

United States Senate

COMMITTEE ON THE BUDGET
WASHINGTON, DC 20510-6100
TELEPHONE: (202) 224-0642 FAX: (202) 224-4835

Friday, August 1, 2014

Dear Colleagues,

Climate change is real and its impacts pose serious threats to our country. We are already seeing some of the negative consequences of a warming planet, from more catastrophic hurricanes and super storms to more intense droughts and wildfires, all of which can have devastating consequences for families and communities. But this is not just an environmental issue. Climate change will also have serious ramifications for our economy and the federal budget, and failure to confront it will make it harder to meet our nation's long-term fiscal challenges. In Congress, we have an obligation to address the budgetary costs and economic risks brought on by climate change and live up to our responsibility to leave behind both a strong and stable fiscal foundation, as well as a safe and healthy environment, for our children and grandchildren.

While skeptics may argue that preparing for climate change will be too costly, failing to combat climate change will have far greater costs for our economy and our budget. The longer we wait, the bigger these challenges will be—and the effects are becoming clearer in certain areas of the budget.

This memo will focus on four ways climate change will directly worsen the fiscal outlook:

- Extreme weather. The federal government spent three times more on disaster relief in the past decade than it did in the previous decade. Left unabated, climate change will result in more frequent and more intense episodes of extreme weather, like the kind we saw during Hurricanes Katrina and Sandy. This will necessitate more federal dollars for disaster relief to help families and communities recover.
- Transportation and water infrastructure. The Department of Transportation today sends approximately \$22 billion a year to state and local governments just to help them keep their existing transportation infrastructure in good repair. But hotter temperatures and more frequent flooding will wash out roads and will put added stress on bridge supports and public transit systems, requiring substantial additional investment. Drinking water, as well as storm and wastewater infrastructure, will also need substantially more funding for upgrades and repairs as a result of heavier rains and altered weather patterns.
- National security. Military experts say that climate change will act as a catalyst for instability and conflict around the world, creating additional threats to our country and adding to the costs of protecting our nation's interests. In addition, U.S. military installations, such as naval ports and military bases, will need to undertake costly adaptation measures to cope with rising sea levels and other hazards posed by a changing climate. We have, in fact, already begun to see the first instances of climate-related damage to military installations, costing taxpayers millions of dollars for each new necessary repair.
- Agriculture. The federal government operates numerous programs and services that are tied tightly to the national and international agriculture market, including crop insurance and nutrition assistance programs. An uptick in temperature and heat waves will reduce annual yields of some

major crops and cause more livestock deaths, hurting farmers and agri-businesses, causing consumer food prices to rise and creating a ripple effect that will increase costs to U.S. taxpayers.

Using just these four examples together, climate change, if left unaddressed, will add tens and potentially hundreds of billions of dollars in fiscal costs over the next decade alone, with much larger costs in later decades. It is important to note, however, that this memo focuses on just a few of the economic and budgetary costs that come with climate change, and the costs identified here are largely unaccounted for in current budget projections. If we do not act to address climate change and its impacts, the budgetary and economic costs will continue to grow and will worsen our long-term fiscal outlook.

I hope this information is helpful to you as we work toward addressing these challenges. By taking steps to confront climate change now, we can protect our environment, improve our fiscal outlook, and live up to our responsibility to future generations.

Sincerely,

A handwritten signature in blue ink that reads "Patty Murray". The signature is written in a cursive, flowing style.

Patty Murray
Chairman, Senate Budget Committee

MEMORANDUM**To: Senate Democrats****From: Senate Budget Committee Chairman Patty Murray****Re: The impact of climate change on the federal budget****Date: Friday, August 1, 2014**

The scientific consensus on climate change and the human activity that contributes to it is well established.¹ Unprecedented levels of heat-trapping emissions—primarily carbon dioxide—cause temperatures to climb, altering weather patterns, triggering a rise in sea levels, and creating the conditions for more frequent and intense extreme weather events. Scientists continue to conduct research into the wide-ranging projected effects of climate change, but it is clear that climate change will dramatically impact the health and wellbeing of families and communities across the country.²

A less-noted consequence of climate change, which also underscores the need to act, is its impact on the federal budget. Climate change, if left unaddressed, will both weaken economic growth and impose additional direct budgetary costs on the federal government. As a result, climate change poses an increasing threat to the federal government's already challenging long-term fiscal outlook.

I. Climate change will negatively impact the U.S. economy and therefore the federal budget

Our near-term budget outlook has improved, but climate change will darken the long-term fiscal picture

Over the last several years, the budget picture has improved significantly, especially in the near-and-medium term. In 2010, the most widely cited budget estimates projected that publicly held debt would reach 233 percent of gross domestic product (GDP) by 2040.³ Just recently, the Congressional Budget Office released new long-term projections in which publicly held debt in 2040 is now expected to be 108 percent of GDP.⁴ That represents undeniable improvement, but clearly, projected debt levels are still much too high. Fundamentally, despite recent progress, there remains a substantial structural gap between expected revenues and expected spending over the next several decades.

Climate change will exacerbate this long-term budget challenge by increasing demand for federal spending and decreasing the ability of the economy to generate federal revenues. The federal budget is exposed to the risks of climate change impacts in a variety of ways, and most of them are not adequately accounted for in current long-term budget projections. Current long-term budget projections rest on various assumptions about economic growth and federal spending that are mainly rooted in recent history. For instance, long-term projections of discretionary spending assume a continuation of the most recent year's levels of funding, updated only for inflation in the first 10 years and then GDP growth after that. These and similar assumptions, which rely heavily on past performance and trends, are unlikely to accurately capture the escalating impacts of climate change because its effects have only begun to be felt and are certain to become much worse over time. In the absence of a budget baseline that adequately accounts for the impacts of climate change or policies that explicitly limit climate change impacts, the effects of climate change will appear as additional costs to the federal budget.

¹ Intergovernmental Panel on Climate Change, Fifth Assessment Report, Working Group One, [2013](#).

² US Global Change Research Program, "US National Climate Assessment," [May 2014](#).

³ Congressional Budget Office, "The Long-Term Budget Outlook," [June 30, 2010](#).

⁴ Congressional Budget Office, "The 2014 Long-Term Budget Outlook," [July 15, 2014](#).

Climate change will impact our budget outlook by weakening the economy

One important, though indirect, way in which climate change will adversely impact the federal budget is through its overall negative impact on the U.S. economy. Without action, climate change will undoubtedly affect our country's ability to produce goods and services, costing jobs and weakening growth. These effects are already being felt due to events such as Hurricane Sandy—which was estimated to have caused \$65.7 billion in economic damage—as well as the massive droughts gripping parts of the country.⁵ Climate change will negatively affect the U.S. economy for decades to come. In fact, it is likely already hampering economic growth.⁶ And because the finances of the federal government are tied so tightly to the broader U.S. economy, the economic damage from climate change will quickly become fiscal damage.

A recent report from the Risky Business Project offers a thorough look at the ways the U.S. economy will be exposed to climate change impacts in both the short and long-term. It finds many troubling economic effects. For example:

- Agricultural yields will fall in current high-yield states, harming many farmers' incomes and the overall contribution of agriculture to Southern and Midwestern states' economic output.⁷
- Rising energy prices, stemming from increased demand as a result of climate change, will take nearly \$12 billion annually out of consumers' pockets and businesses' bottom lines for the next five to 25 years.⁸
- As temperatures across the U.S. rise, productivity in key economic sectors, such as construction, utilities, agriculture, and manufacturing, will likely decline as hazardous conditions outdoors prevent employees from working during the heat of the day.⁹

It is also important to note that the productive capacity of the United States is particularly vulnerable to dangerous weather, ocean storms, and rising seas. According to a report by the Organization for Economic Co-operation and Development (OECD), of the 10 highest asset exposure port cities worldwide, five are located in the United States.¹⁰ **In 2005, the overall value of the assets at risk because of sea level changes and hurricane damage—like the devastation as a result of Hurricane Sandy—in those five cities totaled nearly 9 percent of U.S. GDP.**¹¹

Over the long-term, the economic damage from climate change is likely to grow. Currently, one of the most trusted economic models projects that four degrees Celsius of warming will result in a worldwide economic reduction of about 3.5 percent of global GDP per year.¹² Other models produce estimates that can range significantly higher.¹³ In fact, the more recent the model—that is, models with more up-to-date data based on firmer scientific conclusions—the larger the estimate of global economic damage. A recent report from the White House Council of Economic Advisors predicts

⁵ National Oceanic and Atmospheric Administration, "Billion-Dollar Weather/Climate Disasters 1980-2013," accessed [July 28, 2014](#).

⁶ Risky Business Project, "American Climate Prospectus: Economic Risks in the United States," [June 2014](#); U.S. Global Change Research Program, "US National Climate Assessment," [May 2014](#).

⁷ Risky Business Project, "American Climate Prospectus: Economic Risks in the United States," [June 2014](#)

⁸ Risky Business Project, "The Economic Risks of Climate Change in the United States," [June 2014](#).

⁹ Risky Business Project, "The Economic Risks of Climate Change in the United States," [June 2014](#).

¹⁰ These are Miami, New York, New Orleans, Tampa-St Pete, and Virginia Beach.

¹¹ 8.71% of GDP in 2005. R.J. Nicholls, et.al. "Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes," OECD Environment Working Papers, [March 2008](#).

¹² Nordhaus, William and Paul Sztorc, "DICE 2013R: Introduction and User's Manual," [April 2013](#).

¹³ Tol, Richard, "Correction and Update: the Economic Effects of Climate Change," *Journal of Economic Perspectives*, 28(2), [Spring 2014](#).

that as economic impacts grow, the cost of addressing climate change will also rise, by approximately 40 percent each decade for each decade in which action is delayed.¹⁴

Recent economic research has also indicated that the scientific models and the corresponding estimates of economic damage might substantially underestimate the risk of global climate change.¹⁵ Some experts worry that climate damage could easily be double or triple what current models predict.¹⁶ In fact, the White House Council of Economic Advisors devotes an entire section of their report to a discussion of “catastrophic,” “severe,” and “irreversible” outcomes that are difficult to quantify because they are, so far at least, “outside the range of human experience.”¹⁷ Traditional models, for example, do not take into account “tipping points” in the climate system, points associated with irreversible physical changes in the Earth’s climate system that result in exponentially larger damages.¹⁸ In this sense, we are only beginning to measure the extent to which climate change will cause potentially enormous damage to the U.S. and global economy, and the value of avoiding those extremely high costs.

Looking ahead, we know that lower economic growth reduces the tax base and increases spending on safety net programs, compared to the baseline projections. The Congressional Budget Office estimates that even a small reduction in real GDP growth of just 0.1 percent per year would reduce revenue over the course of the 10-year window by \$272 billion, and add \$40 billion in additional spending.¹⁹ While climate change is unlikely to produce that level of economic drag within the next ten years, experts agree that the economic damage from climate change will grow substantially in future decades, just as the budget challenges become more intractable.

II. The impacts of climate change will be felt across programs in the federal budget

Beyond the underlying economic impacts of climate change, many specific areas of the federal budget will be directly and adversely affected if nothing is done to address climate change and its associated impacts. This memo focuses on four illustrative examples, in the areas of disaster relief, infrastructure, international security, and agriculture, to show how climate change will have direct and long-lasting fiscal ramifications.

It is important to note that the examples discussed below represent only a fraction of the ways in which climate change will interact with federal finances. Similarly, the scope of this memo does not include the full societal, economic and environmental costs of climate change. Instead it is intended to demonstrate the connection that exists and will grow between climate change and the federal bottom line.

¹⁴ White House Council of Economic Advisors, “The Cost of Delaying Action to Stem Climate Change,” [July 2014](#).

¹⁵ Stern, Nicholas, “The Structure of Economic Modeling of the Potential Impacts of Climate Change: Grafting Gross Underestimation of Risk onto Already Narrow Science Models,” *Journal of Economic Literature*, 51(3), [September 2013](#).

¹⁶ Tol, Richard, “Correction and Update: the Economic Effects of Climate Change,” *Journal of Economic Perspectives*, 28(2), [Spring 2014](#).

¹⁷ Council of Economic Advisers, “The Costs of Delaying Action to Stem Climate Change,” [July 2014](#).

¹⁸ Stern, Nicholas, “The Structure of Economic Modeling of the Potential Impacts of Climate Change: Grafting Gross Underestimation of Risk onto Already Narrow Science Models,” *Journal of Economic Literature*, 51(3), [September 2013](#). For more discussion of new modeling methods on this subject see Council of Economic Advisers, “The Costs of Delaying Action to Stem Climate Change,” [July 2014](#).

¹⁹ Congressional Budget Office, “The Budget and Economic Outlook: 2014 to 2024,” [February 2014](#).

NUMBERS TO KNOW:

*With climate change making weather disasters both more likely and more intense, the charge to the federal budget for disaster-related costs will also increase—**potentially to the tune of an additional \$97 billion over 2015-2024.***

*Without addressing climate change, maintaining our transportation infrastructure could cost the federal government **about \$23 billion more over the next ten years** compared to current funding levels.*

*The federal government **allocated more for international disaster relief over the past 8 years than it did during the entire preceding 31 years**, adjusted for inflation.*

*Fire suppression costs have **increased from roughly \$1 billion in the mid-1990s to an average of over \$3 billion**, in inflation-adjusted terms, in the past five years.*

***More than \$100 billion a year** in federal nutrition support programs and benefits is tied directly to food prices, which will rise with unabated climate change.*

Disaster relief

One of the most visceral ways that Americans will experience climate change is through the increasing frequency and severity of extreme weather and natural disasters. Unfortunately, as the impacts of climate change continue to increase, the nation will have to respond to even more of these disasters, putting an enormous burden on families, communities, and local governments, as well as on the federal budget. Indeed, the trend toward higher fiscal costs has already begun, with the U.S. government spending significantly more on disaster relief in recent years than it has in the past. This trend is likely to accelerate.

Impacts from extreme weather events like heat waves, droughts, heavy rainfall, floods, and hurricanes will inevitably ripple onto the federal budget balance sheet. The federal government provides a wide variety of services and relief in preparation for and in the wake of natural disasters, including equipment for first responders, emergency food and water, and temporary housing for those who have been displaced.

According to the most recent and complete assessments,²⁰ climate change is likely to have a broad array of impacts on extreme weather and natural disasters, including longer and hotter heat waves, more extensive and severe drought, and increases in the number and size of wildfires. While some parts of the United States will become hotter and drier, other parts, especially in the Northeast and Midwest, are expected to experience heavier rainfall, a trend that has already begun.²¹ With more frequent and intense downpours, many regions of the country will be hit with more floods as well, including flash floods.²² Additionally, the U.S. Global Change Research Program's Third National Climate Assessment concluded that hurricane intensity will likely increase due to climate change. This will result in more damaging winds, and combined with increases in sea level rise, more destructive storm surges. Similarly, some recent studies also suggest

²⁰ Intergovernmental Panel on Climate Change, Fifth Assessment Report, Working Group Two, "Climate Change 2014: Impacts, Adaption, and Vulnerability," [March 31, 2014](#); US Global Change Research Program, "US National Climate Assessment," [May 2014](#).

²¹ National Oceanic and Atmospheric Association, "Regional Climate Trends and Scenarios for the US National Climate Assessment: Part 1. Climate of the Northeast US," [January 2013](#); National Oceanic and Atmospheric Association, "Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 3. Climate of the Midwest U.S.," [January 2013](#).

²² US Global Change Research Program, "US National Climate Assessment," [May 2014](#).

that climate change is, “likely to increase severe thunderstorm occurrence, thereby increasing the risk of thunderstorm-related damage.”²³

In the past 10 years, the need for disaster relief services has risen dramatically, totaling nearly \$143 billion for federal disaster relief and related insurance payments.²⁴ Adjusting for inflation, disaster costs have averaged about \$15.9 billion a year in the past decade. Compare that to the 1990s, when disaster relief averaged \$4.1 billion a year, or the 1980s, when costs averaged just under \$1 billion a year.²⁵ Using a broader definition of disaster spending, the Center for American Progress found an even larger budget impact. Their 2013 review found that Congress provided more than \$136 billion in just the past three years alone.²⁶ These funds were used for a wide array of needs, ranging from rebuilding infrastructure, as discussed elsewhere in this memo, to providing temporary housing, food assistance, and emergency healthcare, among many other purposes.

CASE STUDY: Rising costs of wildfire suppression and response

*Warming temperatures allow for greater insect activity in forests, increasing tree mortality.²⁷ The combination of warmer, drier conditions as a result of climate change and forests heavily impacted by pests increases the frequency and severity of wildfires.²⁸ The Western U.S., in particular, faces longer wildfire seasons than it did in previous decades, with millions of acres of forest at risk each year.²⁹ According to a 2006 study, “since 1986, longer, warmer summers have resulted in a fourfold increase of major wildfires and a six-fold increase in the area of forest burned compared to the period from 1970 to 1986.”³⁰ The last decade has seen the six most destructive fires on record, even as our ability to fight fires has improved.³¹ As this trend continues, the U.S. Forest Service and U.S. Department of the Interior will face larger wildfire suppression and response costs. **Fire suppression costs have increased from roughly \$1 billion annually in the mid-1990s to an average of more than \$3 billion in the past five years.**³² These costs will continue to rise as Western forests experience more frequent and intense droughts as a result of climate change.³³ In addition to threatening lives and property, these fires will also negatively impact the economy through destruction of private property, grazing and farm lands, and negative impacts on outdoor recreation and tourism.*

²³ Diffenbaugh, Noah et.al. “Robust Increases in Severe Thunderstorm Environments in Response to Greenhouse Forcing.” Proceedings of the National Academy of Sciences, [August 2013](#).

²⁴ Office of Management and Budget, Supplemental Materials, “Public Budget Database: Budget Authority,” accessed [July 28, 2014](#). This calculation refers to total outlays in budget sub-function 453: Disaster Relief and Insurance, with FEMA state and local programs removed since this funding is anti-terrorism related, rather than natural disaster-related. For the fiscal year 2014 value, the Congressional Budget Office’s most recent estimate was used. In 2011, OMB issued a report on disaster relief that used a slightly narrower definition, accounting only for appropriations or authorizations that specifically referenced the Stafford Act. That report found a total of \$131 billion in budget authority from 2001-2010.

²⁵ Office of Management and Budget, Supplemental Materials, “Public Budget Database: Budget Authority,” accessed [July 28, 2014](#). This calculation refers to total outlays in budget sub-function 453: Disaster Relief and Insurance, with FEMA state and local programs removed because that funding is anti-terrorism related, rather than natural disaster-related. For the fiscal year 2014 value, the Congressional Budget Office’s most recent estimate was used. Figures in 2014 dollars.

²⁶ Center for American Progress, “Disastrous Spending: Federal Disaster-Relief Expenditures Rise amid More Extreme Weather,” [April 29, 2013](#).

²⁷ Washington State Department of Ecology, “Warmer Temperatures: More pests in forests and crops,” accessed [July 28, 2014](#).

²⁸ Westerling, A. L., et.al. “Warming and Earlier Spring Increase Western US Forest Wildfire Activity,” *Science*, 313(5789), [August 2006](#); United States Department of Agriculture Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Lab, “Wildfire and vegetation responses to climate changes,” [February 2011](#).

²⁹ Congressional Research Service, “Wildfire Management: Federal Funding and Related Statistics.” [June 2014](#); Union of Concerned Scientists, “Playing With Fire,” [July 2014](#).

³⁰ Science Magazine, “Is Global Warming Causing More, Larger Wildfires?” [August 2006](#).

³¹ National Interagency Fire Center, “Total Wildland Fires and Acres (1960-2009)” accessed [July 28, 2014](#). This calculation excludes 2014 because the data are not available yet. It therefore refers to 2004 to 2013.

³² Congressional Research Service, “Wildfire Management: Federal Funding and Related Statistics.” [June 2014](#).

³³ US Global Change Research Program, “US National Climate Assessment: Southwest,” [May 2014](#); US Global Change Research Program, “US National Climate Assessment: Northwest,” [May 2014](#).

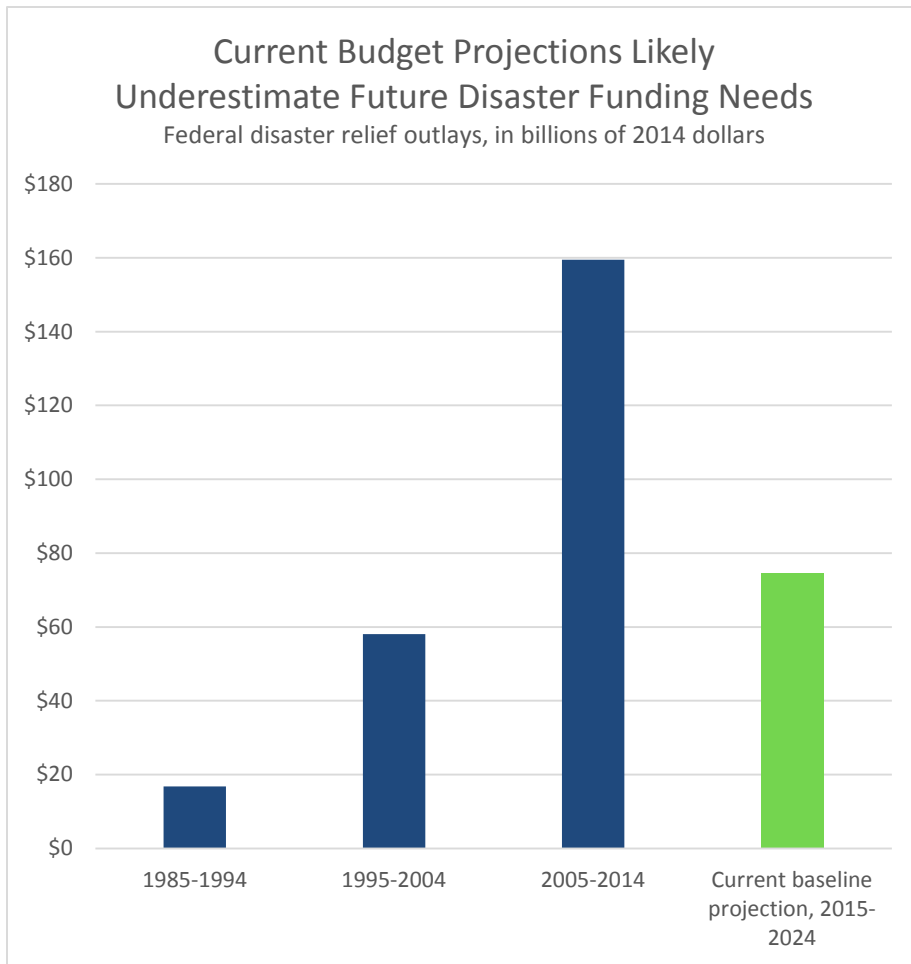
Unfortunately, both the scientific predictions and recent trends point toward more damaging and more expensive weather and climate related disasters in the future. The recent dramatic increase in average disaster costs reflects, in part, the fact that the United States has suffered several incredibly destructive and expensive disasters in the recent past. While no single extreme weather event can be attributed to climate change, recent disasters are part of a larger trend. In the last 10 years, after adjusting for inflation, the United States averaged about seven disasters that caused at least \$1 billion of damage each year, more than twice the rate of similar disasters from the previous 24 years.³⁴

When disaster strikes, the federal government frequently plays a critical role, often to the tune of billions of dollars. With climate change making weather disasters both more likely and more damaging, the exposure of the federal budget to disaster costs will also rise. These costs, by and large, are not captured in current budget baseline projections.

The most recent Congressional Budget Office projections of federal spending assume that inflation-adjusted disaster relief and related insurance payments will average about \$7.5 billion annually over the next ten years, less than half the annual average over the past 10 years. **If, instead, disaster relief costs are more similar to what they have been in recent years, that will add an additional \$97 billion to projected federal spending just over the course of 2015-2024.**³⁵

Transportation and water infrastructure

The federal government makes significant investments in the nation's transportation and water infrastructure, providing roughly one quarter of the more than \$400 billion in annual public funding, according to recent comprehensive data.³⁶



³⁴ National Oceanic and Atmospheric Administration, "Billion-Dollar Weather/Climate Disasters 1980-2013," accessed [July 28, 2014](#). This calculation excludes 2014 because the data are not available yet. It therefore refers to 2004 to 2013.

³⁵ If annual disaster relief spending averages \$15.9 billion, in inflation adjusted terms, from 2015-2024, that would equal a total of \$180.4 billion in nominal dollars over the ten year period. Current projections assume just \$84 billion in disaster spending over that period. Note that these numbers do not correspond directly to the numbers in the graph above, because these figures are nominal while the numbers in the graph are real.

³⁶ Congressional Budget Office, "Public Spending on Transportation and Water Infrastructure," [November 2010](#). This figure has been adjusted for inflation.

These critical investments are vulnerable to damage from a wide range of climate impacts, including extreme temperatures, precipitation, and storm surges.³⁷

In the transportation sector, heat waves and other extreme weather can cause rail lines to buckle, road surfaces to crack, and air travel delays. At temperatures topping 90 degrees, transportation infrastructure like rail lines and bridges can wear down more quickly and buckling can occur, requiring immediate repair.³⁸ Lower temperatures cause freezing and subsequent thawing, leading to potholes and creating additional need for weight restrictions on roadways.³⁹ Water-saturated soils from heavy rains and floods can threaten the structural integrity of roads, bridges, and tunnels, speeding up the aging process for systems that are often already in need of repair.⁴⁰ More precipitation falling as rain rather than snow can increase the risk of landslides and floods, resulting in additional needed road repairs and closures.⁴¹

Climate change also poses serious threats to our country's water infrastructure. Storm surges compromise sewers and storm-water overflow systems, threatening our water quality and drinking water systems. During Hurricane Sandy, for example, storm surges caused power outages and damaged important infrastructure, slowing or shutting down New York City's wastewater treatment plants and releasing over 1.3 billion gallons of improperly treated sewage, storm water, seawater, and wastewater into surrounding waterways.⁴² Powerful storms like Hurricane Katrina test the performance of levee systems and sea walls, leaving communities that depend on them vulnerable.⁴³ Flooding due to increased precipitation can adversely impact commercial waterways, slowing the transportation of products. Flooding also slows product transportation by increasing runoff, debris build-up, and sediment accumulation, all of which lead to shallower channels.⁴⁴ Harbors and shipping channels are sensitive to storm surges and floods, which can change sedimentation rates, altering waterway systems and disrupting port operations.⁴⁵

Conversely, increased drought from climate change reduces available water supply, impacting fisheries and outdoor recreation resources that are critical to local economies. Drought conditions also impact navigable waters like rivers and channels, reducing cargo capacity and ultimately passing on additional costs to consumers. For example, the Great Lakes are projected to experience drier conditions in coming years, prompting officials to study alternatives like limiting vessel size to accommodate lower lake water levels and, in turn, reducing cargo capacity to transport commodities like grains and other agricultural goods.⁴⁶

The Department of Transportation currently allocates about \$22.5 billion annually for transportation infrastructure maintenance and repair.⁴⁷ Typically, the federal share for transportation operation and maintenance costs represents

³⁷ Government Accountability Office, "Climate Change: Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers," [April 2013](#).

³⁸ US Department of Transportation, "Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study," [March 2011](#).

³⁹ Government Accountability Office, "Climate Change: Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers," [April 12, 2013](#).

⁴⁰ Government Accountability Office, "Climate Change: Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers," [April 12, 2013](#).

⁴¹ Government Accountability Office, "Climate Change: Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers," [April 12, 2013](#).

⁴² City of New York, PlanNYC, "A Stronger, More Resilient New York," [June 2013](#).

⁴³ Government Accountability Office, "Hurricane Protection: Statutory and Regulatory Framework for Levee Maintenance and Emergency Response for the Lake Pontchartrain Project," [December 15, 2005](#).

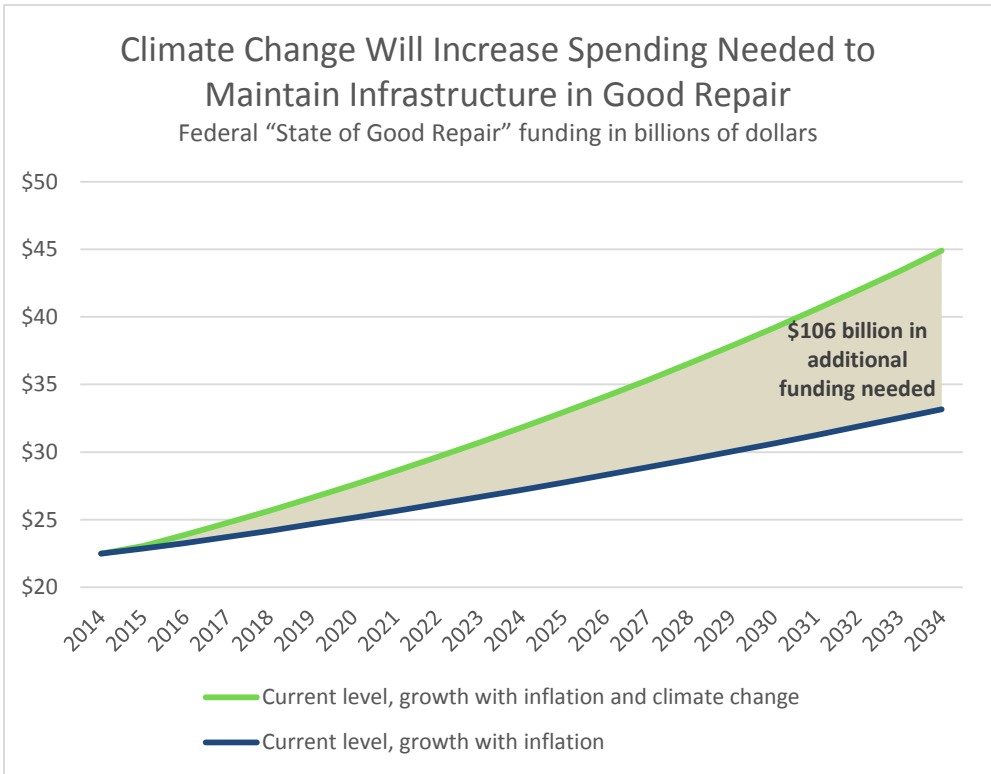
⁴⁴ Environmental Protection Agency, "Climate Impacts on Transportation," accessed [July 28, 2014](#).

⁴⁵ National Research Council of the National Academies, "Potential Impacts of Climate Change on US Transportation," [2008](#).

⁴⁶ National Research Council of the National Academies, "Potential Impacts of Climate Change on US Transportation," [2008](#).

⁴⁷ Department of Transportation, "FY2015 Budget Estimates," [March 2014](#). This calculation refers to fiscal year 2014 total limitation on obligations for the Department of Transportation's State of Good Repair program, which provides, "resources aimed at improving the condition and

about 14 percent of total public investment.⁴⁸ This suggests that state and local governments spend another roughly \$140 billion annually to keep their roads, rails, bridges, and airports in good repair.⁴⁹ As the effects of climate change



intensify, this level of investment—in total about \$160 billion each year—will cover a smaller and smaller portion of total infrastructure maintenance needs. A recent study, for example, found that the effects of a warming planet will raise infrastructure maintenance costs across the state of Alaska by nearly 20 percent through 2030, and even more if no measures are taken to adapt infrastructure to climate change.⁵⁰

If a similar infrastructure maintenance price premium were found to apply nationally, the additional costs to the public will be enormous. Over the next decade alone, the public—local, state, and federal governments—would have to spend

approximately \$165 billion more simply in order to achieve the same infrastructure condition as the current level of investment achieves. Over the next two decades, that added cost would amount to more than \$760 billion.⁵¹ Even if the climate premium were half as high, the added cost to the public would total approximately \$84 billion over ten years, and more than \$380 billion over twenty years.

If the federal share of infrastructure maintenance costs remains constant, **the federal price tag for climate-related maintenance would be as much as \$23 billion above current levels over the next ten years, and \$106 billion over the next two decades.**⁵² However, if the increasing price of maintaining and operating existing transportation infrastructure strains state and local budgets beyond their capacity to absorb their portion of the extra costs, local officials will likely

performance of the Nation’s transportation infrastructure.” Metrics used by the Department of Transportation to measure condition and performance include pavement conditions of national highways, percent of bridge deck area rated structurally deficient, airport runway pavement condition, and number of transit assets in need of replacement or refurbishment.

⁴⁸ Analysis by the staff of the Senate Budget Committee based on Congressional Budget Office, “Public Spending on Transportation and Water Infrastructure,” November 2010. This calculation excludes water supply and wastewater treatment, as well as water resources operation and maintenance.

⁴⁹ This calculation assumes that the \$22.5 billion in allocation for maintenance and repair from the Department of Transportation is a reasonable proxy for total federal investment in transportation infrastructure operation and maintenance.

⁵⁰ University of Alaska-Anchorage, Institute of Social and Economic Research, “Estimating Future Costs for Alaska Public Infrastructure At Risk from Climate Change” June 2007.

⁵¹ Analysis by the Senate Budget Committee staff based on University of Alaska-Anchorage, Institute of Social and Economic Research, “Estimating Future Costs for Alaska Public Infrastructure At Risk from Climate Change” June 2007 and assuming \$162 billion in total public infrastructure maintenance spending in 2014.

⁵² Analysis by the Senate Budget Committee staff assuming an average 13.9 percent share of total public infrastructure maintenance spending.

look to the federal government to make up the difference. Under that scenario, of course, the added costs of climate change to the federal budget would be even higher.

In addition to increasing annual maintenance costs, climate change will likely shorten the useful lifespan of all transportation and water infrastructure, increasing the need for new replacements.⁵³ The federal government spends roughly \$65 billion each year on capital investment in transportation and water infrastructure.⁵⁴ State and local governments, according to the most recent available data, contribute another \$120 billion each year.⁵⁵ The size and import of these investments means that slight increases in new construction costs to compensate for reductions in the life span of existing infrastructure will have significant budgetary implications. For example, each percentage point increase in public spending on new construction translates to about \$45 billion in added costs to federal, state, and local governments over the next twenty years.⁵⁶

CASE STUDY: *The budgetary implications of New York City's climate change vulnerabilities*

*On October 29, 2012, Hurricane Sandy arrived in the New York City area, causing an estimated \$19 billion in damage in the city alone. The "superstorm" cost lives, flooded 51 square miles, knocked out power for nearly two million people, disrupted over 70 percent of New York's water treatment facilities and flooded at least a dozen subway tunnels. These dramatic and tragic consequences prompted former Mayor Michael Bloomberg to call for a comprehensive study of New York City's vulnerabilities to climate change, and a plan to make the city more resilient. In the preface of the plan, released in June 2013, Mayor Bloomberg points out that as climate change proceeds, a storm similar to Sandy could, in 2050, cause more than four times the damage. In order to avoid incurring these costs, the city's resiliency plan includes dozens of specific proposals including measures to resurface roads, elevate traffic signals, protect tunnels from flooding, harden wastewater plants and pumping stations, and retrofit public housing units. In total, the plan would cost nearly \$20 billion over ten years, representing about 2.5 percent of New York City's total projected budget. Of that \$20 billion, New York City expects about \$8 billion to come from federal sources.*⁵⁷

Beyond increased wear and tear, shortened lifespans and higher maintenance costs, our transportation and water infrastructure will also suffer from the direct effects of extreme weather events. When this happens, for example, when a tunnel floods or a bridge collapses, communities often have no choice but to fund emergency repairs and replacements, often at a substantially higher cost than would have been required otherwise. After Hurricanes Katrina and Rita, for example, the federal government spent \$232 million to resume transit services⁵⁸ and \$2 billion to repair and rebuild transportation infrastructure in Louisiana and Mississippi.⁵⁹ After Hurricane Sandy, Congress appropriated more than \$13 billion to the Department of Transportation, of which over \$10 billion was directed to the Federal Transit

⁵³ Government Accountability Office, "Climate Change: Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers," [April 12, 2013](#).

⁵⁴ Congressional Budget Office, "Public Spending on Transportation and Water Infrastructure," [November 2010](#). This figure has been adjusted for inflation.

⁵⁵ Congressional Budget Office, "Public Spending on Transportation and Water Infrastructure," [November 2010](#). This figure has been adjusted for inflation.

⁵⁶ Analysis by the Senate Budget Committee staff based on University of Alaska-Anchorage, Institute of Social and Economic Research, "Estimating Future Costs for Alaska Public Infrastructure At Risk from Climate Change" [June 2007](#) and assuming \$185 billion in total public capital infrastructure spending in 2014.

⁵⁷ New York City, PlanNYC, "A Stronger, More Resilient New York," [June 11, 2013](#); New York City Office of Management and Budget, "Five Year Financial Plan Revenues and Expenditures," [June 2014](#).

⁵⁸ Government Accountability Office, "Emergency Transportation Relief: Agencies Could Improve Collaboration Begun during Hurricane Sandy Response," [May 2014](#).

⁵⁹ US State Department, "Hurricane Katrina: What Government Is Doing," [September 2006](#).

Administration, in part to address the estimated \$5.7 billion in damage to New York and New Jersey transit systems.⁶⁰ These costs were above and beyond what would normally have been needed for routine maintenance. As with the increased climate-related maintenance and repair costs, disaster-related rebuilding costs are not accounted for in current expectations of federal spending.

National security

Ensuring that our men and women in uniform have the resources they need to carry out their mission is critical to their success, and climate change will significantly alter the ways we train, equip, and deploy our forces.

To start with, climate change will seriously degrade critical defense infrastructure that the military relies upon for training and readiness.⁶¹ Coastal bases like Naval Station Norfolk in Virginia and Eglin Air Force Base in Florida are vulnerable to flooding or increased operations costs due to rising sea levels. Other facilities, like those in Hawaii, will be at elevated risk because of increasingly dangerous and frequent extreme weather.

In a May 2014 report, the Government Accountability Office (GAO) found that the Department of Defense is already seeing impacts and vulnerabilities on facilities and operations across the country due to climate change.⁶² For example, GAO found:

- At one early warning radar station, forty feet of shoreline has been lost as a result of erosion, which has also damaged half of the runway. As a result, larger aircraft that would normally be able to land are now unable to do so, limiting access to the station.
- A military installation in the southwestern United States experienced unusual torrential downpours in August 2013, resulting in \$64 million in damage to buildings, roads, a bridge, and fencing.
- Another facility's seawall and runway are under threat from rising seas and thawing permafrost, necessitating a \$25 million project to make upgrades.

In addition to degrading the quality of defense and security infrastructure, climate change also poses more risks that could also increase the frequency, scope, and intensity of military operations. The 2014 Quadrennial Defense Review identified the effects of climate change as "threat multipliers that will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions – conditions that can enable terrorist activity and other forms of violence."⁶³

⁶⁰ Government Accountability Office, "Emergency Transportation Relief: Agencies Could Improve Collaboration Begun during Hurricane Sandy Response," [May 2014](#).

⁶¹ Department of Defense, Strategic Environmental Research and Development Program, "Climate Change and Impacts of Sea Level Rise," accessed [July 28, 2014](#); Government Accountability Office, "Climate Change Adaption: DOD Can Improve Infrastructure Planning and Processes to Better Account for Potential Impacts," [May 2014](#).

⁶² Government Accountability Office, "Climate Change Adaption: DOD Can Improve Infrastructure Planning and Processes to Better Account for Potential Impacts," [May 2014](#).

⁶³ Department of Defense, "Quadrennial Defense Review: 2014," [March 4, 2014](#).

Senior Defense Officials Describe Impacts of Climate Change on National Security

“Because we know that climate change is taking place, we are assessing our coastal and desert installations to help ensure they will be resilient to its effects. Planning for climate change and smarter energy investments not only make us a stronger military, they have many additional benefits – saving us money, reducing demand, and helping protect the environment.” -- Chuck Hagel, Secretary of Defense⁶⁴

“The area of climate change has a dramatic impact on national security. Rising sea levels, severe droughts, the melting of the polar caps, the more frequent and devastating natural disasters all raise demand for humanitarian assistance and disaster relief.” -- Leon Panetta, former Secretary of Defense⁶⁵

“Climate change’s potential impacts are sobering and far-reaching... Scarcity of water, food and space could create not only a humanitarian crisis but create conditions that could lead to failed states, instability and, potentially, radicalization.” -- Admiral Mike Mullen, former Chairman of the Joint Chiefs of Staff⁶⁶

As natural disasters become more frequent and more damaging the United States, including our military, will be called upon to carry out more international relief efforts, as the United States did in response to Typhoon Haiyan, a storm that struck the Philippines and other Southeast Asian countries in November 2013. In the aftermath of Typhoon Haiyan, U.S. military and disaster relief personnel delivered food, water, medicine, and shelter to communities hit hardest by the storm at a cost of nearly \$32 million to the Department of Defense, and \$56 million in disaster assistance and food aid from USAID.⁶⁷ International disaster relief costs have already grown substantially over the past several decades. **In fact, the U.S. government allocated more for international disaster relief over the past 8 years than it did during the entire preceding 31 years.**⁶⁸ Of course, not all of the dramatic increase in international disaster assistance can be or should be attributed solely to climate change. It is, however, indicative of the much larger role that the United States now plays in responding to such events, and therefore the much larger fiscal exposure we have.

Critically, impacts in only one region or affecting only one element of our nation’s security apparatus will have subsequent ripple effects on many other regions and operations. All of these trends will impose additional costs to mitigate threats to U.S. interests, whether abroad or through increased need for disaster response and facility improvements at home. Current assumptions about future federal defense spending needs do not include these additional costs. Under the current budget caps, funding for the Department of Defense is essentially flat, which means that increasing costs from climate change will further strain limited resources, diverting monies away from other defense priorities.⁶⁹

⁶⁴ Remarks by Secretary of Defense Chuck Hagel at Halifax International Security Forum, [November 2013](#).

⁶⁵ Remarks by Secretary of Defense Leon Panetta, [May 2012](#).

⁶⁶ Remarks by Chairman of the Joint Chiefs of Staff, [March 2011](#).

⁶⁷ United States Agency for International Development, “Philippines – Typhoon Yolanda/Haiyan Fact Sheet,” [February 2014](#).

⁶⁸ Office of Management and Budget, Supplemental Materials, “Public Budget Database: Budget Authority,” accessed [July 9, 2014](#). This calculation refers to total budget authority in the USAID International Disaster Assistance account. Historical budget authority adjusted for inflation.

⁶⁹ Goodman, Sherri, Testimony before the U.S. Senate, Committee on the Budget, [July 2014](#).

Agriculture

In 2014, the federal government will spend approximately \$130 billion on nutrition assistance and programs related to agriculture.⁷⁰ These dollars are all tied, in one way or another, to the state of the national and international agriculture industry. Unfortunately, climate change has the potential to affect crops, livestock, soil, water, invasive species, weeds, and other pests. Although crops and livestock are grown and raised throughout the U.S. in varying climates, weather and climate characteristics like temperature, precipitation, and water availability directly affect the health and productivity of the agriculture sector,⁷¹ a key economic engine supporting more than 2 million farms and producing more than \$300 billion in gross farm income per year.⁷² Increases in extreme weather events, like dry spells, sustained drought, heat waves, intense rains, and severe storms, along with rising average temperatures and higher rates of ocean acidification will mean less consistent crop yields, increases in livestock deaths, changes in production quality, increases in invasive species, changes in weed and pest controls, increases in soil erosion, and declines in seafood production.

The effects of climate change on agricultural production will vary significantly by region because crops have different needs in terms of the necessary temperatures for their ideal lifecycle development. While warmer temperatures may make some crops grow faster, for many crops, warmer temperatures can disrupt growing patterns. In many parts of the country, crop choices, varieties, and production methods have been optimized to match the regional climate.⁷³

Without significant adaptation efforts, continued warming will diminish yields. For some of the most economically important crops to the agriculture sector, such as corn, soy, and cotton, projected temperature increases will reduce yields by 2020, with declines from 30 to 82 percent by 2099.⁷⁴ For this reason, without adaptation, overall yields of major crops in North America are projected to decline by mid-century and precipitously so by 2100.⁷⁵ At the same time, many weeds are expected to fare better under warming temperatures,⁷⁶ which will create further difficulties for farmers.

Adapting to a changing climate will also have significant costs. Production costs for farmers will likely rise as farmers are forced to take up new kinds of crops, adopt new planting and harvesting techniques, and purchase new equipment suited to each type of crop during the transitions. Livestock producers will face similar challenges, as suitable ranges for grazing shift and yields of feed crops decline. Furthermore, beyond the adaptations farmers will be forced to make, the increase in extreme weather events will further compound the economic risks associated with farming and ranching, requiring producers to make other changes to their operations to ensure financial security.

⁷⁰ This calculation refers to the projected outlays in budget sub-function 605 and budget function 350.

⁷¹ Department of Agriculture, Agricultural Research Service, Climate Change Program Office, "Climate Change and Agriculture in the United States: Effects and Adaptations," February 2013.

⁷² Department of Agriculture, Agricultural Research Service, Climate Change Program Office, "Climate Change and Agriculture in the United States: Effects and Adaptations," February 2013.

⁷³ Intergovernmental Panel on Climate Change, Fifth Assessment Report, Working Group Two, "Climate Change 2014: Impacts, Adaption, and Vulnerability, Chapter 26. North America," March 31, 2014.

⁷⁴ Intergovernmental Panel on Climate Change, Fifth Assessment Report, Working Group Two, "Climate Change 2014: Impacts, Adaption, and Vulnerability, Chapter 26. North America," March 31, 2014.

⁷⁵ Intergovernmental Panel on Climate Change, Fifth Assessment Report, Working Group Two, "Climate Change 2014: Impacts, Adaption, and Vulnerability, Chapter 26. North America," March 31, 2014.

⁷⁶ US Global Change Research Program, "US National Climate Assessment: Agriculture," May 2014.

CASE STUDY: Adaptation costs for the California drought

The recent drought in California is the state's third worst in recorded history, with water flows down by nearly one-third. Farmers have, however, been able to make up for most of this water shortfall through additional pumping of groundwater, and have limited the revenue losses from the drought to about 3 percent of California's total agricultural economy. Accessing that water, however, comes with additional costs. According to a new report by the University of California at Davis, farmers have had to spend an additional \$500 million in associated pumping costs to obtain the water they need.⁷⁷ And over the long-term, there are significant questions about the sustainability of managing future droughts through groundwater resources. As the climate changes, groundwater recharge in California is projected to be less effective in wet years, reducing available groundwater during future periods of drought.

This combination – more extreme weather incidents like heat waves, droughts, storms, and flooding, along with increases in agriculture commodity prices – will likely cause the costs of federal crop insurance to increase.⁷⁸ Federal crop insurance is designed to be actuarially sound, meaning that if the frequency and severity of crop losses increase over time because of increased extreme weather events, insurance premiums will increase over time as well. This will not only mean higher premium costs for farmers and ranchers, but will also increase costs for the federal government, which partially subsidizes premiums to make them more affordable.

Increases in food costs will also raise the cost of federal nutrition support programs per person participating. For example, in testimony before the Senate Budget Committee, it was noted that prices for fresh fruit and eggs are increasing at a rate roughly twice that seen over the last two decades, partly as a consequence of extreme weather.⁷⁹ Effects like these illustrate how climate change is expected to significantly impact global food commodity production and prices, with some estimates predicting increases in commodity prices by up to 84 percent by 2050.⁸⁰

This year, the federal government will spend about \$106 billion on benefits and reimbursements through federal nutrition programs, such as the Supplemental Nutrition Assistance Program (SNAP) and school meals programs.⁸¹ The benefits for most of these programs are adjusted each year based on food inflation. Therefore, even small increases in food inflation above what is currently expected will mean higher costs to the federal budget.

To be clear, these added costs stem from the fact that it will be more expensive to deliver the same benefit to the same number of beneficiaries. For example, currently, the Congressional Budget Office expects monthly SNAP enrollment to average 33.6 million people in 2024—down from 46.8 million in 2014—and the monthly benefit, which is tied to the price of the “Thrifty Food Plan,” to average \$156.08 per month. However, if food prices rise by just 1 percentage point more than expected over the next decade, that average benefit will have to be \$172.04 in order to buy the same amount of food. That \$16 difference translates into \$6.4 billion in additional costs in that year alone. Over a ten year period, the additional cost totals nearly \$36 billion.⁸² As with so many other costs identified above, these will grow substantially larger in later years.

⁷⁷ University of California-Davis, “Drought Impact Study: California Agriculture faces greatest water loss ever seen,” [July 15, 2014](#).

⁷⁸ Department of Agriculture, Agricultural Research Service, Climate Change Program Office, “Climate Change and Agriculture in the United States: Effects and Adaptations,” [February 2013](#).

⁷⁹ Lubber, Mindy, Testimony before the U.S. Senate, Committee on the Budget. [July 29, 2014](#).

⁸⁰ Intergovernmental Panel on Climate Change, Fifth Assessment Report, Working Group Two, “Climate Change 2014: Impacts, Adaption, and Vulnerability, Chapter 7. Food Security and Food Production Systems,” [March 31, 2014](#).

⁸¹ This calculation refers to the projected fiscal year 2014 outlays in budget function sub-605.

⁸² Based on the April 2014 Congressional Budget Office projections of the Supplemental Nutrition Assistance Program. These calculations do not include any changes to current assumptions about the number of SNAP beneficiaries and exclude payments to Puerto Rico and the American Samoa.

III. Solutions to our budget challenges must include action on climate change

This memo discusses four illustrative areas in which climate change will worsen our budget outlook. It shows that in terms of disaster relief, national security, infrastructure, and agriculture, climate change will increase costs to the federal government and worsen our long-term budget challenges. There are many other ways climate change will impact our budget outlook that were not discussed, such as its effects on health care costs and energy costs. Additional research on the ways in which climate change will impact a range of federal budget issues would be a valuable contribution to the discussion around adapting to and mitigating climate change.

Even without accounting for climate change, the United States already faces long-term fiscal challenges. A warming planet will only make solving those challenges more difficult. To truly tackle our long-term debt and deficits, the U.S. must do more than simply shift these costs from the federal government onto states, families, and communities. An important part of this effort will be developing policies that mitigate costs to the economy and the federal budget from climate change, by reducing carbon pollution as well as making the nation more resilient to climate change impacts.

Fortunately, there are many climate solutions that are both good for the economy and the federal budget. For example, improved fuel efficiency standards for light, medium, and heavy-duty vehicles will save trillions of dollars in fuel costs for consumers and reduce carbon pollution by over six billion tons.⁸³ Making federal buildings more energy efficient will save taxpayers billions of dollars in utility bills and operating costs while improving local air quality.⁸⁴ Switching to cleaner forms of electricity generation will reduce health care costs related to smog and soot pollution.⁸⁵ And public lands can be managed in ways that increase their recreational value while better serving as natural buffers to extreme weather. These and many other options should be explored to address climate change, improve the long-term budget outlook for the nation, and leave a stronger, healthier country and planet for coming generations.

⁸³ Environmental Protection Agency, "Regulations and Standards: Light-Duty," accessed [July 25, 2014](#).

⁸⁴ Department of Energy, Office of Energy Efficiency and Renewable Energy, "Awarded ESPC Projects," accessed [July 25, 2014](#). Department of Energy

⁸⁵ Trust for America's Health, "Saving Lives and Reducing Health Care Costs: How Clean Air Act Rules Benefit the Nation," [November 2011](#).