

Implications of Climate Change for Department of the Air Force Missions and Operations

INSIGHTS FROM RAND RESEARCH



Science tells us that weather and broader climate trends will look less and less like what we have been used to in the past. The “new normal” will continually evolve, and it will no longer be possible to predict future trends using historical statistics. Such circumstances will introduce greater uncertainty into decisionmaking.

Recent legislation passed by Congress, including the Infrastructure Investment and Jobs Act (2021) and the Inflation Reduction Act (2022), contains major national initiatives to improve infrastructure in the context of a changing climate and other steps to ensure future energy and water security. The Department of the Air Force (DAF) has increasingly recognized the importance of climate, energy, and water to achieving its mission, including their mention in the DAF’s 2022 *Climate Action Plan*. The action plan emphasizes climate effects on installations, capabilities, and new missions, as well as reflects the impending energy transition away from fuels and activities that produce greenhouse gases.

The DAF has many other climate-related efforts underway, including its 2020 *Arctic Strategy*, 2021 *Installation Energy Strategic Plan*, forward-leaning energy initiatives such as Energy Prime, the development

of water resilience tools for mission assurance, the growing use of solar energy by installations and the introduction of nontactical electric vehicles into their fleets, and literacy activities by the DAF water resources management program.

The DAF will continue to contend with increasingly adverse weather and climate trends as it seeks to achieve its mission to “fly, fight, and win—airpower anytime, anywhere.” It will do so in two primary ways: (1) by changing how the services operate with respect to energy, infrastructure, capabilities, and logistics and (2) by shifting mission focus and geography.

Research conducted within RAND Project AIR FORCE for the DAF and more broadly across RAND offers insights about climate change and its implications for military operations and other contexts. This multidisciplinary climate research can help answer a variety of questions that are relevant to DAF leaders and other stakeholders.

WHO WE ARE

The mission of Project AIR FORCE is to conduct objective analysis of issues of enduring concern to DAF leaders. Project AIR FORCE addresses these concerns from multiple vantage points, by way of four research programs: Strategy and Doctrine; Force Modernization and Employment; Resource Management (RMP); and Workforce, Development, and Health. This document highlights climate change research from RMP and across the RAND Corporation.



What Does Resilience Mean in the Context of Climate Hazards, and How Is It Measured?

MANY INSTALLATIONS FACE A DIVERSE SET OF HAZARDS ASSOCIATED WITH CLIMATE CHANGE

Climate change has many higher-order impacts. Understanding the variety of related hazards that installations are exposed to is needed to plan for the multiple and sometimes compounding effects of climate change.

The Growing Exposure of Air Force Installations to Natural Disasters

2021, [RB-A523-1](#), www.rand.org/t/RBA523-1

Some U.S. Air Force (USAF) installations face high levels of exposure to flooding, wildfires, or high winds. This research demonstrated how an enterprisewide view of installation exposure to natural hazards can inform a variety of policy decisions.

Building Resilience in an Urban Coastal Environment: Integrated, Science-Based Planning in Jamaica Bay, New York

2018, [RR-2193-RF](#), www.rand.org/t/RR2193

This project considered baywide concepts that could reduce future flood risk exposure in Jamaica Bay while also improving water quality, restoring habitat in and around the bay, and more generally improving resilience to extreme weather events.

UTILITY RESILIENCE NECESSITATES LOOKING BEYOND THE IMMEDIATE USER

Utility systems—from source to transmission to distribution—are sensitive to climate hazards. Focusing climate assessments only on conditions affecting discrete end users misses important connections to hazard impacts across a broader area.

Beyond Recovery: Transforming Puerto Rico's Water Sector in the Wake of Hurricanes Irma and Maria

2020, [RR-2608-DHS](#), www.rand.org/t/RR2608

The aftermath of Hurricanes Irma and Maria highlighted vulnerabilities in Puerto Rico's water sector. This report details a framework for hurricane recovery that was used to identify courses of action focused on Puerto Rico's priorities but that could be used more broadly with applicability to similar challenges faced by USAF.

Air Force Installation Energy Assurance: An Assessment Framework

2017, [RR-2066-AF](#), www.rand.org/t/RR2066

More so than in the past, mission success depends on an installation's assured access to energy. This report presents a framework that mission owners and civil engineers at USAF installations can use to assess their level of energy assurance.



LINKING RESILIENCE WITH MISSION ASSURANCE IS KEY FOR PRIORITIZING INVESTMENTS

Investing in resilience may be less expensive than cleaning up billion-dollar disasters, but the DAF must prioritize where its limited resources should be spent. Understanding the potential impacts to missions and operations is a critical component of these decisions.

Grounded: An Enterprise-Wide Look at Department of the Air Force Installation Exposure to Natural Hazards: Implications for Infrastructure Investment Decisionmaking and Continuity of Operations Planning

2021, RR-A523-1, www.rand.org/t/RR523-1

The authors of this report consider the exposure of DAF installations to flooding, high winds, and wildfires—hazards that have affected DAF installations in the recent past. The report highlights the importance of local assessments to augment enterprise-level decisions.

Assessing Risk to the National Critical Functions as a Result of Climate Change

2022, RR-A1645-7, www.rand.org/t/RR1645-7

National Critical Functions are government and private-sector functions so vital that their disruption would debilitate security, the economy, public health, or safety. The authors developed a framework to assess and manage the risk that climate change

poses to National Critical Functions and used the framework to assess the most-vulnerable ones. This report details the risk assessment portions of the framework.

Decision Support Tool for the San Francisco Bay-Delta Levees Investment Strategy: Documentation and Use

2019, RR-2139-DSC, www.rand.org/t/RR2139

The Sacramento–San Joaquin Delta is a unique ecosystem that faces complex and varied flood risk. Possible investments to mitigate these risks are numerous and will affect Delta risks differently. This report describes the decision support tool and underlying methodology used to support the development of a levee investment strategy for the California Delta Stewardship Council.

Under Which Circumstances Will Climate Change Drive New Mission Areas?

CLIMATE CHANGE WILL AMPLIFY STRESSORS

Climate change does not work in a vacuum to generate novel adverse situations. Rather, it is a stressor that amplifies other sources of tension. The following RAND research highlights some examples.

Climate Change and Implications for Disasters in the United States: Examples from the Arctic, Caribbean, Northeast, and Gulf States

2022, PT-A2094-1, www.rand.org/t/PTA2094-1

In this webinar, researchers discuss the disaster risk from climate change to the Arctic, the Caribbean, the Northeast, and the Gulf states. They examine how climate effects and hazards are affecting communities in the region, ongoing adaptation activities in addressing these hazards, and remaining needs and opportunities.

Transboundary Environmental Stressors on India-Pakistan Relations: An Analysis of Shared Air and Water Resources

2019, RR-2715-RC, www.rand.org/t/RR2715

The authors of this report address the ongoing discourse by governments, news media, and citizens over transboundary water resources and air quality between India and Pakistan. This report presents the results of a preliminary pilot study intended to spur future, in-depth research on the actual causes and effects of water and agricultural management activities.

INCREASING AND DECREASING PHYSICAL ACCESS CAN ALTER THE GEOPOLITICAL BALANCE

Climate change and geopolitics are intertwined, primarily because of the physical effects on access to strategic locations. The RAND research that follows highlights examples of how climate change is currently reshaping parts of the map and how it might do so in the future.

Environment, Geography, and the Future of Warfare: The Changing Global Environment and Its Implications for the U.S. Air Force

2020, RR-2849/5-AF, www.rand.org/t/RR2849z5

This volume of the Future of Warfare in 2030 series examines significant environmental and geographic trends that could affect U.S. national security, including the opening of the Arctic, sea level rise, water scarcity, and increasing urbanization. Implications for USAF are also considered.

China's Strategy and Activities in the Arctic: Implications for North American and Transatlantic Security

2022, RR-A1282-1-v2, www.rand.org/t/RRA1282-1-v2

Although a non-Arctic state, China has become a significant player in the Arctic region. In this report, the authors assess China's strategy and diplomacy in

the Arctic and the potential implications of Chinese investments and activities there for the rules-based order and for regional and transatlantic security.

Exploring Gaps in Arctic Governance: Identifying Potential Sources of Conflict and Mitigating Measures

2021, RR-A1007-1, www.rand.org/t/RRA1007-1

Arctic states have long cooperated to avoid or mitigate conflict in the region. In this report, researchers use an adaptive four-stage approach to identify potential areas of conflict and potential changes to governance mechanisms to help mitigate the identified risks.



MITIGATION POLICIES COULD HAVE RAMIFICATIONS FOR MILITARIES

The United States is moving to address climate change–related global commitments. Climate change mitigation will affect all sectors, including military operations and even missions. The following RAND reports introduce some key issues related to mitigation.

Climate Control: International Legal Mechanisms for Managing the Geopolitical Risks of Geoengineering

2021, PE-A1133-1, www.rand.org/t/PEA1133-1

The prospect of using *geoengineering*—the large-scale manipulation of environmental processes—to address the accelerating effects of climate change is becoming more likely. The authors of this Perspective review the state of geoengineering technologies and their associated geopolitical risks, while considering international governance options. The recommendations offer considerations for climate risk management.

Deep Decarbonization as a Risk Management Challenge

2018, PE-303-RPC, www.rand.org/t/PE303

Deep decarbonization—reducing net human greenhouse gas emissions to zero—presents a risk management challenge. This Perspective describes three concepts that are particularly important for implementing risk management for deep decarbonization: risk governance, complexity, and robustness.

How Can Partnerships Make an Organization Like the DAF More Resilient?

MILITARY INSTALLATIONS SHARE CLIMATE CHALLENGES WITH HOST COMMUNITIES

Military installations colocated with host communities share climate challenges and opportunities for adaptation by virtue of geography. In addition, energy supply chains, communication networks, coastlines, transportation infrastructure, and other physical features susceptible to climate hazards are often shared. RAND research highlights opportunities for partnering born from having shared challenges.

Building Resilience Together: Military and Local Government Collaboration for Climate Adaptation

2020, RR-3014-RC, www.rand.org/t/RR3014

The authors of this report examine the role of collaboration in military and local government climate resilience planning and conclude that such collaboration improves collective capacity to address climate change and identify attributes of effective joint planning.

Military Installation Public-to-Public Partnerships: Lessons from Past and Current Experiences

2016, RR-1419-A/AF/NAVY/OSD, www.rand.org/t/RR1419

This report explores the value in defense installations working with municipalities and other government organizations to create public-to-public partnerships. The authors identify and suggest ways to overcome barriers to the cost-effective application of such partnerships.

PARTNERS OFFER OPPORTUNITIES FOR NOVEL IDEAS AND COST SAVINGS

Considerable work on resource management and climate adaptation has been undertaken by various organizations. Partnerships can offer important insights into planning processes and potential solutions in addition to tangible opportunities to make efficient use of limited resources. The following RAND research reports highlight two very different examples: One examines forward-leaning thinking on decarbonization by a partner nation, and the other focuses on military installations.

A Green Costa Rican COVID-19 Recovery: Aligning Costa Rica's Decarbonization Investments with Economic Recovery

2022, RR-A1381-1, www.rand.org/t/RRA1381-1

In this report, the authors assess how the implementation of Costa Rica's National Decarbonization Plan, which would lead to an unprecedented economic transformation, could contribute to a just and robust COVID-19 recovery.

Improving Army Installation Facility and Land Use Deals and Partnerships

2019, RR-2696-A, www.rand.org/t/RR2696

The authors of this report assess Army installation real estate and facility-sharing deals and partnership approaches, such as large-scale leasing, and provide recommendations to improve installations' use of these approaches to increase benefits and save costs.

PARTNERSHIPS HELP ADDRESS CLIMATE AND EQUITY ISSUES

Vulnerable populations—which, given the services' demographic and geographic diversity, includes DAF personnel—are more susceptible to adverse impacts of climate change and less able to take successful adaptation measures. The following examples of RAND research describe climate change and equity issues related to disasters and to adaptation in the energy sector. They highlight the value of partnerships along multiple dimensions, including crisis response, and in the development of metrics and data to support their use.

The Building Resilient Infrastructure and Communities Mitigation Grant Program: Incorporating Hazard Risk and Social Equity into Decisionmaking Processes

2022, RR-A1258-1, www.rand.org/t/RRA1258-1

The federal Building Resilient Infrastructure and Communities (BRIC) program can help develop community resilience through mitigation activities that emphasize equity goals alongside reduction of risk to physical assets. The authors identify ways for BRIC to meet these goals using a multihazard, forward-looking, and risk-based approach to mitigation.

an illustrative set of context-specific equity metrics that Southern California Edison could build on and incorporate into its ongoing work toward climate adaptation and energy equity.

Assessing Social Equity in Disaster Preparation, Response, and Recovery

2021, PT-A1876-1, www.rand.org/t/PTA1876-1

This webinar reviews the complex nature of social equity—including contextual, procedural, and distributional equity dimensions—and how a robust, evidence-based approach is needed to measure progress toward equity in disaster contexts.

Equity Metrics for Climate Adaptation in the Electricity Sector

2022, RR-A1721-1, www.rand.org/t/RRA1721-1

Social equity has become a key concern among public agencies. In this report, the authors develop

The DAF has taken an important step in developing the *Climate Action Plan*, which builds on important progress made in earlier strategies, pilot programs, and engagement efforts. Now begins the important and challenging work of putting strategy into action and scaling up initial solutions. As shown in these selected examples, RAND research can offer tools and insights to inform these efforts.

Working with Us

WHAT WE DELIVER

RAND Project AIR FORCE's (PAF's) studies and analyses are tailored to the needs of the sponsor. Generally, PAF provides

- continuous interaction with PAF subject-matter experts throughout the project
- accessible, timely, and policy-focused reports that address senior leader concerns and recommend courses of action
- descriptive, transparent, and rigorous supporting materials that describe the project's methodology and support the project's conclusions
- as appropriate, additional outreach materials to help socialize the work to other interested stakeholders, such as the DAF, the U.S. Department of Defense, Congress, or the public.

SPONSOR IDENTIFICATION

All PAF research projects must be sponsored by a USAF general officer (GO) or member of the senior executive service (SES). Most sponsors assign one or more action officers (AOs) to manage the technical and administrative aspects of their PAF projects.

LINES OF FUNDING

DAF organizations can initiate a PAF research project in two ways:

1. **Centrally Funded** (also referred to as “core projects”). Air Force Studies, Analyses, and Assessments (SAF/SA; formerly HAF/A9) employs a rigorous, iterative, GO/SES voting process to select projects for inclusion in its annual research plan. This process accounts for about 70 percent of the projects that PAF will conduct during a fiscal year. Funding

for these projects is part of a line item in the congressional budget and is awarded through the competitive selection process. Project topics are submitted in January, and the research plan is approved by a steering group consisting of three- and four-star GOs between June and July. Maintaining a balance of projects across the DAF and the four PAF programs is key to this selection process.

2. **Sponsor-Funded** (also referred to as “add-on projects” because they are add-ons to the core research agenda). This process accounts for about 30 percent of the projects that PAF will conduct during a fiscal year. Funding for these projects comes directly from the organization requesting the research and does not require a competitive selection process because the requesting organization is paying for the research (and not competing with others). DAF sponsors may initiate a PAF add-on research project at any time of the year by requesting the work, submitting required documentation, and transmitting organizational funds. Ideas and requests for PAF add-on projects may originate from a variety of circumstances (e.g., continuation of prior PAF work or new challenges). To initiate the process, a sponsor or AO typically contacts the appropriate PAF program director or subject-matter expert. The timeline of add-on projects is flexible.

PAF also supports DAF organizations in many informal ways. To request RAND research reports highlighted here or to discuss pressing DAF challenges, contact the director of PAF's Resource Management Program at www.rand.org/paf/about/pafmanagement.

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