caused floods, which did extensive damage to infrastructure in Vermont.

Source: Wendell A. Davis, Jr. / Federal Emergency Management Agency. | GAO-20-100SP

¹The term fiscal exposure refers to the responsibilities, programs, and activities that may either legally commit the federal government to future spending or create the expectation for future spending. In 2015, we created an infographic that described 5 key sources of federal fiscal exposure, the environment and disasters among them. See <https://blog.gao.gov/2015/02/26/fiscal-exposures-5-sources-of-risk-that-drive-future-spending/>.

²See, e.g., Supplemental Appropriations for Disaster Relief Requirements Act, 2017, Pub. L. No. 115-56, div. B, 131 Stat. 1129, 1136 (2017); Additional Supplemental Appropriations for Disaster Relief Requirements Act, 2017, Pub. L. No. 115-72, div. A, 131 Stat. 1224, 1224 (2017); Supplemental Appropriations for Disaster Relief Requirements Act, 2018, Pub. L. No. 115-123, div. B, subd. 1, 132 Stat. 64, 65 (2018); Additional Supplemental Appropriations For Disaster Relief Act of 2019, Pub. L. No. 116-20, 133 Stat. 871 (2019).

³USGCRP, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018.

⁴The term disaster resilience refers to the ability to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions. Hazard mitigation (actions taken to lessen the impact of disasters) and climate adaptation (actions taken to address the actual and anticipated effects of climate change) are two kinds of actions that enhance disaster resilience by reducing disaster risk. The principles of this Framework are designed primarily to support consideration of how the federal government can help itself and nonfederal entities take action to reduce risk from natural hazards, but the principles are not intended to exclude consideration of efforts that might also reduce risk posed by man-made hazards, where applicable.

⁵For the most recent update, see GAO, *High-Risk Series: Substantial Efforts Needed to Achieve Greater Progress on High-Risk Areas*, GAO-19-157SP (Washington, D.C.: Mar. 6, 2019).

⁶GAO, *2017 Hurricanes and Wildfires: Initial Observations on the Federal Response and Key Recovery Challenges*, GAO-18-472 (Washington, D.C.: Sept. 4, 2018).

⁷Multihazard Mitigation Council, a council of the National Institute of Building Sciences, *Natural Hazard Mitigation Saves: 2018 Interim Report* (Washington, D.C.: December 2018).

Cover photo source: Ken Engquist / National Oceanic and Atmospheric Administration. | GAO-20-100SP

We have previously reported that the federal approach to disaster risk reduction has been reactive and fragmented, limiting the federal government's ability to facilitate significant reduction in the nation's overall disaster risk. First, most of the federal government's efforts to reduce disaster risk are reactive and many revolve around disaster recovery. As we reported in 2015, the federal government has primarily funded disaster resilience projects in the wake of disasters—when damages have already occurred and opportunities to pursue future risk reduction may conflict with the desire for the immediate restoration of critical infrastructure.⁸

Moreover, we reported that funding disaster resilience primarily in reaction to disasters that have already occurred has created and exacerbated fragmentation across federal programs with different timelines and purposes, making it more difficult for nonfederal partners to pursue whole systems solutions to risk reduction.⁹ In light of the seriousness and complexity of the problem, solutions will be multifaceted and often will require cooperation across agencies, governments, and sectors. This Framework provides a set of principles that can be applied to any federal effort—post-disaster, pre-disaster, and outside the traditional disaster preparedness and recovery domain—to help federal agencies and policymakers consider what kinds of actions to take if they seek to promote and facilitate disaster risk reduction.

How We Developed This Framework

The Framework is based on (1) a large and expanding literature on resilience, (2) the findings and recommendations of over 50 related GAO reports over the last 15 years, (3) expert review of the Framework, (4) internal review by GAO subject matter experts, and (5) technical comments from federal, state, and non-profit bodies with expertise in resilience.

First, the Framework is informed by a large and expanding literature on resilience from entities such as the USGCRP; the National Academies of Science, Engineering, and Medicine (National Academies); NIBS; the Rockefeller Foundation's 100 Resilient Cities; the National Institute of Standards and Technology; the Federal Emergency Management Agency (FEMA); and the U.S. Department of Housing and Urban Development.

Second, we drew from GAO's wide range of resilience work which includes reports on an investment strategy for national resilience, the use of climate information in design standards, opportunities to reduce federal fiscal exposure to climate change, Department of Defense resilience efforts, electric grid resilience, and wireless network resilience. For a broader list of GAO's work related to disaster resilience, see appendix 1. GAO has also issued numerous recommendations to improve federal disaster resilience efforts, which can be found within the reports listed in appendix 1.

Third, to ensure that the Framework reflects the most current understanding of opportunities for the federal government to enhance the nation's disaster resilience, GAO conducted semi-structured interviews from March-April 2019 with 11 resilience subject matter experts to solicit feedback on a Framework



6,000-pound boulders being stacked to build an 18-foot barrier to reinforce the Bay's Head, New Jersey, sea wall as part of Hurricane Sandy relief efforts.

Source: Rosanna Arias / Federal Emergency Management Agency. | GAO-20-100SP

⁸GAO, *Hurricane Sandy: An Investment Strategy Could Help the Federal Government Enhance National Resilience for Future Disasters*, [GAO-15-515](#) (Washington, D.C.: July 30, 2015).

⁹We recommended a strategy be created to help federal, state, and local governments plan for and invest in enhanced disaster resilience. See [GAO-15-515](#). In response, the Mitigation Framework Leadership Group—the interagency body responsible for overseeing the *National Mitigation Framework*—published the *National Mitigation Investment Strategy August 2019*. The strategy includes recommendations designed to help the federal government and nonfederal partners identify, support, influence, and align hazard mitigation investments. The principles of this Disaster Resilience Framework are not specific prescriptions but are designed to guide broad-based consideration of what the federal government can do to enhance disaster risk-reduction actions at the federal level and by nonfederal decision makers. Nevertheless, the principles in this Framework are compatible with and mutually reinforcing of the more prescriptive recommendations outlined in the *National Mitigation Investment Strategy 2019*.

draft. We provided the Framework to these experts for an additional review prior to publishing. These experts were selected for the breadth of their knowledge and experiences related to disaster resilience such as hazard mitigation, resilience finance and investment, engineering, and urban planning. The Framework incorporates their feedback where appropriate. See appendix 2 for more details on the subject matter expert selection process and acknowledgments.

Fourth, a group of senior GAO officials with expertise in diverse subject matter such as emergency management, climate change, forest and coast management, critical infrastructure protection, intergovernmental relations, flood control, and disaster insurance contributed to, and reviewed, the Framework during its development.

The Framework was also reviewed by:

- representatives from the two most relevant federal interagency coordinating bodies—USGCRP and the Mitigation Framework Leadership Group (MitFLG), interagency groups with responsibility for defining climate trends and coordinating hazard mitigation, respectively.¹⁰
- the Disaster Assistance Working Group of the Council of Inspectors General on Integrity and Efficiency for perspectives on auditing and evaluating federal disaster relief programs.¹¹
- the National Association of State Auditors, Comptrollers, and Treasurers for their perspectives on evaluating state efforts that use federal funds—particularly those that could provide disaster resilience opportunities.¹²
- the National Emergency Management Association’s Hazard Mitigation Committee for their broad policy perspectives on how state emergency managers interact with the federal government to enhance disaster resilience.¹³

We incorporated technical comments from these parties to enhance clarity and provide additional context, where appropriate. We did not incorporate comments that would expand the scope of this project—for example comments to provide prescriptive recommendations or detailed appendixes with specific information about hazard mitigation planning or funding. The goal of the principles in this Framework is to help guide consideration of a very broad range of actions rather than to make specific recommendations about what should be done. Neither did we incorporate comments that would change the focus of this Framework, such as suggestions to expand the principles so that they specifically include hazards other than natural hazards. Although



Bio-swale – a depressed catchment area planted with vegetation that captures and infiltrates runoff.

Source: GAO. | GAO-20-100SP

¹⁰USGCRP is a federal program established by the Global Change Research Act of 1990 that coordinates federal research and investments in understanding the forces shaping the global environment, both human and natural, and their impacts on society. See Pub. L. No. 101-606, § 103, 104 Stat. 3096, 3098 (1990). USGCRP facilitates collaboration and cooperation across its 13 federal member agencies to advance understanding of the changing Earth system and maximize efficiencies in federal global change research.

The MitFLG consists of representatives from state, local, tribal, and federal governments. Federal agencies represented include the Departments of Agriculture, Commerce, Defense, Energy, Health and Human Services, Homeland Security, Housing and Urban Development, the Interior, Justice, Transportation, and Treasury; Environmental Protection Agency; General Services Administration; and Small Business Administration.

¹¹The Council of Inspectors General on Integrity and Efficiency was statutorily established as an independent entity within the United States executive branch by the Inspector General Reform Act of 2008 to address integrity, economy, and effectiveness issues that transcend individual government agencies, among other things. Pub. L. No. 110-409, § 7(a), 122 Stat. 4302, 4305. The Disaster Assistance Working Group is a mechanism for inspectors general at federal agencies with responsibility for providing disaster relief and assistance to collaborate and share information.

¹²The National Association of State Auditors, Comptrollers, and Treasurers membership is comprised of officials who have been elected or appointed to the offices of state auditor, state comptroller, or state treasurer in the 50 states, the District of Columbia, and the U.S. territories. Among other things, it provides leadership and training to help its membership meet increasingly complex state-level challenges.

¹³NEMA is the professional association of and for emergency management directors from all 50 states, eight U.S. territories, and the District of Columbia. NEMA provides national leadership and expertise in comprehensive emergency management.

the principles of this Framework do not necessarily preclude considering risks posed by man-made hazards, we believe the significant fiscal exposure created by natural hazards merits this focused attention.

How to Use This Framework

As shown in figure 1, this Framework is organized around three broad overlapping principles and a series of questions that those who provide oversight or management of federal efforts can consider when analyzing opportunities to enhance their contribution to national disaster resilience.

Figure 1: Disaster Resilience Framework



Source: GAO. | GAO-20-100SP

Users of the Framework can use its principles and questions for consideration to:

- **Analyze Any Type of Existing Federal Effort**

The Framework can be used to analyze a range of federal efforts including: authorizing and reauthorizing programs; considering legislation; creating or updating regulations, directives, guidance, and national or agency-level strategic planning documents; and implementing or operating programs of any size or purpose.

- **Identify Gaps in Existing Federal Efforts**

The Framework can be used to identify opportunities to address gaps in federal efforts by, for example, supporting the identification of options to address government-wide challenges that are of a scale and scope not addressed by existing programs.

- **Adapt the Principles to the Circumstances of the Effort Under Consideration**

The Framework will apply differently to each effort under consideration because of differences in mission, regulatory environment, entity size, and risk tolerance. Not all parts of the Framework will be relevant for every federal effort; some of the principles or concepts are likely to be more relevant in the analysis of certain federal efforts than others. It is appropriate to apply portions of the Framework to improve the resilience of federal programs depending upon the specific circumstances. Users of the Framework should exercise their professional judgment when determining how best to make the principles and concepts meet their needs.

- **Consider the Federal Role**

The federal government shares authority with and provides resources to states, localities, and nongovernmental entities, which often make the decisions that result in greater resilience. Users of the Framework should take into account the relationships between the federal government and the relevant decision makers, and the different ways that the federal government can leverage or influence actions, responsibilities, and interests of the whole system—including other levels of government and private and nongovernmental actors. Figure 2 shows the tools the federal government can apply to influence decision making and examples of decision makers whose actions can result in enhanced disaster resilience.



Bridges serve a vital role in the daily transportation of people, goods, and services. Increasing the disaster resilience of bridges minimizes the chances of disruption of this key economic function.

Source: National Park Service. | GAO-20-100SP

Figure 2: How Federal Action Can Promote and Facilitate Disaster Resilience Decisions



Federal tools for facilitating action:



Policy tools

The federal government can create laws, regulations, and directives that require specific actions for enhancing disaster resilience.



Financial tools

The federal government can use financial assistance such as grants, cooperative agreements, loans, and special tax considerations to provide incentives to individuals, corporations, localities, and states.



Direct action

The federal government can help realize national resilience in the actions it takes as the owner of certain critical infrastructure and property, as a purveyor of information, and in provision of technical assistance or direct services.

Examples of disaster resilience decision makers:

- Federal executives and policymakers with immediate responsibility for protection of infrastructure and ecosystems
- Federal executives and policymakers with responsibility for programs and regulations that promote risk-reduction decisions by nonfederal entities
- State executives and policymakers with responsibility for programs and regulations that promote risk-reduction decisions by jurisdictions within their boundaries
- Local policymakers, managers, and planners with responsibility for land use planning, building code adoption and enforcement, and design decisions
- Private sector owners and operators of critical infrastructure with responsibility for design decisions
- Small business and residential property owners with responsibility for design decisions
- Private financial market actors with the ability to partner with other decision makers to stimulate and leverage risk-reduction investment and enhance loss protection
- Non-governmental organizations with responsibility for establishing and supporting adoption of standards

Source: GAO. | GAO-20-100SP

INFORMATION

Accessing information that is authoritative and understandable can help decision makers to identify current and future risk and the impact of risk-reduction strategies.

Providing Reliable and Authoritative Information about Current and Future Risk

Natural and climate disaster risk information that is accurate, comprehensive, and produced or endorsed by an authoritative source can help decision makers better assess their risk.¹⁴ Federal agencies produce valuable information and have the opportunity to act as a trusted clearinghouse and integrator of federal and nonfederal information in a way that enhances its reach and value. For example, private sector partners, particularly insurers and catastrophe modeling firms, generate valuable data and analytics that enhance risk identification, while federal and state departments and agencies, in pursuit of their various missions, generate other kinds of risk data and information, such as FEMA's Flood Insurance Rate Maps.

We have previously reported on efforts that federal agencies have made towards providing robust and authoritative data, including the Climate Resilience Toolkit to provide scientific tools, information, and expertise to help decision makers manage risks and improve disaster resilience.¹⁵ We have also reported, however, that the best information is not always available to decision makers who need it or as accurate or robust as it could be. For example, in 2019 we reported that federal, state, local, and private sector decision makers may be unaware that climate information exists or may be unable to use what is available, largely because the federal government's own climate data are fragmented across individual agencies that use the information in different ways to meet their missions.¹⁶ Similarly, experts GAO interviewed noted that there are additional opportunities to bring together both public and private sector efforts to make natural and climate disaster risk information more robust.

Questions for Consideration

To what extent could federal efforts:

- enhance the validity and reliability of the disaster risk information produced?
- generate and share additional information that would help decision makers understand their disaster risk?
- reduce the complexity of and translate risk information for non-technical audiences?

- Providing Reliable and Authoritative Information about Current and Future Risk
- Improving the Ability to Assess Alternatives to Address Risk
- Strengthening the Ability to Assess Status and Report Progress



Completed in 2009, the U.S. Army Corps of Engineers rebuilt and added rip rap, or large rock, to the waterside banks of a 400-foot stretch of levee near the Yolo Bypass in West Sacramento, CA.

Source: Tyler Stalker / United States Army Corps of Engineers. | GAO-20-100SP

¹⁴Information that can help decision makers assess their risk and alternatives for responding includes but is not limited to financial, engineering, environmental, and land use planning information.

¹⁵GAO, Climate Information: A National System Could Help Federal, State, Local, and Private Sector Decision Makers Use Climate Information [GAO-16-37](#), (Washington, D.C.: Nov. 23, 2015). The U.S. Climate Resilience Toolkit is a website designed to help people find and use tools, information, and subject matter expertise to build climate resilience. The site is managed by the National Oceanic and Atmospheric Administration.

¹⁶[GAO-16-37](#). To help federal, state, local, and private sector decision makers access and use the best available climate information, we recommended in 2016 that the Executive Office of the President designate a federal entity to develop and periodically update a set of authoritative climate change observations and projections for use in federal decision making, which state, local, and private sector decision makers could also access to obtain the best available climate information and create a national climate information system with defined roles for federal agencies and nonfederal entities with existing statutory authority.

- help leverage and synthesize disaster risk information from other partners across agencies, governments, regional organizations, and sectors?
- promote consensus around the reliability of the sources and methods that produce disaster risk information?

Improving the Ability to Assess Alternatives to Address Risk

Federal efforts can assist decision makers' in identifying and selecting among disaster risk-reduction alternatives by: (1) providing technical assistance, (2) contributing to an understanding of returns on various resilience investments, and (3) identifying available sources of funding for resilience projects.

Some federal efforts provide technical assistance to help decision makers interpret available risk information and analyze alternatives for risk reduction. These types of efforts are particularly important for smaller, low-income, and historically disadvantaged jurisdictions, which may not have other avenues to access this kind of expertise. For example, the Federal Highway Administration (FHWA) developed a Vulnerability Assessment and Adaptation Framework that transportation planning agencies can use to analyze climate adaptation options and incorporate the results of vulnerability assessments into their decision making. According to FHWA, this tool can help these agencies assess options for addressing the impacts of climate change and extreme weather on transportation infrastructure.¹⁷

Federal efforts can also contribute to understanding the return on investment of various alternatives to address risk by developing and disseminating comprehensive approaches for estimating loss avoidance, analyzing costs and benefits of various hazard mitigation alternatives, and considering their impact on programmatic decisions and budgeting for disasters. Several models for estimating the return on resilience investments and loss avoidance currently exist; however, none of these provides a full accounting of all benefits, including indirect and co-benefits.

Finally, federal efforts can connect decision makers with information on how to identify and combine funding sources to maximize disaster risk-reduction opportunities. In 2015 we reported that although state hazard mitigation plans, which are required to receive FEMA funding for hazard mitigation projects, are expected to identify funding sources to pursue disaster resilience, there was variation in the extent to which these plans actively identified multiple funding streams.¹⁸

Furthermore, State Hazard Mitigation Officers were not always aware of all federal funding streams available for hazard mitigation, especially in the wake of a large disaster. Such awareness can be helpful as more and innovative resilience funding structures and mechanisms (e.g., grants, loans, bonds, and private investments) are being created to meet the increasing demand for resilience that has accompanied an increased awareness of its benefits. For example, the Federal Insurance and Mitigation Administration estimates that as a result of enactment of the Disaster Recovery Reform Act of 2018, approximately \$300-500 million could be made available annually for pre-disaster hazard mitigation measures, with significantly greater amounts following years with catastrophic disasters.¹⁹



Reinforced power line poles.

Source: GAO. | GAO-20-100SP

¹⁷U.S. Department of Transportation, Federal Highway Administration, *Vulnerability Assessment and Adaptation Framework*, 3rd Edition (Washington, D.C.: 2017).

¹⁸GAO-15-515.

¹⁹Enacted in October 2018, the Disaster Recovery Reform Act of 2018 includes many provisions designed to enhance disaster recovery. Among them is a provision that authorizes a pre-disaster hazard mitigation program to be funded from the Disaster Relief Fund as a six percent set aside of estimates of all disaster assistance grants. Pub. L. No. 115-254, § 1234(a), 132 Stat. 3186 (2018).

Questions for Consideration

To what extent could federal efforts:

- help decision makers identify and select among disaster risk-reduction alternatives?
- provide technical assistance to help build capacity of nonfederal partners?
- contribute to an understanding of approaches for estimating returns on investment?
- help decision makers identify and combine available funding sources and innovative methods for meeting disaster risk-reduction needs?



Rocks and an angled culvert help prevent bank erosion in North Dakota.

Source: Eliud Echevarria / Federal Emergency Management Agency | GAO-20-100SP

Strengthening the Ability to Assess Status and Report Progress

Standardized approaches to define disaster resilience goals and help the nation monitor progress toward them could help inform where future resilience investments are needed and will provide the most benefit. Multiple efforts currently exist inside and outside of the government to develop approaches to measuring the state of disaster resilience, but none has emerged as a national standard to guide federal investment. According to the National Academies, without some quantitative means of assessing community resilience it would be impossible to identify the priority needs for improvement, to monitor changes, to show that resilience had improved, or to compare the benefits of increasing resilience with the associated costs.²⁰

Even in the absence of standardized national approaches, individual federal efforts can help monitor progress toward risk-reduction goals within their mission areas by providing clear guidance about the definitions and metrics for risk-reduction goals applicable to those areas. As an example of what federal efforts could do, the Department of Homeland Security's Regional Resiliency Assessment Program (RRAP)—a cooperative, voluntary resilience assessment program—provides guidance for examining specific critical infrastructure within a designated geographic area and for conducting a regional analysis of the surrounding infrastructure to address a range of infrastructure resilience issues that could have regionally and nationally significant consequences.

Questions for Consideration

To what extent could federal efforts:

- advance methodologies or processes to measure the current state of nationwide resilience?
- promote monitoring of progress toward resilience on a programmatic basis?

²⁰The National Academies of Science, Engineering, and Medicine, *Disaster Resilience: A National Imperative*. (Washington, D.C.: 2012).

INTEGRATION

Integrated analysis and planning can help decision makers take coherent and coordinated resilience actions.

Building an Overarching Strategic Vision and Goals

The integration of strategic resilience goals across relevant national strategies can help decision makers work toward a common vision and help ensure focus on a wide variety of opportunities to reduce disaster risk. We have previously reported that, in some cases, federal efforts have been hindered by multiple agencies pursuing individual efforts without overarching strategies. For example, in the wake of Hurricane Sandy, we observed that without comprehensive strategic approaches to help Congress and federal agencies that implement disaster resilience-related programs prioritize, align, and guide federal investments, the federal government’s approach has been largely reactive and fragmented.²¹

Federal efforts can also focus attention on disaster risk reduction by creating resilience goals in all relevant national strategies and linking those goals to an overarching strategic vision. For example, the Department of Homeland Security’s Quadrennial Homeland Security Review—the document that defines departmental goals and drives operational planning—includes among its five overarching goals, a section on strengthening the nation’s preparedness and resilience.

Questions for Consideration

To what extent could federal efforts:

- help to establish overarching strategies that guide national resilience efforts?
- ensure that resilience goals are incorporated into relevant national strategies?
- prioritize resilience goals that reflect the most pressing resilience challenges?

Promoting Coordination Across Missions and Sectors

Bringing together the disparate missions and resources that support disaster risk reduction can help to build national resilience to natural hazards. Federal efforts can (1) facilitate coordination across programs, (2) facilitate the combination of federal funding streams, and (3) leverage the expertise of nonfederal partners.

Federal efforts can facilitate coordination and promote governance approaches that mitigate fragmentation by requiring, or funding, mechanisms to enhance the continuity of different efforts across jurisdictions. For example, joint planning processes across different grant programs or resilience focal points with the responsibility and authority to oversee integrated risk-reduction processes can enhance collaboration. We have previously reported that the multiple requirements and timelines for different programs have made leveraging resilience funding difficult.²² These challenges are likely to be

- **Building an Overarching Strategic Vision and Goals**
- **Promoting Coordination Across Missions and Sectors**
- **Recognizing Relationships Among Infrastructure and Ecosystems**



Dams increase resilience by helping to control flooding, and it is important to take action to protect them against failure during a disaster and integrate them effectively with other adaptation and hazard mitigation approaches.

Source: Lee Roberts / United States Army Corps of Engineers. | GAO-20-100SP

²¹GAO-15-515.

²²GAO-15-515.

compounded as more and different programs and strategies incorporate disaster resilience goals.

Federal efforts can also facilitate the combination of funding streams, which may be particularly important for smaller, low-income, and historically disadvantaged jurisdictions. In the aftermath of Hurricane Sandy, the Sandy Regional Infrastructure Resilience Coordination group coordinated long-term recovery, examined gaps in resilience, and determined the funding and resources available from various federal agencies. The group formed teams consisting of staff from the Department of Housing and Urban Development, FEMA, Environmental Protection Agency, and the U.S. Army Corps of Engineers to discuss issues in combining streams of federal funding and identify other potential implementation challenges.

Federal efforts can also leverage the expertise and resources of non-government partners. For example, one subject matter expert we interviewed noted that private sector partners have developed codes and standards for the built environment that might aid federal efforts to adopt more robust risk-reduction measures. Additionally, experts GAO interviewed noted multiple ways in which government efforts have not fully engaged non-government partners, including integrating data and processes, as well as encouraging private sector investment in disaster risk reduction.

Questions for Consideration

To what extent could federal efforts:

- ensure consistent and complementary policies, procedures, and timing across relevant federal funding mechanisms?
- convene stakeholders with different perspectives and interests to create whole systems solutions?
- encourage governance mechanisms that foster coordination and integrated decision making within and across levels of government?
- engage non-government partners in disaster risk reduction?

Recognizing Relationships Among Infrastructure and Ecosystems

Understanding the relationships among infrastructure components and ecosystems and how they interact with any proposed resilience project can help ensure that individual risk-reduction efforts work together effectively to maximize risk-reduction potential. For example, a U.S. Army Corps of Engineers flood control project may affect water levels in multiple areas of a watershed and therefore may have an impact on multiple local jurisdictions. Moreover, damage to one aspect of infrastructure (e.g., part of a power grid) can trigger cascading failures, for example, failures in other systems that rely on electric power, such as telecommunications, ultimately resulting in disruption of communications, health, and other services.

Federal agencies can work together with their nonfederal partners to coordinate and enhance understanding of the relationship between various risk-reduction efforts and existing infrastructure assets. For example, following Hurricane Sandy, the New York/New Jersey Federal Leadership Resilience Collaborative was formed—with representation of the six agencies with the largest disaster recovery appropriations—with a mission to coordinate, plan and share information on key infrastructure projects.



The living shoreline uses marsh plants and other natural features to protect the shore from erosion.

Source: GAO. | GAO-20-100SP

In addition to built-infrastructure assets, information about how natural ecosystems contribute to disaster resilience and overlap with the built environment can help provide additional insight into how to design better solutions that account for the condition and benefits of the whole system. For example, as we have previously reported, coastal ecosystems—including wetlands, marshes, and mangroves—may shield communities from the impacts of climate change.²³

In 2016, we reported that state-level decision makers were interested in understanding how to value the economic benefits of coastal ecosystems to help them select among risk-reduction alternatives.²⁴ Along these lines, the Department of Transportation’s Federal Highway Safety Administration provides research and technical assistance to help state transportation agencies implement nature-based solutions—including cobble beaches, artificial dunes, and living shorelines—to protect coastal highways from storm surge and sea level rise.

Questions for Consideration

To what extent could federal efforts:

- promote better understanding and awareness of the interactions among infrastructure components and ecosystems in disaster resilience actions?
- assist decision makers in determining what combination of ecosystem and built infrastructure solutions will best suit their needs within their constraints?
- assist in ensuring that projects undertaken under different programs and by different actors do not conflict?
- facilitate planning across jurisdictions and sectors to avoid or respond to cascading failure?



New Orleans' Hurricane and Storm Damage Risk Reduction System is comprised of numerous features including levees, floodwalls, floodgates, surge barriers and pump stations.

Source: United States Army Corps of Engineers. | GAO-20-100SP

²³GAO, *Climate Change: Information on NOAA's Support for States' Marine Coastal Ecosystem Resilience Efforts*, [GAO-16-834](#) (Washington, D.C.: September 28, 2016).

²⁴[GAO-16-834](#).

INCENTIVES

Incentives can help to make long-term, forward-looking risk-reduction investments more viable and attractive among competing priorities.

- Providing Financial and Nonfinancial Incentives
- Reducing Disincentives

Providing Financial and Nonfinancial Incentives

Incentives can lower the costs or increase the benefits of risk-reduction measures, which can help stimulate investment by state, local, and tribal governments, individuals, and the private sector. Because much of the nation's infrastructure is not owned and operated by the federal government, many resilience-related decisions ultimately are made by nonfederal actors, and those decision makers face competing priorities.

Incentives—in the form of federal regulatory requirements or as conditions of federal financial assistance—can help promote investments in disaster risk reduction. Such incentives can also help to encourage disaster resilience decision making for infrastructure and ecosystems. An example of this is requiring building codes and standards based on the best available information for infrastructure built or repaired with federal funds. As we reported in November 2016, design standards, building codes, and voluntary certifications play a role in ensuring the resilience of federal and nonfederal infrastructure to the effects of natural disasters and extreme weather.²⁵

Federal financial assistance can also provide matching funding to help stimulate partner investment. For instance, FEMA's Hazard Mitigation Grant Program provides funds for up to 75 percent of project costs to help jurisdictions address their disaster risk in the wake of a disaster, which can encourage local jurisdictions to take actions they otherwise would not have taken to reduce their disaster risk. Another example of a financial incentive is FEMA's National Flood Insurance Program's (NFIP) Community Rating System. In this voluntary program, communities can receive discounts on flood insurance premium rates for floodplain management activities that exceed minimum standards.



Florida homes with elevated structure and tin roofs to mitigate against wind damage.

Source: GAO. | GAO-20-100SP

Questions for Consideration

To what extent could federal efforts:

- make risk-reduction measures more viable and attractive?
- incorporate disaster risk-reduction measures in infrastructure and ecosystem management financial assistance?
- require disaster risk-reduction measures for government-owned or -operated infrastructure and for federally-funded projects?

Reducing Disincentives

When multiple programs and activities and multiple funding streams are involved, there is a risk that the array of requirements will increase administrative complexity. Streamlining confusing or overly complex practices and reducing administrative burden where necessary and appropriate may

²⁵GAO, *Climate Change: Improved Federal Coordination Could Facilitate Use of Forward-Looking Climate Information in Design Standards, Building Codes, and Certifications*, GAO-17-3 (Washington, D.C.: Nov. 30, 2016).

help enhance resilience action. As we reported in July 2015, jurisdictional officials engaged in disaster recovery have encountered complex review processes, conflicting federal guidance, and competing federal priorities that limit participation in resilience programs.²⁶

Federal actions can also create perverse incentives that many diminish the attractiveness of resilience investments. We have previously reported that residents of hazard-prone areas tend to treat the possibility of a disaster's occurrence as sufficiently low to permit them to ignore the consequences and may not act to protect themselves from the effects of severe weather if they believe the federal government will eventually help pay for their losses.²⁷ For example, in the NFIP, premium rates can act as a signal of risk, but federally subsidized rates can reduce motivation to mitigate because it severs the connection between risk and rates.²⁸

Questions for Consideration

To what extent could federal efforts:

- alleviate unnecessary administrative burden?
- streamline review processes?
- improve program design to motivate risk-reduction actions?



Infrastructure on Lock-9 of the Erie Canal system on the Mohawk River is being repaired for flood control systems.

Source: Hans Pennink / Federal Emergency Management Agency. | GAO-20-100SP

²⁶GAO-15-515.

²⁷GAO, *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).

²⁸GAO, *Flood Insurance: Comprehensive Reform Could Improve Solvency and Enhance Resilience*, GAO-17-425 (Washington, D.C.: Apr. 27, 2017).

Appendix 1

GAO Issue Area Collections and Reports Related to the Disaster Resilience Framework

The principles of the Disaster Resilience Framework are grounded, in part, on many GAO reports and recommendations presented in issue area collections; specifically the (1) *Limiting the Federal Government's Fiscal Exposure by Better Managing Climate Change Risks* high risk area, (2) *National Flood Insurance Program* high risk area, (3) *Disaster Assistance* key issue collection, (4) *Flood Insurance* key issue collection and (5) *Priority Open Recommendations: Department of Homeland Security report*.²⁹ As of October 2019, the following key GAO reports formed the basis of these collections and the Disaster Resilience Framework:

- *Emergency Management: FEMA Has Made Progress, but Challenges and Future Risks Highlight Imperative for Further Improvements*, [GAO-19-617T](#) (Washington, D.C.: June 25, 2019).
- *Emergency Management: FEMA Has Made Progress, but Challenges and Future Risks Highlight Imperative for Further Improvements*, [GAO-19-594T](#) (Washington, D.C.: June 12, 2019).
- *Climate Change: Opportunities to Reduce Federal Fiscal Exposure*, [GAO-19-625T](#) (Washington, D.C.: June 11, 2019).
- *Climate Resilience: DOD Needs to Assess Risk and Provide Guidance on Use of Climate Projections in Installation Master Plans and Facilities Designs*, [GAO-19-453](#) (Washington, D.C.: June 12, 2019).
- *Priority Open Recommendations: Department of Homeland Security*, [GAO-19-360SP](#) (Washington, D.C.: April 19, 2019).
- *Fiscal Exposures: Federal Insurance and Other Activities That Transfer Risk or Losses to the Government*, [GAO-19-353](#) (Washington, D.C.: March 27, 2019).
- *2017 Hurricane Season: Federal Support for Electricity Grid Restoration in the U.S. Virgin Islands and Puerto Rico*, [GAO-19-296](#) (Washington, D.C.: April 18, 2019).
- *Puerto Rico Hurricanes: Status of FEMA Funding, Oversight, and Recovery Challenges*, [GAO-19-256](#) (Washington, D.C.: March 14, 2019).
- *U.S. Virgin Islands Recovery: Status of FEMA Public Assistance Funding and Implementation*, [GAO-19-253](#) (Washington, D.C.: February 25, 2019).
- *Climate Change: Activities of Selected Agencies to Address Potential Impact on Global Migration*, [GAO-19-166](#) (Washington, D.C.: January 17, 2019).
- *2017 Hurricanes and Wildfires: Initial Observations on the Federal Response and Key Recovery Challenges*, [GAO-18-472](#) (Washington, D.C.: September 4, 2018).
- *Climate Change: Analysis of Reported Federal Funding*, [GAO-18-223](#) (Washington, D.C.: April 30, 2018).
- *Climate-Related Risks: SEC Has Taken Steps to Clarify Disclosure Requirements*, [GAO-18-188](#) (Washington, D.C.: February 20, 2018).
- *Telecommunications: FCC Should Improve Monitoring of Industry Efforts to Strengthen Wireless Network Resiliency*, [GAO-18-198](#) (Washington, D.C.: December 12, 2017).
- *Climate Change Adaptation: DOD Needs to Better Incorporate Adaptation into Planning and Overseas Installations*, [GAO-18-206](#) (Washington, D.C.: November 13, 2017).

²⁹For more information, click the hyperlinks in the text above or see https://www.gao.gov/key_issues/limiting_federal_government_fiscal_exposure/issue_summary (Limiting the Federal Government's Fiscal Exposure by Better Managing Climate Change Risks high risk area); https://www.gao.gov/key_issues/national_flood_insurance_program/issue_summary (National Flood Insurance Program high risk area); https://www.gao.gov/key_issues/disaster_assistance (Disaster Assistance key issue summary); https://www.gao.gov/key_issues/disaster_assistance/national-flood-insurance-program (Flood Insurance key issues summary); and <https://www.gao.gov/products/GAO-19-360SP> (Priority Open Recommendations: Department of Homeland Security).

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- *Disaster Assistance: Opportunities to Enhance Implementation of the Redesigned Public Assistance Grant Program*, [GAO-18-30](#) (Washington, D.C.: November 8, 2017).
 - *Climate Change: Information on Potential Economic Effects Could Help Guide Federal Efforts to Reduce Fiscal Exposure*, [GAO-17-720](#) (Washington, D.C.: September 28, 2017).
 - *Flood Insurance: Comprehensive Reform Could Improve Solvency and Enhance Resilience*, [GAO-17-425](#) (Washington, D.C.: April 27, 2017).
 - *Electricity: Federal Efforts to Enhance Grid Resilience*, [GAO-17-153](#) (Washington, D.C.: January 25, 2017).
 - *Climate Change: Improved Federal Coordination Could Facilitate Use of Forward-Looking Climate Information in Design Standards, Building Codes, and Certifications*, [GAO-17-3](#) (Washington, D.C.: November 30, 2016).
 - *Federal Fisheries Management: Additional Actions Could Advance Efforts to Incorporate Climate Information into Management Decisions*, [GAO-16-827](#) (Washington, D.C.: September 28, 2016).
 - *Climate Change: Information on NOAA's Support for States' Marine Ecosystem Resilience Efforts*, [GAO-16-834](#) (Washington, D.C.: September 28, 2016).
 - *Federal Disaster Assistance: Federal Departments and Agencies Obligated at Least \$277.6 Billion during Fiscal Years 2005 through 2014*, [GAO-16-797](#) (Washington, D.C.: September 22, 2016).
 - *Flood Insurance: Potential Barriers Cited to Increased Use of Private Insurance*, [GAO-16-611](#) (Washington, D.C.: July 14, 2016).
 - *Climate Change: Selected Governments Have Approached Adaptation through Laws and Long-Term Plans*, [GAO-16-454](#) (Washington, D.C.: May 12, 2016).
 - *National Flood Insurance Program: Continued Progress Needed to Fully Address Prior GAO Recommendations on Rate-Setting Methods*, [GAO-16-59](#) (Washington, D.C.: March 17, 2016).
 - *National Flood Insurance Program: Options for Providing Affordability Assistance*, [GAO-16-190](#) (Washington, D.C.: February 10, 2016).
 - *Supply Chain Risks: SEC's Plans to Determine If Additional Action Is Needed on Climate-Related Disclosure Have Evolved*, [GAO-16-211](#) (Washington, D.C.: January 6, 2016).
 - *Disaster Response: FEMA Has Made Progress Implementing Key Programs, but Opportunities for Improvement Exist*, [GAO-16-87](#) (Washington D.C.: February 5, 2016).
 - *Climate Information: A National System Could Help Federal, State, Local, and Private Sector Decision Makers Use Climate Information*, [GAO-16-37](#) (Washington, D.C.: November 23, 2015).
 - *Highlights Of A Forum: Preparing for Climate Related Risks: Lessons from the Private Sector*, [GAO-16-126SP](#) (Washington, D.C.: November 19, 2015).
 - *Climate Change: HHS Could Take Further Steps to Enhance Understanding of Public Health Risks*, [GAO-16-122](#) (Washington, D.C.: October 5, 2015).
 - *Federal Supply Chains: Opportunities to Improve the Management of Climate-Related Risks*, [GAO-16-32](#) (Washington, D.C.: October 13, 2015).
 - *Hurricane Sandy: An Investment Strategy Could Help the Federal Government Enhance National Resilience for Future Disasters*, [GAO-15-515](#) (Washington, D.C.: July 30, 2015).
 - *Climate Change: Better Management of Exposure to Potential Future Losses Is Needed for Federal Flood and Crop Insurance*, [GAO-15-28](#) (Washington, D.C.: October 29, 2014).

- *Climate Change: USDA's Ongoing Efforts Can Be Enhanced with Better Metrics and More Relevant Information for Farmers*, [GAO-14-755](#) (Washington, D.C.: September 16, 2014).
- *Ocean Acidification: Federal Response Under Way, but Actions Needed to Understand and Address Potential Impacts*, [GAO-14-736](#) (Washington, D.C.: September 12, 2014).
- *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).
- *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).
- *Budget Issues: Opportunities to Reduce Federal Fiscal Exposures Through Greater Resilience to Climate Change and Extreme Weather*, [GAO-14-504T](#) (Washington, D.C.: July 29, 2014).
- *Extreme Weather Events: Limiting Federal Fiscal Exposure and Increasing the Nation's Resilience*, [GAO-14-364T](#) (Washington, D.C.: February 12, 2014).
- *Climate Change: Energy Infrastructure Risks and Adaptation Efforts*, [GAO-14-74](#) (Washington, D.C.: Jan 31, 2014).
- *Climate Change: Federal Efforts Under Way to Assess Water Infrastructure Vulnerabilities and Address Adaptation Challenges*, [GAO-14-23](#) (Washington, D.C.: November 14, 2013).
- *Fiscal Exposures: Improving Cost Recognition in the Federal Budget*, [GAO-14-28](#) (Washington, D.C.: October 29, 2013).
- *Climate Change: Various Adaptation Efforts Are Under Way at Key Natural Resource Management Agencies*, [GAO-13-253](#) (Washington, D.C.: May 31, 2013).
- *Climate Change: Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers*, [GAO-13-242](#) (Washington, D.C.: April 12, 2013).
- *Federal Disaster Assistance: Improved Criteria Needed to Assess a Jurisdiction's Capability to Respond and Recover on Its Own*, [GAO-12-838](#) (Washington, D.C.: September 12, 2012).
- *Climate Change: Improvements Needed to Clarify National Priorities and Better Align Them with Federal Funding Decisions*, [GAO-11-317](#) (Washington, D.C.: May 20, 2011).
- *Climate Change Adaptation: Strategic Federal Planning Could Help Government Officials Make More Informed Decisions*, [GAO-10-113](#) (Washington, D.C.: October 7, 2009).
- *Climate Change: Agencies Should Develop Guidance for Addressing the Effects on Federal Land and Water Resources*, [GAO-07-863](#) (Washington, D.C.: August 7, 2007).
- *Natural Hazard Mitigation: Various Mitigation Efforts Exist, but Federal Efforts Do Not Provide a Comprehensive Strategic Framework*, [GAO-07-403](#) (Washington, D.C.: August 22, 2007).
- *Climate Change: Financial Risks to Federal and Private Insurers in Coming Decades Are Potentially Significant*, [GAO-07-285](#) (Washington, D.C.: March 16, 2007).

This list will be updated periodically and includes key GAO reports as of October 2019. GAO's issue area collections are updated more frequently. See, for example, the Limiting the Federal Government's Fiscal Exposure by Better Managing Climate Change Risks high risk area and the Disaster Assistance key issue collection.³⁰

³⁰For more information, click the hyperlinks in the text above or see https://www.gao.gov/key_issues/limiting_federal_government_fiscal_exposure/issue_summary (Limiting the Federal Government's Fiscal Exposure by Better Managing Climate Change Risks high risk area) and https://www.gao.gov/key_issues/disaster_assistance (Disaster Assistance key issue summary).

Appendix 2

Expert Selection for GAO's Disaster Resilience Framework

We interviewed 11 experts throughout March and April of 2019 to obtain their insights on a draft of GAO's Disaster Resilience Framework. This appendix lists the experts we selected and provides a description of our methodology for selecting them.

Disaster Resilience Framework Reviewers

Jainey Bavishi

Director
New York City Mayor's Office of Recovery and Resilience

Samuel Carter

Director, Resilience Accelerator
100 Resilient Cities

Joyce Coffee

President
Climate Resilience Consulting

Kathy Jacobs

Director, Center for Climate Adaptation Science and Solutions and Professor
University of Arizona

Daniel Kaniewski

Deputy Administrator for Resilience
FEMA

Carolyn Kousky

Executive Director
Wharton Risk Center

Katharine Mach

Associate Professor, Rosenstiel School of Marine and Atmospheric Science Faculty Scholar, UM Abess Center
University of Miami

Samantha Medlock

Senior Vice President and North America Lead, Capital, Science, and Policy
Willis Towers Watson

Josh Sawislak

Senior Advisor
Center for Climate and Energy Solutions

Avery Share

Research Analyst
Institute for Building Technology and Safety

Kate White

Lead, Climate Preparedness and Resilience Community of Practice
US Army Corps of Engineers HQ

Methodology for Selecting Experts

To identify the experts to interview, we compiled an initial list consisting of experts interviewed during recent GAO disaster resilience and climate change work. We also included some experts found through a review of resilience-related literature, websites, and tools. Our initial list of 26 potential experts was developed based on the following criteria:

- **Area of Subject Matter Expertise:** To ensure that our interviews captured as many aspects of disaster resilience as possible, we selected experts that represented a broad array of disaster resilience-related areas of expertise, including: climate adaptation, critical infrastructure, disaster recovery, disaster-related fiscal risk, disaster resilience, emergency management, hazard mitigation, intergovernmental relations, resilience and climate finance and investment, public/private partnerships, and vulnerable populations.
- **Professional Discipline:** To ensure that our interviews captured the breadth of professional disciplines that inform the study and practice of disaster resilience, we selected experts knowledgeable in engineering, public policy, urban planning, architecture and building science, law, science, emergency management, housing, public health, and the military.

-
- **Diversity:** To ensure that our interviews were inclusive of different experiences and perspectives, we selected experts that represented gender, ethnic and racial, regional, and professional diversity.
 - **Organizational Type:** To ensure that our interviews captured the unique roles and perspectives of various entities involved in resilience, we selected experts from the federal government, local government, research institutes or universities, advocacy or membership organizations, and consulting firms.

We worked closely with GAO methodologists and identified the number of resilience-related areas of expertise as our primary criterion for narrowing our list of potential experts. We assigned a score to each potential expert, which corresponded to the number of areas of expertise they have, based on a review of their curriculum vitae, biographies, and publications.

A secondary criterion of organization type was applied to ensure representation of different perspectives and the types of organizations that would work together to enhance disaster resilience. The application of the secondary criteria resulted in the final group listed above.³¹

³¹One selected expert brought a colleague to the interview, resulting in 11 total interviewees with only 10 selected through the process described above.

Appendix 3

GAO Contact and Staff Acknowledgements

GAO Contact

Christopher Currie, 404-679-1875 or curriec@gao.gov

Staff Acknowledgements

In addition to the individual named above, Kathryn Godfrey and Joseph Thompson (Assistant Directors), Christina Cantor, Philip Farah, Susan Irving, Richard Johnson, Tracey King, Jan Montgomery, Patricia Powell, Dan Royer, Edith Sohna, Walter Vance, Adam Vogt, and Kelsey Wilson made key contributions to this report.

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James-Christian Blockwood, Managing Director, spel@gao.gov, (202) 512-4707 U.S. Government Accountability Office, 441 G Street NW, Room 7814, Washington, DC 20548



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