

2021-2022

U.S. Defense Climate Highlights and Case Studies



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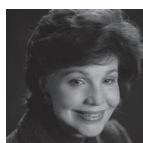
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In this Report

Following the Biden Administration's issuance of Executive Order 14008, *Tackling the Climate Crisis at Home and Abroad*, and Executive Order 14057, *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability*, the Department of Defense (DoD) enterprise, including the Departments of the Air Force, Army, and Navy have all issued climate strategies to outline the challenges and opportunities presented by climate change. ASP created this report to educate and inform policymakers and local stakeholders about major defense enterprise developments over the past 18 months, as well as to highlight key elements of climate security concepts that exist throughout the defense enterprise. The broad overviews in this report are augmented by specific case studies to better inform policy and strategic and operational decision-making.

IN BRIEF

- In 2021-2022, several defense and climate strategies have been released that elevate and enshrine climate security as a key element of national security. These strategies and plans, covered in this report, include:
 - National Security Strategy (NSS)
 - National Defense Strategy (NDS)
 - Department of Defense Climate Risk Analysis
 - Department of Defense Climate Adaptation Plan (CAP)
 - Department of Defense Climate Adaptation Plan 2022 Progress Report
 - Department of the Air Force Climate Action Plan (CAP)
 - Department of the Army Climate Strategy (ACS)
 - Department of the Army Climate Strategy Implementation Plan (ACS-IP)
 - Department of the Navy Climate Action 2030
- Key takeaways and themes:
 - DoD and the services are institutionalizing climate change through their strategies and plans and have an increased recognition of how climate change impacts readiness, missions, operations, installations, and personnel.
 - DoD and the services are continuing to mitigate greenhouse gases (GHG) emissions and enhance energy security through increased electrification, adoption and deployment of electric vehicles (EVs), and installing microgrids on installations.
 - DoD and the services are integrating climate change threats and hazards into planning to foster a more lethal, agile, and resiliency Joint Force.
- There are several military installations and bases where climate change is already impacting readiness, missions, and operations. To better understand how climate change is impacting the military and highlight the adaptation and resilience efforts underway, ASP has identified and explored five domestic case studies in more detail:
 - Marine Corps Recruit Depot Parris Island (South Carolina)
 - Naval Base San Diego/Greater San Diego Region (California)
 - Naval Station Norfolk/Greater Hampton Roads Region (Virginia)
 - Offutt Air Force Base (Nebraska)
 - Tyndall Air Force Base (Florida)

About the Authors

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Executive Summary

Following the Biden Administration's issuance of Executive Order 14008, *Tackling the Climate Crisis at Home and Abroad*¹, and Executive Order 14057, *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability*², the Department of Defense (DoD) enterprise has published several relevant climate strategies and plans. DoD itself, as well as the Departments of the Air Force, Army, and Navy have all issued climate strategies to outline the challenges and opportunities presented by climate change and provide greater clarity on how defense elements view the threats, risks, and hazards of climate change. Although DoD has been planning and preparing for climate impacts for more than 15 years, 2021-2022 were critical years for strategies and plans designed to address climate challenges and seize climate opportunities.

At the federal level, both the National Security Strategy (NSS) and National Defense Strategy (NDS) elevate climate security concepts in national security discourse. Both provide the overall framework for each of the military service climate strategies and plans to operate and recognize climate change as a transboundary threat with profound and largely unpredictable challenges. While not explicitly listed as a priority, climate adaptation and mitigation are key to enhanced resilience, which is mentioned repeatedly throughout both the NSS and NDS. Similarly, both strategic documents further cement energy security and climate security as key elements of our collective national security, and underscore the importance of preparing for complex, compounding climate risks and threats.

While this marks a departure from previous hard-power focused federal strategies of the past, DoD has developed climate policy, directives, plans, and strategic level guidance since at least 2010, with the goal of mitigating climate impacts on operations, missions, and infrastructure.³ The defense enterprise has continued on its demonstrated history of evolving to meet current challenges and has supercharged efforts to transition to cleaner energy, emit less carbon dioxide/greenhouse gases (GHG), and position the Joint Force to be more agile, lethal, aware, and resilient to a climate impacted world. Decarbonization and incorporation of climate security has clear benefits to the defense and security enterprise, including reducing financial costs associated with fossil fuels, improvement of operational capabilities, and enhanced resilience at installations. Each service has put increased electrification, enhanced energy security, and installation of microgrids as key elements of their strategies. This will not only drive innovation and technological advances and foster resilience, but it will also lead to economic growth, increased energy security, and will ultimately save lives.⁴

Each of the service strategies speaks to their own equities and missions, and each underscores that achieving the overall defense and security mission of the armed forces is the highest priority. While there are numerous environmental and emissions reduction benefits through climate mitigation and adaptation, no activity that negatively impacts the ability of DoD to provide the military forces needed to deter war and/or protect the security of the U.S. can or will occur. However, DoD and each of the services recognize that actions and investments which enhance energy efficiency and energy security can simultaneously make the military more resilient, lethal, and agile and can provide distinct advantages against adversaries.

To further illustrate the complex climate change challenges and opportunities facing DoD and the services, we have selected five military installations/bases that are already facing climate impacts: Marine Corps Recruit Depot Parris Island, Naval Base San Diego/Greater San Diego Region, Naval Station Norfolk/Greater Hampton Roads, Offutt Air Force Base, and Tyndall Air Force Base. While climate change is impacting almost every defense asset across the globe, these five case studies clearly highlight how and why integrating climate change into military planning and resilience activities is critical to the safety and security of our nation.

At the time of publication, only one service implementation plan was available. This document will be updated as other implementation plans are distributed.

National Security Strategy

In late 2022, the Biden administration released the latest NSS, the umbrella document for the NDS which outlines the nation's security priorities, key security challenges, and a vision for national security for the future. The 2022 NSS is framed by two strategic challenges for this “decisive decade,” one of which is “cop[ing] with the effects of shared challenges that cross borders.” It includes climate change and food insecurity as specific examples that are “at the very core of national and international security” and calls climate change “the greatest and potentially existential [problem] for all nations.”⁵ Similar to the 2017 NSS, its focus is on constraining and competing with China and Russia, and calls for additional investment in U.S. innovation, strengthening democracy, and modernizing and strengthening the military. The 2022 NSS also lists cooperation on shared challenges such as climate and energy security, pandemics and biodefense, and food insecurity as a global priority. It labels the climate crisis “the existential challenge of our time” and emphasizes the need to hasten the clean energy transition, all of which further underscores that both climate security and energy security are key components of our collective national security.

National Defense Strategy

In late 2022, the Biden administration released the latest NDS, which, for the first time was conducted alongside the Nuclear Posture Review (NPR) and the Missile Defense Review (MDR). It directs DoD to act urgently to sustain and strengthen U.S. deterrence, and is framed around the concepts of “integrated deterrence” and campaigning.⁶ Consistent with the NSS, the NDS specifically labels China as the “pacing challenge”, Russia as an acute threat, and North Korea, Iran, and violent extremist organizations (VEOs) as persistent threats across all domains and technologies, with particular emphasis on cyber, space, and gray-zone operations.⁷ Resilience—the ability to withstand, fight through, and recovery quickly from disruption—plays as a key role throughout the strategy, with obvious implications for climate security. Of primary importance to the climate security community, the NDS states,

“Climate change is an existential threat to our nation's security, and the Department of Defense must act swiftly and boldly to take on this challenge and prepare for damage that cannot be avoided. Every day, our forces contend with the grave and growing consequences of climate change, from hurricanes and wildfires that inflict costly harm on U.S. installations and constrain our ability to train and operate, to dangerous heat, drought, and floods that can trigger crises and instability around the world.”

Secretary of Defense Lloyd J. Austin
October 7, 2021

“...changes in global climate and other dangerous transboundary threats are already transforming the context in which the Department [of Defense] operates. Increasing temperatures, changing precipitation patterns, rising sea levels, and more frequent extreme weather conditions will affect basing and access while degrading readiness, installations, and capabilities. Climate change is creating new corridors of strategic interaction, particularly in the Arctic region. It will increase demands, including on the Joint Force, for disaster response and defense support of civil authorities, and affect security relationships with some Allies and partners. Insecurity and instability related to climate change may tax governance capacity in some countries while heightening tensions between others, risking new armed conflicts and increasing demands for stabilization activities.”⁸ Although not explicitly identified in the four top-level priorities, climate is implicit in the priority for “ensur[ing] our future military advantage [by] build[ing] a resilient Joint Force and defense ecosystem.” The NDS commits to “continuing to analyze climate change impacts on the Joint Force and will integrate climate change into threat assessments” as well as “make reducing energy demand a priority and seek to adopt more efficient and clean-energy technologies.”⁹

DoD Climate Plans

DoD has been conceptualizing climate change as a threat multiplier since at least 2007. Following a landmark report from the Center for Naval Analyses, *National Security and the Threat of Climate Change*¹⁰ and both the 2010 and 2014 Quadrennial Defense Reviews^{11 12}, climate change was cemented in defense lexicon as a threat multiplier – a risk that compounds existing threats and hazards to create multidimensional security challenges. DoD subsequently recognized the need to “craft a strategic approach to climate and energy” since climate change would have a significant role in shaping

“The homeland is no longer a sanctuary... Going forward we’re going to have to embed climate change as a consideration in all that we do.”

Richard Kidd
Deputy Assistant Secretary of Defense for
Environment and Energy Resilience
April 27, 2021

the overall security environment, as well as specific operations, missions, and capabilities. This has resulted in several related strategies and plans, including the 2020 *DoD Sustainability Report and Implementation Plan* which provides details into the ongoing efforts to increase energy efficiency, cut waste, and reduce impacts on the environment. Throughout 2021-2022, several DoD climate related plans have been published. The impetus for comparing them became clear in order to better understand actions, milestones, and anticipated future end states. Below are highlights of the climate plans that have recently been published as well as a short description of major themes and key takeaways.

DoD Climate Risk Analysis

The October 2021 *DoD Climate Risk Analysis* opens by stating that “climate change is reshaping the geostrategic, operational, and tactical environments with significant implications for U.S. national security and defense.”¹³ It further states that DoD will “integrate the security implications of climate change into key strategic documents, programs, and international partner engagements.” It serves as an updated foray into integrating climate security across the DoD enterprise and notably provides specific examples of how climate risk can be integrated into modeling, simulation, and wargaming.

BOX 4. EXAMPLES OF CLIMATE RISK TO BE INCORPORATED INTO MODELING, SIMULATION, AND WARGAMING

- Sensor operations: changes in the operating environment due to temperature extremes or extended rainfall; loss of effectiveness based on climate conditions.
- Information operations: how changes in “normal” climate cycle affect operations.
- Aircraft performance (fixed wing and rotary wing): loss of payload capacity, range, and loiter time based on increased temperatures.
- Wildfires: loss of range or accuracy due to extreme weather conditions.
- Ground mobility: extended monsoon season and trafficability; impact on medical evacuation and resupply by ground means.
- Naval operations: underway replenishment in altered sea conditions; loss of capability/efficiency in fuel transfer (e.g., ship to shore).
- Non-combatant Evacuation Operations: conflict exacerbated by climate change impacts; embassy security or evacuation considerations.
- Access, basing, and overflight constraints.
- Exercises: extreme weather-related cancellations and effects on readiness.
- Threat icons: integrate irregular threat icons that represent non-state actors, transnational criminal organizations, or other unofficial competitors motivated to disrupt operations during an exercise or wargame.
- Critical infrastructure: climate-related delays, disruption, and/or degradation of DoD to produce, package, repair, and distribute materiel and ammunition and its effects on readiness and/or operations.
- Degradation of Joint Force performance due to extreme weather events associated with climate change.
- Consideration of the impact of increased demand for HADR and DSCA.

DoD Climate Adaptation Plan

Following the publication of the 2021 *DoD Climate Risk Analysis* and in accordance with EO 14008's directive to put climate at the center of U.S. foreign policy and national security, DoD published the 2021 *Climate Adaptation Plan* (CAP).¹⁴ The CAP outlined two major lines of effort: 1) adaptation to enhance resilience and 2) mitigation to reduce GHG emissions.¹⁵ CAP provides five lines of effort in its strategic framework: 1) climate-informed decision-making; 2) train and equip a climate-ready force; 3) resilient built and natural infrastructure; 4) supply chain resilience and innovation; and 5) enhance adaptation and resilience through collaboration. It remains DoD policy to include climate considerations across all operations and planning efforts and associated activities with emphasis on 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.

“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 modification to existing and planned equipment.”

2021 Department of Defense Climate Adaptation Plan

DoD Climate Adaptation Plan – 2022 Progress Report

In fall 2022, DoD released its first progress report that provided updates on its CAP priority actions. Each priority action is a “continuous action” that has maintained a level of progress over the first year. Notably, the DoD Climate Working Group continues to function with five sub-working groups: 24/7 Carbon Pollution Free Electricity (CFE); Operational Energy; Climate Literacy; Climate Wargaming; and Electric Vehicle Fleet Charging.

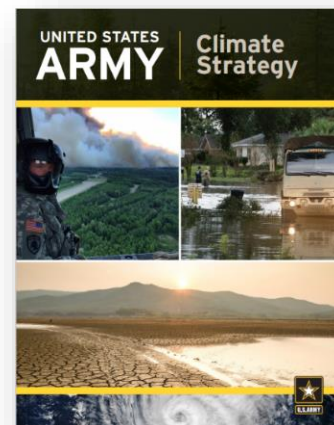
Department of the Air Force Climate Action Plan

The mission of the U.S. Air Force (USAF) is to fly, fight, and win—airpower anytime, anywhere, with core missions for 1) air and space superiority; 2) intelligence, surveillance, and reconnaissance (ISR); 3) rapid global mobility; 4) global strike, and 5) command and control.¹⁶ Since climate change is impacting the operational environment, access, and readiness, the Department views climate as an acute threat to achieving its overall mission. Specifically, extreme weather can impact aircraft performance and payload capacity, and directly effects the health of Airmen and Guardians.¹⁷ Two Air Force Bases, Tyndall Air Force Base (near Panama City, Florida) and Offutt Air Force Base (south of Omaha, Nebraska) have become two of the most known examples of how climate change impacts military infrastructure and readiness. Both are discussed in further detail in the case studies section of this report.

The USAF CAP states an overall goal of a “department that is resilient to the effects of climate change and preserves a combat-credible force that can compete, deter, and win against pacing threats.”¹⁸ The CAP outlines three priorities for the Air Force and the Space Force to increase lethality and survivability: 1) maintain air and space dominance in the face of climate risks; 2) make climate informed decisions and 3) optimize energy use and pursue alternative energy sources.¹⁹ USAF operates 175 Air Force and Space Force installations, and given its resources and mission, the CAP recognizes that USAF is the “responsible for the largest portion of DoD GHG emissions”²⁰ due to the nature of its mission and resources, and commits to being part of overall DoD emission reduction efforts. It outlines several objectives and key targets, including a 50% emissions reduction from 2008 levels throughout its installation portfolio by FY33, 100% CFE on a net annual basis by 2030 (including 50% 24/7 CFE electricity), and 100% zero emission non-tactical vehicles by FY35, including 100% zero emission light-duty vehicle acquisitions by FY27 and aircraft support equipment by FY32.²¹ The CAP also states a key target of a “completed successful pilot of drop-in compatible sustainable aviation fuel at two operational locations” by FY26 where 10% of all purchased aviation fuels consist of sustainable aviation fuel blends at the same or less costs than traditional aviation fuel” and an increase in operational energy intensity of Air Force flying missions.²²

Department of the Army Climate Strategy (ACS)

The U.S. Army's purpose is to "deploy, fight, and win our nation's wars by providing ready, prompt, and sustained land dominance by Army forces across the full spectrum of conflict as part of the Joint Force."²³ The Army recognizes how climate can impact how it deploys and fights in several ways, including supply chain and logistics disruptions, as well as an "increased risk of armed conflict in places where established social orders and populations are disrupted."²⁴ The ACS was the first service-specific climate strategy published and has three primary lines of effort: 1) installations; 2) acquisition and logistics; and 3) training. For the more than 130 Army installations worldwide, the ACS has a desired outcome to "enhance resilience and sustainability by adapting infrastructure and natural environments to climate change risks, securing access to training and testing lands into the future, and mitigating GHG emissions." Although the Army has decreased its overall GHG emissions by 20% since 2008, the ACS commits the Army to 100% carbon-pollution free electricity to meet the needs of its installations by 2030 and installation of a microgrid on every installation by 2035.²⁵ ACS also has stated strategic desired outcomes of an increase in operational capability while reducing sustainment demand and strengthening of climate resilience and preparing a force that is ready to operate in a climate-altered world.

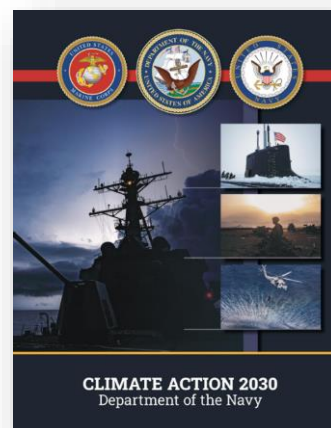


Department of the Army Climate Strategy Implementation Plan (2023-2027) (ACS-IP)

The ACS and ACS-IP "envision the Total Army as a 'resilient and sustainable land force able to operate in all domains with effective mitigation and adaptation measures against the key effects of climate change, consistent with Army modernization efforts'"²⁶ and it has issued the first service-specific implementation plan to guide allocation of resources and the ends, ways, and means of achieving its overarching goals. The ACS-IP guides the decision-making process to reduce GHG emissions and how to address risks to people and property.²⁷ It is focused on implementing several actions between 2023 and 2027, and includes near-term tasks, analyses, and planning required for future actions and plan iterations in three primary lines of effort: 1) installations; 2) acquisition and logistics; and 3) training with subsequent ways and means and specific objectives for each.

Department of the Navy (DoN) Climate Action 2030

The DoN's mission is to recruit, train, equip, and organize to deliver combat ready naval forces to win conflicts and wars while maintaining security and deterrence through sustained forward presence.²⁸ Sea-level rise and the increase in extreme weather are already impacting operations and readiness at Naval Station Norfolk (Virginia), the home port of Fleet Forces Command; Naval Base San Diego (California), homeport of the Pacific Fleet; and Marine Corps Recruit Depot Parris Island (South Carolina). As such, the Navy is exposed to climate change impacts on a routine basis. In support of its overall mission, the DoN *Climate Action 2030* covers both the Navy and the Marine Corps. It outlines two overarching goals to build a climate-ready force: 1) building climate resilience and 2) reducing the climate threat. It defines a climate-ready force as "one that can fight and win around the globe, while anticipating, preparing for, recovering from, and adapting to the evolving climate and security future."²⁹ The strategy points to the Navy's demonstrated evolution from wind to coal to nuclear power, as well as the falling energy consumption rates since 2008 as evidence of its ability to adapt and overcome.³⁰ The strategy outlines specific GHG emissions reduction targets, including a 65% reduction in scope 1 and 2 emissions department wide by 2030; 100% CFE by 2030; 100% zero-emissions vehicles by 2035; and a 50% reduction in emissions from buildings by 2032.³¹ It also commits DoN to leveraging nature-based resilience solutions and enhanced energy resilience with installation microgrids.



Base/Installation Case Studies

The following case studies were chosen based on recent notable climate-related events and the 2019 climate vulnerability lists submitted by each of the service branches to Congress. Each highlights acute climate concerns and mitigation, adaptation, and resilience measures already underway.

Marine Corps Recruit Depot (MCRD) Parris Island

MCRD Parris Island is in Beaufort, South Carolina. It is one of only two installations in the nation where U.S. marine recruits are trained, making it sacred to USMC esprit de corps. Each year, approximately 20,000 recruits are molded into Marines there.³²

Both Parris Island and nearby Air Station Beaufort, home to one of the largest military airstrips in the world,³³ are subject to extreme heat/“black flag conditions,” coastal erosion, and increased exposure to severe flooding due to climate change-fueled sea-level rise. The Beaufort region is “relatively low lying, particularly MCRD Parris Island, where much of the land consists of marshes.”³⁴ Salt marsh makes up more than half of the base’s 8,000 acres, and the fire station—which sits at the depot’s highest point—is just 13 feet above sea level. MCRD Parris Island also has only a narrow, two-lane roadway that connects it to the rest of South Carolina, which is already susceptible to flooding as it sits only a few feet above the water at low tide.³⁵



Aerial view of Parris Island, 2017
Photo By: Carol M. Highsmith Photography, Inc.

According to the Union of Concerned Scientists (UCS), predicted increases of flooding would likely lead to much of the land in the region being considered “unusable.” Presently, tidal flooding already affects “low-lying locations” around the installation, including “extensive wetland areas,” with floods occurring an average of 10 times per year. By 2050, the flood-prone areas within the bases could experience tidal flooding “more than 300 times annually and be underwater nearly 30 percent of the year.” Parris Island could suffer from extreme tides with higher water levels which result in 85 percent of the land being inundated roughly 10 times per year and potentially experience a 6.4 feet sea-level rise.³⁶

Former commanding general of the Parris Island and ASP President Emeritus, Brig. Gen. Stephen Cheney, (Ret.) has long argued for “a sea wall around parts of Parris Island, otherwise it’s going to go under water.”³⁷ In 2018, the former USMC Assistant Commandant Gen. Glenn M. Walters also raised the alarm at a Senate Armed Services Committee readiness hearing by stating that the risk of flooding is the “greatest threat to military readiness” for Parris Island. Although there are currently no plans to build a seawall, some action has been taken to adapt to flooding, including “adjusting the elevation of battalion training facilities.” Other mitigation steps potentially include “stormwater and road upgrades, constructing a tidal exclusion barrier, and planting new forest.”³⁸ Several other mitigation strategies, including “living shoreline projects, [such as] building up coastal oyster reefs to strengthen natural buffers to floods and hurricanes”³⁹ and “shoring up the only road on and off the island, elevating buildings and bolstering the stormwater system of an area where military families live,” informed the 2021 MCRD Parris Island’s *Climate Change Adaptation and Resilience assessment* that resulted in changes to its masterplan projects and adaptation strategies.⁴⁰

Separately, the depot has been recognized for the completed construction of a \$91.1 million project “designed to enhance energy resilience and readiness with upgrades that will reduce energy demand by 75 percent and water consumption by 25 percent.”⁴¹ The project also delivers over 9 MW of power generation, including energy from a “3.5 MW combined heat and power plant, to ensure power supply in the event of utility failures.” These solar and biomass power generation utilities—built in 2019—were intentionally built above the flood zone to make them less susceptible to damage from hurricanes, storms, and sea-level rise, and generate approximately \$10 million per year in energy savings.

Naval Base San Diego/Greater San Diego Region

Naval Base San Diego, located in California, comprises over 1,600 land acres and 236 acres of water along the San Diego Bay. It is home to the Navy's Pacific Fleet and often hosts visiting ships from foreign navies as well as the Coast Guard.⁴² It has the second largest naval personnel concentration in the country and is the homeport for approximately 20% of U.S. Navy vessels, as well as providing 22% of all of the jobs in the region.⁴³ Similar to the Norfolk/Hampton Roads region of Virginia, San Diego is home to several naval facilities, including Marine Corps Air Station Miramar, Marine Corps Base Camp Pendleton, Marine Corps Recruit Depot San Diego, Naval Base Coronado, and Naval Base Point Loma. As such, climate change can and does have an outsized impact on the military capabilities in the area. In 2022, Meredith Berger, Assistant Secretary of the Navy for Environment, Installations, and Energy, remarked that San Diego is "highly impacted" by the effects of climate change but that the effects were not limited to Naval Base San Diego, and extends to the nearby Marine Corps boot camp and beyond, thereby emphasizing the importance of climate adaptation and enhanced community resilience.⁴⁴

The climate challenges facing San Diego installations and bases writ large have been broadly recognized. A March 2009 study sponsored by the California Energy Commission and California Environmental Protection Agency outlined several major climate challenges for the area, including "sea level rise, increased risk of large wildfires, increasingly uncertain water supplies ... increased energy demands, and public health issues associated with heat waves and an increase in some infectious diseases."⁴⁵ Naval Base San Diego has already reported "water and energy shortages, loss of beaches and coastal property, and higher temperatures."⁴⁶ Work to mitigate and adapt to climate change impacts has been underway throughout the civilian and military sectors for several years. In May 2018, the Board of Port Commissioners authorized a first-of-its-kind Memorandum of Agreement (MOA) with Commander Navy Region Southwest, to "share information, evaluate the best available scientific information and modeling related to sea level rise and collaborate to identify complementary adaptation policies and measures." The Chairman of the Port of San Diego Board of Port Commissioners stated that this partnership was "vital" to "evaluate and plan for the potential impacts of sea level rise" and ensure San Diego remains a "resilient, strategic port and economic engine well into the future."

Also in 2018, Naval Base San Diego redesigned a pier replacement project to consider rising sea-level projections, which was not part of the original proposal. Installation officials decided to raise the pier one foot to better account for projected sea-level rise over the course of the pier's 75-year lifespan.⁴⁷ Similarly, in 2022, the U.S. Navy and Port of San Diego signed another first-of-its-kind agreement to reduce GHG emissions and improve air quality and public health.⁴⁸ It allows the Navy to participate in California's Low Carbon Fuel Standard (LCFS) market that can provide "millions of dollars for further electrification for both Naval Base San Diego and the Port of San Diego⁴⁹ and will allow for docked naval vessels to plug into shore power verses powering internally, which can help reduce carbon emissions.⁵⁰



*Smoke fills the sky as wildfires burn in and around Naval Weapons Station Fallbrook in San Diego | U.S. Marine Corps
Photo By: Cpl. Orrin Farmer*

Naval Station Norfolk/Greater Hampton Roads Region

The City of Norfolk and the greater Hampton Roads area in Virginia is home to approximately 1.7 million people⁵¹ and more than a dozen military assets including Fleet Forces Command, the Navy's Atlantic Fleet, and Naval Station Norfolk, the world's largest naval facility. The region is home to approximately 80,000 active-duty personnel, as well as 28,000 veterans.⁵² Estimates project that the Navy's impact on the Hampton Roads economy is roughly "\$15 billion annually."⁵³

The greater Hampton Roads region is an area with "natural subsidence, low-lying topography, and changing ocean circulation patterns [that] contribute to above-average sea level rise," with seas projected to rise between 4.5 and 6.9 feet by 2100.⁵⁴ Due to climate change impacts on ocean currents and geology, the sea-level at Naval Station Norfolk is rising at twice the global average.⁵⁵ In 2014, the U.S. Army Engineer Research and Development Center found that 1.5 feet of sea-level rise would constitute a "tipping point" for the base and recognized sea-level rise as a "significant and pervasive threat multiplier to mission sustainability."⁵⁶ The report added that sea-level rise would contribute to "significantly increasing loadings on built infrastructure, and dramatically increasing risks to system capabilities and service provisioning."⁵⁷ The UCS found that with a sea-level rise of just 1.4 feet, the base's "low-lying areas would flood about 280 times each year, spending 10 percent of the time underwater" by 2050.⁵⁸ In the event of sea-level rise more than three feet, "severe critical systems" at the base would likely become "incapacitated."⁵⁹



Rain and heavy winds from Hurricane Isabel flooded portions of Fleet Parking at Naval Station Norfolk, Virginia
Photo By: U.S. Navy

Military operations and readiness on the base are already routinely being severely impacted by adverse weather conditions. Parts of the main road that lead to the base are also already "impassable several times a year."⁶⁰ This is expected to worsen over time, with one likely outcome being that "access roads will be underwater during high tides for 50 days of the year" by 2037.⁶¹ Once or twice a month, seawater submerges "steam lines that run along the bottom of the piers where the fleet's ships are moored," and this leads to the shutting down of operations and make it "very difficult for people to get around," according to retired Captain Joe Bouchard, a former Naval Station Norfolk base commander.⁶² A category 4 storm would "expose about 80 percent" of Naval Station Norfolk to flooding, and this would rise to 95 percent in 2100, further decimating the base's operability and capacity to function as intended.⁶³

In a 2017 editorial, Bouchard stressed that the base needs a complete overhaul and that "everything is vulnerable," including electrical systems and telecommunications.⁶⁴ Brian P. Ballard, a community planning liaison officer with Navy Region Mid-Atlantic, added that tidal surges exacerbate the level of flooding, and that flooding damages buildings which, in turn, impedes the capacity for the base to function as intended. He noted that there is an updated *Unified Facilities Criteria* that ensures new construction takes "climate change" into consideration, such as building elevation, as well as the design and materials used in construction.⁶⁵

A subsequent study by the Hampton Roads Planning District Commission identified 22 actions needed to improve the safety and security of the region, which includes naval installations and climate resilience. For example, many of the priority actions listed in the study relate to flood mitigation, storm surge barriers, stormwater management strategies, and road drainage.⁶⁶

Offutt Air Force Base

Offutt AFB, located south of Omaha, Nebraska, is the headquarters of U.S. Strategic Command (USSTRATCOM), which is responsible for nuclear strategic deterrence as well as global strike capabilities. It is also home to the 55th Wing, the largest wing in Air Combat Command and the second largest in the Air Force, as well as the 557th Weather Wing. Climate security risks for the base had been identified as early as 2011 when floodwaters “crept to within 50 feet of the runway,” but the response to protect Offutt was “agonizingly slow.”⁶⁷ Flooding risks were “formally recognized” in 2015 via a land use management plan which was produced by Offutt AFB personnel, the city of Omaha, and various cities and counties protected by an existing earthwork levee system. The plan warned that the “levee needed to be built up” (a levee is designed to “contain, control, or divert the flow of water so as to reduce risk from temporary flooding”). The Federal Emergency Management Agency (FEMA) also ordered “19 miles of levees along the Missouri [River] to be raised by 2 feet to protect Offutt and portions of Omaha,” but the improvements were not made in time for the record flood event in March 2019.⁶⁸

In 2019, the base suffered devastating flooding after heavy rains and ice melt resulted in waters from the Missouri River covering more than one-third⁶⁹ of the base, including the runway. The base suffered from a record 720 million gallons of floodwater (combined with raw sewage that also made it a health hazard) which covered roughly one-third of the southeastern portion of the installation. The flood waters affected 137 base facilities (including 44 occupied buildings), 1.2 million square feet of workshop, and \$230 million of simulators, and displaced over 3,200 personnel.⁷⁰

Approximately 700 airmen worked around the clock to fill 235,000 sandbags and create 460 flood barriers in an effort to prevent further damage from floodwaters at the time of the crisis, but this effort was abandoned given the intensity of the flooding.⁷¹ One reporter stated that the damage had “crippled capabilities” of the Offutt AFB that were “considered essential to national security.” Weeks after the initial record flood event, facilities of Offutt AFB remained underwater. More than 1 million square ft. of space was destroyed⁷² and reconstruction is estimated to cost over \$1 billion.⁷³

In the immediate aftermath, the 55th Wing stood up the Flood Recovery Program Management Office, which is now working with personnel from the Air Force Civil Engineering Center, located at Tyndall AFB, and the U.S. Army Corps of Engineers to manage the rebuilding effort.⁷⁴ The rebuild took three years of planning, but adopts a forward-leaning approach similar to Tyndall AFB with “smarter” facilities and structures. Eight on-base campuses and the runway each have different project timelines, but the installation-wide project is scheduled to be completed around 2027.⁷⁵



Offutt Air Force Base,
Photo By: U.S. Air Force Tech. Sgt. Rachelle Blake



Photo By: USSTRATCOM, Twitter

Tyndall Air Force Base (AFB)

Located 12 miles east of Panama City, Florida, Tyndall AFB suffered catastrophic damages from Hurricane Michael in 2018. The Category 5 storm caused almost \$5 billion in damages⁷⁶ and had significant impact on personnel, infrastructure, and readiness, particularly for the F-22 fleet. The F-22 is a critical component of the U.S. global strike force and a premier fighting element that is still suffering from hurricane-related maintenance, training, and workforce pipeline challenges.⁷⁷

Hurricane Michael was one of the strongest recorded hurricanes ever to hit the U.S., and damaged or destroyed every building on base.⁷⁸ USAF has seized the opportunity and designed the rebuild with a forward-leaning approach. Coining the base's new tagline as an "Installation of the Future,"⁷⁹ the redesign and development of the base "promotes sustainable, resilient, and smart technology approaches that... exceed baseline DoD and Unified Facilities Criteria (UFC)... to rebuild without inhibiting innovation and creativity."⁸¹ The UFC system provides planning, design, construction, sustainment, restoration and modernization criteria for DoD-led construction projects,⁸² but instead of rebuilding to the UFC requirements, USAF has adopted Miami-Dade County standards for the exterior of the buildings⁸³ as well as basing wind speed requirements for the rebuild on the Florida Building Code for High Velocity Hurricane Zone (165 mph). Similarly, other High Velocity Hurricane Zone requirements were adopted, such as roof framing to foundation connections, and flood elevation design, which is a combination of Federal Emergency Management Agency (FEMA) base flood levels and the highest DoD regionalized sea level rise scenario for year 2100.⁸⁴ In a 2022 public engagement, Mike Dwyer, Deputy Chief for the Air Force Civil Engineer Center, Natural Disaster Recovery Division, emphasized this innovative approach to rebuilding further by stating that "there is a secondary benefit to not only building the buildings stronger against future hurricanes; there is a great insulating benefit to those thicker glass panels which reduces the energy demand of the new facilities."⁸⁵



Air Force Staff Sgt. Brandon Liptrot sweeps debris off an aircraft at Tyndall Air Force Base, Fla., Oct. 18, 2018, while supporting Hurricane Michael response efforts; Photo By: U.S. Air Force

Tyndall AFB is also using the rebuild opportunity to build "The Flightline of the Future"⁸⁶—a "smarter," high-tech innovation for integrating the flightline while maintaining security, being resilient, and increasing agility.⁸⁷ The Tyndall AFB Program Management Office (PMO) has also deployed the Installation Resilience Operations Center (IROC) to "connect sensors and systems together to break down information silos that impede rapid decision-making" and the Digital Twin Hololab—a "full-scale representation of an Air Force base, 'twinning' to real-world inventory and systems."⁸⁸

Nature-based solutions are also being adopted in the rebuild through reforestation and the Engineering with Nature Initiative.⁸⁹ Tyndall lost nearly 12,000 acres of upland pine forest post-Hurricane Michael and reforestation efforts have been underway since December 2020. As of April 2021, over two million longleaf pine trees were planted on approximately 3,700 acres. By the end of 2023, the goal is to have reforested 5,300 more acres. These longleaf pine trees—unlike slash and loblolly pine trees—can "withstand higher winds and are less susceptible to major insect infestations and diseases."⁹⁰ In turn, these pine trees provide a more resilient landscape for base operations.

The rebuild is expected to last five to seven years but Tyndall has been selected to host new squadrons of the F-35A Lightning II, the first of which is expected to arrive in September 2023.⁹¹

Military Bases/Installations Most at Risk from Climate

The FY2018 National Defense Authorization Act, Section 335, required the Secretary of Defense to report to Congress on the vulnerabilities of military installations.⁹² The lists that were submitted by each of the service branches were based solely on climate science. A subsequent 2019 DoD survey of 79 military installations further highlighted potential climate impacts by stating that two-thirds of the installations are “vulnerable to recurrent flooding” and that another half are under threat by drought or wildfires.”⁹³

Air Force

In 2019, the USAF developed a prioritized list of installations susceptible to the consequences of severe weather events; coastal and inland flooding, wildfires, and/or drought. The following installations were identified as most “at risk.”⁹⁴

1. Vandenberg AFB (California)
2. Eglin AFB (Florida)
3. Hurlburt Field (Florida)
4. Patrick AFB (Florida)
5. Joint Base Charleston (South Carolina)
6. Dover AFB (Delaware)
7. Homestead Air Reserve Base (Florida)
8. MacDill AFB (Florida)
9. Tyndall AFB (Florida)
10. Joint-Base Langley-Eustis (Virginia)

Army

In 2019, the Army evaluated the effect of six climate impacts: flooding, drought, desertification, wildfires, thawing permafrost, and rising sea tides on Army facilities. It identified the following installations as most at risk from weather.⁹⁵ (Not in priority order.)

- Yuma Proving Ground (Arizona)
- Fort Irwin (California)
- Fort Huachuca (Arizona)
- Fort Bliss (Texas)
- White Sands Missile Range (New Mexico)
- Camp Roberts (California)
- Hawthorne Army Depot (Utah)
- Military Ocean Terminal Concord (California)
- Pueblo Chemical Depot (Colorado)

Marine Corps

In 2019, the Department of the Navy identified the following Marine Corps installations as most vulnerable to climate related events.⁹⁶ (Not in priority order.)

- Marine Corps Base Camp Pendleton (California)
- Marine Corps Base Camp Lejeune (North Carolina)
- Marine Corps Base Camp Butler (Okinawa, Japan)
- Marine Corps Base Hawaii (Hawaii)
- Marine Corps Recruit Depot Parris Island (South Carolina)
- Marine Corps Support Facility Blount Island (Florida)
- Marine Corps Air Station Beaufort (South Carolina)
- Marine Corps Base Quantico (Virginia)
- Marine Corps Reserve Forces, New Orleans (Louisiana)
- Marine Corps Recruit Depot San Diego (California)

Navy

In 2019, the Department of the Navy identified the following installations as most vulnerable to climate related events.⁹⁷ (Not in priority order.)

- Naval Air Station Key West (Florida)
- Naval Submarine Base Kings Bay (Georgia)
- Naval Base Guam (Guam)
- Joint Base Pearl Harbor Hickam (Hawaii)
- Wahiawa Annex (Hawaii)
- Naval Magazine Indian Island (Washington)
- Naval Base Coronado (California)
- Naval Base San Diego (California)
- Joint Base Anacostia Bolling (District of Columbia)
- Washington Navy Yard (District of Columbia)
- Andersen Air Force Base (Guam)
- Naval Support Facility Indian Head (Maryland)
- Naval Air Station Oceana (Virginia)
- Naval Air Station Norfolk (Virginia)
- Naval Support Activity Hampton Roads (Virginia)
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