United States Government Accountability Office

GAO

Report to the Ranking Member, Committee on Financial Services, House of Representatives

August 2007

NATURAL HAZARD MITIGATION

Various Mitigation Efforts Exist, but Federal Efforts Do Not Provide a Comprehensive Strategic Framework

GAO-07-403

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Highlights

Highlights of GAO-07-403, a report to the Ranking Member, Committee on Financial Services, House of Representatives

Why GAO Did This Study

The nation has experienced vast losses from natural hazards. The potential for future events, such as earthquakes and hurricanes, demonstrates the importance of hazard mitigation—actions that reduce the long-term risks to life and property from natural hazard events. GAO was asked to examine (1) natural hazards that present a risk to life and property in the United States, areas that are most susceptible to them, factors that may be increasing these risks, and mitigation activities that reduce losses; (2) methods for encouraging and impediments to implementing mitigation activities; and (3) collaborative efforts of federal agencies and other stakeholders to promote mitigation.

To address these objectives, GAO collected and analyzed hazard data, reviewed population information, conducted site visits to locations with comprehensive mitigation programs, and collected information from relevant agencies and officials.

What GAO Recommends

GAO recommends that the Administrator of the Federal Emergency Management Agency (FEMA), in consultation with other appropriate federal agencies, develop and maintain a national comprehensive strategic framework for mitigation. FEMA generally agreed with the report's recommendation.

www.gao.gov/cgi-bin/getrpt?GAO-07-403.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Orice Williams (202) 512-8678 or williamso@gao.gov.

What GAO Found

Natural hazards present risks to life and property throughout the United States. Flooding is the most widespread and destructive of these, resulting in billions of dollars in property losses each year. Hurricanes, earthquakes, and wildland fires also pose significant risks in certain regions of the country. Tornadoes, landslides, tsunamis, and volcanic eruptions can also occur in some areas. Population growth in hazard-prone areas, especially coastal areas, is increasing the nation's vulnerability to losses because more people and property are at risk. Climate change may also impact the frequency and severity of future natural hazard events. A variety of natural hazard mitigation activities exist, which are primarily implemented at the state and local level, and include hazard mitigation planning; strong building codes and design standards; and hazard control structures (e.g., levees). For example, strong building codes and design standards can make structures better able to withstand a hazard event (see fig.) and hazard control structures help protect existing at-risk areas.

Public education, financial assistance, and insurance discounts can help encourage mitigation. For example, federal, state, and local governments provide financial assistance to promote mitigation and insurance discounts can encourage the use of mitigation measures. However, significant challenges exist to implementing natural hazard mitigation activities. Some of these challenges include the desire for local economic development—often in hazard-prone areas—which may conflict with long-term mitigation goals and the cost of mitigation may limit the amount of activities that occur.

FEMA, other federal agencies, and nonfederal stakeholders have collaborated on natural hazard mitigation, but the current approach is fragmented and does not provide a comprehensive national strategic framework for mitigation. Collaboration typically occurs on a hazard-specific basis, after a disaster, or through informal methods. A comprehensive framework would help define common national goals, establish joint strategies, leverage resources, and assign responsibilities among stakeholders.

Effect of a Hurricane on Neighboring Structures Built to Different Versions of Building Codes

Source: © Institute for Business & Home Safety.

Contents

Abbreviations

BCEGS™	Building Code Effectiveness Grading Schedule
CEA	California Earthquake Authority
CRS	Community Rating System
DMA 2000	Disaster Mitigation Act of 2000
FEMA	Federal Emergency Management Agency
FMA	Flood Mitigation Assistance Program
HMGP	Hazard Mitigation Grant Program
NEHRP	National Earthquake Hazard Reduction Program
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
PDM	Pre-Disaster Mitigation Program
RFC	Repetitive Flood Claims Program
SRL	Severe Repetitive Loss Pilot Program
USGS	U.S. Geological Survey

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GAO
Accountability * Integrity * Reliability

United States Government Accountability Office
Washington, DC 20548

August 22, 2007

The Honorable Spencer Bachus
Ranking Member
Committee on Financial Services
House of Representatives

Dear Mr. Bachus:

The hurricane seasons of 2004 and 2005 devastated portions of the United States resulting in extensive loss of life and damage to property. Hurricane Katrina alone caused over 1,500 deaths and an estimated $81 billion in property damages.[1] Obligations from the Federal Emergency Management Agency's (FEMA) disaster relief fund in fiscal year 2004 and 2005 totaled over $43 billion—more than the approximately $37 billion spent during the previous 10 years. Experts predict that future natural hazard events in the United States could be even more damaging and costly. For example, one expert on Atlantic hurricanes predicts a category 3 hurricane hitting the New York City area could produce a storm surge of over 20 feet in some areas, flood local airports and lower Manhattan, and result in extensive economic disruption. Similarly, experts have estimated that an earthquake in San Francisco of the same magnitude as the 1906 earthquake could cause as many as 3,400 deaths, displace up to 250,000 households, and cause as much as $120 billion in property damage.

The losses to life and property from past natural hazard events and the potential for similar or worse events in the future show the importance of taking steps to reduce the impact such events can have on the nation. Hazard mitigation—actions taken before or after a natural hazard event to reduce or eliminate the long-term risks to life and property from natural hazards—can save lives and reduce property damage, potentially reducing the economic and social costs of natural hazard events. The potential for large-scale damage, particularly in densely populated and economically important areas, makes hazard mitigation an important national issue. A recent cost-benefit analysis of a sample of hazard mitigation grants awarded by FEMA—the federal agency that provides leadership in

[1]Preliminary estimate as reported by the National Oceanic and Atmospheric Administration in August 2006. Estimate is in 2006 dollars.

mitigating the effects of natural hazards—found that every $1 spent on mitigation saved society an average of $4.[2]

Given the importance of natural hazard mitigation and its potential for reducing future losses caused by natural hazards, this report examines (1) natural hazards that present a risk to life and property in the United States, areas that are most susceptible to them, and factors that may be increasing these risks; (2) mitigation activities that reduce losses from natural hazards; (3) methods for encouraging and impediments to implementing mitigation activities; and (4) collaborative efforts of federal agencies and other stakeholders to promote mitigation.

To identify the natural hazards that present a risk to life and property in the United States, we used a comprehensive list of natural hazards compiled by FEMA and collected and analyzed data on these hazards. Using these data, we created graphical representations for the hazards that represent large annual losses to the built environment and for which long-term mitigation activities exist. These hazards include floods, hurricanes, earthquakes, wildland fires, tornadoes, and landslides. We also reviewed population information and spoke with officials at several federal agencies to determine natural hazard risks on a national level and factors that may be increasing these risks. To address the remaining objectives, we conducted site visits to four judgmentally selected states. The states represent a variety of natural hazard risks and geographic locations, have comprehensive mitigation programs, or were recommended to us by mitigation experts or federal and state agency officials. We limited the mitigation strategies we reviewed to those that reduced or eliminated the long-term risk to people and property from the effects of natural hazards, whether these activities occurred before or after a natural hazard event. Programs and activities for preparing to respond in advance to natural hazard events (e.g., emergency response and training activities), responses to hazard events, and recovery from hazard events were outside the scope of our report. We also reviewed previous congressional reports and our prior reports and testimonies, policy and research documents, and reports and publications from the federal agencies involved in mitigation activities. Finally, we interviewed officials at five federal agencies—U.S. Army Corps of Engineers (Corps of Engineers), FEMA, U.S. Forest Service

[2]National Institute of Building Sciences, The Multihazard Mitigation Council, *Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities* (Washington, D.C.: 2005).

(Forest Service), National Oceanic and Atmospheric Administration (NOAA), and U.S. Geological Survey (USGS)—involved in mitigation activities, state and local emergency management officials, industry and professional associations, advocacy groups, building and land-use experts, and a risk modeling firm.

We conducted our work in Baltimore, Maryland; Berkeley, Napa, San Francisco, and Sacramento, California; Boston, Massachusetts; Boulder, Denver, Golden, and Fort Collins, Colorado; Deerfield Beach, Miami, Tampa, and West Palm Beach, Florida; Oklahoma City and Tulsa, Oklahoma; and Washington, D.C., between March 2006 and June 2007 in accordance with generally accepted government auditing standards.

Results in Brief

Natural hazards present risks to life and property throughout the United States, and population trends are increasing the nation's vulnerability to these risks, while climate change is expected to change the nature of some of the risks themselves. Flooding is the most common and destructive natural hazard facing the nation and causes billions of dollars in losses each year. Hurricanes, earthquakes, wildland fires, tornadoes, and landslides are less widespread but also pose significant risks to property and residents in susceptible areas. For example, our analysis of NOAA data showed that hurricanes typically impact the Atlantic and Gulf Coast states and occasionally Hawaii. Additionally, according to the USGS, earthquakes pose significant risks to states on the West Coast and Alaska as well as portions of the central United States. We also found that most large wildland fires—which increasingly threaten structures as development continues to expand in or near wildlands—occur in the western United States, although smaller fires, which can be equally as damaging as large fires, also occur in the eastern and southern regions of the country. Other natural hazards, such as tsunamis and volcanic eruptions also present risks to portions of the United States. Furthermore, some natural hazard events can cause another hazard event to occur. For example, an earthquake can produce a tsunami or may cause levees to fail and create flooding. Finally, population trends and climate change are potentially increasing the vulnerability of the nation to losses resulting from natural hazards. For example, NOAA estimates that coastal areas, in particular, are among the most rapidly growing areas in the country; and as we have previously reported, climate change may increase these hazard

risks by altering the frequency and severity of hurricanes, tornadoes, and wildland fires.[3]

A variety of mitigation activities exist that can reduce the risk of losses from natural hazards. These activities, which are mostly implemented at the state and local level, include hazard mitigation planning; the adoption and enforcement of more rigorous building codes; and the use of hazard control structures such as levees, dams, and floodwalls or natural protective features such as wetlands and dunes. Hazard mitigation planning can help communities identify the natural hazards to which they are susceptible and develop a strategy for reducing their vulnerability. Many of the strategies identified in hazard mitigation plans are implemented through land-use planning tools and development regulations that can prevent or limit development in hazard-prone areas. Building codes play an important role in making structures more resistant to the effects of natural hazards. The amount of protection building codes provide depends on the provisions contained in the code that address communities' natural hazard risks and the extent to which communities adopt and enforce these provisions. When development occurs in hazard-prone areas, buildings can be designed or retrofitted (modified to improve resistance to hazards) to increase their chances of surviving known perils. For example, homes built in areas susceptible to wildland fires can incorporate landscape techniques, such as maintaining an open area around the structure's perimeter that limits the amount of vegetation and other flammable objects. Hazard control structures can help protect areas that are susceptible to flooding. For example, the city of Napa, California, is undertaking a large flood protection project that includes levees and floodwalls to reduce the impact of flooding on the region.

Major impediments exist to the implementation of natural hazard mitigation activities, however, some methods are available to help encourage the undertaking of these activities. Mitigation activities are often constrained by conflicting local interests, cost concerns, and a lack of public awareness of the risks of natural hazards and the importance of mitigation. Communities' economic interests can often conflict with long-term hazard mitigation goals. For example, communities' desire for economic growth may allow development to occur in hazard-prone areas (e.g., along the coast or in floodplains). Additionally, the cost to

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

communities to implement and maintain hazard mitigation policies as well as the cost to property owners to make their structures hazard resistant also limits the amount of hazard mitigation activities that occur. The lack of public awareness about natural hazards and risks also constrains efforts to implement new mitigation activities. Efforts to overcome these impediments include, public education and outreach, financial and other types of assistance, and insurance discounts. An example of public education is the Firewise Communities program, which conducts educational activities for local policy makers, home owners, and developers about wildland fire risks and methods to reduce these risks. Additionally, financial assistance is provided by federal, state, and local agencies to promote mitigation activities. For example, at the federal level, FEMA offers assistance to states and local communities through natural hazard mitigation grant programs. At the local level, communities can use economic incentives such as tax benefits to encourage mitigation activities. Finally, insurance discounts can also encourage communities and individuals to undertake mitigation measures.

The approach currently used for natural hazard mitigation efforts, while collaborative, tends to occur on a hazard-specific basis, typically after a disaster, or through informal methods and does not provide a comprehensive strategic framework for mitigation. Successful mitigation efforts require collaboration among federal, state, and local government agencies, and a variety of nongovernmental entities, because mitigation activities are implemented at the state and local level. We identified a number of collaborative methods for mitigation, including developing national mitigation strategies or interagency programs dedicated to reducing losses from particular natural hazards. For example, several federal agencies have developed a national strategy for reducing the risks that wildland fires pose to communities, which identifies the stakeholders responsible for completing tasks to accomplish this goal. Agency officials said that in addition they collaborate on mitigation efforts through a variety of informal mechanisms such as teleconferences and discussions on specific projects or initiatives. The federal government also collaborates on mitigation activities through partnerships with state and local governments and other nongovernmental entities to develop broad community support for mitigation activities. However, these efforts are fragmented and do not provide a comprehensive national strategic framework for mitigation. In the past, FEMA developed a comprehensive strategic framework through the creation of the National Mitigation

Strategy that sought to strengthen partnerships among all levels of government and the private sector.[4] Various provisions of federal laws stress the importance of national efforts in natural hazard mitigation and highlight FEMA's leadership role in such efforts. The absence of a comprehensive framework makes it difficult to ensure that the federal government is effectively identifying hazard risks and that those undertaking mitigation efforts are working collectively. Further, without such a framework federal efforts may not be leveraging resources and developing synergies across the various hazard-specific mitigation efforts to accomplish common national natural hazard mitigation goals.

To more effectively identify natural hazard risks, minimize the effects of hazards before they occur, and reduce overall future hazard losses to the nation, we recommended that the Administrator of FEMA, in consultation with other appropriate federal agencies, develop and maintain a national comprehensive strategic framework for mitigation that incorporates both pre- and postdisaster mitigation efforts. The framework should include items such as common mitigation goals; performance measures and reporting requirements; the role of specific activities in the overall framework; and the roles and responsibilities of federal, state, and local agencies, and nongovernmental stakeholders.

We requested comments from FEMA, NOAA, USGS, the Corps of Engineers, and the Forest Service. The Department of Homeland Security, which provided written comments on behalf of FEMA, generally agreed with our conclusions and recommendation (see app. II). FEMA's comments supported setting a national comprehensive strategic framework and common mitigation goals. But the letter added that the agency believed that it was inappropriate for FEMA to dictate mitigation decisions to the local level and thus disagreed with setting performance measures and reporting requirements. Mitigation activities could benefit from performance measures to ensure that crosscutting agency goals are consistent and that program efforts are mutually reinforcing. With such practices in place, FEMA, in consultation with other federal agencies, could more effectively partner with and develop buy-in from state and local agencies and nongovernmental stakeholders. Trend analysis and progress reporting toward goals, both of which FEMA cited as more appropriate, would be consistent with our recommendation and could be

[4]FEMA, *National Mitigation Strategy: Partnerships for Building Safer Communities* (Washington, D.C.: 1995).

effective in measuring the success of a comprehensive strategic mitigation framework.

The Department of the Interior, which provided written comments on behalf of USGS, also agreed with the recommendation and stressed the importance of a strategy being built collectively by FEMA in partnership with other federal agencies. We have reprinted the Department of the Interior's written comments in appendix III, and we discuss them in greater detail near the end of this letter. The Corps of Engineers, Forest Service, and NOAA did not provide written comments. However, they generally agreed with the report but did not comment on the recommendation.

Background

The rising costs of natural hazard events have led many to recognize the benefits of hazard mitigation. Obligations from FEMA's disaster relief fund grew from $2.8 billion in 1992 to $34.4 billion in 2005 as a result of a series of unusually large events and the increasing federal role in assisting communities and individuals affected by disasters. Given these increasing costs, Congress passed the Disaster Mitigation Act of 2000 (DMA 2000) to establish a national hazard mitigation program to (1) reduce the loss of life and property, human suffering, economic disruption, and resulting disaster assistance costs from natural hazard events and (2) provide a source of predisaster mitigation funding that would assist states and local governments in implementing effective hazard mitigation measures.[5] It also established several initiatives designed to improve state and local hazard mitigation planning—the process these governments use to identify risks and vulnerabilities associated with natural hazards and to develop long-term strategies for protecting people and property in future hazard events.

FEMA, within the Department of Homeland Security, is responsible for leading the country's efforts to prepare for, prevent, respond to, and recover from disasters. In recent years, FEMA has made hazard mitigation a primary goal in its efforts to reduce the long-term effects of natural hazards. For example, FEMA provides guidance for state and local governments to use in developing their hazard mitigation plans, reviews and approves these plans, and administers a number of hazard mitigation

[5]Disaster Mitigation Act of 2000, Pub. L. No. 106-390, 114 Stat. 1552 (codified at various sections of title 42 of the U.S. Code).

grant programs to provide funds to state and local governments to undertake mitigation activities. Table 1 describes FEMA's hazard mitigation grant programs and their fiscal year 2006 funding levels.

Table 1: FEMA Hazard Mitigation Grant Programs

Grant program	Description	Fiscal year 2006 funding (millions)
Hazard Mitigation Grant Program (HMGP)	Provides funds to communities to reduce or permanently eliminate future risk to lives and property from natural hazards. HMGP funds projects in accordance with priorities identified in state, tribal, or local hazard mitigation plans and enables mitigation measures to be implemented during recovery from a disaster.	Approx. $581
Pre-Disaster Mitigation Program (PDM)	Provides funds to communities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to life and property and the future cost of recovering from a disaster event.	$50
Flood Mitigation Assistance Program (FMA)	Provides funds to communities to implement cost-effective measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the National Flood Insurance Program (NFIP).	$28
Repetitive Flood Claims Program (RFC)	Provides funds to reduce or eliminate the long-term risk of flood damage to structures insured under the NFIP that have had one or more claim payment(s) for flood damages. Eligibility is limited to those communities that cannot meet the requirements of the FMA program for various reasons.	$10
Severe Repetitive Loss Pilot Program (SRL)	Provides funds to reduce or eliminate the long-term risk of flood damage to severe repetitive loss residential properties that are insured under the NFIP. Severe repetitive loss properties are residential properties that have incurred flood losses that resulted in either (1) four or more flood insurance claims payments that each exceeded $5,000, with at least two of the payments occurring within a 10-year period or (2) two or more flood insurance claims payments that cumulatively exceed the value of the property.	$40

Source: FEMA.

Note: All grant program funding represents appropriations levels, with the exception of HMGP funding, which represents obligated levels.

FEMA also manages the National Flood Insurance Program (NFIP), which was established by the National Flood Insurance Act of 1968.[6] The NFIP enables property owners in participating communities to purchase flood

[6]The National Flood Insurance Act of 1968, Pub. L. No. 90-448, title XIII, 82 Stat. 572 (codified as amended at 42 U.S.C. §§ 4001 *et seq.)*.

insurance as protection against flood losses.[7] When a community chooses to join the NFIP, it must adopt and enforce the minimum floodplain management regulations established by the program, which are designed to reduce future flood damages. Currently, over 20,300 communities participate in the NFIP. According to FEMA, it is estimated that $1.2 billion in flood losses are avoided annually because of community implementation of the floodplain management requirements of NFIP. In addition to providing flood insurance and helping to reduce flood damages through floodplain management regulations, the NFIP identifies and maps the nation's floodplains. These maps help communities identify their flood risks and are used in implementing floodplain management regulations.

While FEMA's hazard mitigation responsibilities span all natural hazards, other federal agencies that participate in hazard mitigation primarily focus their efforts on particular hazards. Hazard mitigation activities conducted by other federal agencies include providing training, disseminating information, and conducting regional assessments. Many federal agencies have responsibilities related to natural hazard mitigation. Some of these agencies include the following:

- USGS, within the Department of the Interior, is responsible for helping to reduce losses from hazards such as earthquakes, landslides, and volcanic eruptions. USGS provides scientific information that communities can use when developing plans for reducing losses associated with these hazards. Other agencies also rely on USGS information to help them fulfill their responsibilities regarding natural hazards. For example, NOAA's National Weather Service relies on USGS real-time streamflow information for developing flood forecasts and data from USGS-supported seismic networks as a primary input for tsunami warnings.

- Five federal agencies—the Forest Service within the Department of Agriculture and the Bureau of Indian Affairs, Bureau of Land Management, Fish and Wildlife Service, and the National Park Service within the Department of the Interior—all work to minimize losses resulting from wildland fires. For example, these five agencies work to restore the health

[7]Our use of the term "community" throughout this report refers to FEMA's definition of "community" for the NFIP. FEMA's definition includes, among others, any state or area or political subdivision thereof, or any Indian tribe or authorized tribal organization, which has authority to adopt and enforce floodplain management regulations for the areas within its jurisdiction. See 44 C.F.R. § 59.1 (2006). In most cases, a community is an incorporated city, town, township, borough, or village, or an unincorporated area of a county or parish.

of the nation's forests and grasslands to increase resilience to the effects of wildland fires.

- NOAA, within the Department of Commerce, focuses on the condition of the oceans and the atmosphere and conducts activities to reduce losses associated with natural hazards such as hurricanes, tornadoes, coastal flooding, and tsunamis. For instance, NOAA's National Weather Service routinely uses outreach, education, and planning to help communities mitigate these natural hazards. NOAA also works with coastal communities to provide financial, technical, and training support to develop more robust hazard mitigation and land-use plans and improve building code and design standards.

- The Corps of Engineers builds flood damage reduction projects throughout the country. Typically these projects include levees, flood walls, channels, and small dams that help reduce losses associated with floods. Generally, communities fund a portion of the construction costs of the projects and agree to operate and maintain them.

Although FEMA provides leadership for reducing the country's losses caused by natural hazards, it routinely collaborates with other federal agencies as well as state and local governments, among others. Collaboration is a tool that federal agencies use to work with one another and with various stakeholders, generally through partnerships with state and local governments and communities. In previous work, we identified key practices that could help enhance and sustain federal agency collaboration.[8] These activities include (1) defining and articulating a common outcome; (2) establishing mutually reinforcing or joint strategies; (3) identifying and addressing needs by leveraging resources; (4) agreeing on roles and responsibilities; (5) establishing compatible policies, procedures, and other means of operating across agency boundaries; (6) developing mechanisms to monitor, evaluate, and report on results; (7) reinforcing agency accountability for collaborative efforts; and (8) reinforcing individual accountability for collaborative efforts.

[8]We defined "collaboration" broadly to include interagency activities that others have previously defined as cooperation, coordination, integration, or networking. For this report, we used this definition of "collaboration" to describe coordination among federal agencies as well as between federal agencies and nonfederal stakeholders. See GAO *Results-Oriented Government: Practices That Can Help Enhance and Sustain Collaboration among Federal Agencies*, GAO-06-15 (Washington, D.C.: Oct. 21, 2005).

The United States Is at Risk from a Number of Natural Hazards, and Our Vulnerability Is Increasing

Flooding is the most common and destructive hazard facing the nation, but earthquakes, hurricanes, wildland fires, tornadoes, and landslides are also significant risks in certain regions. For example, while floods are potential hazards in most parts of the country, hurricanes are most likely to occur on the Atlantic and Gulf Coasts, and large wildland fires have mostly affected the western United States. The risks caused by natural hazards are exacerbated by the fact that one natural hazard can lead to another. Earthquakes, for instance, can cause tsunamis, landslides, and flooding due to levee failures. In recent years, however, the risk posed by natural hazards has been increasing, fueled by factors that include population trends and the potential effects of climate change. Many hazard-prone regions are experiencing significant population growth, among them the coast of Florida—the most hurricane-prone state in the country—where the population increased by 75 percent between 1980 and 2003. Finally, climate change is potentially increasing the risks faced by some areas by altering the frequency and severity of hurricanes, tornadoes, severe thunderstorms, and wildland fires, and other weather-related events.

Flooding Is the Most Widespread Hazard in the United States, but Other Hazards Affect Specific Regions

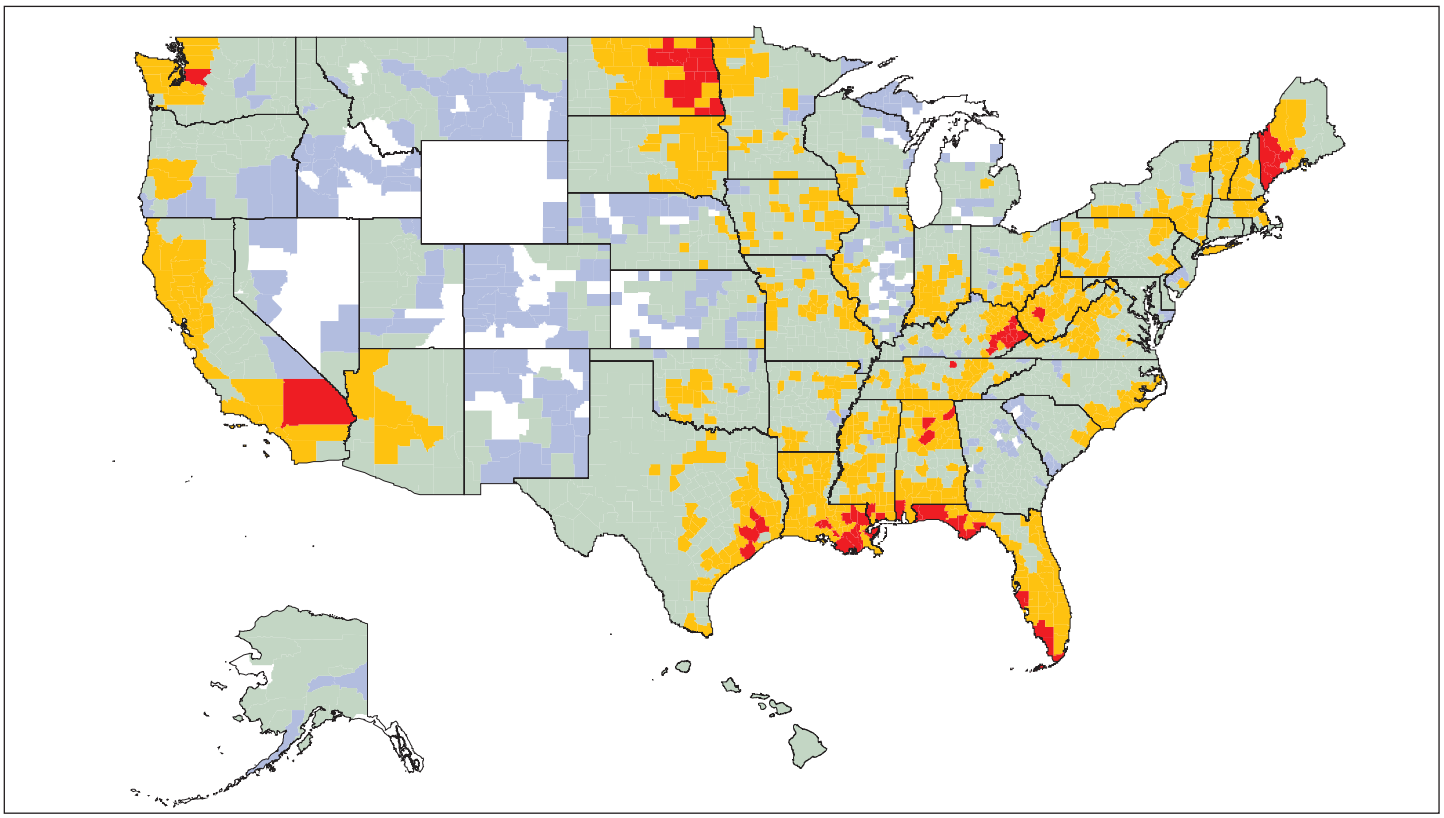
Several natural hazards such as hurricanes, earthquakes, and wildland fires pose risks to certain areas of the United States. Floods, however, are the most common and destructive hazard in the United States, and all states are likely to experience some degree of flooding. There are many different kinds of floods, including, regional floods, flash floods, floods resulting from dam and levee failures, and storm surge floods. Floods can result in the loss of lives, extensive damage to property and agriculture, and large-scale disruptions to business and infrastructure, such as transportation and water and sewer services. According to our analysis of FEMA data, counties in the Gulf Coast states experienced the greatest concentration of major flood disaster declarations from 1980 through 2005 (fig. 1).[9] Additionally, because flooding is so widespread, it presents risks to a large segment of the population. For example, we found that between 1980 and 2005, approximately 97 percent of the U.S. population lived in a county that experienced at least one declared flood disaster; about 93 percent lived in counties that had experienced two or more flood disaster declarations; and 45 percent lived in counties that had experienced six or

[9]Following a disaster, and upon the request of a state governor, the President may issue a major disaster declaration that triggers a range of assistance from federal agencies. See 42 U.S.C. § 5170.

more flood disaster declarations.[10] NOAA estimates that floods cause about 140 deaths each year, and the Corps of Engineers estimates floods cost $6 billion in average annual losses. Economic losses continue to rise, in part, due to increased urbanization and coastal development.

[10]We used Census 2000 data as our population estimates for the number of people living in areas that experienced a natural hazard event from 1980 through 2005 or are at risk from earthquakes and landslides. The Census Bureau defines "county" and "equivalent entity" as the primary legal subdivision of most states. In Louisiana, these subdivisions are known as parishes. In Alaska, which has no counties, the county equivalents are boroughs, a legal subdivision, and census areas, a statistical subdivision. Four states (Maryland, Missouri, Nevada and Virginia) have one or more cities that are independent of any county and thus constitute primary subdivisions of their states. The District of Columbia has no primary divisions, and the entire area is considered equivalent to a county for statistical purposes. In Puerto Rico, *municipios* are treated as county equivalents.

Figure 1: Number of Major Flood Disaster Declarations by County, 1980-2005



Source: GAO analysis of FEMA data.

Note: Figure represents areas where past flooding disasters have occurred. It may not reflect future flooding risks, as mitigation activities may have occurred in some areas.

Hurricanes typically produce violent winds, heavy rains, and storm surges and can result in flooding, coastal erosion, and ecological damage. While Florida has the greatest chance of experiencing a major hurricane

Hurricane Saffir-Simpson Scale

A hurricane is a tropical cyclone in which the maximum sustained surface wind speed (1 minute average) is 74 mph or greater. Hurricane intensity is measured on the Saffir-Simpson hurricane scale, which classifies hurricanes on a scale of 1 to 5, based on the sustained wind speed. Storm surge values depend on the slope of the continental shelf and shape of the coastline and are expressed as general estimates.

Scale number (category)	Sustained winds (mph)	Storm surge on average above normal (feet)
1	74-95	4-5
2	96-110	6-8
3	111-130	9-12
4	131-155	13-18
5	>155	>18

Source: NOAA.

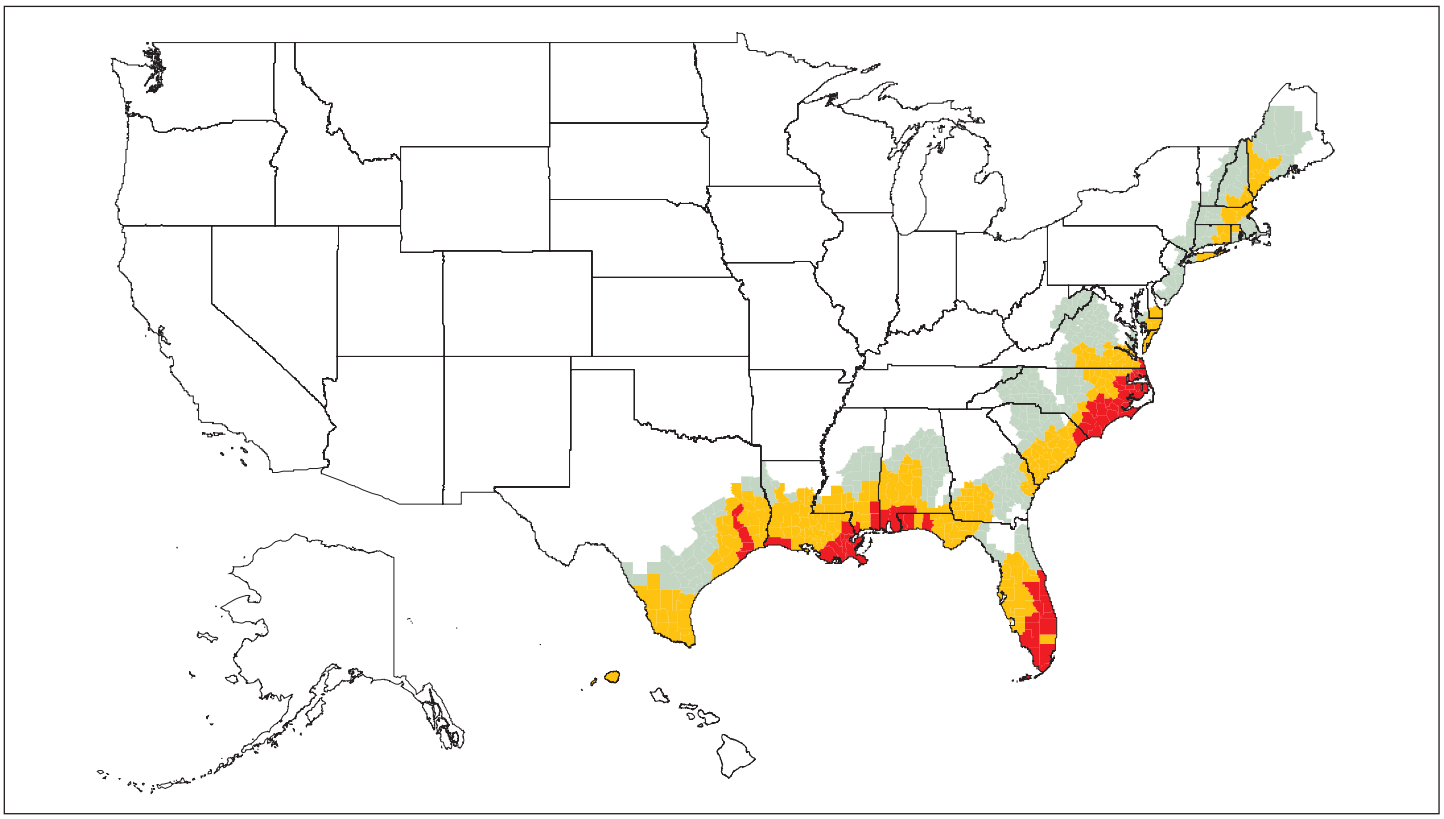
(category 3 or higher), our analysis of NOAA data shows that states along the entire Atlantic coast, particularly North Carolina, the Gulf Coast states, and occasionally Hawaii are also at significant risk for hurricanes.[11] Additionally, we found that approximately 29 percent of the U.S. population lived in a county that experienced at least one hurricane from 1980 through 2005. During this same time, counties in eight states—Alabama, Florida, Louisiana, Mississippi, North Carolina, South Carolina, Texas, and Virginia—experienced five or more hurricanes (fig. 2). Before 2005, Hurricane Andrew, which occurred in 1992, was the single most costly hurricane in terms of private insurer losses, causing $22.3 billion in losses (in 2006 dollars).[12] Comparatively, Hurricane Katrina caused $39.3 billion in private insurer losses (in 2006 dollars).[13]

[11]We did not analyze data for U.S. territories, but they are also subject to hurricanes.

[12]Estimates were adjusted using the calendar year Consumer Price Index for All Urban Consumers, with 2006 as the base year.

[13]Estimate as of February 2006. Private insurer loss estimates for Hurricane Katrina are likely to change as the extent of losses becomes better known.

Figure 2: Number of Hurricanes by County, 1980-2005



Source: GAO analysis of NOAA data.

Earthquake Magnitude and Intensity

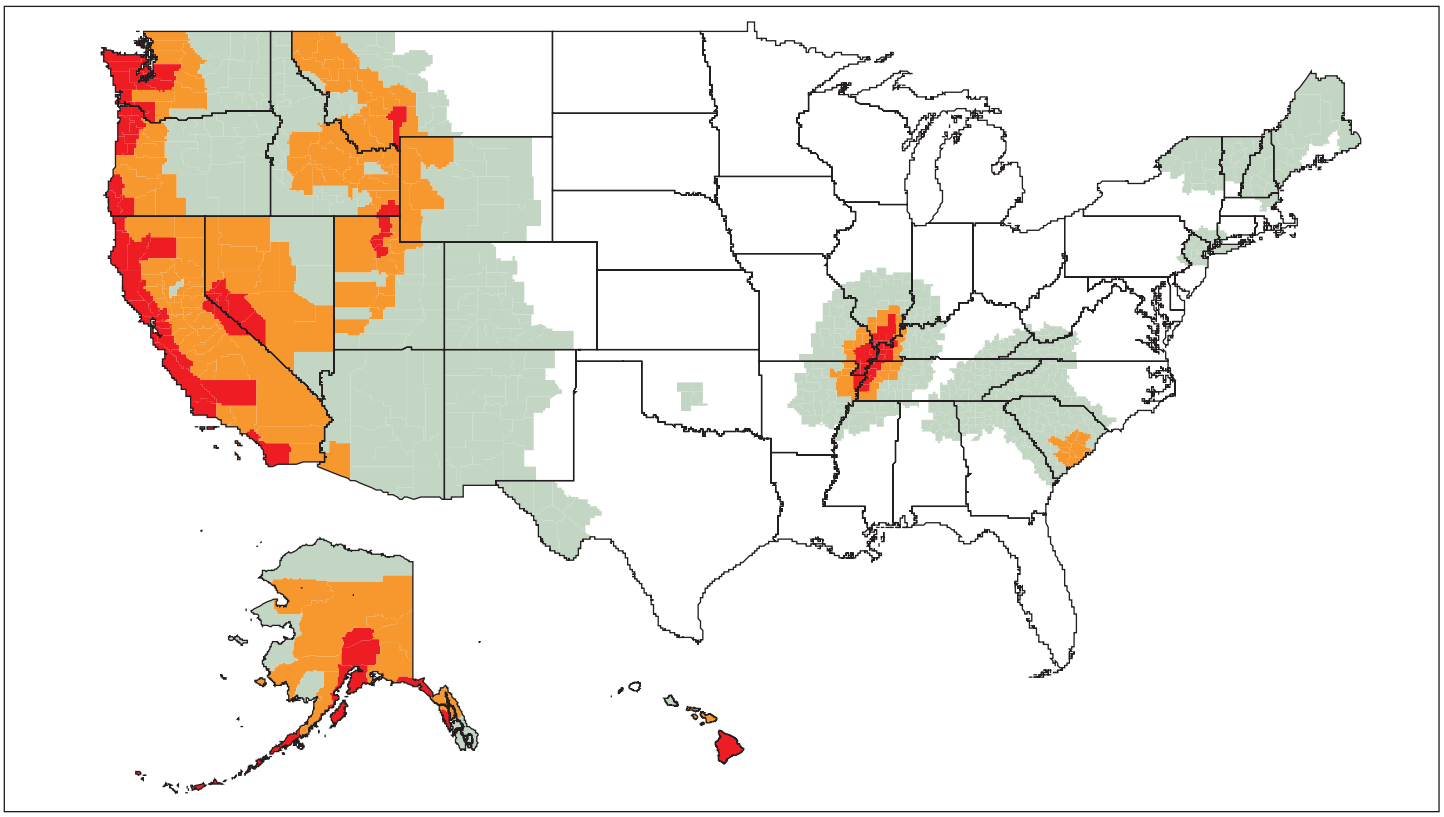
Earthquake magnitude is a measure of the size of an earthquake and is based on ground motions recorded on seismographs. Intensity measures the strength of shaking produced by the earthquake at a certain location and is determined from effects on people, structures, and the natural environment.

Magnitude	Intensity: Effects
1.0 – 2.9	I: Not felt except by a very few.
3.0 – 3.9	II: Felt only by a few persons at rest. III: Felt quite noticeably by persons indoors.
4.0 – 4.9	IV: Felt indoors by many, outdoors by few during the day. V: Felt by nearly everyone; many awakened.
5.0 – 5.9	VI: Felt by all. Damage slight. VII: Damage negligible in buildings of good design and construction; considerable damage in poorly built or badly designed structures.
6.0 – 6.9	VII: (see above) VIII: Damage slight in specially designed structures; damage great in poorly built structures. IX: Damage considerable in specially designed structures. Buildings shifted off foundations.
7.0 and higher	VIII: (see above) IX: (see above) X: Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. XI: Few if any masonry structures remain standing. Bridges destroyed. XII: Total damage.

Source: USGS.

Earthquakes are a sudden slipping or movement of a portion of the earth's crust that releases energy in the form of seismic waves, which can cause shaking and damage over large distances. USGS has estimated that 39 states face significant earthquake risk. Our analysis showed that approximately 41 percent of the U.S. population resided in counties that face medium to high seismic risk. While the risk is concentrated on the West Coast, USGS states that Alaska is the most earthquake-prone state and one of the most seismically active regions in the world, experiencing a magnitude 7 earthquake almost every year and a magnitude 8 or greater earthquake every 14 years (on average). In addition to these areas, the New Madrid seismic zone (which is located in parts of Arkansas, Illinois, Kentucky, Missouri, and Tennessee) also faces medium to high seismic risk (fig. 3). Historically, some of the largest earthquakes in United States have been recorded along the New Madrid fault, and USGS predicts that the region has a 25 to 40 percent chance of experiencing a magnitude 6 or greater earthquake in the area in the next 50 years. Although earthquakes occur with less frequency in the eastern and central United States, according to USGS, a smaller magnitude earthquake in these regions would be just as damaging as a higher magnitude earthquake in the western United States. For example, according to USGS, because of geologic conditions, an earthquake in the east or central part of the country would be felt over a much larger area, and infrastructure in these regions is older and has not been built to withstand earthquake shaking. Similar to a hurricane, a single earthquake can cause great losses. For example, the 1994 earthquake in Northridge, California, caused approximately $59.8 billion in direct losses (in 2006 dollars). FEMA estimates future average annual earthquake losses in the United States at $5.6 billion a year.

Figure 3: Counties That Face Medium to High Seismic Risk

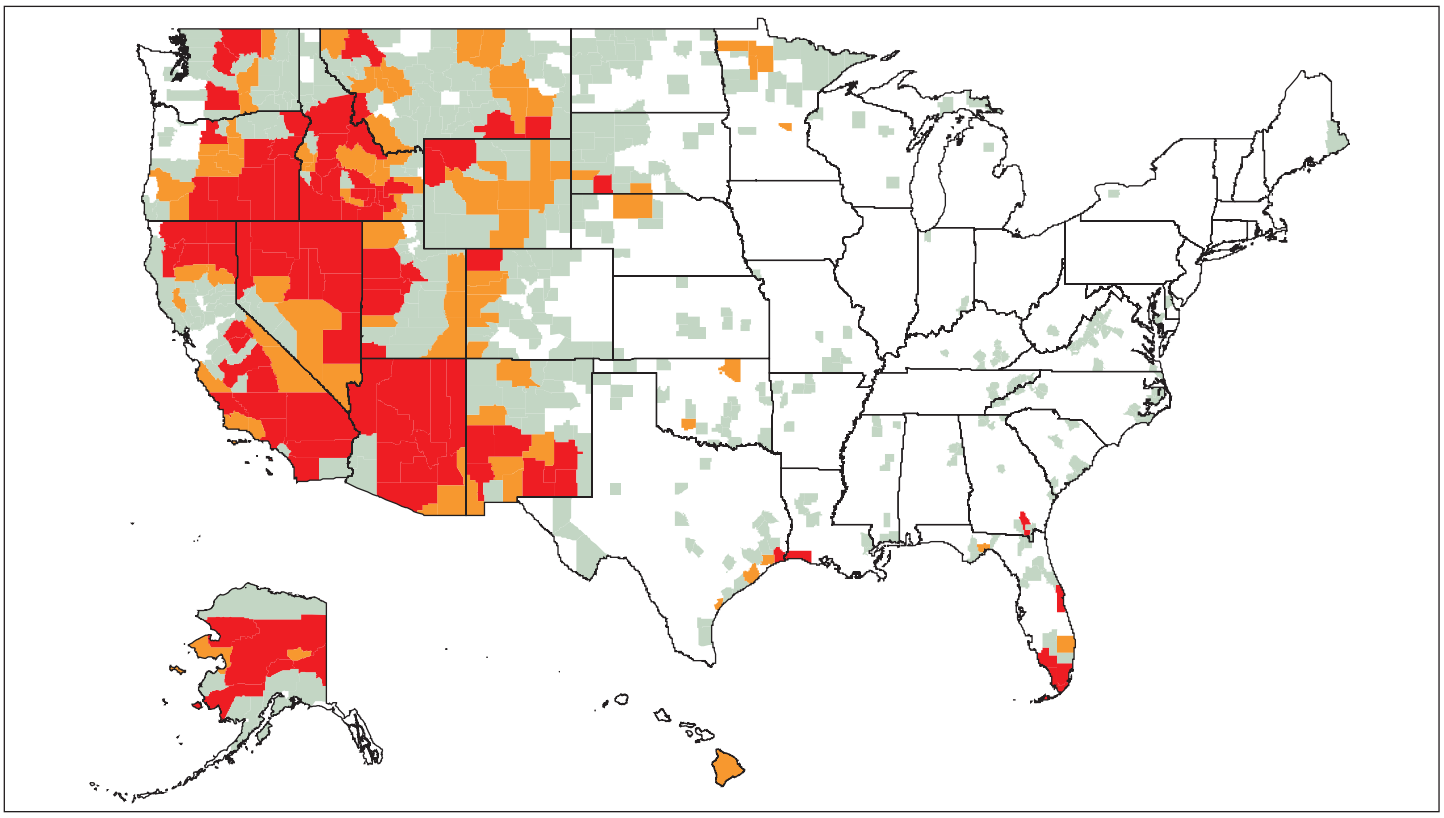


Source: GAO analysis of USGS data.

Wildland fires, which can be triggered by lightning strikes or human activity, play an important ecological role in wildland areas. On average, 100,000 wildland fires are reported each year, but 95 percent are quickly extinguished. Fires that escape initial suppression can grow into large, high-intensity fires that burn quickly and can threaten structures in the wildland-urban interface—the area where structures and other development meet or intermingle with wildlands. According to our analysis, nearly 24 percent of the U.S. population lived in a county where a wildland fire burned over 1,000 acres from 1980 through 2005. Figure 4, which shows the number of these large wildland fires, also shows that they are most likely to occur in western states and Florida. In eight western states—Arizona, California, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming—over 80 percent of the population lived in a county that experienced a wildland fire of over 1,000 acres during the 25-year period we analyzed. According to Forest Service officials, fires less than 1,000 acres can be equally damaging to structures in other parts of the United States, especially in the eastern and southern regions of the country. Additionally, the officials noted that in some western regions of the country, some of the large wildland fires that occur play an important ecological role and may pose less of a threat to life and property because they occur in less populated areas. As we previously reported, wildland fires burned an average of 6.1 million acres per year between 2000 and 2004 and burned an average of about 850 homes each year since 1984.[14]

[14]GAO, *Wildland Fire Suppression: Lack of Clear Guidance Raises Concerns about Cost Sharing between Federal and Nonfederal Entities*, GAO-06-570 (Washington, D.C.: May 30, 2006).

Figure 4: Number of Wildland Fires over 1,000 Acres by County, 1980-2005



Source: GAO analysis of Desert Research Institute data.

Note: Figure represents areas where past wildland fires have occurred. It may not reflect future wildland fire risks, as mitigation activities may have occurred in some areas.

Enhanced Fujita Tornado Damage Scale

Tornadoes are classified on the 6-point Enhanced Fujita Tornado Damage Scale using estimates of wind speed based on the level of damage. The scale uses 3-second gusts estimated at the point of damage based on a judgment of eight levels of damage to different types of structures.

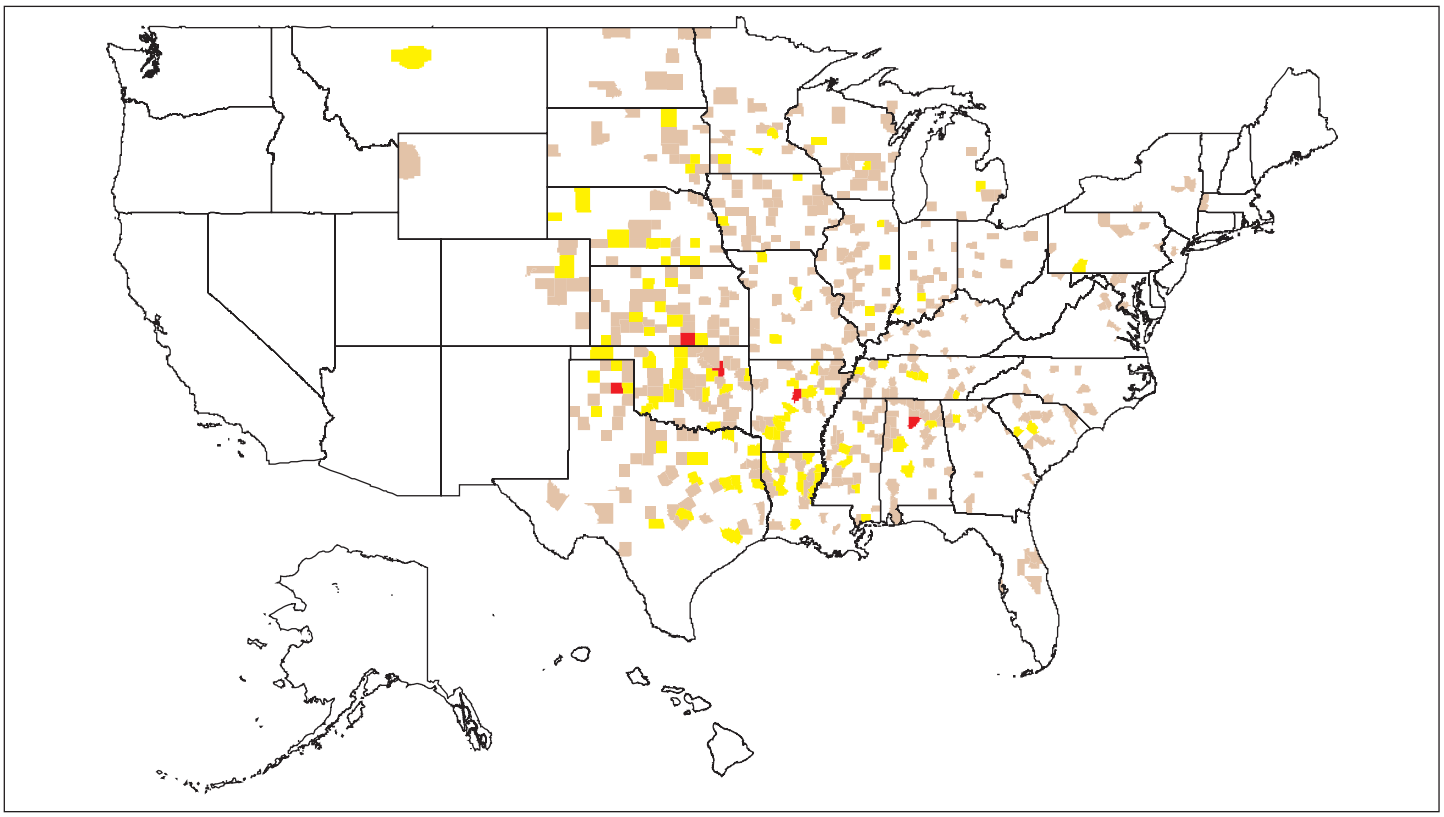
Category	Wind estimate (mph)	Degree of damage in one- and two-family residences
0	65-85	Threshold of visible damage; partial loss of roof covering material, and loss of gutters and vinyl or metal siding.
1	86-110	Broken glass in doors and windows; uplift of roof deck and loss of significant roof covering material; collapse of chimney; garage doors collapse inward; and failure of porch.
2	111-135	Entire house shifts off foundation; large sections of roof structure removed; most walls remain standing; and top floor exterior walls collapse.
3	136-165	Most interior walls of top story collapsed; most walls collapsed in bottom floor, except small interior rooms.
4	166-200	Total destruction of entire building.
5	Over 200	Total destruction of entire building.

Source: NOAA.

A tornado is a violently rotating column of air extending from a thunderstorm to the ground. The most violent tornadoes are capable of tremendous destruction, with damage paths as wide as a mile and as long as 50 miles. In an average year, about 1,000 tornadoes are reported across the United States. While tornadoes have been documented in every state, NOAA data show that the central states are most likely to experience the most severe tornadoes—those with wind speeds of 158 miles per hour or greater.[15] "Tornado Alley," an area covering a stretch of land from central Texas to northern Iowa and from central Kansas and Nebraska to western Ohio, has the highest tornado activity in the nation (fig. 5). Another significant zone of tornado frequency is the central southeast United States, including Louisiana, Mississippi, Alabama, and Tennessee. From 1980 through 2004, five states—Alabama, Arkansas, Kansas, Oklahoma, and Texas—each had one county that experienced five or more severe tornadoes. Tornadoes pose a significant risk to life, causing an average of 80 deaths and over 1,500 injuries a year. Tornadoes can also be costly. For example, NOAA estimates that approximately once per decade, a devastating tornado in the United States has caused $1 billion or more in damages.

[15]For the purposes of this report, we classified tornadoes with wind speeds greater than 158 miles per hour as severe tornadoes. This analysis was based on tornadoes using the Fujita (F) scale where winds of 158 miles per hour begin the category for severe tornadoes (F3). As of February 1, 2007, NOAA began using the Enhanced Fujita (EF) scale for tornado ratings and its category for severe tornadoes (F3) begins with a wind speed of 136 miles per hour.

Figure 5: Number of Severe Tornadoes by County, 1980-2004

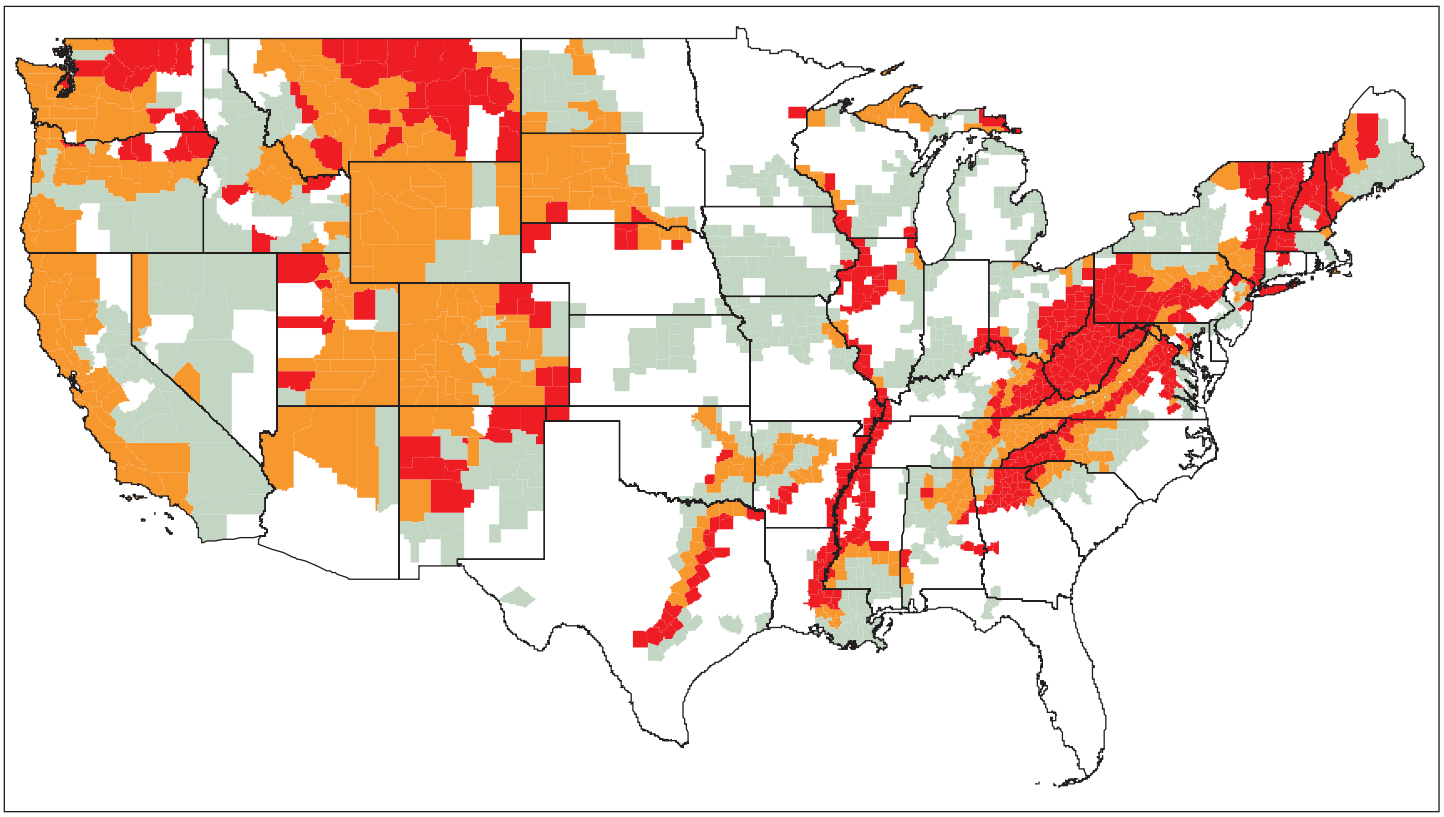


Source: GAO analysis of NOAA data.

Note: Figure represents areas where past tornadoes have occurred. It may not reflect future tornado risks.

Landslides are the movement of a mass of rock, debris, or earth down a slope and can range from a rapidly moving rock avalanche to a more slowly moving earth slide and ground failure. The greatest landslide damage occurs in the Appalachian and Rocky Mountains, as well as the Pacific Coast regions, but USGS data show that all 50 states can experience landslides and other ground-failure problems (fig. 6). We found that from 1980 through 2005, approximately 66 percent of the U.S. population lived in an area where the landslide risk was moderate to high. Landslides can have a significant adverse effect on infrastructure and threaten transportation corridors, fuel and energy conduits, and communications linkages. USGS estimates that landslides cause, on average, $3.5 billion in damage repair and between 25 and 50 deaths a year.

Figure 6: Counties That Face Moderate to High Landslide Risk



Source: GAO analysis of USGS data.

Note: Figure represents areas where past landslides have occurred. It may not reflect future landslide risks.

Other hazards also present risk to portions of the United States. Some of these hazards, including thunderstorms, extreme heat, and winter storms can occur in most areas of the country. Tsunamis—a series of long waves generated by any large-scale disturbance of the sea—can occur in all U.S. coastal regions, but according to NOAA, the west coast, Alaska, and Hawaii are the most vulnerable.[16] Although less frequent than other

[16]Puerto Rico and the Virgin Islands also face significant tsunami risk.

hazards in the United States, tsunamis are a significant natural hazard with great destructive potential. For example a 1964 Alaska tsunami led to 110 deaths, some as far away as Crescent City, California. In addition, according to USGS, in the past few hundred years volcanoes have erupted in Alaska, California, Hawaii, Oregon, and Washington.[17] Since 1980, 45 eruptions and 15 cases of notable volcanic unrest have occurred at 33 U.S. volcanoes.

In addition to the risk that an individual hazard poses, some hazards present multiple risks because they can cause another hazard to occur. For example, hurricanes often produce torrential rain that, in addition to causing floods, can trigger landslides or breach levees. Hurricanes can also damage trees in wildland areas, increasing wildland fire risk in these areas by creating fuel accumulation.[18] Earthquakes can cause tsunamis, landslides, and flooding (e.g., due to levee failures). For example, the devastating December 2004 Indian Ocean tsunami was triggered by an earthquake. In addition, drought can contribute to wildland fires, which can induce other hazards, including floods and landslides. The degradation of soil in an area burned by a wildland fire prevents vegetation from growing back, including features that would hold the soil in place during heavy rains. Consequently, landslides are more likely to occur in burned areas.

Population Trends and Climate Change Are Increasing the Nation's Vulnerability

Population growth in hazard-prone areas and the resulting increase in development in these areas are increasing the vulnerability of the nation to losses resulting from natural hazards. According to a study conducted by NOAA, coastal areas are among the most rapidly growing and developed areas in the nation, with a large percentage of the U.S. population living in coastal counties.[19] These areas are susceptible to hurricanes, earthquakes, flooding, and other natural hazards. For example, the coastal population in Florida grew by 7.1 million people, a 75 percent increase, from 1980 to 2003. According to the study, Florida led all coastal states in issuing

[17]Some of the most active U.S. volcanic regions also include Pacific territories, especially the Commonwealth of the Northern Marianas Islands.

[18]Fuel refers to the dead and living materials in a natural environment that will burn. This can include dead and living grasses, twigs, branches, and trees.

[19]U.S. Department of Commerce, NOAA, *Population Trends Along the Coastal United States: 1980-2008*, September 2004.

building permits for single- and multifamily housing units in coastal counties from 1999 to 2003.

Additionally, the number of people living on the California coast grew by almost 10 million between 1980 and 2003, putting more people and property at risk from earthquake damage. Los Angeles County experienced the greatest increase in population of all coastal counties from 1980 to 2003. A study on the potential damage that an earthquake could cause in downtown Los Angeles found that damages from such an event would likely fall between $82 billion and $252 billion.[20] Other areas prone to natural hazards are also experiencing significant population growth and development. For example, many of the fastest-growing areas in the United States are in the wildland-urban interface, and development in these areas increases the threat of wildland fires. Experts estimate that between 1990 and 2000, 60 percent of all new housing units in the United States were built in the wildland-urban interface, and that in by 2000 about 38 percent of housing units overall were located in these areas. Additionally, urban growth in tornado-prone areas, which in many cases were previously sparsely populated, is increasing the chances that a tornado will hit a heavily developed area. For example, in February 2007, a series of tornadoes damaged over 1,500 homes in 4 central Florida counties, 2 of which have been among the 100 fastest-growing counties in the nation in recent years.

Further, as we have previously reported, key scientific assessments indicate that climate change is expected to alter the frequency or severity of weather-related natural hazards themselves, increasing the nation's vulnerability to such hazards.[21] Global temperatures have increased in the last 100 years and are projected to continue to rise over the next century. Scientific assessments suggest that the potential effects of climate change on weather-related events could be significant. For example, increasing temperatures may impact communities by altering the frequency or severity of hurricanes, tornadoes, severe thunderstorms, and wildland fires. For example, Forest Service officials told us that effects of climate change, such as drought, can increase the risk of wildland fires, especially east of the Mississippi River because of the high density of vegetation and

[20]E.H. Field, H.A. Seligson, N. Gupta, V. Gupta, T.H. Jordan, and K.W. Campbell, *Loss Estimates for a Puente Hills Blind-Thrust Earthquake in Los Angeles, California*, Earthquake Spectra, vol. 21, no. 2, (2005) pp., 329-338.

[21]GAO-07-285.

population. We also reported that experts found that global sea levels rose several centimeters during the past century, potentially increasing the magnitude of hurricane storm surges in some areas. Rising sea levels can also increase coastal inundation and erosion in low-lying areas, resulting in property losses.

Communities' Planning and Mitigation Activities Can Help Reduce the Risk of Losses from Natural Hazards

Hazard mitigation planning activities help communities identify risks from natural hazards and develop mitigation strategies to reduce these risks. The strategies can be implemented through land-use planning tools such as the acquisition of hazard-prone land and development regulations that provide a way to reduce vulnerability over the long term. Building codes and design standards also can be used to help reduce losses from natural hazards by creating structures that are better able to withstand a hazard event. State and local building codes can be designed to reflect communities' hazard risks and can specify more rigorous requirements to address these hazards. Additionally, design, construction, and landscaping features can be included in structures built in hazard-prone areas. For example, construction features such as hurricane straps, which provide extra support in connecting the roof to a building, can help reduce damages during hurricanes. Finally, hazard control structures such as levees, dams, and floodwalls can help protect existing at-risk developments from flood losses.

Planning Efforts Can Help Reduce Losses from Natural Hazards

The best time for communities to take steps to address their natural hazard risks is before a disaster occurs. Hazard mitigation planning, which occurs at the state and local level, helps communities assess their natural hazards risks and develop mitigation strategies. The process typically involves a range of stakeholders, including neighborhood and environmental groups, local businesses, and others. The involvement of stakeholders is an important component to the planning process because it assists in identifying the most vulnerable populations and facilities in the community and in creating community support to implement the plan. The assessment can include gathering information on the types, locations, and potential extent of natural hazards and the types and numbers of buildings, infrastructure, and critical facilities located in hazard areas. Finally, based on a community's assessment of its risks, stakeholders can identify mitigation goals and objectives.

As a condition for receiving hazard mitigation assistance, states and local communities must develop hazard mitigation plans and have FEMA approve them.[22] According to FEMA, all 50 states have approved plans, and approximately 60 percent of the U.S population lives in communities with approved local mitigation plans. One county emergency management official with whom we spoke said that a local mitigation plan is an important component of a community's mitigation program. He noted that developing such a plan requires examining other local plans (e.g., community development and capital improvement plans) to ensure that mitigation goals and objectives are consistent with other community goals. Incorporating elements of communities' hazard mitigation plans into community development plans can facilitate the implementation of hazard mitigation goals. A land-use planning expert told us that incorporating mitigation plans into other long-term strategies not only helps with implementation but also can prevent long-term mitigation objectives from being overlooked when communities develop other short-term objectives. Additionally, a state emergency management department official told us that local mitigation plans are particularly important because they establish a consistent long-term hazard mitigation approach for local governments to take that survives the high staff turnover rates local governments often face.

Communities' development and other plans can be implemented through land-use planning tools and development regulations that provide a way to reduce vulnerability to natural hazards over the long-term. For example, communities can acquire hazard-prone land and retain it as open space in order to limit development in the most at-risk areas, particularly in floodplains and coastal zones. Acquiring flood-prone properties permanently eliminates losses from properties that flood repeatedly. Communities can also use zoning to designate how land will be used, control such features as building density and lot sizes, and restrict building in hazardous areas through the use of setbacks—minimum distances between development and hazardous areas. For example, coastal zone management regulations can impose setbacks to control construction near the coast. Another method of limiting development in hazard-prone areas is the process of subdivision that divides a large lot into any number of

[22]Hazard mitigation assistance includes FEMA's Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation Grant Program funding. Although local communities are required to have an approved hazard mitigation plan to receive this funding, in extraordinary circumstances HMGP funds can be awarded to communities that agree to develop a hazard mitigation plan within 12 months of receiving the project grant.

smaller lots as a means of facilitating development. "Clustering," for instance, allows developers to build the same number of units on their land by placing more buildings on the less hazardous areas and limiting development in the more hazardous areas.

Communities also use other types of planning, such as capital improvement planning, which guides decisions on investing in new infrastructure and repairing and replacing existing infrastructure. Capital improvement planning can prevent damage to infrastructure by making sure it is not built in hazard-prone areas and requiring that existing infrastructure located in such areas be strengthened to provide additional resilience during natural hazards. Capital improvement plans can include activities such as raising bridge heights in flood-prone areas and improving the seismic strength of buildings at risk from earthquakes. Additionally, these plans can be used to guide development away from hazard-prone areas by, for example, not extending water and sewer lines and other utility services into these areas.

California's history of earthquakes has focused attention on the need to strengthen the state's infrastructure against seismic risks. A seismic safety expert estimated that between 1989 and 2006, approximately $15 billion was spent on seismic improvements for utilities and transportation systems in the San Francisco Bay area. Some of these capital improvement examples include the following:

- The California Department of Transportation has rebuilt or retrofitted most of the major roadway bridges in the San Francisco Bay area.
- The Bay Area Rapid Transit system is currently undergoing a major seismic retrofit of its entire system.
- Seismic improvements have also been made for gas, electric, and water systems.

Building Codes and Design Standards Can Lead to More Durable Structures That Provide Protection from Natural Hazards

Building codes, the minimum acceptable standards that are used to regulate the design and construction of the built environment, play an important role in improving the resilience of structures to natural hazards. Because states and localities have the authority to adopt building codes, these codes vary throughout the country.[23] Some states choose to adopt statewide building codes that can help ensure a minimum level of building quality. However, statewide building codes do not necessarily apply to all structures—for example, they may apply only to state-owned buildings, schools, or other public buildings. In Iowa, statewide building codes apply only to structures built with state funds or owned or leased by the state. Additionally, states may give local communities the right to opt out of a statewide code and adopt a local building code.

Many states and localities base their codes on model building codes that are developed on a national level by groups made up of building industry and other professionals. These codes reflect a consensus among building experts on the appropriate level of protection that codes should provide.[24] Model codes incorporate disaster-resistant standards for hazards such as wind, earthquakes, floods, and wildland fires and are specific to the type of structure being built (e.g., new commercial and residential buildings, existing buildings that undergo renovation or alteration, and structures built in wildland-urban interface areas). As of January 2007, the majority of states had adopted some version of a model building code for commercial and residential structures. Additionally, some local jurisdictions within states that have not adopted a statewide model code have adopted model codes on their own. However, according to an insurance services company that assesses the effectiveness of communities' building code enforcement

[23]The exception is factory-built manufactured homes that are transported to sites for installation and are subject to federal construction and safety standards established by the Department of Housing and Urban Development pursuant to the National Manufactured Housing Construction and Safety Standards Act of 1974, title VI of Pub. L. 93-383, 88 Stat. 633, 700 (codified as amended at 42 U.S.C. §§ 5401 *et seq.).* See 24 C.F.R. pt. 3280 (2006). However, each state may establish and enforce standards for the stabilizing and support systems of manufactured homes and for the foundations on which manufactured homes are installed, as long as such standards are consistent with Department of Housing and Urban Development regulations.

[24]Two organizations currently develop model building codes in the United States. They are the International Code Council, which develops various model codes referred to as the International Codes, and the National Fire Protection Administration (NFPA), which develops the NFPA 5000 Building Construction and Safety Code.

throughout the country, there are about 5,000 communities throughout the United States that have not adopted building codes.[25]

Model building codes can be modified by state and local authorities to reflect local hazard risks and can require more rigorous requirements to address these hazards. For example, in the hurricane-prone state of Florida, the Florida Building Code requires that structures built in areas vulnerable to high winds have windows and glass doors that are designed to withstand the impact of wind-borne debris or mandates the use of shatter-resistant glass or shutters. The California Building Code incorporates, among other things, specific seismic requirements to make structures more resilient to earthquakes and requirements for fire-resistant roofing, windows, and building exteriors for structures in wildland-urban interface areas.

Building officials, mitigation experts, and industry groups all commented that enforcing building codes is critical in order to effectively mitigate natural hazard losses. Studies revealed that damage from the 1994 Northridge earthquake would have been reduced if the seismic provisions of building codes had been properly enforced. Reports following Hurricane Andrew in 1992 also found that inadequate code enforcement resulted in significant losses from the hurricane. Enforcement of building codes generally occurs at the local building department level and ensures that builders comply with the standards specified in the codes so that structures provide the level of protection for which they were designed. Enforcement includes activities such as approving permits for new structures or structures undergoing renovation, reviewing construction plans for compliance with the building code, and inspecting construction sites to ensure that construction is proceeding according to the reviewed plan.

When a community adopts and enforces revised building codes designed to improve structural integrity, losses from natural hazard events can be reduced. State and local building code and other local government officials told us that structures built to newer building code standards performed better during natural hazard events than those built to earlier standards. For example, building code officials in California explained that when reviewing the damage from the Northridge Earthquake, they found that

[25]This company does not operate in five states. Accordingly, this estimate of the number of communities without building codes represents only the 45 states in which it operates.

older buildings suffered substantially more damage than newer buildings built using seismic mitigation measures. Figure 7 shows the damage resulting from Hurricane Charley in 2004 to two structures in Florida that are located across the street from one another. The structure on the left, which is an older building, was completely destroyed, while the structure on the right, whose construction was subject to a recent building code, performed well during the storm.

Figure 7: Effect of a 2004 Hurricane on Structures Built to Different Versions of Building Codes

Source: © Institute for Business & Home Safety.

Specific construction, design, and landscaping features can be incorporated into structures built in hazard-prone areas to improve their ability to withstand a natural hazard event. For example, specific construction features such as hurricane straps, which provide extra support in connecting the roof to a building, in areas subject to hurricane-level winds, can help reduce damages during hurricanes (fig. 8).

Figure 8: Hurricane Straps in a Home under Construction

Source: © Institute for Business & Home Safety.

For homes built in wildland-urban interface areas, landscaping techniques can be applied around the perimeter of a structure. By managing the vegetation and reducing or eliminating flammable materials within 30 to 100 feet of a structure, property owners and developers can create a defensible space that substantially reduces the likelihood that a wildland fire will damage or destroy the structure (fig. 9).

Figure 9: Before and after Photos of a Home with a Defensible Space against Wildland Fire

Source: © Institute for Business & Home Safety.

Existing structures can also be made more resistant to natural hazards through retrofitting, or modifying a structure to improve its resistance to hazards. While retrofitting may not bring a structure up to the most recent building code standards, it will help existing structures better withstand natural hazard events. Retrofitting techniques exist for a number of natural hazards, such as hurricanes, earthquakes, floods, and wildland fires. For example, garage doors are vulnerable to hurricane winds because of their size and the strength of the materials used to construct them. If a garage door fails during a storm, it can lead to more severe damages to a home, especially to the roof. However, these doors can be reinforced with horizontal or vertical bracing. Additionally, homes can be retrofitted by anchoring the structure to its foundation, reducing the possibility that the house will move off its foundation during an earthquake or hurricane.

Hazard Control Structures and Natural Protective Features Can Protect At-Risk Areas

Hazard control structures such as levees, dams, and floodwalls provide protection in flood-prone areas and can reduce associated losses. These structures are typically used to protect existing at-risk developments, such as buildings located in floodplains, and provide a certain level of flood protection. They may not provide absolute flood protection, however, because a flood could exceed the intended level of protection, as Hurricane Katrina's storm surge did, allowing floodwater to breach the levees and floodwalls in New Orleans. However, flood control structures can prevent extensive damage in many cases. For example, the city of

Napa developed a flood protection project that incorporates several flood mitigation activities and a combination of hazard control structures, including levees, floodwalls, and other structures, to achieve a 100-year flood protection level.[26] The project is expected to save $26 million annually in flood damage costs when it is completed. According to a city of Napa official, had the project been completed it would have prevented all flood damage that occurred from the flood on New Year's Eve in 2005.

Protecting, restoring, and enhancing natural protective features such as floodplains, wetlands, beaches, dunes, and natural drainage ways can also help mitigate a community's vulnerability to damage from storms and associated flooding. Floodplains and wetlands, for instance, serve as natural buffers, absorbing excess rainfall and limiting the effects of floods on the built environment. Coastal wetlands can absorb storm surge, while beaches and dunes provide physical protection from storm surge. Over time, some of these natural storm protection features have suffered damages and losses as a result of development pressures. A number of communities have adopted policies designed to protect these natural protective features. For example, federal, state, and local government resources have been spent in Florida to restore and enhance these natural protective features, including beach and dune restoration.

[26]A 100-year flood is one that has a 1 in 100 chance (1 percent) of occurring in any given year.

While Various Approaches Are Used to Encourage Natural Hazard Mitigation, Significant Challenges Remain

Federal, state, and local governments provide a variety of financial and other assistance to encourage natural hazard mitigation activities. For example, at the federal level, FEMA offers assistance to states and local communities through grant programs such as the Hazard Mitigation Grant Program (HMGP). At the local level, communities can use economic incentives such as tax benefits to encourage mitigation activities. Insurance discounts can also encourage communities and individuals to undertake mitigation measures. However, despite these methods of encouraging mitigation, several impediments exist to implementing mitigation activities. For example, mitigation efforts are often constrained by conflicting local interests, cost concerns, and a lack of public awareness of the risks of natural hazards and the importance of mitigation.

Financial and Other Assistance Can Help Encourage Some Communities and Individuals to Take Action

Federal, state, and local agencies are taking steps to provide direct assistance to some communities to reduce losses from natural hazards although not all communities have the means to take full advantage of this assistance. This assistance can help communities overcome some of the impediments they face in undertaking mitigation activities by, for example, providing funding to assist in implementing mitigation activities and offering incentives to encourage mitigation activities. At the federal level, FEMA provides funding and technical assistance to help communities reduce losses from natural hazards. To provide states with an incentive to undertake more proactive mitigation activities, DMA 2000 authorized the grant of additional HMGP funds to states where a disaster area is declared if the state has prepared a more advanced hazard mitigation plan.[27] States that demonstrate that they have integrated their hazard mitigation plans with other state or regional planning (e.g., comprehensive and capital improvement plans); effectively administer, implement, and assess existing mitigation programs; and are committed to a comprehensive state mitigation program receive additional funding to conduct mitigation activities. According to FEMA officials, as of May 2007, only 11 states had completed advanced mitigation plans and were eligible for this additional funding.

[27]See Robert T. Stafford Disaster Relief Act § 322 (codified at 42 U.S.C. § 5165); see also 44 C.F.R. pt. 201 (2006). FEMA refers to these plans as enhanced hazard mitigation plans. An enhanced mitigation plan qualifies a state for HMGP funds totaling 20 percent of the total estimated eligible Stafford Act disaster assistance for a particular disaster, compared with 7.5 percent for a state with a standard plan.

With the exception of the flood mitigation grant programs, FEMA's grant programs generally do not specify the hazards that communities must mitigate or the types of activities they must undertake but instead leave these decisions to local communities. For example, in Oklahoma, state officials decided to focus their attention on saving lives during tornado events and developed the Safe Room Program.[28] Using FEMA HMGP funds from a tornado event in 1999, the state offered refunds of up to $2,000 for home owners who built safe rooms in their homes. Some local community hazard mitigation officials with whom we met, however, said that the HMGP application process is complex and time and resource intensive, and that long delays can occur in receiving mitigation funds. Delays in receiving grant funds can lead to additional obstacles for local communities. One local mitigation official told us that delays in receiving grant funds prevents the city from being more cost-effective in terms of mitigation. She stated that it would be most effective to conduct mitigation activities immediately after a storm event, when damages are being repaired, rather than waiting for HMGP funds to become available. According to FEMA, while states have up to 1 year from the date of a disaster declaration to apply for HMGP funds, the approval process can begin much earlier following a disaster if state and local officials have previously identified viable mitigation projects that are consistent with state and local mitigation plans.

Although mitigation grant funds may be available to communities, not all communities are able to capitalize on these opportunities. For example, most of FEMA's grant programs fund up to 75 percent of the mitigation project costs and require local communities to produce the remainder of the funds needed for mitigation projects. Oklahoma state emergency management officials with whom we met noted that although local communities might have several mitigation programs available to them, often, communities do not have the resources needed to provide their share of the cost. The officials further commented that this problem tends to affect many of the smaller communities in the state and that these communities should be careful not to commit themselves to too many mitigation projects.

FEMA also offers support to communities by providing technical assistance on hazard mitigation, offering guidance on how communities can develop hazard mitigation plans and identify the areas most at risk

[28]A safe room is a shelter that provides protection during tornado and other wind events.

from hazards. For example, FEMA developed and provides training on a loss estimation software program (i.e., HAZUS-MH) that analyzes potential losses caused by floods, hurricanes, and earthquakes that communities use to determine where to focus their mitigation efforts. FEMA also provides information directly to help residents and business owners choose the type of flood insurance policy that best suits their needs through its FloodSmart Web site and marketing program aimed at increasing flood insurance coverage nationwide. In addition, FEMA provides multihazard design, construction, and retrofit guidance at no cost for various stakeholders, including design professionals, local officials, homebuilders, home owners, and other building owners.

A number of other federal agencies assist communities in reducing their risk to natural hazards. These agencies generally focus their programs on a specific hazard or hazardous area and work with communities to reduce their natural hazard risks. For example, at the federal level, five wildland fire management agencies work to manage losses resulting from wildland fires by providing grants or other kinds of assistance to help reduce fuels on private land.[29] Through grant programs, these agencies provide funding to state forestry agencies and local fire departments for equipment, training, risk assessment, fire prevention work, and public information and education activities. Similarly, NOAA assists U.S. coastal states through financial and other types of assistance to protect the nation's coastal communities. By partnering with states and local authorities, NOAA helps communities conduct coastal hazards planning and administer state or local land-use programs that guide more prudent development in hazardous coastal areas. Other federal agencies offer a number of programs that can be used to address communities' natural hazard mitigation needs. For example, the Secretary of the Department of Housing and Urban Development has flexibility to use Community Development Block Grant program funds when available to assist communities recovering in presidentially declared disaster areas. These activities can include the acquisition and reconstruction of properties damaged by a natural hazard event.[30]

[29]These agencies include the Forest Service within the Department of Agriculture; and the Bureau of Indian Affairs; Bureau of Land Management; Fish and Wildlife Service; and the National Park Service, within the Department of the Interior.

[30]See 42 U.S.C. § 5321; 24 C.F.R. pt. 570.

State and local governments often have their own programs to promote mitigation that can operate alongside federal programs, including direct subsidies for mitigation activities and services that promote mitigation. Because state and local governments determine the types of programs they implement, the programs can be tailored to focus on a specific local hazard. Examples from communities we visited include the following:

- The Florida Department of Financial Services operates the My Safe Florida Home Program to help Florida residents identify ways to strengthen their homes to reduce damages from hurricanes. The program offers a free home inspection to home owners that meet income and other eligibility requirements to help them identify appropriate mitigation techniques and provides matching grants of up to $5,000 to make the recommended mitigation improvements.

- The city of Berkeley, California, encourages private property owners to conduct seismic retrofit activities by allowing property owners to use a portion of the transfer tax on the sale of a property to fund seismic retrofit work. If owners choose not to use this portion of the tax to fund retrofit activities for their property, this portion goes to the city. The city also subsidizes mitigation by waiving building permit fees on seismic retrofit projects.

- The Boulder County Land Use Department assists home owners' associations by providing grants to conduct fuel management in neighborhoods that are at high risk from wildland fires. The grant recipients reduce their wildland fire risk by cutting tree limbs and clearing other debris from their properties, and the waste is chipped and used to heat county office buildings.

Insurance Premium Discounts Can Encourage Some Communities and Home Owners to Undertake Mitigation Efforts

Insurance premium discounts can promote mitigation by rewarding property owners for actions they take to reduce the effects of natural hazards. At the federal level, the NFIP Community Rating System (CRS) encourages communities to reduce their flood risks by engaging in floodplain management activities. CRS provides discounts on flood insurance for individuals in communities that establish floodplain management programs that go beyond the minimum requirements of NFIP. Depending on the level of activities that communities undertake in four areas—public information, mapping and regulatory activities, flood damage reduction, and flood preparedness—communities are categorized into 1 of 10 CRS classes. A Class 1 rating provides the largest flood insurance premium reduction (45 percent) to communities, while a

community with a Class 10 rating receives no insurance premium reduction.

Mitigation officials with whom we spoke said they believe that the CRS insurance discounts are an effective means of encouraging communities that participate in NFIP to undertake more aggressive flood mitigation. For example, an official from the Palm Beach County Division of Emergency Management noted that the county's CRS rating of 6 entitles flood insurance policyholders in all 37 jurisdictions in the county to a 25 percent reduction in their flood insurance premiums. A city of Napa official said that one of the goals of the Napa River Flood Protection Project is to improve the city of Napa's CRS rating from a Class 7 to a Class 5—a change that would increase the flood insurance policyholder discount by an additional 10 percent. Although these discounts are available, less than 5 percent of the communities participating in NFIP participate in the CRS program.[31] Furthermore, CRS classes 1 through 4 each contain only one community. Of these four communities, Roseville, California has a Class 1 rating and is the only community in the United States eligible for the maximum flood insurance premium discounts of 45 percent. According to FEMA, approximately 1,055 communities will have flood insurance discounts beginning October 1, 2007, which represents about two-thirds of NFIP flood insurance policies.

States and communities can also provide opportunities for property owners to receive insurance premium discounts by participating in the Building Code Effectiveness Grading Schedule (BCEGS™) program, which was developed by ISO.[32] Through the program, communities are assessed according to the building codes adopted in a community, amendments to the code, and how well the codes are enforced. The BCEGS™ program places particular emphasis on reducing losses caused by natural hazards, especially losses caused by hurricanes, tornadoes, and earthquakes. Once assessed, communities receive a BCEGS™ classification, which is provided to insurers to use as an underwriting tool. Insurance companies can voluntarily opt to use this information to offer rate discounts to property owners that live in these communities. According to the officials who developed the program, however, data are

[31]According to FEMA officials, the individuals in participating communities account for 67 percent of NFIP policyholders.

[32]The BCEGS™ was developed by ISO, which is an independent statistical, rating, and advisory organization that serves the property/casualty insurance industry.

not available on the extent to which it is being used as an underwriting tool. The officials also commented that they do not believe many insurance companies are using it for this purpose.[33]

Some states also use insurance discounts to promote mitigation. In Florida, private insurance companies are required by law to offer a discount for structures that incorporate wind mitigation components.[34] In California, state law requires the California Earthquake Authority (CEA)—a privately financed but publicly managed state agency—to offer a 5-percent discount on retrofitted homes that were built before 1979 and that meet other specifications.[35] However, according to information provided by CEA, only about 12 percent of California residents have earthquake insurance. In addition, the CEA Mitigation Program Coordinator stated that it is unclear to what extent insurance premium discounts are an incentive to encourage individual homeowners to undertake earthquake mitigation activities. Also, city officials whom we met with in Florida said that discounts are not very effective for creating incentives for home owners because of the increasing insurance premiums in that state. For example, according to the Florida Financial Services Commission, the largest private insurer in Florida increased its rates by 66 percent in 2006.

Public Education and Outreach Can Help Raise Awareness of Natural Hazards and Mitigation

Individuals and communities must understand the hazards that pose a risk to them and the options for reducing those risks in order to make informed decisions not only about mitigation but also about where to live, purchase property, or locate a business or critical facility. Several state and local officials told us that individuals are often unaware of the risks they face. For example, one county mitigation official in Florida explained that the state's population continues to grow and that most of the new residents were unfamiliar with the state's hazard risks and mitigation options because they come from out of state. Public education and training campaigns help to ensure that communities and individuals

[33]The exception is in Florida where insurance companies are required by law to offer discounts on wind protection premiums based on a community's BCEGS™ rating, and communities that do not participate in the program are assessed a 1 percent surcharge on wind protection premiums.

[34]Florida Statute § 627.0629 requires insurance companies to offer Florida homeowners "*discounts, credits, or other rate differentials...*" for construction techniques that reduce damage and loss in windstorms.

[35]Cal. Ins. Code § 10089.40(d).

receive adequate information on the hazards they face as well as the options for reducing their risk. Education and outreach programs are valuable components of mitigation programs and can take many forms, including distributing educational materials to individuals, organizing community events that discuss mitigation options, and incorporating hazard information into school curriculums.

A number of entities conduct education campaigns on natural hazards to a variety of audiences—the public, home owners, business owners, builders, and developers. For example, the Firewise Communities program, which is made up of nongovernmental organizations and federal agencies, educates home owners about steps they can take to protect their homes from wildland fires and state and local officials about steps they can take to help educate home owners.[36] The program is also used to educate developers who are building homes in the wildland-urban interface about the various landscaping and other mitigation features that can be incorporated into developments to help reduce the risk of damage due to wildland fires. In addition to large national programs, we observed a variety of different public education campaigns at the state and local level during our field work. For example:

- The city of Deerfield Beach, Florida, created a nonprofit organization to educate city residents on how to mitigate hurricane risks. The nonprofit is based in the Disaster Survival House, a home that was built by a major insurance company and donated to the city to show how a house can be built to withstand a catastrophic hurricane. The house serves as an educational center for schoolchildren and the public and as a showcase of building techniques and mitigation measures for builders and home owners.

- Tulsa, Oklahoma, conducts an annual public outreach campaign using information displays and brochures that are placed throughout the area in fast food restaurants. The brochures outline hazards that pose a risk to the community, such as tornadoes, floods, and wildland fires and provide information on how individuals can protect themselves and their property.

[36]Firewise Communities is jointly sponsored by the International Association of Fire Chiefs, National Emergency Management Association, National Association of State Foresters, National Fire Protection Association, FEMA, U.S. Fire Administration, Forest Service, Bureau of Indian Affairs, Bureau of Land Management, Fish and Wildlife Service, and the National Park Service. Numerous state and local fire and forestry officials also participate in Firewise program activities.

When communities take actions to increase public awareness of the hazards citizens face and the options available to reduce them, communities may be more likely to take progressive actions to solve hazard problems. For example, when citizens in Napa, California, were educated about the flood hazard in the community and the options being proposed to address the risk, the community voted to increase the sales tax to fund the local portion of a flood mitigation project. The city of Berkeley, California—another community that has undertaken considerable public education and outreach efforts—has the highest percentage of seismically retrofitted buildings in the San Francisco Bay area. The city has also passed a number of bond initiatives to fund mitigation activities and has been successful in recruiting residents to assist in promoting mitigation activities. However, public awareness alone cannot always overcome some of the difficulties communities have in promoting mitigation activities such as lacking the necessary funding to undertake mitigation activities and the perception that individuals may have that a disaster will not happen in their community.

Conflicting Interests Can Impede Local Mitigation Efforts

Hazard mitigation goals and local economic interests often conflict, and the resulting tension can often have a profound effect on mitigation efforts. As we have previously reported, local governments may be reluctant to take actions to mitigate natural hazards for a number of reasons, such as local sensitivity to such measures as building code enforcement and land-use planning and the conflict between hazard mitigation and development goals.[37] For example, community goals such as building housing and promoting economic development may be higher priorities than formulating mitigation regulations that may include restrictive development regulations and more stringent building codes. In particular, local government officials we contacted commented that developers often want to increase growth in hazard-prone areas (e.g., along the coast or in floodplains) to support economic development. These areas are often desirable for residences and businesses, and such development increases local tax revenues but is generally in conflict with mitigation goals. For instance, during our visit to Tulsa, Oklahoma—a community that has repeatedly experienced dangerous floods—local officials expressed their opposition to a project proposed by developers to construct an island in the Arkansas River. The proposed project would

[37]GAO, *Disaster Assistances: Information on Federal Disaster Mitigation Efforts*, GAO/T-RCED-98-67 (Washington, D.C.: Jan. 28, 1998).

create a 40-acre man-made island with residential and commercial development in the river. According to city officials, this development would be downstream from the Keystone Dam, which in the past has had to release water that has resulted in flooding downstream, and the proposed project would be located in an area that is vulnerable to such flooding. The Tulsa officials said that this project highlights the conflict between economic development and mitigation efforts, as developers are promoting the project as economic development for the city, while emergency management officials are not in favor of the project due to the potential for damage to the proposed islands and other properties downstream.

Land-use planning experts told us that the short-term perspective of some local elected officials can conflict with long-term community efforts such as limiting growth in hazard-prone areas or adopting strong building codes. Political pressures can also play a large role in communities' choice of mitigation activities. National building code officials stated that in some communities, exemptions and variances to existing building codes are made because of political pressure. For example, mitigation experts commented that because of political pressures in Florida, counties located in the Panhandle were originally exempt from stricter statewide building codes for hurricane protection. The exemption was removed from law at the end of the 2006 Florida Legislative session, and buildings in these counties now have to comply with the more stringent hurricane protection requirements of the Florida Building Code. Additionally, in some communities political support for implementing mitigation activities is lacking. For example, during our field work in Colorado, officials told us that while some communities in the state have adopted model building codes, many jurisdictions are "home rule" communities that often resist federal and state regulations, which local citizens view as government intervention. Federal, state, and local officials all cited the importance of political support in implementing mitigation actions and, said that without political support, the amount of mitigation activities that occur would be limited.

Costs Concerns May Hinder Mitigation Efforts

Local communities may encounter difficulties in implementing and maintaining mitigation-related policies due to cost concerns. Local communities can incur large expenses in implementing certain mandatory mitigation requirements, such as hazard mapping, land-use planning, and

local ordinances to address natural hazard risks. For example, the California Seismic Hazards Mapping Act requires cities and counties to use seismic hazard zone maps in their land-use and building permit process.[38] However, according to a 2005 American Planning Association report on landslide hazards and planning, local planning and building officials have been apprehensive about the financial costs of compliance, which requires the use of hazard maps, regional and site-specific hazard assessments, and amendments to local regulations.[39] Additionally, maintaining mitigation-related policies can be difficult for communities because of the costs and resources involved. For example, the process of updating local building codes is resource intensive, and although newer codes may provide better protection from natural hazards, local communities may choose not to adopt them because of the associated expenses (i.e., the adoption and implementation process and the training of building code officials and inspectors on the updated code). Further, information on local natural hazard risks may need to be updated periodically, a process that can be time consuming and expensive. The Oklahoma Water Resources Board floodplain manager told us that updating floodplain maps to reflect changes in local development is expensive because it could require hiring outside engineering contractors.

Financial constraints may also limit communities' decisions to eliminate or limit development in hazard-prone areas. For example, an effective way for communities to eliminate development in high-risk areas is to acquire land and retain it for open space. However, property acquisition is expensive and can require long-range planning, multiple funding sources, and political support. Communities, particularly those dependent on new development for economic growth, can also face resistance to limiting the amount of development that is allowed to occur in hazard-prone areas and may be hesitant to imposing strong mitigation requirements. For example, implementing density restrictions that reduce the amount of development that can occur in a hazard-prone area can result in a perceived or real decrease in the value of land and make the area less attractive for development.

Private property owners are also influenced by cost considerations when deciding whether to implement hazard mitigation. For example, many

[38]See Cal. Pub. Res. Code, §§ 2690 *et seq.;* Cal. Code of Regs., tit. 14, §§ 3270 *et seq.*

[39]American Planning Association, *Landslide Hazards and Planning*, (Chicago, IL: September 2005).

home owners may be reluctant to pay for the additional costs of features that exceed local building codes, such as reinforced concrete walls, fire-resistant building materials, and flood-proofing features, all which add to the cost of building a home. According to building experts, for most home owners and potential home buyers cost is the primary factor in deciding whether to include mitigation features in new or existing homes. Officials from the National Association of Homebuilders told us that the economic cost of mitigation measures should be considered, because every $1,000 increase in median home prices can price about 240,000 home buyers out of the market. During our field work in Lehigh Acres, Florida, officials from the Institute for Business & Home Safety (IBHS) told us that not all new home buyers were willing to spend the additional costs for incorporating mitigation measures, especially first-time buyers. IBHS has developed standards for building hurricane-resistant homes. According to IBHS officials, incorporating these standards can add about 10 to 15 percent to the total cost of building a home. The officials also added that the fact that appraisers often do not include the added costs of mitigation features into the appraised home value is another impediment to mitigation that needs to be addressed. FEMA officials pointed out that, in addition to the cost of mitigation features, the benefits they provide should be communicated to individuals when they purchase a home.

For existing buildings, the high cost of retrofitting has also been cited as an impediment to implementing mitigation measures. In 1986, California enacted a law that required local governments in high seismic regions to inventory unreinforced masonry buildings, that were known to perform poorly during earthquakes and to establish a program for reducing losses from these buildings.[40] According to an estimate prepared by a California Seismic Safety Commission structural engineer, about two-thirds of over 25,000 unreinforced masonry buildings that have been inventoried in California have been retrofitted or demolished. However, about 8,000 buildings in high seismic regions have not been retrofitted, primarily because of the high cost of retrofitting. For example, the cost to retrofit an average-size 10,000-square-foot building is about $400,000. As a result, some buildings that do not generate sufficient income to pay for the cost of retrofitting have been left vacant. Further, a study that assessed the risks and losses of potential earthquakes in the New York, New Jersey, and Connecticut region determined that retrofitting thousands of buildings in

[40]Cal. Gov't Code §§ 8875 *et seq.*

New York would be "impractical and economically unrealistic."[41] This decision was made despite the fact that New York City faces moderate seismic risk and contains a large number of unreinforced masonry buildings used primarily as housing or for commercial purposes. In 1995, New York City passed its first seismic building code, which will help to ensure that new construction meets these standards. However, because these standards do not apply to buildings built prior to 1995, even a moderate earthquake could cause much damage to the existing building stock.

Lack of Rigorous Building Code Enforcement Impedes Hazard Mitigation

Building code officials and others with whom we spoke told us that improvements are needed to address the lack of rigorous enforcement of building codes in the United States. According to ISO officials, of approximately 19,000 communities assessed through the BCEGS™ program, only 5 communities have received the highest classification that indicates exemplary commitment to building code enforcement. The ISO officials also commented that building departments in most of the communities they review conduct more inspections per day than is feasible to provide rigorous code enforcement. National building code officials told us that many local building departments do not have the adequate funds and staffing levels to conduct proper code enforcement. Additionally, they commented that low funding levels can affect the amount of training local building inspectors receive and thereby reduce their ability to enforce the code.

Limited Public Awareness Constrains Mitigation Activities

Efforts to adopt new mitigation activities and strategies have been constrained by the general public's lack of awareness and understanding about natural hazards and risk. Individuals often also have a misperception that natural hazard events will not occur in their community and are not interested in learning of the likelihood of an event occurring. For example, in California—where public perceptions of natural hazard risk are high—some mitigation measures have been implemented, such as strengthening transit systems, bridges, and highways. However, in other parts of the country, where seismic risk is high but damaging earthquakes occur less frequently (e.g., New Madrid

[41]Tantala, M., Nordenson G., et al, "Earthquake Risks and Mitigation in the New York | New Jersey | Connecticut Region," NYCEM, The New York City Area Consortium for Earthquake Loss Mitigation, Final Summary Report, MCEER-03-SP02, Multidisciplinary Center for Earthquake Engineering Research, University at Buffalo, 2003.

seismic zone), public awareness of the risk is lower, and fewer mitigation measures are in place. Additionally, land-use experts and mitigation officials told us that it is often difficult for the public to perceive natural hazard risk or believe that a natural hazard event will occur in their community. However, public skepticism is significantly reduced immediately following natural hazard events, and mitigation activities are often conducted during such periods—for example, the adoption of more stringent building codes after Hurricane Katrina and the seismic retrofitting requirements approved after major earthquakes in California.

Limited public awareness may also be a result of the complexity of the information that is needed for individuals to understand their hazard risks. Local community decision makers may not fully understand the science involved in predicting the probability of natural hazard events such as earthquakes, making it difficult for a community to develop appropriate mitigation plans. For example, USGS officials cited the complexity of geologic science as a challenge to communicating information on hazards. The officials also said that the ability of decision makers to develop mitigation strategies for their communities depended on the availability of appropriate and easily understandable information. As a result, programs to improve public awareness and education are long-term and require sustained effort.

A Number of Collaboration Efforts Exist but Do Not Provide a Comprehensive Strategic Framework for National Natural Hazard Mitigation Goals

Collaboration among federal, state, and local agencies as well as nongovernmental stakeholders on natural hazard mitigation efforts tends to occur on a hazard-specific basis, typically after a disaster, or through informal methods. These efforts include developing national mitigation strategies or interagency programs dedicated to reducing losses from particular natural hazards. In addition, as a way to promote collaboration among all mitigation stakeholders, the federal government develops partnerships with state and local governments, professional associations, nongovernmental groups, businesses, academia, and individual community members—partnerships that are critical to the success of any mitigation program. Although the current approach includes some key practices on collaboration, it is fragmented and does not provide a comprehensive strategic framework that combines both pre- and postdisaster mitigation activities. Without such a framework, the federal government may not be effectively identifying and managing all natural hazard risks nationwide.

Some Collaboration Exists among Mitigation Stakeholders

Mitigation efforts often involve many federal agencies that have defined missions and different programs to achieve mitigation goals related to a specific hazard. Successful mitigation efforts require collaboration not only among federal agencies but also between state and local government agencies as well as a variety of nongovernmental entities, because natural hazard mitigation activities are primarily implemented at the state and local level. Accordingly, participation and, ultimately buy-in from a broad range of stakeholders—including state and local agencies, businesses, professional associations, nonprofit organizations, academia, and members of the community—are vital to the success of any mitigation effort. We identified a variety of ways that federal agencies collaborate with each other and with nonfederal stakeholders. The collaboration efforts are often aimed at establishing approaches to working together; clarifying priorities, roles and responsibilities; and aligning resources to accomplish common outcomes.

First, consistent with key practices in collaboration, federal agencies involved in mitigation create hazard-specific strategies and programs for reducing losses from specific natural hazards.[42] These strategies and programs detail the roles and responsibilities for the federal agencies involved in reducing hazard losses and show how the agencies will work together to achieve that goal. For example

- The National Landslide Hazards Mitigation Strategy, which was developed in 2003 by USGS, recognized that while there are many stakeholders involved in landslide mitigation in the United States, there is little collaboration of mitigation activities.[43] The strategy recommends that collaboration be improved among federal, state, and local agencies in order to (1) establish more effective partnerships with the academic and private sectors and (2) better leverage resources. To eliminate duplication of efforts, the strategy names the federal agencies responsible for leading each activity—a key practice in collaboration. The strategy addresses the need for increased public awareness and education about landslides and names FEMA and USGS as the agencies responsible for leading the development of information and education programs.

[42]GAO-06-15.

[43]USGS, *National Landslide Hazards Mitigation Strategy—A Framework for Loss Reduction*, USGS Circular 1244 (Reston, Virginia: 2003).

- The 10-year Comprehensive Strategy for reducing wildland fire risks to communities and the environment involves many federal and nonfederal stakeholders.[44] This strategy provides a collaborative framework to assist communities in implementing mitigation measures. Both the Departments of Agriculture and the Interior worked with the other stakeholders to develop a plan to implement the strategy.[45] The plan identifies tasks associated with reducing losses from wildland fires, including identifying the level at which collaboration should occur as well as the stakeholders responsible for leading the task. For example, one task was to compile examples of local zoning ordinances and state planning efforts that have successfully reduced risks associated with wildland fire. The plan also specifies that collaboration should occur at the national, state, and local levels and that the National Association of Counties and the National Association of State Foresters would have leadership roles.

- The National Earthquake Hazards Reduction Program (NEHRP) is an interagency program created to reduce risks to life and property in the United States that result from earthquakes.[46] In 2004, Congress established the Interagency Coordinating Committee to plan, manage, and coordinate the NEHRP.[47] This committee consists of FEMA, USGS, the National Science Foundation, Office of Science and Technology Policy, Office of Management and Budget, and, as the lead agency, the National Institute of Standards and Technology. The agencies are working together to develop a NEHRP strategic plan and a coordinated interagency budget. The program also seeks to improve earthquake hazards identification and risk assessment methods. Each agency's mission, although separate and distinct, has been integrated into a complementary program that seeks to promote earthquake mitigation.

Second, federal agencies typically collaborate on mitigation activities after a disaster event in the areas that have been impacted. For example, the

[44]"A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10-Year Comprehensive Strategy," August 2001.

[45]"A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10-Year Strategy Implementation Plan," December 2006.

[46]See the Earthquake Hazards Reduction Act of 1977, Pub. L. No. 95-124, § 5, 91 Stat. 1098 (codified as amended at 42 U.S.C. § 7704).

[47]See National Earthquakes Hazards Reduction Program Reauthorization Act of 2004, Pub. L. No. 108-360, title I, § 103, 118 Stat. 1669 (2004). Prior to the 2004 act, an ad hoc interagency committee had been the coordinating mechanism for the NEHRP with FEMA as the lead agency. See Pub. L. No. 96-472, Title I, § 101, 94 Stat. 2257 (1980).

Department of Homeland Security issued the National Response Plan in December 2004, intending it to be an all-discipline, all-hazards plan establishing a single, comprehensive framework for the management of domestic incidents when federal involvement is necessary. The plan contains one component on postdisaster mitigation that addresses long-term community recovery and mitigation, but does not address predisaster mitigation efforts.[48] Specifically, the plan provides a collaborative mechanism to assist communities that have been impacted by a disaster to (1) identify appropriate federal programs and agencies, (2) avoid duplication of assistance, and (3) ensure follow through of hazard mitigation efforts. These efforts can include developing long-term recovery plans for communities impacted by a disaster, that identify priorities in rebuilding and improving hazard resistance in new structures. FEMA is responsible for leading the effort to implement this component and is supported by six primary federal agencies as well as a number of other agencies that have a supportive role.[49]

Third, agency officials said that they also use a variety of informal mechanisms to collaborate on their mitigation activities. These officials discussed frequent, informal communication such as e-mails, teleconferences, and discussions at regional or local conferences or workshops that occurs on specific projects or initiatives. For example, FEMA officials said that officials from other agencies such as the Departments of Transportation and Energy frequently consult with FEMA staff on flood mitigation in compliance with an executive order on floodplain management.[50] NOAA agency officials also commented that collaboration occurs when agency officials assist in conducting training for other federal agencies. For example, the National Weather Service

[48]The component is "Emergency Support Function #14 – Long-Term Community Recovery and Mitigation Annex." We did not evaluate the effectiveness of this annex in this report. In prior work, however, we have evaluated portions of the National Response Plan. See GAO *Disaster Assistance: Better Planning Needed for Housing Victims of Catastrophic Disasters*, GAO-07-88 (Washington, D.C.: Feb. 28, 2007).

[49]These agencies include the Departments of Agriculture, Commerce, Homeland Security, Housing and Urban Development and the Treasury, as well as the Small Business Administration.

[50]Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. 3 C.F.R. 117 (1977), amended by Exec. Order 121148, 3 C.F.R. 412 (1979).

provides guest instructors for a week-long FEMA training course for emergency managers.

Finally, federal agencies collaborate through partnerships with local government leaders, volunteer groups, the business community, and individual citizens to implement mitigation activities. Several state and local officials with whom we spoke cited Project Impact—one of FEMA's previous predisaster mitigation programs—as a model in helping to develop broad community support for predisaster mitigation activities.[51] Local officials from each of the former Project Impact communities that we visited emphasized that the strength of the original public-private partnerships formed during Project Impact was a key reason their communities' mitigation efforts have been sustainable. The program provided small, one-time grants directly to communities and empowered leaders in those communities to build effective partnerships and encourage private sector financial participation before disasters occurred. For example, Deerfield Beach, Florida—the first Project Impact community—established a program that created partnerships with FEMA, IBHS, and four local lending institutions to provide interest free loans from local banks to help community businesses conduct wind resistance mitigation activities, such as installing impact-resistant glass and shutters, to reduce the effects of high winds.

[51]Project Impact was one of FEMA's predisaster mitigation programs that began in 1997 and ended in fiscal year 2002. It was replaced by the Pre-Disaster Mitigation Program.

The Current Approach to Collaboration on Natural Hazard Mitigation Does Not Provide a Comprehensive Mitigation Framework for the Nation

While collaboration on specific hazard mitigation efforts occurs in a variety of ways, the current approach does not provide a strategic framework for coordinating nationwide pre- and postdisaster mitigation. In the past, such strategic frameworks were developed by FEMA and the Subcommittee on Disaster Reduction, of which FEMA is a participant.[52] These frameworks shifted the focus from reacting to natural disasters to proactive coordinated pre- and postdisaster mitigation efforts.[53] In 1998, we reported that FEMA had taken a strategic approach to mitigation, in part through the development of a National Mitigation Strategy.[54] This strategy called for strengthening partnerships among all levels of government and the private sector and set forth major initiatives, along with timelines, in a number of areas, including leadership and coordination. For example, the strategy required that within 1 year mitigation considerations be integrated into the management and operation of all federal programs that affect the built environment and that a Federal Interagency Mitigation Task Force convene to more closely coordinate federal mitigation authorities, among other things. While these strategies helped to provide a strategic framework for natural hazard mitigation in the past, the current approach tends to occur on a hazard-specific basis, typically after a disaster event, or through informal methods and does not create a similar framework.

Various provisions of federal laws have stressed the importance of national hazard mitigation. For example, recognizing that expenditures for federal disaster assistance were increasing without the likelihood of corresponding reductions in losses from natural disasters, DMA 2000, provides, among other things, a framework for linking pre- and postdisaster mitigation initiatives with public and private interests to ensure an integrated, comprehensive approach to disaster loss reduction.

[52]The Subcommittee on Disaster Reduction is an element of the President's National Science and Technology Council and facilitates national strategies for reducing disaster risks and losses that are based on effective use of science and technology.

[53]FEMA, *National Mitigation Strategy: Partnerships for Building Safer Communities* (Washington, D.C.: 1995); National Science and Technology Council, Committee on the Environment and Natural Resources, Subcommittee on Natural Disaster Reduction, *Reducing the Impacts of Natural Hazards: A Strategy for the Nation* (Washington, D.C.: 1992); National Science and Technology Council, Committee on the Environment and Natural Resources, Subcommittee on Natural Disaster Reduction, *Natural Disaster Reduction: A Plan for the Nation* (Washington, D.C.: 1996).

[54]GAO, *Disaster Assistance: Information on Federal Disaster Mitigation Efforts*, GAO/T-RCED-98-67 (Washington, D.C.: Jan. 28, 1998).

It requires establishing a federal interagency taskforce for the purpose of "coordinating the implementation of predisaster hazard mitigation programs administered by the Federal Government."[55] DMA 2000 further requires that the Administrator of FEMA serve as the chairperson of the taskforce, indicating the leadership role FEMA is expected to provide nationwide for all hazards. DMA 2000 also recognizes the need for nonfederal stakeholder involvement by including state and local governments in the taskforce. While this taskforce has yet to be created, the stated purpose of the taskforce, which is "coordinating the implementation of predisaster hazard mitigation programs administered by the Federal Government," is consistent with the need for the creation of a comprehensive national strategic framework for mitigation.

The Post-Katrina Emergency Management Reform Act of 2006 (Post-Katrina Reform Act), requires major changes to FEMA that are designed to increase the effectiveness of preparedness and response to catastrophic disasters.[56] The act defines emergency management as "the governmental function that coordinates and integrates all activities necessary to build, sustain, and improve the capability to prepare for, protect against, respond to, recover from, or mitigate against threatened or actual natural disasters, acts of terrorism, or other man-made disasters."[57] Moreover, the act defines FEMA's primary mission as reducing the loss of life and property "by leading and supporting the nation in a risk-based comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation."[58]

While the current approach to collaboration on natural hazard mitigation often includes some key practices for collaboration, it tends to occur on a hazard-specific basis, typically after a disaster event, or through informal methods. This fragmented approach does not provide a comprehensive strategic framework for federal agencies and other stakeholders to collectively work toward accomplishing common national hazard

[55]Pub. L. 106-390, § 103, 114 Stat. at 1557 (codified at 42 U.S.C. § 5134).

[56]Pub. L. No. 109-295, title II, 120 Stat. 1355, 1394 (2006) (codified at various sections of titles 6 and 42 of the U.S. Code).

[57]Pub. L. No. 109-295, title II, § 602(7), 120 Stat. 1355, 1394 (2006) (codified at 6 U.S.C. § 701).

[58]Pub. L. No. 109-295, title II, § 611(11), 120 Stat. 1355, 1396-97 (2006) (codified at 6 U.S.C. § 313).

mitigation goals. For example, while federal agency officials with whom we spoke discussed a variety of specific mitigation activities, it was unclear how these efforts fit into a comprehensive strategic framework for mitigation. Similar to the framework provided by the National Response Plan for managing domestic incidents and the frameworks provided in past national mitigation strategies, a comprehensive national framework for pre- and postdisaster mitigation would, among other things, define common national goals, establish joint strategies, leverage resources, assign roles and responsibilities, and develop performance measures and reporting requirements.

A comprehensive strategic framework focused on mitigation activities that occur both before and after natural hazard events could strengthen FEMA's ability to assess whether all mitigation efforts are working together to accomplish national hazard mitigation goals that adequately prepare the nation for its natural hazard risks. Without such a framework, the federal government may not be effectively identifying and managing all natural hazard risks nationwide. Moreover, the current approach does not ensure that collective mitigation efforts are working together in a manner that leverages resources and develops synergies across various hazard-specific mitigation efforts.

Conclusions

No state in the country is immune to the risk from a natural hazard, be it floods, hurricanes, earthquakes, tornadoes, or wildland fires and large percentages of the U.S. population live in areas susceptible to more than one of these hazards. In particular, the coastal areas of the country, which contain a large portion of the nation's population and have experienced substantial growth, are susceptible to many natural hazards. Moreover, the implications of climate change, which may lead to more frequent storms and sea-level rise, increase the vulnerability and risks associated with hazard events. All of these factors present increasing risks to life and property throughout the United States and increasing expenditures by the federal government in the wake of a disaster. As seen in recent years, the level of destruction that a natural hazard event can cause can be devastating to those who experience it and pose major challenges to the federal government, which plays a key role in disaster recovery and assistance. As more people migrate to hazard-prone areas such as Florida and California, the need for a comprehensive strategic framework for natural hazard mitigation takes on new significance because these areas are subject to multiple hazards. Additionally, according to the National Institute of Building Sciences, hazard mitigation activities have been found to be a sound investment with every $1 FEMA provides communities for

mitigation activities, resulting in an average of $4 in future benefits. While the federal government plays a key role in natural hazard mitigation efforts, measures such as hazard mitigation planning, development regulations, and the adoption and enforcement of strong building codes are ultimately the responsibility of local jurisdictions, which make decisions on the extent of development and on how and where new developments are built. Therefore, finding ways to effectively partner with and develop buy-in from state and local governments is critical to any federal mitigation effort.

Federal agencies, particularly FEMA, play an important role in establishing and promoting collaboration on natural hazard mitigation and in developing a national mitigation framework that includes nonfederal stakeholders as active participants in efforts to reduce losses from natural hazards. While the current approach to collaboration on natural hazard mitigation involves a mix of methods and may be useful on a hazard-specific basis or for a particular hazard event, having a fragmented approach does not take full advantage of synergies that may exist among the different mitigation stakeholders. For example, given that many natural hazards are related, such as hurricanes and flooding or wildland fires and landslides, there may be opportunities to leverage resources and for stakeholders responsible for specific hazards to collaborate with other stakeholders on related hazards, such as coordinating earthquake mitigation efforts with tsunami mitigation efforts. The creation of a strategic framework for pre- and postdisaster mitigation among all stakeholders nationwide could help overcome some of the challenges faced in implementing mitigation efforts and would help define common national goals for mitigation, identify risks, establish joint strategies across federal and state programs, leverage resources across agencies, assign lead roles and responsibilities, and include mechanisms to monitor, evaluate, and report on results. FEMA's new organizational changes and responsibilities under the Post-Katrina Reform Act call for the agency to provide Federal leadership in promoting such a strategic framework for mitigation. The federal government could benefit from a comprehensive strategic framework, which could help to effectively identify national natural hazard risks, minimize the effects of hazards before they occur, and reduce overall future hazard losses to the nation.

Recommendation for Executive Action

We recommend that the Administrator of FEMA, in consultation with other appropriate federal agencies, develop and maintain a national comprehensive strategic framework for mitigation that incorporates both pre- and postdisaster mitigation efforts. The framework should include

items such as common mitigation goals; performance measures and reporting requirements; the role of specific activities in the overall framework; and the roles and responsibilities of federal, state, and local agencies, and nongovernmental stakeholders.

Agency Comments and Our Evaluation

We provided a draft of this report to FEMA, NOAA, USGS, the Corps of Engineers, and the Forest Service for review and comments. The Department of Homeland Security and the Department of the Interior provided written comments on behalf of FEMA and USGS, respectively, that are discussed below and presented in appendix II and III.

FEMA generally agreed with our conclusions and recommendation but noted that we did not adequately reflect the success of the floodplain management requirements associated with NFIP, including the community rating system. We added language that FEMA suggested on the estimated annual losses avoided because of NFIP floodplain management activities. However, analyzing the overall effectiveness of floodplain management activities was beyond the scope of this report.

FEMA also noted that it supported a national comprehensive strategic framework and setting common mitigation goals. However, the agency disagreed with setting performance measures and reporting requirements on a process that takes place largely at the local level. The letter stated that it would be inappropriate for FEMA or any other federal agency to dictate mitigation activities, outside of ensuring that mitigation plans and grant applications met the eligibility requirements defined in authorizing statutes and regulations. We agree that local communities are responsible for identifying natural hazard risks and for setting mitigation priorities. But mitigation activities could benefit from having federal agencies set performance measures to ensure that crosscutting agency goals are consistent and that program efforts are mutually reinforcing. With such practices in place, FEMA, in consultation with other federal agencies, could partner with and develop buy-in from state and local agencies and nongovernmental stakeholders. Trend analysis and reporting requirements, both of which FEMA cited as a more appropriate measure, would be consistent with our recommendation and could be effective in measuring the success of a comprehensive strategic mitigation framework.

FEMA also commented that it participates on the Subcommittee on Disaster Reduction, which coordinates the scientific and technical aspects of risk identification and reduction across the federal government. The letter states that the subcommittee accomplishes several of the objectives

identified in our recommendation. We added language clarifying that FEMA participates on the subcommittee. We cite the subcommittee as an example of a governmentwide group that has shifted its focus from reacting to natural disasters to proactively coordinating pre- and postdisaster mitigation efforts using science and technology. We see the subcommittee as an important component of, but not a substitute for, a national comprehensive strategic framework for mitigation.

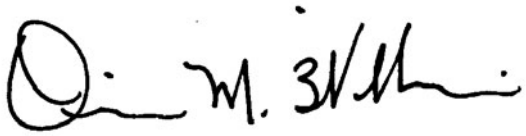
USGS wrote that the agency agreed with the need for a comprehensive strategy and emphasized that USGS believed in the importance of developing such a strategy together with FEMA and in equal partnership with the other agencies. A jointly developed national strategy could play a clear role in preparing for and dealing with natural hazards. USGS added that it would be helpful if the report identified the challenges associated with developing such a national framework. While identifying all the challenges was beyond the scope of this report, we did illustrate several of the obstacles to implementing a comprehensive strategic framework for mitigation—including the fragmented federal approach to mitigation—which does not take full advantage of synergies that may exist among mitigation stakeholders. Additionally, USGS stated that it would be helpful if we identified those programs that have delivered the best value in mitigation and the areas in which mitigation practices would be most effective. We agree with USGS that a discussion of successful mitigation practice is important. In this report, for example, we describe a variety of mitigation activities that exist to reduce the risk of losses from natural hazards, including hazard mitigation planning, the adoption and enforcement of more rigorous building codes, and the use of hazard control structures.

The Corps of Engineers, Forest Service, and NOAA orally commented that they agreed with the report but did not comment specifically on the recommendation. Technical comments provided by the agencies have been incorporated in this report where appropriate.

As agreed with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this report. At that time, we will send copies of this report to the Chairman and Ranking Member of the Senate Committee on Banking, Housing and Urban Affairs; the Chairman of the House Committee on Financial Services; the Secretaries of Agriculture, Commerce, Defense, Homeland Security, and Interior; and other interested parties. This report will also be available at no charge on GAO's Web site http://www.gao.gov.

Please contact me at (202) 512-8678 or williamso@gao.gov if you or your staff have any questions about this report. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix IV.

Sincerely yours,



Orice M. Williams
Director, Financial Markets
and Community Investment

Appendix I: Objectives, Scope, and Methodology

Our objectives were to examine the (1) natural hazards that present a risk to life and property in the United States, areas that are most susceptible to them, and factors that may be increasing these risks; (2) mitigation activities that reduce losses from natural hazards; (3) impediments to implementing and methods for encouraging mitigation activities; and (4) collaborative efforts of federal agencies and other stakeholders to promote mitigation.

To examine the natural hazards that present a risk to life and property in the United States, we used a comprehensive list of natural hazards compiled by the Federal Emergency Management Agency (FEMA) in a guidance document for individual and community preparedness. The list includes floods, tornadoes, hurricanes, thunderstorms and lightning, winter storms and extreme cold, extreme heat, earthquakes, volcanoes, landslides and debris flow (mudslides), tsunamis, fires, and wildland fires. For the purposes of our analysis, we did not include fires because most home and other structure fires are human induced. To identify areas that are most susceptible to natural hazard risks, we created national, county-level maps that show the level of risk for each hazard. We limited our analysis to the 50 states and the District of Columbia. Additionally, we did not create maps for all natural hazards and narrowed the list of hazards we mapped to the following: floods, hurricanes, earthquakes, wildland fires, tornadoes, and landslides. These natural hazards were chosen based on the following criteria. First, we limited the scope of the word "property" in FEMA's definition of hazard mitigation—actions taken to reduce or eliminate the long-term risks to life and property from the effects of hazards—to the built environment and, therefore, did not map hazards that result mainly in losses to agriculture. Next, we focused on hazards for which available mitigation activities are long-term loss reduction measures and not those that primarily focus on monitoring, warning systems, emergency response, and evacuations. Finally, we focused on the natural hazards that represent large annual losses in the United States (where data were available.)

To develop our natural hazard risk maps, we used data from a variety of sources. We used historical hazard data from 1980 to 2005 as a representation of current hazard risk for floods, hurricanes, and wildland fires. For tornadoes, we limited our analysis of historical data from 1980 to 2004. Earthquake and landslide risk were mapped based on the level of future risk for an event occurring. The data used for each of the maps are explained below. We determined these data sources to be sufficiently reliable for our purposes.

- *Floods* – As a proxy for flood risk, we used FEMA data on counties that experienced a major disaster declarations for flooding.

- *Hurricanes* – We obtained data on historical hurricane tracks from the National Oceanic and Atmospheric Administration's (NOAA) Coastal Service Center, which show the track for the eye of a hurricane, to develop the hurricane hazard map. In order to identify counties affected by a hurricane, we used a buffer of 50 miles around the data representing the eye of a hurricane. The 50-mile estimate was based on 29 miles for the eye of the storm and an additional 21 miles for the outer area of high winds. This is roughly equivalent to NOAA's terminology of a hurricane "strike" or "near strike."

- *Earthquakes* – We obtained data representing seismic risk from the U.S. Geological Survey's (USGS) National Seismic Hazard Mapping Project. Risk is depicted as acceleration value. Areas with a value of less than 5 were considered low risk, 5 to 15 as medium risk, and over 15 as high risk.

- *Wildland fires* – We used the Federal Wildland Fire Occurrence Data maintained by the Desert Research Institute to represent wildland fire risk. These data are based on information compiled by the U.S. Forest Service (Forest Service), Bureau of Land Management, Bureau of Indian Affairs, National Park Service, and the Fish and Wildlife Service. Some records in the database were missing latitudinal and longitudinal information. Therefore, our map only includes fires for which this information was available.

- *Tornadoes* – We obtained historical tornado data from the NOAA's National Weather Service that are available for download from www.NationalAtlas.gov. We limited our analysis to tornado events with an F3 (severe) or higher level as measured on the Fujita Scale, because F3 or higher tornadoes cause significant property damage. Not all records in the database included latitude and longitude information; therefore, our map only includes those tornadoes for which latitude and longitude data were available. Additionally, data were only available through 2004.

- *Landslides* – We obtained data representing the susceptibility and incidence of landslides from USGS. We used USGS' classification of areas of high and moderate risk and overlaid it with county data. Counties that contained areas of both high and moderate risk were reclassified as "combination of high and moderate risk."

We also reviewed the annual losses associated with some of these natural hazards, when data were available, and factors that may be increasing

natural hazard risk. As there is no comprehensive source of loss information for natural hazards, we used estimates developed by the federal agencies responsible for overseeing each natural hazard. We adjusted the loss estimates from some historical hazard events to 2006 dollars using the Consumer Price Index for all Urban Consumers. To identify factors that may be increasing natural hazard risks, we reviewed 2000 U.S. Census data, population information, and studies on climatology. We also reviewed previous congressional reports and our reports and spoke with officials at several federal, state, and local agencies.

To examine the mitigation activities that exist to reduce losses from natural hazards and the performance of these activities, we conducted site visits to four judgmentally selected states including—California, Colorado, Florida, and Oklahoma. We selected the locations based on the following criteria: (1) the locations represent a variety of natural hazard risks and geographic locations; (2) Florida and Oklahoma have Enhanced State Hazard Mitigation Plans and, therefore, comprehensive mitigation programs, and California has an Enhanced State Hazard Mitigation Plan that is pending FEMA approval; and (3) mitigation experts and federal agency officials recommended locations to visit within these states. In each of these states, we met with state and local officials to discuss mitigation activities that had been undertaken or are planned, and examples of the performance of some of the activities. Many of the local communities we visited were part of FEMA's former Project Impact program. We also visited the Natural Hazards Research Center in Boulder, Colorado to review an extensive collection of research on natural hazards. Additionally, we reviewed FEMA's Best Practices and Case Studies Portfolio; prior GAO reports; state and local hazard mitigation plans submitted to FEMA under DMA 2000; and numerous other reports, summaries, and studies on natural hazard mitigation activities. We also discussed the types of existing mitigation activities with officials from federal agencies that oversee natural hazard mitigation programs, and with mitigation and planning experts. In addition, we met with industry, nonprofit, and professional organizations; model building code organizations; an insurance services company; and a risk modeling firm to discuss the variety of mitigation methods that exist.

To examine impediments that exist to the implementation of mitigation activities and methods used to promote mitigation, we reviewed congressional reports, our previous reports and testimonies, and background documents related to each of the natural hazards within the scope of our review. These included policy and research documents on floods, hurricanes, earthquakes, wildfires, tornadoes, and landslides, as

well as documents on other natural hazards. We also gathered and analyzed information, documents, reports, and publications from each of the federal agencies we contacted, including FEMA, USGS, NOAA, the Corps of Engineers, and the Forest Service. In addition, we reviewed information provided by professional associations, advocacy groups, nonprofit organizations, and knowledgeable individuals from the academic and research communities, such as the American Society of Civil Engineers, the American Planning Association, Wildlife Federation, and the University of Colorado at Boulder. To examine the various approaches used to encourage mitigation, we conducted interviews, conference calls, and site visits with federal, state, and local officials and members of the academic community to obtain detailed information and specific examples of methods used to promote mitigation.

To examine collaborative efforts of federal agencies and other stakeholders to promote mitigation, we conducted literature reviews of prior reports on natural hazard mitigation, land-use, research, and policy documents from federal, state, and local government agencies, and documentation from nongovernmental stakeholders. We also reviewed our previous reports on federal agency collaboration and summarized the results of these reports to identify elements for effective collaboration among federal agencies and between federal agencies and nonfederal participants. In addition, we consulted with individuals knowledgeable about natural hazards, mitigation, and the role of federal agencies in promoting collaboration on natural hazard mitigation activities. To examine ways federal agencies and nonfederal participants collaborate on mitigation we interviewed federal officials involved in mitigation-related activities, state and local officials, and industry association representatives. To identify the federal agencies that play key roles in natural hazard mitigation, we considered federal agencies that promote mitigation through (1) hazard mitigation grant programs; (2) technical assistance; (3) regional risk assessments, including mapping of hazard risk; (4) information dissemination; and (5) programs that specifically target the reduction of risks caused by natural hazards. We also determined that it was not feasible to include all federal agencies that play a role in mitigation within the scope of this review and excluded agencies that play supplementary, support, and/or secondary roles in natural hazard mitigation. Based on these considerations, we subsequently contacted five federal agencies as part of this review, including FEMA, NOAA, USGS, the Corps of Engineers, and the Forest Service.

We conducted our work in Baltimore, Maryland; Berkeley, Napa, San Francisco, and Sacramento, California; Boston, Massachusetts; Boulder,

Denver, Golden, and Fort Collins, Colorado; Deerfield Beach, Miami, Tampa, and West Palm Beach, Florida; Oklahoma City and Tulsa, Oklahoma; and Washington, D.C., between March 2006 and June 2007 in accordance with generally accepted government auditing standards.

Appendix II: Comments from the Department of Homeland Security

U.S. Department of Homeland Security
Washington, DC 20528

Homeland Security

August 9, 2007

Ms. Orice Williams
Director, Financial Markets
And Community Investment
U.S. Government Accountability Office
Washington, D. C. 20548

Dear Ms. Williams:

Thank you for the opportunity to review and comment on the Government Accountability Office report Natural Hazard Mitigation: Various Mitigation Efforts Exist, but Federal Efforts Do Not Provide a Comprehensive Strategic Framework, GAO 07-403.

General Comments

Floodplain Management - The report does not adequately reflect the extent to which the floodplain management requirements, associated with the National Flood Insurance Program (NFIP), have become established across the nation and make a difference. It is estimated there are $1.2 billion dollars of losses avoided annually because of NFIP floodplain management activities. Not only are there 20,300 communities participating in the NFIP (which is mentioned) but there is a vibrant network of local and state officials who are on the "front lines" making permit decisions that reduce the impact of flooding on a daily basis. It would seem the report might want to highlight this success, without dwelling on it. In fact, the creation of the network of mitigation professionals (as you know, largely due to the efforts of the associations of state floodplain managers (ASFPM) and the Emergency Management Institute's training programs) is a very effective "framework", if not model, that might be replicated to address other hazards. While there are some compliance issues, floodplain management is entrenched. Over 20,000 communities have floodplain management ordinances. There is an abundance of technical resources and guidance materials. The authors might want to capture this, possibly even in the context of "what can we learn" from the floodplain management approach to mitigation.

CRS Community Rating System – Details/accomplishments/history should be laid out and summarized in the beginning of the audit report.

www.dhs.gov

The following is our response to the recommendation.

Recommendation:

We recommend that the Director of FEMA, in consultation with other appropriate federal agencies, develop and maintain a national comprehensive strategic framework for mitigation that incorporates both pre- and post-disaster mitigation efforts. The framework should include items such as common mitigation goals; performance measures and reporting requirements; the role of specific activities in the overall framework; and the roles and responsibilities of federal, state, and local agencies, and nongovernmental stakeholders.

Response:

FEMA is in agreement with most of the recommendation and conclusions of the report. FEMA supports the setting of a national comprehensive strategic framework and setting common mitigation goals. FEMA disagrees with setting performance measures and reporting requirements on a process that largely occurs at local levels of government. Local communities are responsible for making most mitigation decisions with respect to identifying risks in their communities and setting hazard mitigation priorities that mitigate those risks. It would be inappropriate for FEMA, or any other Federal entity, to dictate mitigation direction at the local level, outside of ensuring that mitigation plans and grant applications meet essential eligibility requirements as defined by authorizing statutes and regulations. FEMA recommends that trend analysis and progress reporting toward goals is more appropriate to measure the success of a comprehensive strategic mitigation framework.

The Subcommittee on Disaster Reduction (SDR) of the Committee on Environment and Natural Resources, National Science and Technology Council, was created to, among other things, "establish clear national goals for Federal science and technology investments for disaster reduction" and to "identify and coordinate opportunities for the U.S. Government to collaborate with state, local, and foreign governments, international organizations and private/academic/industry groups in the science and technology of disaster reduction."[1] The role the SDR is to coordinate the scientific and technical aspects of risk identification and risk reduction across the Federal government. FEMA

[1] *See* Charter of the Subcommittee on Disaster Reduction, Committee on Environment and Natural Resources, National Science and Technology Council.

fully participates in the SDR, which accomplishes several of the objectives identified in the report's recommendation.

Once again we thank you for the opportunity to review the draft report and provide comments.

Sincerely,

Steven J. Pecinovsky

Steven J. Pecinovsky
Director
Departmental GAO/OIG Liaison Office

Appendix III: Comments from the Department of the Interior

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

AUG 3 2007

Mr. Andy Finkel
Assistant Director of Financial Markets
and Community Investment
U.S. Government Accountability Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Finkel:

Thank you for providing the Department of the Interior (DOI) with the opportunity to review the U.S. Government Accountability Office (GAO) draft report entitled, "NATURAL HAZARD MITIGATION: Various Mitigation Efforts Exist, but Federal Efforts Do Not Provide a Comprehensive Strategic Framework" (Report Number GAO-07-403).

The GAO staff is to be commended for conducting a well-researched examination of the Nation's natural hazard mitigation efforts. The draft report provides a good summary of selected issues relating to natural hazards within the United States and some of the planning and mitigation efforts to reduce the risk of losses.

We agree with the need for a comprehensive strategy and wish to emphasize the importance of such a strategy being built collectively by the Federal Emergency Management Agency in equal partnership with other agencies that have a clear natural disaster role. We are pleased to see the National Earthquake Hazards Reduction Program (NEHRP) recognized as an example of how Federal agencies work together to create a hazard-specific strategy to reduce losses from earthquakes and to collaborate on mitigation activities after a disaster. This partnership is a model that could be used in addressing the report's major recommendations. NEHRP reaches across Federal agencies and into States to foster mitigation activities, from community–level predisaster mitigation to national-scale post-disaster coordination. NEHRP also provides clear economic incentives (in the form of building codes) for mitigation activities, something the report cites as a general limitation of Federal programs.

Consistent with the report's recommendations, the USGS recently launched a multi-hazard monitoring, assessment, research and coordination demonstration project in Southern California. This project promises to serve as a test case for multi-hazard assessment and coordination that can be applied in other regions. The project relies heavily on local partnerships to transform results into practice, a key need identified in the report.

In concluding that the current approach to institutional collaboration on natural hazard mitigation does not provide a comprehensive mitigation framework for the Nation, it would be helpful if the report identified the challenges associated with developing such a national framework. It would also be helpful for GAO to examine which programs have delivered the best value in mitigation and where the greatest strides in mitigation could be made if we dedicated ourselves to the effort. As further context, the report could address whether other nations have developed national frameworks for mitigation that can provide good examples.

The report mentions new reforms such as the Post-Katrina Emergency Management Reform Act of 2006 that take an all-hazards approach to emergency management, but it would benefit from describing how such reforms address the report's recommendations and what other efforts are needed. Finally, we note the draft report focuses mainly on losses of life and property, but it is important to recognize the impact of social, agricultural, and environmental losses in addressing total losses.

We hope these comments will aid you in preparing the final report.

Sincerely,

James E Cason

James E. Cason
Associate Deputy Secretary

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

Orice Williams, (202) 512-8678 or williamso@gao.gov

Staff Acknowledgments

In addition to the person named above, Andy Finkel, Assistant Director; Nicholas Alexander; Emily Chalmers; Leo Chyi; Isidro Gomez; Eileen Harrity; Christine Houle; Kai-Yan Lee; John Mingus; Marc Molino; Omyra Ramsingh, and William Sparling made key contributions to this report.

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