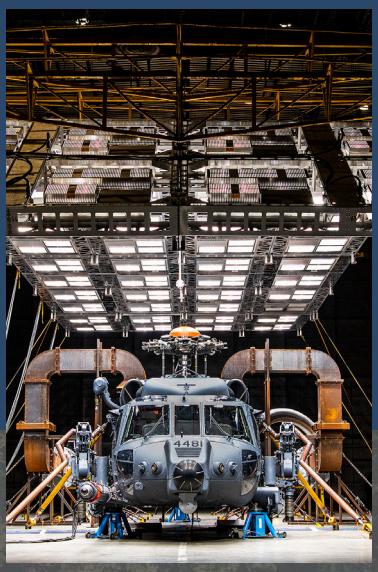
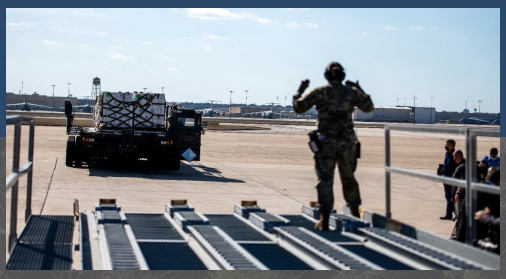
Department of Defense Climate Adaptation Plan

September 1, 2021





To National Climate Task Force and Federal Chief Sustainability Officer

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FOREWORD

We in the Department of Defense (DOD) know first-hand the national security risk posed by climate change because it affects the work we do every day. Around the world, climate change is a destabilizing force, demanding new missions of us and altering the operational environment. At the same time, climate-related extreme weather affects military readiness and drains our resources. In just the past few years, wildfires have forced evacuations at bases in the western United States, while hurricanes on the East Coast and flooding in the Midwest have inflicted billions of dollars of damage on facilities that are home to key warfighting capabilities.

On January 27, 2021, President Biden issued Executive Order (EO) 14008, Tackling the Climate Crisis at Home and Abroad, making it administration policy that climate considerations will be an essential element of United States foreign policy and national security. The EO calls on federal agencies, including the DOD, to prioritize climate change in all our activities and incorporate its security implications into analyses as well as key strategy, planning, and programming documents.

Planning for today and into the future is our business, and we would not be doing our job if we weren't thinking about how climate change will affect what we do. This Climate Adaptation Plan provides a roadmap to ensure the Department maintains the ability to operate under changing climate conditions while preserving operational capability and protecting systems essential to our success.

As I stated when the EO was issued, going forward, the Department will include the security implications of climate change in all our risk analyses, strategy development, and planning. We will incorporate climate risk into planning; into modeling, simulation, and wargaming; and into key documents like the National Defense Strategy. These are essential steps, not simply to meet a requirement, but to defend the nation under all conditions.

Lloyd J. Austin III, Secretary of Defense

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Adaptation: Adjustment in natural or human systems in anticipation of or response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative efforts.

Resilience: The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.

— DODD 4715.21, Climate Change Adaptation and Resilience

Mitigation: Measures to reduce the amount and speed of future climate change by reducing emissions of heat-trapping gases or removing carbon dioxide from the atmosphere.

— U.S. Global Change Research Program

INTRODUCTION

The Department of Defense (DOD) has identified climate change as a critical national security issue and threat multiplier (DOD 2014a) and top management challenge (DOD 2020a). Climate change will continue to amplify operational demands on the force, degrade installations and infrastructure, increase health risks to our service members, and could require modifications to existing and planned equipment. Extreme weather events are already costing the Department billions of dollars and are degrading mission capabilities. These effects and costs are likely to increase as climate change accelerates. Not adapting to climate change will be even more consequential with failure measured in terms of lost military capability, weakened alliances, enfeebled international stature, degraded infrastructure, and missed opportunities for technical innovation and economic growth.

The Department must take bold steps to accelerate adaptation to reduce the adverse impacts of climate change. These adaptation efforts must align with our strategic objectives and mission requirements, ensuring that our military can deter aggression and defend the nation under all conditions. DOD will build upon previous work (see inside back cover). Other DOD actions include scientific and engineering research to understand adaptation requirements, new policies and guidance, improved construction codes and standards, tools to assess and evaluate climate exposure at installations, and a requirement for comprehensive installation master planning.

This Plan builds upon the actions and activities outlined in the DOD 2014 *Climate Change Adaptation Roadmap* (DOD 2014b) and meets the requirements of Section 211 of Executive Order (EO) 14008, *Tackling the Climate Crisis At Home and Abroad*. The Council on Environmental Quality (CEQ) subsequently indicated that the primary purpose of this plan is to "integrate climate change adaptation and climate resilience across agency programs, management of real property, public lands and waters, and financial services." The Department has taken a very expansive approach to this guidance, intending to drive positive change across the largest federal resource-consuming entity in the nation. Some elements of CEQ's prescribed format were modified to enhance understanding within the culture and national security context of the Department.

The Department is responding to climate change in two ways: adaptation to enhance resilience to the effects of climate change; and mitigation to reduce greenhouse gas (GHG) emissions (see definitions on previous page). The DOD's Sustainability Report and Implementation Plan (expected in summer 2021) will further outline each of the Department's climate mitigation strategies.

DEPARTMENT OF DEFENSE AGENCY-WIDE POLICY STATEMENT

It is DOD policy (DOD 2016a) 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 the Department's warfighting requirements. As no entity has the luxury of "opting out" of the effects of climate change, no portion of the Department—not a Service, a Command, or an activity—can "opt out" of the requirement to adapt to a changing climate. Every element in the Department should consider appropriate ways to align their work to the initiatives and activities contained within this document.

OFFICIAL RESPONSIBLE FOR PLAN IMPLEMENTATION: The DOD Chief Sustainability Officer, Mr. Paul Cramer, Acting Assistant Secretary of Defense for Sustainment, is the official responsible for the implementation of this plan.

DOD CLIMATE ADAPTATION END STATE: Ensure the DOD can operate under changing climate conditions, preserving operational capability and enhancing and protecting the natural and man-made systems essential to the Department's success.

CLIMATE ADAPTATION STRATEGIC FRAMEWORK

The Department has modified CEQ's prescribed format to better reflect the scope and scale of the Department's activities as well as to use terminology common to DOD planning efforts. "Actions" were replaced with "Lines of Effort" or LOEs, "Implementation Methodologies" were changed to "Focus Areas," and "goals" were replaced by "outcomes." These revisions better capture the magnitude of DOD's efforts as no set of five actions or a discrete list of methodologies would be adequate to guide the totality of DOD's required adaptation and resilience efforts.

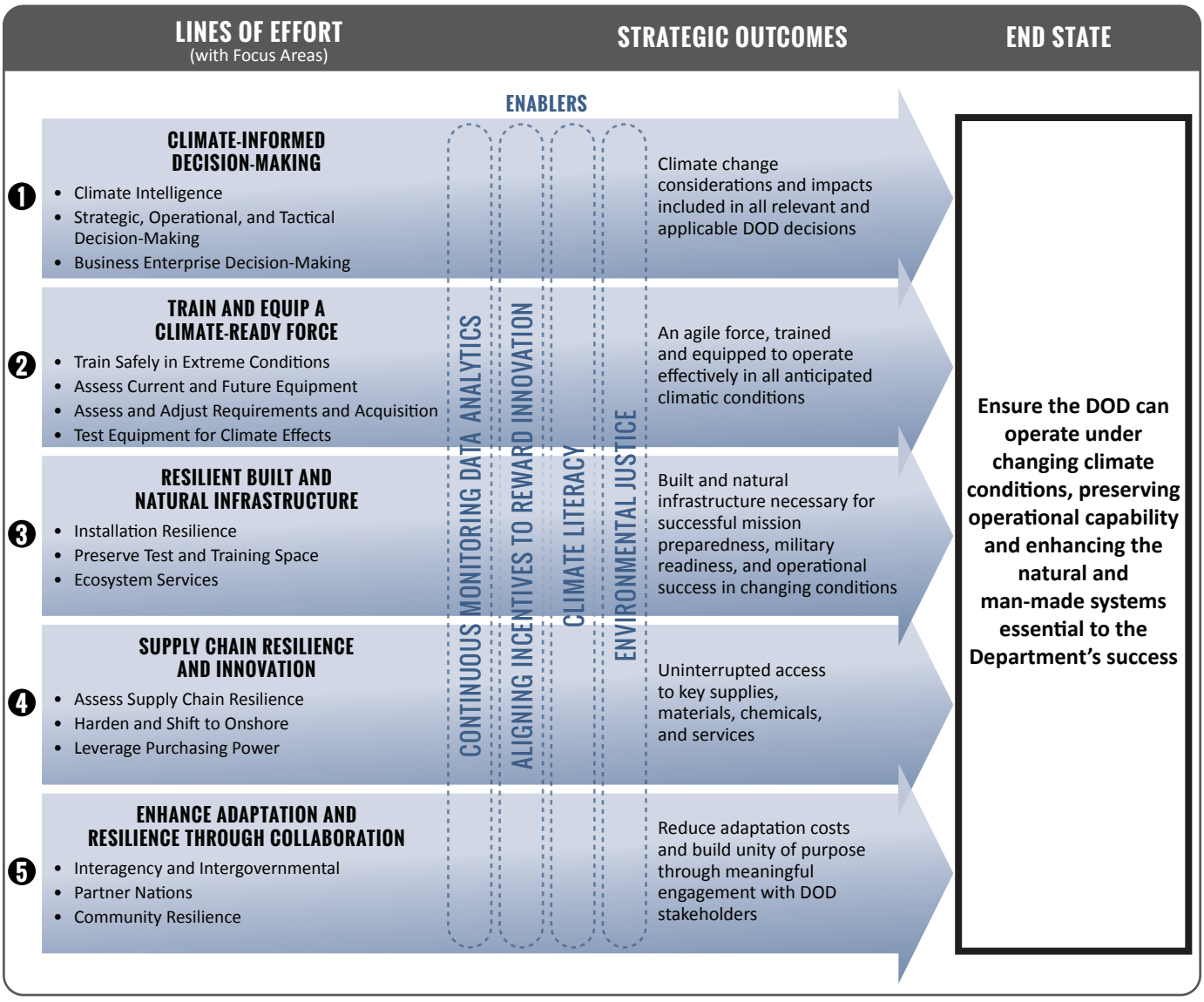


Figure 1. DOD Climate Adaptation Strategy Framework For Current and Future Force Decisions

CLIMATE ADAPTATION STRATEGY ENABLERS

Four enablers support and integrate across all five LOEs.

1 **CONTINUOUS MONITORING AND DATA ANALYTICS:** Sensing is critical to becoming fully aware of the scope and scale of climate impacts and is essential to developing predictive modeling capabilities valuable to all LOEs. The Department will continuously monitor and assess the relevant environmental conditions on operations and installations, and the impacts of its actions, by leveraging the best available and actionable science, together with advances in data analytics, business intelligence, and efficient on-site and remote sensors. The use of new sensing and data analytics requires updated capability to understand military operations and needs in future climates, as well as potentially unforeseen scenarios. Outcomes from these efforts will create a data-driven, shared understanding of the operational environment in Advana (the Department's enterprise analytics platform) to guide climate-informed performance management and resource allocation decisions. Data analytics must support the development and maintenance of performance metrics for all LOEs.

2 **ALIGNING INCENTIVES TO REWARD INNOVATION:** Incentivizing innovation is necessary to efficiently align climate adaptation goals with mission requirements. The Department has significant scientific, research, and development capabilities that offer the potential to accelerate the deployment of technologies needed to build resilience and improve both climate adaptation and mitigation capabilities. Particular attention will focus on collaborating with other agencies and industry on dual-use technologies. Innovation also includes collaboration across the federal government; between federal, state, and local governments; and with non-governmental organization (NGOs).

3 **CLIMATE LITERACY:** Successful implementation of this action plan requires actions specifically directed at building a climate-informed workforce. A climate-literate and capable workforce can more readily integrate climate considerations into all activities, from day-to-day operations to long-term sustainable and climate-resilient installation planning, through the development of joint policy and doctrine that takes climate change into consideration. Topic 2, regarding Climate Literacy, specifically addresses this enabler.

4 **ENVIRONMENTAL JUSTICE:** Climate change impacts can affect sources of raw materials, supplies, equipment, vehicles, and weapons systems as well as their distribution and storage. Environmental Justice considerations require that training and testing, as well as acquisition actions, not disproportionately impact low income and/or minority populations (EO 13985 and EO 13990). Through the updated DOD Environmental Justice Strategy (to be developed per EO 14008) risks and opportunities will be coordinated. The updated Environmental Justice Strategy (expected later in 2021) will address Environmental Justice issues in more detail.

FIVE PRIORITY ADAPTATION ACTIONS: LINES OF EFFORT

Together the five LOE and the four enablers make up the Climate Adaptation Strategic Framework. The LOE are described below, including the details required by CEQ.

LINE OF EFFORT 1:
CLIMATE-INFORMED DECISION-MAKING

DESCRIPTION (CONTINUING EFFORT):

Climate considerations must continue progress toward 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. **All other actions in this plan are dependent on the outcomes of this effort.**

The submarine USS Hartford surfaces near Ice Camp Sargo during Ice Exercise 2016 in the Arctic Circle, March 19, 2016.

FOCUS AREAS:

Implementing climate-informed decision-making in three major areas:

- **Climate Intelligence:** Incorporate climate change factors into all threat assessments and updates that serve as input when developing a shared understanding of the operational environment (e.g., Joint Operating Environment 2035) via deliberate review and revision of current contingency and operational plans. Update the modeling, simulation, and wargaming capabilities to reflect climate change and specifically the Climate Risk Analysis developed per section 103 (c) of EO 14008. Update relevant decision/planning support tools.
- **Strategic, Operational, and Tactical Decision-Making:** Ensure climate change considerations are reflected in all the Department's strategies and policies per section 201 of EO 14008. These updates will include: the incorporation of climate change considerations in warfighting concepts and doctrine, Combatant Commander's region/country engagement plans, and logistics plans; revision of logistics planning factors (as necessary); and development of appropriate decision support tools. Budgetary foresight and long-term funding requirements will be integral to climate-informed decision-making.
- **Business Enterprise Decision-Making:** Incorporate climate exposure and sensitivity in cost benefit analyses, to include consideration of the social cost of GHG emissions in applicable cost-benefit decisions per EO 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*. These updates will include accounting for carbon footprint in acquisition, including transportation and logistics; and incorporating climate exposure and performance metrics into enterprise-wide data analytics efforts.

DIFFERENCE BETWEEN CLIMATE AND WEATHER

The Intergovernmental Panel on Climate Change (IPCC) defines "weather" as the fluctuating state of the atmosphere, characterized by the temperature, wind, precipitation, clouds, and other weather elements. Weather results from systems (e.g., low- and high-pressure systems, fronts, tropical cyclones) that rapidly develop and decay. Weather has only limited predictability (a week or two).

"Climate" refers to the average weather over a certain time span and geographic location. Climate varies from place to place, depending on latitude, distance to the sea, vegetation, presence or absence of mountains, or other geographical factors. Climate varies also in time; from season to season, year to year, decade to decade, or on much longer time scales, such as the Ice Ages.

— After IPCC, 2001

OUTCOME

Climate change considerations and impacts are included in all relevant and applicable DOD decisions.

AGENCY LEADS

Office of Secretary of Defense; DOD Climate Change Working Group; Joint Staff; Combatant Commands; Military Departments; Defense Agencies.

SCALE

Global.

TIMEFRAME

Climate-informed decision-making has been a part of the DOD approach since the 2010 Defense Science Board study on the implications of climate change to national and international security, with a growing emphasis over the past 10 years (see timeline inside back cover). The implementation of climate adaptation is already occurring and will continue to evolve as knowledge increases.

RISKS

- Failure to properly integrate a climate change understanding of related risks may significantly increase the Department's adaptation and operating costs over time, lead to a suboptimal allocation of resources, imperil the supply chain, and/or result in degraded and outdated Department capabilities and operating concepts.
- The need for budgetary foresight and long-term funding is critical to effective climate adaptation.
- To support analyses of adaptation alternatives, measures to quantify economic costs and benefits of climate adaptation are needed.
- Climate-informed decisions will better leverage the Department's scale and scope to drive innovation and enhance DOD climate resilience.

OPPORTUNITIES

- Full life-cycle cost analysis and whole systems design techniques should become the standard for all installation- and infrastructure-related investments.
- By aggressively incorporating climate change considerations into decision-making processes, the Department will gain operational or tactical advantages, remain agile, preserve decision space, and reduce climate hazard risks to missions and operations.
- By identifying climate-impacted problems early, the DOD can better prepare for humanitarian assistance and disaster relief (HADR); adapt or strengthen military-military engagement programs to prepare partners to face potential climate-sourced conflict; thus give the DOD an advantage over adversaries and competitors to better survive and operate in future environments.

PERFORMANCE METRICS

Initial metrics implemented include presence or absence of climate hazards (coastal flooding, riverine flooding, heat, drought, energy demand, land degradation, wildfire, and historical extreme weather events). Advana dashboard metrics also measure whether installation climate exposure assessments were performed and will include crosswalks with installation energy resilience and emergency management plans. Other potential metrics include return on investment (e.g., savings, cost avoidance) and mission-related metrics (e.g., impact on retention, readiness ratings, materiel equipment fielding rates). As climate change adaptation implementation continues, the Department will fully develop these and additional performance metrics.

RESOURCE IMPLICATIONS

DOD is considering how to integrate adaptation resource considerations and cost management including life-cycle costs into plans, business processes, material management, and acquisition strategies, along with associated investment and risk management processes at all relevant levels. This work requires analyzing the costs associated with climate effects and how these can be reduced or mitigated through effective climate change adaptation. For example, cost curves for acquisition and procurement will change, as will costs for management and protection of critical infrastructure.

INTERGOVERNMENTAL COORDINATION

See LOE 5, *Enhance Adaptation and Resilience Through Collaboration.*

CHALLENGES/FURTHER CONSIDERATIONS

Developing sound intelligence estimates and decision-making tools about an inherently uncertain future where some specific climate changes are likely, yet not specifically known, requires both discipline and flexibility. Threat analysis, modeling and simulation, wargaming, and experimentation enhance the Department's understanding of its current and future operating environments. Harnessing artificial intelligence (AI) to develop predictive models and decision support tools for operational and business decision-making processes can inform planning and operations in the U.S. and abroad. Methods considering known or anticipated weather conditions, force requirements, and options for operational fuel efficiency must account for nonlinear and changing future conditions.

The Department of the Navy and Department of the Air Force Meteorological and Oceanographic communities already have several existing weather tools and decision aids such as the Advanced Climate Analysis and Forecasting System or the products hosted by the 14th Weather Squadron. These allow decision-makers to understand climate trends to date to set a context for how future projected climate conditions vary from this observed baseline. Data and information from these tools and systems will be integrated with climate information as appropriate for strategic, operational, and tactical decisions.

EO 14008 emphasizes Environmental Justice in climate adaptation activities. Environmental Justice considerations require that Department programs, policies, and activities address disproportionately high and adverse human health, environmental, climate-related, and other cumulative impacts on disadvantaged communities. DOD business intelligence and metrics across financial and management information systems should include climate-related Environmental Justice and social vulnerability analyses where appropriate.

HIGHLIGHTS OF ACCOMPLISHMENTS TO DATE

Climate Change Adaptation and Resilience Planning Tools: DOD has developed tools for assessing climate change impacts, managing climate-related risks, and informing decision-making across installations. In October 2020, the Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP) launched the DOD Regional Sea Level (DRSL) tool enabling DOD planners and managers to understand and assess a range of site-specific scenarios of future sea level rise and extreme water level conditions for three time horizons: 2035, 2065, and 2100. The scenarios can be adjusted for local conditions of future sea level change and storm surge. The DRSL database contains a graphical user interface that provides users access to the scenario information for DOD coastal and tidally influenced military sites worldwide.

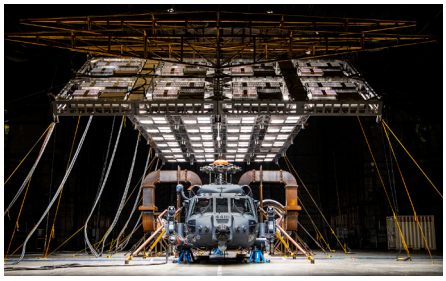
Department of the Air Force: The Geospatial Supply Chain Risk Identification and Monitoring (Geo-SCRIM) tool monitors and alerts organizations when suppliers (e.g., the critical organic industrial base suppliers) are in the pathway of environmental risks such as hurricanes, wildfires, and pandemics (like COVID-19).

Department of the Navy: The DOD Mission Assurance Program provides a comprehensive review of all threats to Department of the Navy installations and ranges. This review includes the exposure to climate and environmental hazards, as detailed in the All Hazard Threat Assessment (AHTA). The AHTA analyzes both the probability and mission impact of climate risks tailored to specific geographic locations to provide a full range of threats. The AHTA is the baseline for each installation to begin design and planning efforts to ensure continuity of operations and feed the development of Installation Energy Plans, Security and Emergency Response Plans, Master Plans, and climate mitigation strategies.

LINE OF EFFORT 2:
TRAIN AND EQUIP A CLIMATE-READY FORCE

DESCRIPTION (CONTINUING EFFORT):

DOD must have prepared combat forces capable of operating under the most extreme and adverse weather and terrain conditions. The nonlinear impacts of climate change require us to expand this work by anticipating, training, and equipping for emerging environmental conditions different from the range of environments existing today. This includes compounding effects of climate hazards together or with other disruptions (e.g., pandemic). The evolving operational environment and the need to operate in new, more extreme environments may require changes to where and how U.S. Forces train for future conflict. The need for new and advanced training systems capabilities may be necessary to meet readiness requirements. This will be reflected in the Department's efforts across activities related to developing, acquiring, fielding, and sustaining equipment and services. DOD will develop a list of adaptation concepts to test in crises action planning, tabletop, and command post exercises. Integrating adaptation concepts into existing major exercises informs the joint force on how to adjust current operational and contingency plans, while identifying scenarios that should have their own individual plan.



An HH-60W Jolly Green II sits under bright lights used to create heat in the McKinley Climatic Lab at Eglin Air Force Base (AFB), Florida (March 19, 2020).

FOCUS AREAS:

Ensuring a climate-ready force by implementing the following actions:

- **Train Safely in Extreme Conditions:** Review and modify existing training programs to safely develop the ability of service members to operate in extreme conditions. Include not only the individual service member, civilian, and contractor but also each unit's collective readiness to operate in extreme conditions. Adjust medical skills and first aid training for extreme heat and assess applicability of alternative training methods to improve safety. Identify equipment solutions needed to protect service members.
- **Assess Current and Future Equipment:** Assess the viability of current equipment to operate in extreme climate conditions. Identify opportunities to incorporate new technologies to improve performance or adapt existing equipment that may fill an emerging climate-related requirement. Evaluate climate performance of future weapons systems.
- **Assess and Adjust Requirements and Acquisition:** For materiel development and acquisition activities, incorporate requirements built around a realistic projection of future operating conditions, with special attention given to the Operational Energy Key Performance Parameter (KPP) as discussed in LOE 4. Identify new requirements to enable the future force such as "tactical cooling," "on-site water generation," and "arctic maneuver."
- **Test Equipment for Climate Effects:** Ensure all equipment testing realistically incorporates expected environmental conditions. In some cases, single-use, purpose-built equipment with associated redundant costs may be an effective adaptation measure. This requires flexible thinking regarding multipurpose, joint-service equipment where redundancies and commonality have reduced equipping, maintenance, and sustainment costs.

OUTCOME

An agile force, trained and equipped to operate effectively in all anticipated climatic conditions.

AGENCY LEADS

Office of Secretary of Defense; DOD Climate Change Working Group; Under Secretary of Defense for Personnel and Readiness; Joint Staff; Combatant Commands; Military Departments.

SCALE

Global.

TIMEFRAME

Training, testing, and equipping combat forces capable of operating under extreme and adverse weather and terrain conditions is the subject of continual review and adjustment from now through the foreseeable future.

RISKS

- Climate effects to training and equipping are manifested in an increased number of suspended/delayed/canceled outdoor training/testing events and increased operational health surveillance, and health and safety risks to the Department's personnel.
- Extreme temperatures and weather conditions can result in increased damage to training equipment and infrastructure.

OPPORTUNITIES

- Effective climate adaptation requires developing innovative measures and methods that support continual training and operations in climate-changed conditions.
- Alternative training methods such as wargaming, enhanced AI-based simulations, and state-of-the-art tabletop exercises may also assist in reducing the risks of actual ground-based maneuvers in extreme conditions.
- The Department should direct efforts in this LOE toward harnessing adaptation and resilience measures to create combat overmatch. This enables U.S. Forces to gain distinct advantages over potential adversaries if our forces can operate in conditions where others must take shelter or go to ground.
- New technologies that reduce fuel consumption may add capabilities such as improving operational mission capabilities without use of the main engine (i.e., silent watch), while also decreasing logistics requirements.

WILDFIRE

Naval Air Weapons Station (NAWS) China Lake, California, experiences adverse impacts to operations due to fire. Examples of operational impacts include the cancellation of 11 Department of State tests by the Quick Reaction Capability Office due to wildfires last year. The Explosive Ordnance Disposal Training Teams also had three full events canceled and one event partially canceled due to the fires. Several air operation sorties were canceled because of the associated smoke and haze from wildfires at NAWS China Lake, California.

PERFORMANCE METRICS

Performance metrics for training, testing, and equipping will be reviewed and updated to reflect evolving understanding of observed and reasonably foreseeable climate changes and the cascading effects that could pose challenges to the mission.

RESOURCE IMPLICATIONS

DOD is assessing how to integrate adaptation resource considerations and cost management (including life-cycle costs) into plans, business processes, material management, and acquisition strategies, along with associated investment and risk management processes at all relevant levels. This work requires analyzing the costs associated with climate effects and how these can be reduced through effective climate change adaptation. For example, cost estimation practices for acquisition and procurement will change, as will costs for management and protection of critical infrastructure.

INTERGOVERNMENTAL COORDINATION

See LOE 5, *Enhance Adaptation and Resilience Through Collaboration.*

CHALLENGES/FURTHER CONSIDERATIONS

Training under more extreme conditions poses challenges to stationing decisions and health surveillance programs, including increased frequency of health monitoring and adequacy of personal protective equipment. Health and safety risks to the Department's personnel and demand for operational health surveillance programs and health services will increase.

DOD must consider the impacts to readiness and mission that substitution of chemicals with global warming and/or unintended environmental consequences may pose. DOD will continue to use its toxicology expertise contained within its Chemical and Material Risk Management Programs to also assess potential human and environmental health effects from exposure to emerging chemicals. Removal of key chemicals from the supply chain may necessitate development of costly alternatives.

HIGHLIGHTS OF ACCOMPLISHMENTS TO DATE

Department of the Army Integrated Training Area Management (ITAM) Program: This program has conducted short- and long-term rehabilitation measures on training ranges for over 30 years. ITAM repairs maneuver training damage and reconfigures training lands to increase soil reliance, which preemptively decreases the negative impacts of extreme weather events on military training. ITAM also conducts active vegetation management within training areas, which reduces the risk of wildland fire exacerbated by increased fuel accumulation and enduring drought conditions.

Joint Services: Under U.S. Northern Command (USNORTHCOM), personnel shelters for use in the Arctic environment are currently undergoing testing, along with plans to incorporate Arctic-capable shelters into exercise Arctic Edge 2022. Combined U.S. and Canadian testing is underway to develop a Cold Rapid Airfield Damage Repair capability.

Department of the Army Cold Weather Exercises: The Army conducts exercises with allies and partners as part of a Department and Combatant Command exercise program. The particular scenario, which may reflect aspects of a changing climate, informs the shape and objectives of these exercises.

Air Force Polar Survival School: The Air Force operates a cold weather survival school at Eielson Air Force Base, Alaska. Hundreds of students from across all services attend each year, learning how to survive in temperatures averaging near 30 degrees below zero.

TRAINING DISRUPTIONS CAN LINGER – ADAPTATION WILL REDUCE FUTURE IMPACTS

In fall 2018, Hurricane Michael, a Category 5 storm, severely damaged Tyndall AFB. As a result of the hurricane's impact, "the F-22 community lost access to its premier simulator" and academic training facility for months. As the Tyndall recovery effort began, F-22 training across the fleet adapted by redistributing personnel, aircraft, and equipment from Tyndall to other locations. The storm results provide the opportunity to consolidate F-22s at Joint Base Langley-Eustis, VA, making it home to both training and operational squadrons.

The Department of the Air Force exceeded Unified Facilities Criteria minimum design requirements in rebuilding Tyndall AFB following Hurricane Michael. The design wind speed used for rebuild is based on the Florida Building Code for High Velocity Hurricane Zone (165 mph), because maximum wind during Hurricane Michael was 161 mph. Other High Velocity Hurricane Zone requirements were adopted, such as roof framing to foundation connections. Design flood elevation merged Federal Emergency Management Agency base flood levels and the highest DOD regionalized sea level rise scenario for year 2100.

LINE OF EFFORT 3:
RESILIENT BUILT AND NATURAL INSTALLATION INFRASTRUCTURE

DESCRIPTION (CONTINUING EFFORT):

Built and natural infrastructure are both necessary for successful mission preparedness and readiness. Built infrastructure serves as the staging platform for the Department's national defense and humanitarian missions; natural infrastructure supports military combat readiness by providing realistic operational testing and combat environments and conditions. Installations and their built and natural infrastructure also serve as the platforms from which the DOD cares for its people and projects and sustains forces. Many global operational missions are accomplished and/or sustained from DOD installations. Changing climate provides an opportunity to reevaluate use of regional approaches that allow for flexibility to adjust to changing conditions while providing an appropriate level of standardization for resilience, efficiency, and costs.

On September 5, 2019, trainees at Fort Jackson, S.C., stack sandbags for use throughout the hurricane season.

FOCUS AREAS:

Achieving resilient built and natural installation infrastructure through the following implementation activities:

- **Installation Resilience:** Engage all DOD installations in a comprehensive installation assessment and resilience planning activity incorporating outcomes into installation resilience plans. Progress and performance will be tracked, and installation "readiness" tested during exercises. Building standards will be updated to ensure continuity of operations under altered climate conditions.
- **Preserve Testing and Training Space:** Complete climate-informed natural resource plans to better protect test and training. Work with surrounding communities to protect land near installations and proactively engage with the private sector to address impacts of off-base development.
- **Ecosystem Services:** Enhance the management of DOD natural assets to preserve or expand ecosystem services, building resilience at the regional level.

OUTCOME

Built and natural infrastructure in place that is necessary for successful mission preparedness, military readiness, and operational success in changing conditions.

AGENCY LEADS

Under Secretary of Defense for Acquisition and Sustainment; Military Departments; Defense Agencies.

SCALE

Global.

TIMEFRAME

Policies and guidance to enhance resilient built and natural infrastructure through adaptation exist today, as do programs that focus on natural infrastructure. These efforts will continue to evolve as climate science advances and knowledge of foreseeable impacts progress.

CYBER SECURITY

Joint Services USNORTHCOM sponsors the More Situational Awareness for Industrial Control Systems Joint Capability Technology Demonstration to ensure industrial control system cyber security and reduce the adversary threat to our nation's critical infrastructure.

RISKS

- Climate change results in variations in frequency and intensity of precipitation patterns, leading some regions to become drier or wetter. Precipitation events are becoming more intense, increasing the risk of local flooding even during drought periods. This trend of varying frequencies and intensities of precipitation globally is expected to continue.
- Coastal installations are susceptible to hazards of sea level rise, coastal erosion, storm surge, and saltwater intrusion.
- Rising temperatures and other climate changes can significantly modify the natural infrastructure in several ways at installations. For example, flora and fauna distributions will be significantly altered as drier conditions will convert many currently forested areas to grasslands. Introduced species, many of which are very disruptive to native ecosystems and species composition, will expand their range. This includes many pest species, competitors with native species, and diseases associated with more tropical regions.
- Energy resilience is crucial to maintain mission essential functions. Increasing frequency and intensity of severe storms, fires, and increased load demand for cooling due to rising temperatures will continue to stress energy resources. Installations that are dependent on the commercial power grid and vulnerable to disruptions due to severe weather may also experience physical attacks and cyber attacks, exploiting that vulnerability.
- Risk of wildfires is projected to increase on many installations, ranges, and in land proximate to installations including where military and civilian personnel reside.
- In the Arctic, permafrost plays an important role regarding natural and built infrastructure. For example, it provides stability of large acreages of wetlands and lakes across the tundra. Permafrost thaw threatens to undermine roads and structural foundations.
- Reductions in access to or restrictions on testing capabilities due to climate impacts may cause relocation or loss of testing capabilities, or limitations on testing which result in increased costs, prolonged delivery schedules, and lower confidence assessments/higher risk acceptance. Reducing risk will increase the reliance on other approaches including modeling and simulation.
- Assured access to an adequate water supply is critical for long-term water security and military readiness. Water service failures present a current and growing risk to installations, as such failures have direct impacts (e.g., disruption, health and safety, financial) on an installation's ability to execute their mission, and the welfare of communities where military and civilian personnel reside. In Outside Continental U.S. (OCONUS) locations, military water requirements might compete with local water needs, creating potential areas of friction or even conflict.
- Critical port facilities will be impacted by rising sea levels and extreme weather events.

OPPORTUNITIES

- DOD components could engage the private manufacturing and technology sectors, presenting anticipated challenges and potential opportunities for private industry to fill future requirements.
- Expanded use of programs such as the Sentinel Landscape Program and the Readiness and Environmental Protection Integration (REPI) program can preserve or enhance natural infrastructure mission capabilities.
- New water resilience initiatives for DOD include constructing additional wastewater treatment and potable water infrastructure capacity at military installations to recapture and reuse water, use of dehumidification to capture water from air, and construction of underground reservoirs for additional reserve capacity.

PERFORMANCE METRICS

Performance metrics will be reviewed and updated to reflect evolving knowledge of observed and reasonably foreseeable climate impacts to built and natural infrastructure. Initial metrics implemented include presence or absence of climate hazards (coastal flooding, riverine flooding, heat, drought, energy demand, land degradation, wildfire, and historical extreme weather events). Advana dashboard metrics also measure whether installation climate exposure assessments have been performed and incorporated in planning, including installation energy resilience plans.

THE SENTINEL LANDSCAPES PROGRAM

The Sentinel Landscapes Program coordinates between DOD, the U.S. Department of Agriculture, and the Department of the Interior. This coalition of federal agencies, state governments, local communities, and private conservation organizations works to advance shared land-use goals around military bases. The program works to identify landscapes across the country where missions of all three agencies—promoting sustainable agricultural and forestry of rural lands, strengthening national defense, and building community resilience to climate change—intersect. The three agencies then coordinate to target their conservation programs to properties within these priority areas. Each project site, or "sentinel landscape," represents remarkably successful collaboration across agricultural, defense, and conservation sectors to tackle complex issues related to water quantity and quality, imperiled species habitat, and wildfire mitigation.

RESOURCE IMPLICATIONS

DOD is assessing how to integrate adaptation resource considerations and cost management (including life-cycle costs) into plans, business processes, material management, and acquisition strategies, along with associated investment and risk management processes at all relevant levels. This work requires analyzing the costs associated with climate effects and how these can be reduced through effective climate change adaptation. For example, cost estimation practices for acquisition and procurement will change, as will costs for management and protection of critical infrastructure, and cost-benefit analyses could be useful in helping decide between alternative adaptation approaches.

INTERGOVERNMENTAL COORDINATION

See LOE 5, *Enhance Adaptation and Resilience Through Collaboration.*

CHALLENGES/FURTHER CONSIDERATIONS

The challenge to maintain present built and natural infrastructure into the future will vary depending on location, climate hazard exposure, and sensitivity of missions and operations. Improving understanding of the effects of climate change adaptation and mitigation measures to infrastructure components and ecosystems is critical. Further, DOD should evaluate its current culture of maintaining and repairing facilities and structures well past their useful lifespan. Adapting current and developing new criteria that accounts for anticipated impacts may result in the demolition, divestiture, or repurposing of structures and facilities, regardless of their age. Combatant Command requirements for future posturing options could conflict with collapsing approaches to reduce footprint and gain efficiencies at home.

Information about how natural ecosystems contribute to ecosystem services (positive benefits including carbon sequestration, timber management, prevention of soil erosion, habitat for threatened and endangered species, and biodiversity) and climate resilience, and how they overlap with the built environment provide insight into how to design better solutions that account for the condition and benefits of the whole system. For example, coastal ecosystems—including wetlands, marshes, and mangroves—may shield communities from the impacts of climate change.

"Lost days" at an individual training/testing location impact the readiness of an individual unit or an individual weapons system's testing regime. The Department must assess climate impacts at local training/testing assets and quantify the cumulative effects across all the Department's training and testing. Reductions in access to training lands may increase the demand for acquisition/development of new training lands or alternative training to maintain unit readiness. Reductions in access to testing capabilities may increase the reliance on modeling and simulation, relocation, or loss of testing capabilities, or limitations on testing which result in increased costs, prolonged delivery schedules, or lower confidence assessments.

HIGHLIGHTS OF ACCOMPLISHMENTS TO DATE

Guam Power: Naval Facilities Engineering Systems Command (NAVFAC) Marianas has partnered with the Guam Power Authority (GPA) as the power utility service provider to military installations on Guam. The GPA's 2010 Long Range Transmission Study established policy to move power generation from shore side to higher inland areas due to risks associated with tsunamis, storm surge, and rising sea levels.

Fort Huachuca REPI: Located in Arizona's Sonoran Desert, Fort Huachuca is accustomed to periodic drought and wildfires that threaten the unmanned aircraft system training and electronic warfare testing missions of this once remote installation. The threat to the installation's physical infrastructure and water security led Fort Huachuca to partner with the Arizona Land and Water Trust (ALWT) to conduct an extensive Water Supply and Use Assessment that included an analysis of groundwater levels and surface flows, a survey of current irrigation and water use, and a comprehensive review of historic pumping records and water rights. In FY 2020, Fort Huachuca and ALWT completed this survey and were awarded $2 million in REPI Challenge funding that, coupled with $4.3 million in partner funding, will protect over 2,000 acres of working ranches and forests from incompatible development that would increase demand for groundwater pumping in the area. Funds will also support installation efforts with the U.S. Forest Service to reduce hazardous fuels within the adjacent Coronado National Forest, resulting in the reduced threat of wildfires in the area and at Fort Huachuca.

U.S. Naval Academy (USNA)/Naval Support Academy Annapolis, Maryland: A DOD-funded resilience study (FY 20–22) will result in a comprehensive plan with specific courses of action to cohesively address and mitigate the combined effects of land subsidence, sea level rise, ground water change, coastal flooding/storm surge, and inadequate stormwater management at USNA. Courses of action will include a mix of approaches: structural (seawalls, bulkheads, floodwalls, stormwater retrofits), natural (earthen berms/levees, rain gardens, living shorelines), non-structural (changes in land use), and temporary solutions to issues where long-term permanent protection may take years to implement. The installation is in the midst of implementing additional stormwater repair projects and proposing to repair and restore the seawall and shoreline along the installation to address structural deficiencies on the existing seawall and potential impacts from future extreme weather events, storm surge, sea level rise, and land subsidence.

Guam Power Authority employee tests equipment for military installations on Guam.

Soldiers conduct unmanned aerial system training for readiness-level progression at Fort Huachuca.

An entrance to the U.S. Naval Academy campus in Annapolis, Maryland (January 9, 2014).

READINESS AND ENVIRONMENTAL PROTECTION INTEGRATION

The REPI program is a particularly effective way to preserve or enhance mission capabilities by protecting lands near installations and ranges (DOD 2021a).

"REPI funds can also be leveraged by our partners to satisfy any matching or cost-sharing requirement of any conservation or resilience program of any federal agency. This presents an incredible opportunity for DOD to collaborate with our interagency partners and enhance state, local, and non-governmental initiatives that complement REPI's climate resilience efforts."

— Deputy Secretary of Defense, Kathleen Hicks
(April 22, 2021)

LINE OF EFFORT 4:
SUPPLY CHAIN RESILIENCE AND INNOVATION

DESCRIPTION (CONTINUING EFFORT):

A climate-resilient supply chain is one in which the Department has ensured that key suppliers and industries can still operate though impacted by climate change. DOD must also consider logistic support of supply chains (e.g., fuel, power requirements) especially in austere locations that are more vulnerable to the effects of climate change. To remain agile and flexible in responding to changing conditions, actions will include energy demand reduction to reduce logistics requirements and establish metrics and measures for tracking progress. The DOD acquisition system must consider operational energy as stated in the Operational Energy KPP (10 USC 2911) that reduces the logistical footprints of contingency locations. Other optimization of logistical support requirements (e.g., water) can improve resilience and make supply lines less vulnerable to the effects of climate change and adversaries.

Air Force Airman loads pallets of water into a C-17 Globemaster at Joint Base San Antonio-Kelly Field, Texas.

FOCUS AREAS:

Building supply chain resilience through the following implementation activities:

- **Assess Supply Chain Resilience:** Include climate change considerations in all supply chain assessments, working with major suppliers to identify risks and corrective actions. Work to realistically "stress test" the supply chain in wargames and simulations.
- **Harden and Shift to Onshore:** Develop a prioritized plan to protect or "harden" and shift to American-made ("onshore") critical supply chains and components with special attention given to "last-mile" resilience. Consider stockpiling key materials and components where this is not already best practice.
- **Leverage Purchasing Power:** Align DOD supply chain resilience efforts to specifically support key climate resilience and mitigation technologies. Act to spur deployment of climate mitigation technologies such as microgrids and power storage when such items align with DOD's mission requirements. Pioneer the use of carbon-sequestering construction technologies. Explore potential for major suppliers to disclose GHG emissions, treat climate change vulnerabilities as a "material weakness" on financial reports, and expect commitments to public reporting on Environment, Social and Governance (ESG) features of their business operations.

DEPARTMENT OF THE AIR FORCE

Demand-side optimization reduces burden on fuel logistics; advanced aerial planning tools and aircraft drag reduction initiatives like C-17 Microvanes are expected to both mitigate climate change and reduce dependence on fuel supply chains.

OUTCOME

Uninterrupted access to key supplies, materials, chemicals, and services.

AGENCY LEADS

Under Secretary of Defense for Acquisition and Sustainment; Military Departments; Defense Agencies.

SCALE

Global.

TIMEFRAME

Supply chain resilience is an area of growing concern. Analyses and required adaptation will occur now through the foreseeable future.

RISKS

- Climate change and extreme weather can disrupt supply chains. Maintaining an effective supply chain security posture through supply chain risk management is fundamental to DOD's ability to meet its mission.
- Higher cost supplies may result due to higher overhead/operating costs of domestic manufacturing.

OPPORTUNITIES

- The Department should assess climate change-related vulnerabilities within our supply chain that can be exploited by would-be adversaries, either for short- or long-term gain.
- To avoid inadvertent shifts of costs and/or liabilities to the DOD operational, logistics, and installations management communities, the DOD Sustainability Analysis Guidance (DOD 2020b) recommends a life-cycle approach to quantify liabilities during system acquisition. These liabilities can include impacts to climate change through GHG emissions or climate change impacts to the system acquisition in question.
- Specific attention should be given to last-mile supply chains in theater in addition to onshoring and hardening locations of supply. Key recommendations by the National Academies of Sciences, Engineering, and Medicine (2020) for supply chain resilience to major climate-related disasters focus not only on the production and shipping of supplies, but the last-mile movement of supplies to their final use. Ignoring last-mile issues (e.g., road access, traffic jams, storage, delivery) will lead to fragile plans for the DOD. This affects DOD personnel and missions in emergency management and HADR support.
- DOD will conduct an analysis to develop a goal for onshoring and supply of "Made in America" critical supplies to define specific requirements for programs of record and for regular acquisitions. Flexibility is needed to be sure any critical components not produced domestically can be sourced from specific allied nations to ensure access during major conflicts or until a domestic production line can be established.
- Sustainable procurement enhances and sustains mission readiness through cost-effective acquisition that achieves compliance; prevents pollution; ensures product availability; and minimizes environmental, safety, and occupational health impacts to the warfighter. As described in DOD Instruction (DODI) 4105.72 (Procurement of Sustainable Goods and Services, DOD 2018b), the Sustainable Procurement Program allows DOD to purchase environmentally preferable products and services.
- The Department will use its position as the single largest buyer of goods and services to drive transparency within and across its supply chain; expecting major supplies to fully disclose GHG emissions and broader ESG performance.

EXECUTIVE ORDER 14008

"Agencies shall consider the feasibility of using the purchasing power of the Federal Government to drive innovation and shall seek to increase the Federal Government's resilience against supply chain disruptions. Such disruptions put the Nation's manufacturing sector at risk, as well as consumer access to critical goods and services."

PERFORMANCE METRICS

Performance metrics will be reviewed and updated to reflect evolving understanding of observed and reasonably foreseeable climate impacts to supply chain.

RESOURCE IMPLICATIONS

DOD is assessing how to integrate adaptation resource considerations and cost management (including life-cycle costs) into plans, business processes, material management, and acquisition strategies, along with associated investment and risk management processes at all relevant levels. This work requires analyzing the costs associated with climate impacts to supply chains and how these can be reduced through effective climate change adaptation.

INTERGOVERNMENTAL COORDINATION

See LOE 5, *Enhance Adaptation and Resilience Through Collaboration.*

CHALLENGES/FURTHER CONSIDERATIONS

DOD must modify and implement requirements analysis and acquisition strategies to account for climate change. For example, DOD must review acquisition processes for strategic reserves and stockpiles for critical components; new and existing weapons systems and their associated maintenance plans; and storage, distribution, and transportation activities, including transportation modes and routes.

DOD is limited in its ability to conduct climate change risk assessments of commercially owned facilities that provide contracted goods or services to DOD, and which support DOD installations and weapons systems. DOD must adopt a comprehensive mission assurance framework to manage risks in a way that accounts for the Department's dependence on non-DOD owned facilities and the consequences of any disruptions to those facilities (Government Accountability Office [GAO] 2020).

Increased resilience in the Department's supply chain may depend in part on collaborative mechanisms that leverage best practices and adaptation strategies across the Department and in the private sector. Collaboration around major manufacturing, supply, and transportation corporations, including shared use of supply/resupply networks and maintenance facilities within the Department and industry as part of the acquisition and procurement process, will increase resilience.

Supply chains can also be at risk due to impacts from drawdown of chemicals associated with GHG emissions (e.g., hydrofluorocarbons [HFCs]) and the potential that DOD does not account for all mission-critical uses of HFCs. This can lead to loss of access to mission-critical chemicals, especially when there are no known or viable alternatives at this time.

U.S. EUROPEAN COMMAND (USEUCOM) AREA OF RESPONSIBILITY (AOR) SEAPORTS

Expected sea level rise by the year 2100 ranges between 0.3 m and 2.5 m. Rising sea levels will directly impact coastal locations that are part of a complex of commercial distribution infrastructure, including seaports of embarkation/debarkation in the USEUCOM AoR. Additional engineering assessments will be required to determine the ability for coastal infrastructure to accommodate higher sea levels along with higher tides, higher wave lengths, and increased soil/shore erosion.

HIGHLIGHTS OF ACCOMPLISHMENTS TO DATE

Department of the Navy Model for Supply Chains: NAVFAC is currently developing an agent-based model for supply chains; this is a project started in FY 20 and continuing through FY 21. It provides a tool to evaluate supply chain disruptions on fuel deliveries and adaptive planning based on perturbations to environmental conditions and available infrastructure. This will simulate and model joint logistics-over-the-shore operations using agents that have local sensing, decision-making, and adaptation capability.

Joint Services: The North American Aerospace Defense Command and USNORTHCOM staff are baselining the fuel supply chain distribution system in the Arctic to better understand the shortfalls and advocate for future infrastructure development to enhance resilience to changing climate.

Department of the Air Force: Through aggressive fleet management, including alternative fuel/hybrid vehicle prioritization, right-sizing, and "U-Drive It" use, the Air Force reduced fleet operating costs by 22.3 percent while increasing Alternative Fuel Vehicle inventory 42.7 percent. U.S. Department of Energy recognized the USAF's progress with the 2020 Federal Energy Management Program award.

LINE OF EFFORT 5:
ENHANCE ADAPTATION AND RESILIENCE THROUGH COLLABORATION

DESCRIPTION (CONTINUING EFFORT):

Instituting effective and efficient climate adaptation over the range of DOD missions, operations, and infrastructure requires leveraging all relevant information, methods, technologies, and approaches. This can only be achieved through close collaboration with others. The Department will build unity of effort and mission across DOD components, commands, services, and theaters to exploit lessons learned and economies of scale. Close cooperation with all who have a stake in our national security (other federal agencies, Congress, private industry, academia, NGOs, the American people, and allies), as well as other nations, will help secure our common interests and promote our shared values.

Community members of the city of Chevak, Alaska, meet with tribal leaders and citizens to discuss disaster assistance measures and processes in light of recent emergencies in preparation for the upcoming flood season.

FOCUS AREAS:

Organizing the Department's climate change adaptation and resilience collaboration activities as follows:

- **Interagency and Intergovernmental:** Given DOD's scale, engage in a wide array of interagency and intergovernmental forums with specific attention given to research and collaboration on new technologies, and regional-based land-use planning to adapt shared ecosystems to climate impacts.
- **Partner Nations:** Build partner nation capacity to respond to climate change-related hazards. Actively participate in technical, academic, and scientific exchanges to accelerate climate change-related knowledge to and from DOD. In concert with partner nations, ensure overseas infrastructure is adapted and resilient to local conditions.
- **Community Resilience:** Work directly with communities adjacent to installations to build shared resilience, enhance shared ecosystems, and preserve test and training lands.

INTERAGENCY COORDINATION OF FEDERAL CLIMATE RESEARCH VITAL TO DOD INTERESTS

DOD coordinates its federal interagency climate science research and development activities through interagency bodies. This coordination provides invaluable opportunities for DOD to coordinate with and leverage their unique capabilities and investments.

- *DOD serves as a representative on the National Science and Technology Council's Committee on Environment to ensure all relevant services and DOD stakeholders have representation at the executive-level, interagency subcommittees.*
- *The Interagency Arctic Research Policy Committee (IARPC) is the Federal Government's primary forum for promoting interagency coordination and collaboration on Arctic research policy and priorities. DOD regularly collaborates with IARPC; is involved in setting the strategy for building capability in the Arctic sciences and collaboration space; and is actively involved in developing the next five-year Arctic Research Plan, which will be issued in 2021.*
- *The Subcommittee on Global Change Research (SGCR) is the governing body of the United States Global Change Research Program (USGCRP), which integrates the products of all-source climate research to provide strategic assessments and reports for policymakers and the public. DOD is a member of the SGCR and provides subject matter expertise that contributes to development of SGCR products, including the Decadal Strategic, an annual report to Congress on USGCRP's activities and accomplishments, and the National Climate Assessment.*

OUTCOME

Reduce adaptation costs and build unity of purpose through meaningful engagement with DOD stakeholders.

AGENCY LEADS

Office of Secretary of Defense; Office of Secretary of Defense Policy; DOD Climate Change Working Group; Joint Staff; Combatant Commands; Military Departments; DOD Office of Intergovernmental Affairs, Defense Agencies.

SCALE

Global.

TIMEFRAME

Efforts to enhance existing collaborations that provide a focus on adaptation to increase mission resilience will continue.

RISKS

- Aspects of the DOD mission, such as Force deployment, may be affected by assets outside our control, such as transportation infrastructure.
- The Department cannot effectively assess its vulnerabilities and implement adaptive responses at its installations if neighboring communities and stakeholders are not part of the process.
- As climate changes, there may be commensurate alterations in local and regional politics to mitigate food and water shortages. These political adjustments could result in increased physical and cyber terrorist attacks from unknown third parties. Therefore, DOD should work to strengthen local mechanisms supporting food and water stability and minimizing risk to critical systems.

OPPORTUNITIES

- The Department's decisions around climate change and those of neighboring communities are intrinsically interconnected. Strengthening these relationships through DOD natural resources programs such as the Sentinel Landscapes REPI program can reduce pollution and its cumulative health impacts and invest in climate-ready infrastructure.
- Extreme weather patterns such as frequent flooding from sea level rise, maximum precipitation events, flash drought, extreme heat, and wildfires can have short-term and long-term impacts, often with disproportionate impacts on socially vulnerable and/or underserved communities. These weather patterns disrupt communities within and external to installations and threaten soil, air, and water quality. Inequitable distribution is particularly noticeable where increasingly intense extreme heat threatens public health and air quality. Leveraging knowledge to address these impacts and inequities secures our common interests and promotes our shared values.

PERFORMANCE METRICS

Performance metrics will be reviewed and updated to reflect evolving understanding of observed and reasonably foreseeable climate impacts to collaboration.

RESOURCE IMPLICATIONS

DOD administers three grant programs that support community coordination with local installations on climate change and extreme weather—the longstanding Compatible Use Study, the Military Installation Resilience Review program, and Defense Community Infrastructure Pilot programs. The resource implications to these programs and other opportunities to enhance adaptation and resilience through collaboration will be reviewed.

INTERGOVERNMENTAL COORDINATION

Intergovernmental coordination is a critical aspect of this LOE.

CHALLENGES/FURTHER CONSIDERATIONS

Leveraging knowledge and actions when planning climate change adaptation and emergency preparedness and response requires expanded collaboration with surrounding communities.

Interaction with other land and/or resource management agencies regarding encroachment challenges may in some cases provide new mechanisms for collaboration. The same holds true for expanded relationships with external, non-federal government land and resource stewardship organizations, NGOs, and with partner nation military and other appropriate organizations for overseas installations.

Military installations coordinate and cooperate with nearby communities for commodities and infrastructure, such as access roads and telecommunications. Communities surrounding installations face the same climate change-related challenges as DOD. Because these communities are often vital to installation resilience, DOD encourages installations to coordinate and cooperate with nearby communities to ensure they remain intact and habitable in the face of ongoing climate change impacts.

HIGHLIGHTS OF ACCOMPLISHMENTS TO DATE

Department of the Army: The Army Future Command's Development Command integrated a tactical microgrid with Italy and Canada in June 2019 during Capable Logistician, a multinational logistics exercise. The purpose of this exercise was to test microgrid interoperability and assess North Atlantic Treaty Organization (NATO) standards at Drawsko Pomorskie Training Grounds, Poland. The exercise, which included approximately 3,450 troops and representatives from 30 nations, demonstrated several innovative, "smart energy" technologies with the potential to reduce fuel waste, improve operational effectiveness, and enhance interoperability among NATO forces. The integration was the first example of a multinational tactical microgrid using an open standard for power source hardware and software interoperability.

Joint Services: USNORTHCOM reports that climate change is incorporated into the Defense Support of Civil Authorities and into the Homeland Defense plans, with respect to Arctic operations. USEUCOM is participating in a NATO assessment of the impacts of climate change on deterrence, defense posture, and civil preparedness for the pending 2021 NATO Summit.

Marine Corps Installation West, Camp Pendleton, CA: The 3rd Marine Aircraft Wing and San Diego County Sherriff's Department are integrating in a live rehearsal exercise (May 2021) in preparation for seasonal wildfire threats to the West Coast. The exercise's purpose is to provide Immediate Response actions according to established procedures during a response request. The exercise will employ Marine aviation to support fire suppression operations in the event of a natural wildfire disaster.

MacDill AFB: The United States Fish and Wildlife Service and regional partners designed and implemented a 1.6-mile-long living shoreline project starting in 2004. This ongoing project helped to adapt to climate change by creating a natural shoreline stabilization system that will adjust to changes in sea level to control shoreline erosion from heavily trafficked shipping lanes in Tampa Bay, Florida. The shoreline is composed of oyster reefs on man-made structures, fossilized shells, and coastal marsh plants. These decrease wave energy, increase sediment accumulation, improve water quality through oyster filtration, enhance biodiversity, and provide habitats for several marine species. This project helps reduce risks to portions of remaining undeveloped shoreline in the Tampa Bay region. Six phases of work have been completed to date with several future phases planned to reduce risks for another half mile of shoreline.

FOUR TOPIC AREAS

Per the *Interim Instructions for Preparing Draft Climate Action Plans Under Executive Order 14008* (CEQ 2021) requirements, this plan includes four topic areas, information on the current status and desired end state of each topic, and other specific requirements.

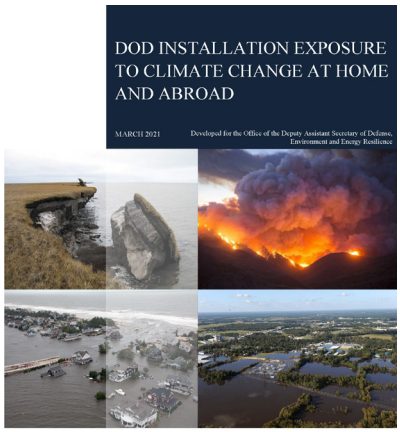
TOPIC 1.
UPDATE CLIMATE VULNERABILITY ASSESSMENTS

END STATE: Develop and implement methods and approaches to update climate vulnerability assessments on a continuing basis to reflect new knowledge.

CURRENT STATUS: Beginning in mid-FY 19, the Office of the Deputy Assistant Secretary of Defense, Environment and Energy Resilience expanded and updated its capability to perform climate vulnerability analyses. The DOD Climate Assessment Tool (DCAT, Gade et al., 2021) provides a screening-level assessment of an installation's future climate exposure related to eight hazards: coastal flooding, riverine flooding, heat, drought, energy demand, land degradation, wildfire, and historical extreme weather events. Climate hazard exposure encompasses two scenarios—lower future warming and higher future warming—and two future epochs: 2035–2064 (reported at 2050) and 2070–2099 (reported at 2085). The DCAT provides a consistent framework allowing for the addition of more installations, additional indicators, and new hazard categories.

The DCAT results for 1,055 locations worldwide were released in April 2021 (Pinson et al., 2021). The Department plans to complete climate exposure assessments on all major U.S. installations with a target of January 2022 and all major OCONUS installations by January 2023.

The DOD Climate Adaptation Roadmap (DOD 214) describes the impacts to DOD with no action. The adaptation implementation methods necessary to reduce climate risks are outlined in the focus areas described for each LOE above. No specific barriers to implementation are identified beyond the risks and challenges identified for each LOE. Additional work is required to determine timelines and metrics for performance. Additional study is planned to determine whether managing risk and overcoming barriers is achievable within existing agency resources and to determine if and how a specific aspect of the vulnerability either is or will be disclosed in annual agency financial reporting and integrated into the agency's enterprise risk management process.



THE NAVAL OBSERVATORY FLAGSTAFF STATION

Naval Observatory Flagstaff Station (NOFS) is an astronomical observatory operated as a dark-sky observation site by the United States Naval Observatory. NOFS's mission involves the analysis and interpretation of astrometric and photometric observations. These observations are used to perform research and to support testing and training requirements for highly specialized electronic, cryogenic, optical, and infrared instrumentation and techniques. The geography, climate, and atmospheric conditions of the Flagstaff region make it an ideal location for scientific research of the night sky. However, over the course of the past decade, astronomers have documented that the "seeing" at NOFS has degraded significantly as changing precipitation patterns have resulted in disruptions to ambient and atmospheric conditions. In addition, the more pervasive threat to night observations as well as physical assets at NOFS Main Site is from high-severity fire. Along with the on-the-ground impacts of fire, smoke from high-severity wildfire can cause damage to sensitive equipment and reduce visibility.

TOPIC 2.
AGENCY EFFORTS TO ENHANCE CLIMATE LITERACY IN ITS MANAGEMENT WORKFORCE

The fact that Topic 2 was identified as a key enabler integral to the success of all DOD climate adaptation efforts (Figure 1), reflects the importance of this topic area to the DOD. The Department recognizes that the ability to prepare for and to respond to climate change risks relies on the knowledge, skills, and capabilities of its workforce and senior leadership. The Department is committed to integrating climate change literacy into all its training and education efforts, from skill-specific military education to graduate training in the war colleges.

END STATE: The capability to include climate change considerations and impacts into all relevant and applicable DOD decisions.

CURRENT STATUS: While the Department does possess significant climate change-related expertise, such expertise is often confined to discrete technical functions or organizations. The intent is to broaden this knowledge over time, across the entire DOD workforce. DOD Senior Leaders are tasked with translating abstract climate hazards to address meaningful emerging risks and to identify gaps in existing knowledge and staff capacities. As a result, executive development and military professional development training (e.g., War Colleges, Naval Postgraduate School) is beginning to include climate literacy scaled to the consequences of their decisions. Each Military Department has produced guidelines to incorporate climate information into installation planning processes (NAVFAC 2017, Air Force 2020, Pinson et al., 2020).

LITERACY TRAINING INITIATED

The Defense Logistics Agency (DLA) Installation Management has drafted the DLA Sustainability Program Awareness training module for DLA's workforce to keep abreast of the climate change efforts the agency has initiated. This training effectively communicates DLA's strategic sustainability objectives in alignment with DOD's broader sustainability objectives. As part of the Sustainability program, climate change adaptation is covered in a portion of the training, which elaborates on basic concepts, studies, policies, and resources. The training module will be accessible through DLA's learning management system and, once launched, will be mandatory to all employees.

While some experts must know how to assess scientifically credible information about climate and communicate about climate and climate change in a meaningful way to support decision-makers, other staff will receive climate literacy training appropriate for their functions. For example, installation management teams should attain climate literacy levels to support their risk-informed and responsible decisions.

Building climate literacy and capability in the workforce appropriate for different functional areas will enable the Department to identify and address climate readiness actions across their areas of responsibility and successfully carry out the mission in an era of rapidly changing climatic conditions. Climate literacy modules should focus on essential principles of climate change as they affect management and financial decisions for different roles and responsibilities.

Collaboration between DOD entities and exemplar business schools with supply chain and logistics specialty advanced degree programs, Master of Business Administration (MBA) concentrations, and research institutions could improve climate literacy in the supply change and logistics area as academic programs increase their offerings in this area. Similarly, supply chain and logistics professional associations (e.g., Association for Supply Chain Management) offer training that enhances climate literacy. Curriculum at DOD professional military education institutions, such as the Air Force Institute of Technology (which offers related Ph.D. programs) and the Naval Postgraduate School's MBA logistics program, could be updated to add value in the climate literacy area.

TOPIC 3.
AGENCY ACTIONS TO ENHANCE RESILIENCE: CLIMATE-READY SITES, FACILITIES, AND INFRASTRUCTURE

END STATE: Installations that can rapidly respond to and recover from disruptive conditions without loss of function or adverse impacts to military mission.

CURRENT STATUS: Since 2010, DOD has developed a comprehensive set of policies, directives, and plans to manage the effects of climate change on its operations, missions, and facilities. The Department has a comprehensive approach to building climate-ready installations. This approach considers resilience in installation planning: installation master planning, installation energy planning, management of natural resources, design and construction standards, utility systems and service, and emergency management operations. This approach is based on several statutory provisions contained in a variety of National Defense Authorization Acts and reflected in Department guidance, instruction, and policy.

For example, the September 2020 update to Unified Facilities Criteria (UFC 2-100-01), *Installation Master Planning* directs installations to develop comprehensive installation resilience plans that incorporate climate resilience analysis to ensure mission sustainment over the intended lifespan of the infrastructure and assets. This document provides instruction on the use of climate scenario planning and refers to the DCAT and the DRSL Database.

Since 2015, the Department has conducted over 35 site-level energy resilience assessments, tabletop exercises, and black start exercises to implement its policies. The lessons learned from these initiatives were used to develop Department-wide policies and procedures to drive behavioral and cultural awareness for installation personnel and energy managers. To ensure the readiness of its installations, the Department conducts statutory black start exercises where installations are disconnected from the wider power grid to determine the resilience of on-site power generation. These black start exercises were completed at Fort Stewart, Fort Greely, Fort Bragg, Hanscom AFB, Vandenberg AFB, Joint Base McGuire-Dix-Lakehurst, and Marine Corps Air Station Miramar. Figure 2 provides a map of all the site-level energy resilience assessments, tabletop exercises, and black start exercises.

INSTALLATION ADAPTATION

Marine Corps Recruit Depot (MCRD) Parris Island: MCRD Parris Island completed a Climate Change Adaptation and Resilience (CCAR) assessment that resulted in changes to its master plan projects and adaptation strategies from spatial planning; to redirecting development away from high-risk areas; to infrastructure projects to manage and respond to sea level rise and effects of climate change. Adaptation projects include stormwater system upgrades, battalion training facilities elevation (main campus), road network upgrades, tidal exclusion barrier, page field training facilities relocations, and reforestation.

Figure 2. Site-level map of energy resilience assessment locations

TOPIC 4.
AGENCY ACTIONS TO ENHANCE RESILIENCE: CLIMATE-READY SUPPLY OF PRODUCTS AND SERVICES

LOE 4, *Supply Chain Resilience and Innovation* addresses the climate-ready supply of products and services.

END STATE: To establish an enterprise architecture that comprehensively addresses supply chain security challenges and leverages opportunities in procurement that support climate adaptation and improve climate resilience.

CURRENT STATUS: DOD has assessed the resilience and capacity of the manufacturing and defense industrial base and supply chains to support national security needs when contingencies occur (DOD 2018c). This report includes extreme weather and other events that may disrupt, strain, compromise, or eliminate the supply chains of goods per EO 13806 (*Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States*, July 2017). Over the next year, additional climate-specific assessments are expected to identify the five most critical or priority supplies or services at risk to extreme weather or climate disruption.

Recently, EO 14017 (*America's Supply Chain*, February 2021) explicitly highlighted the risks posed by climate change to the availability, production, or transportation of critical goods and materials and other essential goods and materials.

The Title III Program under the Defense Production Act (DPA) plays a leading role in strengthening the health and resilience of domestic supply chains of strategic importance. If invoked in the case of a climate disruption, the DPA could be a potential enabler of supply chain resilience for DOD.

INNOVATIVE SUPPLY CHAIN

Marine Corps Logistics Base (MCLB) Albany, Georgia, is one of two Marine Corps bases that provide worldwide, integrated logistics/supply chain with distribution management and depot-level maintenance management. The MCLB Albany 5G Smart Warehouse prototype will provide a secure, open standard 5G environment enabled by Open Radio Access Network, automated asset tracking and movement, machine learning, and Zero Trust Architectures over a Shared Spectrum Testbed.

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2023
By April 2023, DOD will complete climate exposure assessments on all major OCONUS installations using the DOD Climate Assessment Tool (DCAT).
By April 2023, DOD will share DCAT with five partner nations and allies.
By February 2022, DOD will update the 2014 Climate Adaptation Roadmap.
By April 2022, DOD will complete climate exposure assessments on all major U.S. installations using the DCAT.
2022
In September 2021, DOD will publish the Secretary of Defense signed Climate Adaptation Plan (CAP).
By December 2021 the DOD Sustainability Report and Implementation Plan will align with the CAP.
Secretary of Defense signed the Climate Adaptation Plan 1 September 2021 as required by Executive Order (EO) 14008.
DOD released DOD Installation Exposure to Climate Change at Home and Abroad.
2021
DOD submitted a report to Congress on Resilient Defense Infrastructure and Military Installations Resiliency.
DOD updated UFC 2-100-01: Installation Master Planning to institute the DRSL Database for sea level change and include use of the DCAT.
U.S. Army released the Army Climate Resilience Handbook.
U.S. Air Force released the Severe Weather/Climate Hazard Screening and Risk Assessment Playbook.
DOD released the DOD Regional Sea Level Rise (DRSL) Database.
DOD updated Unified Facilities Criteria (UFC) 3-201-02: Landscape Architecture and UFC 3-201-01: Civil Engineering to incorporate climate change and climate resilience.
U.S. Air Force released Instruction 32-1015: Integrated Installation Planning: Assess and Manage Climate Risk.
2020
U.S. Army released the Army Directive 2020-08: U.S. Army Installation Policy to Address Threats Caused by Climate and Extreme Weather.
U.S. Air Force released the Air Force Manual 32-7003: Environmental Conservation, which includes historical and projected climate.
DOD updated UFC 1-200-02: High Performance and Sustainable Building Requirements to ensure appropriate incorporation of climate change impacts.
The Under Secretary of Defense for Acquisition and Sustainment released memo Improving Defense Installation Resilience to Rising Sea Levels.
2019
DOD published the Climate Adaptation for DOD Natural Resource Managers: A Guide to Incorporating Climate Considerations into Integrated Natural Resources Management Plans (INRMPs).
DOD published the Report on Effects of a Changing Climate to the Department of Defense.
U.S. Air Force released Air Force Instruction 90-2001: Mission Sustainment.
2018
DOD Directive (DODD) 3020.40: Mission Assurance stated the Under Secretary of Defense for Acquisition and Sustainment will synchronize and integrate mission assurance with policy and efforts of "climate change adaptation and resilience."
DOD Instruction (DODI) 4715.03: Natural Resources Conservation Program directed all DOD Components to assess the potential impacts of climate change to natural resources on DOD installations and take steps to implement adaptive management to ensure the long-term sustainability of those resources.
DOD Manual 4715.03: INRMP Implementation Manual.
DOD Report: Climate-Related Risk to DOD Infrastructure Initial Vulnerability Assessment Survey.
2017
DODI 3200.21: Sustaining Access to the Live Training Domain required evaluation of risks to training and range capability from the impacts of climate change trends.
Naval Facilities Engineering Systems Command (NAVFAC) released the NAVFAC Climate Change Planning Handbook: Installation Adaptation and Resilience.
2016
DODD 4715.21: Climate Change Adaptation and Resilience directed DOD Components to consider the effects of a changing climate on the DOD mission and plan to address these effects accordingly.
2015
DOD Defense Science Board considered climate change as a "strategic surprise" among global trends and evolving priorities for national security objectives.
DOD conducted a preliminary Screening-Level Vulnerability Assessment Survey of DOD sites worldwide to impacts from climate change and extreme weather (report published in 2018).
Quadrennial Defense Review committed DOD to use creative ways to address the impacts of climate change on the operating environment and roles and missions.
DOD published the 2014 Climate Change Adaptation Roadmap.
An Office of the Secretary of Defense memorandum directed DOD Components on floodplain management, including climate change effects, for DOD installations.
2014
DOD published the 2013 Climate Change Adaptation Roadmap.
DOD's Strategic Environmental Research and Development Program published these reports:
• Assessing Impacts of Climate Change on Coastal Military Installations: Policy Implications
• Integrated Climate Change and Threatened Bird Population
• Modeling to Mitigate Operations Risks on Florida Military Installations
2013
Climate Change Adaptation Working Group established to facilitate implementation of the climate change requirements in EO 13514.
DOD published the Climate Change Adaptation Roadmap.
2012
DOD Defense Science Board published guidance and recommendations on adapting and mitigating against the implications of climate change to national and international security.
2011

The submarine USS Hartford surfaces near Ice Camp Sargo during Ice Exercise 2016 in the Arctic Circle, March 19, 2016.

Air Force Airman 1st Class Veronica Mollema loads pallets of water into a C 17 Globemaster at Joint Base San Antonio Kelly Field, Texas, February 21, 2021.

On September 5, 2019, trainees at Fort Jackson, S.C., stack sandbags for use throughout the hurricane season. The Army recently introduced a new directive to prepare the service s installations against the growing threat of climate change.

Representatives from the Alaska Department of Military and Veterans Affairs, the Department of Environmental Conservation, and the Department of Commerce, Community and Economic Development load onto an Alaska Army National Guard UH 60 Black Hawk helicopter in Chevak, Alaska, on April 9, 2021 to meet with tribal leaders and citizens in Bethel, Tuluksak, and Chevak to discuss disaster assistance measures and preparation for the upcoming flood season.

An HH 60W Jolly Green II sits under bright lights used to create heat in the McKinley Climatic Lab March 19 at Eglin Air Force Base, Florida. The Air Force s new combat search and rescue helicopter and crews experienced temperature extremes from 120 to minus 60 degrees Fahrenheit as well as torrential rain during the month of testing. The tests evaluate how the aircraft and its instrumentation, electronics and crew fare under the extreme conditions it will face in the operational Air Force.