S. HRG. 112–181

# FEDERAL DISASTER ASSISTANCE BUDGETING: ARE WE WEATHER-READY?

## HEARING

BEFORE A

SUBCOMMITTEE OF THE

COMMITTEE ON APPROPRIATIONS

UNITED STATES SENATE

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

**SPECIAL HEARING**

JULY 28, 2011—WASHINGTON, DC

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# FEDERAL DISASTER ASSISTANCE BUDGETING: ARE WE WEATHER-READY?

**THURSDAY, JULY 28, 2011**

U.S. SENATE,
SUBCOMMITTEE ON FINANCIAL SERVICES
AND GENERAL GOVERNMENT,
COMMITTEE ON APPROPRIATIONS,
*Washington, DC.*

The subcommittee met at 2 p.m., in room SD–138, Dirksen Senate Office Building, Hon. Richard Durbin (chairman), presiding.

Present: Senators Durbin and Moran.

OPENING STATEMENT OF SENATOR RICHARD J. DURBIN

Senator DURBIN. I'm pleased to convene this hearing to investigate the Federal Government's responsibilities in terms of dealing with long-term planning to mitigate the economic impact of severe weather events. I welcome my distinguished ranking member, Senator Jerry Moran of Kansas. Other colleagues may join us on the dais today. And they will be invited to send in written questions if they're not in attendance personally.

Joining us today to contribute to the conversation are public officials and experts in disaster relief and catastrophe modeling from the Government, business, and scientific realm.

Our first witness is going to be David C. Trimble, Director of the Natural Resources and Environmental Group with the Government Accountability Office (GAO).

Our second witness is Kathryn D. Sullivan, Ph.D., Deputy Administrator and Assistant Secretary of Commerce for Environmental Observation and Prediction at the National Oceanographic and Atmospheric Administration (NOAA). Incidentally, Dr. Sullivan was the first woman to walk in space and previously served as the NOAA's chief scientist.

Our next witness is James Rivera, associate administrator for the Office of Disaster Assistance at the SBA.

Our fourth witness is Dr. Donald J. Wuebbles. He is an endowed professor at the University of Illinois and recipient of the 2007 Nobel Prize for his work with the intergovernmental panel on climate change. On a prouder note, Dr. Wuebbles is an Illinois native, son of a farmer, raised in Clinton County, Carlyle, Illinois. Glad that you're here.

Our final witness is Franklin W. Nutter, president of the Reinsurance Association of America.

A famous political philosopher named Robert Allen Zimmerman, a.k.a. Bob Dylan, once said, you don't have to be a weatherman to

know which way the wind is blowing. And we are going to discuss today how the wind is blowing in terms of weather events and whether we're prepared for it.

According to the NOAA's National Climate Data Center (NCDC), the United States has already experienced eight natural disasters, with damages totaling more than $1 billion this year—eight. The previous record for weather-related disasters of this magnitude was nine in one year. We're almost at that point and it's only July.

[The information follows:]

NATURAL DISATSER LOSSES IN THE UNITED STATES—FIRST SIX MONTHS OF 2011

[Dollars in millions]

| Event (As of July 6, 2011) | Number of events | Fatalities | Estimated overall losses | Estimated insured losses |
|---|---|---|---|---|
| Severe thunderstorm | 43 | 593 | $23,573 | $16,350 |
| Winter storm | 8 | 15 | 1,900 | 1,425 |
| Flood | 8 | 15 | 2,100 | ([1]) |
| Earthquake | 2 | 1 | 105 | ([1]) |
| Tropical cyclone | ..... | ..... | ..... | ..... |
| Wildfire | 37 | 7 | 125 | 50 |

[1] In progress.

SOURCE.—MR NatCat*SERVICE*.

I fly home to Illinois every weekend. I can tell you that, during the last 6 months, I've seen it all. Chicago and Illinois have experienced blizzards, tornadoes, blistering heat, and severe flooding.

In February, just a few months back now, Chicago—the third-largest city in the United States—was shut down with 2 feet of snow overnight, 60 mile-per-hour winds that hammered the city. That blizzard caused 36 deaths and more than $3.9 billion in damage. This spring, tornadoes damaged homes and businesses throughout our State.

In May, flooding along the Ohio River was so severe, the Army Corps of Engineers was forced to blow a levy in Missouri to prevent homes in Cairo, Illinois, from being completely destroyed.

Last Friday night, as I was telling Senator Moran, I was awakened by what I thought was a storm. It sure was. It dumped almost 7 inches of rain in a little more than an hour, the largest single 1-day rainfall in the history of recorded weather in the city of Chicago. The Metropolitan Water Reclamation District was forced to release untreated sewage into Lake Michigan. The system was overwhelmed.

Last night, several parts of Illinois suffered severe rainstorms that caused the evacuation of hundreds of people and two fatalities. July is now the wettest month in the 122 years of Chicago's recorded history.

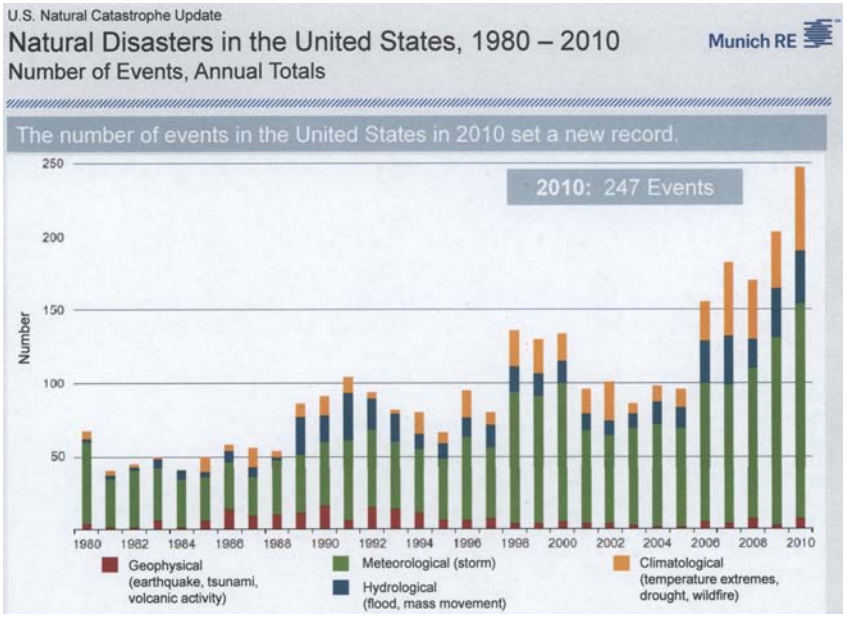
Illinois is not alone in these notable weather events. We've seen droughts in Texas, wildfires in Arizona and New Mexico, flooding in Tennessee, and according to Senator Moran, both drought and flooding in his State.

Today, there are excessive heat warnings in more than 20 communities throughout Kansas, Senator Moran's home State, and flood warnings along the Missouri River.

In 2011 alone, almost $28 billion in damages have already been caused by catastrophic events, and hurricane season is just start-

ing. The economic impact of severe weather events is only projected to grow in future years as the frequency and intensity of weather events continues to grow.

As this chart will show you, the weather is getting worse and more violent; catastrophic, in fact. The Federal Government needs to do more to be ready to protect Federal assets and to provide disaster assistance on an increasing frequency.



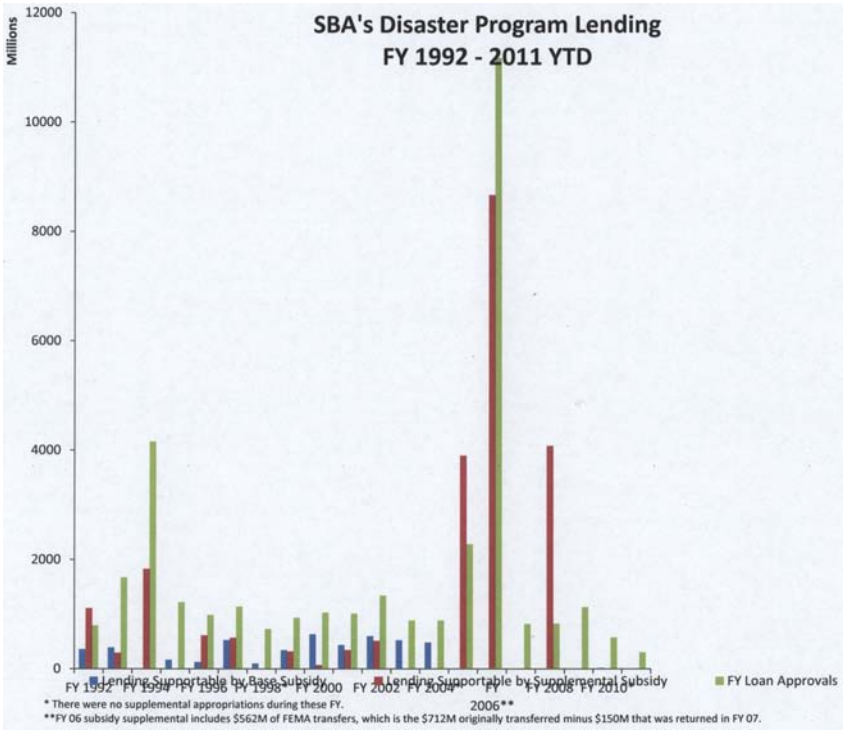

SOURCE.—MR NatCat*SERVICE*.

Are we ready? Well, the private insurance industry is. I was surprised, Mr. Nutter, in visiting some of the leaders in your business, a year or two ago, and realizing how closely they follow weather and weather patterns, principally if they're in the property and casualty realm. And they make business decisions about risk, and whether or not the risks are going to increase to the point where premiums have to go up or they stop writing insurance. And they make those decisions on a regular basis.

You're thinking ahead. I'm not sure the Federal Government is thinking ahead when it comes to our preparedness for disasters. Private insurers handled $89 billion in losses, sustained by 5.5 million policyholders, in the 2004 and 2005 hurricane seasons without any significant setbacks.

Given the industry's success, I want to see if there are budgeting practices the Federal Government could adapt from the private sector to better forecast how we budget for disaster assistance efforts.

Another chart we can put up here, the SBA's Disaster Loan Program provides a good example of the sporadic Federal budgeting associated with natural disasters. Historically, loan volumes under the program average $1 billion a year.




However, the actual amount fluctuates greatly from year to year and often differs significantly from the long-term average. In years with multiple catastrophic events, we are left scrambling to fund relief programs in the short term. In the meantime, we're not focusing strategically on the long-term Federal budgetary impact of what we know is happening, increasingly severe weather events.

With the potential for more severe disasters occurring with greater frequency, I have called this hearing to explore the Federal Government's planning for spending on disaster relief. I don't know that other committees are considering this, but because of our appropriations responsibility, with at least one of the agencies affected, I've tried to coordinate other Federal agencies in this conversation.

PREPARED STATEMENTS

The cumulative expected exposure of the U.S. Government to weather-related disasters over the next 75 years could reach $7 trillion with inflation. If we hope to put this country on a sustainable fiscal path, we need to be prepared to manage this increase in natural catastrophe. We can learn from the private sector how to better prepare.

I ask unanimous consent that the submitted testimonies of Howard Kunreuther and Erwann Michel-Kerjan, and Risk Management Solutions, as well as a copy of an article entitled Redesigning Flood Insurance that appeared in Science magazine on July 22 be part

of the permanent record of this hearing. At this point, I'd like to turn it over to my colleague and friend, Senator Moran.

[The statements follow:]

PREPARED STATEMENT OF SENATOR RICHARD J. DURBIN

Good afternoon. I am pleased to convene this hearing to investigate how the Federal Government could improve its long-term planning to mitigate the economic impacts of severe weather events.

I welcome my distinguished ranking member, Senator Jerry Moran, other colleagues who have joined me on the dais today, and others who may arrive during the course of these proceedings.

Joining us today to contribute to this conversation are public officials and experts in disaster relief and catastrophe modeling from the government and scientific realms.

Our first witness is David C. Trimble, Director of the Natural Resources and Environment Group at the Government Accountability Office.

Our second witness is Kathryn D. Sullivan, Ph.D., Deputy Administrator and Assistant Secretary of Commerce for Environmental Observation and Prediction at the National Oceanic and Atmospheric Administration (NOAA).

Dr. Sullivan was the first woman to walk in space and previously served as NOAA's chief scientist.

Our next witness is James Rivera, Associate Administrator for the Office of Disaster Assistance at the Small Business Administration (SBA).

Our fourth witness is Dr. Donald J. Wuebbles. He is an endowed professor at the University of Illinois and recipient of the 2007 Nobel Peace Prize for his work with the Intergovernmental Panel on Climate Change.

And—I am proud to note—Professor Wuebbles in an Illinois native. He is the son of a farmer and was raised in Carlyle, Illinois.

Our final witness is Franklin W. Nutter, President of the Reinsurance Association of America.

According to the NOAA's National Climate Data Center, the United States has already experienced eight natural disasters with damages totaling more than $1 billion this year.

The previous record for weather-related disaster of this magnitude was nine in one year. We are almost at that point, and it is only July.

I fly home to Illinois almost every weekend. I can tell you that during the last 6 months, Illinois has experienced blizzards, tornados, blistering heat and severe flooding.

In February, Chicago—the third-largest city in the United States—was shut down as 2 feet of snow fell overnight and 60 mile per hour winds hammered the city.

The blizzard caused 36 deaths and more than $3.9 billion in damage.

This spring, tornados damaged homes and businesses throughout Illinois.

In May, flooding along the Ohio River was so severe that the Army Corps of Engineers was forced to demolish a levee to prevent homes in Cairo, Illinois, from being completely destroyed.

This past weekend, 7 inches of rain fell on Chicago in 1 day, the largest recorded single-day rainfall in history. The Metropolitan Water Reclamation District was forced to release untreated sewage into Lake Michigan and to close nearby beaches.

And last night, several parts of Illinois suffered severe rainstorms that caused the evacuation of hundreds of people and two fatalities.

July is now the wettest month in the 122 years of Chicago's recorded history.

And Illinois is not alone. We've seen drought in Texas, wildfires in Arizona, and flooding in Tennessee.

Today, there are excessive heat warnings in more than 20 communities throughout Kansas—Senator Moran's home State—and flood warnings along the Missouri River.

In 2011 alone, almost $28 billion in damages have already been caused by catastrophic events—and hurricane season is just beginning.

And the economic impact of severe weather events is only projected to grow in future years as the frequency and intensity of weather events continues to grow.

The weather is getting worse, catastrophic in fact. The Federal Government needs to do more to be ready to protect Federal assets and provide disaster assistance on an increasing frequency.

Is the Federal Government prepared for this?

The private insurance industry is.

These companies have stayed financially stable despite a dramatic increase in property losses in recent years.

Private insurers handled $89 billion in losses sustained by 5.5 million policyholders in the 2004 and 2005 hurricane seasons without any significant setbacks.

Given the industry's success, I'd like to see whether there are any budgeting practices that the Federal Government could adapt from the private sector to better forecast how we budget for disaster assistance efforts.

The SBA's Disaster Loan Program provides a good example of the sporadic Federal budgeting associated with natural disasters.

Historically, loan volumes under the program average $1 billion a year. However, the actual amount fluctuates greatly from year-to-year and often differs significantly from the long-term average.

In years with multiple catastrophic events, we are left scrambling to fund relief programs in the short term.

But, in the meantime, we're not focusing strategically on the long-term budgetary impacts of what we know is happening—increasingly severe weather events.

With the potential for more severe disasters occurring with greater frequency in the future, I have called this hearing to explore the Federal Government's planning for spending on disaster relief.

The cumulative expected exposure of the U.S. Government to weather-related disasters over the next 75 years could reach $7 trillion, with inflation.

If we hope to put this country on a sustainable fiscal path, we need to be prepared to manage this increase in natural catastrophes.

We can learn from the private sector how to better prepare for the economic impact of severe weather.

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PREPARED STATEMENT OF HOWARD KUNREUTHER AND ERWANN MICHEL-KERJAN

Chairman Durbin and Ranking Member Moran: We are very pleased that you are holding this hearing to examine the costs to the Federal Government associated with natural disasters and steps that could be taken to reduce those costs. We agree that this is an increasingly important subject to understand and address. We, Howard Kunreuther and Erwann Michel-Kerjan, have conducted considerable research in these areas at the Center for Risk Management and Decision Processes of The Wharton School at the University of Pennsylvania. It is a pleasure to share our observations and recommendations with you.

NATURAL DISASTERS IMPOSE SEVERE ECONOMIC LOSSES

In recent years we have witnessed a dramatic increase in the economic cost and death toll from hurricanes, earthquakes, floods, and other natural disasters worldwide. Economic losses from these catastrophic events increased from $528 billion (1981–1990) to more than $1.2 trillion over the period 2001–2010.[1]

Although we are only halfway through 2011, an exceptional number of very severe natural catastrophes, notably the Japanese earthquake and tsunami, makes 2011 the highest economic loss year on record. In the United States, the Southern and Midwestern States were hit by an exceptionally severe series of tornadoes in April and May. Around this time, heavy snowmelt, saturated soils, and more than 20 inches of rain in a month led to the worst flooding of the lower Mississippi River since 1927 with extensive agricultural damage, property, and inland marine losses. The U.S. National Hurricane Center at the National Oceanic and Atmospheric Administration forecast in May that the 2011 hurricane season would have above-average activity in the Atlantic basin.[2]

Given the increasing losses from natural disasters in recent years, it is surprising how few property owners in hazard-prone areas have invested in loss reduction measures. We propose a program that will address this issue directly and hence reduce the need for Federal disaster assistance in the future.

WHY ARE DISASTER LOSSES INCREASING?

There are at least two principal socio-economic factors that directly influence the level of economic losses due to catastrophe events: exposed population and value at risk. The economic development of Florida highlights this point. According to the

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[1] Data from Munich Re and Swiss Re.

[2] NOAA hurricane outlook indicates an above-normal Atlantic season (2011). *Available at*: http://www.noaanews.noaa.gov/stories2011/20110519_atlantichurricaneoutlook.html. May 19, 2011.

U.S. Bureau of the Census, the population of that State has increased significantly over the past 50 years: 2.8 million inhabitants in 1950, 6.8 million in 1970, 13 million in 1990, and 18.8 million population in 2010 (almost a 570 percent increase since 1950). A significant portion of that population increase lives in high hazard areas of the coast. There is thus an increased likelihood of severe economic and insured losses in Florida unless cost-effective mitigation measures are implemented. Recent climate studies indicate we should also expect more extreme weather-related events in the future.[3] The questions that need to be addressed directly by the Congress and other interested parties are:

—Who will pay for these massive losses?

—What actions need to be taken now so our country is more resilient when these disasters occur (as they will) in the future?

## INCREASING ROLE OF FEDERAL DISASTER ASSISTANCE

Not surprisingly, the disasters that occurred in now much more populated areas of the United States have led to historical levels of insurance claim payments[4] as well as a surge in the number of Presidential disaster declarations. In an article published last week in Science about reforming the federally run National Flood Insurance Program (NFIP), we showed that the number of major disaster declarations increased from 252 during the period 1981–1990, to 476 (1991–2000) and 597 during the period 2001–2010. In 2010 alone, there were 81 such major disaster declarations.[5]

American taxpayers paid $89 billion in relief in the aftermath of the 2005 hurricane season (2010 prices). This figure was actually greater than the combined amount that private insurers and reinsurers paid for wind-related insured losses due to Hurricanes Katrina, Rita, and Wilma.[6] This more pronounced role of the Federal Government in assisting disaster victims can also be seen by examining several major disasters that occurred in the past 50 years as shown in the table below.[7]

| Disaster | Federal aid as a percentage of total damage |
|---|---|
| Hurricane Ike (2008) | 69 |
| Hurricane Katrina (2005) | 50 |
| Hurricane Hugo (1989) | 23 |
| Hurricane Diane (1955) | 6 |

Each new massive Government disaster relief program creates a precedent. As a result, not only are there expectations when a disaster strikes that governmental assistance is on the way, but in order to gain politically from their actions, Members of Congress are likely to support bills that authorize more aid than for past disasters. If residents of hazard-prone areas expect more Federal relief following future disasters, they then have less economic incentive to reduce their own exposure and/or purchase insurance.

## REDUCING EXPOSURE TO LOSSES FROM DISASTERS

Today, we can more accurately estimate the risks that different communities and regions face from natural hazards. We are able to reduce potential disaster losses through mitigation measures and know that insurance can provide financial protection to those in harm's way, thus lowering the financial burden on taxpayers and increasing personal responsibility. Yet many residents in hazard-prone areas are still unprotected against earthquakes, floods, hurricanes, and tornados.

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[3] P.C.D. Milly, Julio Betancourt, Malin Falkenmark, Robert M. Hirsch, Zbigniew W. Kundzewicz, Dennis P. Lettenmaier, and Ronald J. Stouffer, *Science* 319, 573 (2008); Knutson, T., J. McBride, J. Chan, K. Emanuel, G. Holland, C. Landsea, I. Held, J. Kossin, A.K. Srivastava and M. Sugi. Tropical Cyclones and Climate Change. *Nature Geoscience* 3, 157–163. (2010).

[4] *See* H. Kunreuther and E. Michel-Kerjan (2009), *At War with the Weather* MIT Press, for a detailed analysis.

[5] E. Michel-Kerjan and H. Kunreuther (2011). Reforming Flood Insurance. *Science* 333, 408–409, July 22.

[6] The figure does not include the $17 billion paid by the NFIP for flood insurance claims for Hurricane Katrina, most of which had to be borrowed from the U.S. Treasury.

[7] E. Michel-Kerjan and J. Volkman-Wise (2011). The Risk of Ever-Growing Disaster Relief Expectations. Wharton Risk Center Working Paper #2011–09. *Available at* http://opim.wharton.upenn.edu/risk/papers.php

We address the following question: How do we reduce the exposure of property to losses from natural disasters and hence reduce the need for disaster assistance following future catastrophes?

We first focus on why many residents in hazard-prone areas do not protect themselves against disasters (which often starts with their moving to high-risk areas—a behavioral perspective). We then propose a course of action that overcomes these challenges (a policy perspective). Specifically, we believe that multi-year disaster insurance contracts tied to the property and combined with risk reduction loans will lead many more individuals to invest in protection and thus be in a much better financial position to recover on their own following the next disaster. The proposed program should thus reduce the need for disaster assistance and be a win-win situation for all the relevant stakeholders compared to the status quo. Current energy efficiency programs can serve as a model for our proposal.

## WHY INDIVIDUALS DO NOT PROTECT THEMSELVES AGAINST POTENTIAL DISASTERS [8]

There is growing empirical evidence from psychology and behavioral economics that many decisionmakers ignore the potential consequences of large-scale disasters for the following reasons:

*Misperceptions of the Risk*.—We often underestimate the likelihood of natural disasters by treating them as below our threshold level of concern. By failing to create scenarios in which a flood or earthquake may plausibly occur, there is no interest in undertaking protective actions such as purchasing insurance or investing in loss reduction measures.

*Ambiguity of Experts*.—There are sometimes differences in experts' estimates of the likelihood and consequences of low-probability events caused by limited historical data, scientific uncertainty, changing environmental conditions due to increased development and/or the use of different risk models. The variance in risk estimates creates confusion by the general public, Government entities, and businesses as to whether one needs to pay attention to this risk. In fact, decisionmakers often utilize estimates from their favorite experts that provide justifications for their proposed actions.

*Short Horizons for Valuing Protective Measures*.—Many businesses and households project only a few years ahead (if not just months) when deciding whether to spend money on loss-reduction measures such as anchoring their roofs to reduce hurricane damage. By focusing on the short-term returns, they fail to invest in risk-reducing measures that could be justified financially when comparing costs and expected returns over the expected life of the property. In other words, cost-effective mitigation measures are often disregarded due to myopic behavior.

*Procrastination*.—If given an option to postpone an investment for 1 month or 1 year, there will be a tendency to delay the outlay of funds. When viewed from a temporal distance the investment will always seem worthwhile, but when it comes time to undertaking the work, the prospect of a slight delay always seems more attractive. Moreover, the less certain one is about a correct course of positive action, the more likely one is to choose inaction. There is a tendency to favor the status quo—to not change whatever one is doing now.

*Mistakenly Treating Insurance as an Investment*.—Individuals often do not buy insurance until after a disaster occurs and then cancel their policies several years later because they have not collected on their policy. They perceive insurance to be a bad investment by not appreciating the adage that the "best return on an insurance policy is no return at all."

*Failure To Learn From Past Disasters*.—There is a tendency to discount past unpleasant experiences. Emotions run high after experiencing a catastrophic event or even viewing it on TV or the Internet. But those feelings fade rapidly, making it difficult to recapture these concerns about the event as time passes.

*Mimetic Blindness*.—Decisionmakers often imitate the behavior of others without analyzing whether the action is appropriate for them. By looking at what other firms do in their industry, or pursuing the actions of their friends and neighbors, decisionmakers can avoid having to think independently.

In addition to these behavioral biases, there are economically rational reasons as to why firms and individuals in hazard-prone areas do not undertake risk-reduction measures voluntarily. Consider the hypothetical Safelee firm in an industry in

[8] The material in this section is based on Kunreuther and Michel-Kerjan (2010) "Overcoming Myopia" *Milken Review*, Fourth Quarter, pp. 48–57. More detail on these behavioral biases appears in Kunreuther, Meyer and Michel-Kerjan (in press). "Overcoming Decision Biases to Reduce Losses from Natural Catastrophes". In E. Shafir (ed.) *Behavioral Foundations of Policy*. Princeton, NJ: Princeton University Press.

which its competitors do not invest in loss prevention measures. Safelee might understand the investment can be justified when considering how it reduces the risks and consequences of a future disaster. However, during normal times, the firm might be at a competitive disadvantage because it cannot match the cost structure of its competitors. The behavior of many banks in the years preceding the financial crisis of 2008–2009 is illustrative of such a dynamic.

Families considering whether to invest in disaster prevention may also find the investment to be unattractive financially if they plan on moving in a few years and if they believe that potential buyers will not take into account the lower risk of a disaster loss when deciding how much they are willing to pay for the property. More generally, families might have other rational reasons for not purchasing disaster coverage or investing in risk-reduction measures when this expense competes with other needs that have to be satisfied with a limited budget (living expenses, education, taxes, other insurance coverage, etc.). This aspect has more significance today given the current economic situation the country faces and the high level of unemployment.

## THE KEY ROLE OF INSURANCE

Our proposed program for reducing disaster losses and the need for the Government to provide assistance to the affected communities directly addresses these behavioral concerns by providing incentives for people and firms to become more resilient. Insurance can play a central role by doing three things. First, if priced appropriately, insurance provides a signal of the risk an individual or a firm faces in their current location. Second, insurance can encourage property owners in hazard-prone areas to invest in mitigation measures by providing them with premium reductions to reflect the expected reduction in losses from future disasters. Third, insurance supports economic resiliency: following a disaster an insured individual or firm can make a claim to obtain funds to help pay for the loss caused by the catastrophe and get back on their feet much more quickly than if they were forced to rely on Federal disaster assistance.

For insurance to play this role, in combination with other programs involving the public and private sectors, we feel it is important that the following two guiding principles[9] be adhered to:

*Principle 1*.—Premiums should reflect risk. Insurance premiums should be based on risk in order to provide signals to individuals about the hazards they face and to encourage them to engage in cost-effective mitigation measures that reduce their vulnerability to catastrophes. Risk-based premiums should also reflect the cost of capital that insurers must integrate into their pricing in order to meet solvency requirement from rating agencies and insurance regulators, and to also assure adequate return to their investors.

Risk-based premiums will provide a clear signal of likely damage to those currently residing in hazard-prone areas as well as those considering locating there. Risk-based premiums also enable insurers to provide discounts to homeowners and businesses that invest in cost-effective mitigation measures. If insurance premiums are not risk-based, insurers are unlikely to offer any premium discounts for those who adopt mitigation measures. In fact, they often prefer not to offer coverage to these property owners because it will be a losing proposition in the long run.

*Principle 2*.—Equity and affordability issues should be addressed. This principle reflects a concern for some residents in high-hazard areas who will be faced with large premium increases based on Principle 1. However, any special treatment given to homeowners currently residing in hazard-prone areas (e.g., low-income uninsured or inadequately insured homeowners) should be funded through an insurance voucher not through premium subsidies (as is often done today).

The offer of insurance vouchers applies only to needy individuals who currently reside in a hazard-prone area. Those deciding to move into the area in the future should be charged premiums that reflect the risk. If they were provided with financial assistance to purchase insurance, this would encourage development in hazard-prone areas and exacerbate the potential for catastrophic losses from future disasters.

[9] More details on these principles appear in H. Kunreuther and E. Michel-Kerjan, *At War with the Weather* (MIT Press), (2009).

OUR PROPOSAL: A MULTI-YEAR INSURANCE-RISK REDUCTION LOAN PROGRAM

Given the behavioral biases and budget constraints individuals face, we propose that insurance and other protective measures be tied to the property rather than the property owner. We recommend the following five features of such a program using the two guiding principles for insurance as a basis for its design:

*Multi-year Insurance Tied to Property*.—When an individual or businesses purchases a piece of property, they should have an opportunity to purchase a multi-year insurance contract (for example, 5 years) at a fixed annual premium that reflects the risk. At the end of the multi-year contract, the premium could be revised to reflect changes in the risk (higher or lower).

*Vouchers for Those Needing Special Treatment*.—We recommend a new disaster insurance voucher program to address issues of equity and affordability to complement the strategy of risk-based premiums for all. Property owners currently residing in a risky area who require special treatment would receive a voucher by the Federal Emergency Management Agency or the U.S. Department of Housing and Urban Development (HUD) as part of its budget or through special appropriation. This program would be similar to the Supplemental Nutrition Assistance Program ("food stamps") and the Low Income Home Energy Assistance Program, which in the United States enables millions of low-income households to meet their food and energy needs every year. The size of the voucher will be determined through a means-test in much the way that distribution of food stamps is determined today.

*Required Insurance*.—Since individuals tend to treat insurance as an investment rather than a protective mechanism, it may have to be a requirement for property located in hazard-prone areas, given the large number of individuals who do not have coverage today.

There is empirical evidence supporting the third feature of the proposed program. Data from HUD reveal that 41 percent of damaged homes from the 2005 hurricanes were uninsured or underinsured. Of the 60,196 owner-occupied homes with severe wind damage from these hurricanes, 23,000 did not have insurance against wind loss.[10] We recently undertook an analysis of all new flood insurance policies issued by the NFIP during the period January 1, 2001 to December 31, 2009 and found that the median length of time before these new policies lapsed is 3 to 4 years. On average, only 74 percent of new policies were still in force 1 year after they were purchased; after 5 years, only 36 percent were still in place. The lapse rate is still high after correcting for migration and does not vary much across flood zones.[11]

*Multi-year Loans for Mitigation*.—To encourage adoption of loss reduction measures, State, Federal Government, or commercial banks could issue property improvement loans so as to spread the costs over time. For instance, a property owner may be reluctant to incur an upfront cost of $1,500 for making his home more disaster resistant but would be willing to pay the $145 annual cost of a 20-year loan (calculated here at a high 10 percent annual interest rate). In many cases the reduction in the insurance premium due to lower losses from disasters will be greater than the loan cost making this investment financially attractive.

*Well-enforced Building Codes*.—Given the reluctance of property owners to invest in mitigation measures voluntarily, building codes should be designed to reduce future disaster losses and be well-enforced through third-party inspections or audits.

LESSONS FROM AN ENERGY EFFICIENCY PROGRAM

As we think about developing incentives for disaster reduction, the Property Assessed Clean Energy (PACE) program that has been adopted by 27 States for promoting energy efficiency has features that can provide insights into designing the above program.

PACE provides long-term funding from private capital markets at low cost and needs no Government subsidies or taxes. It raises property values by making heating and cooling less expensive, and it enjoys broad bipartisan support nationwide at State and local levels. Here are the features of the program that encourage property owners to take measures today to make their home more energy efficient in

[10] U.S. Government Accountability Office (GAO) (2007), *Natural Disasters: Public Policy Options for Changing the Federal Role in Natural Catastrophe Insurance*, Washington, DC: GAO, November. GAO–08–7.

[11] E. Michel-Kerjan, S. Lemoyne and H. Kunreuther (in press). Policy Tenure under the National Flood Insurance Program. *Risk Analysis: An International Journal*.

ways that mirrors how property owners would want to make their homes more disaster resistant:

*Multi-year Financing*.—Interested property owners opt-in to receive financing for improvements that is repaid through an assessment on their property taxes for up to 20 years. PACE financing spreads the cost of energy improvements such as weather sealing, insulation, energy efficient boilers and cooling systems, new windows, and solar installations over the expected life of these measures and allows for the repayment obligation to transfer automatically to the next property owner if the property is sold. PACE solves two key barriers to increased adoption of energy efficiency and small-scale renewable energy: high upfront costs and fear that project costs won't be recovered prior to a future sale of the property.

*Annual Savings*.—Because basic energy efficiency measures can cut energy costs by up to 35 percent, annual energy savings will typically exceed the cost of PACE assessments. The upfront cost barrier actually turns into improved cash flow for owners in much the same way that the reduction of annual insurance premiums could exceed the annual loan costs.

*Transfer to new Property Owner*.—Like all property-based assessments, PACE assessments stay with a property upon sale, until they are fully repaid by future owners who continue to benefit from the improvement measures.

### WE NEED TO ACT NOW

Our country has entered a new era of catastrophes.[12] Our exposure is growing and the damage from disasters over the next few years is likely to be more devastating than what we have experienced during this past decade. When the next catastrophe occurs, the Federal Government will very likely come to the rescue, again. If the public sector's response to recent disasters is an indicator of their future behavior, new records will be set with respect to Federal assistance.

In order to avoid this outcome we recommend that the appropriate government bodies undertake an economic analysis of the benefits and costs of the proposed multi-year insurance-risk reduction loan program in relation to the current system of private and public insurance and Federal disaster assistance.

We have recently proposed a program along the above lines in the context of the reform of the NFIP which is set to expire by September 30, 2011.[13]

We applaud the U.S. Senate for conducting this hearing on long-term exposure of the Federal Government to weather-related risks. We look forward to continuing to work with key stakeholders on these critical issues.

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## RISK MANAGEMENT SOLUTIONS (RMS)

### CATASTROPHE MODELING AND THE EXCEEDANCE PROBABILITY CURVE [1]

A catastrophe model is employed to assess catastrophe risk (e.g., the risk to property from natural hazards, such as earthquakes, floods, hurricanes, and tornado outbreaks) and make corresponding risk management decisions. The model output on quantified losses is presented in a way that is useful to a particular stakeholder (where stakeholders include property owners, insurers, reinsurers, capital markets, government officials). Once these metrics are in hand, appropriate risk management strategies (e.g. mitigation, the use of risk transfer instruments, the accumulation of reserves) can be assessed.

Currently insurers and reinsurers are the stakeholders with the most widespread and integrated use of catastrophe models. The capital markets have also been eager adopters of this technology to accurately price catastrophe bonds. Property owners are less likely to use catastrophe models themselves, but their decision processes are directly or indirectly influenced by the outcomes. At the governmental level, catastrophe modeling can present the means whereby regulators, emergency management agencies, and those in charge of government catastrophe budgets, can gain an appropriate perspective on risk.

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[12] The White House (2007). *Economic Report of the President*. Washington, DC.

[13] E. Michel-Kerjan and H. Kunreuther (2011). Reforming Flood Insurance. *Science* 333, 408–409, July 22.

[1] Main excerpts from Chapter 2 of Catastrophe Modeling: A New Approach to Managing Risk (Grossi and Kunreuther, eds., 2005).

USEFULNESS OF THE EP CURVE

The main output from a catastrophe model is the exceedance probability (EP) curve, plotting loss against annual probability. An annual probability of 0.1 reflects an event that is expected to happen on average once every 10 years. The EP curve is a graphical representation of the probability that a certain level of loss will be surpassed in a given time period. The loss could be that experience by a specific insurance portfolio, or the whole of a nation's economy. The EP curve is strongly skewed—with a long tail extending out to the right displaying the potential for very large losses but at very low probabilities. Figure 1 depicts an EP curve for an insurer with a portfolio of residential earthquake policies in Long Beach, California.

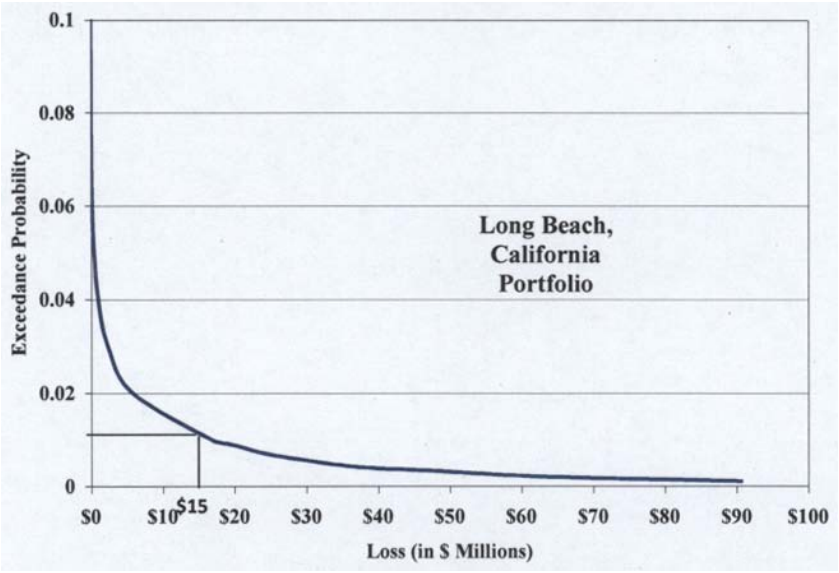


FIGURE 1. An exceedance probability curve for a portfolio of residential risks in Long Beach, California.

An EP curve is particularly valuable for insurers and reinsurers to determine the size and distribution of their potential losses. They will use the EP curve to determine how to develop their portfolio of insured properties, so as to keep the probability of insolvency at an acceptable level. They will also use their loss EP curve to determine what proportion of their risk needs to be transferred to either a reinsurer and/or the capital markets.

However, a loss EP curve could also be employed by a government agency to determine an appropriate perspective on its expected liabilities in the face of a range of potential catastrophe events. The curve can provide planners with the average annualized loss—the amount that would need to be set aside each year to pay for the losses that would accumulate over time. At the same time a government also needs to be aware of what it can infrequently be expected to have to pay out—recognizing that, for example, payments with a 1 percent annual probability (sometimes termed the "one in one hundred year loss") may be many times the payment at a 10 percent annual probability (i.e. the "one in 10 year" payment). For insurers, as for governments, it is tempting to believe that a few years of low level losses, implies that losses will remain low, but the EP curve of expected catastrophe losses illustrates the potential for very large levels at low probabilities, and governments should be planning for the contingency of having to handle very significant catastrophe loss events.

The loss EP curve relevant for a particular problem has to be generated through the application of a catastrophe loss model. These models apply a particular hazard, such as earthquake, hurricane, or tornado, to the particular exposures: buildings, infrastructure, goods, and even people. The models use appropriately tuned vulnerability functions to reflect the way that loss is generated, e.g. determining how much damage would occur to a specific building type at a specific wind speed. For

a government concerned with evaluating the EP curve of potential payments anticipated after catastrophes, the vulnerability functions need to be tuned and calibrated using the actual experience of how payments have had to be made after previous catastrophes.

ABOUT RMS

RMS is the world's leading provider of products, services, and expertise for the quantification and management of catastrophe risk. More than 400 leading insurers, reinsurers, trading companies, and other financial institutions rely on RMS models to quantify, manage, and transfer risk. As an established provider of risk modeling to companies across all market segments, RMS provides solutions that can be trusted as reliable benchmarks for strategic pricing, risk management, and risk transfer decisions.

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[From Science]

## DISASTER MANAGEMENT: REDESIGNING FLOOD INSURANCE [1]

(By Erwann Michel-Kerjan [2] and Howard Kunreuther [3])

Insurance and government assistance play central roles in ensuring economic and social resilience in the aftermath ofcatastrophes in developed countries. Around the globe in the past decade, disasters have led to unprecedented claims payments to insured victims, and government relief to aid the uninsured and the affected communities has risen to historic levels.[4] [5] [6] Increases in population, property values, and concentration of assets in hazard-prone areas are primary causes.[5] Recent climate studies indicate we should also expect more extreme weather-related events in the future.[7] [8] [9]

The cumulative expected exposure of the U.S. government to catastrophes over the next 75 years could reach $7 trillion.[10]

We propose routes to improve flood insurance coverage through the U.S. National Flood Insurance Program (NFIP), one of the largest government disaster-insurance programs in the world. The U.S. Congress is discussing options for continuing the NFIP, which now operates under a 1-year extension, set to expire on 30 September 2011. The Federal Emergency Management Agency (FEMA), which is responsible for the NFIP, is reanalyzing the program. We argue that a new strategy for managing floods can increase personal responsibility, decrease risk, and lower government exposure. Improved scientific knowledge from a range of disciplines will be needed to price the proposed financial products appropriately. If successful in the United States, the approach could be explored by other countries.

INSURING FLOOD RISK

Floods are one of the most destructive hazards.[11] In the United States, floods account for nearly two-thirds of all presidential disaster declarations over the period 1953–2010 (see supporting online material). Hurricanes Katrina, Rita, and Wilma and their resulting storm surge in 2005 cost over $180 billion (2011 prices).[12] In the summer of 2010, one of the worst floodings in Pakistan's history affected more than 20 million people and inflicted $8 billion to $10 billion in recovery and reconstruc-

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[1] Improved knowledge from a range of disciplines ll be needed to price the much-needed financial products appropriately.

[2] Author for correspondence. E-mail: erwannmk@wharton.upenn.edu.

[3] We acknowledge support from the NSF, U.S. Department of Homeland Security, and the Wharton School's Risk Management and Decision Processes Center.

[4] K. Froot, Ed., *The Financing of Catastrophe Risk* (Chicago Univ. Press, Chicago, 1999).

[5] H. Kunreuther, E. Michel-Kerjan, *At War with the Weather* (MIT Press, Cambridge, MA, 2009).

[6] D. Cummins, O. Mahul, *Catastrophe Risk Financing in Developing Countries* (World Bank, Washington, DC, 2009).

[7] D.A. King, *Science* 303, 176 (2004).

[8] P.C.D. Milly, *et al., Science* 319, 573 (2008).

[9] T. Knutson *et al., Nat. Geosci.* 3, 157 (2010).

[10] D. Cummins, M. Suher, G. Zanjani, in *Measuring and Managing Federal Financial Risk*, D. Lucas, Ed. (National Bureau of Economic Research, Univ. of Chicago Press, Chicago 2010), pp. 61–96.

[11] N. Pinter, *Science* 308, 207 (2005).

[12] The White House, *Economic Report of the President* (White House, Washington, DC, 2007).

tion costs.[13] China also experienced the worst floods in a decade, which cost $50 billion.[14] In December 2010, Australia suffered historical flooding.

DEVASTATING LOSSES REQUIRE BETTER INSURANCE

Low-income countries typically rely on government and international aid to cope with major floods. As countries reach a higher level of economic development, insurance mechanisms are used more broadly. Flood insurance can be private, as in Germany and the United Kingdom. In the United States, residents purchase flood insurance mostly through the federally run NFIP, established in 1968 as a result of increased federal relief triggered by disasters in the 1960s and the insurance industry's refusal to cover this hazard because of their inability to accurately assess the risk.[15] The NFIP covers $1.2 trillion of property today (mainly in coastal states), over three times what was covered 20 years ago.[16] [17]

NFIP premiums are established by the federal government. A homeowner can purchase building and contents coverage up to $250,000 and $100,000, respectively, but only if the community that he or she lives in participates in the program. This requires that a flood-risk map has been completed and that the appropriate public body has adopted adequate floodplain management regulations. Homeowners in high-risk areas (defined as "100-year" or "base" levels, expected to be flooded at least once every 100 years) are required to purchase coverage if they hold a federally backed mortgage.

LIMITS OF THE NFIP AS CURRENTLY DESIGNED

The absence of a large reserve has forced the NFIP into debt, as it has borrowed over $19 billion from the U.S. Treasury to cover losses caused by the 2005 and 2008

[13] The World Bank, *Pakistan Floods 2010: Preliminary Damage and Needs Assessment* (World Bank, Washington, DC, 2010).—

[14] Guy Carpenter and Co., *China Floods Report* (Guy Carpenter and Co., New York, 2010); www.gccapitalideas.com/2010/12/20/china%E2%80%99s-costly-floods-in-2010-likely-to-have-limited-impact/.

[15] H. Kunreuther et al., *Disaster Insurance Protection: Public Policy Lessons* (Wiley, New York, 1978).

[16] E. Michel-Kerjan, *J. Econ. Perspect.* 24, 165 (2010).

[17] E. Michel-Kerjan, C. Kousky, *J. Risk Insur.* 77, 369 (2010).

hurricanes and floods.[16] Subsidized insurance is part of the problem: Buildings that are near or below base flood elevation but that were in place before community flood-risk maps were completed are still charged rates that are considerably below the actuarial risk. This was done originally to maintain property values. About one-fourth of insured properties are still subsidized that way.[18] [19] And even properties constructed after flood mapping are charged premiums based only on an average historical loss year.[20]

The NFIP has not been able to enroll and retain many homeowners exposed to flood risk. Recent studies show that insurance penetration in flood-prone areas remains only at about 50 percent.[21] [22] This lack of coverage is likely to increase the need for disaster relief after major floods. This situation is not specific to the United States. In Germany, flood insurance penetration is only 10 percent for single-family homes.[23] After the major 2002 Elbe floods, the German government provided the largest amount of public funds ever paid in the country's history to compensate uninsured flood victims. In China, only 1 percent to 2 percent of the $50 billion losses of last year's floods were insured.[14]

Do a large proportion of homeowners never buy coverage, or do many who once purchased insurance let their policies lapse? To answer this question, we analyzed all new policies issued by the NFIP over the period 1 January 2001 to 31 December 2009 ($n$= 8.9 million).[24] The median length of time before these new policies lapsed is 3 to 4 years. On average, only 74 percent of new policies were still in force 1 year after they were purchased; after 5 years, only 36 percent were still in place. The lapse rate is high even after correcting for migration and does not vary much across flood zones.[25]

Behavioral research can shed light on the underinsurance problem. As the probability of flood in a given year is low, individuals often treat these potential disasters as below their threshold level of concern. Studies on risk perception show that individuals do not understand low probabilities well and often simply ignore likelihood information when making decisions.[25] [26] The language used to communicate risks is also a problem. Scientists often talk about a "100-year return flood," but many individuals do not understand what that means. Some who have suffered a flood believe that they will not have another flood for 100 years. Homeowners are often myopic: If they paid insurance premiums for a few years but have not collected on their policy, they often view insurance as a bad investment and cancel their policy.[15] Finally, there might be rational reasons for not purchasing coverage when this expense competes with other needs that have to be satisfied with a limited budget.

## BETTER TOOLS FOR DISASTER FINANCING

Our proposal for redesigning flood insurance has five prongs, to be implemented simultaneously because they complement each other. First, to account for myopic behavior, we recommend that flood insurance be sold not as 1-year contracts but as multiyear contracts (e.g., 5 or 10 years) that would be attached directly to the property at risk rather than to the homeowner (as is currently done). We propose that this be made mandatory for all homeowners in high-risk areas. To ensure that the requirement is enforced, FEMA could be empowered by Congress to monitor both existing and new construction in those areas. This reform will generate several benefits. It would avoid cancellation of insurance after just a few years. If a homeowner were to move to another location, the contract would be transferred to the new owner. As a result, many more properties will be covered and remain so over time. This should also increase the diversification of the NFIP's portfolio.

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[18] F. Wetmore et al., *An Evaluation of the National Flood Insurance Program: Final Report* (American Institutes for Research, Washington, DC, 2006).

[19] Congressional Budget Office (CBO), *Value of Properties in the National Flood Insurance Program* (CBO, Washington, DC, 2007).

[20] Government Accountability Office (GAO), *Flood Insurance: Public Policy Goals Provide a Framework for Reform* (GAO–11–670T, GAO, Washington, DC, 2011).

[21] W. Kriesel, C. Landry, *J. Risk Insur.* 71, 405 (2004).

[22] L. Dixon, N. Clancy, S. A. Seabury, A. Overton, *The National Flood Insurance Program's Market Penetration Rate: Estimates and Policy Implications* (RAND Corp., Santa Monica, CA, 2006).

[23] A. H. Thieken *et al.*, *Risk Anal.* 26, 383 (2006).

[24] E. Michel-Kerjan, S. Lemoyne de Forges, H. Kunreuther, *Risk Anal.* (doi 10.1111/j539-6924.2011.01671.x; http://opim.wharton.upenn.edu/risk/library/2011-06.pdf.

[25] C. Sunstein, *Yale Law J.* 112, 61 (2002).

[26] H. Kunreuther, R. Meyer, E. Michel-Kerjan, in *The Behavioral Foundations of Policy*, E. Shaffir, Ed. (Princeton Univ. Press, Princeton, NJ, in press); http://opim.wharton.upenn.edu/risk/library/2009-08.pdf.

Second, premiums must be risk-based for all, so that homeowners will be informed of the true exposure of their residence to potential flood damage.

Third, such insurance contracts could be complemented with multiyear home-improvement loans provided by the government or commercial banks to encourage investment in cost-effective risk-reduction measures, such as flood-proofing one's house; the reduction in insurance premiums could offset the annual cost of the loan. The benefits of mitigation may also become more apparent over a 5- or 10-year period.

Fourth, we recommend a new flood insurance voucher program to address issues of equity and affordability to complement the strategy of risk-based premiums for all. Property owners currently residing in a high-risk zone who require special treatment would receive a voucher by the NFIP as part of its budget or through special appropriations. This program would be similar to the Supplemental Nutrition Assistance Program ("food stamps") and the Low Income Home Energy Assistance Program, which in the United States assist millions of low-income households meet food and energy needs every year.

This proposal will require that building vulnerability be updated at policy renewal (every 5 or 10 years) and be reflected in the new premiums. Reevaluation of the flood hazard across the country will be needed over time to reflect hydrological changes due to factors such as additional runoffs caused by new construction, loss of wetlands, and possible effects of a changing climate.[27]

Fifth, given the current level of U.S. public debt and the desire to lower taxpayers' financial liability, we propose that the NFIP reduce its catastrophe exposure by purchasing private reinsurance and catastrophe bonds.[16] [28] We recommend a four-layer approach. After the NFIP determines how much risk to retain, private reinsurers would provide coverage for a second layer of losses. Investors would then provide capital through catastrophe bonds to cover a third layer of losses. For truly exceptional events, the NFIP would utilize its borrowing capacity from the U.S. Treasury (fourth layer). Determination of these layers will be based on their price and how much exposure the program opts to retain or transfer.

Transparent measurement of risk exposure is critical. Sophisticated catastrophe-modeling techniques must be used to determine average annual loss, standard deviation, probable maximum loss, and other features that enter into the pricing of disaster risk-financing instruments. Catastrophe models developed by the scientific community can be used to update U.S. flood maps, as about half of the NFIP's roughly 106,000 maps were more than 15 years old in April 2008.[29] Some steps have already been taken to address this problem. FEMA has begun to digitize flood maps using geographic information systems so that they are easier to update. After the failure of the New Orleans' levee system in 2005, the U.S. Army Corps of Engineers began reevaluating levees throughout the United States using data from hydrology, climatology, soil science, and engineering. These studies have helped determine which levees no longer meet the standards for which they had been designed. These developments in assessing risk more accurately could be useful in determining costs and benefits of the proposed redesign of flood insurance.

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For additional reading, please see: http://www.sciencemag.org/content/327/5964/454.abstract.

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LETTER FROM THE CENTER FOR AMERICAN PROGRESS ACTION FUND

AUGUST 4, 2011.

Hon. RICHARD J. DURBIN,
*Chair, Subcommittee on Financial Services and General Government, Washington, DC.*

DEAR CHAIRMAN DURBIN: We would like to submit the attached Center for American Progress report, "The Year of Living Dangerously: 2010 Extreme Weather Cost

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[27] R. J. Burby, *Global Environ. Change B Environ. Hazards* 3, 111 (2001).

[28] Reinsurance is coverage purchased by one insurer from another. Catastrophe bonds would transfer part of the NFIP exposure directly to institutional investors. If no catastrophe occurs (as defined in the contract), investors would receive their capital back plus a return on their investment and a premium from NFIP. If a predefined catastrophe occurs, the NFIP would use investor payments to cover a portion of the claims. As of December 2010, there were about $13 billion invested in such bonds to cover losses from future disasters in the Americas, Asia, and Europe.

[29] R. King, *Mandatory Flood Insurance Purchase in Remapped Residual Risk Areas Behind Levees* (Report 7–5700, Congressional Research Service, Washington, DC, 2010).

Lives, Health, Economy" for the record of the July 28, 2011 hearing on "Federal Disaster Assistance Budgeting." [1]

This analysis by the Center for American Progress documents the human and economic impact of the extreme weather events in the United States in 2010. Last year, unprecedented extreme weather led to a record number of disaster declarations by the Federal Emergency Management Agency. The United States and the world were swept by flooding, severe winter storms, heat waves, droughts, hurricanes, and heavy rain storms. These are the types of events that scientists predict will occur with more frequency and/or severity as the planet warms due to unchecked emissions of carbon dioxide and other climate pollutants.

The extreme weather of 2010 exacted a huge human and economic toll as well. The CAP analysis found that more than 380 people died and 1,700 were injured due to weather events in the United States throughout the year. And the magnitude of these events forced the Federal Emergency Management Agency,[2] or FEMA, to declare 81 disasters last year. For nearly 60 years, the annual average has been 33.[3] In 2010, total damages exceeded a whopping $6.7 billion. As of April 2011, FEMA had dedicated more than $2.2 billion in financial assistance to those harmed by extreme weather in 2010.

It is difficult, of course, to link or "attribute" individual extreme weather events in a single year to global warming. Climate factors-including human influences-shape weather patterns.

According to Munich Re, one of the world's largest reinsurers, "the only plausible explanation for the rise in weather-related catastrophes is climate change." [4]

Kevin Trenberth, Sc.D., head of the Climate Analysis Section at the National Center for Atmospheric Research,[5] explained at the American Meteorological Society's January 2011 meeting, "Given that global warming is unequivocal, the null hypothesis should be that all weather events are affected by global warming rather than the inane statements along the lines of 'of course we cannot attribute any particular weather event to global warming." [6]

In other words, says Trenberth, "it's not the right question to ask if this storm or that storm is due to global warming, or is it natural variability. Nowadays, there's always an element of both." [7]

Atmospheric concentrations of carbon dioxide and other greenhouse gas pollutants are turning up the heat on our planet. Scientists agree that the string of disastrous weather extremes this past year are the types of severe weather that will become more frequent or ferocious as the planet continues to warm. For instance, in the "first major paper of its kind" tracking global climatic trends from 1951 to 1999, Scottish and Canadian researchers used sophisticated computer models to confirm a human contribution to more intense precipitation extremes with very high confidence.[8]

This analysis is supported by a 2010 Duke University-led study [9] that found, "Global warming is driving increased frequency of extreme wet or dry summer weather in southeast, so droughts and deluges are likely to get worse." [10]

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[1] Daniel J. Weiss, Valeri Vasquez, and Ben Kaldunski, "The year of living dangerously" (Washington: Center for American Progress, 2010), *available at* http://www.americanprogress.org/ issues/2011/04/extreme__weather.html.

[2] "Federal Emergency Management Agency", *available at* http://www.fema.gov/.

[3] "FEMA: Declared disasters by year or state" *available at* http://www.fema.gov/news/disaster__totals__annual.fema.

[4] Munich RE, "Two months to Cancun climate summit/large number of weather extremes as strong indication of climate change", Press release September 27, 2010, *available at* http://www.munichre.com/en/media__relations/press__releases/2010/2010__09__27__press__release.aspx.

[5] "National Center for Atmospheric Research" *available at* http://ncar.ucar.edu/about-ncar.

[6] "Promoting climate information and communication of climate change" *available at* http://ams.confex.com/ams/91Annual/webprogram/Paper180230.html.

[7] Justin Gillis, "In weather chaos, a case for global warming", The New York Times, August 14, 2010, *available at* http://www.nytimes.com/2010/08/15/science/earth/15climate.html?pagewanted=print.

[8] Daniel J. Weiss, Valeri Vasquez, and Ben Kaldunski, "The year of living dangerously" (Washington: Center for American Progress, 2010), *available at* http://www.americanprogress.org/ issues/2011/04/extreme__weather.html.

[9] *Ibid*.

[10] *Ibid*.

A study published in the 2011 Journal of Climate presents "evidence of a significant human influence on the increasing severity of extremely warm nights and decreasing severity of extremely cold days and nights." [11]

Likewise, a report by the National Center for Atmospheric Research,[12] Climate Central, The Weather Channel, and the National Oceanic and Atmospheric Administration shows that "if temperatures were not warming, the number of record daily highs and lows being set each year would be approximately even. Instead . . . record high temperatures far outpace record lows across the U.S."

The recent extreme weather should not be a surprise. In 1999, Trenberth projected that global warming would lead to severe precipitation.

"An increase in heavy precipitation events should be a primary manifestation of the climate change that accompanies increases in greenhouse gases in the atmosphere."

Nine years later, the U.S. Climate Change Program under President George W. Bush came to a very similar conclusion. "Heavy downpours have become more frequent and intense. Droughts are becoming more severe in some regions." [13] These are some of the extreme weather events we experienced this April, and in 2010.

Because we have not brought carbon pollution under control, the weather events of 2010 will continue to revisit us—with a vengeance as they have in 2011. We must act quickly and unequivocally to address climate change before the threat becomes insurmountable. This includes recognizing that global warming is already affecting us both domestically and internationally. There are indications that human and economic losses from extreme weather will continue to grow as the oceans and planet warms.

In April 2011, for instance, the United States was struck by various extreme weather events. The Weather Channel observed that:

"It's been a truly awful, record-setting, tornadic April. We've had 11 major severe weather events, some lasting multiple days." [14]

These April 2011 extreme events included "supercell thunderstorms" [15] in Iowa, severe drought and record wildfires in Texas,[16] and heavy rains [17] across the United States. The April southeastern storms and tornados took at least 297 lives across eight States.[18] And heavy rains in the Mississippi River Valley during April and May caused some of the most severe, damaging floods there this century.[19]

Many States continue to be plagued by extreme weather, including droughts in Texas and Oklahoma, record heat waves in the Midwest, mid-Atlantic and the northeast, and the hottest July on record.

The July 27 hearing was very timely. We share your concern that:

"We are not prepared. Our weather events are getting worse, catastrophic in fact . . . The Federal government is ignoring the obvious. We need to do more to protect Federal assets and respond to growing demands for disaster assistance on an increasing frequency." [20]

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[11] Christidis, Nikolaos, Peter A. Stott, Simon J. Brown, 2011: The Role of Human Activity in the Recent Warming of Extremely Warm Daytime Temperatures. *J. Climate*, 24, 1922–1930.

[12] "Record high temperatures far outpace record lows across U.S.", *available at* http://www2.ucar.edu/news/1036/record-high-temperatures-far-outpace-record-lows-across-us.

[13] US Climate Change Science Program, "Weather and Climate Extremes in a Changing Climate" (2008).

[14] "The Weather Channel" *available at* http://www.weather.com/outlook/weather-news/news/articles/april-severe-scorecard__2011–04–18.

[15] Daniel J. Weiss, Valeri Vasquez, and Ben Kaldunski, "The year of living dangerously" (Washington: Center for American Progress, 2010), *available at* http://www.americanprogress.org/ issues/2011/04/extreme__weather.html.

[16] "Record April: Severe weather scorecard" *available at* http://www.weather.com/outlook/weather-news/news/articles/a pril-severe-scorecard__2011–04–18?page=11.

[17] Daniel J. Weiss, Valeri Vasquez, and Ben Kaldunski, "The year of living dangerously" (Washington: Center for American Progress, 2010), *available at* http://www.americanprogress.org/ issues/2011/04/extreme__weather.html.

[18] *Ibid*.

[19] Louis BURDEAU, "Mississippi River Floods 2011: Deep South Braces For Surge Of Water Not Seen Since 1927", *The Huff Post Green*, April 28, 2011, *available at* http://www.huffingtonpost.com/2011/04/28/mississippi-river-flood-2011__n__855242.html.

[20] "Durbin: Federal Government Unprepared for growing number of extreme weather events", *available at* http://durbin.senate.gov/public/index.cfm/pressreleases?ID=fd009756–5e33–48d7-be3e-9ee0160f1789.

We agree with you that the Federal Government must better prepare to provide damaged communities with the resources they need to recover after extreme weather events.

The old saying that "an ounce of prevention is worth a pound of cure" certainly applies to extreme weather. The cure—ensuring that future budgets include adequate funds to help communities, businesses and families recover—is necessary but not sufficient. It will require budgeting billions of dollars annually to assist areas assaulted by extreme weather events. This will be a challenge at a time when some in the Congress seek deep and lasting reductions in discretionary spending.

In addition, we must also attempt to prevent the rise in extreme weather events and the associated loss of life, injuries, and damages. The most cost effective step would be the reduction of the carbon dioxide pollution responsible for climate change and linked to the growth in deadly and expensive extreme weather events.

Thank you for your leadership in this area, and the opportunity to submit these remarks and the Center for American Progress' report, "The Year of Living Dangerously," for the record of this hearing.

Sincerely,

DANIEL J. WEISS,
*Senior Fellow and Director of Climate Strategy.*
VALERI VASQUEZ,
*Special Assistant, Energy Program.*

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For further information, please see: http://www.americanprogress.org/issues/2011/04/extreme__weather.html

STATEMENT OF SENATOR JERRY MORAN

Senator MORAN. Mr. Chairman, this hearing today will examine the role of the Federal Government in addressing the economic impact of severe weather events through long-term budgetary planning, something that this Congress ought to spend more time on, the budget as well as budgetary planning.

Numerous agencies have significant roles to play in regards to responding to natural disasters. As a member of the Senate Small Business Committee, as well as the ranking member of this subcommittee, I'm very familiar with the assistance that the Small Business Administration (SBA) provides in regard to the disaster loan programs to businesses and families impacted by disasters. I've experienced that and their services in my own home State on many occasions.

Given our Federal Government's fiscal constraints, I believe we must carefully review all Federal funding to ensure that we are budgeting for critical needs appropriately. Reviewing how the Government plans for disasters is an important part of that process and can help ensure that we assist families and businesses in need in a fiscally responsible way.

This critical issue is one that I look forward to hearing witnesses' testimony concerning, and I want to make certain that we have the ability to pursue the opportunity to improve our Government's ability to respond to these matters, and I look forward to hearing from the witnesses.

Senator DURBIN [presiding]. Thank you, Senator Moran. We will start with each witness. You each have 5 minutes. Your written testimony will be part of the permanent and total record of the hearing. And then Senator Moran and others who might show up will ask a few questions. Mr. Trimble, please lead off.

**STATEMENT OF DAVID C. TRIMBLE, DIRECTOR, NATURAL RESOURCES AND ENVIRONMENT, GOVERNMENT ACCOUNTABILITY OFFICE**

Mr. TRIMBLE. Chairman Durbin, Ranking Member Moran, I'm pleased to be here today to discuss the extent to which Federal long-term budget planning contemplates changes in the frequency and severity of weather events that may occur as a result of changes in the climate.

Recent assessments of the potential impacts of climate change in the United States have found, among other things, that many types of extreme weather events, such as heat waves and regional droughts, have become more frequent and intense during the past 40 to 50 years.

Further increases in the frequency and severity of such damaging weather events are projected to affect water resources, agriculture, coastal areas, and infrastructure. The Department of Defense recently noted that climate change may also act as an accelerant of instability or conflict around the world.

Policymakers are increasingly viewing adaptation, defined as adjustments to natural and human systems in response to actual or expected climate change, as a risk management strategy to protect vulnerable sectors and communities that might be affected by changes in the climate. It may be costly to raise river or coastal dikes to protect communities and resources from sea level rise, build higher bridges, or improve stormwater systems, but there's a growing recognition that the cost of inaction could be greater.

Over the years, the GAO has reported on many climate change-related issues, including recent reports on adaptation and Federal funding for climate change programs and activities. Four key points stand out from these reports.

First, climate change adaptation has begun to receive more attention and resources because the greenhouse gases (GHG) already in the atmosphere are expected to continue altering the climate system into the future, regardless of efforts to control emissions.

Further, there is a growing recognition that past practices for making decisions may no longer be reliable. According to the National Research Council (NRC), many decision rules for such things as building bridges or establishing zoning rules assume a continuation of past climate conditions, with similar patterns of variation and the same probabilities of extreme events.

According to the NRC, that assumption, fundamental to the way people and organizations make their choices, is no longer valid. A 2007 GAO report on Federal insurance programs highlights this point. We found, at that time, unlike the private sector, neither the National Flood Insurance Program (NFIP) nor the Federal Crop Insurance Corporation had analyzed the potential impacts of an increase in the frequency or severity of weather events.

Second, Federal, State, and local authorities on the front line of early adaptation efforts face numerous challenges, including insufficient site-specific data such as local projections of expected climate changes. The lack of such data makes it hard for these officials to understand or quantify the potential impacts of climate change, and difficult to justify the cost of adaptation efforts, since projections of future benefits are less certain than current costs.

Third, to be effective, Federal efforts to address these challenges must be coordinated and directed toward a common goal. In 2009, we recommended the development of a national strategic plan for adaptation. The recent Interagency Climate Change Adaptation Task Force is a positive step and responsive to our recommendation, but much work remains.

Fourth and finally, adaptation will require making policy and management decisions that cut across traditional sectors, issues, and jurisdictional boundaries. Many Federal entities, executive offices, and organizations manage programs and activities related to climate change. However, getting these entities to work toward a common goal is complicated.

PREPARED STATEMENT

According to our May 2011 report, Federal funding for climate change programs and activities totaled nearly $9 billion in 2010, with another $7 billion in related tax expenditures. This report found that agencies did not consistently interpret methods for defining and reporting the funding of climate change activities and that there is no consolidated set of strategic priorities that integrates climate change programs and activities across the Federal Government. As more Federal, State, and local agencies focus attention on incorporating climate change into their planning and decisionmaking, the challenges facing these decisionmakers will become increasingly prominent.

Improved accounting over the billions currently spent on climate change-related activities, establishing clear strategic priorities, and aligning funding with priorities will help the Congress address these challenges, and hopefully minimize the economic toll of future severe weather events. That concludes my statement. I'll, of course, be happy to answer any questions.

[The statement follows:]

PREPARED STATEMENT OF DAVID C. TRIMBLE

CLIMATE CHANGE ADAPTATION

*Aligning Funding With Strategic Priorities*

Chairman Durbin, Ranking Member Moran, and members of the subcommittee: I am pleased to be here today to discuss the extent to which Federal long-term budget planning contemplates changes in the frequency and severity of weather events that may occur as a result of changes in the climate. A 2009 assessment by the United States Global Change Research Program (USGCRP) found that many types of extreme weather events, such as heat waves and regional droughts, have become more frequent and intense during the past 40 to 50 years and that changes in these kinds of extreme weather and climate events are among the most serious challenges to our Nation in coping with a changing climate.[1] According to the assessment, changes in extreme weather and climate events will affect human health, water supply, agriculture, coastal areas, and many other aspects of society and the natural environment.

Federal, State, and local agencies are tasked with a wide array of responsibilities, such as managing natural resources, that will be affected by a changing climate. Climate change also has implications for the fiscal health of the Federal Govern-

[1] USGCRP coordinates and integrates Federal research on changes in the global environment—including climate change—and their implications for society. According to a simplified National Aeronautics and Space Administration description, "Weather is what conditions of the atmosphere are over a short period of time, and climate is how the atmosphere 'behaves' over relatively long periods of time. When we talk about climate change, we talk about changes in long-term averages of daily weather."

ment, affecting Federal crop and flood insurance programs, and placing new stresses on infrastructure. Further, in February 2010 the Department of Defense (DOD) issued its Quadrennial Defense Review report.[2] That report noted that:

". . . while climate change alone does not cause conflict, it may act as an accelerant of instability or conflict, placing a burden to respond on civilian institutions and militaries around the world. In addition, extreme weather events may lead to increased demands for defense support to civil authorities for humanitarian assistance or disaster response both within the United States and overseas."

In recent years, climate change adaptation—defined as adjustments to natural or human systems in response to actual or expected climate change—has begun to receive more attention because the greenhouse gases already in the atmosphere are expected to continue altering the climate system into the future, regardless of efforts to control emissions. According to the National Research Council, however, individuals and institutions whose futures will be affected by climate change are unprepared both conceptually and practically for meeting the challenges and opportunities it presents. In this context, adapting to climate change requires making policy and management decisions that cut across traditional economic sectors, jurisdictional boundaries, and levels of government. We have previously reported that when agencies do not collaborate well when addressing a complicated, interdisciplinary issue like climate change, they may carry out programs in a fragmented, uncoordinated way, resulting in a patchwork of programs that can limit the overall effectiveness of the Federal effort.[3]

My testimony today addresses:

—the actions Federal, State, and local authorities are taking to adapt to climate change;

—the challenges that Federal, State, and local officials face in their efforts to adapt and actions Federal agencies could take to help address these challenges; and

—the extent to which Federal funding for adaptation and other climate change activities is consistently tracked and reported and aligned with strategic priorities.

The information in this testimony is based on prior work, largely on our recent reports on climate change adaptation and Federal climate change funding.[4] Additional information on our scope and methodology is available in each issued product. All of the work on which this statement is based was performed in accordance with generally accepted government auditing standards.

## FEDERAL, STATE, AND LOCAL AUTHORITIES ARE BEGINNING TO TAKE STEPS TO ADAPT TO CLIMATE CHANGE

Our October 2009 report on climate change adaptation found no coordinated national approach to adaptation, but our May 2011 report on climate change funding cited indications that Federal agencies were beginning to respond to climate change more systematically.[5] About the same time as the issuance of our October 2009 report, Executive Order 13514 on Federal Leadership in Environmental, Energy, and Economic Performance called for Federal agencies to participate actively in the Interagency Climate Change Adaptation Task Force.[6] The task force, which began meeting in spring 2009, is co-chaired by the Council on Environmental Quality

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[2] According to the DOD, the Quadrennial Defense Review (QDR) is to set a long-term course for DOD as it assesses the threats and challenges that the Nation faces and re-balances DOD's strategies, capabilities, and forces to address today's conflicts and tomorrow's threats. As required by law, the most recent QDR examined the capabilities of the armed forces to respond to the consequences of climate change, in particular, preparedness for natural disasters from extreme weather events and other missions the armed forces may be asked to support inside the United States and overseas.

[3] *GAO, Results-Oriented Government: Practices That Can Help Enhance and Sustain Collaboration among Federal Agencies*, GAO–06–15 (Washington, D.C.: October 21, 2005), and *Managing for Results: Barriers to Interagency Coordination*, GAO/GGD–00–106 (Washington, D.C.: March 29, 2000).

[4] GAO, *Climate Change Adaptation: Strategic Federal Planning Could Help Government Officials Make More Informed Decisions*, GAO–10–113, (Washington, D.C.: October 7, 2009), and *Climate Change: Improvements Needed to Clarify National Priorities and Better Align Them with Federal Funding Decisions*, GAO–11–317, (Washington, D.C.: May 20, 2011).

[5] *See* GAO–10–113 and GAO–1 109317. For a list of Federal adaptation efforts by agency as of 2009, *see Climate Change Adaptation: Information on Selected Federal Efforts to Adapt To a Changing Climate* (GAO–10–11 4SP, *October 7, 2009), an E-supplement to* GAO–10–113, GAO–10–114SP, (Washington, D.C.: October 2009).

[6] For more information about the Interagency Climate Change Adaptation Task Force, *see* http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation.

(CEQ), the National Oceanic and Atmospheric Administration (NOAA), and the Office of Science and Technology Policy (OSTP), and includes representatives from more than 20 Federal agencies and executive branch offices. The task force was formed to develop Federal recommendations for adapting to climate change impacts both domestically and internationally and to recommend key components to include in a national strategy.

On October 14, 2010, the task force released its interagency report outlining recommendations to the President for how Federal policies and programs can better prepare the United States to respond to the impacts of climate change. The report recommends that the Federal Government implement actions to expand and strengthen the Nation's capacity to better understand, prepare for, and respond to climate change. These recommended actions include making adaptation a standard part of agency planning to ensure that resources are invested wisely and services and operations remain effective in a changing climate. According to CEQ officials, the task force will continue to meet as an interagency forum for discussing the Federal Government's adaptation approach and to support and monitor the implementation of recommended actions in the progress report. The task force is due to release another report in October 2011 that documents progress toward implementing its recommendations and provides additional recommendations for refining the Federal approach to adaptation, as appropriate, according to CEQ officials.[7]

Individual agencies are also beginning to consider adaptation actions. For example, in May 2009, the Chief of Naval Operations created Task Force Climate Change to address the naval implications of a changing Arctic and global environment. The Task Force was created to make recommendations to Navy leadership regarding policy, investment, and action, and to lead public discussion. In addition, the Department of the Interior issued an order in September 2009 designed to address the impacts of climate change on the Nation's water, land, and other natural and cultural resources.[8] Among other things, the order requires each bureau and office in the Department to consider and analyze potential climate change impacts when undertaking long-range planning exercises, setting priorities for scientific research and investigations, developing multi-year management plans, and making major decisions regarding potential use of resources. In another example, according to the NOAA, its Regional Integrated Sciences and Assessments (RISA) program supports climate change research to meet the needs of decisionmakers and policy planners at the national, regional, and local levels.

In October 2009, we reported that some State and local authorities were beginning to plan for and respond to climate change impacts.[9] We visited three U.S. sites in doing the work for that report—New York City; King County, Washington; and the State of Maryland—where State and local officials were taking such steps. We have not evaluated the progress of these initiatives since the issuance our 2009 report.

*New York City*.—New York City's adaptation efforts stemmed from a growing recognition of the vulnerability of the city's infrastructure to natural disasters, such as the severe flooding in 2007 that led to widespread subway closures. At the time of our October 2009 report, New York City's adaptation efforts typically had been implemented as facilities were upgraded or as funding became available. For example, the city's Department of Environmental Protection (DEP), which manages water and wastewater infrastructure, had begun to address flood risks to its wastewater treatment facilities. These and other efforts are described in DEP's 2008 Climate Change Program Assessment and Action Plan.[10] Many of New York City's waste-

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[7] The White House Council on Environmental Quality, *Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy* (October 5, 2010). This report is available at http://www.whitehouse.gov/sites/default/files/microsites/ceq/Interagency-Climate-ChangeAdaptation-Progress-Report.pdf.

[8] Secretarial Order No. 3289 (September 14, 2009), as amended by Secretarial Order No. 3289, Amendment No. 1 (February 22, 2010). As originally enacted, the order also designated eight regional Climate Change Response Centers, which were subsequently renamed Climate Science Centers. According to the Department of the Interior, these centers will synthesize existing climate change impact data and management strategies, help resource managers put them into action on the ground, and engage the public through education initiatives. Interior has also identified specific adaptation strategies and tools for natural resource managers. For example, Interior provided a number of adaptation-related policy options for land managers in reports produced for its Climate Change Task Force, a past effort that has since been expanded upon to reflect new priorities.

[9] GAO–10–113.

[10] New York City Department of Environmental Protection Climate Change Program, with contributions by Columbia University's Center for Climate Systems Research and HydroQual

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water treatment plants, such as Tallman Island, are vulnerable to sea level rise and flooding from storm surges because they are located in the floodplain next to the bodies of water into which they discharge. In response to this threat, DEP planned to, in the course of scheduled renovations, raise sensitive electrical equipment, such as pumps and motors, to higher levels to protect them from flood damage.

*King County, Washington*.—According to officials from the King County Department of Natural Resources and Parks, the county took steps to adapt to climate change because its leadership was highly aware of climate impacts on the county. For example, in November 2006, the county experienced severe winter storms that caused a series of levees to crack. The levees had long needed repair, but the storm damage helped increase support for the establishment of a countywide flood control zone district, funded by a dedicated property tax.[11] The flood control zone district planned to use the funds, in part, to upgrade flood protection facilities to increase the county's resilience to future flooding. In addition to more severe winter storms, the county expected that climate change would lead to sea level rise; reduced snowpack; and summertime extreme weather such as heat waves and drought, which can lead to power shortages because hydropower is an important source of power in the region. The University of Washington Climate Impacts Group, funded by NOAA's RISA program, has had a long-standing relationship with county officials and worked closely with them to provide regionally specific climate change data and modeling, such as a 2009 assessment of climate impacts in Washington, as well as decisionmaking tools.[12]

*Maryland*.—Maryland officials took a number of steps to formalize their response to climate change effects. An executive order in 2007 established the Maryland Commission on Climate Change, which released the Maryland Climate Action Plan in 2008.[13] As part of this effort, the Maryland Department of Natural Resources (DNR) chaired an Adaptation and Response Working Group, which issued a report on sea level rise and coastal storms.[14] The 2008 Maryland Climate Action Plan calls for future adaptation strategy development to cover other sectors, such as agriculture and human health. Additionally, Maryland provided guidance to coastal counties to assist them with incorporating the effects of climate change into their planning documents. For example, DNR funded guidance documents to three coastal counties—Dorchester, Somerset, and Worcester—on how to address sea level rise and other coastal hazards in their local ordinances and planning efforts.[15]

## GOVERNMENT OFFICIALS FACE NUMEROUS CHALLENGES WHEN CONSIDERING ADAPTATION EFFORTS, AND FURTHER FEDERAL ACTION COULD HELP THEM MAKE MORE INFORMED DECISIONS

In our prior work, we found that the challenges faced by Federal, State, and local officials in their efforts to adapt to climate change fell into several categories:

*Focusing on Immediate Needs*.—Available attention and resources were focused on more immediate needs, making it difficult for adaptation efforts to compete for limited funds. For example, several Federal, State, and local officials who responded to a questionnaire we prepared for our October 2009 report on adaptation noted how difficult it is to convince managers of the need to plan for long-term adaptation when they are responsible for more urgent concerns that have short decisionmaking timeframes. One Federal official explained that "it all comes down to resource prioritization. Election and budget cycles complicate long-term planning such as adaptation will require. Without clear top-

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Environmental Engineers & Scientists, P.C., *Report 1: Assessment and Action Plan—A Report Based on the Ongoing Work of the DEP Climate Change Task Force* (New York City, N.Y., 2008).

[11] King County Ordinance 15728 (April 25, 2007). The district is funded by a countywide ad valorem property tax levy of 10 cents per $1,000 assessed value.

[12] University of Washington Climate Impacts Group, The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate (Seattle, Wash., 2009).

[13] Maryland Commission on Climate Change, *Climate Action Plan* (Annapolis, Maryland, 2008).

[14] Maryland Commission on Climate Change Adaptation and Response Working Group, *Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change Phase I: Sea Level Rise and Coastal Storms*.

[15] Wanda Diane Cole, Maryland Eastern Shore Resource Conservation & Development Council, *Sea Level Rise: Technical Guidance for Dorchester County*, a special report prepared at the request of the Maryland Department of Natural Resources, March 2008; URS and RCQuinn Consulting, Inc., *Somerset County Maryland Rising Sea Level Guidance*, a special report prepared at the request of Somerset County, Maryland, Annapolis, Md., 2008; and CSA International Inc., *Sea Level Rise Response Strategy Worcester County*, Maryland, a special report prepared at the request of Worcester County, Maryland Department of Comprehensive Planning, September 2008.

down leadership setting this as a priority, projects with benefits beyond the budget cycle tend to get raided to pay current-year bills to deliver results in this political cycle."

*Insufficient Site-specific Data*.—Without sufficient site-specific data, such as local projections of expected changes, it is hard to predict the impacts of climate change and thus hard for officials to justify the current costs of adaptation efforts for potentially less certain future benefits. This is similar to what we found in past work on climate change on Federal lands. Specifically, our August 2007 report demonstrated that land managers did not have sufficient site-specific information to plan for and manage the effects of climate change on the Federal resources they oversee.[16] In particular, the managers lacked computational models for local projections of expected changes. For example, at the time of our review, officials at the Florida Keys National Marine Sanctuary said that they did not have adequate modeling and scientific information to enable managers to predict the effects of climate change on a small scale, such as that occurring within the sanctuary.[17] Without such modeling and information, most of the managers' options for dealing with climate change were limited to reacting to already-observed effects on their units, making it difficult to plan for future changes. Furthermore, these resource managers said that they generally lacked detailed inventories and monitoring systems to provide them with an adequate baseline understanding of the plant and animal species that existed on the resources they manage. Without such information, it is difficult to determine whether observed changes are within the normal range of variability.

*Lack of Clear Roles and Responsibilities*.—Adaptation efforts are constrained by a lack of clear roles and responsibilities among Federal, State, and local agencies. Of particular note, about 70 percent (124 of 178) of the Federal, State, and local officials who responded to a questionnaire we prepared for our October 2009 report on adaptation rated the "lack of clear roles and responsibilities for addressing adaptation across all levels of government" as very or extremely challenging. For example, according to one respondent, "there is a power struggle between agencies and levels of government . . . Everyone wants to take the lead rather than working together in a collaborative and cohesive way."

These challenges make it harder for officials to justify the current costs of adaptation efforts for potentially less certain future benefits. A 2009 report by the National Research Council discusses how officials are struggling to make decisions based on future climate scenarios instead of past climate conditions.[18] According to the report, requested by the Environmental Protection Agency and NOAA, usual practices and decision rules (for building bridges, implementing zoning rules, using private motor vehicles, and so on) assume a stationary climate—a continuation of past climate conditions, including similar patterns of variation and the same probabilities of extreme events. According to the National Research Council report, that assumption, which is fundamental to the ways people and organizations make their choices, is no longer valid; Climate change will create a novel and dynamic decision environment.

We reached similar conclusions in a March 2007 report that highlighted how historical information may no longer be a reliable guide for decisionmaking.[19] We reported on the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP), which insures properties against flooding, and the U.S. Department of Agriculture's (USDA) Federal Crop Insurance Corporation, which insures crops against drought or other weather disasters. Among other things, the report contrasted the experience of private and public insurers. We found that many major private insurers were proactively incorporating some near-term elements of climate change into their risk management practices. In addition, other private insurers were approaching climate change at a strategic level by publishing reports outlining the potential industry-wide impacts and strategies to proactively address the issue.

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[16] GAO, *Climate Change: Agencies Should Develop Guidance for Addressing the Effects on Federal Land and Water Resources*, GAO–07–863, (Washington, D.C.: August 7, 2007).

[17] We conducted our work for GAO–07–863 between May 2006 and July 2007. The agencies involved with this work are now beginning to consider climate change adaptation in planning decisions.

[18] National Research Council (2009), *Informing Decision in a Changing Climate*. Panel on Strategies and Methods for Climate-Related Decision Support, Committee on the Human Dimensions of Global Change, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

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

In contrast, we noted that the agencies responsible for the Nation's two key Federal insurance programs had done little to develop the kind of information needed to understand their programs' long-term exposure to climate change for a variety of reasons. As a FEMA official explained, the NFIP is designed to assess and insure against current—not future—risks. Unlike the private sector, neither this program nor the Federal Crop Insurance Corporation had analyzed the potential impacts of an increase in the frequency or severity of weather-related events on their operations over the near- or long-term. The proactive view of private insurers in our 2007 report was echoed on March 17, 2009, by the National Association of Insurance Commissioners, which adopted a mandatory requirement that insurance companies disclose to regulators the financial risks they face from climate change, as well as actions the companies are taking to respond to those risks. We have not studied the progress of these specific programs in managing the Nation's long-term exposure to climate change since the issuance of our 2007 report.

Based on information obtained from studies, visits to sites pursuing adaptation efforts, and responses to a Web-based questionnaire sent to Federal, State, and local officials knowledgeable about adaptation, our October 2009 report identified three categories of potential Federal actions for addressing challenges to adaptation efforts:

—First, training and education efforts could increase awareness among Government officials and the public about the impacts of climate change and available adaptation strategies. A variety of programs are trying to accomplish this goal, such as the Chesapeake Bay National Estuarine Research Reserve (partially funded by NOAA), which provides education and training on climate change to the public and local officials in Maryland.

—Second, actions to provide and interpret site-specific information could help officials understand the impacts of climate change at a scale that would enable them to respond. About 80 percent of the respondents to our Web-based questionnaire rated the "development of State and local climate change impact and vulnerability assessments" as very or extremely useful.

—Third, the Congress and Federal agencies could encourage adaptation by clarifying roles and responsibilities. About 71 percent of the respondents to our Web-based questionnaire rated the development of a national adaptation strategy as very or extremely useful. Furthermore, officials we spoke with and officials who responded to our questionnaire said that a coordinated Federal response would also demonstrate a Federal commitment to adaptation. Importantly, our October 2009 report recommended that within the Executive Office of the President (EOP) the appropriate entities, such as CEQ, develop a national adaptation plan that includes setting priorities for Federal, State, and local agencies. CEQ generally agreed with our recommendation.

Some of our other recent climate change-related reports offer additional examples of the types of actions Federal agencies and the Congress could take to assist States and communities in their efforts to adapt. Our August 2007 report, for example, recommended that certain agencies develop guidance advising managers on how to address the effects of climate change on the resources they manage.[20] Furthermore, our May 2008 report on the economics of policy options to address climate change identified actions the Congress and Federal agencies could take, such as reforming insurance subsidy programs in areas vulnerable to hurricanes or flooding.[21]

FUNDING FOR ADAPTATION AND OTHER FEDERAL CLIMATE CHANGE ACTIVITIES COULD BE BETTER TRACKED, REPORTED, AND ALIGNED WITH STRATEGIC PRIORITIES

Our May 2011 report on Federal climate change funding found that:

—agencies do not consistently interpret methods for defining and reporting the funding of climate change activities;

—key factors complicate efforts to align such funding with strategic priorities; and

—options are available to better align Federal funding with strategic priorities, including governmentwide strategic planning.[22]

Any effective Federal climate change adaptation strategy will need to ensure that Federal funds are properly tracked and that funding decisions are aligned with strategic priorities. Given the interdisciplinary nature of the issue, such alignment is a challenge as formidable as it is necessary to address.

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[20] GAO–07–863.

[21] *Climate Change: Expert Opinion on the Economics of Policy Options to Address Climate Change*, GAO–08–605, (Washington, D.C.: May 9, 2008).

[22] GAO–11–317.

In our report, we identified three methods for defining and reporting climate change funding, foremost of which is guidance contained in OMB's Circular A–11.[23] The circular directs agencies to report funding that meet certain criteria in three broad categories—research, technology, and international assistance. According to OMB staff, Circular A–11 is the primary method for defining and reporting long-standing "cross-cuts" of funding for climate change activities. Interagency groups, such as USGCRP have collaborated in the past with OMB to clarify the definitions in Circular A–11, according to comments from CEQ, OMB, and OSTP.[24]

Our work suggests that existing methods for defining and reporting climate change funding are not consistently interpreted and applied across the Federal Government.[25] Specifically, for our May 2011 report, we sent a Web-based questionnaire to key Federal officials involved in defining and reporting climate change funding, developing strategic priorities, or aligning funding with strategic priorities. Most of these respondents indicated that their agencies consistently applied methods for defining and reporting climate change funding. Far fewer respondents indicated that methods for defining and reporting climate change funding were applied consistently across the Federal Government. Some respondents, for example, noted that other agencies use their own interpretation of definitions, resulting in inconsistent accounting across the Government. Respondents generally identified key reasons agencies may interpret and apply existing methods differently, including difficulty determining which programs are related to climate change.[26] In comments to our May 2011 report, CEQ, OMB, and OSTP noted that consistency likely varies by method of reporting, with Circular A–11 being the most consistent and other methods being less so.

In addition, our work identified two key factors that complicate efforts to align Federal climate change funding with strategic priorities across the Federal Government. First, Federal officials lack a shared understanding of priorities, partly due to the multiple, often inconsistent messages articulated in different sources, such as strategic plans.[27] Our review of these sources found that there is not currently a consolidated set of strategic priorities that integrates climate change programs and activities across the Federal Government. As we stated in our May 2011 report, in the absence of clear, overarching priorities, Federal officials are left with many different sources that present climate change priorities in a more fragmented way. The multiple sources for communicating priorities across the climate change enterprise may result in conflicting messages and confusion.

The second key factor that complicates efforts to align Federal funding with priorities is that existing mechanisms intended to do so are nonbinding, according to respondents, available literature, and stakeholders. For example, some respondents noted that the interagency policy process does not control agency budgets and that agencies with their own budget authority may pay little attention to Federal strategic priorities. In other words, Federal strategic priorities set through an interagency process may not be reflected in budget decisions for individual agencies.

As OSTP officials acknowledged to us, "The major challenge is the need to connect climate science programs with broader inter- and intra-agency climate efforts." In comments to our report, OSTP stated that while significant progress is being made in linking the climate science-related efforts, individual agencies still want to advance initiatives that promote or serve their agency missions. This, according to OSTP, yields a broader challenge of tying climate-related efforts (science, mitigation, and adaptation) together into a coherent governmentwide strategy.

Our May 2011 report identified several ways to better align Federal climate change funding with strategic priorities, including:

—options to improve the tracking and reporting of climate change funding;

—options to enhance how strategic climate change priorities are set;

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[23] The other methods identified by respondents were guidance from interagency programs and periodic "data calls" to collect information for unique reporting needs.

[24] CEQ, OMB, and OSTP submitted consolidated technical comments on our May 2011 report. These comments are reflected in this statement as appropriate.

[25] In GAO–11–317 we analyzed OMB funding reports and responses to a Web-based questionnaire sent to key Federal officials with the assistance of the EOP and interagency coordinating bodies.

[26] These key reasons are discussed in detail in our May 2011 report: GAO–11–317.

[27] These sources include:

—strategic plans for interagency programs and agencies;

—executive-level guidance memoranda;

—the development of new interagency initiatives;

—regulations and guidance memoranda;

—international commitments; and

—testimony of Federal executives before the Congress.

—the establishment of formal coordination mechanisms; and
—continuing efforts to link related climate change activities across the Federal Government.[28] Specific options are discussed in detail in our May 2011 report and include a governmentwide strategic planning process that promotes a shared understanding among agencies of strategic priorities by articulating what they are expected to do within the overall Federal response to climate change. Also discussed in detail is an integrated budget review process that better aligns these priorities with funding decisions through a more consistent method of reporting and reviewing climate change funding.

Federal entities are beginning to implement some of these options. For example, there has been some recent progress on linking related Federal climate change programs, according to OSTP. Specifically, OSTP stated that the science portion of the CEQ, NOAA, and OSTP-led Climate Change Adaptation Task Force is being integrated within USGCRP. OSTP also stated that it is working to create an interagency body that will bring together agencies that provide climate services to allow for better links between climate services and other Federal climate-related activities.

To further improve the coordination and effectiveness of Federal climate change programs and activities, we recommended in our May 2011 report that the appropriate entities within the EOP, in consultation with the Congress, clearly establish Federal strategic climate change priorities and assess the effectiveness of current practices for defining and reporting related funding.

Chairman Durbin, Ranking Member Moran, and members of the subcommittee, this concludes my prepared statement. I would be happy to respond to any questions that you or other Members of the subcommittee may have.

## APPENDIX

### WHY THE GAO DID THIS STUDY

A 2009 assessment by the USGCRP found that many types of extreme weather events, such as heat waves and regional droughts, have become more frequent and intense during the past 40 to 50 years. According to the assessment, changes in extreme weather and climate events will affect many aspects of society and the natural environment, such as infrastructure. In addition, the Department of Defense found that climate change may act as an accelerant of instability or conflict, placing a burden to respond on militaries around the world.

According to the National Academies, USGCRP, and others, greenhouse gases already in the atmosphere will continue altering the climate system into the future regardless of emissions control efforts. Therefore, adaptation-defined as adjustments to natural or human systems in response to actual or expected climate change—is an important part of the response to climate change.This testimony addresses:

—the actions Federal, State, and local authorities are taking to adapt to climate change;
—the challenges that Federal, State, and local officials face in their efforts to adapt and actions Federal agencies could take to help address these challenges; and
—the extent to which Federal funding for adaptation and other climate change activities is consistently tracked and reported and aligned with strategic priorities. The information in this testimony is based on prior work, largely on the GAO's recent reports on climate change adaptation and federal climate change funding.

### WHAT GAO FOUND

Federal, State, and local authorities are beginning to take steps to adapt to climate change. Federal agencies are beginning to respond to climate change systematically through an Interagency Climate Change Adaptation Task Force formed to recommend key components for inclusion in a national adaptation strategy. Individual agencies are also beginning to consider adaptation actions. For example, in May 2009, the Chief of Naval Operations created Task Force Climate Change to address the naval implications of a changing Arctic and global environment. Some State and local government authorities were beginning to plan for and respond to climate change impacts, the GAO reported in 2009. For example, the State of Maryland had a strategy for reducing vulnerability to climate change, which focused on protecting habitat and infrastructure from future risks associated with sea level rise and coastal storms. In another example, King County, Washington, established a

[28] These were identified by respondents, available literature, and stakeholders.

countywide flood control zone district to upgrade flood protection facilities and increase the county's resilience to future flooding, among other things.

Federal, State, and local officials face numerous challenges in their efforts to adapt to climate change, and further Federal action could help them make more informed decisions. These challenges include a focus of available attention and resources on more immediate needs and insufficient site-specific data—such as local projections of expected climate changes. The lack of such data makes it hard to understand the impacts of climate change and thus hard for officials to justify the cost of adaptation efforts, since future benefits are potentially less certain than current costs. The GAO's October 2009 report identified potential Federal actions for improving adaptation efforts, including actions to provide and interpret site-specific information, which could help officials understand the impacts of climate change at a scale that would enable them to respond. In a May 2008 report on the economics of policy options to address climate change, the GAO identified actions Congress and Federal agencies could take, such as reforming insurance subsidy programs in areas vulnerable to hurricanes or flooding.

Funding for adaptation and other Federal climate change activities could be better tracked, reported, and aligned with strategic priorities. The GAO's report on Federal climate change funding suggests that methods for defining and reporting such funding are not consistently interpreted and applied across the Federal Government. The GAO also identified two key factors that complicate efforts to align funding with priorities. First, officials across a broad range of Federal agencies lack a shared understanding of priorities, partly due to the multiple, often inconsistent messages articulated in different policy documents, such as strategic plans. Second, existing mechanisms intended to align funding with government-wide priorities are nonbinding and limited when in conflict with agencies' own priorities. Federal officials who responded to a Web-based questionnaire, available literature, and stakeholders involved in climate change funding identified several ways to better align Federal climate change funding with strategic priorities. These include a governmentwide strategic planning process that promotes a shared understanding among agencies of strategic priorities by articulating what they are expected to do within the overall Federal response to climate change.

Senator DURBIN. Thank you very much. I mentioned earlier, Mr. Trimble is with the GAO and has published, at least, his climate change adaptation publication, that I believe was issued on July 28. Is that correct?

Mr. TRIMBLE. Yes, we have a written statement for today's hearing——

Senator DURBIN. Good.

Mr. TRIMBLE [continuing]. A longer statement.

Senator DURBIN. Thank you very much. Kathryn Sullivan, as I mentioned earlier, is with the NOAA and is our next witness. Please proceed.

**STATEMENT OF KATHRYN D. SULLIVAN, Ph.D., ASSISTANT SECRETARY OF COMMERCE FOR ENVIRONMENTAL OBSERVATION AND PREDICTION, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, DEPARTMENT OF COMMERCE**

Dr. SULLIVAN. Thank you, Chairman Durbin and Ranking Member Moran, for this opportunity to testify on Federal disaster budgeting and whether our Nation is weather ready. As you mentioned, I am from the NOAA and am the deputy administrator there. The chairman just gave a very cogent and remarkable account of the sequence of events that we've seen so far this year in severe weather and the great toll that they've taken on our country to date.

I won't repeat that long string of events, but it is compelling, indeed, and in fact, the trends are moving in a direction that suggest we will have more such events. The NOAA's role in supporting Federal disaster budgeting for these events is to predict them ahead of time, to observe them in real time, and to help people prepare in advance for the impacts they're likely to have.

This advance awareness is, in fact, the very foundation of a weather-ready Nation. Businesses, State and local governments, and our citizens rely on the NOAA for reliable weather and water forecasts to underpin their responses and their long-range planning. We've made tremendous strides in our forecast and warning capability over the past few decades.

Our lead time for tornadoes has doubled since we modernized our technology and infrastructure in the 1980s and early 1990s. We've made significant leaps in our seasonal predictive capability, due mainly to researching the weather patterns associated with El Niño and La Niña, and also improvements in numerical modeling methods.

Advances in understanding these, and other larger-scale phenomena, and their relationship to high-impact weather events has been the key to giving us the ability to help the Nation to give the Nation advance notice and time to prepare.

For example, we were able, this year, to provide the Midwest with spring flood outlooks as early as January, and to foresee the continued severity of Texas' historical drought. Even as our predictions improve, however, factors such as demographic trends and population growth make society more vulnerable than ever to high-impact events. Nearly 90 percent of all Presidentially declared disasters are weather- and water-related. And as the chairman noted, studies show that frequency of these events is increasing.

As a result, many concerns from agriculture to city planners, business, and the military, are looking for ways to increase their resilience now.

The city of Chicago, heeding recent NOAA data on trends, and our analytical climate support, is preparing for the likelihood of more intense storms and rainfall, along with warmer temperatures. Similar adaptation planning is underway in New York City, with particular focus on the risk of flooding from rising sea level.

The Navy's Task Force on Climate Change has advised that service to prepare to police the equivalent of an extra sea, as Arctic ice melts. These decisionmakers and many others, are using NOAA science and support to take mitigating steps now in order to increase their resilience to these events and reduce the potential of severe societal and economic impacts. They realize that the past is, indeed, no longer prologue.

In my written testimony, I describe the four pillars that support the NOAA's, i.e., the Nation's, predictive capabilities: environmental observations; including weather satellites; computer modeling; scientific research; and of course, our people, the technical experts who provide the forecasts, warnings, and decision assistance. To improve both our short-term, local-impact forecasts, and the long-range outlooks that enable advance planning, we need to invest in each of these pillars. As President Obama said in his address to the Nation on Monday, while we all want and need a Government that lives within its means, there are still things we need to pay for as a country, such as weather satellites.

I need hardly note to this body that the funding for that critical infrastructure is in jeopardy this year. The NOAA's Federal, academic, and private sector partners play critical roles in mitigating the impacts of weather and water events. We work hand-in-hand

with our Federal partners, such as the U.S. Geological Survey (USGS), the Army Corps of Engineers, and the Federal Emergency Management Agency (FEMA).

This quartet of core partners often acts as conveners and integrators of necessary information and people, including State and local emergency officials and managers.

This is just one key part of our efforts to prepare for and mitigate impacts. We work very closely together to minimize redundancies and enhance the sum of our parts. Our combined efforts, before and during this year's historical floods, provide an excellent example of the efficacy of these partnerships.

The spring flood outlooks the NOAA issued in January along with local decision support, allowed many communities to take actions that limited flood impacts, including massive levee reinforcements to, eventually, precautionary evacuations. FEMA and the Red Cross prepositioned assets. The USGS ensured the river gauges were operational.

We can do better. The NOAA, the USGS, and the Corps of Engineers recently signed a memorandum of understanding to begin significant advancement of our joint efforts in water resource observations, prediction, and management. We've committed to a framework that will provide an integrated, common operating picture for water resources and management nationwide.

This is known as the Integrated Water Resource Science and Service Initiative (IWRSSI). This is just one of many ways in which the NOAA is working to improve our ability to provide climate information and services effectively to public and private sector partners.

In closing, I'd like to emphasize that the Nation's investments in the NOAA's weather prediction and warning capabilities have directly saved lives this year.

PREPARED STATEMENT

We are clearly experiencing a trend toward more high-impact weather and water events. Thanks to the Congress' support, the NOAA, today, is able to help the Nation anticipate their development and prepare for their impacts.

The NOAA is committed to continual improvement of our predictive capabilities, and working with our Federal and private sector partners, to providing the highest level of preparedness and promoting our Nation's resilience to these events. Thank you, Mr. Chairman, Mr. Moran, and I look forward to any questions you may have.

[The statement follows:]

PREPARED STATEMENT OF KATHRYN D. SULLIVAN, PH.D.

Good morning Chairman Durbin, Ranking Member Moran, and members of the subcommittee. My name is Dr. Kathryn D. Sullivan, and I am the Assistant Secretary of Commerce for Environmental Observation and Prediction for the National Oceanic and Atmospheric Administration (NOAA). Thank you for the opportunity to testify today at this hearing about the Federal Government's role in mitigating the economic impact of severe weather events. High-impact weather sometimes takes the form of relatively short-lived, but extreme events such as tornados, flash floods, hurricanes, wildfires, tsunamis, dust storms, or heat waves—but also of longer-term events such as floods and drought, which have broader impacts across many economic sectors. The NOAA's short-term weather forecasts of conditions out to about

2 weeks have been critical to saving lives and property in the days leading up to and during the extreme events we've been seeing this spring and summer. The NOAA's long-range weather and seasonal forecasts, also known as "climate forecasts," have been critical to making the advance planning decisions, from weeks to months ahead of time, that allow rapid response to the onset of these weather events.

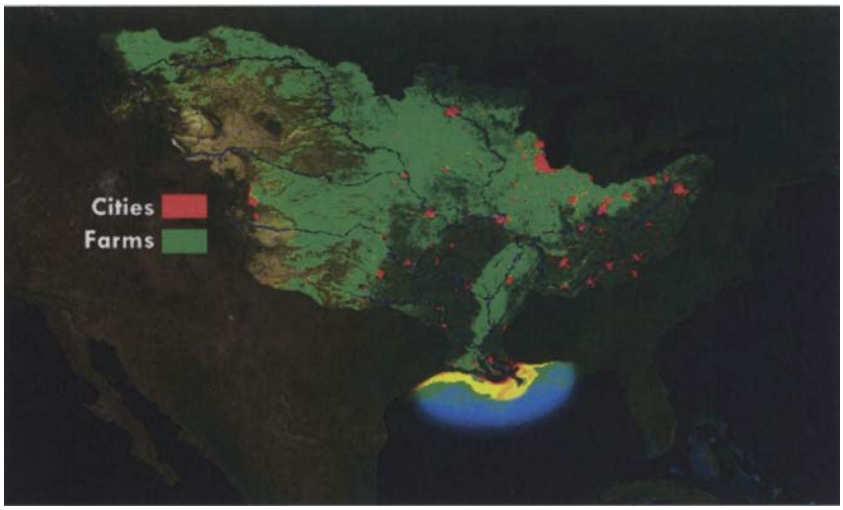
*An Historic Year in the Making*

The year 2011 has already established itself in the record books as an historic year for weather-related disasters and it is not over—in fact hurricane season is just getting underway. Just past the year's midpoint, we have already seen eight $1-billion-plus disasters. Total damages from weather- and water-related events since January for the United States are well more than $32 billion and climbing (Lott, et al. 2011). Tied for fifth, 2011 is as the deadliest tornado year for the United States since modern recordkeeping began in 1950, with 537 people killed so far. April 2011 ranks as the most active tornado month on record with 875 tornadoes, breaking the previous record of 542 set in 2003. More tornadoes occurred on April 27 of this year than any other day in the past 61 years. On May 22, a large portion of Joplin, Missouri was devastated by an EF–5 (winds greater than 200 mph) tornado, resulting in more than 150 fatalities and more than 1,000 persons injured. The Joplin tornado was the deadliest this year and is ranked seventh among the deadliest tornadoes in U.S. history.

Prime wildfire conditions prevailed across portions of the Southern Plains and Southwestern States, with a record breaking 1.79 million acres burned across the country in April alone, with Texas, New Mexico, and Arizona bearing the brunt of the wildfire activity. Nearly 6 million acres have burned nationwide—double the 10-year average by this time of year.

Fueled by record-setting precipitation totals, historic flooding has hit the Midwest and Ohio Valley, from the smallest streams to the largest rivers. The Ohio Valley region had its wettest April on record, and the record goes back to 1895 for some States. Record breaking heavy rains across Montana and the Dakotas, combined with runoff from record winter snowpack, caused tremendous flooding across those States, with Minot, North Dakota, being among the hardest hit. Forecasts now indicate this season could rival the Great Flood of 1993. In that year, the Upper Midwest endured persistent, record-breaking floods from April through August, impacting nine States and causing more than $25 billion in damages (adjusted for inflation)(Lott, et al. 2010). The effects of floods are felt far downstream as well. Following the 1993 flood, the spatial extent of the hypoxic zone, or "dead zone" in the Gulf of Mexico more than doubled its size, to more than 18,000 $km^2$, and persisted at that size through midsummer 1997. The tremendous amount of water flowing into the Gulf of Mexico from this year's record spring flooding is expected to cause the largest ever "dead zone", surpassing that of 1993 (Rabelais, et al 2011). Dead zones—areas lacking the necessary oxygen and salinity to fuel marine life—are primarily caused by the effects of runoff from floods, which carry not only the upstream sediments such as agricultural nutrients, but also the tremendous freshwater influx to the gulf waters. This stimulates an overgrowth of algae that sinks, decomposes, and consumes most of the life-giving oxygen supply in the water. The Gulf of Mexico dead zone is of particular concern because it threatens valuable commercial and recreational gulf fisheries that generate about $2.8 billion annually.

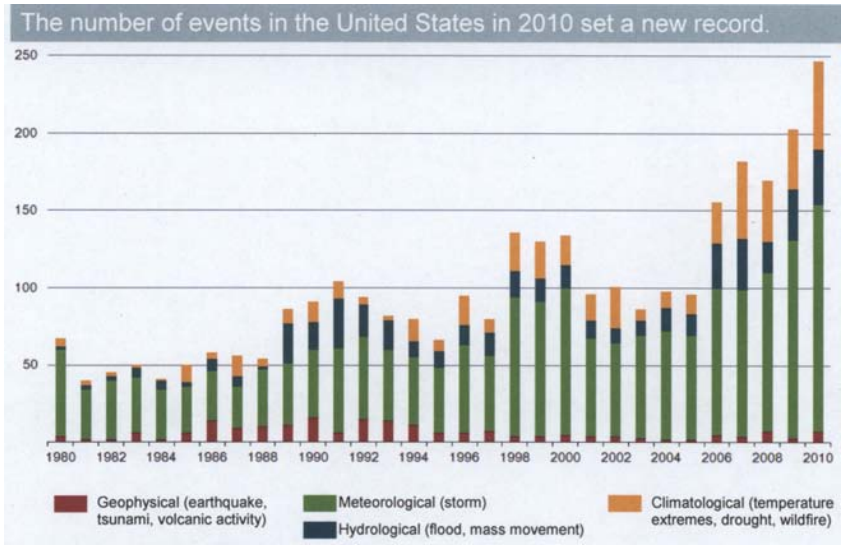
DEPICTION OF GULF OF MEXICO HYPOXIA ZONE IMAGE




SOURCE.—NOAA.

WHAT IT MEANS

Nearly 90 percent of all Presidentially declared disasters are weather and water-related, and our vulnerability to the impacts is increasing as our population grows. As shown in the chart below, the, the number of these events is trending upward, with 2011's numbers on track to surpass last year's record.




SOURCE.—Munich Re NatCat*SERVICE*.

Over the past 30-plus years, the United States has seen a total of 107 weather-related disasters each totaling more than $1 billion in damage. Total standardized losses since 1980 exceed $750 billion.

Demographic trends and population growth and an increased reliance on technology, coupled with this trend in extreme weather events, have made our society more vulnerable to high-impact events. As a result, many agricultural, business, and urban planners are looking for ways to increase community resilience now. For example, the city of Chicago is taking steps to prepare for the likelihood of intense storms striking more often, of rainfall events causing more flooding, and of warmer temperatures. Local climate studies, along with recent trends such as an increase in the frequency of heavy rainfall events, have led them to conclude that this is the soundest action to take in order to mitigate the cost and impact of these events. New York City is also engaged in adaptation planning, with particular focus on the risk of flooding from rising sea level. The Navy's Task Force on Climate Change has advised that the Navy should prepare to police the equivalent of an extra sea as the Arctic ice melts. These cities and organizations, among many others, recognize the need to understand changes and trends in weather patterns, and to apply this to planning that may reduce vulnerability to high-impact weather and water events. Their recognition for the need to reduce their vulnerability to weather and water extremes is an important first step. However, there is much more that needs to be done in other sectors of our economy and with the general public to increase our resiliency to the impacts of these events.

There is more that can be done, and that communities and businesses are mobilizing to do. This is why the NOAA's mission to understand and predict changes in climate, weather, oceans, and coasts, to share that knowledge and information with others, and to conserve and manage coastal and marine resources is so vital. Our vision for healthy ecosystems, communities, and economies, that are resilient in the face of change, can lead to improved economic viability of weather-dependent sectors like agriculture and other businesses, as well as more lives saved.

## THE VARIOUS ROLES OF NOAA

Many Federal agencies have a critical role in preparing for weather and water disasters, including the United States Geological Survey (USGS), the United States Army Corps of Engineers (USACE), and the Federal Emergency Management Agency (FEMA). The NOAA works collaboratively with these Federal agencies to ensure preparedness and a coordinated approach to preparedness.

### *Research, Observations, and Prediction*

NOAA scientists have been at the forefront of weather and climate science, forecasting and public preparedness for decades—our science helps save lives and livelihoods. The NOAA has a leading role in understanding changes in weather and climate extremes, such as trends in severe local storms and extremes in precipitation—too little or too much, too often or too infrequent.

Longer lead-time forecasts for droughts, seasonal flooding, heavy rainfall events, heat waves, and cold spells provide tremendous economic value for the Nation. The NOAA provides a spectrum of critical information across a range of time and space scales, which is used by government, business, emergency managers, planners, and the public. That information's value increased when businesses, farmers, energy producers and utilities, as well as the general public, are prepared and have effective plans of action to mitigate impacts.

Our Nation's environmental predictive capabilities are supported by four foundational pillars: observations, computer models, research, and our people, who provide forecasts, warnings, and decision assistance to key decisionmakers. By strengthening the pillars—through improved satellite and in-situ observations, computational capacity, and coupled atmosphere, ocean, land models, and necessary research—we can revolutionize the forecast process across the entire spectrum, from relatively small-scale, short-range applications to long-range weather and climate predictions. For example, on the larger scale, coupled models provide improved simulations of the interaction between the ocean and atmosphere, resulting in more accurate predictions of tropical cyclone behavior. On smaller scales, higher-resolution observations and models can provide the type of short-term severe weather predictions that will one day allow us to "warn on forecast," or know up to 60 minutes ahead of time where a tornado will touch down.

We know that shifts in weather patterns are often regional in nature, and have variable time spans. For example, El Niño and La Niña, which have become household words, are generally predictable over fairly definable areas and time spans. During the 1997–1998 El Niño and 1998–1999 La Niña, the U.S. agricultural sector experienced damages of $2.4 billion–$2.8 billion and $3.6 billion–$10.7 billion (in 2010 dollars), respectively (Adams, et al. 1999). We are coming to understand many of these larger-scale phenomena, such as the North Atlantic Oscillation, which is a change in the water temperature in the North Atlantic that is strongly correlated

with heavy snowfall events in the Mid-Atlantic and Northeast States. However, we still do not always fully understand how these pattern shifts relate to or affect one another, and there are likely many other phenomena we have yet to discover. For example, while there are some known correlations between the La Niña phase and tornadic activity across the United States, significant research is required to improve our scientific understanding of links between climate patterns and local weather extremes.

Our tornado warnings have improved significantly over the past two decades primarily because of past research efforts. More research would help us better understand the rapid evolution of severe thunderstorms and why some produce tornadoes and others do not. We face a similar challenge with our understanding of hurricanes. While our track forecasts have improved greatly—our forecast location for 5 days out is now as accurate as the forecast location for 3 days out was 15 years ago—we still do not understand what causes some tropical systems to jump two intensity categories in less than 24 hours, while others do not. Understanding these atmospheric evolutions will help us increase forecast lead time and accuracy for these damaging and deadly storms.

*Getting the Word Out*

As the Federal Government's sole official voice for issuing warnings during life-threatening weather events, and as an established reliable and trusted source, the NOAA provides the Nation's first line of defense against severe weather. NOAA operates the Nation's geostationary and polar orbiting satellites, a nationwide network of Doppler weather radars and surface observing stations. Scientists develop computational models that combine these observations with equations describing the physics of our atmosphere and ocean, and our forecasters interpret and deliver critical information. Alerts and warnings for severe weather and other near-term hazards (tornados, hurricanes, severe thunderstorms, winter storms, most floods, chemical spills, volcanic ash, tsunami, space weather, etc.,) are delivered through multiple redundant mechanisms, including: NOAA Weather Radio, which triggers the Emergency Alert System; NWSChat, which focuses on real-time coordination with local core customers in the broadcast media and emergency management; the Internet; and, through our private sector partners—commercial television and radio, which communicate critical information to much larger audiences and effectively inform those in harm's way to take appropriate action.

*Preparedness*

Our prospects for success in this role, and of achieving our vision of resilient communities, lie in our unique enterprise capabilities. The goal of disaster resilience is to enhance the capacity of a community exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure. The preparedness challenge remains essentially the same across both short-term and long-term weather and water events: public awareness, education, and plans of action to mitigate impacts on the personal, community and regional scales provide the best protection against potential disasters. The NOAA has long-held and strongly established ties to the emergency management community, through State, local and tribal officials, which help ensure appropriate action is taken to prepare communities for weather and water events. The NOAA and its partners, such as the National Sea Grant network, use integrated research, training, and technical assistance to enhance the ability of communities to prepare for, respond to, and rebuild after disasters strike. For example, we are developing a Coastal Resilience Index that provides a tangible way for communities to identify gaps and examine how prepared they are for storms and storm recovery, and provide guidance on how to increase resilience through measures including strengthening infrastructure or adopting stricter building codes.

The historic floods currently spanning from Montana across the Dakotas, into the northern and central plains and southern Mississippi Valley are an excellent example of why we need to prepare for catastrophic events. The NOAA/National Weather Service (NWS) spring flood outlook highlighted those particular areas as having the likelihood of major flooding. Our River Forecast Centers and local Weather Forecast Offices worked with Federal, State, and local emergency managers and planners to help prepare for and plan to mitigate the impact of the flooding. Based on our forecasts, communities took extensive actions to limit the impact of the flooding, including massive levee reinforcements and eventual evacuations to prevent loss of life. FEMA prepositioned relief assets, and the USGS ensured their river gauges were operational—all of the agencies worked together to help mitigate the potential impact.

The NOAA often plays a key Federal role throughout these events as an integrator of the many Federal capacities applied to alert communities and regions to an event and its likely impacts, and to help mitigate those impacts as they're occurring and afterward. For example, due to the large extent of the Midwest floods this year, we are predicting a very extensive "dead zone" in the Gulf of Mexico, due to the excessive fresh water flowing into the gulf. This will have a significant impact on the lives and livelihoods of those in the gulf region. The NOAA is working to ensure the gulf region, its communities, and the commercial interests are aware of the impacts and timing of this event, and supporting mitigation efforts.

Unfortunately, in spite of our best efforts, severe weather events still cause loss of life and significant damage. More of this could be mitigated with more timely, accurate and focused warnings. The impacts and lives lost from the disasters mentioned above would have been far worse without critical data input of observations from satellites and in-situ observations, and the extensive work of the NOAA and our Federal, non-Federal, State, and local partners to improve the Nation's preparedness for these events through education and outreach. However, as evidenced by the tragic loss of life in a number of these events, there is a long way to go to truly achieve a weather-ready Nation.

ACHIEVING A WEATHER- AND WATER-READY NATION

We have made tremendous strides thanks to the modernization of the NWS two decades ago. Because of advances in data assimilation and modeling, and critical sampling of the atmosphere from our polar orbiting satellites and geostationary satellites, model forecasts for 3 days and beyond have improved substantially. For example, our forecasts for 3 days away are now as accurate as they were for 2 days away only 10 years ago. These improvements have allowed for advance lead times between first alert and the actual event.

For example, leading up to the "Snowmageddon" event of February 2010, the NOAA was able to detect the storm threat 7-plus days in advance and begin alerting the east coast up to 5 days in advance of the storm. This allowed States to implement contingency and continuity of operations plans, airlines to rearrange flights, and the retail industry to pre-stock their shelves. As a result, there was minimal impact to national and local airline and highway transportation. This long lead time was made possible in large part by observations obtained by NOAA's polar-orbiting satellite and numerical weather prediction models. Polar-orbiting satellites are the backbone of all model forecasts at 3 days and beyond; however, the launch of the next generation of the NOAA's polar-orbiting satellites, the Joint Polar Satellite System (JPSS), has been delayed by the fiscal year 2011 appropriations process. As a result, the NOAA is faced with a nearly 100 percent chance of a data gap in the U.S. civilian polar orbit, on which both civilian and military users rely, by late 2016 to early 2017 when the current polar satellites reach the end of their life expectancy. The JPSS is a critical part of NOAA's future infrastructure needed to continue our path of forecast improvement—and to maintain what we have built during the last 30 years.

The NOAA was also able to highlight the likelihood for severe weather in southwest Missouri several days in advance of the May 22 Joplin tornado. Even our lead times for imminent hazards have increased: the tornado warning for the Joplin area was issued 24 minutes before the tornado struck, a substantial improvement over the 5-minute advance warnings that were typical just two decades ago. We have achieved similar forecast improvements for hurricanes. The NOAA's hurricane forecast track error has decreased 60 percent since 1990. All these advances have come about through the close coupling of research and operations in NOAA's weather enterprise. All of these advances have helped save lives and reduce the economic impacts of severe weather.

With the high death toll and impacts we've seen this year, we take little solace in knowing that outcomes could have been worse without the extensive work of NOAA and our Federal, non-Federal, State, and local partners. There is much more that needs to be done to improve the Nation's resilience for these events. Research, education, and outreach are the essential ingredients to improving preparedness and via improved forecast and warning accuracy and lead times. Realizing a weather-ready Nation, where society is prepared for and responds to weather-dependent events, is vital.

Weather-related catastrophes with high economic and social costs are not just acute events like tornado outbreaks or hurricanes, but also longer-term events such as seasonal or prolonged flooding, droughts, wildfire outbreaks, and other phenomenon brought on or enhanced by environmental change. These forces of nature can sometimes exact an even higher cost, since they occur over longer periods of

time, impact greater areas, and require longer-term planning to mitigate. The NOAA has significant expertise in this area, and our products, services, information, and planning are being used more broadly and sought out more fervently than ever before. One example is the NOAA's work with our partners as part of the Devils Lake Task Force. Devils Lake is an enclosed basin in north-central North Dakota with no natural outlet. The water level in the lake has risen more than 50 feet in the last 50 years. Flood damages in the Devils Lake Basin have exceeded $300 million and inundated more than 138,000 acres since 1993 (Wiche, et al. 2010), and increased in volume by six times. The community's concerns continue to grow regarding how much more of their land and homes, their businesses and infrastructure, the lake will consume, and how much more damage it may cause. The NOAA is using our weather and climate information—spanning from daily weather forecasts to seasonal outlooks and local and regional climate trends and analysis—to provide decision-support services to the local community, as well as resource management and disaster-response partners at FEMA, USGS, USACE, USDA, and others. It is this type of science-based support that these decisionmakers demand and need as they plan current and future actions to better prepare for both the continued flooding, and the potential impacts of a spill catastrophe should the lake reach critical spill elevation.

As noted earlier, demographic trends and population growth, plus our increased reliance on technology, have made our society more vulnerable to extreme weather. The NOAA has started a national dialog with the Nation's top experts in broadcast meteorology, emergency management, and the weather industry to examine what is happening with severe weather and what can be done in the short- and long-term to improve the Nation's severe weather forecasts and warnings, and community preparedness. Included in this effort are social sciences, innovative technologies, and social media to improve our effectiveness in reaching those in harm's way and provoking appropriate response, whether to the urgency of a tornado or tsunami warning, or to the longer-term likelihoods of flooding or drought. For example, most NWS offices have established Facebook pages, providing an additional medium for conducting outreach and education, as well as highlighting information about ongoing or upcoming weather events. Additionally, the NOAA uses NWSChat to give private sector partners an invaluable opportunity to interact with NWS experts, and to refine and enrich their communications to the public. Moreover, more private companies are carrying weather warnings on wireless networks, providing real-time alerts to your cell phone or email.

Sea level rise, the increased number and intensity of heavy rainfall events and strong coastal storms, and other natural and human hazards are putting more people and property at risk, with major implications for human safety, economic vitality, and environmental health, especially in coastal areas. A new study by the NOAA indicates that coastal communities along the U.S. east coast may now be at greater risk of inundation during El Niño years due to higher sea levels, accompanied by more destructive storm surges. To achieve a weather-ready Nation, it is essential that residents of communities understand these risks and learn what they can do to reduce their vulnerability and respond quickly and effectively when events occur.

The NOAA is working on a number of efforts to increase the resilience of coastal communities. The NOAA's multi-mission National Water Level Observation Network provides water level data that supports near-term warnings conducted by the NWS for storm surge and tsunamis, and provides long-term climatic records for sea level trends. The NOAA has worked with many entities to help them incorporate sea level trend guidance into their policy and planning documents. The NOAA also maintains the National Spatial Reference System (NSRS), which is the national coordinate system that defines position (latitude, longitude, and elevation), distances and directions between points, strength of gravitational pull, and how these change over time. The NSRS is a network of precisely located, permanently marked, in-ground geodetic reference points critical for accurate GPS use, and is critical to determine an accurate depiction of the shoreline. Both systems are needed to accurately model coastal inundation ranging from short-term extreme events to long-term sea level changes.

A key component of achieving a weather-ready Nation is community preparedness. NOAA's StormReady program works at the local level to ensure communities, both inland and coastal, have the warning capabilities and plans in place to help safeguard them against all types of disasters. This effort is complemented by NOAA's Coastal Storms Program (CSP), which is a nationwide effort to reduce loss of life and mitigate impacts of storms on coastal communities and the environment. CSP provides dedicated resources and expertise from across NOAA to deliver capacity-building tools, training, data, and other products and services to enhance hazard

resilience in coastal communities in particular. For example, NOAA is working with communities along the Gulf of Mexico to provide a simple, inexpensive method for leaders to perform a self-assessment of their community's resilience to coastal hazards. The results help communities prioritize what needs to be addressed before the next extreme event. Through these various community resilience efforts, NOAA is placing an increased focus on social science to better understand how and why decisions are made at the State and local levels and how NOAA can improve its efforts to communicate risk and uncertainty to the public at large.

Sustaining our commitment to existing services, while continuing to improve our capacity to meet the Nation's weather and water needs, requires targeted investments to shore up aging infrastructure, improve scientific understanding, and implement enhanced services to reduce risk to the Nation caused by weather and water. Today's services are built upon earlier investments in innovative science and technology as well as our highly skilled workforce. Our capacity to collect and assimilate increasing amounts of data to improve model performance must increase to realize their potential. This is achieved through making critical improvements to science and technology. Future technology improvements include continued polar and geostationary satellites, more sophisticated radar coverage, observing systems, and improved computing capabilities. These technology assets are crucial pieces of our national infrastructure. The gap in data from the NOAA's JPSS will significantly impact our ability to achieve a weather-ready Nation, because it will degrade our ability to accurately forecast severe weather events 3 days and beyond.

Water management decisionmakers also require a new generation of water information, forecasts, and decision support. The NOAA is working with its Federal partners USGS, USACE, and others to implement Integrated Water Resources Science and Services, creating an integrated, high-resolution common operating picture for water information, supporting timely and critical water management decision in full coordination and collaboration with forecasting and decision support services.

We know that the NOAA forecasts, warnings, and community-based preparedness programs are vital in enhancing the economy and saving lives. It all starts with a commitment on improved forecasting and ends with a weather-ready Nation in which businesses, governments, and people are prepared to use those forecasts to mitigate impacts.

SUMMARY

To achieve an increase in community resilience and reduce the Nation's vulnerability to weather- and water-related extreme events, we must continue to improve predictions. Again, our Nation's environmental predictive capabilities are supported by four foundational pillars: observations, computer models, research, and our people. By strengthening the pillars—through improved satellite and in-situ observations, computing capacity, coupled atmosphere, ocean, land models, and necessary research and science improvement—we can revolutionize the forecast process across the entire spectrum from relatively small-scale, short-range applications to long-range weather and climate predictions.

The dual goals of preparing for and mitigating natural hazards require the continuous commitment and partnership of many individuals and sectors—from Federal, State, tribal, and local to public, private, and academic. The investments made by the Congress and the administration in NOAA's weather prediction and warning capabilities directly save lives in the United States during these weather disasters. NOAA remains committed to leading U.S. efforts to save lives and property through preparedness, detection, modeling, and forecasting efforts necessary for improved decisionmaking. Although nothing can eliminate the physical threat that severe weather and natural hazards pose, NOAA has demonstrated success in better predicting them, reducing their impact, and helping vulnerable communities become more resilient to their devastating effects—and will work to continuously improve its natural hazards products and services to the Nation.

Senator DURBIN. Thanks, Dr. Sullivan. James Rivera is here, Associate Administrator, Office of Disaster Assistance, Small Business Administration. Please proceed.

**STATEMENT OF JAMES RIVERA, ASSOCIATE ADMINISTRATOR, OFFICE OF DISASTER ASSISTANCE, SMALL BUSINESS ADMINISTRATION**

Mr. RIVERA. Good afternoon, Chairman Durbin, and Ranking Member Moran, and distinguished members of the subcommittee.

My name is James Rivera and I'm the associate administrator for the Office of Disaster Assistance at the SBA.

Thank you for inviting me to testify on my experience in administering the Disaster Loan Program and how the SBA budgets for its response in disasters.

The SBA is responsible for providing affordable, timely, and accessible financial assistance, following a disaster to businesses, homeowners, and renters. This financial assistance comes in the form of low-interest loans to affected homeowners, renters, businesses, and nonprofit organizations.

Since the SBA was created in 1953, we have provided more than 1.9 million loans amounting in more than $49 billion. In terms of recent activity, as a result of the recent spring floods, tornadoes, and disaster events, the SBA has responded in 13 States and has provided more than $220 million in loans to homeowners and businesses. This is for uninsured losses.

With regards to budgeting, the Federal Credit Reform Act of 1990 requires the President's annual budget reflect the estimated long-term costs of Federal credit programs on a net present value basis. Accordingly, we estimate subsidy cost of our credit program.

Subsidy models are based on the available, historical data, so that the estimates can be performed, and therefore, the budget formulation subsidy is broadly based on loans made in response to historical disasters.

The Disaster Loan Model produces cash flow projections for budget formulations, subsidy estimates, and re-estimates. The model uses the historical performance of more than 650,000 loans since 1992 to project future cash flows. The model also predicts individual loan performance based on current performance, and the historical experience of loans with similar characteristics.

Loan characteristics found predictive for disaster loan behavior include whether the loan was made to a home, or a business, the size of the loan, deferral period, type of injury, and the age of the loan.

The SBA recognizes the added value of external modeling, and uses this approach to gather information from these models to provide additional event-specific information that will refine and improve the SBA's ongoing response. The Department of Homeland Security and FEMA have a tool called Hazards United States (HAZUS) that is a loss-estimation methodology for natural disasters in the United States.

HAZUS is a powerful program for analyzing potential losses from floods, hurricanes, and earthquakes. The program couples the latest scientific and engineering knowledge with advanced geographic information systems technology to produce estimates of hazard-related damage before, during, or after disaster.

The use of the HAZUS Program, allows the SBA to produce more accurate, actionable, and timely information when responding to natural disasters. We also incorporate this information for our Scalability Model. The model is designed to further refine and analyze disaster loan estimates for the purpose of accurately correlating damage estimates into actionable, and immediately staffing, budgetary projections.

This year, as in past years, Dr. Gerry Bell, a climate specialist and research meteorologist at the NOAA's Climate Prediction Center, will brief the SBA's senior management on the NOAA's updated hurricane prediction.

Dr. Bell specializes in monitoring global climate variability, especially patterns related to El Niño, and La Niña, and other atmospheric processes. This briefing will aid the SBA in our strategic planning efforts in this hurricane season.

I would also like to quickly highlight some recent improvements to our disaster operation. The SBA is partnering with Agility Resource Solutions and we provide monthly webinars on preparedness. We also partner with the Red Cross and leverage the Ready Rating Program for homeowners and businesses.

We've invested in our infrastructure and have increased the number of workstations for disaster staff employees from 300 to more than 2,100 work stations, which include 350 surge workstations at another location. We've increased the capacity of our computer system, the Disaster Credit Management System, from 800 concurrent users up to 10,000 concurrent users.

PREPARED STATEMENT

Since Hurricane Katrina, the SBA has processed applications within 10 days, with an average goal of 14 days for homes and 18 days for businesses. To put this in perspective, the average processing during the 2005 gulf coast hurricanes was 74 days for homeowners and 66 days for business loans.

I appreciate the opportunity to share with the subcommittee the role the SBA plays in disaster recovery. We believe that we're prepared to be effectively and efficiently respond to the needs of disaster victims. I look forward to your questions and thank you.

[The statement follows:]

PREPARED STATEMENT OF JAMES RIVERA

Good afternoon Chairman Durbin, Ranking Member Moran, and distinguished members of the subcommittee. Thank you for inviting me to testify on my experiences administering the Small Business Administration (SBA) Disaster Loan Program and how the SBA budgets for its response to disasters.

Disaster assistance has been part of the SBA's mission since 1953. Through the SBA's Office of Disaster Assistance (ODA), the SBA provides affordable and timely financial assistance to disaster victims. This financial assistance comes in the form of low-interest loans to affected homeowners, renters, businesses, and nonprofit organizations.

Many disaster victims have insurance, which covers part or all of the physical property losses due to a natural disaster. But for disaster losses not covered by insurance, an the SBA loan is the primary form of Federal financial assistance. Since the SBA's inception in 1953, we have provided more than 1.9 million loans totaling more than $49 billion to help disaster victims in the wake of natural—as well as manmade—disasters. These loans are the only form of SBA assistance not limited to small businesses. The majority of the SBA disaster loans approved—about 80 percent—go to homeowners and renters.

In terms of recent disaster events, in response to the severe storms and flooding this spring, the SBA has approved more than 3,700 loans totaling more than $207 million. And last year, as a result of the Deepwater BP oil spill, small businesses in the gulf region that earn their living fishing in these waters, as well as seafood retailers, boat yards, shipping companies, processing plants, and other coastal small businesses faced the potential of tremendous financial losses from having to shut down operations because of the oil spill. The SBA assisted these small businesses by making Economic Injury Disaster Loans (EIDL) available for small businesses

in Louisiana, Mississippi, Alabama and Florida, and approved $41 million to affected small businesses.

THE SBA'S ROLE IN RESPONDING TO A DISASTER

The SBA is not a "first responder agency" following a disaster. Rather, the SBA's role focuses on providing loans as part of the recovery effort. The SBA carries out this role in coordination with other government partners at the Federal, State, and local levels.

When the President makes a disaster declaration, various forms of Federal assistance, including SBA's Disaster Loan Program, become available. If the Federal Emergency Management Agency (FEMA) declines a request for a declaration or if the State determines the damage is not extensive enough to request FEMA assistance, the State can request an "Administrative/Agency Declaration" from the SBA's Administrator. And if that request meets the SBA's damage requirements, area residents and business owners may apply for SBA disaster assistance.

Disaster loans are a vital source of economic support in the affected areas. As part of an overall effort to get victims back on their feet, the SBA's disaster home loans of up to $200,000 help local community members return and rebuild their homes. Moreover, businesses and nonprofits of all sizes are eligible for loans of up to $2 million to assist with any uninsured and otherwise uncompensated physical losses sustained during a disaster. These funds are used to repair or replace damaged physical property.

Additionally, the SBA offers EIDLs to small businesses, small agricultural cooperatives, aqua culture businesses and most private nonprofit organizations that have suffered economic injury caused by a disaster. If a small business or organization is unable to meet obligations and pay its ordinary and necessary operating expenses, an EIDL loan can help. These loans provide working capital to businesses or organizations. The maximum loan amount is $2 million combined for both physical and economic injury.

In processing applications under longstanding program criteria, the SBA does not price loans based on the types of disasters that occur—interest rates for disaster victims are not based on the types of exposure that have the potential of higher losses. Funds are available and based on needs of each particular disaster and more specifically the disaster victim and their damages. Unlike other financial institutions, we do not use a progressive scale in determining interest rates based on potentially higher loss rates. However, the SBA has a responsibility to taxpayers to be a prudent lender and to not only require a reasonable assurance of repayment ability, but also to impose requirements upon disaster borrowers that will help minimize the potential need for future disaster loans (e.g., through insurance requirements mandated by regulations and SBA policy).

BUDGET FORMULATION SUBSIDY ESTIMATES

The Federal Credit Reform Act of 1990 requires that the President's budget reflect the estimated long-term cost of Federal credit programs on a net present value basis. Accordingly, credit agencies estimate the subsidy costs of Federal credit programs prior to submission of the President's annual congressional budget submission. Subsidy models are oriented primarily toward preparing budget formulation subsidy estimates based on the available historical data so that estimates can be performed long before the fiscal year begins. For disaster assistance loans, we cannot know what kinds of disasters will occur in advance or how they will interact with other events. Therefore, the budget formulation subsidy estimate is broadly based on loans made in response to historical disasters.

The disaster loan model produces cash flow projections for budget formulation subsidy estimates and re-estimates. The model uses the historical performance of more than 650,000 loans disbursed since 1992 to project future cash flows. The model predicts individual loan performance based on current performance and the historical experience of loans with similar characteristics. Loan characteristics found predictive for disaster loan behavior include whether the loan was made to a home or a business, the size of the loan, grace period length, type of injury (economic or physical), and age of the loan.

ADDITIONAL RESOURCES

The SBA recognizes the added value of external modeling approaches and uses information gathered from these modeling approaches to provide additional, event-specific information that will refine and improve the SBA's ongoing response.

*HAZUS–MH*

Hazards-US/Multi-Hazard (HAZUS–MH) is the Department of Homeland Security's loss-estimation methodology for natural hazards in the United States. HAZUS–MH, also commonly referred to as The Risk Map Assessment Tool, is a powerful program for analyzing potential losses from floods, hurricanes and earthquakes. The program couples the latest scientific and engineering knowledge with advanced geographic information systems technology to produce estimates of hazard-related damage before, during, or after a disaster.

The ODA is a strong partner in the HAZUS modeling community and actively works with FEMA's HAZUS program management office and developer community to strengthen and support Government and industry use of HAZUS technology for responding to, and mitigating against, potential disaster losses. Use of the HAZUS–MH program allows the ODA to produce more accurate, actionable, and timely information when responding to natural disasters.

In addition to HAZUS–MH, the primary model used by the ODA is the Scalability Model. This model is a custom developed program exclusive to the SBA. It was designed to further refine and analyze disaster loss estimates from models such as HAZUS for the purpose of accurately correlating damage estimates into actionable and immediate staffing and budgetary projections.

The ODA has joined the Department of Homeland Security (DHS), FEMA, and other Federal partners in establishing the first ever Geospatial Concept of Operations (GeoCONOPS). The GeoCONOPS is an effort focused on geospatial communities supporting the DHS and the emergency management activities under the National Response Framework (NRF). It is a multiyear effort designed to document the current geospatial practices supporting NRF and Stafford Act activities. The participants include the 15 emergency support functions, and other Federal mission partners.

*National Oceanographic and Atmospheric Administration (NOAA)*

This year, as in years past, Dr. Gerry Bell, climate specialist and research meteorologist at NOAA's Climate Prediction Center, will brief SBA's Senior Management on NOAA's updated hurricane predictions. Dr. Bell specializes in monitoring global climate variability, especially patterns related to the El Niño, the multi-decadal cycle, and other large-scale atmospheric processes. He is the chief editor and co-author of the monthly Climate Diagnostics Bulletin, which provides the latest El Niño analysis and diagnosis, along with a description and analysis of global weather and climate conditions. This briefing will aid the SBA in our strategic planning efforts this hurricane season.

Another step we took to help small business owners in these areas who were repaying existing SBA disaster loans, was to allow them to request a deferment. Additionally, the SBA strongly encouraged its participating private lenders to consider on a case-by-case basis deferment relief for borrowers with SBA-guaranteed 7(a) loans and 504 loans.

SIGNIFICANT IMPROVEMENTS SINCE HURRICANE KATRINA

Since 2005, we have seen a great deal of improvement in our disaster program. While we fortunately had a light 2010 hurricane season, in fiscal year 2010 we responded to more small-scale disasters (51 agency declarations and 15 economic injury declarations) than in the past 10 years combined. Following the 2005 gulf coast hurricanes, the SBA faced severe challenges in providing disaster assistance in a timely fashion. As a result, we made dramatic improvements in our operations and processes. Today, by incorporating lessons learned, SBA's Disaster Assistance Program has overhauled its processes and improved response times. The SBA is now better prepared to process loans faster, provide a better quality of service, and be more helpful to disaster victims.

To ensure overall preparedness, the disaster program has increased the number of workstations for disaster-assistance employees from 300 to more than 2,100, and we have brought online a "surge" center with 350 additional workstations. We are currently staffed at approximately 974 employees with a reserve force of more than 2,000. Additionally, the SBA has the ability to request assistance from Small Business Development Centers and other SBA resource partners.

The SBA has also improved its Disaster Credit Management System, which now gives the agency improved technology to serve many users, with increased disaster recovery capacity from 800 to 10,000 concurrent users.

We have also processed applications within 10 days on average with a goal of 14 days for home loans and 18 days for business loans. To put this into perspective, the average processing time during the 2005 gulf coast hurricanes was 74 days for

disaster home loans and 66 days for disaster business loans. Additionally, in August 2008, the SBA introduced an electronic loan application that allows disaster victims to apply for assistance online. Currently, this mechanism accounts for approximately one-third of all applications submitted.

The SBA has also revamped the postapproval process, improving the processes and tools for loan closings and funding disbursements. Our emphasis is on customer service and accountability, with each approved loan being assigned an individual case manager.

In regards to marketing and outreach, the SBA has developed an aggressive plan to reach all potential applicants in an area before a disaster strikes. We are concentrating on areas that are vulnerable to recurring similar disasters to provide expanded outreach efforts before the disaster occurs. Additionally, we have provided all SBA employees with access to an online "Disaster Tool Kit" with detailed information on the agency's role in preparedness, outreach, and assistance.

The SBA has also signed a Memorandum of Understanding (MOU) with the American Red Cross and the Agility Recovery Solutions. Both MOUs are designed to promote disaster preparedness and educate potential disaster victims on the benefits of advanced planning for disasters.

We have also instituted annual disaster trainings for the SBA's Regional Administrators, District Directors, and Disaster Public Information Officers. And finally, we are currently involved in an overall assessment of our disaster assistance messaging, branding, and outreach.

In closing, we appreciate the opportunity to share with the subcommittee the role the SBA plays in small business disaster recovery efforts. We firmly believe that the reforms we have instituted have enabled us to be prepared to effectively and efficiently respond to the needs of our Nation's disaster victims.

Senator DURBIN. Thanks a lot for your testimony, Mr. Rivera, and I will have a few questions for you. I'd like to invite Dr. Wuebbles, at this point, to proceed with his testimony.

**STATEMENT OF DR. DONALD J. WUEBBLES, THE HARRY E. PREBLE PROFESSOR OF ATMOSPHERIC SCIENCES, UNIVERSITY OF ILLINOIS-URBANA, ILLINOIS**

Dr. WUEBBLES. Thank you. Thank you for the opportunity to testify today. I'm professor in atmospheric sciences at the University of Illinois and an expert in the physics and the chemistry of the atmosphere.

Along with the many scientific articles I've published in peer-reviewed literature, I've also been a leader in national and international assessments to look at various concerns about our climate system. As a son of an Illinois farmer, I know the impacts of severe weather are of great concern, to me, the people, and my country.

As we will discuss, the evidence is strong, and there is an increasing trend of a—recent decades for severe weather, especially very heavy precipitation events. Scientific analysis also suggests that the likelihood for these events is likely to further increase as our climate continues to change over this century.

In today's testimony, I will focus on four main points about severe weather events in the United States and their relationship to changes occurring in our climate system. First, there are strong indications that the United States is seeing more extreme weather-related events in recent decades than in the past.

We've already had some discussion about what's been going on in—in 2011. We've seen more than $32 billion in damages already this year, and that doesn't account for recent events such as the flooding in Iowa, and in the Midwest, and the—on the Missouri River, et cetera, wildfires in Arizona and New Mexico during late June, or the heat waves that gripped most of the country this last week. This year, 2011, is just part of the picture.

Overall, there's been an increase in some—in key types of extreme weather events, at—since at least 1980. Widespread changes in temperature extremes have been observed over the last 50 years. In particular, the number of heat waves, globally, has increased and there has been a widespread increase in the number of warm nights, cold days, cold nights, and days with frost have become rarer.

Changes are also occurring in the amount, intensity, frequency, and types of precipitation. I'll highlight a few specific examples of the observed trends. First of all, we're now seeing breaking—we're now breaking twice as many heat records as cold records in the United States, and seeing this over the last 50 years.

Since 1957, there has been an increase in the number of historically top 1 percent of heavy precipitation events across the United States, with an increase in such events of more than 30 percent in the Midwest and 67 percent in the Northeast.

Our ongoing analyses of the repeat or recurrent frequencies of large precipitation storms, which, by the way, I'm doing, the people from the NOAA, are showing that such events are occurring more often than in the past. For example, the historical 20-year storm in the Midwest, of roughly 4.4 inches of precipitation in a single day, has now become the 12- to 13-year storm event.

The pattern of precipitation change is one of increases generally at high northern latitudes because of—as the atmosphere gets warmer, it holds more moisture, and drying in the tropics and subtropics over land, so the wetter getting wetter and the dryer getting dryer.

Number two, there is clear scientific understanding that the Earth's climate system is changing and that it is largely happening because of human activities. There is no debate in the scientific community, based on the peer-reviewed literature, about the large changes occurring in the Earth's climate or the connection of these changes to human activities, largely the result of the burning of fossil fuels and other human-related emissions.

The science is clear and convincing that climate change is happening, happening rapidly, and happening primarily because of human activities.

Number three, scientific analyses are now indicating a strong link between changing trends in severe weather events and changing climate. Every weather event that happens nowadays takes place in the context of changes in this background climate system.

Globally, the temperatures are higher, the sea level is higher, and there is more water vapor in the atmosphere, which energizes storms. So nothing is entirely natural anymore. The background atmosphere has changed and continues to change because of the changing climate.

It's important to bear in mind that when one considers interpretation of specific severe events, it's a fallacy to think that individual events are caused entirely by any one thing, either human variation or human-induced climate change. Every event is influenced by many factors. Human-induced warming is now a factor in all climate events.

I could go on and give other examples, but I think I'll go onto number four. Climate analyses suggest that the severe weather

and storm events are likely to become more common in the future. Other modeling results indicate that, if the nations continue to increase their emissions of GHG, the U.S. ratio of daily record highs to record lows are likely to increase by 20 to 1 by mid-century and 50 to 1 by the end of the century.

Our analyses of projected climate changes in the Chicago region have shown that the previously unheard of 1995-type heat wave is likely to become commonplace by the end of the century, occurring, at minimum, every few years. Over the coming decades, we can expect that the hottest summer you have ever experienced will become the norm. Severe precipitation events will also become more commonplace.

PREPARED STATEMENT

Water vapor will continue to increase in the atmosphere, along with the water—and large precipitation events will continue in intensity and frequency. While we are already seeing the climatic effects of heat-trapping gases, it is important to recognize that the future lies largely in our hands, while we reduce our emissions and have a future of less warming and less severe impacts, or while we continue to increase our emissions and have a future with more warming, more severe weather, including the type of things we've been seeing recently. The choice is ours.

[The statement follows:]

PREPARED STATEMENT OF DR. DONALD J. WUEBBLES

Thank you for the opportunity to testify today on the changing trends in severe weather and the relationship of these trends to ongoing changes in the Earth's climate system, and the risks and opportunity those challenges pose for our Nation's energy and economic security.

I am a professor and atmospheric scientist in the Department of Atmospheric Sciences at the University of Illinois. I am an expert in atmospheric physics and chemistry, and have authored more than 400 scientific articles in peer-reviewed journals, books, chapters of books, and in a number of national and international assessments related to concerns about ongoing changes in the Earth's climate and atmospheric chemistry. I am a coordinating lead author for the next major international Intergovernmental Panel on Climate Change (IPCC) assessment of climate change and a member of the Executive Secretariat and the Federal Advisory Committee that is undertaking the next U.S. National Climate Assessment.

As the son of an Illinois farmer, I know that the impacts of severe weather are of great concern to farmers and many other people because of the effects on our economy and on our personal well-being. As we will discuss, the evidence is strong that there is an increasing trend over recent decades for severe weather, especially very heavy precipitation events. Scientific analyses also suggest that the likelihood for these events is likely to further increase as our climate continues to change over this century. In today's testimony, I will focus on four main points about severe weather events in the United States and their relationship the changes occurring in our climate system.

THERE ARE STRONG INDICATIONS THAT THE UNITED STATES IS SEEING MORE EXTREME WEATHER-RELATED EVENTS IN RECENT DECADES THAN IN THE PAST

Analyses from the National Oceanic and Atmospheric Administration (NOAA) National Climate Data Center (NCDC) indicate that 2011 has so far been one of the most extreme weather, and most costly, years in the history of our country. As of early June, there have roughly $32 billion in damages from severe events in 2011, the highest damage costs-to-date for any year since 1980 when the NOAA started tracking the major damaging events. The events they have evaluated this year include major blizzards last January and February, the outbreak of tornadoes in April and May, the drought and wildfires in Texas, New Mexico, and Oklahoma during the spring and early summer, and major flooding on the Mississippi River. However,

these analyses do not include the damages from other recent events, such as the effects of flooding of the Missouri and other rivers in Iowa and other Midwest States, the wildfires in Arizona and New Mexico during late June, or the heat wave that gripped most of the Midwest, South, and Northeast just last week.

However, 2011 is just part of the picture. Overall, there has been an increase in some key types of extreme weather events since at least 1980. Widespread changes in temperature extremes have been observed over the last 50 years. In particular, the number of heat waves globally has increased, and there have been widespread increases in the numbers of warm nights. Cold days, cold nights, and days with frost have become rarer. Changes are also occurring in the amount, intensity, frequency, and type of precipitation (note that these aspects of precipitation generally exhibit large natural variability compared to temperature, making it harder to detect trends in the observational record thus requiring sophisticated analysis techniques). I will highlight a few specific examples of the observed trends:

—We're now breaking twice as many heat records as cold records in the United States (see Figure 1). If the climate weren't changing, the number of record daily highs and lows being set each year would be approximately even. Instead, from 1950 to 2009, we have observed a shift to twice as many daily heat records being broken as night-time records. If we look at 2011, so far the heat records outnumber cold records by a ratio of 2.2 to 1 (based on the NOAA NCDC datasets). Overall, we're seeing more extreme heat and less extreme cold, as you'd expect in a warming climate.

—Since 1957, there has been an increase in the number of historically top 1 percent of heavy precipitation events across the United States (see Figure 2 from the U.S. Global Change Research Program (USGCRP), 2009), with an increase in such events of more than 30 percent in the Midwest and by 67 percent in the Northeast. Over the United States as a whole, there's been a 20 percent increase in the amount of precipitation falling in the heaviest events. More intense rainfall means an increased likelihood of floods.

—Our ongoing analyses (by Ken Kunkel of the NOAA NCDC, one of my students, and I) of the repeat or reoccurrence frequencies of large precipitation storms are showing that such events are occurring more often than in the past. For example (see Figure 3), the historical 20-year storm in the Midwest (NOTE.—A 20-year storm has a 5 percent chance of occurring each year so that the odds are that one occurs every 20 years) of roughly 4.4 inches of precipitation in a single day has now become the 12- to 13-year storm event. Similarly, our analyses are showing that the 5-year storm in the Northeast (3.5 inches in a day) has now become the 3-year storm event.

The pattern of precipitation change is one of increases generally at higher northern latitudes (because as the atmosphere warms it holds more moisture) and drying in the tropics and subtropics over land. The wet are get wetter and the dry are get drier.

For some severe weather events, such as tornadoes, lightning, hail and strong winds, uncertainties in the data collection make it difficult to determine statistically significant trends.

### THERE IS CLEAR SCIENTIFIC UNDERSTANDING THAT THE EARTH'S CLIMATE SYSTEM IS CHANGING AND THAT IT IS LARGELY HAPPENING BECAUSE OF HUMAN ACTIVITIES

There is no debate within the science community, based on the peer-reviewed literature, about the large changes occurring in the Earth's climate or the connections of these changes to human activities, largely the result of the burning of fossil fuels (e.g., see national and international assessments of our climate such as USGCRP, 2009 and IPCC, 2007). The science is clear and convincing that climate change is happening, happening rapidly, and happening primarily because of human activities.

There are an ever-increasing number of many independent surface observations that give a consistent picture of a warming world. Such multiple lines of evidence, the physical consistency among them, and the consistency of findings among multiple, independent analyses form the basis for the conclusion from the 2007 IPCC international climate assessment that the "warming of the climate system is unequivocal". As part of the changing climate, along with changes in the mean temperature being seen worldwide, there is likely to be an amplified change in extremes, both in temperature and in precipitation.

SCIENTIFIC ANALYSES ARE NOW INDICATING A STRONG LINK BETWEEN CHANGING TRENDS IN SEVERE WEATHER EVENTS AND THE CHANGING CLIMATE

Every weather event that happens nowadays takes place in the context of the changes in the background climate system. Globally, the temperatures are higher, the sea level is higher, and there is more water vapor in the atmosphere, which energizes storms. So nothing is entirely "natural" anymore. The background atmosphere has changed and continues to change because of the changing climate. It is important to bear this in mind when one considers interpretation of specific severe events. For example, a pure meteorological analysis of the 2011 would events would note their consistency with the behavior from the La Niña cold Pacific temperatures found earlier this year and the effects of the phase of the North Atlantic Oscillation ocean-atmosphere interactions, but would the severity of the 2011 events been as bad as they are without the changes in the background climate system. Analyses still need to be done to sort this out.

It's a fallacy to think that individual events are caused entirely by any one thing, either natural variation or human-induced climate change. Every event is influenced by many factors. Human-induced warming is now a factor in all weather events.

We're seeing more heat waves and they are hotter and they last longer. And while we might still have had a particular heat wave in the absence of human-induced warming, it would not have been as hot, or lasted as long, and such events would not occur as frequently. For example, an analysis of the 2003 European heat wave (Stott et al., Nature, 2004) that killed tens of thousands of people was shown to be about four times more likely due to human-induced warming. And in the future, summers that hot will be commonplace, if we continue on our current path of increasing emissions of heat-trapping gases.

The changes occurring in precipitation are also consistent with the analyses of our changing climate. For extreme precipitation, we know that more precipitation is falling in very heavy events. And we know key reasons why—warmer air holds more water vapor, and so when any given weather system moves through, all that extra water dumps out in a heavy downpour. And in between these downpours there are longer periods without rain. So you get this cycle of very wet and very dry conditions. And we're seeing this happening now, just as climate studies indicated it would.

A key ingredient in changes in character of precipitation is the observed increase in water vapor and thus the supply of atmospheric moisture to all storms, increasing the intensity of precipitation events on average. Widespread increases in heavy precipitation events and risk of flooding have been observed, even in places where total amounts have decreased. Hence the frequency of heavy rain events has increased in most places but so too has episodic heavy snowfall events that are thus associated with the changing climate.

CLIMATE ANALYSES SUGGEST THAT SEVERE HEAT AND STORM EVENTS ARE LIKELY TO BECOME MORE COMMON IN THE FUTURE

Sophisticated computer models of the global climate system are being used to determine how severe weather is likely to change during the course of this century. For example, in a study of record high and low temperatures by Jerry Meehl of National Science Foundation's National Center for Atmospheric Research, climate modeling results indicate that if nations continue to increase their emissions of greenhouse gases in a "business as usual" scenario, the United States ratio of daily record high to record low temperatures would increase to about 20 to 1 by mid-century and 50 to 1 by 2100. The mid-century ratio could be much higher if emissions rose at an even greater pace, or it could be about 8 to 1 if emissions were reduced significantly.

Our analyses (see Chicago Climate Action Plan or Wuebbles et al., Journal of Great Lakes Research, 2010) of projected climate changes in the Chicago region have shown that the previously unheard of 1995 type heat wave is likely to become commonplace by the end of the century, occurring at minimum every few years. Over the coming decades, we can expect that the hottest summer you have ever experienced will become the norm.

As the climate system continues to warm, these models of the Earth's climate system indicate severe precipitation events will also become more commonplace. Water vapor will continue to increase in the atmosphere along with the warming, and large precipitation events will increase in intensity and frequency. At the same time, droughts like we have been seeing in recent years in the Southwest will likely become stronger and more frequent as the climate change continues. Basically, we expect the wet to get wetter and the dry to get drier.

Some people have criticized climate models. However, today's climate models encapsulate the great expanse of current understanding of the physical processes involved in the climate system, their interactions, and the performance of the climate system as a whole. These complex numerical models account for the many feedbacks that occur through interactions among the components of the climate system:

—the atmosphere;
—oceans;
—land; and
—cryosphere (which includes sea, lake and river ice, snow cover, glaciers, ice caps, ice sheets, and frozen ground).

Today's climate models are extensively tested relative to observations and are able to reproduce the key features found in the climate of the past century, and simulations of the evolution of global surface temperature over the past millennium are consistent with past climate reconstructions.

However, these models are not perfect and likely can't ever be perfect. Uncertainties arise from shortcomings in the understanding and how to best represent complex processes in models. Nonetheless, these models do many things well and provide the best representation possible of the climate system and its changes.

Because models do differ in their representation of certain processes, we make use of these differences by examining suites of models in the climate assessments. However, it is worth noting that they all give the same basic story—human-related activities are significantly heating up the Earth's climate and altering its precipitation patterns and will continue to do so over this century and beyond unless the human effects are reduced. Also, despite the tremendous improvements in the climate modeling capabilities over my 40 years as a scientist, the basic response of a significant effect on the climate system from human activities continues to be about the same as the models were finding 40-year ago. These models are the only crystal balls we have—and although not perfect, they are very useful tools. By downscaling approaches that account for local/regional observations, the results from these models can and are being used to clearly illuminate the choices we face—between a future with lower versus higher impacts on humanity and ecosystems.

While we are already seeing the climatic effects of our emissions of heat-trapping gases, it is important to recognize that the future lies largely in our hands. Will we reduce our emissions, and have a future with less warming and less severe impacts, or will we continue to increase our emissions and have a future with more warming and more severe impacts, including more extreme weather events? The choice is ours.

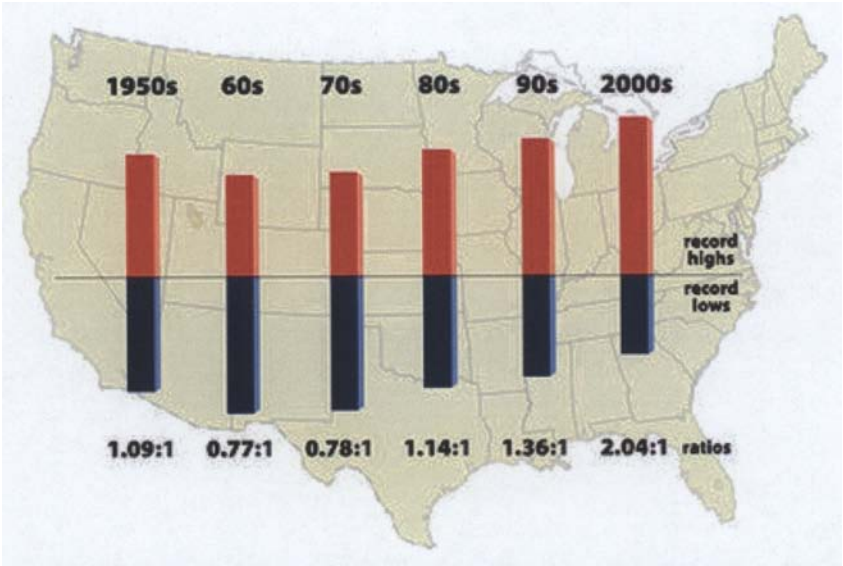



FIGURE 1.—This graphic shows the ratio of record daily highs to record daily lows observed at about 1,800 weather stations in the 48 contiguous United States from January 1950 through September 2009. Each bar shows the proportion of record

highs (red) to record lows (blue) for each decade. The 1960s and 1970s saw slightly more record daily lows than highs, but in the last 30 years record highs have increasingly predominated, with the ratio now about 2 to 1 for the 48 States as a whole (based on Meehl et al., Geophysical Research Letters, 2009).

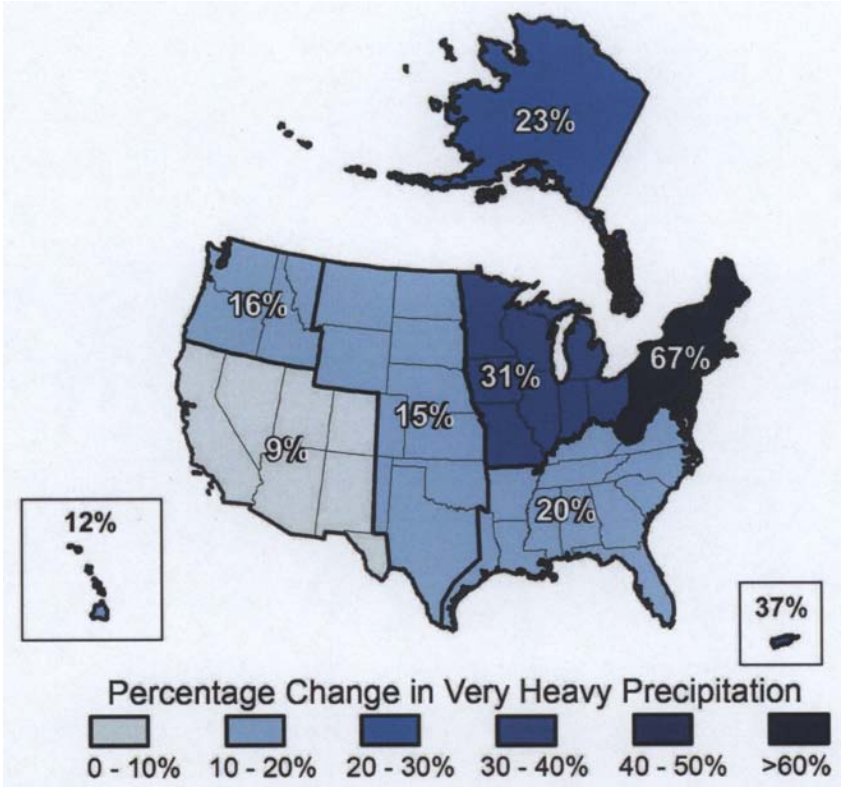



FIGURE 2.—The map shows percent increases in the amount falling in very heavy precipitation events (defined as the heaviest 1 percent of all daily events) from 1958 to 2007 for each region. There are clear trends toward more very heavy precipitation for the Nation as a whole, and particularly in the Northeast and Midwest. (from Global Climate Impacts in the United States, USGCRP, 2009).

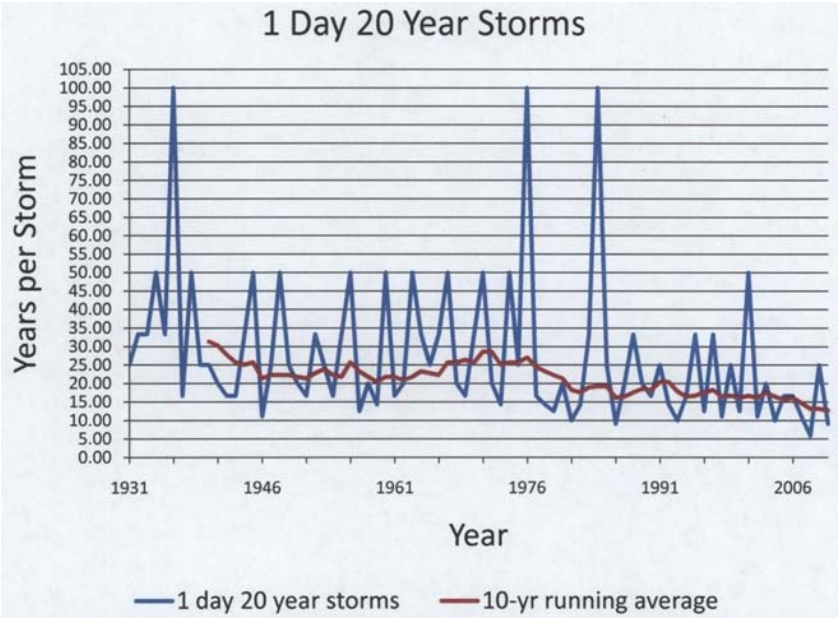



FIGURE 3.—Using NOAA daily precipitation data (from the NOAA NCDC) for 497 stations in the Midwest, we have been analyzing the returns for the Midwest in terms of a single-day event returning in 5 years, 10 years, and 20 years (we are also analyzing multiple-day events). The graph shows the single-year analyses and a 10-year running mean of the 20-year storm event in the Midwest for data starting in 1930 through 2010 (it does not include the huge rainfalls already observed in 2011). As would be expected, the annual signal is noisy, but much less noisy for the 10-year running mean. This analysis suggests that what was a 20-year precipitation event over the Midwest is becoming more common over time and has become a 12- to 13-year event in recent years.

Senator DURBIN. Thank you very much, Dr. Wuebbles. Franklin Nutter is president of the Reinsurance Association of America. Please proceed.

**STATEMENT OF FRANKLIN W. NUTTER, PRESIDENT, REINSURANCE ASSOCIATION OF AMERICA**

Mr. NUTTER. Chairman Durbin, Ranking Member Moran, thank you very much for this opportunity. Reinsurance is, essentially, the insurance of insurance companies. It serves a variety of purposes, but most relevant to this hearing, it is the financing of risk for severe and infrequent natural and manmade catastrophes.

We share the subcommittee's concern that an increase in severe weather events requires a more forward-looking and proactive approach to financing recovery from disasters. I have attached to my statement a series of slides, like the ones you show here, about the number and the increase in number of events, but also the financial impact in the United States and outside the United States of natural catastrophes.

Much of this increase can be attributed to changes in weather intensity and climate-related impacts, but a fundamental driver is the increase in the number of people living in areas vulnerable to

natural catastrophes, the increase in property values, and the vulnerability of construction materials and technology.

The reality is that our society has moved increasingly to areas with the greatest exposure to natural catastrophes, along our coasts and rivers, and invaded the natural landscape in areas susceptible to wildfire and drought. The subcommittee asked that I address how insurers prepare and evaluate this changing risk landscape, and how that might be applied in a public sector.

And indeed, as was mentioned by the chairman, the Federal Government has much the same insured exposures through the NFIP and the Federal Crop Insurance Program. But, of course, the Federal Government has the additional responsibility for disaster assistance.

While no one can reliably predict specific weather events, this does not preclude financial planning for the likelihood of these events, or through—for the reliance of—on the scientific community to assess future conditions that can be used to make decisions about appropriate policy.

The insurance industry believes that long-term solutions to hazard reduction should be driven by mitigation and adaptation strategies. Federal incentives for improved natural hazard building codes, improved financing for mitigation and relocation of repetitive lost properties in the NFIP, better preservation of natural habitats that service protected areas for property and people should all be included in the Government's portfolio of approaches.

The insurance industry funds research in this area through the Institute for Business and Home Safety, which recently opened a research facility, which replicates natural hazards in a controlled environment and assesses their impact on commercial and residential structures.

The traditional insurance model is largely an actuarial one. A pool of data of actual loss is trended forward, using economic factors.

And insurers rely primarily on three interrelated approaches for financial protection for future severe and infrequent events, the first being actuarially driven pricing that reflects actual risk assessment; the second being diversification of its portfolio of insured properties, geographically and by line of insurance.

And the third is the utilization of reinsurance to transfer risk beyond which the insurer wishes to retain. In recent years, the insurance industry has modified this traditional approach to its business by assessing and pricing catastrophe risk.

After Hurricane Andrew in 1992, it was clearly obvious that a retrospective loss model, as I had described momentarily above, was inadequate, and indeed, misleading for future catastrophic events.

To address this dilemma, probabilistic models were developed to assess a financial impact of catastrophic natural hazards, simulating possible future events over long periods of time, to produce a representative loss scenario.

As it has become standard practice for insurers and reinsurers, I recommend this approach to the subcommittee and to the Government as a means for planning for future funding needs related to

natural catastrophes. These models operate on the following principles.

A hazard component, populated by teams of scientists, creates a catalog of thousands of potential computer-simulated catastrophes. I might add that most of that information, really, is derived from Government programs and Government-funded programs through the National Science Foundation and through the NOAA.

The engineering component consists of detailed information about properties exposed to these events in specific locations or regions.

And the financial component derives information—provides information about potential losses for individual properties, or groups of properties, and applies a probability of loss.

PREPARED STATEMENT

These models allow users to assess the impact and severity of future loss scenarios, analyze the effect of changes in conditions, or propose changes in hazard mitigation, assess adaptation scenarios, and determine the appropriate pre-funding needs.

In the case of the insurance industry, that would apply to the insurance premiums, in the case of Government, the pre-funding disaster assistance needs. Mr. Chairman, we commend you and the subcommittee for looking at this very important issue and look forward to exploring the kind of risk management and risk-financing techniques used in the private insurance sector for public needs. Thank you.

[The statement follows:]

PREPARED STATEMENT OF FRANKLIN W. NUTTER

I am Franklin Nutter, president of the Reinsurance Association of America (RAA). Thank you for the opportunity to testify.

Reinsurance is essentially the insurance of insurance companies. It serves a variety of purposes in the financial structure of insurance companies, but perhaps the most relevant to this hearing is the financing of risk for severe and infrequent natural and manmade catastrophes. Reinsurers have borne significant shares of insured losses from many major catastrophic events including 55 percent of September 11 losses; 33 percent of Hurricanes Katrina; Rita and Wilma; 40 percent of the recent Japanese earthquake and tsunami; and 33 percent of the recent Midwest tornadoes.

We share the subcommittee's concern that an increase in severe weather events requires a more forward-looking and proactive approach to financing recovery from disasters. Attached to this testimony are a series of slides showing a clear increase in the number and financial impact of United States and non-United States natural catastrophes including geophysical (earthquake); climatological (extreme temperature, drought, wildfire); hydrological (flood); and meteorological (winter and thunderstorms and related hurricanes and tornadoes) events. Much of this increase can be attributed to changes in weather intensity and climate-related impacts. However, the fundamental driver is the increase in the number of people living in areas vulnerable to catastrophic storms, the increase in property values in these high-risk areas, and the vulnerability of construction materials and technology. The reality is that our society has moved increasingly to areas with the greatest exposure to natural catastrophes along our coasts and rivers and invaded the natural landscape in areas susceptible to wildfire and drought. Where these areas once served as natural habitats to wildlife and buffers from natural hazards, they are now populated with communities and infrastructure.

The subcommittee asked that I address how insurers prepare and evaluate this changing risk landscape and how that might be applied in the public sector. Indeed the Federal Government has much the same insured exposure through the National Flood Insurance Program (NFIP)—with 5.5 million homes insured—and the Federal Crop Insurance Program (FCIP). The Federal Government has the additional bur-

den of disaster assistance following catastrophic events and appears to rely primarily on postevent appropriations. No one can reliably predict specific weather events more than a few days in advance and there is no reliable prediction for earthquakes. That does not preclude, however, financial planning for the likelihood of these events or for reliance on the scientific community to assess future conditions that can be used to make decisions about appropriate policy matters. Support of the work of the National Science Foundation and National Oceanographic and Atmospheric Administration (NOAA) remain an important part of assessing risk from natural forces. The private sector benefits immensely from funded research programs by these institutions.

The insurance industry believes that long-term solutions to hazard reduction should be driven by mitigation and adaptation strategies. Federal incentives for improved natural hazard building codes, improved financing for mitigation and relocation of repetitive loss properties in the NFIP, better preservation of natural habitats that serve as protective areas for property and people should all be included in the Government's portfolio of approaches for minimizing the economic consequences of natural disasters—many of which are ultimately borne by U.S. taxpayers. The insurance industry also funds research to address building features and styles that can significantly reduce damage to property. The Institute for Building and Home Safety recently opened a new research facility which replicates natural hazards (hurricanes, thunderstorms, hail, wildfire) and their impact on residential and commercial structures. Its research will lead to improved building and community resilience.

The traditional insurance model applied to automobiles, workers' compensation and homes as it relates to non-natural peril insurance coverage's is largely an actuarial one: a pool of data of actual losses trended forward using economic factors such as cost of living adjustments and inflation. Insurers then seek to collect a premium from an insured based on this analysis not knowing of course whether any specific insured property would suffer damage, but predicting reasonably well what the likely loss experience of the pool of insureds would be over a period of time.

Insurers rely primarily on three interrelated approaches for financial protection from severe and infrequent events:

*Actuarially Driven Pricing That Reflects Actual Risk Assessment*.—Unfortunately, the NFIP reports that it subsidizes about 25 percent of its properties, that 1 percent of the properties account for 30 percent of the losses as repetitive loss properties and then relies on borrowing from the U.S. Treasury for funding shortfalls. The Program is $18 billion in debt to the Treasury at this time.

*Diversification*.—Variation of the portfolio of insured properties geographically and by line of insurance.

*Utilization of Reinsurance To Transfer Risk Beyond What the Insurer Wishes To Retain*.—NFIP legislation recently passed by the House authorizes the NFIP to purchase reinsurance rather than rely exclusively on Federal debt. The FCIP is already a public private partnership.

Given the enormous recent losses of property and people to natural events, the insurance industry in recent years has modified its approach to assessing and pricing catastrophe risk. After Hurricane Andrew in 1992, it was clearly obvious that a retrospective loss business model as described above was inadequate, and indeed, misleading for catastrophic events, particularly if a changing pattern of weather and climate were developing. Assessing risk by applying historical loss events over current insured properties leads to an underestimation of potential losses. To address this dilemma, probabilistic models were developed to assess the financial impact of catastrophic natural hazards simulating possible future events over long periods of time to produce a representative loss scenario. As it has become standard practice for insurers and reinsurers, I recommend this approach to the subcommittee as a means to plan for future funding needs related to natural catastrophes.

These catastrophe models are provided to subscribers by several firms whom I have identified in the appendix and in some cases by reinsurers and reinsurance brokers. The models operate on the following principles:

—The hazard component, populated by teams of scientists (meteorologists, seismologists, geophysicists, and hydrologists) creates a catalog of thousands of potential computer simulated catastrophes and applies the intensity of an event at specific locations.

—The engineering component consists of detailed information about the properties exposed to these events in specific locations or regions (including location data and building characteristics).

—The financial component provides information about potential losses for individual properties or groups of properties and applies a probability of loss.

These models allow users to assess the impact and severity of future loss scenarios, analyze the effects of changes in conditions or proposed changes in hazard mitigation (e.g. building codes, structural changes to properties), assess adaptation scenarios and determine the appropriate pre-funding needs. In the latter case that would apply to insurance premiums, or in the case of the Government, to pre-funding disaster assistance needs. These models are routinely updated to reflect new scientific or local infrastructure and building information. Some of these models have been applied to pandemics, terrorism-related events and climate change as well.

Mr. Chairman, on behalf of the RAA, we look forward to exploring the risk management and financing techniques currently in practice in the reinsurance industry to determine how the Government can improve its financial planning needs related to manmade and natural catastrophes.

Senator DURBIN. Thank you very much. I know Senator Moran has to go to another meeting, but I thank you for attending today. If we have any written questions, we will submit them to be entertained by the panel here. Mr. Nutter, I think you sent us this chart here. I'm taking a look at it, Top 16 Most Costly World Insurance Losses. Is that your chart——

Mr. NUTTER. Yes, I have——

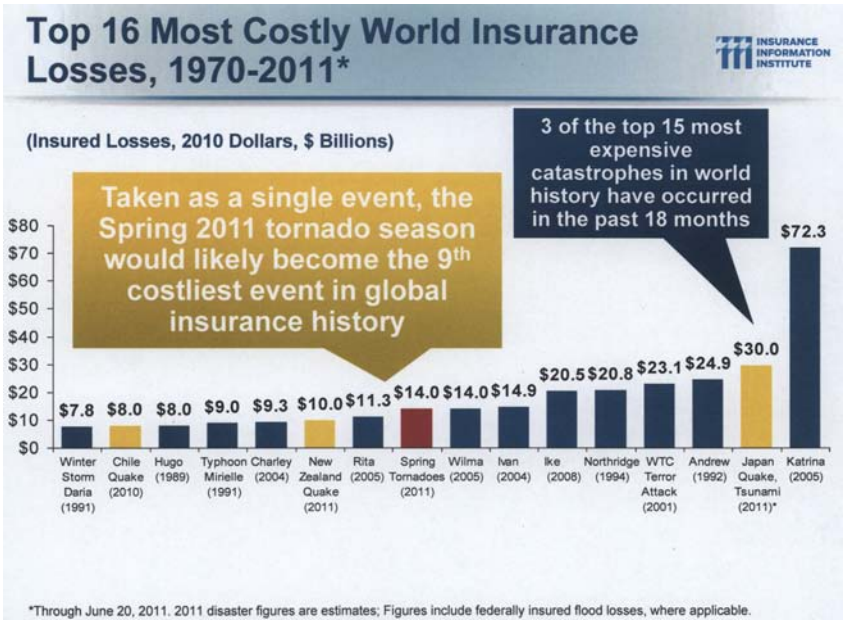
Senator DURBIN. For the insurance?

Mr. NUTTER. I have several. Let me make sure I have the one that you're——

Senator DURBIN. Insurance Information Institute? I don't think we have that in large font, do we?

Mr. NUTTER. I have that here with me.

Senator DURBIN. Do you? Well, this chart, as it is titled, Top 16 Most Costly World Insurance Losses, 1970 to 2011—so that's a 41-year period of time. And it says two noteworthy things. Taken as a single event, the spring 2011 tornado season would likely become the ninth costliest event in global insurance history. (50:26 of webcast)




SOURCES.—Swiss Re *sigma 1/2011*; AIR Worldwide, RMS, Eqecat; Insurance Information Institute.

And then it says 3 of the top 15 most expensive catastrophes in the history of the world have occurred in the past 18 months. So let me ask you this question, and then I think I know the answer, but I want it on the record. Do you adjust these dollar losses to inflation?

Mr. NUTTER. These all reflect 2011 dollars. They've been adjusted so that they can be reconciled with each other.

Senator DURBIN. So we just can't argue that things are more expensive now than they were 20 years ago, and a small event today may cost a lot more money than it did 20 years ago?

Mr. NUTTER. That's correct.

Senator DURBIN. These have been adjusted accordingly?

Mr. NUTTER. That's correct.

Senator DURBIN. So, then, this is noteworthy. And let me ask you, what is the impact of this kind of information on your industry, when the people are trying to decide whether they'll write insurance, and if they do, what kind of reserve they need, what kind of premiums they charge?

Mr. NUTTER. Well, Mr. Chairman, as you mentioned in your opening comments, obviously, the insurance industry looks at historical losses and determines whether or not the premiums that it's charging reflect the risk that it's assessing.

But in this area of natural catastrophe, the industry has tried to do a better job in assessing the probability of future events, and adjusted, you know, these premiums accordingly.

So, in some cases, insurance companies have looked at their exposures, what they've written in high-risk areas. Think coastal areas, the State of Florida, the east coast, the gulf coast.

And some insurance companies have pulled back from those areas because they feel like that—what they should charge, related to the risk of exposure, they can't, or that the regulatory system inhibits them, so that they pull back. They decline coverage or they nonrenew coverage.

On the other hand, in our community, the reinsurance community looks to right catastrophe risk, largely because it does not have regulated premiums, but in fact, operates at a very competitive environment not unlike the insurance industry in the State of Illinois operates in a competitive rate environment. So in our sector, catastrophe risk is somewhat counterintuitive. In fact, they look to right this risk, believing that they can assess it.

Senator DURBIN. So let me ask you, from an actuarial or a statistical point of view, how do they factor in whether something is an aberration, a once-in-a-100-year event, or a pattern emerging?

Mr. NUTTER. Yes, it really is a probabilistic analysis. It's a stochastic analysis, if you will, trying to assess whether or not these events are, indeed, outliers.

I think what we would say is that the outliers have become commonplace, not unlike Dr. Wuebbles said that your—you know, the hottest day you've experienced will become the norm going forward, that the insurance industry looks at these losses as being common, largely because of the movement of people into these high-risk areas.

If you looked at the development, as well as population shifts to coastal areas in particular, it's pretty notable. So we don't—I don't think the industry sees these as outliers, any one event, but in fact, a pattern that's going to continue and continue to grow going forward.

Senator DURBIN. So you see the weather pattern and also the residential or settlement pattern coming together?

Mr. NUTTER. Absolutely, in the wrong way.

Senator DURBIN. Magnifying these losses in the wrong way. Let me, if I can, turn to Mr. Rivera, because, following what Mr. Nutter has just said, it's very clear that they're looking beyond any fiscal year to a pattern that would lead them to decide whether to write insurance, and if so, what reserves are necessary to protect their risk.

You discussed the advanced modeling that you're using for budget projections for the Federal Government. You have one small, but important, part here, SBA disaster loans. And you used, as I understand it, these budget projections, for short-term estimates only—seasonal and annual. So what, if anything, are you doing to look to the long term?

Mr. RIVERA. Thank you, Senator. You know, as I'm listening to Mr. Nutter here, he's talking about his actuarial approach, pricing risk, diversification, and reinsurance. We pick up some of those components.

We do look at historical data that takes in the recent weather patterns. We look at the long-term costs, and we do the annual as-

sessment based on the Federal Credit Reform Act, since 1990, and moving forward.

But the thing that I find very interesting is, in the Federal Government, or at least with the Disaster Loan Program, the SBA is not able to price risk as the private sector is. So for example, a disaster applicant comes to me and whether they're insured or uninsured, or underinsured, we go ahead and provide that loan to them from that perspective.

We're open and interested in trying to figure out if we can make a connection between what the private sector is doing and what we're doing in the Federal Government. I mean, that makes a lot of sense.

But the different perspective of us not being able to price our product, for example, the maximum interest rate for a homeowner loan can be no more than 4 percent by statute. So we're a little bit more boxed in from that perspective.

Senator DURBIN. So let's follow up on that, Mr. Trimble. It seems to me that, as I try to take Mr. Nutter's good advice about what the private sector is doing and apply it to the Federal Government, in our exposure to weather events, Mr. Rivera has just identified a problem. The people setting the premiums, interest payments, and such, happen to be Members of Congress and the President, who enact laws.

So as we try to envision a more challenging world, in terms of risk exposure, has the GAO taken a look at whether or not we are adjusting our economic models and projections, in terms of premiums collected, monies set aside, or are we just going to rely on disaster payments if we get into a fix?

Mr. TRIMBLE. Well, we looked, as part of a study a couple years ago, at two Federal insurance programs, the crop insurance and the flood insurance programs. And what we found was similar.

Their perspective was budgeting by year, based on past losses. But at that time, the point was also made that those programs operate under different constraints and imperatives, based on their statutory requirements.

So we've not done a full examination of the constraints of those statutory requirements, in terms of how they operate day-to-day. I think the question is, what latitude they have to incorporate climate change under the existing requirements they're under.

Senator DURBIN. Dr. Sullivan, I suspect that some of the information that Mr. Nutter and his industry uses comes from your agency, in terms of what you are observing and the changes that are taking place.

And you've made a good point about how you need to continue to have the technology, keep up with the science, so that you can avoid exposure for loss of life and dollar cost that might be associated with it. So are you—as you look at these projections from the NOAA's point of view, seeing these severe weather trends emerging and growing in the future?

Dr. SULLIVAN. Senator, we're not assuming in our analyses, that the patterns, specifically that we see in past data, will remain the patterns that future data will show. Mr. Nutter's testimony alluded to this. Excuse me, Dr. Wuebbles's testimony alluded to this.

The 50-year flood is now the 20-year flood, is now the 12-year flood. So analytical methods that our NCDC personnel use in concert, in partnership with a variety of academic partners, such as Dr. Wuebbles, test and examine repeatedly, almost continually, in fact, those trends, those patterns, and try to arrive at some statistical confidence about what slant, what trend should be incorporated in forward projections so that we have what are called nonstationary statistics.

I'd also comment, if I may amplify a bit on what I mentioned about the IWRSSI effort that we're doing with the Corps of Engineers and the USGS. We're working there to make all of our data systems, from maps to stream flow data and everything in between, fully interoperable and fused on a common platform, common portal.

And that will allow Federal partners, who try to support regional, local, and State officials in flood-prone areas do the things that Mr. Nutter was talking about, not just give you a forecast for a point on a river at a certain point in time, but actually let you interactively translate that into specific inundation levels that may be expected at your Main Street bridge in your neighborhood, and lay that against the Census, and other demographic and economic data to readily give you an economic outlook for the possible damage that you may be seeing if the flood really reaches the stage that's been forecast.

Senator DURBIN. Dr. Wuebbles, I've had the good fortune of meeting a lot of Illinois farmers, which is your family background. They are courteous and thoughtful people who come to visit me and consider an important part of their responsibility to help educate a Senator about agriculture and the world that they live in, in Illinois or around the Nation.

And for a period of time there, I'd asked each group of farmers from Illinois, who came in to see me, the same question. I asked them how many of you believe that man's activity on Earth is changing the climate that we live with? Is it changing the weather patterns, or the temperatures, the world that we live with?

And I would say, out of, perhaps, 100 farmers, 2 said yes. And I would, then, pursue with them, do you believe that things are changing in this world? Are glaciers melting? Do you see changes in the weather patterns? And if so, how do you explain it? If it isn't our activity adding to this, what's causing it?

And they would kind of be very quiet. I had to probe, come on now, give me an answer. And you know, one farmer said to me, from Illinois—he said, Senator, 8 years ago, I had a flood. Last year, I had a drought. God's going to throw different things at me from time to time. It's kind of this divine mood swing that they really view as behind this.

So I'd like to say to you that I'm not going to try to resolve that political environmental question here. But I think what we try to do in this hearing is to acknowledge what is objective and obvious. Something's changing. I don't know the reason. I mean, I think I happen to agree with you what the reason is.

But whether or not you agree with your premise, or mine, or someone else's, the facts are the facts. Things are changing in weather patterns here. I guess the only thing that I know with any

degree of certainty is what it's like to make 48 round trips between Illinois and Washington a year for 29 years.

I've spent a lot of time in airplanes, and I'll tell you, the weather is a mess this year, and I've never seen it this bad. And it continues to be bad, way beyond the spring storms that we're used to. The point I'd like to get to is whether or not we can come to some consensus here, beyond the political debate about climate change, about the reality of what we face.

Within the academic community, where there might be a difference of opinion about man's impact on the environment, is there at least a common conclusion that things are changing in a patterned way?

Dr. WUEBBLES. Basically, yes, I think you'd find very strong consensus that a—what's occurring in the long-term averages of weather, in the statistics of weather, are changing. You know, there's no question about that.

You know, more than 90 percent of the glaciers in the world are decreasing significantly. And there's—I've talked today about precipitation events, you know. The data itself is very, very strong that things are changing.

I think, if you had asked the farmers a different question, if you'd asked them, are you seeing changes occurring in what you're doing in your fields and in trying to get out there each year, I think you would have gotten a little bit different answer, that you—they definitely are seeing more, in the Midwest, in Illinois, more situations of flooding, strong precipitation in the spring, can't get out into their fields as soon.

And so I think you would have seen that, yes, they definitely have—they know that something's happening. And it's not just what it was 30, 40 years ago.

It's—if we turn back to the science community, you know, that's very clear, that, as I said in my testimony, if you go and look at the peer-reviewed literature, which is how we—you know, scientists judge ourselves by publishing papers and having our peers look, examine those papers, before they can be published.

And so it's our way of trying to put in checks and balances of it in what we do. You don't find a disagreement about the fact that humans are having an impact on our climate system. It's just not there. And very, very few papers make it in at all. And those that do usually are shot down pretty rapidly because they've made mistakes in the evaluation of the data, so I think the evidence is quite strong that, you know, it's unequivocal that our climate is changing, and that there is a strong relationship to what's—what human activities are doing.

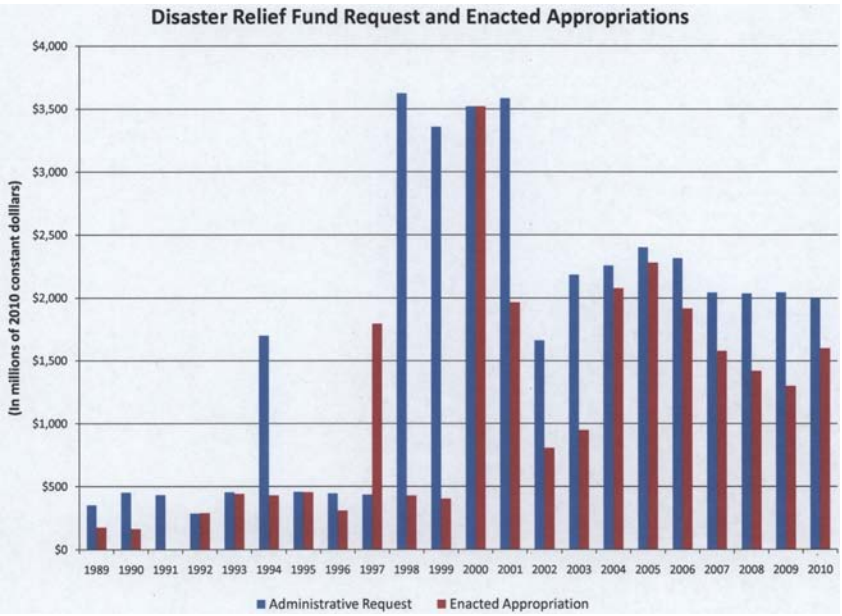
Senator DURBIN. So let me try to draw all of you into this common question. Going back to Mr. Nutter's premise, I assume that, if you guess wrong in the insurance business, it's going to affect the bottom line, whether or not you're profitable, whether you've collected enough premiums and set aside enough reserves. And so we do things a little differently in Washington.

If we guess wrong, in terms of a program that is supposed to protect people from a disaster, let's say crop insurance, if we guess wrong, we have something called a supplemental appropriation, which means we make up the difference with a disaster payment.

And they frequently are coming through the Congress for everything you can imagine, from earthquakes in California to, you name it, droughts, and fires, and all the rest. So we move in with the supplemental appropriations, which are unpredictable, and usually just go directly to the deficit, with very, very few exceptions.

Now, I served on the Deficit Commission, the Bowles-Simpson Deficit Commission, that the President created. And they decided to try to do something about that. And I'm going to ask you all to think about this, that have not heard it before, and react to whether or not you think this is constructive, is complete, or how you might modify it. The Fiscal Commission emphasized that restoring fiscal discipline requires honest budgeting.

And a given disaster may, itself, be unpredictable, but the need to pay for some level of disaster relief is not. Federal budgets rarely set aside adequate resources in anticipation of disasters, and instead, rely on emergency supplemental funding requests.




With that premise, the Commission plan explicitly called for setting aside funds for disaster relief and establishing stricter parameters for their use. The disaster fund budget authority would be limited to the rolling—this is the operative sentence—average of disaster spending in the most recent 10 years, excluding the highest and lowest years.

Any unused budget authority would be rolled forward to increase the disaster fund budget authority available the following year. Any spending above the disaster fund limit would need to be offset with reductions in spending in other areas or special parliamentary procedures.

So, if you can follow the premise, it's pretty basic. You can, without a statistics course, I think, understand it. Take the last 10

years. Throw out the highest and the lowest year. Average it. And we're going to make sure we have at least that amount of money available each year.

If we don't spend it all, we'll roll it over to the next year. Now, apply that model to what you've seen in the last 10 or 20 years, or what you see coming, and tell me whether or not you think that's adequate. What do you think, Mr. Nutter?

Mr. NUTTER. I would start, and I think the insurance industry learned a lesson some time ago, that 's not an adequate way to do that.

Senator DURBIN. Not adequate?

Mr. NUTTER. Not an adequate way to do that. That as I said in the testimony, when prior to Hurricane Andrew, which is 1992, the industry had an estimate, that the potential losses of a hurricane in that area would be about $8 billion. That was the number.

It turned out to be $25 billion when it actually occurred. And it really was a change in the thinking of the industry, that you can't just presume that the past is prologue. You can't take past events, and overlay it on current infrastructure and inventory of homes, and presume that 's what's going to happen.

So these probabilistic models that developed, really, were an effort to try and look at the probability of much more extreme future events. And let me take two of the programs you mentioned—have been mentioned here repeatedly, the NFIP. It effectively does use an average annual loss scenario for its pricing. And it does have some statutory limitations and caps.

The House of Representatives, just in the last month, reauthorized the NFIP and included in there a provision that the program was authorized to go to the private reinsurance sector and assess the reinsurance sector's capacity and pricing. We have encouraged the Senate, when it considers the Banking Committee, considers the flood program to do the same thing because it does bring in that kind of private sector risk assessment scenario that we think would, in fact, change the thinking about what you presume.

The NFIP is $18 billion in debt, not counting the 2011 storms or whatever borrowing it might have. The debt is to the Treasury. It's a postevent funding scenario, as you have said. The insurance industry can't do that.

So the industry relies on a pre-event funding scenario, where it assesses risk and tries to price for it. We really think, by introducing private sector risk assessment principles in programs like the NFIP, would change that mindset, that the assumption that's made in the report, valuable as it may be, in fact, probably understates, and underestimates, and is really misleading about what the costs are likely to be.

One more quick comment, the Crop Insurance program is actually a public-private partnership. You have private insurance companies and the Federal Government with both a risk-bearing role. And in fact, I read a report the other day that said the Federal Government's actually made money in the Federal Crop Insurance Program because of that kind of involvement with the private sector.

Senator DURBIN. It would seem to me that what you're suggesting is that we are understating the premiums necessary to

cover the risk, which is probably a great political decision on our part, but not a very good actuarial decision in terms of what we need to pay out. Is that fair?

Mr. NUTTER. Fair comment. I understand the political problem of asking people to pay more for their insurance, but you're either asking the people who have the risk, who have the homes and properties in these areas, to pay a risk-based premium, which is what the insurance companies would do, or you're asking the taxpayers to, effectively, subsidize those decisions by issuing debt after the fact.

Senator DURBIN. Mr. Rivera, what would it mean if we followed the private sector model and, as Mr. Nutter has questioned, whether or not we can do the past-as-prologue premise?

Mr. RIVERA. Chairman Durbin, looking at the chart over there. And the SBA chart, if I can just point to it for just a minute, the red bars are the supplementals that we've had and the green bars is our lending authority. So if you look at it, there have been four big spikes. There was one in 1994, we had the Northridge earthquake. I think that's the third.

Senator DURBIN. Yes.

Mr. RIVERA. And then we had, in 2005, Hurricanes Katrina, Rita, and Wilma. That's the big one in the middle. We had the two, the four Florida hurricanes in 2004, and then Gustav and Ike in 2008, the 2008 gulf coast hurricanes. So if you look over the last—I think that's, since 1992—18, 19 years?

Senator DURBIN. Yes.

Mr. RIVERA. We've really only needed a supplemental in those four cases. So the methodology that you mentioned is really what we really do. We look back over the last 10 years. We knock out the big year, which is Katrina in this case. That's the $11 billion year we had. And we average $1 billion a year.

And we have no-year funds, fortunately for us. We're able to carry over funds from year to year. So in the event that there is a need above the normal appropriations of $1 billion, we're able to use it from year to year.

So the theory, as far as, we should look forward, it's a little bit different statutorily, because we use the Credit Reform Act and we have to go off of historical data. But in this case, out of, you know, 19 years, there's been four major supplementals.

I'm not going to sit here and argue that we should stick with our current process because we're willing and would look at the opportunity to meet with the insurance company or the reinsurers. The parameters that we have from a statutory perspective, I think makes the model pretty successful. Now, I hope I don't jinx myself, that we don't have a tropical storm right now.

Senator DURBIN. I hope we don't.

Mr. RIVERA. I think from that perspective, that's the approach that we've been taking.

Senator DURBIN. So Mr. Trimble, I'd like your reaction to this Deficit Commission, a 10-year look back. Now, are we stuck with that because of the way we do business in Government, as opposed to the way Mr. Nutter deals with the insurance industry?

Mr. TRIMBLE. We have not looked at or considered that proposal, to my knowledge, I would point to the statement in my testimony

regarding what the National Research Council pointed out, and what we said here, which was, past is not prologue.

Past models aren't necessarily great predictors. I think you'd really have to go into the basics of the statutes these guys are operating under and then look at the models. You may be able to go historical for a while, but the question becomes how long does your luck hold out?

Senator DURBIN. Mr. Rivera, the SBA Disaster Loan Program has provided close to $50 billion in loans since it began in 1953. In contrast to the private sector insurers, SBA cannot charge borrowers more or less to price relative risk, based on exposure to natural disasters.

In fact, the SBA disaster loans help borrowers recover losses that the private sector insurance does not cover. As private sector insurers decline to issue policies in risky areas, due to exposure to erratic weather patterns, will more and more of the financial burden shift to the Government?

Mr. RIVERA. Chairman Durbin, we do assume the risk. I mean, that's part of the program, as we continue to get individuals that are underinsured or uninsured.

Once we do make the loan, we do require insurance. And there's a limit on a "like kind" event. We will not provide any additional insurance for like-kind disasters moving forward, so we try to protect ourselves, from that perspective.

Senator DURBIN. Well, let me go to Mr. Nutter. There was a—correct me if I'm wrong here—conscious decision made by some insurers not to insure in Florida after certain hurricane experiences. Is what I just said accurate?

Mr. NUTTER. It's—it's probably an overly broad statement. I think some insurers pulled back from the immediate coastal areas in Florida, as they did in coastal areas in the gulf coast.

Senator DURBIN. And so they made a decision, obviously, based on their loss experience, that they couldn't write a reliable policy, profitable policy, with any degree of certainty in that area. So do we—I know the answer, but I'm going to ask you anyway—follow that kind of decisionmaking when it comes to our exposure for the Federal Government?

Mr. NUTTER. Chairman Durbin, we—we provide disaster assistance to all disaster victims, as long as they have repayment ability and are credit worthy. We don't—we do not, not make a loan just because the individual does not have insurance or doesn't have—what we've discovered in Florida is that, after the—the 1992 and the—and the 1994 hurricane season, is it—the hazard insurance policy that used to protect hurricanes—I mean, homeowners from windstorm insurance—they've peeled that off, and now—now, they add that on as a rider.

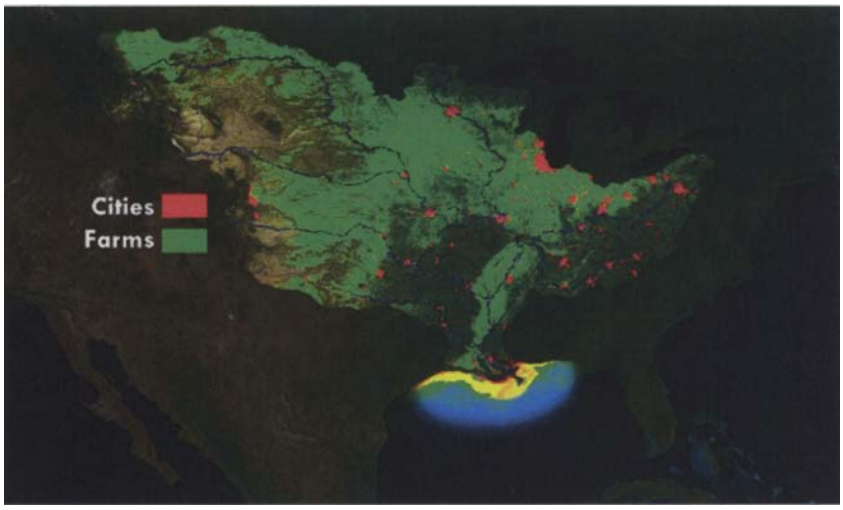
So the insurance company has continued to minimize their risk by separating certain aspects of a policy. We find that all over the gulf coast.

Senator DURBIN. Let me talk about the gulf for a moment. Dr. Sullivan, in your testimony, you mentioned that runoff from severe chronic flooding in the Midwest will lead to hypoxic dead zones in the Gulf of Mexico. And you stated, the Gulf of Mexico dead zone is a particular concern because it threatens valuable commercial

and recreational gulf fisheries, that generate about $2.8 billion annually.

So what is the size of this dead zone in the Gulf of Mexico, compared to that? Let me see if I can point to this here. And perhaps, you can identify this a little better than I can. Is the bright blue area the dead zone that we're talking about here?

DEPICTION OF GULF OF MEXICO HYPOXIA ZONE IMAGE




SOURCE.—NOAA.

Dr. SULLIVAN. Yes, Senator, the red and orange areas are the longshore coastal flow. Those regions also are most depleted in oxygen, so they also are dead. And the blue zone is depleted, to varying different levels, so sort of a contour of oxygen depletion in the waters.

Senator DURBIN. And it's not altogether clear in this photograph, but we're looking at the continental United States, with the Gulf of Mexico in the bright area down to the right there. And what I see is the flow of the Mississippi River, and all its tributaries into the Gulf of Mexico, and all of those chemicals we pay so much for in Illinois, coming down that river into the Gulf of Mexico. So what is the size of the dead zone that we're talking about here, compared to the 2010 BP oil spill?

Dr. SULLIVAN. Senator, an estimate was just released—a forecast was just released, a couple weeks ago by the NOAA and our partners down in Louisiana that the dead zone this year will be between 8,500 and 9,400 square miles. Put that in perspective. That's about the size of New Hampshire, slightly larger than New Jersey. There are crews underway right now that are making those measurements.

So I think, in a few weeks, we'll have an update to that figure. The Deepwater Horizon spill, in comparison, was 29,000 to 31,000 square miles, closer to the size of South Carolina. So this is forecast to be one of the largest, if I may, dead zones produced by the

watershed drainage and runoff, that we've seen in many years, coming in, according to the forecast, between 8,500 and 9,400 square miles.

Senator DURBIN. So for the record, what is a dead zone?

Dr. SULLIVAN. A dead zone is an area where a bulge of freshwater, such as comes down the Mississippi River, plus the sediments and other chemicals that are in that water, cause a blossoming of algae that consumes all the oxygen in the water.

That burst deprives the oxygen other animals in the marine environment require that they need to grow.

Senator DURBIN. And so there's little or no marine life in this area?

Dr. SULLIVAN. Becomes what's called hypoxic. Marine life that's mobile will flee, and they'll sense the oxygen gradient, and go somewhere where they can still breathe, if you will. Facile or attached marine life from bottom-dwelling creatures to plants—plant species that grow along the shores, corals—they're stuck and they will suffer a degradation, as the oxygen is removed from the water.

Senator DURBIN. Heavy rain in the Midwest, water flowing down through the rivers, flooding that it causes on the way down, the damage——

Dr. SULLIVAN. Yes.

Senator DURBIN [continuing]. Ultimately ending up in the Gulf of Mexico, creating a dead zone area that is about one-third, if I was trying to calculate quickly, one-third of the area affected by the BP oil spill.

Dr. SULLIVAN. Roughly one-third.

Senator DURBIN. All right. So how long will these effects last in this dead zone?

Dr. SULLIVAN. It's hard to predict how long they will last, Senator. It depends on further rainfall. Tropical Storm Dawn, which is moving across the western Gulf of Mexico now—forecasts bring 5 to possibly 7 inches of rain as it goes ashore, and then later tomorrow.

That water and the winds associated with the storm may help mix the waters and disperse this bulge of freshwater and the chemicals more efficiently. So certainly, factors enter in, but it's normally, at least months and some of it endures year-to-year.

Senator DURBIN. It's not my part of the world, but I assume this has an impact on the gulf economy?

Dr. SULLIVAN. It would have a tremendous impact, affecting the coastal habitat that supports the oyster fisheries, nursery grounds for many other commercial fish species that are fished in the gulf, the shrimp fishery.

Senator DURBIN. Dr. Wuebbles and Dr. Sullivan, both of your testimonies point to the fact that there's a projected rise in sea levels. And that will have a dramatic impact on risk in many communities. Mr. Trimble has talked about adaptation as a result.

Dr. Sullivan, you point to the effect this will have on East Coast communities during El Niño years. And Professor Wuebbles, you state that, globally, the temperatures are higher. The sea level is higher.

There's more water vapor in the atmosphere, which energizes storms. So what are some of the specific dangers that could occur

because of these changing weather patterns and this rising higher sea level, Dr. Wuebbles?

Dr. WUEBBLES. Well, the—the best analysis right now are—are indicating that, if we continue the pathway we're going without making, you know, extensive decreases in the emissions of these, you know, heat-trapping gases that are affecting our climate system, that by the end of this century, we may see in the order of a—of a meter, and possibly even more, increase in sea level.

Now, it isn't just the increase in sea level that gets you. It's the storm surges. So when you have a—a large storm or a hurricane, you get even more damage because of, you know, that large amount of water that's there. So that itself is a big concern. In addition, we can expect that the amount of, you know we've been seeing an increase in severe precipitation events.

We can, I think, further expect that we're going to see more such events. Basically, the parts of the country where—which tend to be wet are likely to be wetter. The parts of the country that tend to be dry are likely to be dryer. So we're going to see an increase both in droughts and in floods that are likely to be important to us all.

Senator DURBIN. Mr. Nutter, do you buy that?

Mr. NUTTER. Yes, the industry is very concerned about storm surge. I would have said the same thing that Dr. Wuebbles did, that the—we've increasingly built properties in very attractive coastal areas, often with not a sufficient setback, certainly probably in the current environment.

But if you have an increasing sea level rise and you have storms, you're going to have more water pushed on shore and more storm surge-related property damage.

Senator DURBIN. And is that why, the insurance industry is pulling back from some of these coastal areas?

Mr. NUTTER. It is. It is why a number of insurers have pulled back or sought much higher insurance premiums for properties in those areas, absolutely.

Senator DURBIN. So Dr. Sullivan, can you help us out here? As you project forecasting capabilities, is there any way that we can reduce this projected problem and the economic impact of these catastrophes?

Dr. SULLIVAN. Well, Senator, certainly, if nations around the world choose to take GHG mitigation actions and reduce those emissions, that would certainly lower the projected trend from that cause. This is a problem that's already affecting certain coastal communities. New York has planning underway.

The city of Norfolk, with—where I will visit in a couple of weeks, has been experiencing more frequent local inundation. And the Navy there is even looking at the prospect of needing to elevate their piers to accommodate the changing shoreline.

So there are some signs there's sea level rise induced by continuous and secular change in climate, plus the potential that further warming of the planet and associated changes alter the large-scale circulation in our major ocean basins.

There was a 2-foot sea level anomaly in some portions of the U.S. east coast, including Chesapeake Bay, back in 2009, that was due principally to natural variations in a North Atlantic oscillation and effects that this had on the gulf stream and longshore currents.

So we live in a very dynamic environment. We are citing tremendously expensive infrastructure, highly built cities, dense populations, preferentially in these coastal zones. There are certainly things we can do to make our coastal communities more resilient. The NOAA has developed a tool called the Coastal Resilience Index, intended to help local planners.

It's a simple, several-hour question and answer exercise that planners can use to bring key community stakeholders together, and take stock of where they have key vulnerabilities, key gaps in their preparedness, and look to take immediate and near-term actions to remedy those.

Senator DURBIN. Does anyone have anything they'd like to add that we haven't touched on here, that you think might be important or relevant, Dr. Wuebbles?

Dr. WUEBBLES. It's just one minor thing, that—an important but minor thing for—for this. As we look at—at the projections of climate, and we recognize that the—the oceans have a large heat capacity. So they respond much more slowly than the rest of the atmosphere.

The real response from these emissions occur 20 to 30 years after the initial emissions. So we're seeing the effect right now of the emissions we made 20 or 30 years ago. The emissions since then have continued to increase, so we can expect larger impacts in—over the coming decades just because of that impact, effect, that—that the oceans are going to take a much longer time to respond. That—that's one of the reasons for urgency in considering doing something.

Senator DURBIN. Thanks. I said to my staff, I want to hold this hearing. I want to figure out how we can talk about this issue because nobody else is talking about it. We stopped talking about this on Capitol Hill.

We decided that the debate over global warming was too contentious, too politically charged, and too divided for us to have any meaningful conversation about what to do with it. And so we stepped away from it. I think it's a big mistake.

I think that we are overlooking the obvious. Dramatic things are happening. They are things that are affecting lives, and fortunes, and are going to affect us, and the way we live, and the way we govern.

I don't think we have really measured, adequately, the impact of our exposure at the Government level to the things that are happening in weather pattern change, nor the exposure of our economy to what's going to happen as these unfold. And that is unfortunate.

And I'm hoping that, at least on our watch on the subcommittee, that we have raised an issue which is not being discussed very frequently on Capitol Hill. And I think we need to step back and ask honest questions about whether we are portraying our risk and our exposure as taxpayers and as a Government against what may likely occur in the near future.

And I will just say, confessing my bias if I have any, and I probably have plenty, I happen to believe that Dr. Wuebbles's approach to this is a sensible one, that small changes in our lifestyles today can make a dramatic difference in our future.

And if we ignore them and say let the next generation take care of it, then the last point you made is an obvious one. Their problems are going to go on much longer and much worse than what we've seen.

ADDITIONAL COMMITTEE QUESTIONS

Now, on that happy note, I thank you all for coming. And we will probably send some written questions your way. I hope you'll have a chance to respond in a timely fashion. The record will remain open until next Thursday, August 4, at 12 noon—I hope we are gone by then—for subcommittee members to submit statements and other materials.

I greatly appreciated all five of you for taking the time in getting us such valuable testimony.

[The following questions were not asked at the hearing, but were submitted to the Department for response subsequent to the hearing:]

QUESTIONS SUBMITTED BY SENATOR RICHARD J. DURBIN

QUESTIONS SUBMITTED TO KATHRYN D. SULLIVAN, PH.D.

*Question.* Dr. Sullivan, in both your written statement and verbal testimony, you addressed the importance of computer modeling and forecasting for the United States to be prepared for severe weather events in the long-term.

Given the importance of accurate models to proper budgetary planning, what key enhancements do you think could be made to improve these models?

Answer. As mentioned in my testimony, our Nation's environmental predictive capabilities are supported by four foundational pillars:

—observations;
—computer models;
—research; and
—our people.

The computer models pillar includes the entire computer-based forecast system—which is composed of forecast model software, data assimilation software for initializing the model, and a supercomputer to carry out the calculations. An accurate forecast requires both initial information on the state of the atmosphere, and an accurate physical depiction of the evolution of the atmosphere during the forecast. The President's fiscal year 2012 request invests in high-performance supercomputing for the National Weather Service (NWS), sustaining the rate of improvement in our numerical weather prediction modeling capability that is key to our plans to take advantage of improved observations.

The following key enhancements are critical to improve the models:

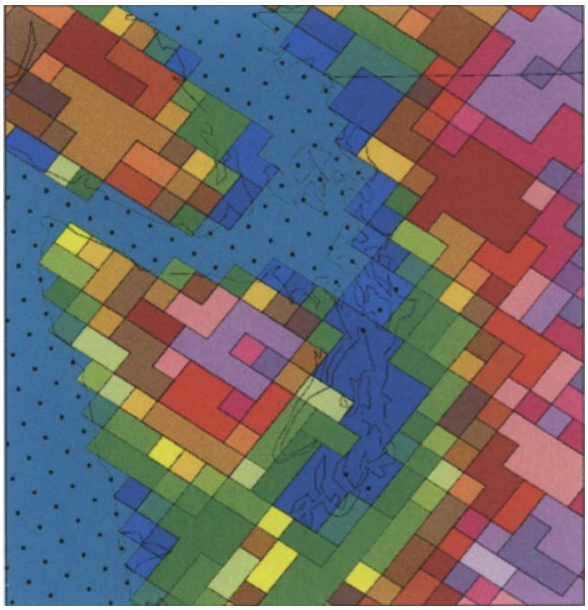
*Advanced Data Assimilation*.—An analysis is a process resulting in an accurate image of the atmosphere at a given time, represented in a model as a collection of numbers—and data assimilation is an analysis technique in which the observed information is accumulated into the model state. Probably the most important of the enhancements overall, advanced data assimilation techniques are needed to provide more accurate initial conditions using information from observations. New techniques are being developed to extract more usable information from all available observations. These are undergoing testing, and should be operational in 1–2 years.

*Model Physics*.—The forecast model contains representations of clouds, precipitation, the daily sunlight radiation cycle, evaporation and heating from the Earth's surface, and more. In nature, each of these elements of physics plays a major role in determining the evolving weather. Generally, the more accurate they are represented in the forecast model, the more accurate the forecast.

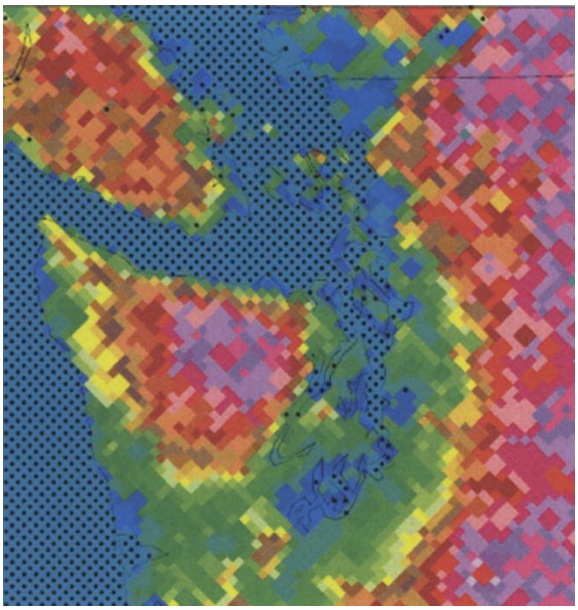
*Use of Ensemble-based Forecast Systems*.—Making multiple model forecasts with slightly different initial conditions, or with other slight alterations, gives us the ability to make definitive statements about our confidence in the operational forecast. These statements of confidence can be very important to decisionmakers, especially when major events are predicted. For example, if multiple runs of one or more models show strong agreement on the path of a hurricane or the development of a major storm, we can place a high confidence in

the forecast and resulting impacts for that event. The higher our confidence level in the forecast, the more likely appropriate action will be taken in advance.

*Model Resolution*.—Representing the detailed evolution of the atmosphere depends on the resolution of the forecast model. Following this paragraph are two figures with 12 km and 4 km representations of the topography over Puget Sound, Washington. Clearly, the one with 4 km resolution contains more detail. Experience has shown that forecast models with higher resolution will give more detail and greater accuracy. The 4 km forecast uses 27 times more computer resources than the 12 km forecast, which is why computer power is critical for weather forecasting models used in operational forecasts. Model resolution is particularly important for major weather events such as hurricanes, severe spring and summer convective storms and winter snow and ice storms.



12 km



4 km

*Improved Observation Network and Observation Use*.—Increased information from observations, through the data assimilation process, results in more accurate initial conditions. Critical observations include those from current and future weather satellites (the Joint Polar Satellite System (JPSS), the GOES–R Program), commercial aircraft, Dual Polarization Radar, and advanced technology sensors for measuring temperature and moisture in the lowest 3,000 ft of the atmosphere. Research, leading to operational implementation of new, cost-effective observing systems, is also necessary for progress in this area.

Again, our Nation's environmental predictive capabilities are supported by four foundational pillars:

—observations;
—computer models;
—research; and
—our people.

These pillars are completely interdependent, and should be enhanced in a balanced way in order to promote a strong and vibrant foundation for improvements. For example, investments in supercomputing capability strengthen and enhance all four pillars in an integrated way, as all benefit from the advanced guidance and improved accuracy delivered by the additional computing capacity. All four of the pillars require continuous and balanced strengthening in order to achieve significant advancements in our environmental prediction capabilities.

*Question.* How could better forecasting capabilities help reduce the economic impact of the increased natural catastrophes?

Answer. In addition to advising the public and our partners of immediate impacts that threaten life and property, National Oceanographic and Atmospheric Administration's (NOAA) environmental forecasts and warnings also provide the capability to mitigate the economic impact of the wide variety of natural hazards that face our Nation through advanced alerts to potential impacts.

Improved numerical model information would enable NOAA forecasters to produce forecasts and warnings with increased confidence, consistency, and accuracy. Even a small improvement in forecast accuracy can result in more effective and/or timely positioning of critical and limited resources ahead of and even during environmental disasters. This is key to saving lives and containing cost.

Specific scenarios follow to illustrate these and additional benefits of improved forecasts to users, sectors, or others:

*Climate*

Improved seasonal forecasts would enable more effective actions across a number of economic sectors, from optimizing the seasonal acquisition of road salt supplies, to planning ship routing and timing strategies, to long-term actions associated with clothing and food supplies. In addition, improved seasonal forecasts would facilitate more efficiency in planning the opening and closing of fisheries, and recreational areas/beaches.

Improved forecasting capabilities would enable users of climate information to better prepare for extremes in weather and climate and attempt to mitigate them. For instance, the State of California determined a savings of around $1 billion during the 1997–1998 El Niño compared to the 1982–1982 El Niño. This is largely attributed to having enough time to implement extensive mitigation activities.[1] Other sectors of the economy that stand to benefit from improved forecasts include water resource managers, energy producers, distributors, and providers, the transportation and agricultural sectors, to name a few.

*Aviation*

Improved forecasting capabilities would reduce economic impacts resulting from air traffic delays. The total cost of domestic air traffic delays to the U.S. economy in 2007 was as much as $41 billion, with an estimated $10 billion lost by industries that rely on air traffic for supplies or customers (U.S. Congressional Joint Economic Committee, 2008). Weather is the major cause of most flight delays, reroutes and cancellations.

NOAA will support the FAA in its evolution to the Next Generation Air Traffic Control System (NextGen) through provision of a four-dimensional (three-dimensional space along with time) cube of weather information, which will be used to project conditions for airline trajectories in space and time, requiring improvements in spatial and time-scale forecast accuracy.

*Winter Storm*

Improved weather modeling would lead to better preparation for severe winter storms, including readying of equipment, personnel, and supplies to fight effects of a heavy snow, ice storm, or severe cold outbreak. Advanced warnings could save additional millions of dollars in potential disruptions, power outages, stranded planes, and commerce.[2] In general, improved weather forecasts would support optimization of surface rail and road systems, ensure on-time delivery of services, minimize infrastructure and capacity damage, and improve maintenance scheduling.

*Flood*

High-resolution, geo-referenced flood forecast inundation maps would enable emergency managers to preposition people and resources to more effectively reduce the impacts of flood events. These maps depict the areal extent and depth of flood waters, linked with other infrastructure and demographic information such as FEMA's HAZUS. It would also enable the high-resolution water resources analyses and forecasts (e.g., soil moisture, evapotranspiration, ground water, water quality, snow water equivalent) necessary to better manage our increasingly limited water supply and support routine high-value decisions in the transportation, hydropower, agricultural, water supply, recreational, and floodplain management sectors.

Improved forecasts of runoff and stream discharge, if combined with high-resolution, geo-referenced flood forecast inundation maps depicting the areal extent and depth of flood waters, could also be linked to infrastructure- and demographic-based information, to facilitate the pre-positioning of resources to reduce the impacts of flooding events.

*Marine*

Improved forecasting capabilities would help to better inform the decisions made by commercial and recreational fishermen, such as whether to stay in port, remain at sea, or alter course depending on forecast conditions, thus maximizing resources and safety, while reducing economic impact and loss of life.

Charter fishing guides could make better decisions by knowing, days in advance, when staying in port or going out would be in the best interest of their vessels or customers. Maintenance could be scheduled well ahead for bad weather days, saving

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[1] Chagnon, S.A. (ed.) (2000). *El Nino 1997–1998: The Climate Event of the Century*. New York, NY: Oxford University Press, 147–148.

[2] Adams, R., L. Houston, and R. Weiher, (2004, August), "The Value of Snow and Snow Information Services," Report prepared for NOAA's National Operational Hydrological Remote Sensing Center. Chanhassen, MN.

the economic loss of performing maintenance when they could be carrying passengers and earning revenue.

Large ship (oil tankers, container ships, aircraft carriers) operators at sea could alter course and speed to avoid or mitigate storm conditions affecting their route, thus preventing loss of cargo and/or personnel.

Coast Guard and other rescue operators could better anticipate needs for additional manpower, and adjust staffing to meet anticipated needs.

*Fire Weather*

Improved forecasting of key fire weather variables such as temperature, humidity, and wind would reduce the risk of firefighter and public fatalities by providing advanced notice of fire movement and extreme fire behavior. This would, in turn, allow appropriate evacuations and safe fire management tactics to be implemented in a more effective and cost-effective manner.

Improved fire weather forecasts would also allow for more efficient prepositioning of firefighting resources before an anticipated fire outbreak. This would increase initial attack success, and therefore lower the risk of large, costly wildfires. Also, improved fire weather forecasts would support safer and more cost-effective land management treatments, and would greatly lessen the risk of escaped prescribed burns.

*Tropical Storm/Hurricane*

Improved hurricane forecasts would reduce impacts from unnecessary evacuations along the Nation's coastlines prior to hurricane landfall. These impacts reach farther than the great inconvenience and cost of moving large numbers of people out of potential danger, with lost business revenues and nationwide resource impacts due to significant transportation delays.

Improved storm surge forecasts would result from improved hurricane track and intensity forecasts, resulting in far better mitigation plans for resulting flood impacts, targeted to the areas which need it.

Improved hurricane forecasting would reduce the amount of lives and property lost from unforeseen rapid deepening of storms as they approach land. An example is Hurricane Charley in 2004, which rapidly intensified to a Category 4 hurricane before making landfall in southwest Florida, where it claimed at least 16 lives and left tens of thousands seeking emergency shelter.

NOAA's making targeted investments toward improvements in these forecasts.

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## QUESTIONS SUBMITTED TO DAVID C. TRIMBLE

### DANGERS AND DRAWBACKS OF FRAGMENTED MANAGEMENT

*Question.* Mr. Trimble, in the Government Accountability Office's (GAO) prepared statement you make an observation that can be attributed, regrettably, to a wide array of disparate Government programs. I recall hearing a similar refrain relating to our Nation's fragmented food safety system.

You explain that "when agencies do not collaborate well when addressing a complicated, interdisciplinary issue (like climate change), they may carry out programs in a fragmented, uncoordinated way, resulting in a patchwork of programs that can limit the overall effectiveness of the Federal effort." These stovepipes can also mean redundancies, management challenges, and competition for scarce funds.

What are the key ingredients of a new approach to doing business and instituting a Government wide approach?

Answer. Based on our past work (GAO–06–15, GAO/GGD–00–106) key practices that can help agencies enhance and sustain their Government wide collaborative efforts include:

—defining and articulating a common outcome among agencies with different missions;
—agreeing on roles and responsibilities in achieving the common outcome;
—establishing compatible policies, procedures, and other means to operate across agency boundaries;
—identifying and addressing needs by leveraging resources, such as by collectively funding interagency initiatives; and
—developing mechanisms to monitor, evaluate, and report on results.

As we have previously reported (GAO/T–GGD–00–26), perhaps the single most important element of successful management improvement initiatives is the demonstrated commitment of top leaders to change. Top leadership involvement and clear lines of accountability are critical to overcoming natural resistance to change, marshalling needed resources, and building and maintaining the commitment to new ways of doing business.

*Question.* What impediments need to be removed in order to make a different approach workable?

Answer. As reported in our October 2009 report on climate change adaptation (GAO–10–113), we found that the challenges faced by Federal, State, and local officials in their efforts to adapt to climate change fell into several categories. First, available attention and resources were focused on more immediate needs, making it difficult for adaptation efforts to compete for limited funds. Second, without sufficient site-specific data, such as local projections of expected changes, it is hard to predict the impacts of climate change and thus hard for officials to justify the current costs of adaptation efforts for potentially less certain future benefits. Third, adaptation efforts are constrained by a lack of clear roles and responsibilities among Federal, State, and local agencies.

According to Federal, State, and local officials we interviewed and other information we analyzed for our October 2009 report, potential Federal actions for addressing such challenges fall into three areas:

—Federal training and education initiatives that could increase awareness among Government officials and the public about the impacts of climate change and available adaptation strategies;

— actions to provide and interpret site-specific information that could help officials understand the impacts of climate change at a scale that would enable them to respond; and

—steps the Congress and Federal agencies could take to encourage adaptation by setting priorities and re-evaluating programs that hinder adaptation efforts.

In our October 2009 report, we recommended that the appropriate entities within the Executive Office of the President (EOP) develop a national adaptation plan that includes setting priorities for Federal, State, and local agencies. The Council on Environmental Quality (CEQ) generally agreed with our recommendations, and said that the Interagency Climate Change Adaptation Task Force will prepare a report in October 2011 that documents its progress.

In addition, our May 2011 report on Federal climate change funding (GAO–11–317) found that agencies do not consistently interpret methods for defining and reporting the funding of climate change activities, and that Federal officials lack a shared understanding of priorities, partly due to multiple, often inconsistent messages articulated in different sources, such as strategic plans. We also found that existing mechanisms intended to align funding with Government wide priorities are nonbinding and limited when in conflict with agency priorities. Federal officials who responded to a Web-based questionnaire for this report and other sources identified ways to better align Federal climate change funding with strategic priorities, including:

—options to improve the tracking and reporting of climate change funding;

—options to enhance how strategic climate change priorities are set;

—the establishment of formal coordination mechanisms; and

—continuing efforts to link related climate change activities across the Federal Government.

In May 2011, we reported that Federal entities were already taking steps to implement several of these options. Specifically, the Interagency Climate Change Adaptation Task Force, co-chaired by CEQ, the National Oceanic and Atmospheric Administration (NOAA), and the Office of Science and Technology Policy (OSTP), was formed to develop Federal recommendations for adapting to climate change impacts and to recommend key components to include in a national strategy. In addition, the NOAA's proposed Climate Service would, according to NOAA, provide a single, reliable, and authoritative source for climate data, information, and decision-support services to help individuals, businesses, communities, and governments make smart choices in anticipation of a climate changed future.

In our May 2011 report, among other things, we recommended that the appropriate entities within the EOP, in consultation with the Congress clearly establish Federal strategic climate change priorities and assess the effectiveness of current practices for defining and reporting related funding. We requested comments on a draft of this report from the chair of CEQ, the Director of the Office of Management and Budget, and the Director of the OSTP. They did not provide official written comments to include in our report. Instead, they provided technical comments, which we incorporated as appropriate.

ADDRESSING GOVERNMENT CHALLENGES BY ADAPTING PRIVATE SECTOR TOOLS

In the prepared statement for the hearing, the GAO sets forth three categories of the challenges faced by government officials at all levels in their efforts to adapt to climate change.

The GAO cites "focusing on immediate needs", "insufficient site-specific data", and "lack of clear roles and responsibilities" as the key areas which hamper informed Government decisionmaking.

GAO references the lack of adequate computational modeling in an example about how a Florida marine sanctuary had difficulty planning, and lacked inventories and monitoring systems to frame a baseline of the types of plants and animals thriving on the resources they managed, thus making it hard to know whether particular habitat changes they observed are "normal" or aberrant.

*Question.* Does this data problem facing the Government stem from a wholesale lack of any models that could be adapted?

Answer. Based on our prior work, finding the right model for the right application is challenging. Interpreting the output of such models can be equally, if not more challenging. Senior Federal officials spoke of the need for a "clearinghouse" to validate available models which can be of varying quality. The National Research Council (NRC) is analyzing many of these issues right now in a study titled "A National Strategy for Advancing Climate Modeling."

*Question.* Why do agencies have such difficulty developing the kinds of important information they need to analyze impacts and better understand long-term exposure to risk as a result of changing weather events?

Answer. As we reported in October 2009, adaptation information challenges generally fit into two categories:

—the difficulty in justifying the current costs of adaptation with limited information about future benefits; and

—translating climate data—such as projected temperature and precipitation changes—into information that officials need to make decisions.

According to a recent NRC report, while the costs of policies to mitigate and adapt to climate change may be considerable, it is difficult to estimate the costs of inaction—costs which could be much greater. This report cites the long time horizon associated with climate change, coupled with deep uncertainties associated with forecasts and projections, among other issues, as aspects of climate change that are challenging for decisionmaking.

As we reported in October 2009, the process of providing useful information to officials making decisions about adaptation can be summarized in several steps, each of which is complicated. First, data from global-scale models must be "downscaled" to provide climate information at a geographic scale relevant to decisionmakers. Second, climate information must be translated into impacts at the local level, such as increased stream flow. Third, local impacts must be translated into costs and benefits, since this information is required for many decisionmaking processes. Fourth, decisionmakers need baseline monitoring data to evaluate adaptation actions over time.

*Question.* How complicated would it be, in terms of time and resources, to compile inventories to establish foundational starting points to better recognize and measure environmental change (and the impact of an increase in frequency or severity of weather-related events) when it is observed?

Answer. We have not evaluated the time or resources needed to establish or improve monitoring systems for weather-related events. Regarding efforts to measure environmental change and the impact of an increase in the observed frequency or severity of weather-related events, NOAA tracks and consolidates data on its climate services Web site at http://www.climate.gov/#climateWatch. Data on this site are provided by various NOAA centers, including the National Climatic Data Center and the National Weather Service Climate Prediction Center. In addition, we are currently reviewing the NOAA's U.S. Historical Climatology Network, used to track national trends in basic meteorological variables such as temperature and precipitation.

*Question.* What private sector experiences, techniques, and lessons learned would be useful to evaluate and adapt to address the challenges the GAO describes?

Answer. Our 2007 report on Federal flood and crop insurance programs (GAO–07–285) found that many major private insurers were proactively incorporating some near-term elements of climate change into their risk management practices. In addition, other private insurers were approaching climate change at a strategic level by publishing reports outlining the potential industry-wide impacts and strategies to proactively address the issue. Statements from the reinsurance industry at your July 28 hearing emphasized these issues.

In addition, we are beginning an engagement on climate change adaptation and infrastructure development. As we noted in our October 2009 report (GAO–10–113), of particular importance in adaptation are planning decisions involving physical infrastructure projects, which require large capital investments and which, by virtue of their anticipated lifespan, will have to be resilient to changes in climate for many

decades. The techniques used by the private sector and lessons arising from this work may also prove useful.

CONCLUSION OF HEARING

Senator DURBIN. This hearing of the subcommittee stands recessed.

[Whereupon, at 3:15 p.m., Thursday, July 28, the hearing was concluded, and the subcommittee was recessed to reconvene subject to the call of the Chair.]

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