11. ANALYSIS OF FEDERAL CLIMATE FINANCIAL RISK EXPOSURE

I. EXECUTIVE SUMMARY[1]

Climate change impacts are being felt across the United States, including in the form of increasingly costly disasters and slower but notable changes in drought, heat, and precipitation. These changes pose financial risks to the services and programs of the Federal Government. As directed by the President in Executive Order 14030, "Climate-Related Financial Risk", the Office of Management and Budget is working with Federal Agencies to conduct assessments of the Government's climate financial risk exposure and is taking steps to reduce these risks to both the Government and the Nation. This chapter presents two detailed assessments of climate financial risk to agency programs, specifically the U.S. Department of Agriculture's (USDA) Livestock Forage Disaster Program; and the Department of Agriculture Forest Service (USDA FS) and U.S. Department of the Interior (DOI) wildland fire suppression programs. The chapter also includes additional agency highlights that demonstrate various approaches currently being employed to assess physical climate risk to agency programs, facilities, and services. This year's chapter on Federal climate financial risk notes:

- The USDA estimates that due to increased drought fueled by climate change, the Agency could see up to double the number of ranchers seeking assistance under the Livestock Forage Disaster Program by the end of the century compared to today. This corresponds to $800 million more per year in Federal expenditures, by the end of the century.
- The USDA FS and DOI estimate that climate-fueled wildland fires could burn an additional 3.2 million acres of federally owned forests—an increase of 86 percent compared to today—by the end of the century, increasing expected suppression costs to $4.7 billion per year—compared to an average of $3.4 billion currently. Federal Agencies are taking action to reduce these risks through a range of climate risk management programs and investments, and developing new decision support tools and analytical capabilities.
- Building on over $50 billion in historic climate resilience investment provided by the Infrastructure Investment and Jobs Act (Public Law 117-58) and the Inflation Reduction Act of 2022 (Public Law 117-169), this year's Budget also invests in the development of new analytical capabilities to characterize and manage the financial risks posed by climate change; responds to wildland fire assessment findings by bolstering the wildland fire workforce and expanding hazardous fuels reduction efforts; invests in flood hazard mapping; and continues funding for a range of Agencies' technical assistance programs that provide decision-relevant information to help communities, States, and Tribes manage their climate financial risks.

[1]The 2025 Climate Financial Risk *Analytical Perspectives* Chapter was authored by a collaborative team of Federal officials from the Assessments of Federal Financial Climate Risk Interagency Working Group. The Office of Management and Budget is deeply appreciative of the Interagency Working Group's contributions, including the following individuals who authored sections of the chapter: Lead Chapter Editors & Authors (Christopher Clavin (OMB), Bryan Parthum (EPA), Robert Richardson (OMB)); USDA Livestock Forage Disaster Program (Aaron Hronzencik (USDA ERS)); USDA Forest Service & DOI Wildland Fire Suppression (Jeffrey Prestemon (USDA FS Southern Research Station), Jeffrey Morisette (USDA FS Rocky Mountain Research Station), Erin Belval (USDA FS Rocky Mountain Research Station), Jennifer Costanza (USDA FS Southern Research Station), Shannon Kay (USDA FS Rocky Mountain Research Station), Karin Riley (USDA FS Rocky Mountain Research Station, Karen Short (USDA FS Rocky Mountain Research Station)); HUD Commercial Loan Climate Risk Assessment (Ian Feller (HUD), Elayne Weiss (HUD)); DOE Managing Climate Risk at DOE Sites (Craig Zamuda (DOE), Steve Bruno (DOE)); Exploratory Analyses on Federal Lending Portfolio of Single-Family Housing (Nathalie Herman (OMB), Michael Craig (HUD), MingChao Chen (GinnieMae), Alex Masri (USDA)); EPA Managing Physical Climate Risk at Superfund Sites (David Nicholas (EPA)); DOD Managing Climate Risks at DOD Sites (Kathleen White (DOD), Shubhra Mistra (DOD)); New Analytical Capabilities (Quentin Cummings (FEMA), Karen Marsh (FEMA), Casey Zuzak (FEMA), Jesse Rozelle (FEMA), Julian Reyes (OSTP/US Global Change Research Program), Stacy Aguilera-Peterson (OSTP/US Global Change Research Program))

II. INTRODUCTION

Climate change is already affecting people and communities across the United States, including through the effects of climate-related extreme weather events. Human activities are affecting climate system processes in ways that alter the intensity, frequency, and/or duration of many weather and climate extremes, including extreme heat, extreme precipitation and flooding, agricultural and hydrological drought, and wildfire.[2] The impacts of climate change to the Nation's economy, communities, and

[2] Leung, L.R., Terando, A. , Joseph, R., Tselioudis, G., Bruhwiler, L.M., Cook, B., Deser, C., Hall, A., Hamlington, B.D., Hoell, A., Hoffman, F.M., Klein, S., Naik, V., Pendergrass, A.G., Tebaldi, C., Ullrich, P.A., & Wehner, M.F. (2023). Ch. 3. Earth systems processes. In: *Fifth National Climate Assessment*. Crimmins, A. R., Avery, C. W., Easterling, D. R., Kunkel, K. E., Stewart, B. C., & Maycock, T. K., Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023.CH3*

households continue to be realized through a range of increased costs, from goods and services such as healthcare, food, and insurance, to the costs of repairing and recovering from extreme weather events and natural disasters.[3] These effects are felt across the Nation, with their collective impacts projected to reduce economic output and labor productivity across sectors and regions—particularly in places that have historical or cultural connections to, or dependence on, natural resources.[4]

Some communities are at higher risk of negative impacts from climate change due to social and economic inequities caused by environmental injustice and ongoing systemic discrimination, exclusion, underinvestment, and disinvestment. Many such communities are also already overburdened by the cumulative effects of adverse environmental, health, economic, or social conditions. Climate change worsens these long-standing inequities, contributing to persistent disparities in the resources needed to prepare for, respond to, and recover from climate impacts.[5] Not only are the risks and impacts of climate change disproportionately concentrated in low-income communities and communities of color, as well as in Tribal Nations, but these communities also often face a steeper road to recovery when disaster strikes.[6]

Further, the frequency of intense extreme weather events with significant financial impacts has increased. Forty years ago, the United States experienced, on average, one billion-dollar disaster every four months, adjusting to 2022 dollars.[7] Today, the Nation experiences a billion-dollar disaster every three weeks.[8] Weather-related disasters currently result in at least $150 billion per year in average direct damages, and the frequency and intensity of such disasters are expected to increase in the near term.[9] Each of these extreme events typically causes direct economic losses through damages to homes, buildings, and infrastructure; disruptions in services; and impacts to social and health-related outcomes that often exacerbate existing inequities.[10] These effects are expected to increase costs to public programs, including those provided by the Federal Government, posing additional challenges to public budgets that fail to account for the risks posed by climate change.[11,12]

Notable Federal Climate Risk Reduction and Resilience Action Since the Publication of the 2024 Budget

Action is being taken across governments, sectors, and regions to identify, assess, and mitigate the risks that climate change poses to operations, assets, and the economy. In the past year alone, the Federal Government has made great strides in understanding the economic risks climate effects are already having—and will have—on the Nation's infrastructure, social safety nets, public health, national security, and the ability to prepare for and respond to the impacts of natural disasters to protect American lives and livelihoods. Under the Infrastructure Investment and Jobs Act (Public Law 117-58) (IIJA) and the Inflation Reduction Act of 2022 (Public Law 117-169) (IRA), the Administration has invested over $50 billion to help communities advance climate resilience, increase the resilience of the grid and critical infrastructure, reduce flood risk to communities across the Nation, and invest in conservation to advance resilience. Further, since the publication of last year's *Analytical Perspectives*, the Administration has continued to take a whole-of-Government approach to make historic investments that increase the Nation's resilience to climate change impacts. Notable highlights include the following:

In September 2023, the Administration published the first-ever *National Climate Resilience Framework*, which provides a vision for climate resilience across the Nation and identifies opportunities for action to reduce climate risk across sectors. Consistent with Executive Order 14030 and this report, the National Climate Resilience *Framework* recognizes the need for continued research and development of modeling capabilities to integrate projections of climate change using models of changes

[3] Hsiang, S., Greenhill, S., Martinich, J., Grasso, M., Schuster, R. M., Barrage, L., Diaz, D. B., Hong, H., Kousky, C., Phan, T., Sarofim, M. C., Schlenker, W., Simon, B., & Sneeringer, S. E. (2023). Ch. 19. Economics. In: Fifth National Climate Assessment. Crimmins, A. R., Avery, C. W., Easterling, D. R., Kunkel, K. E., Stewart, B. C., & Maycock, T. K., Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023.CH19*

[4] *Ibid.*

[5] Jay, A.K., Crimmins, A.R., Avery, C.W., Dahl, T.A., Dodder, R.S., Hamlington, B.D., Lustig, A., Marvel, K., Méndez-Lazaro, P.A., Osler, M.S., Terando, A., Weeks, E.S., & Zycherman, A. (2023). Ch. 1. Overview: Understanding risks, impacts, and responses. In: *Fifth National Climate Assessment*. Crimmins, A. R., Avery, C. W., Easterling, D. R., Kunkel, K. E., Stewart, B. C., & Maycock, T. K., Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023.CH1*

[6] National Climate Resilience Framework. (2023). The White House, Washington, DC, USA. *https://www.whitehouse.gov/wp-content/uploads/2023/09/National-Climate-Resilience-Framework-FINAL.pdf*

[7] Marvel, K., Su, W., Delgado, R., Aarons, S., Chatterjee, A., Garcia, M. E., Hausfather, Z., Hayhoe, K., Hence, D. A., Jewett, E. B., Robel, A., Singh, D., Tripati, A., & Vose, R. S. (2023). Ch. 2. Climate trends. In: *Fifth National Climate Assessment*. Crimmins, A. R., Avery, C. W., Easterling, D. R., Kunkel, K. E., Stewart, B. C., & Maycock, T. K., Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023.CH2*

[8] *Ibid.*

[9] Hsiang, S., Greenhill, S., Martinich, J., Grasso, M., Schuster, R. M., Barrage, L., Diaz, D. B., Hong, H., Kousky, C., Phan, T., Sarofim, M. C., Schlenker, W., Simon, B., & Sneeringer, S. E. (2023). Ch. 19. Economics. In: *Fifth National Climate Assessment*. Crimmins, A. R., Avery, C. W., Easterling, D. R., Kunkel, K. E., Stewart, B. C., & Maycock, T. K., Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023.CH19*

[10] Environmental Protection Agency. (2021). Climate Change and Social Vulnerability in the United States. *https://www.epa.gov/system/files/documents/2021-09/climate-vulnerability_september-2021_508.pdf*

[11] Dolan, F., Price, C.C., Lempert, R.J., Patel, K.V., Sytsma, T., Park, H.M., De Leon, F., Bond, C.A., Miro, M.E., & Lauland, A. (2023). The Budgetary Effects of Climate Change and Their Potential Influence on Legislation: Recommendations for a Model of the Federal Budget. Santa Monica, CA: RAND Corporation. *https://www.rand.org/pubs/research_reports/RRA2614-1.html*

[12] For the purposes of this chapter, "Analysis of Federal Climate Financial Risk Exposure,", "financial climate risk" refers to the budgetary risks borne by the Federal Government through the administration of programs and policies.

in land use, demographics, and the built environment, to support risk-informed decision making.

In June 2023, in response to Executive Order 14030, the U.S. Department of the Treasury's Federal Insurance Office released the *Insurance Supervision and Regulation of Climate-Related Risks* report that provides a comprehensive set of 20 recommendations to incorporate climate-related risks into insurance regulation and supervision. The report commends and encourages continued collaboration with the National Association of Insurance Commissioners and state insurance regulators for the nascent and growing efforts to incorporate climate-related risks in regulation and supervision.

In November 2023, the Office of Management and Budget (OMB) published Memorandum M-24-03, *Advancing Climate Resilience through Climate-Smart Infrastructure Investments and Implementation Guidance for the Disaster Resiliency Planning Act*. This memorandum recommends tangible steps Agencies can take to enhance the climate resilience of infrastructure that is being built in communities across the Nation, and as required by the Disaster Resiliency Planning Act, provides guidance to Federal Agencies on addressing the risks that natural hazards and climate change pose to the Federal Government's facilities.

The White House Council on Environmental Quality and OMB provided revised instructions to Principal Agencies[13] to incorporate a data-driven assessment of climate risk in all Agencies' Climate Adaptation Plans. These updated Climate Adaptation Plans, scheduled to be published in 2024, use a climate science-informed approach to plan and implement climate adaptation measures that safeguard Federal investments and manage risks due to the observed and expected changes in climate that are relevant to agency missions and programs.

Recent Costs of Climate-Related Disaster Impacts and Historic Investments to Continue Reducing National Climate Risk and Enhancing Resilience

In the last five years (2019-2023), there have been notable climate-related financial impacts to the Government due to disasters and preparing for disasters. For the built environment, notable impacts include:

- The Federal Emergency Management Agency (FEMA) obligated $97.8 billion from the Disaster Relief Fund between 2019 and 2023 for natural disasters;
- The U.S. Department of Housing and Urban Development (HUD)'s Community Development Block Grant Disaster Recovery program obligated $37.5 billion to support long-term housing, economic development, and infrastructure recovery needs; and
- The U.S. Army Corps of Engineers obligated $3.6 billion for its disaster response and recovery efforts.

This level of financial support needed to restore the built environment emphasizes the need for forward-looking designs that reduce physical climate risk and avoid locking in land use and infrastructure designs that are based on historical climate assumptions.[14] Policies like the Federal Flood Risk Management Standard and its implementation across the Government are essential tools to manage development and reduce the risk of future flood damages.[15]

Wildland fire management activities, including hazardous fuels treatments (e.g., prescribed fire) and suppression operations, are also important for disaster preparedness and response. The number, extent, and intensity of catastrophic wildfires has increased in recent decades, leading to significant economic damages. The economic burden of wildfires on the United States economy includes wildfire-induced damages and losses as well as the management costs to suppress and mitigate ignitions and fire spread. These trends are notable due to the following:

- The annualized burden of wildfires in the United States is estimated to be in the tens to hundreds of billions of dollars per year.[16,17] Federal expenditures on wildland fire management are substantial and they have increased steadily over the past three decades.
- More recently, between 2019 and 2023, USDA FS and DOI obligated over $16.5 billion toward suppression operations.
- These costs continue a trend where, since 1989, annual suppression costs have more than tripled in inflation-adjusted terms, which has been partly driven by climate change impacts.[18]

[13] Executive Order 14057, "Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability" 86 FR 70935 (December 13, 2021) defines Principal Agencies to include the Departments of State, the Treasury, Defense (including the United States Army Corps of Engineers), Justice, the Interior, Agriculture, Commerce, Labor, Health and Human Services, Housing and Urban Development, Transportation, Energy, Education, Veterans Affairs, and Homeland Security; the Environmental Protection Agency; the Small Business Administration; the Social Security Administration; the National Aeronautics and Space Administration; the Office of Personnel Management; the General Services Administration; and the National Archives and Records Administration.

[14] Chu, E.K., Fry, M.M., Chakraborty, J., Cheong, S.-M., Clavin, C., Coffman, M., Hondula, D.M., Hsu, D., Jennings, V.L., Keenan, J.M., Kosmal, A., Muñoz-Erickson, T.A., & Jelks, N.T.O. (2023). Ch. 12. Built environment, urban systems, and cities. In: *Fifth National Climate Assessment*. Crimmins, A. R., Avery, C. W., Easterling, D. R., Kunkel, K. E., Stewart, B. C., & Maycock, T. K., Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023.CH12*

[15] See recent Federal Flood Risk Management Standard proposed rules at FEMA and HUD.

[16] Thomas, D., Butry, D., Gilbert, S., Webb, D., & Fung, J. (2017). The costs and losses of wildfires: A literature review. NIST Special Publication 1215. Gaithersburg, MD: National Institute of Standards and Technology. *https://doi.org/10.6028/NIST.SP.1215*

[17] Wildland Fire Mitigation and Management Commission. (2023) ON FIRE: The Report of the Wildland Fire Mitigation and Management Commission. *https://www.usda.gov/sites/default/files/documents/wfmmc-final-report-09-2023.pdf*

[18] CBO. (2022) Wildfires. *https://www.cbo.gov/system/files/2022-06/57970-Wildfires.pdf*

Additional investment in wildland fire management and mitigation could help society avoid some of the large losses associated with catastrophic wildfire by reducing the intensity of and damage from future fires.[19]

While these programs represent only a select set of disaster assistance and recovery programs and activities, they highlight that climate-related extreme weather events have significant fiscal impacts that are expected to increase in future years unless continued action is taken to reduce exposure and manage Federal programs' vulnerability to expected changes in climate conditions.

Notable Climate Financial Risk Findings from the Fifth National Climate Assessment

The *Fifth National Climate Assessment* (NCA5)—the Nation's preeminent source of authoritative information on the risks, impacts, and responses to climate change—was published in November 2023. NCA5 documents observed and projected vulnerabilities, risks, and impacts associated with climate change across the United States and provides examples of response actions underway in many communities. NCA5 includes an economics chapter for the first time, in addition to analyses on a range of other societal and economic sectors and regional-focused analyses.

NCA5 finds that future changes in the climate are expected to impose substantial new costs to the United States economy and harm economic opportunities for most Americans, including through increased costs of healthcare, food, and insurance. Over the next few decades, climate change is projected to continue causing increased ecosystem disruptions, water stress, agricultural losses, and further disruptions to supply chains.[19,20] A rise in extreme heat is expected to lead to lost labor hours—particularly for workers of color, low-income individuals, and those without a high school diploma—with projected wages lost due to unsafe heat ranging from $19 billion to $46 billion annually by 2050.[21] In the long term, the Nation faces relocation costs and damages to property due to flooding, wildfires, drought, and other perils; disruptions to food systems from drought or extreme rain events; risks to loss of life or property from wildfires; substantial health costs that disproportionately hit the most marginalized or disadvantaged; and challenges for public budgets with programs that rely on historical climate assumptions for estimating revenues or outlays.

Specifically, with regard to economic impacts, NCA5 finds that, to date, direct economic impacts of climate change have already been observed. For example, weather-related disasters result in at least $150 billion in costs to the United States per year (in 2022 dollars) through effects such as infrastructure damage, worker injuries, and crop losses. Future impacts are expected to be more significant and apparent. These effects are estimated to be non-linear and subject to sudden increases and decreases resulting from both direct and complex interactions between climate hazards and economic sectors.[22] NCA5 provides *sample future economic impact estimates*, such as finding that GDP growth would be expected to be 0.13 percentage points lower per year per one degree of global temperature warming, and that by the end of the century, the aggregate effect of multisector impacts ranges from 0.1 percent GDP growth to 1.7 percent GDP loss for a low emissions scenario and 1.5 percent to 5.6 percent GDP loss for a high emissions scenario. For context, the so-called Great Recession of 2007-2009 was associated with a 4.3 percent GDP loss in the United States,[23] and it was unprecedented in the post-war era for its severity and duration.[24] These figures and the rest of the NCA5 findings underline that economic impacts of climate change are expected to vary by location and sector, and are projected to impact all levels of Government budgeting through changes in revenues, spending, and borrowing costs.

Chapter Scope

To improve the Federal Government's capabilities to assess and reduce the risk that climate change poses to the Government and the economy, the President signed Executive Order 14030, "Climate-Related Financial Risk" on May 20, 2021.[25] Section 6(b) of Executive Order 14030 directs "[t]he Director of OMB and the Chair of the Council of Economic Advisers, in consultation with the Director of the National Economic Council, the National Climate Advisor, and the heads of other Agencies as appropriate, [to] develop and publish annually, within the President's Budget, an assessment of the Federal Government's climate risk exposure." Additionally, Section 6(c) of the Executive Order directs "[t]he Director of OMB [to] improve the accounting of climate-related Federal ex-

[19] Hsiang, S., Greenhill, S., Martinich, J., Grasso, M., Schuster, R. M., Barrage, L., Diaz, D. B., Hong, H., Kousky, C., Phan, T., Sarofim, M. C., Schlenker, W., Simon, B., & Sneeringer, S. E. (2023). Ch. 19. Economics. In: *Fifth National Climate Assessment*. Crimmins, A. R., Avery, C. W., Easterling, D. R., Kunkel, K. E., Stewart, B. C., & Maycock, T. K., Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023.CH19*

[20] Kosmal, A., A.R. Crimmins, F.J. Dóñez, L.W. Fischer, J. Finzi Hart, D.L. Hoover, B.A. Scott, and L.I. Sperling, 2023: Focus on risks to supply chains. In: *Fifth National Climate Assessment*. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023.F4*

[21] Hayden, M. H., Schramm, P. J., Beard, C. B., Bell, J. E., Bernstein, A. S., Bieniek-Tobasco, A., Cooley, N., Diuk-Wasser, M., Dorsey, M. K., Ebi, K. L., Ernst, K. C., Gorris, M. E., Howe, P. D., Khan, A. S., Lefthand-Begay, C., Maldonado, J., Saha, S., Shafiei, F., Vaidyanathan, A., & Wilhelmi, O. V. (2023). Ch. 15. Human health. In: *Fifth National Climate Assessment*. Crimmins, A. R., Avery, C. W., Easterling, D. R., Kunkel, K. E., Stewart, B. C., & Maycock, T. K., Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023.CH15*

[22] Burke, M., S.M. Hsiang, & E. Miguel. (2015). Global non-linear effect of temperature on economic production. *Nature*, *527* (7577), 235–239. *https://doi.org/10.1038/nature15725*

[23] Rich, R. (2013). The Great Recession. Federal Reserve History. *https://www.federalreservehistory.org/essays/great-recession-of-200709*

[24] Schanzenbach, D. W., Nunn, R., Bauer, L., Boddy, D., & Nantz, G. (2016). Nine facts about the Great Recession and tools for fighting the next downturn. The Hamilton Project, The Brookings Institution. *https://www.brookings.edu/wp-content/uploads/2016/07/fiscal_facts.pdf*

[25] Executive Order 14030, "Climate-Related Financial Risk", 86 FR 27967 (May 20, 2021). *https://www.federalregister.gov/documents/2021/05/25/2021-11168/climate-related-financial-risk*

penditures, where appropriate, and reduce the Federal Government's long-term fiscal exposure to climate-related financial risk through formulation of the President's Budget and oversight of budget execution." Building on the assessments of climate-related financial risk published in the *2023* and *2024* Budgets, this chapter meets the requirements of Executive Order 14030 Sections 6(b) and (c) for 2025.[26]

For 2025, this chapter presents a wide range of Federal agency climate risk assessments and management approaches prepared by the Assessments of Federal Financial Climate Risk Interagency Working Group. It is intended to provide a demonstration of the various approaches currently being employed to assess physical climate risk to agency programs, facilities, and services, including two analyses that provide detailed projections of quantified financial risks to agency programs. These qualitative and quantitative assessments are organized into five themes: 1) disaster preparedness and response, 2) risks to long-term infrastructure, 3) social safety net and human health, 4) national security, and 5) highlights of new climate risk assessment capabilities and decision support tools, including those recently published alongside the *Fifth National Climate Assessment*. This year's assessment does not address risks to Government revenues and does not address risks posed by transitioning the economy to clean energy sources (i.e., transition risk). Further, this chapter is not intended to provide a comprehensive whole-of-Government assessment of physical or transition risks of climate change.

[26] The analyses presented in this chapter are complementary to the climate-related projections for gross domestic product (GDP) and the debt based on long-term budget projections that are published in Chapter 3, "Long-Term Budget Outlook". Chapter 3 meets the requirements of Section 6(a) of Executive Order 14030, which states that "[t]he Director of OMB, in consultation with the Secretary of the Treasury, the Chair of the Council of Economic Advisers, the Director of the National Economic Council, and the National Climate Advisor, shall identify the primary sources of Federal climate-related financial risk exposure and develop methodologies to quantify climate risk within the economic assumptions and the long-term budget projections of the President's Budget."

III. FEDERAL ACTIONS TO IDENTIFY, ASSESS, AND REDUCE CLIMATE FINANCIAL RISK

Disaster Preparedness and Response

This section provides details on two risk assessments included in this chapter: 1) an overview of the climate financial risk associated with the U.S. Department of Agriculture (USDA)'s Livestock Forage Disaster Program, and 2) an update on projected wildland fire suppression costs due to climate change impacts on lands managed by the USDA Forest Service and the bureaus of the U.S. Department of the Interior (DOI).

U.S. Department of Agriculture: The Climate Financial Risk of the Livestock Forage Disaster Program

Climate change is already impacting many sectors of the United States economy.[27] The agricultural sector is particularly vulnerable to the impacts of climate change as crop yields, forage availability, and farm profits depend on evolving climatic conditions.[28,29] The Federal Government administers a variety of programs to support climate change resilience and climate risk mitigation within the agricultural sector.[30] Several of these programs, such as the USDA Farm Service Agency's (USDA-FSA) Livestock Forage Disaster Program (LFP), aim to compensate ranchers against drought risk. The LFP, and other Federal programs like it, constitute a financial climate risk for the Federal Government,[31] as projections of climate in the United States suggest that drought conditions are likely to become more frequent and intense for many regions in the future.[32,33,34,35]

The LFP was initially established by the 2008 Farm Bill and provides compensation to livestock producers

[27] Jay, A.K., Crimmins, A.R., Avery, C.W., Dahl, T.A., Dodder, R.S., Hamlington, B.D., Lustig, A., Marvel, K., Méndez-Lazaro, P.A., Osler, M.S., Terando, A., Weeks, E.S., & Zycherman, A. (2023). Ch. 1. Overview: Understanding risks, impacts, and responses. In: *Fifth National Climate Assessment*. Crimmins, A. R., Avery, C. W., Easterling, D. R., Kunkel, K. E., Stewart, B. C., & Maycock, T. K., Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023.CH1*

[28] Hsiang, S., R. Kopp, A. Jina, J. Rising, M. Delgado, S. Mohan, D. J. Rasmussen, R. Muir-Wood, P. Wilson, M. Oppenheimer, K. Larsen, & T. Houser. (2017). Estimating economic damage from climate change in the United States. *Science*, *356*, 6345, 1362-1369. *https://doi.org/10.1126/science.aal4369*

[29] Malikov, E., Miao, R., & Zhang, J. (2020). Distributional and temporal heterogeneity in the climate change effects on U.S. agriculture. *Journal of Environmental Economics and Management*, *104*, 102386. *https://doi.org/10.1016/j.jeem.2020.102386*

[30] Baldwin, K., Williams, B., Tsiboe, F., Effland, A., Turner, D., Pratt, B., Jones, J., Toossi, S., & Hodges, L. (2023). U.S. Agricultural Policy Review, 2021. USDA Economic Research Service, Economic Information Bulletin Number 254, February 2023. *https://doi.org/10.22004/ag.econ.333549*

[31] Hrozencik, R. A., Perez-Quesada, G., & Bocinsky, K. (2024). The stocking impact and financial-climate risk of the Livestock Forage Disaster Program (Report No. ERR-329). U.S. Department of Agriculture, Economic Research Service. *https://ers.usda.gov/publications/pub-details/?pubid=108371*

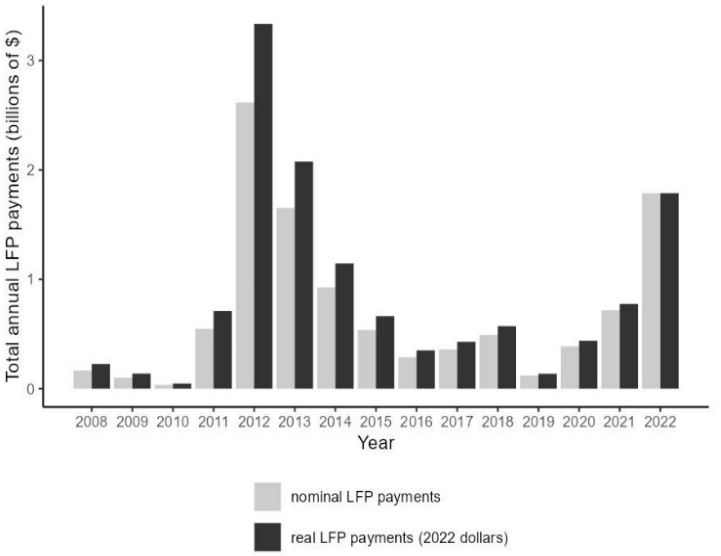
[32] Lehner, F., Coats, S., Stocker, T. F., Pendergrass, A. G., Sanderson, B. M., Raible, C. C., & Smerdon, J. E. (2017). Projected drought risk in 1.5 C and 2 C warmer climates. *Geophysical Research Letters*, *44*(14), 7419-7428. *https://doi.org/10.1002/2017GL074117*

[33] Leng, G., & Hall, J. (2019). Crop yield sensitivity of global major agricultural countries to droughts and the projected changes in the future. *Science of the Total Environment*, *654*, 811-821. *https://doi.org/10.1016/j.scitotenv.2018.10.434*

[34] Zhao, T., & Dai, A. (2017). Uncertainties in historical changes and future projections of drought. Part II: model-simulated historical and future drought changes. *Climatic Change*, *144*, 535-548. *https://doi.org/10.1007/s10584-016-1742-x*

[35] Climate change also poses financial risks for individuals and firms, these risks are not considered here.

Chart 11-1. Total Annual Nominal and Real LFP Payments, 2008-2022



Source: USDA, Economic Research Service using data provided by USDA-FSA. Note: nominal payments represent the value of the payment in the year provided, and real payments represented inflation-adjusted amounts in 2022 dollars.

experiencing losses in forage due to drought.[36,37] LFP payments cover feed costs for a variety of livestock species, ranging from beef cattle to reindeer, on a per-animal basis for eligible expected losses due to drought. USDA-FSA annually sets species-specific per-animal payment rates as well as county-level eligible grazing periods. LFP payment rates are set to reflect feed costs and generally aim to cover 60 percent of monthly per-animal feed expenditures. To be eligible for LFP payments, the county that a livestock producer operates within must experience drought conditions exceeding a specified threshold during the county's eligible grazing period.[38] County-level drought conditions are classified weekly by the U.S. Drought Monitor (USDM), which designates five levels of increasing drought severity ranging from D0: Abnormally Dry to D4: Exceptional Drought.

Chart 11-1 plots annual aggregate LFP payments, in nominal and real values, between 2008 and 2022, highlighting the potential financial climate risk posed by the program, especially during periods of severe drought. Specifically, LFP payments peaked to more than $3 billion (in 2022 dollars) in 2012, when many livestock production regions of the United States were affected by unprecedented levels of drought severity. Not only was this the first drought since 1988 that impacted almost the entire Corn Belt, it also was unique in how quickly it developed and intensified.[39] Financial climate risks are particularly pertinent to the LFP as eligibility and program payments are a function of drought severity. If projected increases in drought incidence and severity are realized, then the Federal Government's budgetary expenditures associated with the LFP may also increase substantially.

Modeling the financial climate risk of the LFP involves integrating projections of future drought conditions, under differing emissions scenarios, with historical data relating drought severity and duration to LFP payments. Recently, researchers have raised questions regarding classifications of drought in a changing climate, suggesting that classifications of drought based on long-term historical climate conditions, e.g., USDM's classifications,[40] may bias current and future drought assessments toward classifying a region as experiencing drought when more recent climatic data would suggest that a region is not experiencing drought compared to more recent dry or arid

[36] Livestock producers also face risks of losses from the impacts of wildfires. However, the LFP only indemnifies producers if the wildfire occurred on Federally managed grazing land.

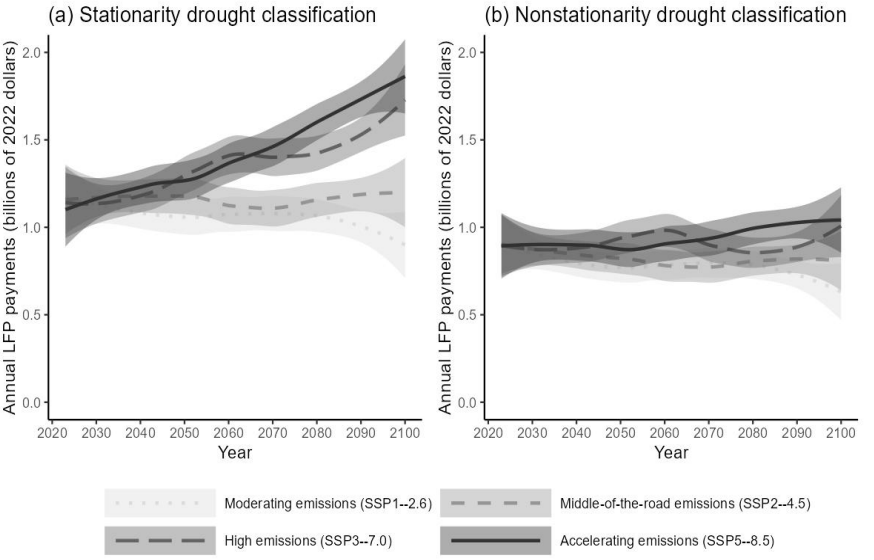
[37] MacLachlan, M., Ramos, S., Hungerford, A., & Edwards, S. (2018). *Federal Natural Disaster Assistance Programs for Livestock Producers, 2008-16* (No. 1476-2018-5471). *https://doi.org/10.22004/ag.econ.276251*

[38] Livestock producers become eligible for one month of LFP payments if the county where they operate experiences eight or more weeks of continuous severe drought (D2) during the eligible grazing period. Producers become eligible for additional months of LFP payments when experiencing more severe drought. For example, producers experiencing at least one week of exceptional drought (D4) during the eligible grazing period are eligible for four months of LFP payments.

[39] Fuchs, B., Umphlett, N., Timlin, M. S., Ryan, W., Doesken, N., Angel, J., Kellner, O., Hillaker, H. J., Knapp, M., Lin, X., Foster, S., Andresen, J., Pollyea, A., Spoden, G., Guinan, P., Akyüz, A., Rogers, J. C., Edwards, L. M., Todey, D., ... & Bergantino, T. (2012). From Too Much to Too Little: How the central US drought of 2012 evolved out of one of the most devastating floods on record in 2011. National Drought Mitigation Center, National Integrated Drought Information System. *https://drought.gov/documents/too-much-too-little-how-central-us-drought-2012-evolved-out-one-most-devastating-floods*

[40] It is important to note that the USDM was created to be a single measure to index drought conditions that impact many different sectors, not only agriculture.

Chart 11-2. Projected LFP Payments, 2023-2100



Source: USDA, Economic Research Service using data provided by USDA, Farm Service Agency, parameter estimates generated by econometric modeling and projections of future drought conditions across differing emissions scenarios and models.

conditions.[41,42] To address these drought classification issues, the LFP financial climate risk model uses medium- and long-term climatic data to construct alternative drought classifications. This analysis presents alternative drought classifications to represent their potential impact on LFP payments; however, neither this assessment nor its results take a position on broader considerations and consequences of modifying classifications of drought.

Chart 11-2 presents projections of future aggregate annual LFP payments and 95 percent confidence intervals through 2100 across a range of emissions scenarios and two methods for classifying drought. The left panel shows projected LFP expenditures under longer-term, historical climate data (60+ years) used to define drought classifications (stationarity drought classification). The right panel plots projected LFP expenditures for the case where drought classifications are instead based on decadally updated 30-year climate "normals" (non- stationarity drought classification). In each panel, average annual LFP expenditures are presented for four different climate scenarios, with 95 percent confidence intervals.[43]

Modeling results, presented in the left panel of Chart 11-2, suggest that under higher GHG emissions scenarios (high/SSP3-7.0 and accelerating/SSP5-8.5) and stationarity drought classification, annual Federal Government expenditures on the LFP may increase by more than 100 percent, or more than $800 million per year (in 2022 dollars), by the end of the century compared to average aggregate annual expenditures between 2014 and 2022 (in 2022 dollars). In the middle-of-the-road emissions scenarios (SSP2-4.5), model results indicate that Federal Government LFP expenditures may increase by 65 percent, or more than $400 million per year (in 2022 dollars), by the end of the century. These projected increases in LFP payments are relatively small compared to current Federal Government expenditures associated with the Federal Crop Insurance Program (FCIP). For example, average annual Federal Government expenditures for FCIP exceeded $8 billion over the 2011 to 2021 time period.[44] However, given that FCIP premium rates (before subsidies) are set to be actuarily fair, projected percent

[41] Hoylman, Z. H., Bocinsky, R. K., & Jencso, K. G. (2022). Drought assessment has been outpaced by climate change: empirical arguments for a paradigm shift. *Nature Communications*, 13, 1, 2715. *https://doi.org/10.1038/s41467-022-30316-5*

[42] Parker B., Lisonbee, J., Ossowski, E., Prendeville, H., Todey, D. (2023). Drought Assessment in a Changing Climate: Priority Actions & Research Needs. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of Oceanic and Atmospheric Research, National Integrated Drought Information System. NOAA Technical Report OAR CPO-002. *https://drought.gov/sites/default/files/2023-11/Drought-Assessment-Changing-Climate-Report-11-2023_0.pdf*

[43] These parameter estimates are then combined with projected future drought conditions in the United States, which distill future climate conditions into USDM classifications and months of LFP eligibility using eight different climate change models. For each climate change model, annual aggregate LFP payments are generated by multiplying econometric model parameters by the number of LFP eligible months projected by the model for each county and summing across counties. Annual results from each climate model are then aggregated and confidence intervals estimated using locally weighted (LOESS, locally weighted scatterplot smoothing) regression techniques. See Cleveland, W. S., & Devlin, S. J. (1988). Locally weighted regression: an approach to regression analysis by local fitting. Journal of the American Statistical Association, 83, 403, 596-610. *https://doi.org/10.1080/01621459.1988.10478639*

[44] GAO (Government Accountability Office). (2023). Farm Bill: Reducing Crop Insurance Costs Could Fund Other Priorities. GAO-23-106228. February 16, 2023. *https://gao.gov/products/gao-23-106228*

increases in FCIP expenditures under climate change are generally smaller than those predicted for the LFP.[45]

When drought classification methods update decadally to reflect changing climate patterns, the model results demonstrate that the financial climate risk of LFP diminishes (right panel of Chart 11-2). Specifically, in higher emissions scenarios (high/SSP3-7.0 and accelerating/SSP5-8.5), annual Federal Government expenditures related to LFP may increase by more than 25 percent, or approximately $200 million (in 2022 dollars), by the end of the century compared to average aggregate annual expenditures between 2014 and 2022 (in 2022 dollars). In the middle-of-the-road emissions scenario, the model results indicate that Federal Government LFP expenditures may increase by 14 percent, or approximately $200 million per year (in 2022 dollars), by the end of the century. Comparing projections of future LFP payments generated under stationary and non-stationary drought classification methods highlights the importance of drought classification methods in characterizing the climate financial risk of LFP. Specifically, if the methods used to classify drought do not adjust as the future climate changes (e.g., aridification), then LFP constitutes a potentially larger financial climate risk to the Federal Government's budget, particularly in higher emissions scenarios. However, using methods to classify drought for LFP eligibility that adapt to evolving climate patterns diminishes the financial climate risk of the LFP to the Federal Government, particularly in lower emissions scenarios.

The modeling results presented in Chart 11-2, both left and right panels, rely on several key assumptions. The most restrictive of these assumptions is that the United States livestock sector will not adapt to evolving climatic conditions by changing production practices or relocating production to regions less impacted by drought. This is a strong assumption given the possibility that producers may adapt to changing patterns of drought.[46] Any livestock sector adaptation to climate change and drought would decrease future financial climate risk of LFP. Additionally, modeling results do not incorporate potential changes in LFP payment rates through time that may be influenced by persistent and severe drought conditions. Specifically, USDA-FSA determines LFP payments rates based on forage and feed prices. If future drought conditions impact larger commodity markets (e.g., corn), and those goods' prices rise more than overall inflation, then LFP payment rates will increase to reflect higher costs of feed and forage. These LFP payment adjustments potentially increase the financial climate risk of the program as drought conditions would lead to larger Government expenditures to fund the program. Given the countervailing impacts of these two key modeling assumptions—and the many other avenues of uncertainty when projecting LFP payments into the future—the results presented in Chart 11-2 constitute neither an upper nor lower bound on future LFP payments.

U.S. Department of Agriculture Forest Service and U.S. Department of the Interior: Update on Projected Wildland Fire Suppression Costs due to Climate Change Impacts

Climate change is anticipated to raise land and ocean temperatures globally, change precipitation patterns, and drive changes in land use, including in the United States, and this change is likely to lead to shifts in the rate, severity, and extent of wildfire on Federal lands. Relevant to the Budget, such changes bring with them the expectation that spending to suppress wildfires and manage wildfire hazards, including emergency spending and spending necessary to rebuild or replace Federal infrastructure lost to wildfires, would generally change as the climate changes.[47] This report extends similar work done in 2016 and 2021-2022, with the 2021-2022 work published in the 2023 Budget. Similar to that work, USDA FS evaluates how changes to climate in the United States could lead to changes in annual spending to suppress wildfires on USDA FS and DOI managed lands by the middle and the end of the current century without holistic changes to the wildland fire mitigation and management. USDA FS builds on the previous analyses by refining the models to improve fit, updating data on wildfire suppression expenditures through 2019 (from 2005 for the USDA FS and 2013 for DOI), increasing the spatial resolution of the observations for suppression and wildfire, increasing the time span of historical wildfire to Fiscal Years 1993 through 2019, and expanding consideration of the potential drivers of wildfires. Similar to the 2023 Budget report, USDA FS developed statistical models of wildfire and its associated spending based on historical data on climate and wildfire.

In the current effort, USDA FS assembled an expanded set of climate projections by five global climate models (GCMs) and two warming scenarios (representative concentration pathway (RCP) 4.5 and RCP8.5) through 2099 for the continental United States (CONUS) at the 1/24th-degree grid scale.[48] This resulted in ten potential scenarios for both historical (1993-2019) and future (2020-2099) time periods.[49] Compared to the previous efforts, this effort refined spatial resolution of the resulting wildfire projections for USDA FS to the National Forest level

[45] Crane-Droesch, B. A., Marshall, E., Rosch, S., Riddle, A., Cooper, J., & Wallander, S. (2019). Climate change and agricultural risk management into the 21st century. *Economic Research Report-Economic Research Service, USDA*, (266). *https://ers.usda.gov/webdocs/publications/93547/err-266.pdf*

[46] Rojas-Downing, M. M., Nejadhashemi, A. P., Harrigan, T., & Woznicki, S. A. (2017). Climate change and livestock: Impacts, adaptation, and mitigation. *Climate Risk Management*, *16*, 145-163. *https://doi.org/10.1016/j.crm.2017.02.001*

[47] It is important to note that total costs from wildfires are much larger than Federal Government expenditures on preparedness and fire suppression.

[48] Area burned on FS lands in Alaska comprised less than 0.06 percent of historical wildfire for FS. Further, USDA FS lacked for this study monthly data on projected climate corresponding to the two national forests in the State, precluding projections of wildfire using climate data. Hence, in the current study, USDA FS does not model or consider FS spending in Alaska.

[49] See accompanying white paper for more details on the methods underlying this assessment.

Table 11–1. PROJECTED INCREASES IN AREA BURNED AND SUPPRESSION EXPENDITURES FOR FOREST SERVICE AND DEPARTMENT OF THE INTERIOR

Model	Time Period	Forest Service (FS)	Department of the Interior (DOI)	Combined (FS + DOI)
Area Burned	Mid-Century	98% [42%, 306%]	77% [43%, 163%]	86% [44%, 234%]
Area Burned	Late-Century	232% [29%, 2,488%]	171% [71%, 635%]	205% [73%, 1,399%]
Suppression Expenditures	Mid-Century	42% [20%, 84%]	31% [17%, 55%]	40% [19%, 81%]
Suppression Expenditures	Late-Century	81% [71%, 283%]	58% [26%, 173%]	76% [16%, 265%]

Detailed projections of increases in area burned and suppression spending, by USDA FS and DOI and combined, percentage changes from modeled historical area burned (2013-2019) and spending (2013-2019) for mid-century (2041-2059) and late century (2081-2099) projections. Lower (5th) and upper (95th) percentile bounds for a 90 percent uncertainty band are shown in brackets. Large upper tails are connected to the exponential functional form of area burned and to the wildfire outcomes generated from the climate predictions of the Hadley Centre Global Environment Model version 2 climate model (HadGEM2-ES365), which projects substantially hotter and drier conditions under both RCP 4.5 and 8.5 compared to the majority of the climate models included in this analysis.

(from the region level)[50], accounted for the negative feedback effect of historical wildfire on current period fire by introducing temporal lags to national forest wildfire models, and refined the DOI spatial resolution to the region by bureau level (from the region level Department-wide). Uncertainty in the area burned and suppression spending for each climate projection was quantified using Monte Carlo (bootstrapping) simulations, where the regression models used to project area burned and suppression costs are fit using a random sample of historical data for each iteration of the bootstrap. Overall uncertainty about climate was captured by projecting wildfires and suppression spending under the ten projections (5 GCMs x 2 RCP scenarios). The ten projections differed widely in their projected futures (by intention), with GCMs selected to capture a range of plausible futures in two climate dimensions: temperature and precipitation.[51] Additionally, this analysis identifies a single baseline for historical burned areas and suppression spending with which to compare future projections. The baseline is provided by modeled (or backcast) historical area burned and spending for 1999-2019. Future projections for 2020-2099 were then modeled for the area burned and suppression spending.[52]

Results show that the median area burned per year, across both USDA FS and DOI lands and across all climate projections, is projected to be 86 percent higher by mid-century (average from 2041-2059 projections) and 205 percent higher by late-century (average from 2081-2099 projections). Applying these percentage changes to historical area burned, area burned is projected to rise from the 2013-2019 average of 3.77 million acres per year to 7.02 million acres by mid-century and 11.49 million acres by late-century. Similarly, annual spending of both USDA FS and DOI are projected to rise. Compared to historical backcast spending (2013-2019) expenditures per year will rise by 40 percent by mid-century and 76 percent by late-century. Applying these percentage increases to observed historical spending, USDA FS projects that total Federal spending for USDA FS and the DOI will rise from a historical average of $3.35 billion per year (in 2022 dollars) to a projected $4.69 billion per year in mid-century and $5.9 billion per year by late century (see Table 11-1).

It bears emphasizing that this analysis only considers suppression expenditures by USDA FS and DOI, not additional wildfire-related damages in terms of losses to property, natural resources, human health, or other economic costs, nor suppression expenditures by other private and public entities. As such, the analysis covers a subset of all economic impacts generated by wildfire occurring on Federally managed lands in the CONUS. It is also important to note that not all wildfires need or receive management, and smaller or less intensive fires may result in more area burned but less suppression costs. Additionally, hazardous fuels were not directly modeled and, therefore, this analysis does not account for ongoing Federal efforts to address and mitigate associated risks. Even with these caveats, the models provide evidence that both wildfire areal extent and suppression expenditures are expected to increase with climate change. The modeling results show that increases in area burned could plausibly triple and inflation-adjusted suppression spending could nearly double, in this century.

[50] The lagged wildfire negative association included in the statistical models for the national forests cannot indicate whether a specific parcel within a national forest would be subject to reburning within a specific time span. However, the statistical result for the national forests implies that historical wildfire reduces current period wildfire, with implications for suppression spending.

[51] Langner, L. L., Joyce, L. A., Wear, D. N., Prestemon, J. P., Coulson, D., & O'Dea, C. B. (2020). Future scenarios: A technical document supporting the USDA Forest Service 2020 RPA Assessment. Gen. Tech. Rep. RMRS-GTR-412. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 34 p. *https://doi.org/10.2737/RMRS-GTR-412*

[52] Using backcast data allows for consistent projections of magnitude changes in wildfire and suppression spending, reducing the effects of the biases contained in the underlying global climate models with respect to wildfire and spending.

Risks to Long-Term Infrastructure

This section provides highlights of forthcoming analysis and Federal agency efforts to address climate risk to the Federal Government's investments in physical assets: 1) an overview of ongoing assessments by the U.S. Department of Housing and Urban Development's commercial loan portfolio, and 2) a widespread accounting of the U.S. Department of Energy assets and infrastructure in the face of climate change.

U.S. Department of Housing and Urban Development: Commercial Loan Climate Risk Assessment Plans for 2026+

HUD's Federal Housing Administration (FHA) insures single family and commercial portfolios of mortgages and seeks to proactively manage credit risk, including from current and future climate-related natural disasters. This includes managing the credit risk of FHA's multifamily and healthcare (collectively "commercial") loan portfolios, which, as of month end August 2023, had nearly 15,000 loans totaling $162 billion in unpaid principal balances (UPB).[53] To better understand the effect of climate change on the multifamily and healthcare loan portfolios, and quantify these values for the public, HUD is developing several budget impact analyses in 2024 to present in the 2026 budget. Climate change poses several risks to HUD's commercial portfolio; most notably, buildings with chronic damage from coastal or riverine flooding, or acute damage from physical natural disasters, may experience reduced market values. When these borrowers default, whether due to economic causes or physical disasters, HUD's recoveries on lender claims will be lower, increasing the costs of these loan programs. The analyses described below evaluate the degree to which FHA's commercial portfolios are at risk of climate-related impact and identify the dollar value of projected gains or losses.

HUD FHA's Office of Risk Management and Regulatory Affairs (Risk) regularly estimates the budgetary impacts of three commercial loan portfolios: 1) multifamily housing, 2) nursing home, assisted living, board and care, and 3) hospitals. For these calculations, Risk maintains financial models that forecast the probability of prepayment by the borrower, probability of insurance claim payment by FHA (due to borrower default), and probability of recovery on claimed loans/properties. These models allow Risk to produce reports for audits, budgets, portfolio management, and ad hoc policy analyses.

These models use a series of factors to forecast loan performance, including:

1. Loan characteristics (e.g., term, interest rates, etc.);
2. Borrower characteristics (e.g., default history, physical inspection score, etc.);
3. Borrower financial statements; and
4. Macroeconomic projections (e.g., vacancy rate, median household income, etc.).

These models undergo annual updates to incorporate the latest historical loan performance data and forecasted macroeconomic projections, as well as adjustments to the underlying methodology, if appropriate. These updates are evaluated and approved by HUD FHA's Model Risk Governance Board, overseen by OMB, and audited by HUD's Office of Inspector General. Given the maturity and independent oversight of these models, HUD will use them as the starting point for the planned climate analyses.

Notably, these models do not include the impact of natural hazard risk, such as whether the property would be covered by hazard insurance, or the effects of climate change on natural hazard risk. Therefore, HUD proposes three novel analyses to incorporate physical climate risk into its models:

- *Approach 1: Simplified natural disaster cost calculation:* incorporate physical natural disaster hazards into FHA's loan forecasting models and calculate the costs to FHA's commercial loan portfolios.
- *Approach 2: Historical loss data aggregation:* In tandem with Approach 1, HUD plans to attribute historical claims and losses to historical natural disasters, consistent with standard econometric modeling techniques.
- *Approach 3: Advanced forecast of budgetary impacts:* FHA plans to develop an advanced budgetary forecast by incorporating robust climate data regarding transitional, chronic, and catastrophic risks into its loan performance models. Specifically, HUD will obtain property-level climate risk data for the probability of natural disasters, such as hurricanes, floods, and wildfires; the Approach will incorporate time-varying macroeconomic forecasts on the transitional risks related to climate changes.

In Fiscal Year 2024, FHA is assessing the feasibility of these approaches for analyzing climate risks to its commercial loan portfolio. Results from one or more of these analyses are expected to be included in the Fiscal Year 2026 Budget chapter on climate-related financial risk.

U.S. Department of Energy: Managing Climate Risk at Department of Energy Sites

The U.S. Department of Energy (DOE) is committed to leading Federal efforts to manage the short- and long-term effects of climate change and extreme weather on its mission, policies, programs, and operations. In October 2021, DOE issued its *Climate Adaptation and Resilience Plan* (CARP) to meet the goals of Executive Order 14008: Tackling the Climate Crisis at Home and Abroad, and to make climate adaptation and resilience an essential element of the work DOE does.

The financial impact of climate change on DOE's sites has been significant. Since 2000, DOE sites reported 31

[53] These multifamily and healthcare Government loan programs are negative subsidy and self-funded. Therefore, they do not require or receive annual appropriations from Congress.

separate events each costing the Department over $1 million, with an aggregated cost of $518 million. Future damage costs are projected to increase without mitigation and adaptation. Facilities are vulnerable to a range of hazards, including extreme precipitation events, inland and coastal flooding, wildfires, and extreme temperatures. These major damages have impacted DOE's mission and affected a range of sites, facilities, and infrastructure. Climate hazards vary across the DOE locations. For example, from June to August 2011, a wildfire burned virtually unchecked in the Jemez Mountains near Los Alamos National Laboratory, and the fire's intensity and proximity to the Laboratory resulted in a nine-day closure for all non-essential personnel. The Las Conchas fire, the largest recorded wildfire in New Mexico history, burned 154,000 acres, including some Los Alamos National Laboratory land, and direct Laboratory damages were estimated at $15.7 million, not including lost productivity.[54] In September 2013, Los Alamos received 450 percent of historical average rainfall, leading to ground saturation. The unusually heavy precipitation event caused $17.4 million in damages to environmental restoration infrastructure, monitoring gages, roadways and storm water control structures on the National Laboratory property alone.[55] In February 2015, severe winter weather, including an historic ice storm, hit the Y-12 National Security Complex in Tennessee. The storm caused significant damage to the facility, resulting in costs totaling $13.6 million.[56] The storm was characterized by freezing rain and ice accumulation, which caused widespread power outages and damage to infrastructure. In August 2020, the West Hackberry site of the Strategic Petroleum Reserve in southern Louisiana suffered considerable damages from Hurricane Laura totaling $35 million. Other sites have suffered damages from severe winter weather events, flooding, and other hazards.

In response to the CARP requirements, DOE's sites developed *Vulnerability Assessment and Resilience Plans* (VARPs) in 2021 to understand their individual site risks and the resilience actions necessary to mitigate the projected impacts of climate change. In this process, sites identified critical assets, analyzed historic climate events and damages, projected future climate hazards and associated risks, and developed sets of resilience solutions that respond to the identified risks. The VARP methodology (described in further detail in the *white paper* accompanying this chapter), follows a nine-step process where a multidisciplinary planning team identifies critical assets and infrastructure that are integral to their site's mission, identifies regional climate hazards, and forecasts the projected impacts of these hazards on their critical assets and infrastructure.

DOE's recent advances that address site-based climate vulnerability assessments and implement VARPs, include:

- *Incorporating Climate Risks in VARP Methodology.* Climate risks are projected to vary on a regional basis.[57] For example, many sites in the Midwest are projected to experience increased drought and extreme weather, while the Northeast, Southeast, and Southern Great Plains sites are projected to experience increased heat waves and storm activity. The Northwest and Southwest sites may experience increased heat, extreme precipitation, and wildfire. Coastal facilities, particularly along the Gulf and East Coast, may experience a combination of more extreme storm events, such as hurricanes, along with sea level rise and storm surge. Based on historical events and climate projections, the DOE sites most at risk are located in the Northwest, Southwest, and Southeast.

Table 11–2. EXAMPLES OF RESILIENCE SOLUTIONS IDENTIFIED BY DOE SITES AND THE CLIMATE HAZARD(S) THEY ADDRESS

Resilience Solution	Climate Hazard Addressed
Implement advanced cooling for transformers, cooling centers for workers	Heatwave
Install microgrid/battery storage infrastructure	Drought, Wildfire
Bury aboveground power lines	Strong Wind
Controlled burns and vegetation management	Wildfire
Reduce water intensity of operations, recycle water	Drought
Install seawalls, floodwalls, levees, or wetlands restoration	Riverine and Coastal Flooding, Tsunami
Install onsite renewable electricity generation with backup battery storage	All hazards

[54] DOE. (2015). Climate Change and the Los Alamos National Laboratory: The Adaptation Challenge. PNNL-24097. Richland, Washington, Pacific Northwest National Laboratory. *https://pnnl.gov/main/publications/external/technical_reports/PNNL-24097.pdf*

[55] *Ibid*.

[56] National Oceanic and Atmospheric Administration, National Weather Service. (2015). February 20-21, 2015 Historic Ice Storm. Nashville, Tennessee Weather Forecast Office. *https://weather.gov/ohx/20150221*

[57] Current VARP methodology encourages the use of historical weather data and projections of climate impacts. The methodology encourages the use of RCP 4.5 and 8.5 emission scenarios, and for DOE sites to use the National Climate Assessment regional chapters as the basis for projections. Additional resources such as the U.S. Climate Resilience Toolkit, the Climate Explorer, and resources from Climate Impact Labs are referenced in the appendix of the VARP methodology.

- *Resilience Solution Identification and Implementation.* To address their projected vulnerabilities, DOE sites identified resilience solutions in their VARPs. To aid sites in this, DOE partnered with the National Oceanic and Atmospheric Administration (NOAA) to provide technical assistance and access to a climate adaptation strategies tool, which provided actions grouped by hazard and asset. The three most common solution categories were upgrades to heating, ventilation, and air conditioning systems (19 percent), operational/managerial improvements (19 percent), and energy and water improvements (16 percent). Examples of common DOE resilience solutions can be found in Table 11-2 along with the climate hazard they address.
- *Further Advancing DOE Site Resilience and Needed Capabilities.* DOE's resilience planning has taken a major step forward to increasing understanding of the risks to mission and operations, as well as site resilience planning. The resilience solutions currently identified are a significant step forward for DOE, as many site-specific hazards, vulnerabilities, solutions, and implementation plans had not been previously characterized. In 2024, DOE plans to prioritize sites' identification of comprehensive solution sets, including prioritized implementation plans. DOE will assess the need for additional technical tools, support, and the sharing of best practices. Just as important, however, is the need to identify or create new tools that enable sites to model the financial costs and benefits and return-on-investment of various solutions. Such tools would enable sites to monetize and prioritize investments, and to compare and contrast the costs and benefits of investing in different types of resilience solutions versus taking no action.

Social Safety Net and Human Health

This section provides an overview of analysis prepared in response to Executive Order 14030's requirements to address climate-related financial risk in Federal agency underwriting standards and loan terms of Federal lending programs, and highlights from the Environmental Protection Agency, Office of Land and Emergency Management's efforts to manage physical risks at Superfund sites.

Update on Exploratory Analyses on Federal Lending Portfolio of Single-Family Housing

Executive Order 14030, Section 5(c) directs the Secretary of Agriculture, the Secretary of Housing and Urban Development, and the Secretary of Veterans Affairs "to consider approaches to better integrate climate-related financial risk into underwriting standards, loan terms and conditions, and asset management and servicing procedures, as related to their Federal lending policies and programs." OMB accordingly established the 5(c) Task Force under the Federal Credit Policy Council, with HUD, USDA, and the U.S. Department of Veterans Affairs (VA) (lending Agencies) to conduct initial analyses and to create a replicable framework for assessing climate risk in Federal lending programs. Last year marked the first time that the Federal Government had undertaken the task of broadly examining how climate-related financial risks could impact Federal lending across multiple Agencies and evaluating the limitations of current tools used to calculate those risks.

The 5(c) Task Force had determined that the first step to considering new approaches for integrating climate-related financial risk in various lending programs is to understand the nature and extent of risks to the single-family guaranteed housing programs at each Federal Agency. These programs include:

- USDA's Rural Development (RD) Single-Family Housing Guaranteed Loan Program (SFHG);
- HUD FHA Single-Family Mortgage Insurance Program;
- HUD's Government National Mortgage Association (Ginnie Mae) Mortgage-Backed Security (MBS) guarantee program; and
- VA's Loan Guaranty program.

In 2021, Federal lending programs for single-family housing had a cumulative outstanding exposure of $2.1 trillion, and this exposure has increased to $2.3 trillion as of 2023.

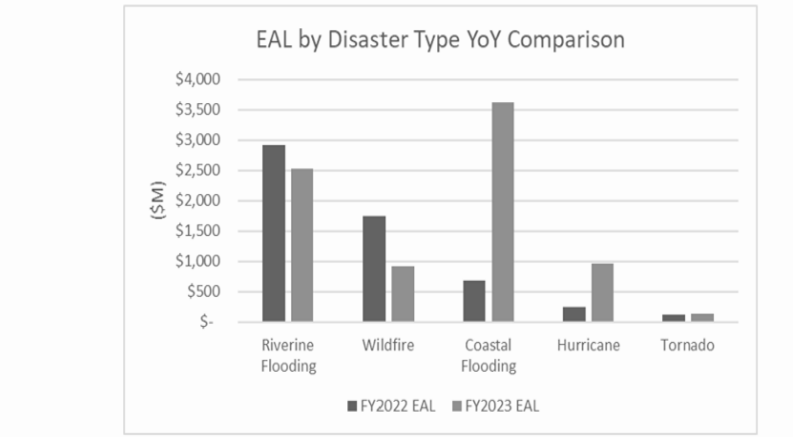
In order to gain a better understanding of the cost of climate change to the Federal lending portfolio, as well as the limitations of today's climate financial risk tools, OMB and the lending Agencies conducted three exploratory analyses to evaluate retrospective, current, and future climate risk.[58] It was concluded that the analysis was limited by today's climate financial risk models that failed to include a broad range of climate events. As a result, the risk is likely underestimated. Results do not represent official Government estimates of the projected losses. Instead, results were presented as illustrative test cases to highlight where further research is needed to address data gaps and methodologies and improve modeling.

It was determined that further analyses needed to be conducted, as other variables such as granularity and the inclusion of other climate events might better capture the severity of the risk. Consequently, this year, the Agencies continued to explore methodologies and refine analyses to better account for climate-related financial risks to the SFHG programs.

This year's analysis makes significant advances towards quantifying past losses to the Federal single family guarantee portfolio. Limitations still exist and should continue to be addressed in the next iteration of the ret-

[58] Retrospective climate risk refers to expected losses from past exposure using data originations from 2004-2017. Current risk analysis calculates expected annual loss (EAL) using data from the FEMA NRI database, as well as the Agencies' self-reported unpaid principal balance (UPB) estimates. Future climate risk is a 30-year lookout analysis that uses an industry standard tool to determine expected losses in the Agencies' mortgage portfolios that could occur given different scenarios of world events, economic trends, and climate change impacts.

Chart 11-3. Expected Annual Loss by Disaster Type, Year-Over-Year Comparison



rospective analysis. However, further analyses need to be conducted as more granularity, data availability, and refinements to the assumptions might well change the severity of expected losses.

Retrospective Risk

To examine past risk, the lending Agencies executed a more refined retrospective analysis. The Agencies elected to pilot a mortgage-level analysis developed by HUD. This analysis offers several critical methodological improvements compared to the previous report including the generation of a total cost estimation for the mortgage insurance portfolio. The analysis is based on a ten percent sample of internal FHA data containing originations from 2004 to 2017 and publicly available disaster data from FEMA's Open Data portal consisting of 320 total declared major disasters for that time period. The retrospective analysis demonstrated that mortgages with disaster exposure are 1.14 to 1.21 times more likely to end in claims during each of the first three years post-disaster compared to mortgages without disaster exposure. The claims costs simulations calculate a difference in expected claims of $1.2 billion attributable to major disasters for the studied period. This is approximately 1.5 percent of the $80 billion in total claims paid on the FHA portfolio over this same period. Unfortunately, data and resource limitations prohibited the same calculation for the USDA and VA portfolios; however, Agencies intend to work to gather data components for those portfolios in the next iteration. As discussed further below, since climate change is expected to increase the frequency and severity of wildfires as well as the intensity of hurricanes, this risk is likely to grow over time.

Current Risk

To examine current risk, the Agencies used last year's novel expected annual loss (EAL) calculation developed using portions of the FEMA National Risk Index (NRI) database, as well as their own self-reported UPB estimates. Compared with the Fiscal Year 2022 analysis, the Fiscal Year 2023 analysis includes three main changes: 1) the assessment is based on the outstanding Ginnie Mae guaranty portfolio as of March 2023, which has increased in total volume by 4.6 percent from last year's analysis with the composition of loans insured by FHA, VA, and RD remaining mostly unchanged; 2) the latest NRI release used includes additional historical data, census tract data, and a major methodology overhaul for its coastal flooding and Historical Loss Ratio models; and 3) the Agencies conducted a supplementary analysis of recent originations. Calculations for each Agency were tabulated for five select hazards: 1) hurricanes, 2) coastal flooding, 3) riverine flooding, 4) wildfires, and 5) tornadoes[59] (see Chart 11-3). This risk assessment determined that for the Ginnie Mae portfolio, which represents an amalgam of the three Agencies' portfolios, the total EAL from climate-related events amount for the combined portfolio increased from 0.27 percent to 0.38 percent of the total portfolios. Additionally, coastal flooding and riverine flooding emerged as the top two natural disaster risks to the Agencies with EAL for these two climate events, accounting for 74 percent to 77 percent of EALs (see Chart 11-3).

Compared to the historical portfolio, EAL for wildfire has increased in recent origination cohorts[60] (2018-2022), indicating a growing risk due to wildfires (see Table 11-3). EAL for wildfire as a share of total cohort EAL increased by 3.9% between 2018 and 2022, while the share for other disaster types decreased during that period. It is important to note that this analysis does not include the impact of natural disasters on issuer performance or the impact

[59] Tornados have a complex and subtle relation to climate change. Tornados, as part of severe convective storms, are highly localized event and observed after the event, as opposed to modeled, which makes it difficult to link directly or attribute to global climate trends. See National Academies of Sciences, Engineering, and Medicine. (2016). Attribution of Extreme Weather Events in the Context of Climate Change. Washington, DC: The National Academies Press. *https://doi.org/10.17226/21852*

[60] Cohort analysis is based on a calendar year.

Table 11–3. EXPECTED ANNUAL LOSS BY DISASTER TYPE
(As a percentage of total cohort)

Disaster Type	2018 Cohort	2019 Cohort	2020 Cohort	2021 Cohort	2022 Cohort	% Change from 2018 to 2022
Riverine Flooding	34.0%	33.3%	30.3%	29.3%	30.9%	–3.1%
Wildfire	8.8%	9.9%	11.6%	12.3%	12.7%	3.9%
Coastal Flooding	42.2%	42.1%	44.5%	45.4%	42.2%	–0.0%
Hurricane	13.1%	12.9%	12.0%	11.5%	12.6%	–0.5%
Tornado	1.9%	1.9%	1.6%	1.5%	1.7%	–0.2%
Total Cohort	100.0%	100.0%	100.0%	100.0%	100.0%	

of climate change on investors' appetite for the Ginnie Mae MBS program.

Future Risk

With regard to future risk, the Agencies conducted another prospective analysis of the impact of climate events to a simulated Federal housing portfolio over the next 30 years. For this analysis, the Agencies ran the portion of their overall portfolio backed by Ginnie Mae, which constitutes about 87 percent of the overall portfolios of the three Agencies, through an industry-standard proprietary model. This model projects the expected loss in the lending Agencies' mortgage portfolios that could occur for different scenarios of world events, economic trends, and some climate impacts. The most recent iteration of the model includes the addition of climate risk assumptions consistent with a range of scenarios, including those from Central Banks comprising the Network for Greening the Financial System. The Agencies used this model to estimate losses to each Agency under two assumptions of future economic conditions (a 50th percentile baseline scenario and a 96th percentile severe adverse scenario) and then compared losses in these scenarios with and without climate shocks occurring. Federal researchers found that the model showed little risk, which is not considered an official Government estimate of projected losses; this analysis is considered preliminary and partial due to limitations in the analytical methods available. For example:

- The projected climate shocks are based on the FEMA-designated natural disasters for riverine and coastal floods, hurricanes, typhoons, and tornadoes, rather than global climate modeling.[61] The magnitude of the impact of other natural disasters that are not accounted for in this model—such as wildfires and winter storm events—is unknown and warrants further analysis.
- The modeling is agnostic to the varying insurance structures by program, which guarantee different amounts of losses through claims to lenders/issuers, and ignores that insurance and Federal and state disaster relief are effectively shifting portfolio hazard risk onto State and Federal entities. The analysis was conducted at the state level due to data limitations.
- Each program has unique coverage and policy requirements, which may change the overall Federal Government exposure to the respective portfolios.

In the next phase of the 5(c) workstream, the Task Force will improve upon existing tools and methodologies, as well as determine new tools that are needed to identify, assess, and respond to the risk climate change poses to the portfolios. The Task Force is planning to engage NOAA and DOE National Laboratories climate modeling experts in tool design and development, leverage the latest in climate modeling capabilities, and engage stakeholders, including climate-related data and analytics providers, non-profit organizations, and academia.

To refine and expand this analysis, the 5(c) Task Force continues to recommend the following key next steps:

- building expertise and learning within the interagency through a Climate Data Working Group that relies on the latest climate and hazard models and defining appropriate data sources for current and future climate risk analysis, as well as relevant data sets for consideration;
- developing or procuring the necessary skills and resources in order to improve quantitative capabilities in a rapidly evolving landscape;
- determining an appropriate cadence for repeating and refining the analyses, based on the availability of budget resources and workload requirements;
- sharing lessons learned on risk analysis with other programs within the Agencies, and more broadly with other Federal lending and guarantee programs;
- engaging with NOAA, the DOE National Laboratories, and private sector stakeholders through conversations on current practices and challenges posed by climate change in the financial and housing sectors and identifying appropriate foundational data sets for climate financial risk models that are temporal as well as spatial;

[61] The weather shocks follow a static probability table derived from the historical experience. No linkage was made to climate warming, and there was no drift in probabilities in the future due to a climate change scenario or view. However, there was one climate warming scenario/trajectory that was built into the financial risk model. This trajectory impacts on the future economic variables (GDP growth, interest rates change, prepayment speeds etc.) that ultimately drive the calculation of the dollar expected loss.

- analyzing options suggested by academics, industry groups, and other stakeholders for managing increasing risks from climate change;
- expanding the pool of assets to be analyzed by working with Government-sponsored enterprises and appropriate Agencies on identifying a pool of Federally owned or subsidized housing assets to conduct rigorous analysis of current and future climate risk; and,
- coordinating across Agencies to identify programs, funding, and procedures to disclose and manage climate risk reduction for the housing pool.

U.S. Environmental Protection Agency: Managing Physical Climate Risk at Superfund Sites

The U.S. Environmental Protection Agency (EPA) Office of Land and Emergency Management (OLEM) proactively manages current and anticipated impacts of climate change on hazardous waste site remediation programs. Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, or commonly, Superfund) (Public Law 96-510), as amended, EPA has authority at private-party sites as the lead Agency to carry out response actions to protect human health and the environment with respect to releases of hazardous substances, pollutants, or contaminants.[62] The Superfund program is EPA's primary program to remediate sites contaminated by release of hazardous substances. Activities include establishing a National Priorities List, investigating sites for inclusion on the list, determining their priority, and conducting and supervising cleanup and other remedial actions related to the physical risks at the site, many of which are inseparable from climate change. These risks include extreme weather events that threaten remediation systems, such as increased intensity of hurricane winds, flooding, and drought. EPA also assesses site resilience when there have been changes in site-level conditions that were not considered in initial site design conditions, such as increased stormwater intrusion, or a technological problem, such as an increased risk of power loss, that can arise in the system or site infrastructure due to changes in climate. EPA OLEM is taking action to address these known physical risks. Consistent with CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP),[63] as well as agency policy and guidance documents, OLEM is integrating climate resilience in the Superfund cleanup process.

Since 2021, OLEM has made significant progress in assessing site remedy protectiveness and anticipating the impacts of climate change to hazardous waste site remediation programs. These efforts have emphasized integrating adaptation efforts across the site cleanup and waste management programs. As a direct response to manage physical risks of climate change on Superfund sites, in 2021, OLEM published national program guidance[64] on considering climate resilience in Superfund site management. This guidance established policies that encourage regional site managers to consider potential impacts of extreme weather events and changing climate conditions at Superfund sites to ensure the long-term integrity and resilience of actions taken at the site.

Site changes and vulnerabilities, in some cases, involve climate-related changes that are more gradual, such as sea level rise, seasonal changes in precipitation or temperatures, increasing risk of floods, increasing intensity and frequency of hurricanes and wildfires, and melting of permafrost in northern regions. If the original remedial action selected in a record of decision (ROD) requires climate resilience-related changes, they are to be documented in an explanation of significant difference or ROD amendment consistent with the provisions in CERCLA (e.g., § 117) and the NCP (e.g., 40 CFR §300.435). Additionally, the guidance requires regional site managers to assess the vulnerability of a remedial action's components, including its associated site infrastructure and evaluate whether the long-term integrity of a selected remedy may be impaired by adverse effects of climate change. Based on any potential vulnerabilities identified above, regional site managers generally should evaluate adaptation measures that increase the system's resilience to a changing climate and ensure continued protectiveness of human health and the environment.

The following provide examples of vulnerability assessment methods and climate resilience case studies produced by OLEM:

- *Rocky Mountain Arsenal Site Case Study*: The *Rocky Mountain Arsenal site* in Commerce City, Colorado is vulnerable to wildfires and the threats they pose to the site's existing infrastructure and buildings for system maintenance and groundwater treatment. The site is in the wildland-urban interface, which implies additional risks of wildfires to surrounding communities. In December 2021, a wildfire quickly spread across more than 6,000 acres due to an unusually high amount of dry grass acting as fuel, a low amount of recent snowfall, and wind gusts exceeding 100 miles per hour. In response to the identified remedy vulnerabilities to climate change and to adapt to these changing conditions, the site undergoes periodic prescribed burns conducted to expend potential wildfire fuels in a controlled a manner. This practice also helps maintain the desired perennial grasses providing habitat for native and migratory wildlife, prevents onsite growth of invasive plant species, and fosters local biodiversity.
- *Port Hadlock Site Case Study*: The *Port Hadlock site* borders Port Townsend Bay, a marine inlet off the Olympic Peninsula in Washington. Due to its coastal location, the covered landfill is vulnerable to erosion associated with tidal action and storm surge. EPA Region 10 site managers, in collaboration with Department of Defense partners, have responded to these risks through site inspections and remedy

[62] 42 U.S.C. §9604(a)(1).

[63] 40 C.F.R. Part 300.

[64] EPA Memorandum OLEM Dir. No. 9355.1-120, Consideration of Climate Resilience in the Superfund Cleanup Process for Non-Federal National Priorities List Site. *https://semspub.eda.gov/work/HQ/100002993.pdf*

reviews that allow for more precise repairs to the landfill cap and armor rock replacement. In addition to addressing these climate-related risks at the site, these resilience measures provide improved habitat for shellfish rebound, reduce shellfish-related control costs, proactive investments, and sustainable planning.

National Security

This section provides a highlight from the U.S. Department of Defense on the policy, programs, and analytical capabilities currently being implemented to respond to national security risks posed by current and future climate change impacts.

U.S. Department of Defense: Managing Climate Risks at U.S. Department of Defense Sites

Climate change is adversely affecting the U.S. Department of Defense's (DOD's) national security-related missions and operations by amplifying operational demands on the force, degrading installations and infrastructure, and increasing health risks to service members. The risks of climate change to DOD strategies, plans, capabilities, missions, and equipment, as well as those of United States allies and partners, are growing.[65] DOD has been forced to absorb billions of dollars in recovery costs from extreme weather events typical of those fueled by climate change. This includes: $1 billion to rebuild Offutt Air Force Base, Nebraska after historic floods; $3 billion to rebuild Camp Lejeune, North Carolina after Hurricane Florence; and $5 billion to rebuild Tyndall Air Force Base, Florida after Hurricane Michael. Most recently, estimates show that an extreme precipitation event at the U.S. Military Academy, West Point, NY in July 2023 caused more than $200 million in damages.

DOD is responding to climate change with a myriad of policy and planning efforts to reduce risk to national security. DOD's predominant approaches enhance resilience to the effects of climate change through adaptation, in order to reduce DOD's operational and installation energy demand. DOD's existing policy for adaptation and resilience dates to the release of the DOD 2014 Climate Change Adaptation Roadmap and the establishment of *DOD Directive (DODD) 4715.21, Climate Change Adaptation and Resilience*, in 2016. DODD 4715.21 (updated in 2018) establishes policy and assigns responsibilities to provide the DOD with the resources necessary to assess and manage risks associated with the impacts of climate change. This involves deliberate preparation, close cooperation, and coordinated planning by DOD to:

- Facilitate Federal, State, local, Tribal, private sector, and nonprofit sector efforts to improve climate preparedness and resilience, and to implement the *DOD 2014 Climate Change Adaptation Roadmap* and its successor 2021 *DOD Climate Adaptation Plan*;
- Help safeguard United States economic, infrastructure, environment, and natural resources; and
- Provide for the continuity of DOD operations, services, and programs.

Climate Adaptation to Enhance National Security Resilience

The financial and national security consequences of failing to adapt to climate change will only compound over time, due to lost military capability, weakened alliances, weakened international stature, degraded infrastructure, and missed opportunities for technical innovation and economic growth. Since the release of the *DOD 2014 Climate Change Adaptation Roadmap*, DOD policy has required that all operations, planning activities, business processes, and resource allocation decisions include climate change considerations. The purpose of doing so is to ensure the military forces of the United States retain operational advantage under all conditions, leveraging efficiency and resilience to ensure our forces are agile, capable, and effective. Climate change adaptation must align with and support DOD's warfighting requirements.

The DOD climate adaptation framework for current and future force decisions laid out in the 2021 *DOD Climate Adaptation Plan* provides an update to the 2014 Roadmap and has five major lines of effort: 1) climate-informed decision-making, 2) train and equip a climate-ready force, 3) resilient built and natural infrastructure, 4) supply chain resilience and innovation, and 5) enhance adaptation and resilience through collaboration. Four enablers support and integrate these efforts: continuous monitoring and data analytics, aligning incentives to reward innovation, climate literacy, and environmental justice.

All actions in the DOD Climate Adaptation Plan are dependent on the outcomes of the first line of effort, climate-informed decision-making. Climate considerations must continue becoming an integral element of DOD's enterprise-wide resource allocation and operational decision-making processes. Climate assessments must be based on the best available, validated, and actionable climate science that informs the most likely climate change outcomes. Climate data sources must be continuously monitored and updated—with consideration of the operational impact—to account for the rapid rate of climate change and its impacts. Examples of assets supporting climate-informed decision-making include the DOD Climate Assessment Tool (DCAT), DOD Regionalized Sea Level (DRSL) Database, and the issuance of guidance on climate parameters for wargames. DCAT is discussed below, and other examples are provided in the accompanying *white paper*.

The DOD Climate Assessment Tool (*DCAT*), developed in accordance with Section 326 of National Defense Authorization Act of 2020 and released in 2021, integrates climate risk into DOD's risk management processes by assessing climate exposure at more than 2,300 DOD locations around the globe, including all major installa-

[65] Department of Defense, Office of the Undersecretary for Policy (Strategy, Plans, and Capabilities). (2021). Department of Defense Climate Risk Analysis. Report Submitted to National Security Council. *https://media.defense.gov/2021/Oct/21/2002877353/-1/-1/0/DOD-CLIMATE-RISK-ANALYSIS-FINAL.PDF*

tions (per 10 USC 2721 and DODI 4165.14, Real Property Inventory and Forecasting) and locations of interest identified by the Military Departments. The climate hazards addressed in DCAT are coastal flooding, riverine flooding, extreme temperature, drought, energy demand, land degradation, wildfire, and historical extreme conditions, supported by 33 indicators providing more granular information on specific conditions (e.g., coastal flood extent, five-day maximum temperature). DCAT aggregates exposure across these eight hazards and, for all but historical extreme conditions, provides information on how these hazards are projected to change over the 21st century.

DCAT contains exploratory visualizations and automated reports, along with screening-level inundation mapping of projected coastal flooding associated with changing sea levels (from DRSL). For riverine flooding, the initial release incorporated the freeboard approach of the Federal Flood Risk Management Standard (FFRMS). A second FFRMS method is being added in 2024: the 0.2 percent annual exceedance probability level for flood inundation. DCAT reports climate exposure information and mapping information critical to climate risk management and long-term planning, such as the exposure of its almost 670,000 buildings, structures, and linear structures. GIS analyses allow DOD to understand current and future exposure by class of facilities (e.g., percentage and type of buildings impacted by flooding in a future scenario). DCAT reports also include context for past extreme weather events by providing information sourced from NOAA about the damages they inflicted on counties containing installations.

New Analytical Capabilities

Each of the prior sections demonstrated an increasing need for Federal-wide and agency-specific analytical capabilities to identify relevant projections of the physical impacts of climate change. Ensuring these capabilities are usable, available, and accessible to the public is essential to managing climate risk to the Nation. This section provides a discussion of recent and forthcoming analytical capabilities provided by the Federal Emergency Management Agency and decision support tools published alongside NCA5.

Climate Risk Analytical Tools from the Federal Emergency Management Agency

Providing relevant, reliable, and actionable data in a usable format is a hallmark responsibility of the Federal Government. To fulfill this responsibility, FEMA produces data in an accessible format to improve awareness and understanding of climate risks, and to help people anticipate, prepare for, and adapt to future-based risks. Through interagency and private-sector collaborations, FEMA has published three tools that help emergency managers, community leaders and the public develop strategies for resilience:[66]

- The *Climate Risk and Resilience Portal (ClimRR)*[67] provides dynamical downscaled climate datasets to support analysis and data-driven planning for future climate risks. ClimRR hazards include maximum and minimum temperature, cooling and heating degree days, heat index, precipitation/lack of precipitation, wind speed, and fire weather index, all downscaled to 12 km grid cells for CONUS and most of Alaska under two potential future warming scenarios (RCP8.5 and RCP4.5). In 2024, ClimRR will include new projection data for coastal and inland flooding, available for 200m grid cells and displayed by hydrologic unit code (HUC) 12 watersheds, and begin to provide datasets that are downscaled to a finer resolution of 4 km grid cells for CONUS, and all of Alaska and Puerto Rico.
- The *Resilience Analysis & Planning Tool (RAPT)* is a browser-based GIS tool to examine the interplay of population demographics, infrastructure and hazards, weather, and risk. RAPT includes over 100 pre-loaded data layers[68] and easy-to-use analysis tools for data-driven decision making for all phases of emergency management. Additionally, RAPT includes the FEMA Community Resilience Challenges Index (CRCI), a composite index of 22 resilience indicators that have been used in multiple peer-reviewed research methodologies.
- The *National Risk Index (NRI)* is an index that assesses risk at a census tract-level for 18 natural hazards[69] and helps planners and emergency managers at the local, regional, state, and Federal levels, as well as other decision makers and interested members of the general public, better understand the natural hazard risks to their communities. It is one component of the methodology that is used to implement the Community Disaster Resilience Zones Act (CDRZ). The NRI and the Climate and Economic Justice Screening Tool help determine which census tracts are most in need of assistance for resilience-building projects and CDRZ designation.
- *Climate Informed NRI.* FEMA is expanding the NRI by developing a prototype platform to project how climate change and future conditions will change the impact of natural hazards through the mid- and late-century. Coastal flooding, drought, heatwave,

[66] These tools and their associated data are meant for planning purposes only.

[67] ClimRR was developed by the Center for Climate Resilience and Decision Science at Argonne National Laboratory in collaboration with AT&T and FEMA.

[68] RAPT includes data layers on population and community characteristics (e.g., population with a disability, mobile homes as a percentage of housing), infrastructure (e.g., hospitals, high hazard dams, places of worship), and hazards (e.g., real-time national weather service weather data, flood hazard zones, and sea level rise). RAPT data comes from authoritative sources, including U.S. Census Bureau, Homeland Infrastructure Foundation-Level Data, NOAA, USGS. Additional data can also be added to RAPT for more tailored analysis.

[69] These include avalanche, coastal flooding, cold wave, drought, earthquake, hail, heatwave, hurricane, ice storm, landslide, lightning, riverine flooding, strong wind, tornado, tsunami, volcanic activity, wildfire, and winter weather.

hurricane wind, and wildfire are included in the prototype. The Climate Informed NRI, anticipated to be released in 2024, describes climate change impact metrics by deriving Climate Informed Adjustment Factors (CIAF) from the ClimRR, RAPT, and the NRI.[70] This factor is a multiplicative adjustment that is applied to the Expected Annual Loss (EAL), as calculated in the NRI. To calculate the CIAF, a climate variable that is highly correlated with an aspect of current losses is used. Finally, the platform will calculate the other projected metrics, such as the Scores and Ratings index, relative to the present hazard levels and thresholds.

The Fifth National Climate Assessment Interactive Atlas and Climate Mapping for Resilience and Adaptation Updates

As described in the *National Climate Resilience Framework*, the Federal Government has published and is updating a range of analytical tools. These analytical capabilities are needed by a range of stakeholders, including architects and engineers, farmers and ranchers, and municipal government officials that are incorporating climate risks in updates to their general plans. NCA5 is the preeminent source of authoritative information on the risks, impacts, and responses to climate change in the United States. This section presents highlights of new analytical tools published alongside NCA5—specifically, the *NCA5 Atlas* and new updates to the *Climate Mapping for Resilience and Adaptation portal*—and includes additional technical background on downscaling methods employed in NCA5.

- *NCA5 Atlas*: To make the downscaled climate projections more accessible for the public, the U.S. Global Change Research Program published the *NCA5 Interactive Atlas* (NCA5 Atlas). The NCA5 Atlas provides digital access to downscaled climate projections of physical climate data (temperature and precipitation) used in NCA5. It will include projections of future sea-level rise in the near future. The NCA5 Atlas is an extension of NCA5, offering interactive maps that show projections of future conditions in United States. While the NCA5 is a static report, the NCA5 Atlas allows users to access and explore climate data for locations across the United States, even if those data were not explicitly presented in NCA5. Projections in the NCA5 Atlas are from GCMs that participated in CMIP6. To make the CMIP6 projections more relevant at regional-to-local scales, results from global models were spatially downscaled using statistical methods documented by LOCA2 and STAR-ESDM.

- *CMRA Updates*: With updated projections from the NCA5, the *U.S. Climate Resilience Toolkit* and *Climate Mapping for Resilience and Adaptation* (CMRA) portal has been updated and leveraged as primary knowledge-sharing hubs that are intended to support the development and co-production of adaptation and resilience solutions by sharing real-world case studies on resilience-building efforts. Using the NCA5 data as a foundation, the CMRA portal has been updated to represent the latest climate risks. For example, a new hazard topic, extreme cold, will be added to the popular dashboard of real-time climate-related hazards. The user experience has been improved on CMRA, including explaining that checking past and projected future climate is one of the first steps in protecting a community from climate hazards. CMRA reports will also better link to FEMA's NRI and *NOAA's Billion-Dollar Weather and Climate Disasters* site,[71] providing additional context of climate risks. Along with the NCA5 Atlas, these tools represent implementation pilots of the Climate Resilience Information System (CRIS), which will provide the information infrastructure needed for easy and consistent access to observed climatologies, climate projections, and other decision-relevant climate-related data. Collectively, these online resources represent a major opportunity to better support communities in localizing climate hazard data with other relevant information, such as infrastructure and socio-economic conditions.

[70] Additional details on the underlying data sources and methodology for the Climate Informed NRI are provided in the accompanying white paper.

[71] NOAA's National Centers for Environmental Information tracks the number and types of weather and climate disasters where overall damages/costs reached or exceeded one billion dollars.

IV. REDUCING CLIMATE-RELATED FINANCIAL RISK IN THE 2025 BUDGET

This chapter represents the Government's third published assessment of climate-related fiscal risk in the President's Budget since the release of Executive Order 14030. The 2023 Budget included assessments of fiscal risk due to crop insurance, the National Flood Insurance Program, flood risk to Federal facilities, and wildland fire suppression costs. In the 2024 Budget, illustrative analyses demonstrated advances in combined flood modeling and damage assessment of Federal facilities and projected heating and cooling demands, which could affect the Low-Income Home Energy Assistance Program. Additionally, it presented a new mandatory proposal to provide incentives to farmers to plant cover crops, which was a direct response to the prior year's assessment results.

This section addresses section 6(c) of Executive Order 14030, which calls for OMB to reduce the Government's long-term fiscal exposure to climate-related risk through the Budget. Building on the work conducted in prior years and the agency assessments and highlights presented in this chapter, the 2025 Budget includes a series of investments that directly respond to assessment findings. Table 11-4 includes a listing of notable examples of investments in reducing fiscal exposure to climate-related risk in the 2025 Budget. These examples, while not comprehensive,

Table 11–4. NOTABLE INVESTMENTS IN REDUCING FISCAL EXPOSURE TO CLIMATE-RELATED RISK IN THE 2025 BUDGET

Theme	Agency	Objective	Amount (in $ millions)
Reducing risk exposure	USDA FS and DOI	Invest in wildland fire management workforce by supporting permanent, comprehensive pay reform and expanding workforce capacity, health services, and Government housing.	$522
	USDA FS and DOI	Establish a new Joint Office for Wildlife Science & Technology and continue investing in the Joint Fire Sciences Program.	$13
	DOE	Invest in the Federal Energy Management Program to provide technical and financial assistance to Federal Agencies to advance Federal facility resilience.	$64
	EPA	Support Tribes in performing direct implementation of EPA prorams and authorities in Indian Country, with a focus on reducing vulnerability to climate change impacts.	$13
	EPA	Provide grants to municipalities or intermunicipal, interstate, or State agencies for planning, designing, or constructing projects that increase the resilience of publicly owned treatment works to natural hazards through the Clean Water Infrastructure Resiliency and Sustainability Program.	$25
	EPA	Assist public water systems serving small and underserved communities in the planning, design, construction, implementation, operation, or maintenance of a drinking water program or project that increases resilience to natural hazards, including climate change, through the Drinking Water Infrastructure Resilience and Sustainability Program.	$65
	U.S. Bureau of Reclamation	Support for the U.S. Bureau of Reclamation (USBR) for the WaterSMART program, through which Reclamation funds projects to conserve and use water more efficiently and build long-term resilience to drought.	$ 65
	USBR	Provide emergency drought relief for federally recognized Indian Tribes for near-term drought relief to mitigate drought impacts for Tribes impacted by the operation of a Reclamation water projects.	$ 9
	DOE	Invest in scientific developments and public-private partnerships to support the development and use of AI technologies to advance climate modeling, increase the nation's resilience to climate impacts and address climate risks.	$ 10
Develop technical capacity within the Federal Government to model and assess physical asset risk and connect those models to understand potential impacts of Federal program expenditures	U.S. Geological Survey (USGS)	Work with FEMA to study and develop methods that project future disaster-related outlays due to coastal hazards and hurricane events.	$ 2
	U.S. Department of Transportation	Conduct a study to develop methods and tools to improve the ability of transportation infrastructure asset owners to assess the climate change vulnerability of their assets and projects, identify evidence-based approaches to resilience improvements, and estimate financial risks associated with the impact of climate change.	$ 4
Investments to accompany the release of National Climate Resilience Framework, including discretionary resources to advance the development and public use of Federal climate services	FEMA	Investments in the Building Resilient Infrastructure and Communities grant program paid for out of the Disaster Relief Fund.	$ 1,000
	FEMA	Support for the flood hazard mapping program.	$ 517
	NOAA	Support for advances in the Climate Mapping for Resilience and Adaptation (CMRA) portal assessment tool ($2 million) and accelerate the development of the Climate Resilience Information System (CRIS) ($5 million).	$ 7
	USDA	Continued support of the USDA Climate Hubs.	$ 22
	USGS	Invest in the National and Regional Climate Adaptation Science Centers.	$ 69
	DOE	Create a multi-office extreme heat community initiative that will design and scale.	$ 105
	Corporation for National and Community Service	Invest in the American Climate Corps (ACC) by providing funding to support an ACC hub at AmeriCorps and grow the number of ACC volunteers.	$ 38
	EPA	Support of the Climate Adaptation Program, which funds targeted assistance to States, Tribes and Indigenous peoples, territories, local governments, communities, and businesses to bolster climate resilience efforts.	$ 20
	U.S. Department of Health and Human Services	Fund the Office of Climate Change and Health Equity, which aims to protect the health of people throughout the US in the face of climate change, especially those experiencing a higher share of exposures and impacts.	$ 5

highlight the range of investments the Administration continues to make that reduce the Nation's exposure and risk to climate change impacts.

Investments in the 2025 Budget build on a historic level of over $50 billion in funding from both the Infrastructure Investment and Jobs Act (Public Law 117-58) and the Inflation Reduction Act of 2022 (Public Law 117-169) that is directly increasing the Nation's resilience to climate change impacts, and reducing the fiscal risk of the Federal Government to these impacts in the future. Notable examples of these investments are highlighted in Table 11-5.

Table 11–5. NOTABLE INVESTMENTS IN REDUCING FISCAL EXPOSURE TO CLIMATE-RELATED RISK IN THE INFRASTRUCTURE INVESTMENT AND JOBS ACT AND THE INFLATION REDUCTION ACT

	Agency	Objective	Amount (in $ millions)
Investments in funding from IIJA and IRA	EPA	Fund EPA's Environmental and Climate Justice Community Change Grants program to support community-driven projects that deploy clean energy, strengthen climate resilience, and build community capacity to respond to environmental and climate justice challenges.	$ 2,000
	NOAA	Increase coastal resilience, building natural infrastructure, and protecting coastal natural resources.	$ 2,600
	USDA FS and DOI	Invest in wildland fire and hazardous fuels management programs to expand efforts to reduce wildfire risk, prepare for and respond to catastrophic wildfires, and support post-fire recovery.	$ 6,900
	DOE	Support DOE's efforts to strengthen and modernize the electric grid, increasing reliability of service and reducing impacts of extreme weather events.	$ 3,900

V. CONCLUSION

This chapter of the 2025 Budget presents assessments and program highlights of climate financial risk exposure and an expanded view of both future risks due to climate change impacts and actions that the Government is taking now to reduce these risks. These efforts, called for in Executive Order 14030, are directly responding to the latest scientific conclusions that sectors across the economy, including public-sector budgets, need to adapt to a changing climate in order to be sustainable. New analytical capabilities presented here build on the physical asset risk and Federal expenditure analytical approaches presented in the 2024 Budget, and continue to address the need for additional technical capabilities. Lastly, the Budget proposals highlighted in this chapter directly respond to this year or prior years' climate risk exposure assessments, and aim to advance the Administration's goal to enhance the Nation's climate resilience.