

24. FEDERAL BUDGET EXPOSURE TO CLIMATE RISK

No challenge poses a greater threat to future generations than climate change. This past year was the planet's warmest on record. The 15 warmest years on record have all fallen in the first 16 years of this century. Across the American landscape, the impact of climate change is undeniable. Along our Eastern seaboard, a number of cities now flood regularly at high tide. The vast majority of the largest wildfires in modern U.S. history have occurred since 2000. In parts of the Midwest, higher temperatures will increase irrigation demand and exacerbate current stresses on agricultural productivity. And in the Mississippi and Missouri River Basins, numerous studies indicate increasing severity and frequency of flooding, leading to potential disruptions to the Nation's inland water system, as seen most recently in the devastating and widespread flooding in the interior of the United States. The imprint of climate change on the Federal budget is increasingly apparent—in the escalating costs of disaster response and relief, flood and crop insurance, wildland fire management, Federal facility management, and a host of other Federal programs that are vulnerable to the impacts of climate change. For this reason, understanding the Federal Government's exposure to climate change risks is increasingly critical for policymakers charged with making sound investment decisions and stewarding the Federal budget over the long term.

The Third National Climate Assessment (NCA) concludes that climate change is already affecting every region of the country and key sectors of the U.S. economy. The report was developed over four years by a team of more than 300 of the Nation's top climate scientists and technical experts, guided by a 60-member Federal Advisory Committee, and extensively reviewed by the public and experts including the National Academy of Sciences. Key findings of the NCA include the following:¹

- Heavy downpours are increasing nationally, and this trend in extreme precipitation is projected to continue for all U.S. regions.
- Floods and droughts are increasing in some regions. Drought in the Southwest is projected to increase. Heat waves have become more frequent and intense, and this trend is projected to continue as average temperatures rise.
- The intensity, frequency, and duration of North Atlantic hurricanes and the number of strongest storms (Category 4 and 5) all increased in the last

few decades. Hurricane intensity and rainfall are projected to increase with further climate change.

- Winter storms have increased in frequency and intensity since mid-20th Century, and their tracks have shifted northward.
- Global sea level has risen by about 8 inches since reliable record keeping began and is projected to rise another 1 to 4 feet by 2100.
- Oceans are becoming more acidic as they absorb a quarter of the carbon dioxide emitted annually, forming carbonic acid and thereby putting marine ecosystems at risk.

The Federal Government has broad exposure to escalating costs and lost revenue as a direct or indirect result of a changing climate. For example, the Federal Government plays a critical role in helping American families, businesses, and communities recover from the impacts of catastrophic events. As economic damages from such events grow, so does the liability for the Federal budget. At the same time, the Federal Government is directly at risk from extreme weather impacts to Federal facilities nationwide and the growing incidence of fire on Federal lands.

While existing climate change-related expenditures can be identified for a number of Federal programs, it is inherently difficult to isolate climate change-related expenditures for many other programs across the Federal Government. Even in these cases, however, the directional impact on the Budget of expected climatic changes is clear.

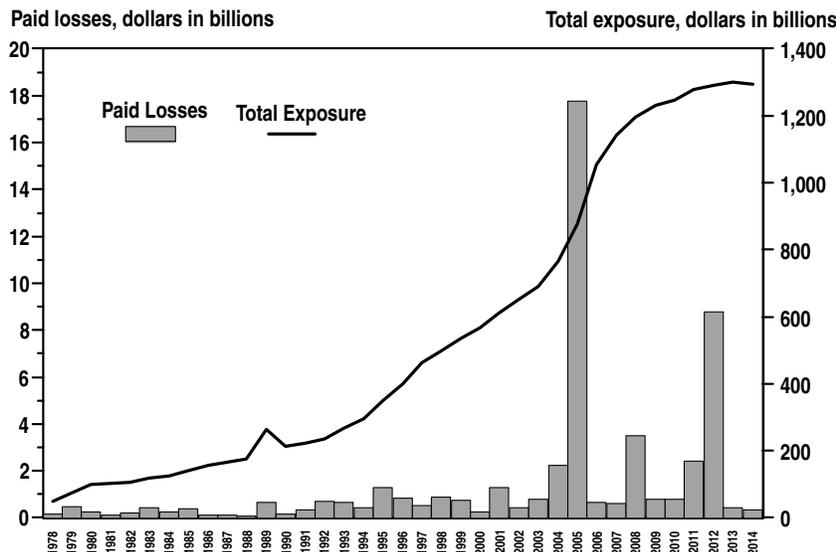
Identifiable Costs

Over the last decade, the Federal Government has incurred over \$357 billion in direct costs² due to extreme weather and fire alone, including for domestic disaster response and relief (\$205 billion), flood insurance (\$23 billion), crop insurance (\$67 billion), wildland fire management (\$34 billion), and maintenance and repairs to Federal facilities and Federally managed lands, infrastructure, and waterways (\$28 billion). Additional costs have been incurred for international disaster response and relief in the wake of extreme events like droughts, floods, and storms. While it is not possible to identify the portion of these costs incurred as a result of human-

¹ Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014. *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

² This figure is revised from the estimate in the FY 2016 President's Budget. The difference is largely attributable to improved estimation, rather than increased costs in 2015. This estimate does not include some categories of spending, such as international disaster response and relief, military spending, direct healthcare costs, as well as some Federal property and resource management costs. As a result, this estimate potentially significantly understates actual direct Federal costs due to extreme weather and fire.

**Chart 24-1. National Flood Insurance Program
Paid Losses & Total Exposure**



induced climate change, costs for each of these Federal programs have been increasing, are inherently sensitive to the effects of climate change, and can therefore be expected to continue to rise as the impacts of climate change intensify.

Domestic Disaster Response and Relief

The Federal Emergency Management Agency (FEMA) has incurred roughly \$90 billion in costs for domestic, extreme weather-related disaster response and relief over the last decade. Over that time period, other Federal agencies received appropriations of roughly \$99 billion for domestic disaster relief efforts, largely related to the 2005 Gulf Coast hurricanes and Superstorm Sandy. An additional \$16 billion in tax expenditures were incurred between 2006 and 2015 for tax relief associated with the 2005 Gulf Coast hurricanes, according to the Congressional Budget Office (CBO) and the Joint Committee on Taxation.³

Climate models predict that climate-driven changes, such as higher sea levels and stronger hurricanes, as well as increases in extreme precipitation, are likely to magnify damages due to extreme weather and associated needs for disaster response and relief.⁴ For example, the National Climate Assessment found that the amount of rain falling in very heavy precipitation events since 1991 has increased in the Northeast, Midwest, and upper Great Plains by more than 30 percent above the 1901-1906 average. This has caused an increase in costly flooding events in the Northeast and Midwest in particular, such as the most recent flooding in the Mississippi River Basin. This trend towards increased heavy precipitation events is expected to continue, threatening levees and other in-

frastructure and the communities that depend on them. In the coastal environment, a review by the Government Accountability Office of 20 scientific studies found a predicted increase of 14-47 percent in inflation-adjusted U.S. hurricane losses by 2040, attributable to changes in the severity of storms. By 2100, losses are projected to grow by 54 to 110 percent. Accounting for the combination of projected sea-level rise and changes in hurricane activity, hurricane losses could more than quadruple by the year 2100.⁵

Historically, the cost of Federal action following a major disaster has averaged roughly a third of total economic losses.⁶ If this share of total losses continues, Federal disaster response and relief costs can be expected to rise proportionately with projected increases in total economic losses. However, this type of linear extrapolation may underestimate the true exposure of the Federal budget given that a major event or series of major events could, for example, affect the solvency of an industry, municipality, or State.

Flood Insurance

In addition to its disaster response activities, FEMA manages the National Flood Insurance Program (NFIP), established in 1968. NFIP is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of flood damage. While the program is designed to offset paid losses with premium collections, catastrophic events in any given year can have outsized impacts on NFIP. Due largely to Hurricane Katrina in

³ Congressional Budget Office, 2007. The Federal Government's Spending and Tax Actions in Response to the 2005 Gulf Coast Hurricanes. Prepared for the House Budget Committee.

⁴ Kopp, Robert, and Solomon Hsiang, 2014: American Climate Prospectus. Economic Risks in the United States. Rhodium Group, LLC.

⁵ U.S. Government Accountability Office, 2014. Climate Change: Better Management of Exposure to Potential Future Losses Is Needed for Federal Flood and Crop Insurance. GAO 15-28: Published October 29, 2014.

⁶ Cummins, J. David, Michael Suher, and George Zanjani. 2010. Federal Financial Exposure to Natural Catastrophe Risk in Lucas, D. (ed.) Measuring and Managing Federal Financial Risk. National Bureau of Economic Research. University of Chicago Press.

2005 and Superstorm Sandy in 2012, the program incurred substantial paid losses in excess of premiums collected, incurring approximately \$23 billion in debt to the U.S. Treasury as of June 2015. The figure above details the program's historical paid losses and total exposure—the total value of property insured by the program. NFIP's total exposure has quadrupled over the last two decades to \$1.3 trillion due to an increase in the number of insured properties, as well as the value of those properties.

Nationwide, the Special Flood Hazard Area—the land area subject to a one percent or greater chance of flooding in any given year—is projected to increase by 40-45 percent by 2100 (with large regional variations), driven predominantly by the effects of climate change, according to a FEMA study.⁷ In the coastal environment, this projected increase is a result of rising sea levels and increasing storm intensity and frequency. In the riverine environment, less than one-third of the increase in typical areas is attributable to population growth and associated impacts on stormwater runoff, while more than two-thirds is attributable to the influence of climate change. As a result of the projected increase in the flood hazard area, the average loss cost per policy⁸ in today's dollars is estimated to increase approximately 50-90 percent by 2100, with a 10-15 percent increase as soon as 2020. These increases will be compounded by projected growth in the total number of policyholders participating in NFIP—approximately 80-100 percent through 2100 as a product of population growth and also the expansion of the flood hazard area. These projected increases in loss cost per policy are median estimates; catastrophic events in any

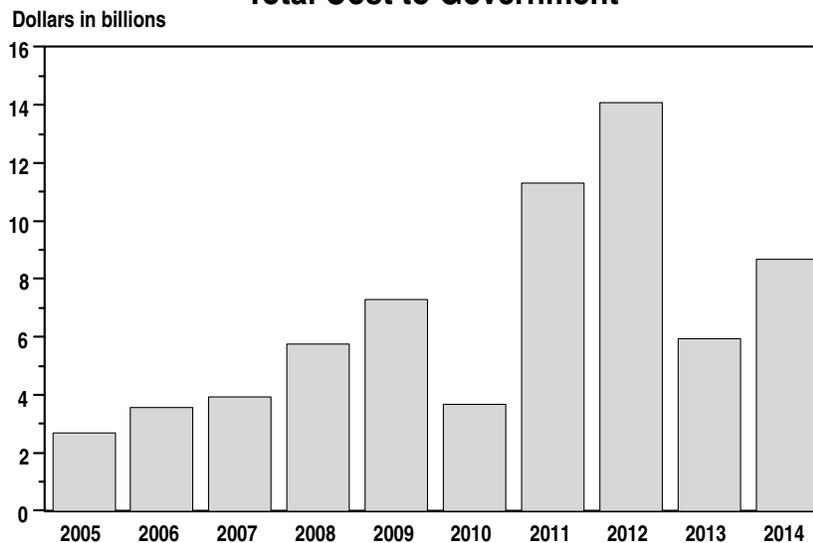
given year could have much larger impacts on NFIP and the Federal budget.⁹

The expected implications of climate change for hurricane-related damage is supported by preliminary CBO findings. CBO modeled increases in expected storm damage in 2075 due to coastal development and climate change. Both factors were found to exacerbate storm damage. However, while the damage due solely to coastal development was found to grow more slowly than gross domestic product (GDP), the damage due to the combined effect of coastal development and climate change was found to grow more rapidly than GDP.¹⁰

Crop Insurance

The United States Department of Agriculture's Risk Management Agency (RMA) provides crop insurance to American farmers and ranchers through the Federal Crop Insurance Corporation (FCIC). Federal crop insurance policies cover loss of crop yields from natural causes including drought, excessive moisture, freeze, disease, and hail. The Federal Government incurs costs for crop insurance in the form of subsidized premiums, losses associated with any claims paid in excess of collected premiums, and costs for program administration and operation—a total of \$67 billion between 2005 and 2014. Costs can increase sharply in years affected by extreme weather. For example, droughts caused the surge in costs in 2011 and 2012 shown above. The Federal Government's total exposure for crop insurance is currently about \$120 billion, up from \$67 billion in 2007.

**Chart 24-2. Crop Insurance
Total Cost to Government**



⁷ AECOM, 2013. The Impact of Climate Change and Population Growth on the National Flood Insurance Program through 2100. Prepared for Federal Emergency Management Agency.

⁸ Loss cost is a measure of expected loss payments per \$100 of insured building value.

⁹ AECOM, 2013. The Impact of Climate Change and Population Growth on the National Flood Insurance Program through 2100. Prepared for Federal Emergency Management Agency.

¹⁰ Dinan, Terry, 2015. Hurricane Damage: Effects of Climate Change and Coastal Development. Congressional Budget Office.

Wildland Fire Management

The U.S. Forest Service (USFS) and Department of the Interior (DOI) manage wildland fire to protect human life and property. Climate change is contributing to an increase in wildland fire frequency and intensity across the western United States and Alaska.¹¹ The majority of the largest fires in modern U.S. history have occurred in just the last two decades. On average, firefighting appropriations grew 25 percent per year over that period, adjusted for inflation. At the USFS, appropriations for wildland fire management grew from 16 percent of the agency's total budget in 1995 to 52 percent in 2015. These budget increases are due to a number of factors, including population growth in the wildland-urban interface, a legacy of aggressive fire suppression, and climatic factors. For example, in the Southwest, increased warming, drought, and insect outbreaks, all caused by or linked to climate change, are creating chronic forest stress and increased tree mortality rates, increasing the risk for wildfire and its impacts to people and ecosystems. Fire models project more wildfire and increased risks to communities across extensive areas.¹² Increasing temperatures may contribute to increased fire frequency, intensity, and size in parts of the Southeastern United States, and notably Florida, as well.¹³

Federal Property and Resource Management

Federal facilities are directly at risk from the extreme weather events that are being influenced by climate change. At this time, there is no government-wide total cost estimate for these impacts because Federal agencies do not separately track facility-related expenditures that are incurred as a consequence of extreme weather events. However, the last decade has provided a long list of examples of costly damage to Federal facilities. Those facilities damaged by major events have often required significant supplemental appropriations to repair those damages—roughly \$19 billion throughout the last decade to agencies as diverse as NASA, the Coast Guard, the National Park Service, the Federal Bureau of Prisons, and the National Cemetery Administration. An additional \$8 billion was appropriated in the wake of major storms to agencies that manage land, infrastructure, and waterways.

While these costs were associated with large events like the 2005 Gulf Coast hurricanes and Superstorm Sandy, smaller events and ongoing impacts of climate change also have cost and mission implications. For example:

- An Army installation in the Southwest incurred \$64 million in damages due to extreme torrential downpours. Within an 80-minute period, the installation experienced as much rain as typically falls over the course of a year. The flooding caused by the storm damaged 160 facilities, 8 roads, 1 bridge, and 11,000 linear feet of fencing.

- At Cape Lisburne Air Station on the Alaskan coastline, home to a vital early-warning radar site, erosion of the stone seawall due to increased coastal flooding is putting the installation's airstrip at risk. The Air Force recently began a \$41 million project to protect the runway, the primary avenue for resupplying the installation and its Airmen.
- Record-breaking rainfall and severe flash flooding in 2010 overwhelmed man-made drainage systems at the Department of Energy's Pantex Plant—the Nation's only nuclear weapons assembly and disassembly facility. Since the incident, the facility has invested in improved drainage, response plans, and procedures to better prepare for flash flooding events.

Under Executive Order 13653, Federal agencies must continue to update comprehensive adaptation plans that indicate how the agency will integrate climate resilience into agency actions, such as supply chain management, real property investments, and capital equipment purchases. Such consideration could include updating agency policies for leasing, building upgrades, relocation of existing facilities and equipment, and construction of new facilities. Under Executive Order 13690, which establishes a Federal Flood Risk Management Standard, Federal agencies are directed to integrate current and future flooding considerations into their investments, where relevant. In addition, Executive Order 13693 directs Federal agencies to convene regional interagency workshops to address water resource management and drought response opportunities, and climate change preparedness and resilience planning in coordination with State, local, and tribal communities. Finally, under Executive Order 13677, agencies with international development programs are now systematically factoring climate-resilience considerations into new international development investments, including planning and managing overseas facilities.

Other Direct and Indirect Costs

The Federal Government's climate risk exposure extends well beyond disaster response, flood and crop insurance, wildland fire management, and Federal property management. For example, the Federal Government will likely incur additional direct and indirect costs for health care, national security, and species recovery efforts as a result of climate-driven changes across sectors of the economy. However, it is inherently difficult in these areas to identify current expenditures that are related to climatic factors such as extreme weather and rising temperatures.

Health Care

Climate change threatens the health and well-being of Americans in a number of ways, including increasing impacts from extreme weather events, wildland fire, decreased air quality, and illnesses transmitted by food, water, and disease carriers such as mosquitoes and ticks. While the economic literature on the current and project-

¹¹ Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014. *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

¹² Ibid.

¹³ Ibid.

ed health costs associated with climate change is limited, a number of studies have found substantial health costs due to climate-related events.¹⁴ The Federal Government is the Nation's largest purchaser of health care services—spending nearly \$900 billion in 2015 on Medicare, Medicaid, and the Children's Health Insurance Program. These programs provide health care for those most vulnerable to the health-related impacts of climate change: children, the elderly, and low-income individuals.

National Security

National security, diplomacy, and development agencies expect that climate change will intensify the challenges of global instability, hunger, poverty, conflict, emerging disease, disputes over water, food, and energy resources, and destruction by natural disasters. The Department of Defense (DOD) refers to climate change as a "threat multiplier" because it can exacerbate many challenges, including population migration and global instability. Climate change will impact the Department's military readiness, personnel training, stationing, environmental compliance and stewardship, and infrastructure protection and maintenance. DOD is conducting vulnerability assessments at major military installations to consider current and projected climate impacts, and to assess and manage risks to man-made and natural infrastructure. The Department will incorporate climate change considerations in its natural resource management, historic preservation, design and construction standards, asset management, encroachment management, utility systems, and emergency management operations. Climate impacts may adversely influence the frequency, scale, and complexity of future operational missions, and may increase the need for defense support to civil authorities. Climate impacts may affect supply chains and critical equipment replenishment needs. These impacts could be a burden on the Federal budget as costs increase for military and humanitarian operations.

DOD has taken several concrete steps to improve its ability to mitigate the risks climate change poses to its mission. DOD issued its Climate Change Adaptation and Resilience Directive in January 2016. The Directive establishes policies and assigns responsibilities to various departmental offices to assess and manage risks associated with climate change. For example, the Directive requires DOD organizations to consider climate change and resiliency when developing installation plans, making basing decisions, and determining acquisition strategies.

DOD also has three pilot projects with local communities to address common, region-specific climate change impacts. One of the DOD pilots is at Mountain Home Air Force Base in Idaho. The Base is working with nearly 50 stakeholders, including city, county, and state governments, as well as tribal, academic, and nonprofit organizations and other Federal agencies to develop a regional Action Plan for climate change and

resilience. The plan, which is expected to be completed in 2016, will include partner roles and responsibilities, establish milestones for actions, as well as specify other opportunities for developing climate risk partnerships.

In the Hampton Roads/Norfolk, VA area, White House offices and Federal partners, led by the Department of Defense, are participating with State, local, and academic officials to support an Intergovernmental pilot project addressing sea level rise in that area. The pilot is a two-year project to develop a regional "whole of government" and "whole of community" approach to sea level rise preparedness and resilience planning in Hampton Roads that also can be used as a template for other regions.

Species Recovery

Climate change is expected to fundamentally alter ecosystems in ways that are costly to those systems and the people who depend upon and value them. For example, a changing climate is expected to cause rapid shifts in habitat and species ranges and to exacerbate the non-climatic stressors (e.g., habitat loss, overutilization, invasive species) that affect plants and animals, leading to potential reductions in biodiversity through the local or global loss of species.

For example, climate change appears to be a key driver causing a mismatch between the life cycle of the Edith's checkerspot butterfly and the timing of the flowering plants it depends on, causing the butterfly's population to crash along its southern range. Similarly, warming and reduced stream flows due to declining snowmelt are affecting salmon species. A small increase in water temperature can cause coho salmon eggs to hatch weeks early, leading to a mismatch between the time the salmon reach the ocean and the abundance of their prey.¹⁵ Researchers estimate that up to 90 percent of species may be displaced from their current range and forced into new areas or to go extinct.¹⁶

The Intergovernmental Panel on Climate Change (IPCC), in its recent Fifth Assessment Report, found that a large fraction of terrestrial, freshwater and marine species face increased extinction risk due to climate change during and beyond the 21st century, especially as climate change interacts with other stressors.¹⁷ These and other ecosystem impacts are likely to pose significant costs, though it is difficult to monetize the precise value of lost species and ecosystem services. In addition to costs to private citizens and industry, the expected decline in species may increase the costs of Federal species recovery efforts.

¹⁵ National Fish, Wildlife and Plants Climate Adaptation Partnership. 2012. National Fish, Wildlife and Plants Climate Adaptation Strategy, Association of Fish and Wildlife Agencies, Council on Environmental Quality, Great Lakes Indian Fish and Wildlife Commission, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service. Washington, DC.

¹⁶ Lawler, J. et al., 2009: Projected Climate-Induced Faunal Change in the Western Hemisphere. *Ecology*, 90(3), 2009, pp. 588–597.

¹⁷ IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 67.

¹⁴ Kopp, Robert, and Solomon Hsiang, 2014: American Climate Prospectus. Economic Risks in the United States. Rhodium Group, LLC.

Lost Revenue

Unabated climate change is projected to hamper economic production in the United States and across the globe. Economic loss in the United States means lost revenue for the Federal Government. Projections by the IPCC include a warming range of about 3.5 to 5.5 degrees Celsius (6.3 to 9.9 degrees Fahrenheit) over preindustrial levels by 2100 if recent global emissions are allowed to continue along IPCC's high-end scenario.¹⁸ Available economic assessments of warming of four degrees Celsius indicate economic damages of more than four percent of global GDP each year by 2100.¹⁹

There are a number of factors that may affect the accuracy of this estimate. For example, the estimate does not account for important factors that are inherently difficult to quantify or monetize, such as biodiversity loss, increased ocean acidification, changes in weather related to changes in ocean circulation, catastrophic events, irreversibility of climate change impacts, tipping points leading to non-linear changes to the climate, and heightened political instability as a result of climate impacts. In addition, current models factor in economic damages over time but treat rate of growth exogenously. Yet, there is some evidence that climate losses may also undermine the rate of GDP growth.²⁰ As a result, this four percent estimate could understate the potential economic impact on global GDP.

The uncertainty of economic loss projections is compounded when attempting to estimate the associated

¹⁸ IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 67.

¹⁹ Nordhaus, William, 2007. Dynamic Integrated Climate and Economy (DICE), as presented in the Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. Interagency Working Group on Social Cost of Carbon, United States Government.

²⁰ Burke, M., H. Solomon, and E. Miguel, 2015. Global Non-Linear Effect of Temperature on Economic Production. *Nature*. 527: 235-9.

potential for lost Federal revenue in the United States. For illustrative purposes only, assuming the underlying economic loss projection is accurate, that the United States incurs a share of global losses proportional to its current share of global GDP, and that Federal revenue as a share of U.S. GDP remains constant, lost revenue could be as high as 0.7 percent of U.S. GDP in 2100. Today, a loss of that magnitude would translate to \$120 billion in lost tax revenue. It should be noted that this example does not take into account the fact that a portion of the projected economic losses include non-market losses that may not directly translate into lost revenue.

The Need for Action

The exposure of the Federal budget to climate risks provides yet another call to action for policymakers. How we respond to one of the most significant long-term challenges that our country and our planet faces speaks volumes about our values. It speaks to who we are as policymakers—if we embrace the challenge of developing pragmatic solutions. It speaks to who we are as Americans—if we seize this moment and lead. It speaks to who we are as parents—if we take responsibility and leave our children a safer planet.

The President has set the United States on an ambitious course and provided leadership that helped secure a strong global agreement to tackle emissions and prepare our communities for the effects of climate change not only because he believes we have a moral obligation, but also because climate action is an economic and fiscal imperative. For this reason, the President's Budget invests in building a climate-smart economy, creating a 21st Century Clean Transportation System, doubling our clean energy research and development, implementing common sense standards for carbon pollution, partnering with communities to tackle climate risk, and continuing leadership in international efforts to cut carbon pollution and enhance climate change resilience.