United States Government Accountability Office

Report to Congressional Requesters

October 2014

CLIMATE CHANGE

Better Management of Exposure to Potential Future Losses Is Needed for Federal Flood and Crop Insurance

GAO-15-28

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Better Management of Exposure to Potential Future Losses Is Needed for Federal Flood and Crop Insurance

GAO Highlights

Highlights of GAO-15-28, a report to congressional requesters

Why GAO Did This Study

The May 2014 National Climate Assessment indicates that the frequency and/or severity of many weather and climate extremes may increase with climate change. Public and private property insurers can bear a large portion of the financial impact of such weather-related losses. In the public sector, federal insurance includes NFIP, managed by FEMA, and the federal crop insurance program, managed by RMA.

GAO was asked to review climate change's effect on insurers. This report examines (1) how federal and private exposure to losses has changed since GAO's 2007 report on the subject, and what is known about how climate change may affect insured and uninsured losses; (2) how public insurers are preparing for climate change, and any challenges they face; and (3) how private insurers are preparing for climate change and any challenges they face. GAO reviewed 20 studies, examined federal and private sector data on exposure to losses from 2000 to 2013, reviewed agency documents, and interviewed agency officials and a nonprobability sample of eight insurers and reinsurers.

What GAO Recommends

GAO recommends that FEMA and RMA take additional steps to encourage flood and crop insurance policyholders to adopt building and agricultural practices that reduce long-term risk and federal exposure to losses. FEMA agreed with GAO's recommendation, and RMA neither agreed nor disagreed with GAO's recommendation.

View GAO-15-28. For more information, contact J. Alfredo Gómez at (202) 512-3841 or gomezj@gao.gov.

What GAO Found

Since GAO's 2007 report on flood and crop insurance, exposure growth in hazard-prone areas has increased losses, and climate change and related increases in extreme weather events may further increase such losses in coming decades. Scientific and industry studies GAO reviewed generally found that increasing growth and property values in hazard-prone areas have increased losses to date and that climate change may compound this effect. From 2007 through 2013, data from the Federal Emergency Management Agency (FEMA) and the Risk Management Agency (RMA) show that exposure to potential losses for insured property grew from $1.3 trillion to $1.4 trillion (8 percent). According to industry data, private sector exposure to such loss grew from $60.7 trillion to $66.5 trillion (10 percent) from 2007 through 2012. Federal exposure to uninsured loss also increased by 46 percent over this period, based on a 2013 analysis by the Congressional Research Service. According to the studies GAO reviewed, climate change may substantially increase losses by 2040 and increase losses from about 50 to 100 percent by 2100.

FEMA and RMA have taken some steps to better understand and prepare for climate change's potential effects under the National Flood Insurance Program (NFIP) and the federal crop insurance program by, for example, commissioning climate change studies. However, both agencies face challenges that may limit their ability to minimize long-term federal exposure to climate change. For example, because of the short-term nature of insurance (i.e., contracts typically estimate and communicate risk of property losses for the 1-year term of a policy), FEMA and RMA face a challenge in encouraging policyholders to reduce their long-term exposure to climate change risks. Specifically, flood insurance policyholders who build to NFIP standards—which are based on current flood risk and not on long-term risks—may unintentionally increase their vulnerability to climate change as sea-level rises. Also, while federal law prohibits crop insurance from covering losses due to a farmers' failure to follow good farming practices, such as various irrigation methods, some of these practices maintain short-term production but may inadvertently increase the vulnerability of agriculture to climate change through increased erosion and inefficient water use. A recent executive order directed federal agencies to reform policies that may, perhaps unintentionally, increase the vulnerability of economic sectors or communities to climate change. Without encouraging NFIP and crop insurance policyholders to adopt building and agricultural practices that reduce long-term risk, FEMA and RMA may send policyholders signals that unintentionally encourage their vulnerability to climate change, counter to the direction of the executive order, which could exacerbate federal exposure to losses.

Many private insurers and reinsurers have taken steps since 2007 to better understand and prepare for climate change effects and related challenges, including participating in industry climate change surveys, and issuing reports that identify and assess climate change risks and trends in weather-related losses. According to industry officials, they can manage their exposure to climate change and related challenges through risk-based premiums, reinsurance, and other practices, although estimating weather-related risks still includes elements of uncertainty.

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Abbreviations

ARS	Agricultural Research Service
Biggert-Waters Act	Biggert-Waters Flood Insurance Reform Act of 2012
DHS	Department of Homeland Security
DRF	Disaster Relief Fund
FAIR	Fair Access to Insurance Requirements
FEMA	Federal Emergency Management Agency
NAIC	National Association of Insurance Commissioners
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RMA	Risk Management Agency
RMS	Risk Management Solutions
SFHA	special flood hazard area
USDA	U.S. Department of Agriculture

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Congressional Requesters

The impacts and costs of certain weather disasters—such as floods, drought, and hurricanes—will increase in significance as previously rare events become more common and intense due to climate change, according to the United States Global Change Research Program's May 2014 National Climate Assessment.[1] While the magnitude and extent of future climate change effects are uncertain, climate change presents a significant financial risk to the federal government in many areas. As a result of these risks and the nation's fiscal condition, in February 2013, we added Limiting the Federal Government's Fiscal Exposure by Better Managing Climate Change Risks to our list of areas at high risk to fraud, waste, abuse, and mismanagement, or most in need of transformation.[2]

The uncertain and potentially large losses associated with weather-related events are among the biggest risks that property insurers face. The property and casualty segment of insurance, which spans both the public and private sectors, bears a large portion of the financial impact of weather-related losses. In the public sector, federal insurance programs include the National Flood Insurance Program (NFIP), administered by the Federal Emergency Management Agency (FEMA) within the U.S. Department of Homeland Security, which makes flood insurance available to residential property owners and businesses, and the federal crop insurance program, administered by the Risk Management Agency (RMA) within the U.S. Department of Agriculture (USDA), which protects farmers against financial losses caused by drought, floods, and other natural disasters, among other things. In addition, the federal government

[1]Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, eds., *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program (Washington, D.C.: U.S. Government Printing Office, 2014). Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (Cambridge University Press: 2009). The 2014 report summarizes the impacts of climate change on the United States, now and in the future. A team of several hundred experts guided by a 60-member Federal Advisory Committee produced the report, which was extensively reviewed by the public and experts, including federal agencies and a panel of the National Academy of Sciences.

[2]GAO, *High-Risk Series: An Update,* GAO-13-283 (Washington, D.C.: February 2013).

provides disaster assistance through FEMA and other federal agencies.[3] In certain states, insurance pools are administered by governmental entities or entities established pursuant to state law that provide coverage for losses caused by weather-related events. In the private sector, primary insurers provide insurance to individuals and businesses directly, and reinsurers provide insurance to primary insurers.

As of June 2014, FEMA's debt to the U.S. Treasury from flood insurance payments totaled about $24 billion—primarily to pay claims associated with Hurricane Katrina in 2005 and Hurricane Sandy in 2012—and FEMA had not repaid any principal on its loan since 2010. NFIP has been on our High-Risk List since March 2006 because of concerns about its long-term financial solvency and related operational issues.[4] While FEMA is implementing some changes to NFIP in response to recently enacted legislation, it is unclear to what extent these changes will improve the program's financial condition.[5] Additionally, in our 2013 High-Risk Update, we concluded that FEMA obligated over $80 billion in federal assistance for disasters declared during fiscal years 2004 through 2011.[6] As of June 2014, FEMA's Disaster Relief Fund had spent $3.8 billion for fiscal year

[3]FEMA's Disaster Relief Fund (DRF) is the major source of federal disaster recovery assistance for state and local governments when a disaster is declared. FEMA obligates funds from the DRF to help jurisdictions respond to and recover from declared disasters. The DRF is generally funded at a level that is sufficient for what are known as "normal" disasters, with outlays less than $500 million. When a large disaster occurs, additional funding for the DRF may be provided through emergency supplemental appropriations. For more information, see Congressional Research Service, *Disaster Relief Funding and Supplemental Appropriations for Disaster Relief*, R40708 (Washington, D.C.: Aug. 5, 2013) and GAO, *Federal Disaster Assistance: Improved Criteria Needed to Assess a Jurisdiction's Capability to Respond and Recover on Its Own*, GAO-12-838 (Washington, D.C.: Sept. 12, 2012).

[4]GAO-13-283.

[5]FEMA will need to implement provisions in both the Biggert-Waters Flood Insurance Reform Act of 2012, Pub. L. No. 112-141, tit.II, subtit. A, 126 Stat. 405 (2012) and the Homeowner Flood Insurance Affordability Act of 2014, Pub. L. No. 113-89, 128 Stat. 1020 (2014), that affect many aspects of NFIP, including its finances, rate setting, mapping, and participation, among other things. In addition, over the past 11 years, we have made numerous recommendations to FEMA to improve its administration of the program. However, as we recently reported, FEMA has not fully addressed all of our prior recommendations. See GAO, *Overview of GAO's Past Work on the National Flood Insurance Program*, GAO-14-279R (Washington, D.C.: Apr. 9, 2014).

[6]GAO, *Fiscal Exposures: Improving Cost Recognition in the Federal Budget*, GAO-14-28 (Washington, D.C.: Oct. 29, 2013); GAO-13-283; and GAO-12-838.

2014, with an unspent balance of over $11.3 billion. We have previously found that the federal government does not fully budget for these costs—in part because supplemental appropriations are largely used to fund them—obscuring the full cost of disaster relief commitments.[7]

Further, as we reported in 2014, the federal government's crop insurance costs have increased in recent years, with appropriations more than doubling from $3.4 billion in fiscal year 2001 to $7.6 billion in fiscal year 2012 as program expansion and rising crop prices have led to increasing subsidy values and higher claims payments.[8] In 2007, we found that climate change could increase federal insurers' financial risk and recommended that the Secretaries of Agriculture and Homeland Security analyze the potential long-term fiscal implications of climate change for crop insurance and flood insurance, respectively, and report their findings to Congress.[9] USDA and DHS agreed with these recommendations and in response issued reports containing such analyses.

You asked us to review the implications of climate change on public flood and crop insurance and private sector insurance. This report examines (1) how federal and private exposure to losses has changed since our 2007 report on flood and crop insurance and how climate change may affect insured and uninsured losses; (2) how public insurers are preparing for climate change and associated challenges, if any; and (3) how selected private insurers and reinsurers are preparing for climate change and associated challenges, if any.

To determine how exposure to losses has changed since our 2007 report on flood and crop insurance and how climate change may affect insured and uninsured losses, we reviewed scientific studies and other available

[7]GAO, *Extreme Weather Events: Limiting Federal Fiscal Exposure and Increasing the Nation's Resilience*, GAO-14-364T (Washington, D.C.: Feb. 12, 2014); GAO-14-28; and *Budget Issues: Budgeting for Federal Insurance Programs*, GAO/T-AIMD-98-147 (Washington, D.C.: Apr. 23, 1998), According to FEMA officials, FEMA recently increased the requested amount of disaster relief funding during the budget cycle, which may reduce the federal government's fiscal exposure.

[8]GAO-14-364T; GAO-14-28; GAO, *Crop Insurance: Savings Would Result from Program Changes and Greater Use of Data Mining,* GAO-12-256 (Washington, D.C.: Mar. 13, 2012).

[9]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).

literature on climate change and analyzed federal and private sector exposure data from 2007 through 2013. To understand longer-term trends in exposure, we also analyzed federal exposure data from 2000. We assessed the reliability of the exposure data and reviewed the methodological soundness of each study and determined that the data and studies were sufficiently reliable for describing trends in exposure and the potential effect of climate change on insured and uninsured losses.[10] To determine how public insurers are preparing for climate change, we reviewed FEMA and RMA documents and interviewed agency officials and a nonprobability sample of three state insurers that were identified by an industry forecaster as most at-risk of natural disasters, whether the state had an insurance pool administered by a governmental entity or entity established pursuant to state law, and whether the state had experienced an extreme weather event in the past decade.[11] Further, to determine how private insurers and reinsurers are preparing for climate change, we reviewed over 20 industry reports and other information from industry representatives we interviewed. We interviewed a nonprobability sample of eight insurers and reinsurers, representing over 25 percent of the U.S. property and casualty insurance market, 15 percent of the private crop insurance market, and over 30 percent of the U.S. reinsurance market. We selected both large and small insurers with relevant experience in flood or crop insurance, to collect a variety of perspectives. We also interviewed two catastrophe modeling firms, two reinsurance brokerage firms, and eight industry groups representing more than 1,000 large and small property and casualty insurers. Because we used a nonprobability sample to select interviewees, our results are not generalizable to the industry as a whole but provide illustrative examples. Appendix I presents a more detailed description of our objectives, scope, and methodology.

We conducted this performance audit from November 2013 to October 2014 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to

[10]To assess the reliability of exposure data, we reviewed federal agency procedures for collecting and updating the data. For private sector exposure data, we compared exposure estimates from two separate firms. To assess the reliability of scientific studies, staff from our Chief Scientist's office and Center for Economics reviewed each study to determine whether their methodologies were sound and appropriate for our purposes.

[11]Because we used a nonprobability sample to select states, our results are not generalizable to all 50 states; however, our results can provide illustrative information.

obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Insurance can spread risk over time, across geographical areas, and among industries and individuals. While private insurers assume some financial risk when they write policies, they employ various strategies to manage risk so that they limit potential financial exposures, earn profits, and build capital needed to pay claims. For example, insurers charge premiums for coverage and establish underwriting standards, such as refusing to insure customers who pose unacceptable levels of risk, or limiting coverage in particular geographic areas. Insurance companies may also purchase insurance from reinsurers to cover specific portions of their financial risk. Reinsurers use similar strategies to limit their risks, including charging premiums and establishing underwriting standards.[12] States regulate private insurance and may impose various restrictions on insurers' risk management practices, such as premium rate increases and coverage limitations, to protect consumers and to ensure insurer solvency. However, many of these risk management strategies are not available to NFIP, which is required to assume and retain all of the risk and to generally accept all insurance applicants, including those with potentially high-risk properties.

The uncertain and potentially large losses associated with weather-related events are among the biggest risks that property insurers face. Virtually anything that is insured—property, crops and livestock, business operations, or human life and health—is vulnerable to weather-related events. For insurers, remaining financially solvent generally involves estimating and setting rates that reflect insured risks; any unanticipated changes in the frequency or severity of weather-related events can have financial consequences for them. Recent scientific assessments have found that climate change has or will alter the frequency and/or severity of

[12]According to National Association of Insurance Commissioners (NAIC) data, property and casualty insurers wrote around $521.87 billion in premiums in the United States in 2012, with 11 insurance companies comprising about 50 percent of the property and casualty market. Also in 2012, reinsurers wrote about $32.98 billion in reinsurance premiums in the United States, a 10.5 percent increase from 2011.

damaging weather-related events—such as droughts and floods, alter crop productivity, and threaten coastal communities as sea-level rises.[13]

Under certain circumstances, the private sector may consider some risks uninsurable. In other instances, the private sector may offer to insure a risk, but at rates that many property owners cannot afford. Without insurance, affected property owners must rely on their own resources or seek disaster assistance from local, state, and federal sources in the event of a loss. In situations where the private sector will not insure a particular type of risk, the public sector may create markets to ensure the availability of insurance. For example, several states have established Fair Access to Insurance Requirements (FAIR) and windstorm plans, that pool resources from insurers doing business in the state to make insurance available to property owners who either cannot obtain coverage in the private insurance market or cannot do so at an affordable rate.

Similarly, at the federal level, the NFIP and the federal crop insurance program were established to provide coverage where private markets did not exist, and partly to provide an alternative to disaster assistance. NFIP has three components: (1) the provision of flood insurance; (2) the requirement that participating communities adopt and enforce floodplain management regulations that are at least as stringent as FEMA's national minimum standards; and (3) the identification and mapping of floodplains, which helps to determine which insurance premiums and regulations apply to a particular property. Community participation in NFIP is voluntary. However, communities must join NFIP and adopt FEMA-approved building standards and floodplain management strategies in order for their residents to purchase flood insurance through the program.[14] In addition to meeting these federal standards, the regulations that each community enacts and implements must meet the minimum state requirements, which are established consistent with NFIP

[13]Melillo, Richmond, and Yohe, eds., *Climate Change Impacts in the United States: The Third National Climate Assessment*, and Field, C.B. et al., eds., Summary for Policymakers in: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation,* A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (Cambridge University Press, Cambridge, UK, and New York, NY, USA, 2012).

[14]NFIP regulations identify minimum requirements that communities must fulfill to join and stay in the program. The requirements that apply to a particular community depend on its flood hazard and the level of detail of the data FEMA provides to the community.

standards.[15] For example, communities must adopt at least the minimum standards for floodplain management regulations, including building requirements to reduce future flood damage, such as requiring new and substantially improved or substantially damaged structures in special flood hazard areas to be elevated to or above base flood elevation levels. Additionally, FEMA provides premium reduction incentives for policyholders within communities that take measures to mitigate flood risk beyond NFIP minimum requirements through the agency's program, the Community Rating System.[16] Under NFIP, the federal government assumes the liability for covered losses and sets rates and coverage limitations. While NFIP does not subsidize most policies, policyholders with certain types of insured properties pay subsidized premiums.[17]

For crop insurance, farmers participate voluntarily, but the federal government encourages participation by subsidizing their insurance premiums. USDA's RMA administers the federal crop insurance program, including issuing new insurance products and expanding existing products to new geographic regions. RMA administers the program in partnership with private insurance companies that share a percentage of the risk of loss or the opportunity for gain associated with each policy. Federal law prohibits crop insurance from covering losses due to a farmer's failure to follow good farming practices. Good farming practices are identified by agricultural experts in a given area and provide acceptable farming methods for crop insurance policyholders to use in producing yields consistent with historical production. Agricultural experts

[15]Any property owner in a participating community may purchase flood insurance. However, in participating communities, certain property owners are required to purchase flood insurance. Specifically, owners of properties in special flood hazard (SFHA) areas who obtain mortgages from federally regulated lending institutions or federal agency lenders or who receive direct financial assistance for acquisition or construction of the property are required to purchase flood insurance. In addition, individuals in SFHAs who receive federal disaster assistance after September 23, 1994, for flood losses to real or personal property are also required to purchase and maintain flood insurance on the property as a condition for receiving future disaster assistance. FEMA defines SFHAs as land in the flood plain subject to a 1 percent or greater chance of flooding in any given year—also referred to as the "100-year flood."

[16]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 fall into 1 of 10 rate reduction classes. See GAO-14-297R.

[17]For example, as mentioned previously, recently enacted legislation required FEMA to phase out subsidies for some properties, such as nonprimary residences and business structures, through 25 percent annual premium increases until the full-risk rate is reached.

are individuals employed by USDA's Cooperative Extension System or the agricultural departments of universities, or other approved persons, whose research or occupation is related to the specific crop or practice for which expertise is sought.

The federal government's disaster relief and flood and crop insurance programs create fiscal exposure to weather-related events and climate change. For the purposes of this report, fiscal exposures are responsibilities, programs, and activities that may either obligate the federal government to future spending or create the expectation for future spending.[18] For example, the government's response to a weather-related event or series of events can strengthen expectations that the government will respond in the same way to similar events in the future.

Differences exist in the types of property that public insurers insure, as well as their time horizons. For example, federal flood and crop insurance programs insure different types of property, with different time horizons. While state insurers and NFIP insure permanent structures that are designed to last years or decades, federal crop insurance primarily covers agricultural commodities that farmers plant and harvest each year. This annual cycle can allow farmers to adapt their insured property to changes in weather-related risk more easily than state or NFIP policyholders can adapt their permanent structures to changing wind or flood risks.

Uncertainty about the magnitude, timing, and extent of the effects of climate change in the future presents challenges to both public and private insurers. For example, NFIP will likely be affected by future sea-level rise. According to the May 2014 National Climate Assessment, although global mean sea level may increase anywhere from 8 inches to 7 feet in this century, the magnitude of the projected future sea-level rise varies considerably along the U.S. coastline due to a variety of factors, such as land subsidence and uplift.[19] Officials from public insurers and some representatives from private industry stated that uncertainty regarding climate projections presents challenges to these insurers' ability

[18]For more information, see GAO, *Fiscal Exposures: Improving the Budgetary Focus on Long-Term Costs and Uncertainties*, GAO-03-213 (Washington, D.C.: Jan. 24, 2003); and GAO-14-28.

[19]Land subsidence is the gradual settling or sudden sinking of the earth's surface, whereas uplift is the rising of the earth's surface caused by geophysical forces. Both land subsidence and uplift can affect sea-level rise.

to plan for the future.[20] However, as stated in a 2010 National Research Council (NRC) report, even though uncertainties exist regarding the exact nature and magnitude of impacts, mobilizing now to increase the nation's resilience can be an insurance policy against future climate change risks.[21]

We define resilience as the ability to prepare and plan for, absorb, recover from, and more successfully adapt to actual or potential adverse events.[22] Hazard mitigation—actions that reduce the long-term risks of life and property by lessening the impact of disasters—and climate change adaptation—the adjustments to natural or human systems in response to actual or expected climate change—promote resilience to extreme weather events, among other things.

Recent executive orders have addressed the topics of vulnerabilities to extreme weather events and climate change-related risks. Executive Order 13632, which was signed in December 2012, established the Hurricane Sandy Rebuilding Task Force to, among other things, assess current vulnerabilities to extreme weather. The task force was also to identify opportunities for achieving rebuilding success and improving the affected region's resilience, consistent with the National Disaster Recovery Framework's commitment to support economic vitality, enhance public health and safety, protect and enhance natural and man-made infrastructure, and ensure appropriate accountability. Executive Order 13653, which was signed in November 2013, directs federal agencies to, consistent with their missions, (1) address barriers to the nation's resilience to climate change; (2) reform policies that may, perhaps unintentionally, increase the vulnerability of natural or built systems, economic sectors, natural resources, or communities to climate change;

[20]According to NOAA officials, for shorter time frames, natural climate variability can limit predictability.

[21]NRC, America's Climate Choices: Panel on Adapting to the Impacts of Climate Change, *Adapting to the Impacts of Climate Change* (Washington, D.C.: 2010). NRC is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering.

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

and (3) identify opportunities to support and encourage smarter, more climate-resilient investments.[23]

Growth in Federal and Private Sector Exposure Has Increased Losses to Date, and Climate Change May Increase Losses in Coming Decades

Growing federal and private sector exposure since our 2007 report on flood and crop insurance has increased insured and uninsured losses to date, and climate change and related increases in the frequency and severity of extreme weather events may further increase such losses in coming decades.

Federal and Private Sector Exposure Have Grown and Increased Losses to Date

Federal and private sector exposure to potential insured losses grew since 2007. Specifically, inflation-adjusted federal exposure to potential insured losses grew from $1.3 trillion to $1.4 trillion (8 percent) from 2007 through 2013. According to our analysis of the most recent data available, private sector exposure grew from an estimated $60.7 trillion to $66.5 trillion (10 percent) from 2007 through 2012, in 2014 dollars.[24] Property insured under the NFIP comprised 91 percent of federal exposure to insured loss in 2013, but it grew the least (4 percent) from 2007 to 2013. Property insured under the federal crop insurance program accounted for 9 percent of total federal exposure to insured loss in 2013, but it grew the most (68 percent) since 2007, as shown in table 1.

[23]Executive Order 13653: *Preparing the United States for the Impacts of Climate Change,* November 6, 2013.

[24]Private sector exposure is based on estimates from two insurance industry modeling firms, AIR Worldwide and Risk Management Solutions (RMS). Growth is shown through 2012 rather than 2013 because RMS and AIR Worldwide did not calculate estimates for 2013.

Table 1: Federal Exposure to Potential Loss from Insured Property, 2007 to 2013, in 2014 Dollars

Dollars in billions

	Total value of property insured		Percentage of federal exposure	Percentage increase
Program	**2007**	**2013**	**2013**	**2007-2013**
Federal				
National flood insurance	$1,267	$1,321	91%	4%
Federal crop insurance	$75	$125	9%	68%
Total	**$1,342**	**$1,446**	**100%**	**8%**

Sources: GAO analysis of Federal Emergency Management Agency and Risk Management Agency data on total exposure. | GAO-15-28

For historical context, in comparing the 7-year period shown in the table to the preceding 7-year period (2000 to 2006), NFIP's exposure to loss grew more slowly from 2007 to 2013, and the federal crop insurance program's exposure grew more quickly.[25] From 2000 to 2006, inflation-adjusted NFIP exposure grew from $749.2 billion to $1.20 trillion (60 percent), compared with 4 percent from 2007 to 2013. In contrast, from 2000 to 2006, the federal crop insurance program's exposure grew from $45.5 billion to $56.9 billion (25 percent) compared with 68 percent from 2007 to 2013, adjusted for inflation. Also, as a share of total federal exposure, in 2006, federal crop insurance comprised 5 percent of total federal exposure, compared to 9 percent in 2013.

Disaster relief appropriations—which could be considered a proxy for federal exposure to uninsured losses—also grew.[26] Based on a 2013 analysis of disaster relief appropriations by the Congressional Research Service, the amount of inflation-adjusted disaster relief per fiscal year increased from a median of $6.2 billion for the years 2000 to 2006, to a median of $9.1 billion for the fiscal years 2007 to 2013 (46 percent).[27]

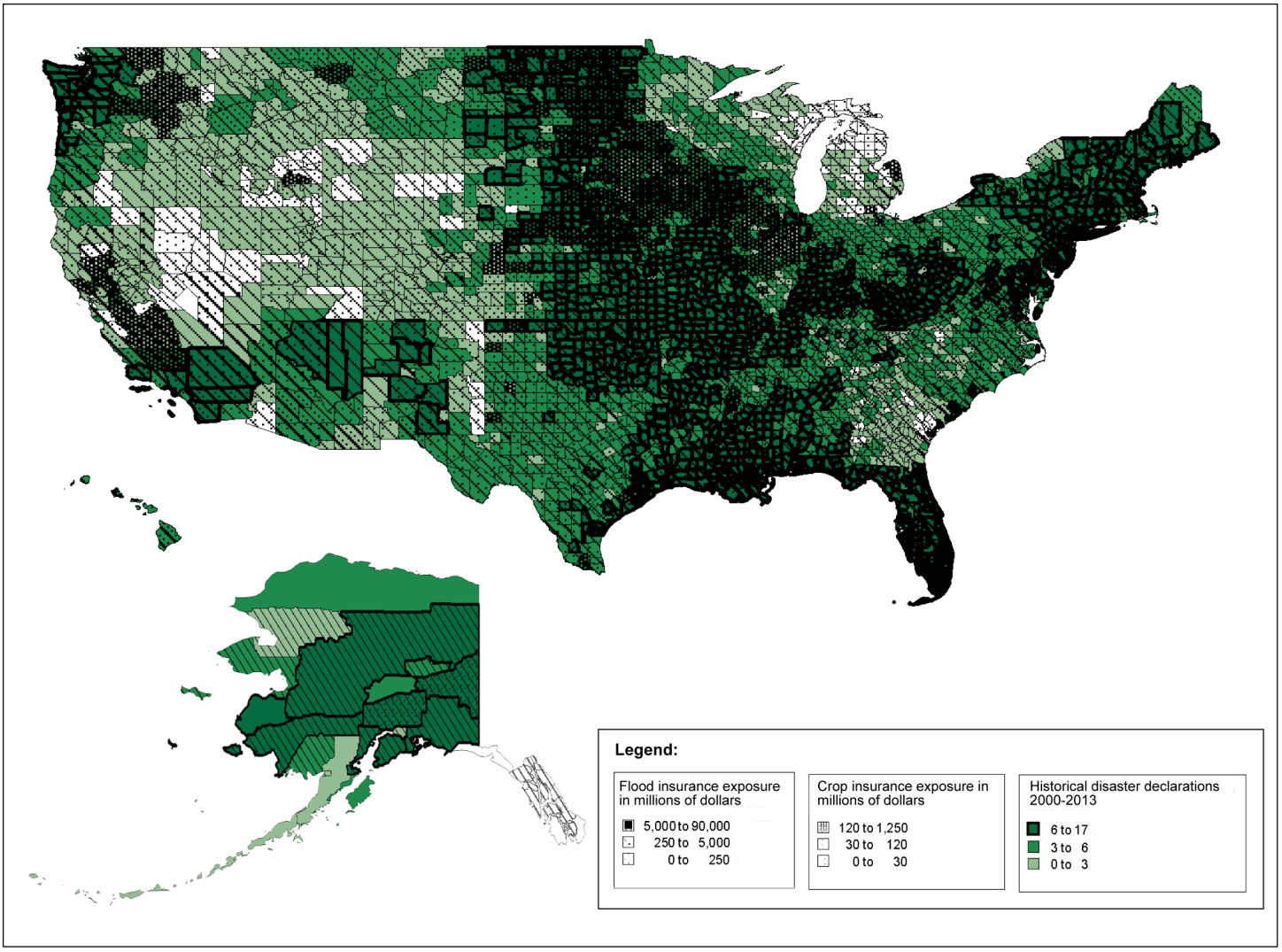
[25]For the purposes of this report, we included data on exposure during the time frame covered by our prior work for context.

[26]We compared the median value of disaster appropriations over a multiyear time period to control for large fluctuations in annual disaster relief appropriations from year to year.

[27]Congressional Research Service, *Disaster Relief Funding and Supplemental Appropriations for Disaster Relief*, R40708 (Washington, D.C.: Aug. 5, 2013) and Congressional Research Service, *FEMA's Disaster Relief Fund: Overview and Selected Issues*, R43537 (Washington, D.C.: May 7, 2014). Not all disasters are weather-related, such as earthquakes.

Although federal exposure spans all 50 states, it is concentrated in certain parts of the country, such as the Mississippi River Basin, California's central valley, and coastal areas, as shown in figure 1.

Figure 1: Disaster Declarations 2000-2013, Federal Flood Insurance and Federal Crop Insurance 2013 Exposure by County



Sources: GAO analysis of Federal Emergency Management Agency and Risk Management Agency data; MapInfo (map). | GAO-15-28

Notes: We included disaster declarations from 2000 to 2013 to better represent geographic exposure, given the annual variability of weather-related events. 137 out of 15,457 declarations (0.9 percent) during this period were not weather-related and include events such as earthquakes and tsunami-related flooding. The flood insurance program, administered by the Federal Emergency Management Agency, within the U.S. Department of Homeland Security, makes flood insurance available to residential property owners and businesses. According to USDA's website, the federal crop insurance program promotes the economic stability of agriculture through a sound system of crop insurance and

providing the means for the research and experience helpful in devising and establishing such insurance. Management is vested in a Board of Directors, subject to the general supervision of the Secretary of Agriculture.

Federal and private insured exposure to loss grew for a variety of reasons, including increases in the value of property insured and increases in the amount of coverage written. For example, according to data that the National Oceanic and Atmospheric Administration (NOAA) obtained from the U.S. Census Bureau, the U.S. coastal population grew by 39 percent from 1970 to 2010, and population density in coastal areas is six times greater than inland areas. Furthermore, a study by an insurance industry modeling firm found that the total value of property in U.S. East Coast and Gulf Coast areas grew by just under 4 percent each year since 2007 to over $10 trillion in 2012, in nominal dollars. Some studies and our prior work, suggest that the current level of federal fiscal exposure to losses may become increasingly difficult to sustain in coming decades, given these socioeconomic factors and other budget constraints.[28]

The 20 scientific and industry studies we reviewed that examined the historical loss record generally found that the exposure growth in hazard-prone areas has largely driven increased insured and uninsured losses to date. Specifically, most loss analyses we reviewed that found an upward trend, identified socioeconomic factors, such as growth in population and the value of property, as the primary drivers of increasing losses to date. Most studies we reviewed did not find a statistically significant increase in such losses conclusively attributable to climate change.[29] One assessment of loss studies noted that climate change cannot be ruled out as a factor because of limitations in data quality, different methods of correcting for socioeconomic trends, and changes in insurance

[28]J. David Cummins, Michael Suher, and George Zanjani, “Federal Financial Exposure to Natural Catastrophe Risk,” chapter in *Measuring and Managing Federal Financial Risk*, National Bureau of Economic Research, ed. Deborah Lucas (Chicago: University of Chicago Press, 2010) 61-92 and GAO-14-28.

[29]Some of the studies we reviewed did find a statistically significant trend in losses for certain weather events, however, studies also cited a variety of potential reasons other than climate change for the identified trends, such as natural variability.

coverage.[30] Although most of the studies we reviewed did not find a clear climate change signal in historical losses, they noted that climate change may start to affect losses in the near future.

Climate Change and Related Extreme Weather May Increase Insured and Uninsured Losses in Coming Decades

Recent assessments of loss projections for certain weather events suggest that climate change may increase losses substantially by 2040, and potentially double annual losses by 2100, compounding existing loss trends. For example, our analysis of 20 scientific studies shows a wide range of projections that, on average, predict a 14 to 47 percent increase in inflation-adjusted U.S. hurricane-related losses—which significantly contribute to total U.S. losses—attributable to changes in the severity of storms by 2040, and a 54 to 110 percent increase in losses by 2100, as shown in table 2.

Table 2: Estimated Percentage Change in Inflation-Adjusted U.S. Hurricane Insured and Uninsured Losses Potentially Attributable to Climate Change Based on Peer-Reviewed Studies Conducted Since 2007

	Percentage change from 2000 to 2040		Percentage change by end of century (year)	
Study author, date	Range in losses	Central estimate in losses	Range in losses	Central estimate in losses
Hallegatte, 2007	NA	22%[a]	NA	54% (2100)
Bender et al., 2010	-27 to 36%	14%[a,b]	-54 to 71%	NA[b,c](2090)
Nordhaus, 2010	12 to 92%	47%[a]	30 to 220%	110% (2100)
Mendelsohn et al., 2012[d]	NA	NA	54 to 240%	93% (2100)

Sources: Adapted from Bouwer, L.M., Projections of Future Extreme Weather Losses Under Changes in Climate and Exposure, Risk Analysis, vol. 33 (2013) 915-930; McAneney, J., et al., Market-Based Mechanisms for Climate Change Adaptation: Assessing the Potential for and Limits to Insurance and Market-Based Mechanisms for Encouraging Climate Change Adaptation, National Climate Change Adaptation Research Facility (Gold Coast, Australia: 2013); Hallegatte, S., The Use of Synthetic Hurricane Tracks in Risk Analysis and Climate Change Damage Assessment. Journal of Applied Meteorology and Climatology, vol. 46, (2007) 1956-1966; and Mendelsohn et. al.,"The impact of climate change on global tropical cyclone damage." *Nature Climate Change,* vol. 2, (2012) 205-209. | GAO-15-28

Notes: These estimates are based on different assumptions and methods, including different models of climate change's potential effects. Uncertainty remains about the potential feedback effects in various earth systems that may affect the magnitude of changes in hurricane severity. The end of century estimates extrapolated expected damages based on different time periods: Hallegate and Bender et al. (1900-2005), Nordhaus (1900-2008), and Mendelsohn et al. (1960-2009).

[a]These estimates were scaled to a linear trend from estimates covering different time periods in Bouwer, 2013. We excluded two studies included in Bouwer, 2013, because they were not peer-reviewed.

[b]This estimate measures damage potential rather than expected damage, which requires differentiating between hurricanes that strike the coast and those that remain offshore.

[30]Summary for Policymakers in: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation,* A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (Cambridge University Press, Cambridge, UK, and New York, NY, USA, 2012).

[c]Although an average value of 28 percent is reported in McAneney et al., we could not verify the average because we did not have sufficient information from the source to independently verify the average.

[d]Results are for North America, not the U.S. alone.

With exposure projected to increase over the same period, annual insured and uninsured losses could be much higher by 2100 based on some of the studies we reviewed.[31] Specifically, one peer-reviewed study projected property exposure in hazard-prone areas to more than double losses by 2100.[32] When combined with the range of climate change projections, total losses could increase anywhere from about 50 to 340 percent by 2100.

For agriculture, climate disruptions to production have increased in the past 40 years, and the May 2014 National Climate Assessment projects such disruptions will increase over the next 25 years. According to this report, producers have many available strategies for adapting to the average temperature and precipitation changes projected for the next 25 years, including technological advancements, expansion of irrigated acreage, and regional shifts in crop production, among others. However, according to the report, by midcentury, when temperatures could increase by between 1.8°F and 5.4°F and precipitation extremes could further intensify, expected yields of major U.S. crops and farm profits could decline, even with the current pace of technological advances and geographic shifts.[33]

[31]McAneney, J., et al., *Market-Based Mechanisms for Climate Change Adaptation: Assessing the Potential for and Limits to Insurance and Market-Based Mechanisms for Encouraging Climate Change Adaptation,* National Climate Change Adaptation Research Facility (Gold Coast, Australia: 2013) and Mendelsohn et al., *The Impact of Climate Change on Global Tropical Storm Damages,* The World Bank Policy Research Working Paper (Washington, D.C.: 2011).

[32]Mendelsohn et al.,"The Impact of Climate Change on Global Tropical Cyclone Damage." *Nature Climate Change*, vol. 2 (2012) 205-209.

[33]Melillo, Richmond, and Yohe, eds., *Climate Change Impacts in the United States: The Third National Climate Assessment.*

Public Insurers Have Begun Taking Steps to Prepare for Climate Change Effects, but Challenges May Limit Their Ability to Manage Future Exposure

Public insurers have commissioned climate change studies, incorporated climate change adaptation into their planning, and taken other steps to better understand and prepare for climate change's potential effects. However, inherent challenges of federal insurance programs, such as how federal insurers can address policyholders' long-term risk given the short-term focus of insurance contracts, may impede NFIP and RMA's ability to minimize long-term federal exposure to climate change.

Public Insurers Have Begun Taking Steps to Understand Climate Change Risk and Prepare for Related Effects

Public insurers have begun taking steps to understand climate change risks, such as sea-level rise, and have identified actions that could manage their exposure to climate change's effects. For example, federal insurers commissioned climate change studies and modeling to better understand the long-term implications of climate change for their programs. Regarding flood insurance, a FEMA-commissioned June 2013 study found that sea-level rise, erosion, and other changes in coming decades will affect the NFIP by expanding areas prone to flooding and requiring premium increases to cover higher losses.[34] The report also found that small annual rate increases could allow NFIP to adjust to gradual climate change effects. Based on this report's findings, FEMA initiated two pilot studies to analyze sea-level rise and its impacts in special flood hazard areas. FEMA appointed members to a Technical Mapping Advisory Council to, among other things, develop recommendations to ensure FEMA uses the best available methodology to consider future development on flood risk as required by the Biggert-Waters Flood Insurance Reform Act of 2012 (Biggert-Waters Act).[35] According to FEMA officials, the council expects to release its flood mapping report in September 2015.

Regarding crop insurance, RMA's 2009 study found that the crop insurance program has self-correcting features, which allow RMA to

[34]AECOM, *The Impact of Climate Change and Population Growth on the National Flood Insurance Program Through 2100*, a report prepared for the Federal Insurance and Mitigation Administration, Federal Emergency Management Agency (June 2013).

[35]Pub. L. No. 112-141, div. F, tit. II, subtit. A, §100215 126 Stat. 405, 924-27 (2012).

manage its exposure to gradual changes in climate.[36] For example, farmers' annual production history determines their coverage and, if yields decrease under climate change, the program's exposure adjusts downward as well. RMA may also adjust the availability of coverage for crops to respond to geographic shifts in production as conditions become more or less favorable for certain crops. According to RMA officials, farmers' desire to maximize their profits and maintain their businesses will motivate them to alter their production practices as climate change effects occur. However, the agency's 2009 study also recommended that RMA should better monitor weather and climate to understand potential rapid changes in future conditions and how to adapt agricultural and risk management practices to address climate change. RMA entered into a cooperative agreement with Oregon State University's Parameter-elevation Regressions on Independent Slopes Model (PRISM), Climate and Weather Group that will enhance RMA's monitoring of weather and climate.[37] Representatives from PRISM and RMA said the two organizations have engaged in a long-term program to develop a 100-year historical weather time series that could help analyze climate change's effect on agriculture.

Furthermore, in response to recent executive orders, FEMA and RMA have developed climate change adaptation plans, which outline planned agency actions to manage significant climate change related risks to, and vulnerabilities in, agency operations and missions.[38] For example, according to its climate change adaptation policy statement, FEMA will continue its study of climate change impacts on NFIP. Furthermore, according to program officials, climate change efforts will incorporate the best climate science available into flood maps—which form the basis for identifying property owners' flood risk and providing guidance to communities on land-use decisions. According to its adaptation plan,

[36]RTI International, *Climate Change Impacts on Crop Insurance*, a report prepared at the request of Risk Management Agency, U.S. Department of Agriculture (December 2009).

[37]The PRISM Climate Group gathers climate observations from a wide range of monitoring networks, puts its data and analysis through peer reviews, and develops spatial climate datasets to reveal short- and long-term climate patterns. The resulting datasets incorporate a variety of modeling techniques and are available at multiple spatial/temporal resolutions, covering the period from 1895 to the present.

[38]Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance* and Executive Order 13653, *Preparing the United States for the Impacts of Climate Change*.

RMA will update program parameters, such as the earliest and final planting dates. Changing planting dates, as needed, can help farmers avoid exposing crops to new changes in weather or climate. RMA officials told us that they also recently worked with USDA's Natural Resources Conservation Service to ensure consistency between crop insurance and conservation programs that protect soil and water resources.

RMA also participates in the broader USDA climate change effort, such as USDA's Global Change Task Force, according to RMA and USDA officials. This task force coordinates USDA activities related to climate change and provides a venue for sharing information within the agency, according to an agency document. In addition, USDA's Agricultural Research Service (ARS), has identified several climate change adaptation strategies to promote long-term resilience to climate change effects such as increased soil erosion and water scarcity. Specifically, a 2013 ARS report found that resilient agricultural practices such as conservation tillage—where farmers leave some crop residue on fields—and water conservation will help minimize climate change costs and sustain agricultural production in a changing climate. According to USDA officials, the agency also plans to develop region-specific adaptation strategies through its newly established Regional Climate Hubs, which are to deliver science-based, practical information to farmers and to support decision making related to mitigation of, and adaptation to, climate change.

Additionally, for a variety of reasons, federal insurers have adjusted their rate-setting calculations in ways that may better position them to respond to climate change. Although not specific to climate change, the Biggert-Waters Act requires NFIP to establish a reserve to help meet expected future obligations and to establish standards that ensure that its flood maps' flood risk determinations are adequate, both of which should help the agency collect funds that more closely match the risks it incurs or that are more likely to be sufficient to cover losses. FEMA officials said the agency has also increased the reserve amount in premiums to cover flood risk uncertainty, to better reflect the current flood risk associated with properties below base flood elevation. Recently enacted legislation required FEMA to phase out subsidies for some properties such as nonprimary residences and business structures through 25 percent annual premium increases until the full-risk rate is reached.

In response to a 2011 rate study, RMA changed its rate calculations to more heavily weigh recent weather data, which RMA documents suggest could enable premiums to more quickly and fully reflect changes in the

climate.[39] By law, RMA must set crop insurance premiums at rates sufficient to cover projected claims. Due in part to weather variability, in some years, RMA will likely collect more premiums than it pays in claims, and vice versa. RMA currently uses an average of the previous 20 years of yields to calculate its rates, rather than the previous method of assigning equal weight to all years back to the fixed base year of 1975—which was in place prior to 2012.[40]

Moreover, FEMA, in conjunction with other federal agencies, has taken some recent steps to manage future risks related to climate change for disaster relief. For example, the Hurricane Sandy Rebuilding Task Force implemented a minimum flood risk reduction standard for Sandy-related disaster funding to account for future sea-level rise in response to Executive Order 13632.[41] Under this standard, structures repaired or rebuilt must meet forward-looking standards, such as elevating the ground floor of a building 1 foot higher than existing FEMA standards. In addition, according to FEMA officials, a current interagency effort seeks to develop a Federal Flood Risk Reduction Standard that would apply to future disaster relief appropriations—although it is too early to know whether such a standard will incorporate future risk. Furthermore, according to a July 2014 White House statement, FEMA will issue new guidance that requires states to incorporate climate change into their hazard mitigation plans as a condition for receiving disaster relief.[42] FEMA's Hazard Mitigation Assistance programs and post-disaster grants

[39]Section 508(i)(2) of the Federal Crop Insurance Act as amended requires RMA to periodically review the methodologies for rating plans.

[40]RMA can still use historical data more than 20 years old for estimating potential catastrophic events. However, in the total rate calculation, the old data will receive less weight than in pre-2011 calculations.

[41]This task force was established by Executive Order 13632: *Establishing the Hurricane Sandy Rebuilding Task Force,* December 7, 2012.

[42]According to a July 2014 White House statement, FEMA will release new guidance for state hazard mitigation plans that calls upon states to consider climate variability as part of their requirement to address the probability of future events in state planning efforts, in an effort to rebuild stronger and safer after natural disasters and ensure that states prepare for the impacts of climate change. The White House, Office of the Press Secretary, July 16, 2014, *Fact Sheet: Taking Action to Support State, Local, and Tribal Leaders as They Prepare Communities for the Impacts of Climate Change,* accessed August 1, 2014, http://www.whitehouse.gov/the-press-office/2014/07/16/fact-sheet-taking-action-support-state-local-and-tribal-leaders-they-pre.

currently do not require grantees to incorporate sea-level rise into their cost-benefit calculations for proposed projects, although they do allow it.[43]

Regarding other public insurance programs, at the state level, some state insurers in hazard-prone areas have transferred risk to the private sector to reduce their exposure to claims. Specifically, officials at two of the state insurers we interviewed told us they have sold policies ("depopulation"), bought reinsurance to transfer a portion of the risk in their portfolio to another insurer, and sold bonds that provide funding to the insurer should a catastrophic weather event occur ("catastrophe bonds"). These risk transfer methods reduce exposure to losses from extreme weather. Reinsurance and catastrophe bonds are short-term, market-based risk transfer methods, typically of 1 to 3 years in duration.[44] We previously concluded that there are several strategies—many which would require statutory authority to implement but a few that FEMA currently has authority to implement—to be considered at the federal level to allow the transfer of risk to the private sector.[45] The Biggert-Waters Act also required FEMA to issue a report in 2013 that assessed the capacity of the private reinsurance, capital, and financial markets to assume a portion of the insurance risk of NFIP.

Federal Insurers Face Challenges Managing Future Exposure to Climate Change

Federal insurers face two main program challenges that may constrain their ability to manage their fiscal exposure and address future climate change risk. First, federal law encourages federal insurers, such as FEMA and RMA, to provide affordable insurance to policyholders through subsidized rates, which lessens the agencies' ability to collect sufficient

[43]FEMA's Hazard Mitigation Assistance programs include the Hazard Mitigation Grant Program, which assists in implementing long-term hazard mitigation measures following a major disaster; the Pre-Disaster Mitigation Program, which provides funds for hazard mitigation planning and projects on an annual basis, and Flood Mitigation Assistance Program, which provides funds for projects to reduce risk of flood damage to buildings that are insured under NFIP on an annual basis.

[44]For reinsurance and catastrophe bonds, the market sets the cost. The transaction occurs at a price acceptable to both the buyer(s) and seller(s) of the risk.

[45]GAO, *Flood Insurance: Strategies for Increasing Private Sector Involvement,* GAO-14-127 (Washington, D.C.: Jan. 22, 2014). NFIP's operating environment differs from that of traditional insurers and limits FEMA's ability to keep the program financially sound. In particular, NFIP assumes and retains all of the risks for the policies it sells, is required to accept virtually all applicants for insurance, and cannot deny coverage for potentially high-risk properties.

premiums from policyholders to pay claims, increases the federal government's fiscal exposure, and may reduce policyholders' incentives to manage risk by giving them inaccurate signals about the level of risk.[46] Specifically, federal insurers face a challenge between providing affordable premiums through subsidies and managing financially self-sufficient programs by charging policyholders full-risk premiums. Additionally, while insurers, in general, communicate the risk of incurring losses to policyholders through their premium rates, by subsidizing some policies, federal insurers have not provided all policyholders with accurate price signals about their risk of incurring losses.[47] As a result, some NFIP and federal crop insurance policyholders may perceive their risk of loss to be lower than it really is and may have less financial incentive to reduce this risk.[48]

For example, FEMA offers subsidized premium rates for policies covering certain structures, some of which are in high-risk areas. As a result of NFIP's historical rate structure, the program has generated sufficient premiums to cover claims in years with average losses but has not had sufficient funds to cover claims in catastrophic loss years, and FEMA has an outstanding balance with the U.S. Treasury of $24 billion to pay for claims in these years. Although FEMA is phasing out most subsidies, they may remain in place for many years, and while they are in place, newly

[46]Although the Homeowners Flood Insurance Affordability Act requires FEMA to phase out premium subsidies, this process may take several years. Consequently, subsidized rates remain a program challenge.

[47]We previously found that subsidized policies in 2012 accounted for about 20 percent of NFIP policies, and premium subsidies accounted for about 62 percent of crop insurance premiums collected by RMA in 2011. See GAO, *Flood Insurance: More Information Needed on Subsidized Properties*, GAO-13-607 (Washington, D.C.: July 3, 2014) and GAO-12-256.

[48]According to RMA, under the crop insurance program, insurance providers notify every producer about how much premium was paid by the government and how much is paid by the producer. Under the Homeowner Flood Insurance Affordability Act of 2014, FEMA is required to communicate full-risk flood determinations to individual property owners regardless of whether their rates are full-risk or subsidized. However, in a July 2013 report, we found that property elevations—which inform flood risk determinations—are unknown for 97 percent of both 1.15 million historically subsidized policies and more than 700,000 subsidized policies in special flood hazard areas. In the report, we concluded that FEMA will need elevation certificates to phase out and eventually eliminate subsidies and revise rates over time. GAO-13-607. We recommended that FEMA develop and implement a plan, including a timeline, to obtain needed elevation information as soon as practicable.

purchased residential properties may qualify for subsidized NFIP rates.[49] As long as some NFIP policyholders only pay for a portion of their risk of losses due to subsidized premiums, they receive inaccurate price signals about their property's full flood risk—regardless of what other information FEMA may provide. Consequently, policyholders who receive subsidized rates may have limited financial incentive to take steps, such as floodproofing their homes above base flood elevation, to reduce their risk.[50]

For federal crop insurance, although RMA is required to collect sufficient premiums to cover projected claims, the premiums are subsidized by the federal government. For example, we previously found that the government paid about 62 percent of premium costs for the program in 2011. The government continued to pay 62 percent of premium costs in 2013, which totaled about $7.3 billion.[51] Also, in August 2014, we found that the costs of federal crop insurance have grown, primarily due to an increase in the value of premium subsidies.[52] According to an April 2014 Congressional Budget Office report, crop insurance program costs are expected to average $8.9 billion annually, for fiscal years 2014 through 2023. Similar to flood insurance, federal crop insurance policyholders receive inaccurate price signals about their potential risk of loss when they receive such premium subsidies. Although farmers are informed of the subsidy amount and have an incentive to maximize their annual yields, they do not bear the true cost of their risk of loss due to weather-related events, such as drought—which could affect their farming decisions.[53]

[49]Pub. L. No. 112-141, div. F, tit.II, subtit. A (2012), Homeowner Flood Insurance Affordability Act of 2014, Pub. L. No. 113-89 (2014).

[50]According to FEMA guidance, floodproofing is any combination of structural and nonstructural additions, changes, or adjustments to structures which reduce or eliminate flood damage to real estate or improved real property, water and sanitary facilities, structures and their contents. For example, a property owner could make their structure watertight below base flood elevation.

[51]See also GAO-12-256 for more information on historical premium subsidy rates.

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

[53]For example, if a farmer has to make a decision about whether to farm land that may pose a higher risk of loss, the farmer is less likely to do so if he or she would have to pay a full rather than a subsidized insurance premium.

In prior work, we concluded that reducing subsidies and charging full-risk premiums to individual policyholders would decrease the federal government's fiscal exposure under the flood and crop insurance programs.[54] Reducing the federal government's fiscal exposure to losses under federal insurance programs and sending more accurate signals to policyholders about their risk, become even more important as the risks from climate change and related extreme weather events increase.

Second, given the short-term nature of insurance, public insurers face a challenge in encouraging their policyholders to reduce their long-term exposure to climate change risks.[55] Property insurance contracts typically estimate and communicate risk of property losses for the 1-year term of a policy. However, climate change effects on insured property, such as buildings or fields in production, may span decades. Because FEMA and RMA only provide policyholders with price signals for expected losses in the upcoming year, these policyholders may not be encouraged to reduce long-term risks for their property. Similarly, in agriculture, the tension between the short- and long-term extends beyond insurance into farming operations. According to RMA officials, farmers make annual decisions on the starting times and types of crops they plant and buy seed for the following year. They focus more heavily on this short-term time horizon, in part because seed and farming technology constantly change.

Furthermore, building to community standards that are identical to existing NFIP standards—which are based on near-term flood risk—may unintentionally increase policyholders' long-term vulnerability to climate change as sea-level rises or erosion increases properties' flood risk—which does not reflect the direction contained in Executive Order 13653.

[54]GAO-14-700, GAO-13-607, and GAO-12-256. We have also found that the federal government's cash-based budgeting does not adequately reflect the government's cost or the economic impact of federal insurance programs. Cash-based budgeting generally recognizes costs as they are paid, whereas accrual-based budgets recognize costs when commitments are made. We concluded the potential benefits of an accrual-based budgeting approach for federal insurance programs warrant continued effort in the development of risk-assumed cost estimates. See GAO/T-AIMD-98-147. As we previously found, the full cost of crop insurance subsidies and administrative costs is reflected in the budget. GAO-14-28.

[55]If insurance contracts were long-term, other, different challenges could result. For example, long-term contracts could be more difficult to price and could be prohibitively expensive because of the need for greater risk margins reflecting the greater uncertainty of the magnitude of long-term changes.

This is because, in the short-term, policyholders may be less likely to consider taking actions to protect their homes or localities against future risk and may continue to build in high-risk areas. According to FEMA guidance, the NFIP standards are periodically revised to incorporate new regulations or clarify old ones. Communities in turn must then update their own regulations to maintain consistency with the NFIP standards. Without incorporating forward-looking minimum standards into NFIP's requirements, similar to the minimum standard applied by the Hurricane Sandy Rebuilding Task Force, NFIP policyholders and localities may continue to build and rebuild structures to current community standards that may not reflect the changing weather-related risks faced over structures' designed life spans—thereby exacerbating the federal financial risk to climate change.

Regarding the federal crop insurance program, federal law prohibits crop insurance from covering losses due to farmers' failure to follow good farming practices. RMA's good farming practices provide acceptable farming methods for crop insurance policyholders to use in producing yields consistent with historical production. However, these practices are focused on maintaining historic crop yields over the term of the annual insurance contract, and some of these practices may unintentionally increase the vulnerability of agriculture to climate change, contrary to Executive Order 13653's directive for agencies to manage vulnerabilities to climate change. For example, certain practices, such as conventional tillage and traditional irrigation methods, may maintain historic crop yields in the short-term, but they may inadvertently reduce agriculture's long-term resilience through increased erosion, depleted soil quality, and inefficient water use. RMA officials said that crop insurance adjusts to farmers' best management practices and should follow their adjustments rather than dictate their behavior. However, a variety of factors influence farmers' production practices and, in some cases, farmers may not adopt resilient practices unless these practices also maximize farmers' short-term net benefits, consistent with crop insurance's focus on maintaining historic production.[56] By not encouraging agricultural experts to recommend or incorporate resilient agricultural practices into their expert guidance for growers' good farming practices, RMA is likely missing an opportunity to decrease existing and future fiscal exposures to climate

[56]For example, RMA officials said that appropriate farming practices vary depending on the farm location and the conditions specific to any given year.

change. Consequently, crop insurance may continue to cover losses resulting from practices that increase vulnerability to climate change.

Many Private Insurers and Reinsurers Have Identified and Assessed Climate Change Risks, but Preparing for Long-Term Effects Is Challenging

Many private property and casualty insurers and reinsurers have taken some steps since our 2007 report on flood and crop insurance to understand and report on their risks associated with climate change, including participating in industry climate change surveys, and issuing reports that identify and assess climate change risks and trends in weather-related losses. While selected insurers we interviewed said they manage climate change risks through their underwriting practices, we found that the industry faces challenges in preparing for long-term climate change, such as short-term insurance contracts and catastrophe modeling limitations.

Many Private Insurers and Reinsurers Identified and Assessed the Climate Change Risks They May Face

Since our 2007 report on flood and crop insurance, industry representatives, including insurers, reinsurers, and brokerage firms, have reported on climate change risks they face. For example, many insurers have reported on how they incorporate climate change into their risk management practices through an annual industry survey adopted by the National Association of Insurance Commissioners (NAIC) in 2010.[57] According to an analysis by the California Department of Insurance, which administers the survey, 1,067 insurers participated in the climate risk disclosure survey in 2013, for reporting year 2012.[58] The California Department of Insurance found that 74 percent of insurers that participated in the 2012 survey indicated that they have a process for identifying and assessing climate change-related risks, and 65 percent of insurers indicated that they have encouraged policyholders to reduce the

[57]According to NAIC, the climate risk disclosure survey was designed to inform state regulators about how insurers incorporate climate change into their risk management practices and provide benchmarks that insurers could use to assess their climate change strategies and identify how climate change affects their business. The survey consisted of eight questions, asking insurers to describe how they incorporate climate risks into their mitigation, risk management, and investment plans, and to identify steps taken to engage key constituencies and policyholders on the topic of climate change.

[58]The California Department of Insurance presented its analysis of the 2012 survey results in March 2014 to NAIC's climate change working group. We did not assess the reliability of the California Department of Insurance's findings.

losses caused by climate change-influenced events. According to several insurers and industry representatives we interviewed, insurers generally manage their exposure to weather-related losses associated with climate change through their underwriting practices, which include charging risk-based premiums, managing coverage options, and sharing exposure to losses by purchasing reinsurance.

In addition to insurers' participation in the climate risk disclosure survey, other insurance industry representatives have identified and assessed risks associated with climate change. For example, representatives from three of four reinsurers we interviewed said that they have issued reports on climate change risks or weather-related losses. In addition, one of two reinsurance brokers we interviewed has reported on climate change risks and scientific assessments. The other reinsurance broker we interviewed has issued monthly and annual reports on natural catastrophe losses worldwide based on publicly available industry and climate data that cover topics associated with climate change, including trends in hurricane frequency, global temperatures, and weather-related losses.

Preparing for Long-Term Climate Change Effects is Challenging for Private Insurers

Private insurers face several challenges to prepare for the long-term effects of climate change. One key challenge is similar to that identified by public insurers: the short-term nature of insurance contracts. Insurers generally write property coverage for 1-year terms. While short-term contracts allow insurers flexibility to manage their exposure to losses through (1) changes in coverage or pricing or (2) not renewing a particular policy, the annual period of each contract makes it challenging for insurers to incorporate long-term climate change projections into their risk management practices.

According to several industry representatives we interviewed, insurers and reinsurers use advanced computer modeling, known as catastrophe models, to help estimate risks and price insurance policies. While catastrophe modeling helps insurers and reinsurers estimate potential short-term weather-related losses, they said that incorporating the effects of climate change into catastrophe models remains a challenge. According to a representative of a catastrophe modeling firm we interviewed, catastrophe models that insurers use to price policies generally estimate short-term risks based on historical weather data and

past losses and not on long-term climate change projections.[59] Many industry representatives said that advances in catastrophe modeling have improved risk measurement over time. However, estimating weather-related risks still includes elements of uncertainty, and catastrophe modeling information is limited for some weather-related risks. We interviewed representatives from two catastrophe modeling firms and a reinsurance broker that have developed models to estimate risks associated with hurricanes, including wind and storm surge impacts, as well as a model for estimating the effects of weather on crops. Several firms are developing catastrophe models for inland flood risk, which will help estimate potential flood risks, although FEMA officials and several industry representatives said these models are not yet advanced enough to allow insurers to estimate or price flood risk for individual properties.

Even with these challenges, several industry representatives said that, barring any additional regulatory restrictions, insurers and reinsurers are positioned to continue managing risks associated with climate change through their ability to set risk-based prices, write coverage, or manage exposure to losses. However, two reports by an industry group and academics have found that past catastrophic events have caused the private property casualty insurance market to retract following a major disaster, placing greater pressure on public insurers to provide coverage. For example, according to a 2012 Insurance Information Institute report, some insurers became insolvent or stopped writing coverage in certain areas following Hurricane Andrew in 1992 and, since then, Florida's state insurer has grown from a market of last resort to the state's largest insurer.[60] While some industry representatives we interviewed said insurers and reinsurers have successfully managed weather-related risks through underwriting, some said additional incentives are needed to help the private sector, government programs, and individuals manage their

[59]Two catastrophe modeling firms whose representatives we interviewed have developed hurricane models that include both historical weather information and projections based on sea surface temperature changes, but most catastrophe models are based on historical weather data and scenario-modeling based on previous weather events.

[60]McChristian, Lynne, *Hurricane Andrew and Insurance: The Enduring Impact of an Historic Storm* (Tampa, FL: Insurance Information Institute, August 2012).

exposure to risks associated with climate change.[61] For example, several industry representatives have said that South Carolina's tax credit program for homeowners who fortify their homes to make them more resistant to hurricanes, catastrophic wind events, or flooding could encourage individuals to take steps to reduce their exposure to such risks.[62]

Some industry representatives we interviewed also suggested that federal, state, and local government adoption of building and land use practices that recognize potential climate change effects would help decrease both public and private exposure to insured and uninsured weather-related losses.[63] For example, land use practices and zoning regulations that recognize potential climate change impacts could help reduce public and private exposure to climate change by limiting new construction or relocating existing structures from hazard-prone areas. In addition, several insurers and reinsurers we interviewed and other industry representatives have suggested that incentives are needed to encourage more state or local governments to adopt resilient building standards to help mitigate against weather-related losses. The Hurricane Sandy Rebuilding Task Force reported in August 2013 that using disaster-resistant building codes is the most effective method to ensure new and rebuilt structures are designed and constructed to a more

[61]Some insurers offer incentives to customers for mitigation. For example, one insurer we interviewed offers discounted premiums on homeowners' insurance to homeowners that have taken steps to improve their structures ability to withstand strong winds and hail. In addition, Florida law requires insurers licensed in the state to offer discounts to homeowners who take certain steps to mitigate wind storm damage. Further, several industry representatives said insurers provide educational information to homeowners to encourage both mitigation and preparedness for risks associated with climate change such as hurricanes, floods, and wildfires.

[62]South Carolina's Omnibus Coastal Property Insurance Reform Act of 2007 provides state income tax credits for the costs a homeowner incurs to retrofit one's home to make it more resistant to loss due to hurricanes, rising floodwaters, or other catastrophic windstorm events. S.C. Code Ann. § 12-6-3660.

[63]As one industry group has reported, several states have not updated their building codes to reflect the most recent international standards. As such, these codes may not protect structures against current risk, regardless of climate change. See Insurance Institute for Business and Home Safety, *Rating the States: An Assessment of Residential Building Code and Enforcement Systems for Life Safety and Property Protection in Hurricane-Prone Regions* (Tampa, FL: Insurance Institute for Business and Home Safety, December 2011).

resilient standard.[64] The task force recommended that states and local governments adopt the most current building codes to ensure that buildings and other structures incorporate the latest science, advances in technology, and lessons learned. A representative from one industry group said updated and more resilient building codes, as well as improved enforcement measures, would help reduce exposure to weather-related risks including hurricanes, floods, wildfires, hail, and wind storms, which are associated with climate change. The industry group reported in December 2011 that while several hurricane-prone states, including Florida, Virginia, and New Jersey, have adopted more resilient building codes, opportunities exist for others to adopt stronger standards and better enforcement measures.[65]

To examine these and other issues, in November 2013, the President established a Task Force on Climate Preparedness and Resilience composed of state, local, and tribal leaders to advise the President and an interagency council on how the federal government can support state, local, and tribal preparedness for and resilience to climate change, among other things. The task force's recommendations, expected in the fall of 2014 according to a White House press release, will address removing barriers to resilient investments—such as improving data and tools available to state and local decision makers, reforming existing policies and federal funding programs, and identifying opportunities to support more climate-resilient investments by states, local communities, and tribes.[66]

[64]Hurricane Sandy Rebuilding Task Force, *Hurricane Sandy Rebuilding Strategy: Stronger Communities, a Resilient Region* (Hurricane Sandy Rebuilding Task Force, August 2013).

[65]Insurance Institute for Business and Home Safety, *Rating the States* (December 2011).

[66]According to White House press releases, in March 2014, the White House launched a Climate Data Initiative to leverage government resources and data to build tools that will make communities more resilient, in partnership with the private sector. In addition, in June 2014, senior administration officials met with a group of insurance and reinsurance industry leaders to discuss the economic consequences of increasingly frequent and severe extreme weather. The discussion centered on opportunities to share data between the federal government and the insurance industry to better communicate and reduce risks to policyholders, communities, and taxpayers. Participants also agreed to find ways to collaborate to create broader community resilience to strengthen neighborhoods and businesses.

Conclusions

FEMA and RMA have commissioned climate change studies, incorporated climate change adaptation into their planning, and taken other steps to address aspects of their federal flood and crop insurance programs that create fiscal exposures associated with climate change and extreme weather. However, the agencies continue to face fundamental challenges that send inaccurate price signals to policyholders about their potential risk of loss and increase federal fiscal exposure, and may unintentionally increase their policyholders' vulnerability to climate change risks. We have previously concluded, among other things, that reducing subsidies and charging full-risk premiums to individual policyholders would decrease the federal government's fiscal exposure under the flood and crop insurance programs.

Executive Order 13653 directs federal agencies to, consistent with their missions, reform policies that may, perhaps unintentionally, increase the vulnerability of natural or built systems, economic sectors, natural resources or communities to climate change. Regarding FEMA's flood insurance program, the agency is phasing out most subsidies, and is studying how to incorporate the projected effects of climate change, such as future sea-level rise and erosion, into its flood maps, but the mapping advisory council's recommendations aren't expected until September 2015. Until the agency implements these changes, some NFIP policyholders will continue to receive inaccurate signals about their current risk of loss, and all may not receive signals about their future risk of loss over the designed lifespan of their insured property. Furthermore, NFIP standards may not fully reflect policyholders' long-term vulnerability to climate change because these standards are based on current risk that does not reflect future sea-level rise, erosion, or other changes. Without incorporating forward-looking minimum standards into NFIP's construction and rebuilding requirements, similar to the minimum standard adopted by the Hurricane Sandy Rebuilding Task Force, NFIP policyholders and communities may continue to build and rebuild structures to current NFIP standards that do not necessarily reflect the changing weather-related risks faced over structures' designed life spans—which could exacerbate federal fiscal exposure amid already strained federal resources.

In addition, a variety of agricultural practices are available to farmers that would improve their long-term resilience to climate change, such as practices that would promote long-term water conservation and soil conservation. However, federal crop insurance policyholders may receive inaccurate price signals about their current risks because of subsidized

premiums and because of the short-term nature of annual insurance contracts they may not receive signals that reflect the long-term implications of their short-term farming practice decisions. Additionally, federal law prohibits crop insurance from covering losses due to a farmers' failure to follow good farming practices, although some of these practices may increase the vulnerability of agriculture to climate change, which may not reflect the direction contained in Executive Order 13653. Without working with agricultural experts to recommend or incorporate resilient agricultural practices into their expert guidance for growers' good farming practices, RMA is likely missing an opportunity to decrease existing and future fiscal exposures to climate change. Consequently, crop insurance may continue to cover losses resulting from practices that increase vulnerability to climate change.

Recommendations for Executive Action

We are making two recommendations in this report.

- To promote forward-looking construction and rebuilding efforts while FEMA phases out most subsidies, we recommend that the Secretary of the Department of Homeland Security direct FEMA to consider amending NFIP minimum standards for floodplain management to incorporate, as appropriate, forward-looking standards, similar to the minimum standard adopted by the Hurricane Sandy Rebuilding Task Force.
- To promote greater resilience to climate change effects in U.S. agriculture, we recommend that the Secretary of Agriculture direct RMA to consider working with agricultural experts to recommend or incorporate resilient agricultural practices into their expert guidance for growers, so that good farming practices take into account long-term agricultural resilience to climate change.

Agency Comments and Our Evaluation

We provided a draft of this report to USDA, Commerce, DHS, and Treasury for review and comment. USDA provided written comments, which are reproduced in appendix II; Commerce provided technical comments, which we incorporated as appropriate; DHS provided written comments, which are reproduced in appendix III; and the Department of the Treasury did not provide comments. USDA did not specify their agreement or disagreement with our recommendation, and DHS agreed with our recommendation.

In its written comments, USDA referenced our finding that RMA's good farming practices focus on maintaining historic crop yields over the term of the annual insurance contract and that some of these practices may

unintentionally increase the vulnerability of agriculture to climate change, contrary to Executive Order 13653's directive for agencies to manage vulnerabilities to climate change. USDA stated that RMA does not direct producers to take or carry out certain agronomic practices, but rather relies on guidance from agricultural experts in the area. USDA also stated that to the extent that agricultural experts in an area recommend or incorporate resilient practice recommendations into their expert guidance for growers in a given area, then RMA would consider such in its good farming practice determination for coverage of losses. While RMA may not direct producers to follow certain agronomic practices, it can provide incentives for farmers' adoption of resilient practices by working with agricultural experts to recommend or incorporate resilient practices into their expert guidance for growers' good farming practices and therefore eligibility determinations for claim payments. As we note in the report, RMA has an opportunity to potentially reduce agriculture's long-term vulnerability to climate change by encouraging the adoption of resilient practices now. For that reason, we recommend that RMA consider working with agricultural experts to recommend or incorporate resilient agricultural practices into their expert guidance for growers so that good farming practices take into account long-term agricultural resilience to climate change.

In addition, USDA refers to one of our identified program challenges to insurers that federal law encourages them to provide affordable insurance to policyholders through subsidized rates, which may reduce policyholders' incentives to manage risk by giving them inaccurate signals about the level of risk. USDA states that, while the federal government does subsidize a significant share of a producer's premium, every producer receives a notification from his or her insurance provider, which explains how much premium was paid by the government and how much is to be paid by the producer. Therefore, USDA states that all producers are made aware of the full risk. While notifying farmers of the subsidy amount provides useful information, farmers do not bear the true cost of their risk of loss. As a result, the market signal sent by federal insurers for the price of the policyholders' risk is the amount the policyholders actually pay. We have modified the report and our recommendation to respond to USDA's comments.

In its written comments, DHS concurred with our findings that FEMA has taken action to better understand and prepare for climate change's potential effects and that FEMA faces challenges that may limit its ability to minimize long-term federal exposure to climate change.

DHS also concurred with our recommendation to consider amending NFIP minimum standards for floodplain management to incorporate, as appropriate, forward-looking standards, similar to the minimum standard adopted by the Hurricane Sandy Rebuilding Task Force. In particular, DHS stated that FEMA has already taken action to consider amending NFIP minimum standards by (1) commissioning a 2006 study to assess the adequacy of the NFIP's minimum standards, (2) participating in a 2004 forum with key stakeholders about amending the NFIP minimum standards, and (3) encouraging communities to participate in the NFIP's Community Rating System, which offers discounted flood insurance rates in exchange for a community's proactive efforts to reduce its flood risk.[67]

We do not believe that these actions meet the intent of our recommendation for several reasons. First, commissioning a study and participating in a policy forum that discussed several aspects of NFIP minimum standards are not sufficient evidence that FEMA officials considered adopting forward-looking standards. FEMA has not provided documentation of internal policy discussions or other actions taken in response to the study or forum's findings. Additionally, the study commissioned by FEMA is 8 years old, and it therefore does not reflect scientists' current understanding of sea-level rise and other climate change effects identified in more recent National Climate Assessments. Similarly, the discussion with stakeholders occurred 10 years ago, and it therefore does not reflect the current state of the program, stakeholders' current understanding of climate-related risks, the adequacy of FEMA's floodplain maps, and recent advances in mapping technology. Moreover, the Community Rating System is voluntary and, as of March 2014, 1,296 of the nearly 22,000 NFIP-participating communities are in the program. These communities represent about 67 percent of NFIP policyholders. Accordingly, amending the NFIP minimum standards could reach the over 20,000 nonparticipating communities.

As the summary report from the 2004 forum notes, building in a margin of error such as adding a foot or more to the calculated base flood

[67]American Institutes for Research, *Assessing the Adequacy of the National Flood Insurance Program's 1 Percent Flood Standard*, a report prepared under subcontract to the American Institutes for Research as part of the 2001-2006 Evaluation of the National Flood Insurance Program (October, 2006); and American State Floodplain Managers Foundation, *Reducing Flood Losses: Is the 1% Chance Flood Standard Sufficient?,* a report of the 2004 Assembly of the Gilbert F. White National Flood Policy Forum (September, 2004).

evaluation for flood hazard assessment at the outset of the program could have avoided many of the program's current problems regarding uncertainty—including the uncertainty of climate change. We continue to believe that FEMA should consider amending the NFIP minimum standards to incorporate, as appropriate, forward-looking standards, and we therefore do not consider the recommendation resolved and closed.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the appropriate congressional committees, the Secretary of Agriculture, the Secretary of Commerce, the Secretary of Homeland Security, the Secretary of Treasury, and other interested parties. In addition, the report will be available at no charge on the GAO website at http://www.gao.gov.

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or gomezj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix IV.

J. Alfredo Gómez
Director, Natural Resources and Environment

List of Requesters

The Honorable Michael Bennet
Chairman, Subcommittee on Conservation, Forestry, and Natural Resources
Committee on Agriculture, Nutrition, and Forestry
United States Senate

The Honorable Sheldon Whitehouse
Chairman, Subcommittee on Oversight
Committee on Environment and Public Works
United States Senate

The Honorable Jack Reed
Chairman, Subcommittee on Securities, Insurance, and Investment
Committee on Banking, Housing, and Urban Affairs
United States Senate

The Honorable Peter DeFazio
Ranking Member
Committee on Natural Resources
House of Representatives

The Honorable Thomas Harkin
United States Senate

The Honorable Tom Udall
United States Senate

Appendix I: Objectives, Scope, and Methodology

To determine how federal and private sector exposure to losses has changed since our 2007 report on flood and crop insurance and how climate change has or may affect insured and uninsured losses, we analyzed federal and private sector exposure data from 2007 through 2013. To understand longer-term trends in exposure, we also analyzed federal exposure data from 2000, and we reviewed scientific studies and other available literature on climate change. Specifically, we collected agency data on the total value of property insured under the National Flood Insurance Program (NFIP) and the federal crop insurance program. For the private sector, we collected estimates of the total value insured by property-casualty insurers—excluding auto—as determined by two industry catastrophe modeling firms, AIR Worldwide and Risk Management Solutions. We assessed the reliability of the agency and industry data we collected and determined it was sufficiently reliable for describing the total value of property insured.[1] We also conducted a literature review to identify pertinent studies on how climate change has or may affect insured and uninsured losses. Specifically, we searched for scholarly articles, industry articles and reports, think-tank reports, conference reports, and government publications published from 2007 onward. Through the literature search, we identified a number of studies that discussed climate change's potential effects on insured and uninsured losses and stakeholder perspectives of climate change risks. For summarizing the effect of climate change on insured and uninsured losses, we limited our review to scientific, empirical studies that evaluated the historical loss record or projected future losses. Each of these studies used various techniques to discern the respective influences on the loss record of changes in exposure (e.g., wealth, population, insurance penetration) versus changes in weather patterns. Based on these criteria, we identified a total of 64 studies that were relevant and applicable to our report, 20 of which directly addressed the issue of climate change's effect on losses. We reviewed the methodologies of these studies to ensure that they were sound and determined that they were sufficiently reliable for describing the potential effect of climate change on insured and uninsured losses.

[1]To assess the reliability of exposure data, we reviewed federal agency procedures for collecting and updating the data. For private sector exposure data, we compared exposure estimates from two separate firms. To assess the reliability of scientific studies, staff from our Center for Science, Technology and Engineering office and Center for Economics reviewed each study to determine whether their methodologies were sound and appropriate for our purposes.

To determine how public insurers are preparing for climate change, we reviewed agency documents related to climate change. We reviewed the Department of Homeland Security's (DHS) 2012 Climate Change Adaptation Roadmap, the 2011 Federal Emergency Management Agency's (FEMA) Climate Adaptation Policy Statement, and a 2013 AECOM climate change study which FEMA commissioned. We also reviewed the Risk Management Agency's (RMA) 2012 Climate Adaptation Plan and 2011-2015 Strategic Plan, RMA's cooperative agreement with Oregon State's PRISM group, documents related to the agency's 2011 rate change calculations, and a 2009 RTI climate change and modeling study which the agency commissioned. In addition, at the federal level, we interviewed officials from NFIP, RMA, the U.S. Department of Agriculture, the National Oceanic and Atmospheric Administration, the Federal Insurance Office, and Council on Environmental Quality. We also reviewed the Biggert-Waters Flood Insurance Reform Act of 2012, the Homeowner Flood Insurance Affordability Act of 2014, and the Agricultural Act of 2014. At the state level, we interviewed officials from the Department of Insurance in three states and the wind insurers in two of those three states. We selected a nonprobability sample of states based on the following factors: identified by an industry forecaster as most at-risk to natural disaster, whether the state had an insurance pool administered by a governmental entity or entity established pursuant to state law, and whether the state had experienced an extreme weather-related event in the past decade. Because we used a nonprobability sample to select states, our results are not generalizable to all 50 states; however, our results can provide illustrative information. We also spoke with several academic experts on agriculture and modeling identified from publications, other experts, and our prior work.

Further, to determine how private insurers and reinsurers are preparing for climate change, we reviewed over 20 industry reports and other information from industry representatives, and we interviewed a nonprobability sample of representatives from four insurers and four reinsurers, as well as catastrophe modeling firms, reinsurance brokers, and industry groups representing more than 1,000 large and small property casualty insurers. We selected a sample of four insurers to interview based on market share, experience with flood or crop insurance, and involvement in climate change issues. For insurers selected based on market share, we identified those with a large share of the U.S. property casualty market (about 50 percent cumulative share of the U.S. property casualty market) and others with a smaller share of the market (1 percent or less), based on 2012 industry data. Among these firms, we

selected four insurers with diverse experience in the public and private insurance markets, and the four firms we interviewed represented over a 25 percent share of the U.S. property and casualty insurance market, and a 15 percent share of the private crop insurance market. We also interviewed representatives from a sample of 4 reinsurers, from among 10 reinsurance firms with the greatest share of the U.S. reinsurance market. The reinsurers we interviewed represented over a 30 percent share of the U.S. reinsurance market, based on 2012 industry data. In addition, we interviewed 11 other industry participants, as well as academic researchers for context. We identified industry participants to interview through our prior work and relevant publications, as well as suggestions from other interviewees. Industry participants we interviewed included representatives from two catastrophe modeling firms, two reinsurance brokerage firms, and seven industry groups representing insurers, reinsurers, and others. Among the industry groups we interviewed, two groups represented more than 1,000 large and small property casualty insurers. Because we used a nonprobability sample to select interviewees, our results are not generalizable to industry as a whole but provide illustrative examples.

We conducted this performance audit from November 2013 to October 2014 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Comments from the U.S. Department of Agriculture

USDA

United States Department of Agriculture

Farm and Foreign Agricultural Services
Risk Management Agency

October 6, 2014

TO: J. Alfredo Gomez
Director, Natural Resources and Environment
U.S. Government Accountability Office

FROM: Brandon Willis
Administrator
Risk Management Agency

SUBJECT: U.S. Department of Agriculture Comments- U.S. Government Accountability Office Draft Report, Climate Change: Better Management of Exposure to Potential Future Losses is Needed for Federal Flood and Crop Insurance, GAO-15-28 (361517)

The U.S. Department of Agriculture (USDA) appreciates the opportunity to review the subject Government Accountability Office (GAO) draft report. The Risk Management Agency has comments to this draft.

General Comments:

The first point is that RMA's construct of *Good Farming Practices*[1] "may unintentionally increase the vulnerability of agriculture to climate change, contrary to Executive Order 13653's directive for agencies to manage vulnerabilities to climate change" (p. 21). RMA does not direct producers to take or carry out certain agronomic practices, but rather it relies on guidance from agricultural experts in the area. The current definition "Good Farming Practice" allows for consideration of "sustainable farming practices". To the extent that agricultural experts in an area recommend or incorporate resilient practice recommendations to their expert guidance for growers in a given area, then RMA would consider such in its Good Farming Practice determinations.

The second point made in the report is that subsidies to federal crop insurance "may reduce policyholders' incentives to manage risk by giving them inaccurate signals about the level of risk" (p.18). While the Federal government does subsidize a significant share of the producer's premium, every producer receives a notification from their insurance provider which explains how much premium was paid by the government and how much is paid by the producer. Therefore, all producers are made aware of the full risk.

RMA

Deputy Administrator for Compliance
1400 Independence Ave., SW • STOP 0806 • Washington, DC 20250-0806

The Risk Management Agency Administers and Oversees
All Programs Authorized Under the Federal Crop Insurance Corporation

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In general, the potential for insurance to reduce the incentive to mitigate risk, also referred to as moral hazard, is a familiar challenge for all types of property and casualty insurance. The crop insurance program has several mechanisms in place to address the potential for moral hazard. First of all, producers have a deductible, so that they directly bear a significant share of any loss before receiving a crop insurance payment. Second, when a claim is filed, insurance companies will generally send loss adjustors to investigate the claim and assure that good farming practices were followed. Third, when a producer has a loss, his or her average yield decreases, which increases the premium rate and decreases coverage in future years. The strong actuarial performance of the crop insurance program over the last twenty years indicates that these measures have been generally successful in addressing the challenge of moral hazard.

[1] Good Farming Practices (GFP) is defined in section 1 of the Common Crop Insurance Policy Basic Provisions (7 C.F.R. § 457.8)

Appendix III: Comments from the U.S. Department of Homeland Security

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

Homeland Security

October 10, 2014

Mr. J. Alfredo Gomez
Director, Natural Resources and Environment
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Re: Draft Report GAO-15-28, "CLIMATE CHANGE: Better Management of Exposure to Potential Future Losses is Needed for Federal Flood and Crop Insurance"

Dear Mr. Gomez:

Thank you for the opportunity to review and comment on this draft report. The U.S. Department of Homeland Security (DHS) appreciates the Government Accountability Office's (GAO) work in planning and conducting its review and issuing this report.

The Department is pleased to note GAO's acknowledgement that the Federal Emergency Management Agency (FEMA) has taken action to better understand and prepare for climate change's potential effects under the National Flood Insurance Plan (NFIP), such as commissioning climate change studies. Additionally, we appreciate GAO's recognition that FEMA faces challenges that may limit its ability to minimize long-term federal exposure to climate change.

The draft report contained one recommendation for DHS with which the Department concurs. Specifically, GAO recommended that the Secretary of Homeland Security direct FEMA to:

Recommendation: Consider amending NFIP minimum standards for floodplain management to incorporate, as appropriate, forward-looking standards, similar to the minimum standard adopted by the Hurricane Sandy Rebuilding Task Force.

Response: Concur. FEMA has already taken action to consider amending the minimum NFIP minimum floodplain management standards, recognizing that increasing these standards has both benefits and implications for the 22,000-plus communities participating in the program and mindful of the potential economic effects of such a change. For example, in 2006 FEMA commissioned a study assess the adequacy of the current standards.[1] FEMA has also actively participated in national policy dialogs with key stakeholders regarding amending the current minimum standards.[2] FEMA recognizes the potential benefits of higher regulatory standards and

[1] "Assessing the Adequacy of the National Flood Insurance Program's 1 Percent Flood Standard" http://www.fema.gov/media-library-data/20130726-1602-20490-6095/nfip_eval_1_percent_standard.pdf
[2] "Gilbert F. White National Flood Policy Forum Reducing Flood Losses: Is the 1% Chance Flood Standard Sufficient?" http://www.asfpmfoundation.org/2004forum.htm

actively encourages communities to enact standards that exceed the minimum requirements, as appropriate for local conditions, through the NFIP's Community Rating System (CRS). Specifically, the CRS program offers discounted flood insurance premium rates in exchange for a community's proactive efforts to reduce flood risk. Given the aforementioned actions, which FEMA believes fulfills the intent of the recommendation, we request that GAO consider the recommendation resolved and closed.

Again, thank you for the opportunity to review and comment on this draft report. Technical comments were previously provided under separate cover. Please feel free to contact me if you have any questions. We look forward to working with you regarding future Homeland Security issues.

Sincerely,

Jim H. Crumpacker, CIA, CFE
Director
Departmental GAO-OIG Liaison Office

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Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

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

Staff Acknowledgments

In addition to the individual named above, Michael Hix (Assistant Director), Charles Bausell, Alicia Puente Cackley, Heather Chartier, Kendall Childers, Melinda Cordero, John Delicath, Steven Elstein, Diantha Garms, Cindy Gilbert, Kathryn Godfrey, Susan Irving, Richard Johnson, Jessica Lemke, Armetha Liles, Susan E. Offutt, Jeanette Soares, Vasiliki Theodoropoulos, Frank Todisco, Lisa Van Arsdale, Patrick Ward, Eugene Wisnoski, and Franklyn Yao made important contributions to this report.