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## **Broadening Horizons:** *Climate Change and the U.S. Armed Forces*

By Commander Herbert E. Carmen, USN, Christine Parthemore  
and Will Rogers



**Center for a  
New American  
Security**

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### Cover Image

Scientists with the Applied Physics Laboratory Ice Station clear ice from the hatch of the attack submarine USS Annapolis (SSN 760) after breaking through ice on March 21, 2009, while participating in Ice Exercise (ICEX) 2009 in the Arctic Ocean.

(MASS COMMUNICATION SPECIALIST 1ST CLASS TIFFINI M. JONES/U.S. Navy)

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## EXECUTIVE SUMMARY

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**Broadening Horizons:**  
*Climate Change and the U.S. Armed Forces*



## EXECUTIVE SUMMARY

Climate change holds important consequences for national security and the way the Department of Defense (DOD) does business. The effects of global climate change are likely to reshape the current and future security environment. Analysts expect changes such as extreme drought, more frequent heat waves, desertification, flooding and extreme weather events. The combined impact of these effects will intertwine with existing political, social, cultural and economic trends, with significant implications for U.S. interests worldwide. Countries and regions of strategic importance – from Afghanistan to the Arctic, China to Yemen – are likely to confront major environmental pressures on both their societies and ecosystems. Physical changes to the environment may also disrupt U.S. military capabilities and facilities. For instance, military installations or training ranges may experience increased flooding, wildfires or major coastal erosion.

Addressing the dual pressures of climate change and energy analyzed in this report will require the Department of Defense, U.S. armed services and combatant commands to explore how they might plan and adapt, help partner nations around the world adapt, and mitigate climate-changing greenhouse gas emissions. In some cases, such as with improving energy efficiency, solutions will be simple. In others, addressing these issues will require tough trade-offs. This report identifies many of the key policy questions and trade-offs, and, we hope, assists in mapping a road ahead that meets U.S. national security needs.

Based on extensive research, expert interviews and site visits, this report offers the following recommendations to improve the country's ability to promote national security in the face of a changing climate:

- DOD should ensure that it is included in the emerging debate over geoengineering (the intentional manipulation of the climate, which is often

discussed as a means to counter the effects of the climate change generated by human activity).

- The Senate should ratify the UN Convention on the Law of the Sea (UNCLOS) in order to protect U.S. and DOD interests.
- U.S. Northern Command (NORTHCOM) should be assigned the role of the supported commander on issues related to the Arctic.
- The U.S. government should make an informed decision about siting nuclear reactors on military bases as a means of generating carbon-free energy; as a first step, it should establish a blue ribbon panel led by the Department of Energy to examine this issue.
- The Congress and DOD should provide incentives to encourage the armed services to implement conservation and efficiency practices and continue to invest in renewable energy programs.
- All of the services should improve their understanding of the effects of climate change and what these effects will mean for their specific missions and capabilities.
- The Air Force should fully integrate energy security and climate change into planning efforts.

This report contains several elements. First, it begins with a capstone that summarizes key findings that cut across the armed services and regional combatant commands. Second, it examines how climate change is likely to affect the military services, with separate chapters on the maritime, air and ground forces. Third, the report examines the national security implications of climate change on the regional combatant commands, which will make the operational and tactical level decisions about how to adapt. Finally, an appendix to this volume examines how DOD integrated climate change considerations into the Quadrennial Defense Review.





**CHAPTER I:**  
BROADENING HORIZONS:  
CLIMATE CHANGE AND THE U.S. ARMED FORCES

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By Commander Herbert E. Carmen, USN, Christine Parthemore and Will Rogers



## BROADENING HORIZONS: CLIMATE CHANGE AND THE U.S. ARMED FORCES

By Commander Herbert E. Carmen, USN,  
Christine Parthemore and Will Rogers

The effects of global climate change are likely to reshape the current and future security environment. Analysts expect changes such as extreme drought, more frequent heat waves, desertification, flooding and extreme weather events. The combined impact of these effects will intertwine with existing political, social, cultural and economic trends, with significant implications for U.S. interests worldwide. Countries and regions of strategic importance – from Afghanistan to the Arctic, China to Yemen – are likely to confront major environmental pressures on both their societies and ecosystems. Physical changes to the environment may also disrupt U.S. military capabilities and facilities. For instance, military installations or training ranges may experience increased flooding, wildfires or major coastal erosion.

As the largest consumer of fossil fuel in the world and a defender of global security interests, the U.S. military both influences and is influenced by climate change. To reduce the military's own climate-changing emissions and increase operational effectiveness, the most direct approach in the near term is to improve energy efficiency (i.e. to ensure the Department of Defense [DOD] gets more use out of the energy it consumes). In addition, the United States must adapt to and prepare for the expected effects of climate change. Developing a more nuanced understanding of where, when and how climate change will affect U.S. security interests will improve the odds that the U.S. government can properly plan for contingencies. It will also help partner countries to adapt in ways that will hedge against destabilizing forces.

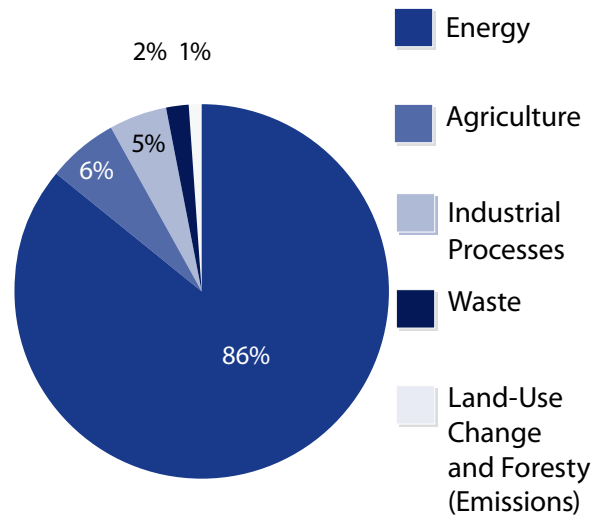
Beyond the operational benefits of improving energy efficiency and the strategic benefits of addressing climate change, DOD is increasingly subject to new policy requirements that all federal agencies work to reduce climate-altering greenhouse gas emissions and reduce

petroleum consumption. These requirements are likely to mount. Given that 86.1 percent of U.S. greenhouse gas emissions are tied to energy use, over the medium and long term, the United States and DOD should strive to transition to a lower-carbon energy system.<sup>1</sup> This transition would present several opportunities. Addressing climate change will give DOD a better understanding of the operational environment and global trends, as it requires analyzing information concerning the major political, economic, security and environmental characteristics of the world. Most importantly, it can often bring operational and tactical benefits in the short term in addition to long-term emissions reduction benefits. As for readiness considerations, energy efficiency and fuel conservation can increase flexibility in logistics chains, allow ships and aircraft to travel greater distances and remain on station longer and mitigate contributions to climate change.

This transition also presents challenges. While, at first glance, energy efficiency appears to be a win-win approach to addressing the energy and climate issues raised above, in practice the need for DOD to use less polluting fuels may entail difficult trade-offs. Fuel usage, after all, has profound consequences for readiness to conduct military missions, whether those missions rely on refueling stations, ships at sea or refueling aircraft in flight. The standardization of fuels (ensuring that the armed services can operate a wide range of equipment on a single type of fuel) has had enormous logistical benefits, especially given that the United States can acquire petroleum supplies worldwide. Particularly in a time of war, such operational considerations should remain paramount.

Despite these current operational needs, however, current energy use cannot be held in isolation from the effects of its use. Given the

**Table 1: U.S. Greenhouse Gas Emissions by Sector**



Source: Environmental Protection Agency, "Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008."

geopolitical, budgetary and operational risks our current energy system entails – not to mention the changing global regulatory and business environments – perpetuating DOD reliance on high-carbon fuels, and in particular petroleum, may set DOD on an unsustainable course in the longterm.

To address these critical issues, the Center for a New American Security (CNAS) launched this research project in the summer of 2009. The multifaceted nature of the climate change challenge means that no one enterprise has all the answers. Thus, we engaged a diverse range of stakeholders in an ongoing discussion and debate in order to understand the complexity of climate science and projected climate effects, identify which climatic changes could impact security, and what the solutions might be. Through the course of this project, we conducted independent research and analysis, personal

interviews and group discussions. We met with representatives of every regional combatant command, several functional combatant commands and bases around the country in order to foster a climate change dialogue.

To effectively study what climate observations and projections mean for specific actors within the DOD, we conducted separate studies of how the effects of climate change – both the environmental changes and the policy changes – would affect ground, air and maritime environments, missions and capabilities. We also studied the specific roles of the combatant commands and their greatly differing areas of responsibility, which warranted focused attention. These studies, originally released as individual working papers, are included in this volume and also summarized here.

### **Climate Change and the Services: A Summary**

Within the DOD structure, the services individually choose how to prioritize the short- and long-term implications of climate change. All share the priority of ensuring secure access to energy and learning how to improve efficiency. However, understanding of how climate change may affect the strategic environment, missions and capabilities varies across the services.

Among the services, the Navy has been most proactive in addressing the related challenges of climate change and energy security. The Chief of Naval Operations, Admiral Gary Roughead, established Task Force Energy and Task Force Climate Change in 2009 to recommend appropriate actions and investments in both areas. The first major step was the release of the Arctic Roadmap, a comprehensive five-year strategy intended to help the Navy navigate future challenges in a thawing Arctic. Additionally, Secretary of the Navy Ray Mabus issued a set of ambitious new plans to boost Navy and Marine

Corps energy efficiency and alternative energy use, including the goal of fielding a completely sustainable carrier strike group. Task Force Energy and Task Force Climate Change coordinate closely, ensuring these issues are considered together. In the maritime chapter of this report we outline in detail the multi-year process the Navy has undertaken in order to better understand how climate change will affect it and the Navy's best policy responses. We find that it is a highly replicable model that would benefit the Army and Air Force as well.

The Air Force has focused its efforts on reducing its demand for energy. It prioritizes assured access to fuel supplies because doing so reduces operating costs and has a direct, positive impact on mission effectiveness. Energy security and cost volatility are major concerns for the Air Force. A 10-dollar increase in the price of a barrel of oil, for instance, increases the annual fuel cost by 619 million dollars. But even if fuel were free, transporting, storing and delivering aviation fuel in a combat zone constitutes a significant logistical risk.

Turning to the ground forces, the U.S. Army, Marine Corps and National Guard are in the early phases of considering how climate change might affect them in the future. Each has focused attention on improving energy efficiency, particularly operational energy use on the battlefield, and individuals within each of the services have devoted careful attention to considering what climate change could mean for their future responsibilities. However, deeper study along the lines of the Navy's efforts over the past several years of how climate change will affect the ground forces' specific equities would help to ensure that both analyses and policies are tailored correctly to the concerns of these services.

The different emphasis placed on climate change by the services is easy to explain: services like

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the Navy witness the effects of climate change daily, especially in areas of major concern like the Arctic. The Coast Guard too has observed discernible climate change impacts firsthand, such as a reduction in Arctic summer ice and a northerly migration of fish stocks. Indeed, the Arctic is proving to be the first case study in how climate change affects military missions, and the maritime services are gaining firsthand experience on the impacts and complexities that may lie ahead for the United States. Several Alaskan villages are being relocated with the help of the maritime services and National Guard. Increased human activity from boaters

and ecotourists with inadequate survival equipment and increased maritime traffic through an increasingly open Northwest Passage creates the possibility of a daunting scenario: a large scale search and rescue mission in the Arctic. What concerns the services is that they don't have sufficient capacity or the required capabilities – such as communications equipment and operable icebreakers – to respond to such a mission on a large scale, a more frequent basis or quickly enough to save lives in the frigid Arctic waters.

For the Army and Air Force, the ways in which climate change may affect them in the future are not as apparent. Without currently observable indicators, in many cases the information needed for them to conduct analysis with meaningful fidelity is simply lacking today.

To address the variables of climate change effectively, the services will need to determine how climate change will modify the existing physical, military and civil conditions within the context of the operational environment. These conditions are variables used in the mission essential task development process to describe the current and potential capabilities of the armed forces. In order to do this, the services will need better – and more localized – information on when and to what degree different climatic effects could manifest. For example, climate change could cause reductions in permafrost which could then affect terrain firmness, terrain traction and runway weight bearing capacity. Changes to the ocean due to melting ice can cause changes in currents, salinity, ocean acoustics, shipping presence and ambient noise. Resulting sea level rise can cause changes to coastal terrain features, and availability of space for maritime maneuver. Because sea level rise is difficult to project and will vary by location, it is difficult to accurately determine which coastal areas are most at risk. In such cases, regional, coastal or base-by-base

assessments might better inform the services rather than global climate projections.

With improved information, more extensive analysis and targeted investments, the services will be able to navigate the challenges posed by the effects of climate change. But to help them do so, DOD, executive branch leaders and Congress will need to address several key issues.

### Key Issues

Our research highlighted several pressing issues at the nexus of climate change, energy and national security. These threads emerged in our study of each of the services as well as the combatant commands.

**Climate change holds important consequences for national security and the way DOD does business. However, since DOD will likely not be the lead agency for addressing most climate change and energy issues, defining DOD's proper voice in addressing these matters will be critical.**

Climate change will sculpt the future security environment. As such, promoting national security in the decades ahead will require non-military capacities and extensive efforts by non-DOD government agencies in addition to DOD roles and responsibilities. Indeed, the Quadrennial Defense Review (QDR) notes that DOD will need to rely on the knowledge and capacities housed in other U.S. agencies in order to effectively address climate change:

As climate science advances, the Department will regularly reevaluate climate change risks and opportunities in order to develop policies and plans to manage its effects on the Department's operating environment, missions, and facilities. Managing the national security effects of climate change will require DoD to work collaboratively, through a whole-of-government approach, with both traditional allies and new partners.<sup>2</sup>

President Obama's Interagency Ocean Policy Task Force may be an early example of the kind of interagency collaboration called for in the QDR and the kind of collaboration necessary for the maritime services to address climate change effectively. Launched in June 2009, it brought together the Council on Environmental Quality, the Coast Guard, the National Oceanic and Atmospheric Administration (NOAA), the Environmental Protection Agency, the Navy and other agencies to coordinate policies throughout the government on oceans and coastal areas, and international governance thereof. Its early work identified "resiliency and adaptation to climate change and ocean acidification" as one of the priorities.<sup>3</sup> The Pentagon, the services and the combatant commands are also collaborating in important ways with the Department of Energy and the U.S. Department of Agriculture on energy infrastructure, biofuels and improvements to U.S. electric grids. These kinds of interagency partnerships often lead to important advances for meeting DOD energy needs and reducing emissions, and they serve the important symbolic effect of showing that even with the heavy security implications they carry, solutions are not primarily the responsibility of the DOD.

**Deepening understanding of the security implications of climate change is likely to add to current questions about the proper role of the DOD relative to civilian agencies.**

As the military increasingly engages in activities such as building water infrastructure and improving agricultural practices in Afghanistan, debates over the "militarization" of foreign policy and the role of the armed services in development activities are heating up. The effects of climate change on environmental conditions in regions of high strategic importance to DOD will make questions regarding the proper balance of civilian and military activities

overseas even more salient. And for situations like the current opening of Arctic sea ice, it is important to consider the public and international impression involved with the Navy and Coast Guard serving as, for the most part, the leading experts and proponents on Arctic issues. While interagency collaboration is useful for meeting this challenge, matching the advanced work by the Navy and Coast Guard on issues like climate change with equal civilian leadership will be critical.

**Inadequate fidelity in climate projections affects planning, budgeting and acquisition decisions, with repercussions that can last for decades.**

Though planning for an uncertain future is common for the DOD, improved observations and projections of how climate change is manifesting around the world would go a long way toward improving the process of integrating climate science into security decision making. For now, gaps or vagueness in climate information reduce the likelihood that policy decisions will account for the knowledge that the science community could add. Luckily, many countries are working to address deficiencies in information. The recent launch of the European Space Agency's CryoSat 2, which can measure ice thickness to within 1 centimeter, may one day greatly improve the accuracy of climate projections.<sup>4</sup> Until better projections are available, the Air Force and the ground forces have given less attention to what the mid- to long-term climate change effects will be on their missions or how they will incorporate climate change into future planning considerations. Climate change has not yet affected their operating environments as tangibly as it has the maritime services.

**For more localized energy and climate-related acquisition decisions, not providing a financial incentive for cost avoidances and reallocating**

**savings to other programs is effectively serving as a disincentive.**

Stated simply, we found that many officials charged with improving energy efficiency, increasing alternative energy use and reducing DOD greenhouse gas emissions did not see a direct benefit to doing so. In every case where individuals still worked to meet climate and energy requirements, the lack of financial or other tangible incentives seemed to cause frustration. While fuel dollars saved from efficiencies gained in the air, at sea and on land are considered cost avoidances, those dollars are spent elsewhere within the services. Thus, to the installation managers and operational forces, there are no direct financial incentives for saving energy – or, relatedly, for reducing greenhouse gas emissions. Indeed, many representatives from all of the services spoke of meeting their climate and energy requirements as unfunded mandates. The 2009 stimulus package provided funding for an array of clean energy projects at bases nationwide, and the Obama administration and Congress should examine lessons learned from dispersing this funding and find ways to replicate its successes.

The next policy decisions regarding energy and climate change will be more sweeping and more difficult, but could result in dramatic improvements to long-term U.S. security. The services (and the nation broadly) have been working for years to increase energy efficiency, which means that the most basic and easiest measures (such as switching to energy-saving light bulbs and increasing vehicle fuel economy) are already underway. Meanwhile, the challenge of transitioning to a low-carbon energy economy that meets domestic, geopolitical and military needs is looming larger than ever. Fortunately, as U.S. policy follows along, scientists and engineers – including those at DOD labs and the Defense Advanced Research Projects Agency – are



making bold strides and often rapid advances in next-generation biofuels and electric transportation. However, if embraced, these advances will require major policy decisions. Nuclear energy advances will raise safety and proliferation concerns. And policy makers may need to grapple with efforts at atmospheric manipulation to cool the global climate.

### Recommendations

Throughout our research, several specific policy issues emerged continually and we believe that four in particular will present the toughest and most complicated climate change-related decisions in the coming years. As a result, the following section makes recommendations to help the United States better navigate the potential geopolitical implications of the changing climate. Specifically, we recommend that the United States engage in a serious international discussion of geoengineering; ratify the UN Convention on the Law of the Sea; and designate U.S. Northern Command to take responsibility of the Arctic region, with support from European Command and Pacific Command. Finally, we believe that nuclear power will be the biggest question in debates concerning how to improve energy security and mitigate greenhouse gases at domestic DOD installations. Consequently, we recommend that the U.S. government create a clear policy regarding nuclear reactors on military installations.

#### 1. GET INVOLVED IN THE GEOENGINEERING DEBATE

A lingering but critical policy question for DOD is what its role should be in discussions concerning geoengineering, i.e. the intentional manipulation of the climate, which is often discussed as a means to counter the effects of the climate change generated by human activity. This issue involves U.S. bilateral and multilateral relations, domestic science and technology policy and an array of other security issues. Perhaps most starkly, it involves the potential of

a single nation to intentionally manipulate the air and sea environments globally.

The security issues at stake are today not even well defined or fully explored but key questions include:

- Does the United States consider deliberate, unilateral and intentional manipulation of the climate a threat to the global commons, and if so, how are U.S. greenhouse gas emissions characterized?<sup>5</sup>
- Will the international community even know when and how another country engages in geoengineering if that country does not declare it publicly?
- Who is responsible for negative climatic effects of geoengineering on other countries and how should those repercussions be addressed?
- If the international community embraces geoengineering as a means for addressing climate change, who will fund, direct and provide oversight for research, development and implementation?

The debate over geoengineering today is both nascent and polarized. Opponents are already advocating a binding international treaty akin to the Biological Weapons Convention or Non-Proliferation Treaty, or complete bans on researching or implementing possible geoengineering techniques. At the same time, others are advocating geoengineering as a cheap and easy band-aid for the climate damage that human activity has created (this argument is often a thinly veiled attempt to simply stop any requirements for mitigating greenhouse gas emissions). Both sides tend to ignore the relatively weak scientific foundation most geoengineering approaches have today.

Still, the debate on this issue is heating up, and there are to date no international treaties, laws or even norms that point to a pragmatic

approach to this policy question. Congress is beginning initial steps to explore this issue. The House Committee on Science and Technology, for example, held a series of three hearings between November 2009 and March 2010 to examine geoengineering, and it signed a joint statement with the commensurate UK House of Commons committee. (Notably, while this document speaks of “important international implications” of geoengineering, the words “security” and “defense” do not appear.)<sup>6</sup> In the executive branch, we recommend that the White House Office of Science and Technology Policy be the lead agency examining this policy question for the federal government, as it can convene and coordinate among the myriad federal agencies that have strong interests in climate, space and atmospheric issues. Yet some of the most important questions will involve U.S. security and foreign policy issues. Particularly as it involves deliberate manipulation of what the United States considers the global commons, DOD has an interest in – at minimum – being at the table for discussions of this approach to the climate change challenge.

## 2. RATIFY THE UN CONVENTION ON THE LAW OF THE SEA AT THE EARLIEST PRACTICAL OPPORTUNITY

Ratifying the UN Convention on the Law of the Sea (UNCLOS) is perhaps the most important next policy step in ensuring that the United States and DOD are prepared to adapt to a changing climate and realize the opportunities that climate change may enable. Senate ratification of this treaty would afford the United States a major leadership role in maritime security issues that it presently cannot fully perform from the sidelines. UNCLOS gives the United States legal certainty in securing resource rights in its Exclusive Economic Zones (EEZs). By the nature of its coastline, the United States enjoys the largest EEZ in the world, which includes Alaska’s connection to a changing Arctic Ocean. For these economic and security

reasons, UNCLOS ratification has long enjoyed strong support across the maritime services – not only for ensuring U.S. interests given the opening Arctic, but across the oceans worldwide. Reductions in Arctic summer sea ice have created new opportunities for access to maritime trade routes and sea lines of communication, and potential access to vast supplies of zinc, nickel, palladium, precious stones and other various minerals, as well as oil and natural gas under the ocean with an estimated value of 1.2 trillion dollars. Many of these resources lie in the extended continental shelf up to 600 nautical miles of the Alaska coast. As access to the Arctic and industry technologies continue to improve, heightened energy needs could spur private corporations to increase exploration and exploitation of these reserves. UNCLOS establishes the process for mining firms to obtain access and exclusive rights to these resources and title to the minerals once recovered. A failure to ratify UNCLOS prevents the United States from submitting a claim for rights in the extended continental shelf and prevents firms from securing these rights. This will hinder growth in the emerging seabed mining industry and related industries in the United States – as well as the jobs supporting those industries – because corporations will wisely seek the protection and legal certainty afforded only to member nations of UNCLOS before investing in these opportunities. Ratification of UNCLOS therefore protects and adds certainty to U.S. economic interests.

Furthermore, the signed 1994 UNCLOS agreement gives the United States the only permanent seat on the Council of the International Seabed Authority, its main decision-making body. The United States would be afforded this opportunity by virtue of having the largest economy in terms of gross domestic product on the date of agreement. Failure to ratify the treaty as currently agreed would effectively abdicate a uniquely

influential role in seabed mining. If a subsequent UNCLOS treaty agreement is reached before Senate ratification, there is no guarantee that the United States will still have the opportunity for this permanent seat, and if the treaty is not ratified, it will have no legitimate international voice on these issues.

The Obama administration began initial work with the Senate to push for UNCLOS ratification in mid-2009. The Interagency Ocean Policy Task Force noted in its September 2009 interim report that “By joining the Law of the Sea Convention now, we can reaffirm and enhance U.S. leadership in the development and interpretation of international law applicable to the ocean.”<sup>7</sup> It states explicitly that the Office of Science and Technology Policy intends to “Work to ratify the Law of the Sea Convention – an agreement supported by more than 150 countries, which will protect our economic and security interests.”<sup>8</sup> Likewise, Secretary of State Hillary Clinton stated in her January 2009 confirmation hearing before the Senate Foreign Relations Committee that the administration favored UNCLOS ratification, including to advance U.S. mining and other commercial interests in the opening U.S. Arctic territories.<sup>9</sup>

Despite a long history of overwhelming bipartisan support for UNCLOS, the political hurdles to its Senate ratification persist. The most frequently and vocally cited objection is the contention that ratifying UNCLOS will reduce U.S. sovereignty by forcing it to provide economic and technical information and to participate in consensus decision making internationally. Three U.S. representatives formed a “Sovereignty Caucus” in early 2009 to support the narrative that U.S. treaty participation negatively affects the U.S. ability to protect its interests.<sup>10</sup> This argument has been a pervasive part of the UNCLOS dialogue since its first ratification attempt in 1982. We contend that U.S. leadership

in international forums, and coordination with other countries is vital to protecting U.S. maritime interests worldwide. The security interests at stake with this treaty are becoming increasingly clear with the effects of climate change on the Arctic, and the U.S. Congress has a responsibility to promote these interests.

Though ratifying UNCLOS is important to America’s ability to protect its security interests, history shows the difficulty in obtaining advice and consent ahead of an election cycle. A failed attempt at ratification could be more damaging to the overall ability to ratify it, particularly because this treaty is so critical to the economic future of the United States. Timing is important, but so is ratification. Thus, the introduction of the UNCLOS for legislative consideration should be well considered and carefully done.

### **3. DESIGNATE U.S. NORTHERN COMMAND AS THE SUPPORTED COMMANDER ON ARCTIC ISSUES, SUPPORTED BY U.S. EUROPEAN COMMAND AND U.S. PACIFIC COMMAND**

In the current Unified Command Plan, UCP 2008, three separate unified combatant commanders have responsibilities for portions of the Arctic. Until now, this has not presented a problem, but the effects of climate change in the Arctic have given rise to and may ignite new security challenges and expanded military missions. As other Arctic nations build capabilities to increase their presence in the Arctic, the United States currently lacks unity of command and unity of effort in the Arctic. Without unity of effort, the U.S. hampers its ability to protect its own interests, project a credible U.S. presence and coordinate diplomatic, military and inter-agency efforts in the region. A single supported unified combatant commander is needed in order to deal with the challenges ahead in the Arctic.

U.S. Northern Command (NORTHCOM) should assume the role as the supported commander on issues related to the Arctic. NORTHCOM’s

area of responsibility (AOR) includes Alaska and adjacent waters, meaning that the U.S. EEZ is within the AOR of NORTHCOM. NORTHCOM already has functional relationships with the Department of Homeland Security and other agencies that have interests or operate in the Arctic. Furthermore, NORTHCOM collaborates with Canadian forces in much of its activities related to security. While U.S. European Command's AOR includes the Arctic nations of Denmark, Norway and Russia and a correspondingly large portion of the Arctic coast, the commander's dual role as the military commander of NATO could place EUCOM in a difficult position. Therefore, we feel that NORTHCOM is best positioned to take the lead.

If NORTHCOM is designated as the supported commander for the Arctic, direct senior civilian involvement in such an arrangement would be critically important from the start. A potential solution is suggested by our colleagues Patrick Cronin and Kristin Lord in an April 2010 op-ed:

We need to create civilian-led equivalents of military combatant commands that can unify our diplomatic, development, public engagement and defense efforts... Washington-based agencies focus on formulating and coordinating policy, not implementation. That step must occur in the field. This does not necessarily mean simply placing a civilian on top of an existing military command, such as U.S. Africa Command, where a civilian is a prominent deputy. It may mean creating regional or subregional hubs, regional equivalents of embassy country teams, that enable U.S. agencies to integrate diplomacy, development, public engagement and defense more effectively.<sup>11</sup>

This kind of regional hub for the Arctic could be designed as a test case for the concept of creating

these "civilian COCOMs." The military challenges in the Arctic resulting from changing climatic conditions generally stem from non-military U.S. interests. Even more important, ensuring U.S. security interests in the Arctic will be impossible without strong and dedicated diplomacy and international coordination. Joint DOD and State Department leadership of this region offers the ideal way of promoting U.S. interests in the Arctic.

#### 4. MAKE INFORMED DECISIONS ABOUT NUCLEAR REACTORS ON MILITARY BASES

Adjudicating whether or not domestic military bases should embrace nuclear energy as a means of meeting emissions reductions and energy security goals is beyond the scope of this study. Yet interviewees asked "where is Washington" on this issue in nearly every meeting we held at DOD installations around the country (not to mention several vocal proponents and critics within the Pentagon). Depending on technological advances and other factors, there are likely benefits to this approach but there are also serious drawbacks. Thus, there is a strong need for the federal government to examine carefully and create policy guiding the installation of nuclear power generation on domestic DOD bases.

A persistent question that civilian and military officials raised in our discussions over the past year therefore concerned the status of what many consider to be the ultimate no-carbon energy source: nuclear power. The 2005 Energy Policy Act required domestic federal buildings to reduce energy use and increase the use of renewable energy. Subsequent 2007 legislation increased these targets to achieve 30 percent energy consumption reductions by 2030.<sup>12</sup> As the services have done well to implement the relatively easy measures to reduce energy use and increase low-carbon energy generation, it may be increasingly difficult to continue meeting these targets. Could locating small nuclear power plants on U.S.

## THE U.S. MILITARY AND NUCLEAR ENERGY: A HISTORY

As the United States assesses installing nuclear power reactors on domestic military bases, as mandated by both the FY 2009 and 2010 National Defense Authorization Acts, it may be useful to look back to the country's history of producing nuclear energy on U.S. bases.

Under the Army Nuclear Power Program (ANPP), which ran from 1952 until 1979, U.S. bases featured both portable and stationary reactors at the following locations:

### **Fort Belvoir, Va.**

Stationary: Pressurized Water, 1957-1973

### **National Engineering and Environmental Laboratory, Idaho**

Stationary-Testing: Gas Cooled, 1959-1962

Portable-Testing: Gas Cooled, 1961-1965  
Stationary-Testing: Boiling Water, 1958-1961\*

### **Camp Century, Greenland**

Portable: Pressurized Water, 1960 - 1964

### **Fort Greeley, Alaska**

Stationary: Pressurized Water, 1962-1972

### **Sundance, Wyo.**

Portable: Pressurized Water, 1962-1968

### **McMurdo Sound, Antarctica**

Portable: Pressurized Water, 1962-1972

### **MH-1A Sturgis floating nuclear power plant, Panama Canal**

Docked: Pressurized Water, 1967-1976

Major ANPP activities ceased in 1977, following the closing of the Sturgis plant, due to changing military requirements and funding limitations. Nevertheless, a historical examination of previous efforts to generate nuclear power on U.S. bases may be useful to inform public policy on this issue moving forward.

*By Daniel Saraceno, Joseph S. Nye, Jr. National Security Researcher*

*Source: U.S. Department of Energy National Nuclear Security Administration Office of the Deputy Administrator for Defense Programs, Highly Enriched Uranium: Striking a Balance (September 2001): 145 - 148.*

*\*destroyed in an accident*

military bases be the next logical step in improving energy security and reducing emissions?

Proponents point to several benefits. Nuclear energy does not produce the climate-changing greenhouse gases that coal, oil and natural gas-based electric generation create. Nuclear reactors produce energy at a consistent rate, which is best for outdated U.S. power grids. Until better energy storage devices are on hand, they may also be the most reliable form of carbon-free power generation available to achieve the energy security goals of bases being self-sufficient during emergencies or long-duration power outages. Though security levels vary by location, proponents assert that military bases tend to have the gates and guards necessary to provide

basic security measures necessary for nuclear facilities.

Many serious complications must be weighed as well. Military base personnel often do not have the necessary training in nuclear reactor management, oversight and regulatory credentials. Nuclear reactors would necessitate additional qualified personnel and improved physical security requirements to meet the 24/7 operations needs. As with siting for all energy production, local public resistance could be problematic. When considering the impact of a reactor casualty, the resulting impact on the operational mission effectiveness of the tenant commands on the base must also be considered so as to avoid a single point vulnerability that

disables all military operations on site. And while many private companies are touting new designs for small reactors that would work well in this capacity, the technology may still be years away from fully meeting technical requirements and federal regulatory standards.<sup>13</sup> Proliferation considerations would also need to be part of any adjudication of what types of reactors are most suitable for these purposes.

The question of whether or not to locate nuclear reactors on domestic DOD installations has been raised for years, and the 2010 National Defense Authorization Act required DOD to assess the feasibility, costs and benefits of going this route. The need to mitigate greenhouse gas emissions, and recent debates over “islanding” energy systems and integrating smart grid technologies for energy and cyber security reasons, have all created a new sense of urgency for definitive answers to this pressing policy question.

The concept of energy islanding is enjoying increased attention today, and several Army, Navy and Air Force officials we spoke with explicitly stated that small nuclear reactors could help DOD to create islanding capabilities. The February 2008 Defense Science Board report “More Fight – Less Fuel” states that “The Task Force recommends DoD pursue the concept of ‘islanding,’ which would isolate critical loads, and selectively entire installations, from the grid and make them self-sufficient.”<sup>14</sup> Likewise, in response to a question about islanding for DOD bases, Deputy Under Secretary of Defense for Installations & Environment Dr. Dorothy Robyn stated in February 2010 that the source of electricity generation could be important to meeting the goals of islanding: “Is the backup diesel capability, or whatever that we now have, sufficient? Do we need to do more than that? And renewable can be helpful, nuclear could be very helpful, I don’t see renewable and nuclear as either or, it could be both.”<sup>15</sup>

If improving energy security includes all strategic assets, personnel and logistics involved with a given base’s activities, then the definition of islanding would similarly need to expand to include parts of the greater community around the base, for example nearby ports. There is also a concern over negative public image that could stem from military bases having vast energy resources while the surrounding communities experience disruptions and other problems. This speaks to the idea that promoting nuclear energy for the purpose of creating islanding capabilities for bases would require careful definition of the goals of this approach and intricate planning.

The DOD-led report required by the 2010 NDAA is sure to offer initial insights on some of the important costs and benefits to consider in adjudicating this policy question. However, final policy choices should be informed by an extensive review conducted by an entity external to DOD (for example the National Academies of Science or DOE). While the United States has had nuclear reactors on domestic bases in the past, modern climate and energy concerns require a fresh look at siting nuclear reactors on military bases, and recommendations to Congress on whether (and perhaps where) this approach to increasing the use of climate-friendly energy is feasible and desirable. While providing a definitive answer to the question of siting nuclear reactors on military bases is beyond the scope of this project, we strongly recommend that a non-DOD entity conduct a major thorough examination of this question with the goal of setting national policy on this topic. A high-level public effort to define and answer this question is overdue.

On January 29, 2010, Energy Secretary Steven Chu announced his establishment of the Blue Ribbon Commission on America’s Nuclear Future to “provide recommendations for developing a safe, long-term solution to managing the

Nation's used nuclear fuel and nuclear waste."<sup>16</sup> We recommend that the Obama administration follow up that initiative by applying the same model to the pressing national policy question of whether the United States should locate nuclear reactors on DOD installations.

## CONCLUSION

Given the complexity of climate change and its implications for national security, we do not imagine that a single research project could answer all questions or address every facet of climate change and national security. While we hope that we have provided both useful observations and concrete recommendations, our primary goal was to spark a richer and more public discussion on the national security implications of climate change and to link this discussion to the needs of America's armed forces.

Yet we do believe that this project succeeded in highlighting the most important near-term policy questions for the military services, combatant commands, the Department of Defense and policy makers concerning energy and climate change. In the near term, decision makers will need to answer important questions identified in this report's chapters, to include the following:

- How can DOD balance energy consumption, mission effectiveness and national climate change mitigation goals in concert?
- What trade-offs are involved with focusing time and funding on climate change, given that operational and maintenance budgets are finite and increasingly constrained?
- What specific climate change effects are likely to occur and how are these effects likely to affect the armed services?
- How can officials access actionable climate

science data and use it to better plan for future contingencies?

- Where would DOD make the greatest contributions to national security goals through its study of climate change and investments in reducing emissions?

The following chapters analyze how climate change may affect U.S. maritime, air and ground forces and the combatant commands. In so doing, they provide some preliminary answers to these questions and point to key challenges ahead.

While we believe there is still much work ahead, there is a growing commitment to addressing energy and climate change within the DOD. Indeed, in our conversation with officials in the Office of the Secretary of Defense for Policy, it was clear that, in developing the climate change and energy section of the 2010 QDR, the Department of Defense has developed a nascent, intellectual infrastructure of civilian and military professionals who will continue to study the national security implications of climate change, and, we hope, will continue to reevaluate climate change risks and opportunities as the science continues to evolve. We applaud these efforts. As the United States addresses the global implications of climate change and reduces its own operational vulnerabilities, this understanding will enhance American security.

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**CHAPTER II:**  
CLIMATE CHANGE AND THE MARITIME SERVICES

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By Christine Parthemore

A P R I L 2 0 1 0

**Broadening Horizons:**  
*Climate Change and the U.S. Armed Forces*



## CLIMATE CHANGE AND THE MARITIME SERVICES

By Christine Parthemore

Climate change carries broad implications for U.S. interests. Scientists forecast, and in some regions are already observing, an increasingly accessible Arctic, sea level rise, melting glaciers and ice sheets, changing patterns of natural disasters and alterations to ocean conditions. These physical changes hold consequences for national security. They could affect military installations, generate new challenges for continued U.S. access to the global commons and contribute to economic and political instability abroad in ways that affect U.S. maritime missions in particular. Leaders in the U.S. Navy and Coast Guard (collectively referred to as the maritime services in this paper<sup>1</sup>) are expending significant effort to understand and respond to this challenge.

The unique capabilities and missions of the maritime services require a nuanced understanding of changes to the world's ecosystems, and they are therefore as aware as any civilian scientists that actual observations of climatic changes are outpacing projections. Combined with strong leadership, this awareness is driving the Navy and Coast Guard to explore more deeply than many other government departments how climate change will affect them. Complicating these efforts are continuing difficulties with interpreting climate projections and determining how these analyses should inform policy decisions.

In September 2009, the Center for a New American Security (CNAS) convened representatives from the Navy and Coast Guard, scientists, government agency officials, nongovernmental organization representatives and security and foreign policy experts to discuss the implications of climate change for the maritime services.<sup>2</sup> This chapter crystallizes how they are thinking about this problem, based on discussions in that meeting, a series of interviews and independent research conducted by CNAS.

### Defining the Climate Change Challenge

Leaders within the maritime services have launched several initiatives over the past few years to better understand what climate change projections and observed changes mean for their missions, operating environment and capabilities. Their experience is instructive.

The Coast Guard has actively observed changing conditions, and several of its leaders have voiced concern over changing patterns in maritime shipping and other economic activities. In response, Coast Guard Commandant Admiral Thad Allen has called for new assessments to determine future Coast Guard mission requirements, and he has conducted extensive outreach, including everything from Congressional testimony to blog posts.

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*In speaking with Navy and Coast Guard personnel about the effects of climate change, there is one often-cited refrain:*

*We will adjust, as we always have.*

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Turning to the Navy, the Chief of Naval Operations (CNO), Admiral Gary Roughead, commissioned several exploratory studies in 2008 about how climate change may affect the maritime environment and therefore the Navy.<sup>3</sup> These far-ranging studies included expert working groups and focused on a broad range of initial findings on potential climate effects, such as alterations in ocean salinity and changes to the Arctic region. Initial assessments pointed to specific effects on which the Navy should focus, working with scientists and other

climate experts to determine which issues are likely to be problematic. Admiral Roughead then built upon this initial research and analysis by establishing two related task forces: Task Force Climate Change, charged with creating an Arctic Roadmap and later a roadmap for full global climate change effects;<sup>4</sup> and Task Force Energy, which examined maritime, aviation, expeditionary and shore energy vulnerabilities to price volatility, limited range and grid fragility. It has also created working groups on fuels, the environment and strategy. The two task forces coordinate closely with one another, ensuring that these interrelated issues are considered together. In the coming months, these task forces will incorporate their findings into comprehensive energy and climate strategies. In September 2009, the CNO also commissioned a Naval Studies Board project to examine specific climate change questions for the maritime services,<sup>5</sup> and the leaders of each task force continue to deliver public speeches, interact with the policy community, and otherwise disseminate their findings to date.

Task Force Climate Change has considered several key questions for the Navy including: what specific effects does the most current climate science indicate are likely to happen; what tradeoffs are involved with focusing time and funding on climate change, including the costs and benefits of making investments to adapt to climatic changes early and waiting for improved climate models to provide more specific information; and where are contributions to the study of climate change and investments by the Navy and Department of Defense (DOD) in general most useful? As one Navy officer noted, these questions are intended to make senior leaders feel comfortable in dedicating finite (and possibly increasingly constrained) resources to addressing climate change at any level.

One outcome of these efforts is that the maritime services have a clearer vision than the other services and federal departments of how climate



The Los Angeles-class submarine USS *Annapolis* (SSN 760) broke through three feet of ice during Ice Exercise (ICEX) 2009 in the Arctic Ocean. ICEX 2009 was intended to test and evaluate naval submarine operability in the changing Arctic environment. (MASS COMMUNICATION SPECIALIST 1ST CLASS TIFFINI M. JONES/U.S. Navy)

change is likely to affect their work, instilling a high level of confidence that they will be able to adapt. In speaking with Navy and Coast Guard personnel about the effects of climate change, there is one often-cited refrain: We will adjust, as we always have. Those who make a living of monitoring the environment – particularly the oceans – have long experienced its changing conditions and adapted accordingly. This experience also clarifies to maritime service personnel the importance of understanding changing conditions, an important result of which is an increasingly clear identification of which climate change effects are likely or unlikely to cause much concern for the maritime services.

### **Today's Biggest Challenge: The Arctic**

Through the process described above, the maritime services identified the Arctic as the most important near-term challenge. Indeed, because there are tangible, measurable changes occurring in that region

today, many already consider the Arctic to be the first case study in how climate change may combine with other forces to affect maritime missions. According to NASA:

Satellite observations since 1979 have shown that [the] amount of ice that survives the summer is getting smaller; declines have been especially dramatic in the past decade...the summer melt season is getting significantly longer.<sup>6</sup>

The opening of the Northwest Passage for transit several consecutive years – coupled with Russia's 2007 placement of a titanium flag under the North Pole and climate observations and projections indicating that it could continue to open up annually – are driving home the need for deeper analysis of the implications of Arctic climate change for the maritime services.

With more than 140 years of service in the Arctic and 11 statutory responsibilities there, the U.S.

Coast Guard is at the center of efforts to adapt to change in the Arctic. Its missions in the Arctic include protecting indigenous populations and marine life as well as law enforcement and interdiction. These missions give the Coast Guard unique responsibilities for managing the effects of environmental change on human populations in the Arctic. Several Alaskan villages, including Newtok, Shishmaref and Kivalina, are already being relocated with assistance from the Navy, Marine Corps, Coast Guard and National Guard. Other towns experiencing ocean inundation and rapid erosion caused by decreasing ice cover throughout the year are requiring increased in-place assistance from the Coast Guard and Navy.

Perhaps the more important change to date is the increasing number of people traveling to the Arctic. At a modest but still worrying scale, the Coast Guard has observed ecotourists, sailors and boaters operating vessels in Arctic waters and encountering difficulty due to equipment that is inadequate for operations in that environment.

An even bigger concern is increasing activity by people seeking economic opportunities in the Arctic, where a series of presidential directives and bilateral treaties govern the activities of the United States and other nations and establish exclusive economic zones and transit agreements.<sup>7</sup> The U.S. Geological Survey estimates that the Arctic holds about 90 billion barrels of undiscovered oil and 1,669 trillion cubic feet of natural gas<sup>8</sup> in addition to likely abundant mineral resources including iron, zinc and manganese. The Coast Guard is also observing northern movement of fish stocks and melting summer ice that could make new shipping lanes viable for transporting goods. These economic opportunities are sure to increase the number of workers in the Arctic region. The scale of this increasing activity may be minor today and seemingly slow to build, but it still holds implications for the maritime services: according to some experts, the worst-case logistical and operational

challenge for the Coast Guard in the Arctic is a large-scale rescue mission.

Coast Guard officials and other experts voice concern that they are not yet equipped to deal with a significant increase in their Arctic activities, should that requirement arise, citing a lack of sufficient communication equipment that can function reliably in the Arctic region<sup>9</sup> and only a small number of icebreakers. The National Research Council concluded in 2007 that the United States needed to maintain a fleet of three ships with icebreaking capabilities—in addition to the one existing research-only ship operated by the National Science Foundation—just for the Coast Guard to meet its existing responsibilities in the Arctic. Given the disrepair of two of the current three icebreakers, the report recommended the construction of replacements, which would take eight to ten years to complete, rather than financing repairs.<sup>10</sup>

However, other estimates based on the most current climate change projections indicate that a fleet of three icebreakers would be either barely sufficient or fully inadequate if missions expand along with increased Arctic activity. Coast Guard Commandant Admiral Thad Allen testified in July 2009, “What we have right now, in my view, is the minimum capability we need to be able to respond if all three of them are operating, and they are not,” noting also, “If...you want to be able to get as far into the ice any time of the year that you need to, north and south, to be able to keep somebody on station, it takes three cutters to do that. And if you’re talking North and South, it would be six, if that was your requirement.”<sup>11</sup>

If Admiral Allen’s estimate is correct, this gap between U.S. security needs and U.S. capabilities in the Arctic points to a need for more specific information about climate change’s effects. But whether or not more detailed projections become available in the coming years, important policy decisions

## THE NAVY: CONSIDERING CLIMATE IN ENERGY DECISIONS

As the Navy invests in energy research and development, it is considering its own contribution to climate change.

Navy leaders point to a history of research and development in nuclear energy as proof that it can play a role as an early adopter of technologies and practices that promote energy security – and as proof that low-carbon technologies can also address military needs. The difficult questions lie in where investments will have the greatest returns now, given the need to both reduce greenhouse gas emissions and to find alternative fuels that do not harm warfighting capabilities.

In order to address energy and climate concerns in managing Navy installations, the Navy is investing in grid and metering improvements, energy efficiency and conservation, photovoltaic systems and other energy solutions as required by Congressional legislation, Executive Orders and DOD instruction. Such investments, particularly on efficiency measures, can assist in meeting greenhouse gas reduction targets, reduce vulnerabilities and save the maritime services money over time. With the goals of finding cost-effective energy sources and increasing range between refueling, the Office of Naval Research has long invested in alternative fuels research and development, including biofuels and unmanned aerial vehicles powered with hydrogen fuel cells. Secretary of the Navy Ray Mabus also set goals in 2009 for reducing petroleum use, integrating energy targets into contracting, purchasing alternative fuel vehicles, deploying a “Great Green Fleet” powered by nuclear and biofuels and in the slightly longer term (by 2020) using alternative energy sources for half of all consumption.<sup>14</sup> Additionally, the Navy recently began



An F/A-18E Super Hornet aboard the USS *Nimitz*. The Navy recently started testing biofuels in the F404 F/A-18 engine. (COMMUNICATTION SPECIALIST 3RD CLASS JOHN PHILIP WAGNER JR./U.S. Navy)

biofuels testing for the F404 F/A-18 engine with the hope of certifying it as a “Green” Hornet by 2010.<sup>15</sup>

Many of the decisions faced by the maritime services involve difficult tradeoffs. Fortunately, some energy solutions involve clear climate benefits with acceptably low risks. Chief among these are opportunities to seize tactical or operational advantages through investments that also save money and reduce greenhouse gases over the long term. Some energy efficiency improvements increase range or extend energy use by several days without refueling. As one Navy leader described during the September 2009 CNAS workshop, the Navy is looking for emissions-reducing energy solutions that allow more time back at station and provide longer endurance for operations.

Despite many advances, there is significant room for improvement in how the Navy makes energy investments. Investments are too often still ad hoc and are not evaluated against clear criteria that ensure they are the

best ways to meet Navy, DOD and federal goals. With budgets likely to tighten in the future, some Navy leaders wish for more stringent processes to determine which alternative energy sources and target technologies are viable and most likely to pay off. Yet this desire competes with the pressure to cast a wide net in order to ensure that no potential game-changers (for example, energy technologies that can produce dramatic results, such as eliminating the need for liquid fuels in some applications) are overlooked.

Understanding the complexity of balancing risk in investments is a valuable first step. Task Forces Energy and Climate Change are considering quantitative and qualitative methodologies for charting potential investment courses and for determining which Navy goals the investments might work to achieve. Key questions will include how long it takes to break even in alternative fuel investments and the nature and scope of the impact upon the fully burdened cost of fuel.

may still arise, and the maritime services will need to continue to evaluate how climate change will affect their missions.

### Key Policy Implications

Beyond analyzing potential security implications and adjusting to changing physical conditions, climate change is already raising two important policy questions broader than purchasing ice-breakers and other equipment. Concerns about managing the changing Arctic are increasing the need for U.S. ratification of the UN Convention on the Law of the Sea (UNCLOS) and beginning to generate debate over how the different Combatant Commands (COCOMs) that include the Arctic in their areas of responsibility – EUCOM (European Command), PACOM (United States Pacific Command) and NORTHCOM (Northern Command) – will work together.

The maritime services, the Office of the Secretary of Defense and the White House have all recommended in strong terms that the United States ratify the UNCLOS, though it remains to be seen when and how this might occur. The Senate's previous inability to ratify it stemmed from arguments concerning national sovereignty and a distaste for licensing fees for some businesses operating within U.S. territory, among other concerns. One reporter noted in February 2010, "While the issue has support on both sides of the aisle, as well as from the oil industry and environmentalists, finding time for it on the Senate calendar has been an obstacle,"<sup>12</sup> and the same doubts of previous Congresses still linger. To date, there is a dearth of good analysis regarding the likelihood of and major issues regarding Senate ratification of UNCLOS in the coming years.

Analysts and decision makers are also beginning to raise questions surrounding how the relevant COCOMs will manage responsibilities in the Arctic. In the February 2010 Senate hearing on the fiscal year 2011 budget, Alaska's Senator Begich asked Chairman of the Joint Chiefs of Staff, Admiral

Michael Mullen, whether he saw a need for a single, unified command to govern the Arctic. While Admiral Mullen answered in the negative, the question is being raised with increasing frequency.<sup>13</sup> While the maritime services alone will not determine the answer to this question, lessons from their experiences in the Arctic in recent years and the input of their leaders are sure to influence decisions.

As the Navy and Coast Guard incorporate climate change projections into their planning and policy makers begin to examine the policy decisions laid out above, a strong desire for more detailed projections of climate change effects is emerging. The most crucial missing ingredient from the Navy's perspective is a timeline based on the best scientific projections. As the result of its work to study climate change, the Navy has a good sense of the range of plausible effects. However, to effectively incorporate climate considerations into its planning it will need better information on when different effects could manifest. One Navy officer noted, for example, "If we are going to increase operations in the Arctic we need to know when and by how much the Arctic is going to open up. Even with uncertainty we need a best guess." For example, to make decisions on whether and how many ice-hardened vessels to build – a very costly decision – maritime service leaders need to understand the full benefits that each additional vessel could bring given how climate change will be affecting the Arctic region. Today, the only part of the equation the maritime services know with a high degree of certainty is the cost, while U.S. needs and benefits remain less clear.

In the coming years, the United States must strike a delicate balance between spending money too soon and potentially wasting resources by placing bad bets and investing too late and risking failure or preventable complications in future missions. Several Navy officials expressed hope that future collaboration with the National Oceanic and Atmospheric Administration (NOAA) and other



research organizations will focus on gaining a more granular understanding of regional effects and timing. The Navy's desire is to eventually have much more detailed projections, including estimates of likely climate effects in timelines as short as six months. The goal of the Navy's efforts is not to know exactly what will happen years and even decades in the future, but to ensure that scientific forecasts are included in planning, budgeting and especially acquisitions, since purchasing decisions have impacts that last for decades.

In the longer term, sea level rise is one of the most complicated problems for the maritime services, as its effects could make adaptation extensive and difficult. Navy observations show the Greenland and Arctic ice sheets changing in ways that previous climate models did not portend. Moreover, current climate projections do not provide much detail about the likelihood or extent of sea level rise in particular geographic regions. As a result, one admiral suggested that the maritime services might not currently be able to model or project sea level rise in ways that will be directly useful, despite its potential to produce effects ranging from coastal population displacement to changing patterns of littoral activities and erosion and flooding of low-lying installations. However, it is difficult to answer questions of where, when and to what degree any of these effects are likely to occur.

While the maritime services wish to include climate considerations in their decision making, the lack of detailed projections regarding sea level rise remains problematic. At the same time, efforts to acquire more actionable climate data have hopeful side effects. The strong interest of the maritime services in climate change analyses is sending a strong demand signal for better information and encouraging collaboration between the maritime services and outside scientists. In order to best prepare for the full range of effects stemming from climatic changes, however, collaboration on action will be as vital as collaboration on analysis.

### **A Need for Collaboration**

The 2010 Quadrennial Defense Review (QDR) suggests, "Climate change will require DOD to work collaboratively, through a whole of government approach, with both traditional allies and new partners."<sup>16</sup> This is certainly true for the maritime services, as their work to date has shown. Collaboration with other federal agencies and international partners will be imperative, but it is unclear exactly what that will look like.

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*In the coming years, the United States must strike a delicate balance between spending money too soon and potentially wasting resources by placing bad bets and investing too late and risking failure or preventable complications in future missions.*

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President Obama's Interagency Ocean Policy Task Force may be an early example of the kind of interagency collaboration called for in the QDR and the kind of collaboration necessary for the maritime services to address climate change effectively. Launched in June 2009, it brought together the Council on Environmental Quality, the Coast Guard, NOAA, the Environmental Protection Agency, the Navy and other agencies to coordinate policies throughout the government on oceans and coastal areas, and international governance thereof through UNCLOS and other treaties. One of the

priorities its early work identified is “resiliency and adaptation to climate change and ocean acidification.”<sup>17</sup> In another example of such interagency coordination, in January 2010, Navy Secretary Ray Mabus and Agriculture Secretary Tom Vilsack signed a memorandum of understanding to coordinate the two departments on biofuels work. This is an important step: it will be impossible for the Navy to meet its current clean energy goals if the fuels it desires are unavailable, and its goals will be skewed if it does not account for the realities of the developing advanced biofuels market. Secretary Mabus cited the rationale for this collaboration as to “secure the strategic energy future of the United States, create a more nimble and effective fighting force and protect our planet from destabilizing climate changes.”<sup>18</sup>

These types of partnerships and collaborative efforts can produce tangible results such as ensuring that government actions are not working at cross purposes (for example, by considering national security, economic or environmental goals separately). Navy and Coast Guard coordination with other government agencies on climate change and related issues also have two important symbolic effects: showing how their plans align with the president’s climate and energy goals and encouraging the view that that protecting national security must involve civilian agencies beyond the DOD and the Department of Homeland Security. However, interagency partnerships and working groups can also be short-lived, and the benefits often begin and end with symbolism. It is incumbent upon individuals championing these issues to carry out related policy changes.

The process of analyzing problems and developing goals across government agencies can have lasting effects, such as building personal relationships and raising awareness of important issues. However, it is less clear which agencies and actors will be charged to lead the process of turning the progress to date into tangible results and on what timeline – for example, steering ratification of the Law of the Sea Treaty through Congress.



NOAA Administrator Dr. Jane Lubchenco and U.S. Coast Guard Commandant Admiral Thad Allen participated in a trip to Alaska in August 2009 as part of an interagency task force. (ADM. THAD ALLEN/U.S. Coast Guard)

The QDR also calls for collaboration with international partners, including Canada, NATO allies and Russia, to address the effects of climate change in general, and the Arctic specifically.<sup>19</sup> While this is likely correct, it will not be simple, and many other analyses have recognized the obstacles to collaboration. One maritime scholar noted recently:

The only thing in the Arctic melting faster than the northern ice cap is the international comity...What was once a part of an untapped commons is now increasingly being contested. Sovereignty and border disputes have existed for years without resolution.<sup>20</sup>

Navy Secretary Ray Mabus has noted “potential sources of conflict and harmful environmental side-effects” in the changing Arctic, in addition to opportunities for cooperation, and he has stated his optimism for developing a coordinated Arctic approach in the coming years despite the absence of one today.<sup>21</sup> Until there is more clarity, based on climate change projections, regarding what effects the maritime services are likely to see and where or when such effects will manifest, it will

remain difficult to calculate which international relationships may be affected and where important opportunities for partnership lie.

While the key stakeholders in the Arctic are relatively clear, it is less clear with whom the United States should collaborate to address other effects of climate change. The United States may choose to develop international, interagency and nongovernment partners as needs arise. However, this process does not have to be entirely ad hoc. Instead, national security analysts should conduct country-level assessments to determine which will be most severely affected by climate change and which countries are best positioned to work constructively with the United States to address issues of shared concern. Such assessments would represent an important next step in research and analysis on climate change and national security.

### **Conclusion**

The maritime services have developed an advanced understanding of the implications of climate change projections for their missions and capabilities. Yet challenges remain. In the near term, the toughest policy hurdles may be promoting the ratification of UNCLOS and preparing for potential delays in this process, and contributing to a blueprint for how the Combatant Commands will manage the Arctic area of responsibility. Over the longer term, the maritime services will need to continue building upon their interagency coordination to date, and continue collaborating with nongovernmental and international partners to identify where the effects of climate change are most likely to complicate the maritime services' mission. With access to the global commons and stability abroad potentially at stake, analyzing and addressing the effects of climate change will remain important to the ability of the Navy and the Coast Guard to successfully fulfill their missions.

## ENDNOTES

1. I use the term “maritime services” generally in reference to the U.S. Navy and the U.S. Coast Guard, as many of the issues outlined may apply to each of them. However, most observations relate to specific services and are noted as such. The U.S. Marine Corps will be included in a forthcoming (March 2010) policy brief on climate change and ground forces. A forthcoming brief on climate change and air missions will also cover U.S. Navy issues on that topic.
2. This CNAS discussion was held on background.
3. This included the CNAS March 2009 working paper, “Uncharted Waters: The U.S. Navy and Navigating Climate Change,” by Sharon Burke, Jay Gulledege, Michael Horowitz, Christine Parthemore, and Nirav Patel (30 March, 2009) and Michael Bowes, “Impact of Climate Change on Naval Operations in the Arctic” (Alexandria, VA: CNA, April 2009).
4. Task Force Climate Change/Oceanographer of the Navy, “U.S. Navy Arctic Roadmap; October 2009” (10 November 2009): 5.
5. These questions include, among others, the potential impacts of climate change on naval antisubmarine warfare operations and the specific capabilities that will be required. See The National Academies Current Projects System, “Project Information; National Security Implications of Climate Change on U.S. Naval Forces” (2010).
6. National Aeronautics and Space Administration (NASA), “Melt Season in the Arctic Getting Longer” (28 January 2010).
7. These include: “PDD (Presidential Decision Directive)/NSC26: U.S. Antarctica Policy” (9 March 1996); “NSPD (National Security Presidential Directive)-66 / HSPD (Homeland Security Presidential Directive)-25” (9 January 2009); the UN Convention on the Law of the Sea; the “Canada and United States Agreement on Arctic Cooperation” (11 January 1988); and the U.S.-USSR Maritime Boundary Agreement (Bureau of European and Eurasian Affairs, “Status of Wrangel and other Arctic Islands” [8 September 2009]).
8. U. S. Geological Survey, “Circum-Arctic Resource Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle” (2008).
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10. National Research Council, *Polar Icebreakers in a Changing World: An Assessment of U.S. Needs* (Washington, DC: National Academy of Science, 2007).
11. Admiral Thad Allen, “Testimony in Hearing of the Oceans, Atmosphere, Fisheries and Coast Guard Subcommittee of the Senate Commerce, Science and Transportation Committee” (7 July 2009).
12. Dina Fine Maron, “Canada will Use Robot Subs to Map Sea Floor, Boost Territorial Claims” *Greenwire* (10 February 2010).
13. The final working paper in the CNAS “Promoting the Dialogue” series, to be released in spring 2010, will examine the Combatant Commands and climate change.
14. “Remarks by the Honorable Ray Mabus, Secretary of the Navy, Naval Energy Forum, Hilton McLean Tyson’s Corner, McLean, Virginia, Wednesday, October 14, 2009” (14 October 2009).
15. Billy Ray Brown, “Test Results Promising that Navy Hornet Can Fly on ‘Green Fuel’” (29 October 2009).
16. U.S. Department of Defense (DOD), “Quadrennial Defense Review Report” (February 2010).
17. White House Council on Environmental Quality, “Interim Report of the Interagency Ocean Policy Task Force” (10 September 2009): 7.
18. Navy Office of Information, “USDA, Navy Sign Agreement to Encourage the Development, Use of Renewable Energy” (21 January 2010).
19. U.S. DOD, “Quadrennial Defense Review Report”: 59-62
20. Frank Hoffman, “The Maritime Commons in the Neo-Mahanian Era,” in *Contested Commons* (Washington, DC: Center for a New American Security, 2010): 78.
21. Center for a New American Security, “Strategic Resources and Global Security Trends: Prepared Remarks of the Honorable Ray Mabus, Secretary of the Navy” (18 November 2009).



**CHAPTER III:**  
CLIMATE CHANGE AND AMERICA'S AIR FORCES

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By Will Rogers

A P R I L 2 0 1 0

**Broadening Horizons:**  
*Climate Change and the U.S. Armed Forces*



## CLIMATE CHANGE AND AMERICA'S AIR FORCES

By Will Rogers

Climate change could have significant implications for U.S. air missions, which are critical to America's ability to protect the homeland, project power and ensure access to the global commons.<sup>1</sup> In the short term, the Air Force and Navy are determining how to consider climate change in their energy strategies, both to ensure more dependable access to and more efficient use of fuel, and to meet energy and greenhouse gas (GHG) reduction requirements set by the president, Congress, Department of Defense and state governments. In the medium to long term, climate change has the potential to affect air forces more directly by changing operating and strategic environments. For example, environmental changes could affect installations or equipment, or they may generate destabilizing conditions that could reshape the international security environment. To date, however, analysts have not fully explored what these effects could mean for U.S. air forces specifically.

Currently, the air forces are split in how they consider the short- and long-term implications of climate change and how they prioritize energy and climate change concerns. The Navy, for example, has been proactive in tying its energy conservation and diversification efforts to national climate change goals to reduce GHG emissions. It recognizes its own role in mitigating climate change and believes that climate change will affect its operating environment in observable ways in the near future.<sup>2</sup> In contrast, the Air Force is committed to reducing its demand for energy and increasing use of alternative fuels, but has been primarily concerned with ensuring access to fuel for mission effectiveness purposes, with less direct focus on how reducing GHG emissions will affect its operating environment or capabilities.

In June 2009, the Center for a New American Security initiated its this project to study how climate change could affect the various military services and how these services are planning to

adapt to those impacts. In accordance with the 2008 National Defense Authorization Act, which required the Department of Defense to consider the impact of climate change on its “facilities, capabilities and missions,” the air forces have started to consider how climate change could affect their ability to operate in a changing security environment. Through extensive research and personal interviews with Navy and Air Force officials, this working paper synthesizes how America’s air forces are considering climate change in their near- and long-term planning and identifies the role energy concerns play in the services’ decision-making calculations. While the majority of this chapter will focus on the Air Force, observations about Navy aviation offer a point of comparison.

### **Climate Change and Energy Strategy: U.S. Air Forces Today**

The most immediate effect of climate change on U.S. air forces is the consideration of climate change in the services’ energy security strategies. While energy and climate change are related concerns (86 percent of U.S. greenhouse gas emissions stem from energy use<sup>3</sup>), there is an ongoing tension within most of the military services on how to strike a balance between the desire for energy security (i.e., assured access to fuel in order to promote mission effectiveness) and national climate change goals. However, this tension derives, in part, from a false dichotomy between energy security and climate mitigation efforts perpetuated by the services. There is an often-cited concern by the services that energy conservation and efficiency practices and alternative fuel development that promote mission effectiveness may be at cross-purposes with meeting GHG reduction targets. But the two are not mutually exclusive. In fact, as this paper intends to demonstrate, the air forces have indicated through their various conservation and efficiency practices and overall energy strategies that there are areas where these concerns can be linked and even mutually reinforced.

Indeed, linking energy security and climate change can have near- and long-term implications for mission effectiveness. In the near term, reduced energy demand and employment of more fuel-efficient aircraft have the potential to give air forces longer endurance (i.e., the ability to refuel less often and stay in combat maneuvers longer) and reduce logistical constraints (e.g., not having to scale back operations because of access to fuel). In the long term, linking energy and climate change offers an opportunity to strengthen mission effectiveness by limiting the amount of GHG emissions that would contribute to global climate change, which in turn could have strategic and operational implications due to changes in the physical, social, cultural and political environments.

Energy security and climate change increasingly have become linked at the highest levels of national policy; this linkage now extends to the Department of Defense. Energy concerns have long topped the agenda for the Department of Defense, the single largest consumer of fuel in the U.S. government. Yet as the 2010 Quadrennial Defense Review (QDR) explicitly states, climate change, energy security and economic growth are “inextricably linked.” Recognizing this linkage signals a preference for investments in energy sources and technologies that both promote improved energy assurance and reduce GHG emissions (such as greener alternative fuels and new aerospace designs that consider fuel efficiency as part of key performance parameters). Though the explicit linkage of energy security and climate change is new, requirements from the president and Congress increasingly promote GHG considerations alongside energy decisions. For example, President Barack Obama signed Executive Order 13514 in October 2009, which requires all federal agencies to establish GHG emissions reduction targets and to factor these into long-term planning and purchasing.<sup>4</sup> To align with the president’s national climate change priorities, the Department of Defense issued an instruction to reduce GHG





An F/A-18 Super Hornet from Air Test and Evaluation Squadron (VX) 23 at Patuxent River, Md. The Super Hornet, with the green insignia and the U.S. Navy Energy Security logo, will be testing a drop in replacement biofuel made from the camelina plant on Earth Day 2010. (NOEL HEPP/U.S. NAVY)

emissions by 34 percent for non-combat activities at its domestic installations by 2020.<sup>5</sup>

For the air forces in particular, aviation fuels are one of the most important areas where efforts to address energy concerns also create potential opportunities for the department to meet GHG reduction targets. With aviation fuel consumption constituting nearly 62 percent of DOD's total fuel demand, the Navy and Air Force have both given serious consideration to improving energy security in order to improve mission effectiveness, reduce costs and ensure access to fuels by combining alternative energy technologies with efficiency and conservation efforts.<sup>6</sup> The Navy, for example, has tested biofuel blends in its F/A-18 Super Hornet engine with the intent of conducting a test flight on Earth Day – April 22, 2010.<sup>7</sup> Meanwhile, the Air Force recently conducted a successful test flight of a biofuel blend in both engines of an A-10 Thunderbolt II – the first time a military or civilian aircraft has been tested with biofuel blends in both engines.<sup>8</sup> However, the Navy and Air Force may continue to have a difficult time translating how these efforts contribute to national climate change goals.

This problem stems, in part, from the difficulty in quantifying how much those energy security efforts reduce GHG emissions. Indeed, this difficulty is a part of the frustration the services share about attempting to tie their energy security efforts to climate change priorities. To date, it is not clear to what extent alternative fuels could reduce GHG emissions compared to conventional petroleum-based fuels; estimates vary widely based on the data and models used. Measuring the lifecycle production of alternative fuels is complex and not well defined. (For example, analysis of algae-based fuel must include the total GHG emissions from developing an algal pond, processing the algae, extracting the oil from the algae, synthesizing the biofuel and shipping the fuel off for consumption.) There is no U.S. government baseline to measure the lifecycle production process for alternative or renewable fuels. The Environmental Protection Agency (EPA) recently released a lifecycle analysis on renewable fuels, while the Navy's Office of the Assistant General Counsel (Installations and Environment) is developing its own lifecycle analysis to help the Navy meet its environmental requirements with fuels that reduce its carbon footprint. Because the Federal Aviation Administration (FAA), the Air Force and industry producers have not adopted a single baseline or methodology for calculating GHG emissions, they may generate inconsistent and incomparable data that makes quantifying their efforts more difficult. Developing a U.S. government baseline should be a priority interagency effort among the Department of Defense, Department of Energy and Environmental Protection Agency.

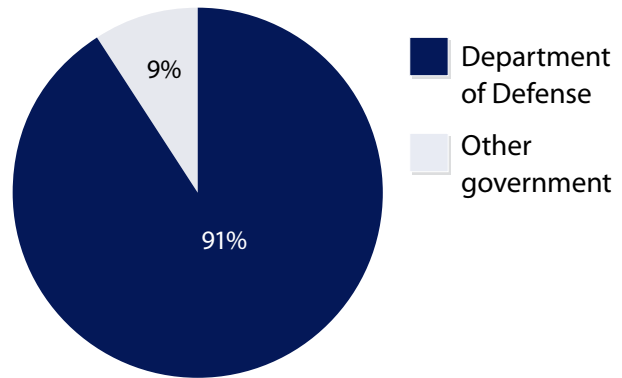
Given the challenges and ongoing tensions within the air services on how to approach and quantify energy security and climate change efforts, it is important to understand how the Navy and Air Force have each taken steps to tackle these issues and the reasoning behind their efforts.

**THE NAVY**

In 2009, the Navy established two task forces, Task Force Energy and Task Force Climate Change, to study these issues.<sup>9</sup> The Chief of Naval Operations charged Task Force Energy with exploring options to bolster the Navy’s energy security, efficiency and environmental stewardship. Task Force Climate Change was charged with assessing the Navy’s preparedness in responding to climatic changes and providing science-based projections for such changes. However, as conversations with Navy officials confirmed, leaders in both task forces engage each other regularly and work across the two task forces to advance the Navy’s objectives: creating an implicit understanding that energy security and climate change can and should be considered in tandem in order to ensure the Navy’s success in its mission. Indeed, as of late, the link between climate change and energy has been made explicit and embraced by Navy Secretary Ray Mabus. “The global implications of expanding demand and continued reliance on fossil fuels are significant,” Mabus told an audience at the Defense Attachés Association Annual Conference in November 2009. “The stock of proven fossil fuel reserves worldwide is finite, costs will almost certainly continue to go up, and the current way we extract and use fossil fuels too often harms the environment and contributes to climate change.”<sup>10</sup>

As a result of this high-level commitment, the Navy has been proactive in balancing energy security with climate change mitigation in its approach to achieving energy security. Aviation fuels account for approximately 42 percent of the Navy’s total fuel consumption; the Navy has been working to reduce that through efficiency in its aircraft performance and through alternative fuel development – particularly in the F/A-18 Super Hornet, the most ubiquitous fixed-wing aircraft in the Navy’s fleet.<sup>11</sup> According to Mabus, the Navy is working to improve the F404 F/A-18 engine’s efficiency by 3 percent, to be operational by 2015.<sup>12</sup> Speaking before the Naval Energy Forum in October 2009, Mabus said these engine improvements “could save us 127,000 barrels of fuel per year,

**Table 1: U.S. Government Fuel Consumption**

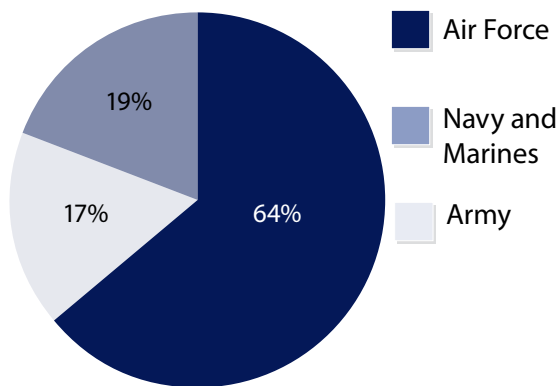


Source: Assistant Secretary of the Air Force for Installations, Environment and Logistics, Air Force Energy Plan 2010.

amounting to 15 million dollars for the Fleet per year at today’s fuel prices.”

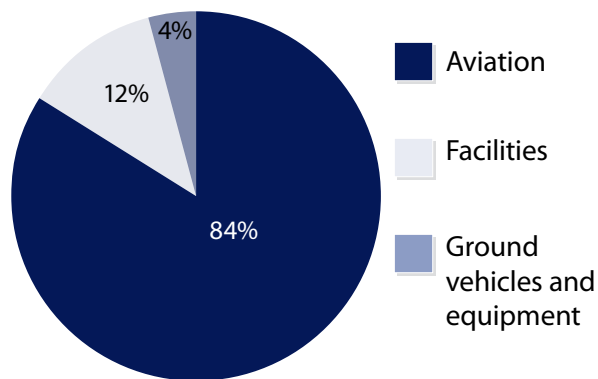
When it comes to aviation fuels, the Navy has been forward-leaning in terms of testing and evaluating biofuel blends in its F/A-18 Super Hornet engine as well. Mabus announced at the Naval Energy Forum that by 2020, 50 percent of the Navy’s tactical vehicles and shore installations, including its aircraft, will be fueled using alternative sources of energy. It is unclear what percentage of the Navy’s aircraft will use alternative sources of fuel to help meet this benchmark, but by shifting to a biofuel blend, the Navy is positioning itself to take advantage of potential GHG emissions reductions compared to conventional petroleum-based fuels. Indeed, it is the Navy’s history and leadership on energy innovation – specifically nuclear propulsion – that helped trigger experimentation with alternative aviation fuels that may promote energy security and mitigate climate change. Speaking before the Naval Energy Forum, Mabus said, “We are a better Navy and a better Marine Corps for innovation; we have led the world in the adoption of new energy strategies in the past. This is our legacy.”<sup>13</sup>

**Table 2: Armed Forces Fuel Use**



Source: Assistant Secretary of the Air Force for Installations, Environment and Logistics, Air Force Energy Plan 2010.

**Table 3: Air Force Energy Consumption**



Source: Assistant Secretary of the Air Force for Installations, Environment and Logistics, Air Force Energy Plan 2010.

#### THE AIR FORCE

In contrast, the Air Force is prioritizing assured access to fuel supplies and has not as strongly or directly linked its efforts to achieve energy security with the goal of climate change mitigation. Moreover, due to other pressing institutional challenges, the Air Force has simply devoted less attention to the issue of climate change to date.

In the last several years the Air Force has undergone a period of introspection and institutional transformation in order to address a crisis of identity: in the words of Air Force Chief of Staff General Norton Schwartz, “what it is” versus “what it should be.”<sup>14</sup> A spate of incidents over the last several years, including the breach in U.S. nuclear weapons security that led to the forced resignations of Air Force Chief of Staff General T. Michael Moseley and Air Force Secretary Michael W. Wynne in June 2008, brought unwelcome attention to the service.<sup>15</sup> As a result, in September 2008, General Schwartz, speaking before the Air Force Association’s annual conference, said that the Air Force is “taking a hard look at what we do, how we do it and why.”<sup>16</sup> In addition, the current conflict landscape has helped shepherd the Air Force through its evolution from a purely *air* force

to one that is increasingly exercising “control and exploitation of air, space and cyberspace.”<sup>17</sup> The wars in Afghanistan and Iraq have been “simultaneously conducted hand-to-hand, and at global distances” and are “characterized by face-to-face meetings with other cultures, yet also by electrons traveling through satellites 22,000 miles overhead.”<sup>18</sup> For example, new technological advancements in unmanned aerial vehicles have allowed the Air Force to carve out a niche role in today’s counterinsurgency operations and missions.

Whereas the Air Force has devoted less attention to climate change, as a result of recent institutional shifts and focus on force structure, it has focused intently on assuring access to fuel, which is considered a more immediate challenge to personnel, equipment, policies and mission effectiveness. The ability to project power globally depends on assured access to energy. The service’s outsized dependence on energy means that, for every 10-dollar increase in the price of a barrel of oil, the Air Force increases its annual fuel cost by 619 million dollars.<sup>19</sup> As the single largest consumer of fuel within the Department of Defense,

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*In the short term, the Air Force's most successful efforts to reduce GHG emissions and mitigate climate change are likely to come from the same measures that boost its mission effectiveness: reducing demand for energy through conservation and efficiency efforts.*

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utilizing approximately 64 percent of DOD's fuel budget, energy security and cost volatility are, not surprisingly, major concerns for the Air Force.<sup>20</sup> Furthermore, the need to transport, store and deliver aviation fuel to aircraft in flight and to bases deep inside active combat zones constitutes a significant logistical risk. In fact, one Air Force official said that even if fuel were free and carbon emissions were nil, fuel would still constitute a major vulnerability given the long logistics tail necessary to support air operations in remote operating theaters and over long distances through the air. Given these considerations, it is understandable that the Air Force has primarily approached energy by balancing best business practices with operational security, leaving climate impacts mostly aside.

However, there are opportunities for the Air Force to integrate energy and climate goals, as seen in the Air Force's 2010 energy plan. Goals include increasing supply, reducing demand and changing

the culture – including a goal to “reduce consumption of aviation fuel by 10% by 2015 against a FY2006 baseline.”<sup>21</sup> According to the 2010 QDR, “By 2016, the Air Force will be postured to cost-competitively acquire 50 percent of its domestic aviation fuel via an alternative fuel blend that is *greener* [author's emphasis] than conventional petroleum fuel.”<sup>22</sup> The emphasis on greener fuels lies, in part, with the Air Force's previous experience with testing and evaluating coal-to-liquid fuels which, without large-scale carbon capture, are likely to increase greenhouse gas emissions compared to petroleum-based fuel. (As mentioned earlier, there is no baseline for lifecycle GHG emissions, but the EPA, at the time, had projected coal-to-liquid fuels to contribute more than 100 percent of the emissions of conventional gasoline without carbon capture and sequestration.) Nevertheless, in the near to long term, the Air Force will continue to collaborate with the national labs and look for private sector partnerships to develop greener substitutes, including plans to test blends of algae-based biofuel in its aircraft, as recently demonstrated with the successful testing of biofuels in both engines of the A-10 Thunderbolt II.<sup>23</sup> While these efforts may be aimed at increasing energy security and maximizing mission effectiveness, and not directly linked to reducing GHG emissions, these efforts ultimately could help the Air Force achieve broader emissions reduction targets.

### **Not Just Biofuels: Energy Efficiency, Conservation and Alternatives in the Air Force Fleet**

In the short term, the Air Force's most successful efforts to reduce GHG emissions and mitigate climate change are likely to come from the same measures that boost its mission effectiveness: reducing demand for energy through conservation and efficiency efforts such as partnering with the commercial aviation industry, training pilots in flight simulators instead of fuel-guzzling aircraft and investing in adaptive wing and alternative



Secretary of Defense Robert M. Gates sits in the cockpit of a flight simulator at Warrior Hall Flight School XXI Simulation Complex at Hanchey Army Airfield, AL. Today, the Air Force is streamlining training in flight simulators to reduce fuel demand. (U.S. AIR FORCE MASTER SGT. JERRY MORRISON/U.S. DEPARTMENT OF DEFENSE)

propulsion technologies. In fact, the commercial sector is likely to help hasten the Air Force's efforts to integrate energy performance with its broader emissions reduction targets. While the drafters of the 2010 QDR expect that the Air Force's testing and standard-setting in alternative fuels will "[pave] the way for the much larger commercial aviation sector to follow," the Air Force has a rich history in learning lessons from the larger commercial aviation industry and is poised to take advantage of the conservation and efficiency practices advanced by the commercial sector.<sup>24</sup>

There are numerous instances in which the Air Force has learned important lessons from the commercial aviation industry and then leveraged those lessons successfully to reduce its own energy demand and, as a consequence, reduce GHG emissions. Useful lessons in energy conservation and efficiency have been drawn from the commercial

airline industry by the Air Mobility Command (AMC), the Air Force's major command leading airlift and refueling operations (i.e., strategic airlifters like C-5s, C-17s; tactical airlifters like the C-130; aerial refuelers like the KC-10 and KC-135). Today, AMC operations consume approximately 44 percent of the Air Force's total fuel consumption.<sup>25</sup> In October 2008, the command stood up a Fuel Efficiency Office (FEO) to explore options to reduce its total energy demand. According to FEO Chief Colonel Kevin Trayer, the Air Force is integrating lessons learned from the commercial sector into its own practices.<sup>26</sup> The Air Force is also leveraging the experiences of its reservists and national guardsmen, some of whom are employed by commercial carriers.<sup>27</sup>

In another example of learning from industry practices, the Air Force has streamlined training with flight simulators and brought in commercial

airline pilots to advise the service on fuel savings, including scaling up use of flight simulators.<sup>28</sup> Most of the major shifts in training started with heavy-lift aircraft like the C-17, with pilots certified after 70 hours in a high-fidelity simulator and four hours of real cockpit time.<sup>29</sup> While shifting training in fighter jets to simulators will be much slower due to the difficulty of simulating real-life conditions of aerial combat, the Air Force is looking to reduce the number of real cockpit hours combat pilots need to certify by substituting additional simulator training. Importantly, this will require improvements in the Air Force's simulators in order to ensure that increasing their use does not reduce training or readiness. The cumulative effects of these reduced flight requirements cut fuel usage significantly.

The Air Force is also cooperating with the FAA to develop a satellite-based system of air traffic management, known as the Next Generation Air Transportation System, to replace today's ground-based system of air traffic control.<sup>30</sup> This system will increase the capacity and efficiency of air travel while reducing the environmental impact of the aviation industry and allowing it to develop more precise, direct jet routes and approaches, which in turn help to reduce fuel burn and GHG emissions.<sup>31</sup> In addition, the Air Force and the National Aeronautical Space Administration are conducting aircraft trial tests using adaptive wing technology that would cut drag and offer potentially 30 percent fuel savings on subsonic commercial aircraft.<sup>32</sup>

Air Force Research and Development, in partnership with leading aerospace agencies, is developing opportunities in alternative propulsion that will bolster mission effectiveness. The Air Force has several ongoing initiatives to develop potentially game-changing propulsion systems, including: INtegrated Vehicle ENergy Technology (INVENT); Highly Efficient Embedded Turbine Engine (HEETE); and ADaptive Versatile ENgine Technology (ADVENT). Each of these programs

is intended to increase aircraft endurance, range and/or fuel efficiency. For example, the Air Force Research Laboratory's INVENT program aims to extend the range and endurance of aircraft 10 to 15 percent, while increasing power and thermal capacity 10 to 30 percent by integrating new power and thermal management systems in existing tactical, unmanned and long-range aircraft.<sup>33</sup> Meanwhile, the HEETE program focuses on embedded technologies that will also increase aircraft endurance and range for a variety of Air Force platforms. For this program, General Electric is working with the Air Force to develop an ultra-high-pressure ratio compressor and new thermal management systems that could improve fuel burn by 25 percent.<sup>34</sup> Finally, the ADVENT program is a research effort to study variable-cycle technologies that would give pilots the flexibility to change operational requirements (e.g., switching from tactical maneuvers to long-range flight in the same aircraft) while accommodating lower fuel requirements for the aircraft.

#### OVERCOMING INSTITUTIONAL IMPEDIMENTS

Despite the important lessons the Air Force has learned from commercial carriers and its ongoing partnerships with the aerospace community, institutional impediments prevent the Air Force from taking full advantage of advancements made in fuel conservation, efficiency and aerospace design. Today, one of the greatest challenges facing the Air Force is the difficulty in recapitalizing its aircraft fleet.<sup>35</sup> Airlines can quickly recapitalize their fleets either by replacing aging aircraft with more efficient, off-the-line models or by just replacing outdated engines with more fuel-efficient ones. Indeed, there are financial incentives for commercial carriers to do so since aircraft improvements that result in better fuel efficiency strengthen their bottom line. By contrast, the Air Force fleet cannot recapitalize as quickly, in part due to budgetary limitations. Air Force platforms are procured with the intention of lasting decades and funding is authorized according to those timelines.

The other challenge facing the Air Force lies in fuel data collection and analysis. According to one Air Force official, the Air Force is behind the commercial airline industry when it comes to analyzing its own fuel consumption. Airlines use state-of-the-art information technology systems to analyze fuel data in real time. For example, when a commercial aircraft lands, the carrier can assess in real time the aircraft's departure overfuel (i.e., how much excess fuel the aircraft is carrying for the flight that it did not use). Carriers can then make the necessary corrections to optimize fuel conservation for its aircraft fleet. The Air Force, however, still records and inputs this information manually, requiring more time to analyze data and make corrections to optimize aircraft performance. A 2007 Air Force Audit Agency report found that the Air Force does not have an effective or efficient method for obtaining reliable aviation fuel consumption data.<sup>36</sup> As DOD Inspector General Claude Kicklighter reported to Congress in 2007, “[Air Force] Auditors concluded that the Air Force could better optimize aviation fuel use through centralized visibility and implementation of a formalized fuels management program with clearly defined policies and procedures, goals, metrics and incentives.”<sup>37</sup>

#### ENERGY INVESTMENTS AT AIR FORCE INSTALLATIONS

Air Force officials are making significant investments in better efficiency, conservation and renewable energy programs at domestic installations. While there are tangible benefits in reduced GHG emissions, Air Force installation officials are reducing their energy consumption and developing alternative on-base energy sources, in large part to meet energy requirements and mandates at the state and federal level. Some installation commanders may also be concerned with energy assurance and look for opportunities to reduce energy dependence on the domestic electric grid. They do this out of concern that missions could be more vulnerable when installations are tied to what has been described as a brittle domestic energy grid.<sup>38</sup> These efforts are aimed at mitigating that

vulnerability and ensuring mission effectiveness.

Regardless, in the last several years the Air Force has been making steady investments in energy efficiency at its facilities and implementing renewable energy projects in order to reduce its energy demand and strengthen energy security. Energy use at Air Force facilities accounts for approximately 15 percent of the service's total energy consumption.<sup>39</sup> According to its 2008 Infrastructure Energy Strategic Plan, the Air Force reduced its total facility energy consumption by 30 percent between 1985 and 2005; it is poised to reduce its facility energy demand by another 30 percent by 2015.<sup>40</sup> But in order to accomplish that goal the Air Force plans “to get more aggressive.”<sup>41</sup> In 2009, the Air Force reduced its energy intensity (i.e., the amount of energy used per gross square foot) by 13 percent from a 2003 baseline established by the Energy Policy Act of 2005.<sup>42</sup> According to a June 2009 Air Force Energy Program Policy Memorandum, the Air Force aims to continue to “procure energy-efficient products and vehicles” and plans to “[d]esign new buildings that are 30 percent better than American Society of Heating, Refrigerating & Air Conditioning Engineers (ASHRAE) standards” in order to achieve its objectives for reducing its total energy demand.<sup>43</sup>

The Air Force is also making significant investments in renewable energy programs, with 34 on-base renewable energy projects in operation.<sup>44</sup> Today, the Air Force operates the largest solar array in North America at Nellis Air Force Base (AFB), Nevada, generating approximately 14 megawatts of energy, or 25 percent of the base's total energy demand.<sup>45</sup> According to President Obama, the Nellis solar array will “reduce harmful carbon pollution by 24,000 tons per year, which is the equivalent of removing 4,000 cars from our roads.”<sup>46</sup> Meanwhile, the Air Force plans to expand its solar energy portfolio with a 3,200-acre solar power project at Edwards AFB, California, which is slated to generate

*While the Air Force is resilient and capable of adapting to changes as needed, it will still need better climate science and future projections to generate more useful planning documents.*

approximately 600 megawatts and would surpass Nellis AFB as the largest solar project.<sup>47</sup> Continuing its investment in renewable energy projects is likely to pay significant climate dividends by reducing the Air Force's carbon footprint while achieving its own energy security objectives. Indeed, given the recent DOD instruction to reduce GHG emissions by 34 percent from non-combat activities at its more than 300,000 domestic installations by 2020, the Air Force would do well to consider explicitly linking energy security with climate change to take full credit for the work it is already doing to meet the department's goals.<sup>48</sup>

Despite these investments, however, there are no financial incentives for Air Force base and installation commanders to scale up these conservation, efficiency and renewable energy programs beyond what they need to do to meet their own installation's energy requirements. Indeed, the lack of incentives is a point of frustration for some Air Force officials who would like to reinvest money saved from reduced energy consumption in better base infrastructure and training platforms, such as state-of-the-art flight simulators. However, money saved from reduced energy consumption is not considered money saved, but rather a

cost avoidance (i.e., the money was authorized by Congress, but because it was not used it does not need to be allocated). In fact, there may even be a disincentive for Air Force commanders to scale up these programs since it could result in budget cuts in the next fiscal year if Congress adjusts for (or cuts) the money the Air Force did not need for purchasing fuel or electricity.

### **Climate Change and Joint Air Power: Future Challenges and Opportunities**

While it is clear that energy security will continue to sculpt how the air forces integrate climate change considerations into their strategic and operational planning, less clear are the mid- to long-term implications that climate change will have on air forces. While the Department of Defense anticipates increased requests to conduct humanitarian assistance and disaster relief (HA/DR) operations in response to increased and possibly more severe natural disasters resulting from climate change,<sup>49</sup> current climate science has yet to offer the level of detail or fidelity that would be necessary to fully elucidate the impacts of climate change on the air operating environment. Potential effects could include, for example, more turbulent air, changes in bird migration, increased low-level fog density and more intense and potentially frequent storms at air force and naval installations.

Conversations with Air Force officials show that they are acutely aware that climate change could alter the strategic environment by necessitating more frequent responses to natural disasters and relief missions, circumstances in which the air forces already play a critical role.<sup>50</sup> Domestically, air missions were a critical part of the joint operations in the wake of Hurricane Katrina. The Air Force played a significant role in search-and-rescue, evacuation and relief drop missions, for instance. Air Force helicopters and fixed-wing aircraft flew 648 and 4,095 sorties respectively, rescuing 4,322 stranded people and evacuating 26,943



displaced persons from the affected region.<sup>51</sup> Air missions were also essential in responding to the December 2004 Indian Ocean tsunami and the October 2005 earthquake in Pakistan. Most recently, the air forces have played a crucial role in U.S. response efforts to Haiti following the January 12, 2010 earthquake. While the temblor was not a climate-induced disaster per se, the resulting air missions performed in Haiti are likely to be replicated in similar disaster response missions where millions of lives are affected and where air force assets can provide critical information to joint and interagency efforts. For example, with the U.S. Air Force taking a lead in military space missions, Air Force Intelligence, Surveillance and Reconnaissance (ISR) agencies provided joint and interagency partners with unclassified high-altitude surveillance imagery to assist in recovery and relief operations in Haiti.

Even while the Air Force “recognizes the importance of addressing climate change, and supports all DOD and administration objectives in tackling this global problem,” it has yet to fully conceptualize the effects that climate change may have on its strategic and operating environments.<sup>52</sup> Similar to the challenges facing the other services, Air Force officials are not clear about how climate change could affect their facilities, capabilities and missions in ways that go beyond their capacity to adapt. For example, it is not clear if there is a threshold in the number of HA/DR missions it could be tasked with responding to that would force the Air Force to fundamentally reorient the service for long-term responses to climate change (i.e., it is unclear how many HA/DR missions would be equivalent to the resources, capabilities, and forces need for Air Force operations in Iraq or Afghanistan). Nevertheless, while the scale and types of missions are distinct and require different resources, Air Force officials are confident that those types of disaster relief missions will not approach the

scale of operations in Iraq and Afghanistan and that they will be able to adapt to changes in the strategic environment as needed.

#### THE NEED FOR FURTHER CLIMATE SCIENCE

While the Air Force is resilient and capable of adapting to changes as needed, it will still need better climate science and future projections to generate more useful planning documents.

Indeed, Air Force leadership needs to systematically study how and if climate change will affect its operating environment given current and advancing scientific projections. It is still unclear if and how climate change will affect atmospheric chemistry in ways that compromise current and future Air Force platforms, facilities and operations. This lack of understanding is rooted, in part, in the lack of fidelity in the kinds of information that the Air Force – or any of the military services – would find useful. As a forthcoming CNAS report will show, there is a serious “translation” problem between what the effects of climate change mean for the Department of Defense and the various military services, Combatant Commands and defense agencies.<sup>53</sup> Numerous conversations with government officials, including those in the Air Force, indicate a lack of “actionable” data, or scientific data that can be used to make clear policy decisions, to help defense officials make decisions that relate to climate change – especially at the operational level.

To quantify the effects of climate change on their operating environment, Air Force officials have expressed interest in a base-by-base assessment of how climate change will affect facilities and operations at specific locations. For example, a base-by-base assessment could analyze whether climate change will cause changes in fog density that could disrupt low-level flight operations. In particular, climate-induced bird migrations could cause more frequent bird strikes during low-level flight operations. The Air Force’s Bird/Wildlife Aircraft Strike Hazard Team already studies how to preserve war-

fighting capability by reducing wildlife hazards with aircraft, and the Department of Defense has members on the Bird Strike USA steering committee to study this very issue. There is a developing need to study climate-induced shifts in bird migrations and what that could mean for strikes on aircrafts. A base-by-base assessment would help identify hazard areas and sites where flight operations need to be more closely monitored to prevent accidents.

### Recommendations

**The Air Force should fully integrate energy security and climate change into its future planning efforts.** While there are clear indicators that the Air Force can better align energy and climate change efforts – and indeed is enacting short- to near-term testing with biofuel blends in its aircraft fleet – it is not clear if these efforts will be fleeting or are intended to reduce GHG emissions over the near- to long-term. Until the Air Force has fully developed an understanding of the implications of climate change, there may not be a vested interest in developing a long-term strategy that fully and effectively integrates energy security and climate change mitigation. Indeed, adopting a long-term strategy that integrates these two related concerns has long-term (if uncertain) benefits for mission effectiveness. These could include longer, less energy-intensive missions and reduced GHG emissions that contribute to global climate change, which could have strategic and operational implications, as outlined above. What is more, integrating the two could also have immediate, positive consequences. The Air Force would demonstrate that its goals align more broadly with DOD’s vision for energy security and climate change – as articulated in the 2010 QDR – and the president’s national climate and energy goals. The Air Force would also improve its public image on these issues by taking full credit for the climate change mitigation efforts already undertaken through its extensive, cross-cutting energy security strategy.

**The Department of Defense should systematically study what incentives would encourage Air Force, Navy and other service-level commanders to implement conservation and efficiency practices and invest in renewable energy programs at the base and installation level.** For example, today’s “cost avoidance” structure is a disincentive for many of the services to invest in renewable energy programs. Reduced energy costs do not translate into real dollars that commanders can invest in other programs. In fact, those commanders could see budget reductions since they did not use all of the money authorized to them. Properly aligned incentive structures have the potential to generate tremendous benefits in reduced energy demand and alternative energy production. The Air Force has already demonstrated the benefits of large scale conservation, efficiency and renewable energy programs.

**Congress should examine how to better ensure that the Air Force and Navy can take advantage of advances in energy efficiency and conservation, including improved engine models and structural enhancements made by the commercial sector.** Perhaps the most immediate gains could come from investments in a fuel data collection system that allows the Air Force and Navy to analyze fuel data and make corrections in real time.

**Finally, the Air Force should develop a research agenda that studies a range of potential short- and long-term operational and strategic challenges linked to climate change.** The Navy’s Task Force Climate Change is a model that could be replicated. Task Force Climate Change has considered several key questions about the implications of climate change for the Navy that are intended to make senior leaders more comfortable in dedicating operation and maintenance resources to study and respond to climate change.<sup>54</sup> Air Force strategists should develop similar questions aimed at determining which specific effects current climate science models indicate are likely to occur; where the Air

Force can build synergies with the climate science community to help improve its understanding of climate changes, including potential changes to atmospheric chemistry that could have implications for the Air Force (and Navy); how these impacts could affect the Air Force's ability to conduct missions at the strategic and operational level; what trade-offs are involved with focusing time and funding on climate change; and what interagency and joint partnerships would further its understanding of, and preparation for, climate change.

### Conclusion

U.S. air forces have yet to fully develop an advanced understanding of the complex consequences of climate change. However, understanding how climate change could affect air forces in the short to long term will offer them an opportunity to prepare for changes in the strategic and operating environments in anticipation of potential challenges that could threaten mission effectiveness. It is clear, and not at all unexpected, that energy security remains a priority for the air services. While the Navy's history and leadership have positioned it to be more forward-leaning in tying its energy security initiatives to climate change, the Air Force continues to maintain separate energy security and climate change strategies. It should link the two together to take full credit for climate mitigation efforts tied to its robust energy security strategy.

The Air Force has made great strides in adopting conservation and efficiency practices within its aviation platforms and installations and integrating aerospace advancements into its existing fleet. But institutional challenges surrounding recapitalization of its fleet and its inefficient fuel optimization data collection and analysis system inhibit the Air Force's ability to reap the total benefits of these practices. Meanwhile, the lack of incentives to scale up on-base renewable energy programs needs to be resolved.

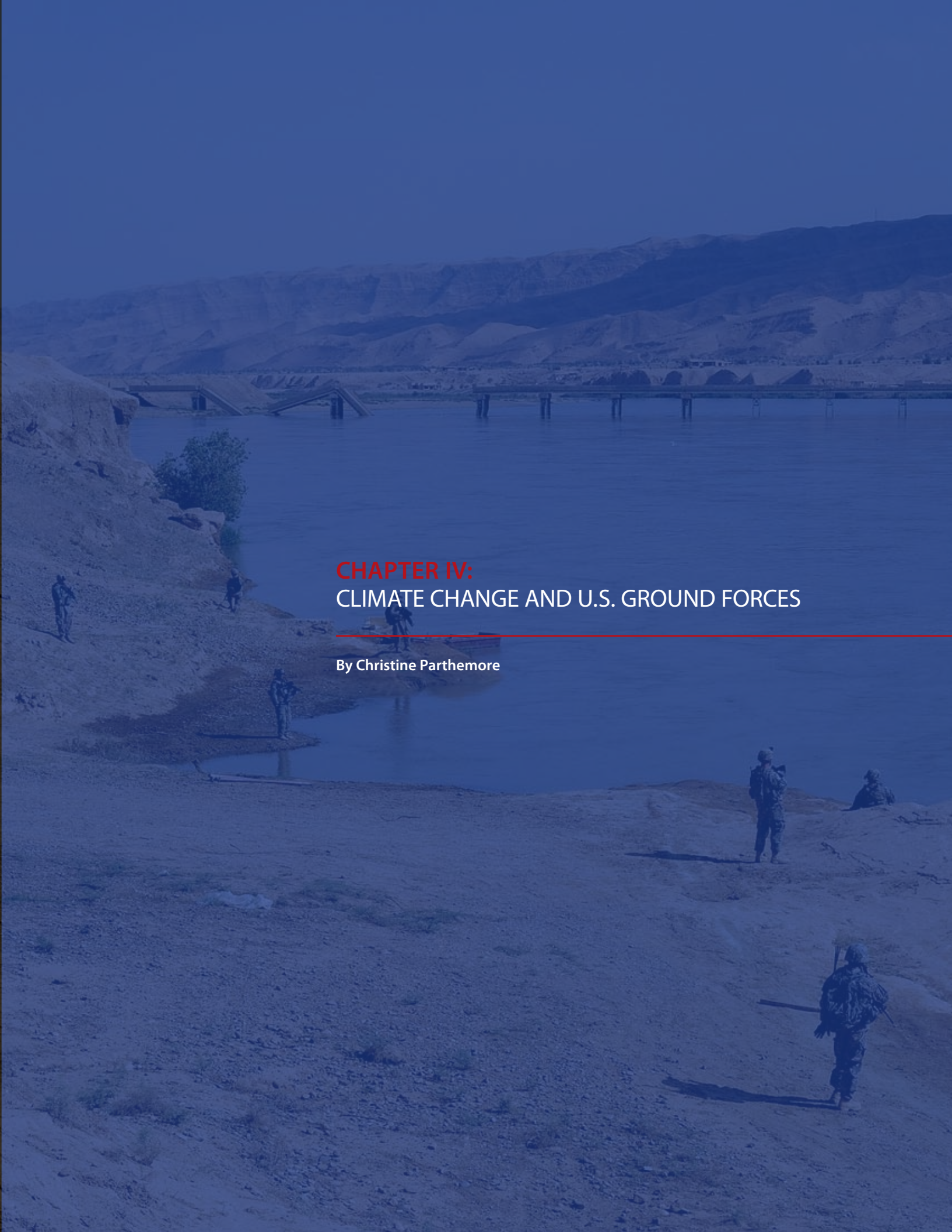
Though the Air Force is confident in its ability to adapt to changes in the security environment, it has not fully conceptualized how difficult it may be to adapt to potential climate changes. At the operational level, current climate science can not yet adequately explain how climate change will affect the air forces' platforms and installations. As posited earlier, climate change could potentially affect the operating environment with more turbulent air, changes in bird migration, increasing fog density and more intense and potentially frequent storms at air force and naval installations. Better assessments and models will increase the understanding of the operational implications of climate change for all air forces. The Navy's adoption of the inextricable link between energy and climate change and its process of integrating these issues into its planning and making leaders more comfortable about dedicating finite resources to study these issues could serve as a useful model for the Air Force. Indeed, the Air Force has a vested interest in developing a more robust understanding of the effects climate change could have on its facilities, capabilities and missions.

## ENDNOTES

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A blue-tinted photograph of a river valley. In the foreground, several soldiers in camouflage gear are positioned on a sandy bank. A river flows through the middle ground, with a bridge visible in the distance. The background features rolling hills and mountains under a clear sky.

**CHAPTER IV:**  
CLIMATE CHANGE AND U.S. GROUND FORCES

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By Christine Parthemore





## CLIMATE CHANGE AND U.S. GROUND FORCES

By Christine Parthemore

At a time when U.S. ground forces must wage two protracted wars in Iraq and Afghanistan, design overarching visions for future needs and plan and equip accordingly, analyzing how climate change might affect the Army, Marine Corps and National Guard<sup>1</sup> might seem like an abstract exercise. Yet ensuring U.S. security has always required more than just prevailing in current conflicts. It requires understanding and planning for the trends and threats America is likely to face in the future.

Civilian and military leaders, Congressional leaders and security analysts all identify climate change as an issue that may have a significant impact on the armed forces. As the 2010 Quadrennial Defense Review (QDR) states, “climate change, energy security and economic stability are inextricably linked. The actions that the Department takes now can prepare us to respond effectively to these challenges in the near term and in the future.”<sup>2</sup> Indeed, climate change stands to affect military installations at home and abroad, domestic policy and environmental conditions in areas of strategic importance to the United States. All these factors have implications for the missions and operations of the U.S. ground forces. Preparing adequately, as the QDR suggests, will require more extensive analysis of what this challenge means for the Army, Marine Corps and National Guard.

The Center for a New American Security (CNAS) launched this project in June 2009 to examine how climate change might affect the military services. This chapter, which will accompany additional papers on maritime and air missions and the Combatant Commands, is based on personal interviews, research and site visits that included discussions with key representatives of the Army, Marine Corps and National Guard. These working papers will identify important aspects of the current discussions concerning climate change and national security and highlight important questions for further research.

**Installations: Reducing Emissions at Home**

Today, the Army, Marine Corps and National Guard confront climate change issues most directly in meeting requirements for reducing greenhouse gases at domestic installations. These military bases must abide by laws and regulations passed by Congress, Executive Orders (EOs) signed by the President and state laws and regulations that demand lower emissions, energy efficiency and less reliance on high-carbon energy.

For example, in October 2009 President Obama signed EO 13514, which requires all federal agencies to set targets for lowering emissions and to consider those targets in planning and purchasing. To carry out this order, the Department of Defense (DOD) set a goal of reducing greenhouse gas emissions by 34 percent by 2020 for non-combat activities at its more than 300,000 buildings.<sup>3</sup> While combat vehicles and activities are exempt from this requirement, steps to improve operational energy efficiency for the sake of improved mission effectiveness may further reduce emissions.

Despite this growing legal and regulatory demand to address climate considerations, the degree to which climate is a concern still depends to a large degree on individual interest. Many domestic bases benefit from managers who are motivated to focus on alternative energy and understand how to combine funding from disparate streams (like various types of contracts and grants) to procure higher-efficiency technologies or install lower-carbon power generation.

The Army and Marine Corps emphasize a wide range of environmental issues (e.g., considering water and land use along with energy and climate considerations) in managing their domestic installations. For example, the Marine Corps “Ten by ‘10” campaign plan describes goals of ensuring energy and water supplies, meeting efficiency mandates and “reduc[ing] life cycle operating costs of Marine Corps facilities and manag[ing] future

commodity price volatility.”<sup>4</sup> Several Army installations have drawn attention for their energy and environmental achievements as well, including Fort Carson in Colorado, which combines conservation and efficiency practices for both energy and potable water.<sup>5</sup>

In addition to efforts to reduce greenhouse gas emissions and meet related energy goals, some installations and training ranges may also be susceptible to environmental changes. DOD’s Strategic Environmental Research and Development Program is working to analyze several of these changes, noting that “Maintaining readiness requires a natural and built infrastructure that is sustainable and adaptive in the face of climate change.”<sup>6</sup> Some effects of climate change could strain budgets and reduce assured access to energy and other resources. Indeed, one Army program is currently examining how the effects of climate change may alter land, water and air conditions around training ranges. The goal is to ensure that mission readiness does not suffer due to changing environmental conditions.<sup>7</sup>

Beyond the direct energy and environmental benefits derived from implementing EOs and meeting legal requirements to save energy, various carbon pricing mechanisms are generating new issues over financial benefits. Installation managers in states like California that are likely to adopt carbon markets and renewable portfolio standards are beginning to raise questions regarding potential monetary or credit earnings that they may derive from providing cleaner energy to their local utilities. The prospect of a carbon price is creating a strong need to think through what federal agencies lowering their emissions must do with any subsequent proceeds. To give a hypothetical example, if an Army base invests in a major solar energy installation, and the resulting clean energy earns carbon credits under that state’s emissions-trading scheme, do those credits belong to that base, the Army, DOD or the federal government?

Answering questions like this will be important for understanding the full business cases for investing in clean energy and efficiency measures, and there is a growing need for high-level instruction on how the services should handle many of the specifics involved in carbon credit markets. One benefit, as officials at installations begin to wrestle with ways to lower greenhouse gas emissions and navigate clean-energy financial considerations, is that more and more individuals are learning important lessons that may be useful for others. The services should find new ways of collecting and disseminating these lessons learned regarding sustainability, energy efficiency and reducing greenhouse gas emissions. Use of wikis, listservs or any searchable social media may prove useful for sharing recommendations, with minimal management required. Given the vast number of alternative power generation and emissions-reducing energy projects that the Army and Marine Corps have undertaken on its domestic installations, sharing lessons for implementation would also showcase the variety of ways in which the services are working to meet their energy and emissions requirements.

Still, climate change is important for the ground forces far beyond their requirements to reduce emissions. Indeed, the Army, Marine Corps and National Guard have been increasingly integrating consideration of climate change into their strategy documents and planning. Looking to visions of the future security environment and the shape of the current missions in which they are engaged – including counterinsurgency in Afghanistan, counter-narcotics operations in Central America and responses to domestic crises – can help clarify how understanding climate change better may be relevant to future missions.

### **Ground Missions: Climate Considerations for Current and Future Security Needs**

A consistent stream of planning, strategic debates and leadership decisions continuously set direction and establish priorities for the Army,

Marine Corps and National Guard. Looking to Congressionally-mandated reports such as the Army Posture Statements and the DOD-wide Quadrennial Defense Review, as well as leadership statements, can provide good indications of what challenges the Obama administration and military leaders expect to dominate their future missions. These documents, paired with scientific projections, can provide an indication of the general ways in which climate change may affect U.S. ground forces.

It remains unclear exactly how, when and where the effects of climate change will likely combine with political, social and economic trends in shaping the future security environment; however, many analyses point to the need to understand climate change in the context of these other factors. “While climate change alone does not cause conflict,” the 2010 QDR notes, “it may act as an accelerant of instability or conflict, placing a burden to respond on civilian institutions and militaries around the world.”<sup>8</sup> The 2009 Army Posture Statement (a report the Army submits to Congress with its budgets, which can serve to justify budget requests and activities, and as strategic communications tool) describes today’s world and that of the future as an “Era of Persistent Conflict.” Its authors see a future of protracted challenges, including rapid changes in technology, proliferation of weapons of mass destruction, failing states, dramatic demographic shifts and increasing frequency or intensity of natural disasters, as well as a changing climate.

Both documents also concur on one important aspect of addressing climate change: that doing so will not be up to DOD or the services alone. The 2009 Posture Statement outlines important policies and tools for addressing these challenges, highlighting interagency cooperation, working with partners abroad and preparing for the full spectrum of military operations. It also argues that the Army’s modular structure should make it more

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*Bolstering agricultural production is certainly not a traditional security mission – and, in particular, not a DOD mission – yet in conflicts such as the one in Afghanistan today it can become a key variable of success.*

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agile in responding to a variety of challenges.<sup>9</sup> The 2010 QDR likewise notes that “managing the national security effects of climate change will require DOD to work collaboratively, with many branches of government and with both traditional allies and new partners.”<sup>10</sup> It describes shifting patterns of natural disasters domestically and abroad that could lead to increased demands for disaster and humanitarian relief missions, noting that, “In some nations, the military is the only institution with the capacity to respond to a large-scale natural disaster. Proactive engagement with these countries can help build their capability to respond to such events.”<sup>11</sup>

Interagency collaboration, though certainly the appropriate way to address climate-related issues, will not always be smooth or simple. Looking at ways in which the effects of climate change could have important implications for economic and political stability can help illustrate the kind of issues that may arise for the U.S. ground forces.

Projections indicate changes varying dramatically by region, with water availability decreasing in some

regions with flooding in others, and land arability benefiting in some regions with desertification spreading in others. Both factors will affect agriculture around the world, raising productivity in some areas and lowering it in others. Bolstering agricultural production is certainly not a traditional security mission – and, in particular, not a DOD mission – yet in conflicts such as the one in Afghanistan today it can become a key variable of success.

However, the U.S. government lacks sufficient capacity for economic development and non-military security assistance.<sup>12</sup> American ground forces have therefore in some cases taken responsibility for non-combat activities that bolster stability and security. Recent attention to activities like the National Guard’s Agricultural Development Teams (ADTs), in which troops are teaching Afghans farming methods and distributing food, has led some development and relief groups to publicly argue that combat forces should not engage in these kinds of activities regularly or on a large scale.<sup>13</sup> Yet, as defense strategist Andrew Krepinevich cautioned, if civilian government agencies “prove unable to meet their obligations as partners in restoring stability, the Army must also be prepared to engage in operations to help restore the threatened state’s governance and infrastructure.”<sup>14</sup> Given that this would involve (among other things) many of the types of activities that may become more important to state stability in a climatically changing future, this debate will likely be prominent in any discussion of climate change implications for U.S. ground forces.

In addition to the debate on the proper roles of the American military in non-military activities, climate change may add new dynamics to more traditional security assistance activities by changing the needs of nations with which the United States forms partnerships. For example, the United States already provides significant security and other assistance to Colombia to promote regional goals like countering narcotics production and

trade. According to a 2009 CNA report, Colombia is likely to face an array of climate change effects unique to its geography and landscape. This, in turn, is likely to “worsen long-standing problems (e.g., drug trafficking and crime, natural disasters, forced migration or displacement),” and drive an increasing need for Colombian armed forces to “provide security assistance, along with civilian partners, to the public.” Natural disasters and other environmental changes could also “divert resources from other missions and operations” by increasing the need for humanitarian response and damaging infrastructure.<sup>15</sup> These trends could complicate U.S. abilities to meet its regional security objectives.

The Army itself has identified several other implications of climate change for its missions. Specifically, migration and other ancillary effects of climate change could complicate ongoing missions. The Army Corps of Engineers, whose responsibilities include managing water resources and reducing risks to infrastructure from natural disasters, may see a rise in sea level affect installations at home and abroad, and it may be asked to collaborate more often with key international partners to help them adapt to climatic changes.<sup>16</sup>

On the U.S. domestic front, the most often cited effect is that some National Guard units may be called upon more often if climatic changes spur more or more intense natural disasters or if the secondary effects of climate change affect border security. In interviews, several Guard representatives voiced their sense that they will have sufficient capacity to adjust if demands increase, and will be able to adapt accordingly. However, several noted that more detailed climate projections and related information would assist in preparing for worst-case contingencies. Questions surrounding the roles, responsibilities, and command and control of ground forces within the continental United States have risen to cabinet-level debate recently as the southern border has posed an increasing

threat to national security.<sup>17</sup> This situation provides a window into more complex questions about the possible effects of more or more serious natural disasters in North and Latin America, or increasing movements of people as a result of changing environments.

These issues may seem relevant only for the more distant future. However, given challenges related to climate change that might confront the country in the long term, more concerted consideration of them in the near term is certainly warranted.

### Research Needs

Good policy solutions regarding questions like those identified above will remain elusive without far more thorough analysis of how climate change may affect U.S. ground forces, future missions and capabilities. Our work points to two key research priorities.

**Afghanistan and Pakistan.** Given the large presence of American ground forces in Afghanistan and their mission not just to secure but to stabilize that war-torn country, one important exercise would be to examine regional climate projections for Central Asia, focusing on how changing climate conditions may affect agriculture (and, related, water supplies) in Afghanistan and Pakistan. In addition to U.S. military forces, USAID, the U.S. Department of Agriculture and other civilian agencies are engaged in diversifying and improving the region’s agricultural sector to promote economic growth and long-term stability.<sup>18</sup> The Intergovernmental Panel on Climate Change and other climate science projectors tend not to provide great detail on many countries in conflict such as Afghanistan, in part due to lack of consistent monitoring of environmental trends. Clearly identifying a need for the science community to develop better projections for Afghanistan and Pakistan (or for that broad region, should sufficient information on those two specific countries prove unavailable) could



A National Guard Humvee departs the New Orleans Superdome in Louisiana on Sept. 5, 2005 to provide disaster relief following Hurricane Katrina. The National Guard will likely play a unique role in domestic efforts to adapt to the effects of climate change. (U.S. ARMY)

provide a focused, relevant topic around which security planners could build new relationships with the climate science community toward a specific security goal. This kind of analysis could also be useful in setting priorities for the water, energy and agricultural projects that are important to long-term prosperity in Afghanistan and avoiding what is becoming a proverbial warning -- building a hydroelectric power system on a river that is unlikely to exist in 15 years. Perhaps most important, this type of exercise could also showcase the importance of contributions of U.S. civilian agencies to meeting U.S. security needs.

**Domestic Climate Change Effects.** The Army and National Guard would benefit from deeper examination of how climate change will affect the continental United States. Analysis of the security consequences of climate change often

focuses on those developing countries least capable of adapting to change. American ground forces are unlikely to be called upon to engage in these locations unless other U.S. interests are directly at stake. However, they will continue to have domestic roles and responsibilities, and indeed the Army Corps of Engineers and National Guard will likely play unique roles in domestic efforts to adapt to the effects of climate change. Individuals within both organizations are beginning to engage with other federal, state and local agencies as needs arise -- adapting to water shortages in the western United States (the type of issue likely to arise more with a changing climate), for example. The more that future demand can be quantified based on projected climate effects -- and the less ad hoc this process is -- the smoother will be the process of adjusting to changing domestic needs.

As the Army, Marine Corps or National Guard (or researchers focusing on these services) consider how to undertake deeper examinations of what climate change means for their missions and capabilities, looking to the Navy's process may be instructive. Several years ago, it began analyzing how climate change might affect its missions, operating environment, equipment and capabilities by commissioning broad initial studies that identified a wide range of potential issues. It has since worked to study these potential issues more deeply, parsing which will or will not be problematic, in an effort to best place further research and investments. By systematically identifying the most likely climate change-related issues it will face, the Navy has been able to build solid policies and plans without an oversized dedication of resources.

Such analysis must also be matched by actionable climate change projections from partners in the science community. For example, although generating climate projections (like all projections) will remain an inexact practice, more clear indications of how and where natural disasters could drive increased HA/DR missions could assist in more efficient planning. Until U.S. ground forces create a demand for information that is relevant to their specific missions and responsibilities, climate scientists and modelers are unlikely to generate optimal projections for their use. This will require further developing and maintaining just the kind of interagency relationships that the QDR suggests will be important in regularly evaluating climate science projections and their security implications.

For the U.S. ground forces, delaying concerted research on this issue for too long increases the risks that speculation, rather than security priorities or solid methods, will drive research needs. For example, some commentators are now speculating that the effects of climate change are likely to spawn more terrorism.<sup>19</sup> Proving such a link would require extensive multidisciplinary analysis. Unless backed by rigorous study, this kind of claim may

detract from more likely scenarios that should be of greater concern to U.S. ground forces. Given the pressing priorities for U.S. ground forces at this time, non-governmental organizations should be able to meet these research needs if the military services are unable to commit the resources to doing so in the near term.


### **Conclusion**

The U.S. Army, Marine Corps and National Guard are in the early phases of considering how climate change might affect them in the future. These services possess the size and enterprising individuals to make significant progress on reducing emissions at domestic installations. Each service has been shaped by the current wars in ways that have helped it articulate a vision of a complex future. This understanding can serve as a foundation for better understanding how climate change as an unconventional global issue may affect the ground services as well. Deeper intellectual study of how climate change is likely to affect the U.S. ground forces, combined with leadership attention to the practical questions being raised as the services work to meet energy and climate requirements, will set the Marine Corps, Army and National Guard on a solid footing for understanding what this issue means for them.

## ENDNOTES

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**CHAPTER V:**  
ON THE FRONT LINES: CLIMATE CHANGE  
AND THE COMBATANT COMMANDS

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By Commander Herbert E. Carmen (USN), Christine Parthemore and Will Rogers

A P R I L 2 0 1 0

**Broadening Horizons:**  
*Climate Change and the U.S. Armed Forces*



## CLIMATE CHANGE AND THE COMBATANT COMMANDS

By Commander Herbert E. Carmen, USN,  
Christine Parthemore and Will Rogers

As the U.S. military responds to the national security implications of climate change, the regional combatant commands will make the operational and tactical level decisions about how to adapt. Climate change, the 2010 Quadrennial Defense Review (QDR) observes, is “an accelerant of instability or conflict,” and could exacerbate trends such as coastal erosion, drought, crop failure, group grievance, uneven economic development and state illegitimacy. In every region of the world, the changing climate will influence political, social, economic, environmental and cultural trends in ways that could destabilize societies or exacerbate conflicts. These developments will present new challenges to combatant commanders and U.S. military and civilian officials operating in their respective areas of responsibility (AOR). For example, extreme and extended drought in Afghanistan could undermine agricultural development, which President Obama has identified as a cornerstone to long-term stability there. However, it is not clear how, when and on what scale climate change may impact agriculture, which provinces will be most affected or what the United States should do in response. Meanwhile, the opening of the Arctic for commercial shipping and competition over resources will present new challenges, including how to navigate responsibility of the Arctic among overlapping regional combatant command jurisdictions.

Across the Department of Defense (DOD) and the military services, individuals are working to further understand and articulate the security consequences of climate change. This understanding, however, has not extended consistently or broadly to operational planners at the combatant command level. For a variety of reasons, many officials at the command level have yet to fully conceptualize how climate change could impact their AOR.

Yet, as operational leaders on the front lines, the U.S. unified combatant commanders' roles require them to understand the impact of climate change and incorporate its effects into theater-level planning, coordination and execution. In concert with a range of emerging security threats, climate change is likely to affect many features of the future security environment and, as a result, efforts to plan for and equip America's armed forces. In an April 2008 speech to the Association of American Universities in Washington, Secretary of Defense Robert M. Gates described some of the "new threats to national security" that will interact with climate change:

"Rather than one, single entity – the Soviet Union – and one, single animating ideology – communism – we are instead facing challenges from multiple sources: a new, more malignant form of terrorism inspired by jihadist extremism, ethnic strife, disease, poverty, climate change, failed and failing states, resurgent powers, and so on. The contours of the international arena are much more complex than at any time during the Cold War. This stark reality – driven home in the years since September 11th – has led to a renewed focus on the overall structure and readiness of our government to deal with the threats of the 21st century."<sup>1</sup>

This paper focuses on the six geographic combatant commands as a way to address the effects of climate change and related energy security challenges on U.S. national security interests in regions across the globe. Because the geographic combatant commands are suitably positioned to observe physical environmental change and resulting effects, they also should be able to identify how these effects drive security requirements within their respective AORs.

Based on substantial independent research and personal interviews with representatives of

## WHAT ARE THE UNIFIED COMBATANT COMMANDS?

The system of unified combatant commands began during World War II with the establishment of geographic areas of operations. After the war, President Harry S. Truman codified this arrangement in the first Unified Command Plan (UCP) in 1946. The UCP, a classified document that defines military command structure, establishes the missions and geographic responsibilities among the combatant commanders.

These commanders are responsible to the president and the secretary of defense for accomplishing the missions assigned to them and exercising command authority over the forces assigned to them. The military departments provide facilities and headquarters support, and they organize, train and equip forces to fulfill the combatant commanders' operational mission requirements.

The unified command structure generated by the UCP is flexible and changes as required to accommodate evolving U.S. national security needs. President George W. Bush signed the latest change to the UCP in 2008 formally establishing missions and responsibilities for U.S. Africa Command (AFRICOM) and placing parts of the Caribbean in the U.S. Northern Command's (NORTHCOM's) AOR.

each combatant command, this paper examines how projected environmental changes will intertwine with the political and economic dynamics that Secretary Gates identified as shaping the nature of future conflict. As the study of the security implications of climate change is relatively nascent, we relied on several relevant but more established data sets to analyze the relationship between environmental trends and political challenges. To gain an

Chart 1: Unified Command Map of the Arctic



Source: National Geospatial-Intelligence Agency

understanding of the impact of sea level rise on ports and cities, we describe the current and projected effects on selected cities and ports in each AOR using data from an Organisation for Economic Co-operation and Development (OECD) study. This study estimates the exposure of the world's large port cities to coastal flooding due to rising sea level and increased – and perhaps more severe – storm surge and damage due to high winds. Because climate change effects can drive or exacerbate instability, we examine data from the Failed States Index to identify the extent to which countries in that AOR already run a significant risk of collapse. Finally, we highlight the degree to which developing economies are vulnerable to climate change negatively impacting their agricultural industries, which serve as the sole income sources for large portions of certain populations. While this is an inexact method of examining what environmental pressures may become important to the combatant commands

– especially given the dearth of extensive studies of causal relationships among these factors – it is meant to illustrate how climate change may interact with other security trends to challenge U.S. national security interests.

The following sections describe each combatant command; its mission and AOR; and relevant climate projections and economic and political assessments. We highlight unique characteristics of each combatant command that shed light on how the United States and the DOD will address future climate change challenges and resulting effects. We start by examining the Hawaii-based U.S. Pacific Command (PACOM) because it represents an important case study for considering the nexus of climate change, energy and security in a strategic forward operating location.

### U.S. Pacific Command

PACOM's AOR is vulnerable to a daunting range of potential repercussions of climate change in addition to traditional threats such as interstate tensions, transnational crime and weapons proliferation.<sup>2</sup> PACOM is already experienced at helping partner countries deal with the effects of tsunamis, earthquakes and typhoons; but climate change could increase both the number and severity of natural disasters. In addition, a 2010 climate change assessment by Oak Ridge National Laboratory suggests several specific risks:

- Heat waves in China and Northern Australia are likely to increase over the next 40 years, and more expansively across the AOR over a longer timeline, with significant implications for agricultural output and food security.
- Flooding – a particular concern in major river areas – is likely to increase for much of PACOM's AOR due to increases in precipitation during the winter in some regions and during the summer in others.

- Sea level rise will very likely affect coastlines around the world, albeit unevenly, exposing people and infrastructure to flooding, erosion and storm impacts. Observed rates of sea level rise show effects to date are on pace with the high end of projections.<sup>3</sup>

Of even more direct relevance to PACOM, climate projections suggest that throughout this century, the Hawaiian and Pacific Islands (including the location of PACOM's headquarters) are likely to experience rainy seasons shifting from winter to summer months. This would likely increase rates of flooding, strain infrastructure and affect agriculture and fresh-water supplies. According to a 2009 report by the U.S. Global Change Research Program (USGCRP):

In addition to gradual sea-level rise, extreme high water level events can result from a combination of coastal processes. For example, the harbor in Honolulu, Hawaii, experienced the highest daily average sea level ever recorded in September 2003. This resulted from the combination of long-term sea-level rise, normal seasonal heating (which causes the volume of water to expand and thus the level of the sea to rise), seasonal high tide, and an ocean circulation event which temporarily raised local sea level. The interval between such extreme events has decreased from more than 20 years to approximately 5 years as average sea level has risen. ... Flooding related to sea-level rise and hurricanes and typhoons negatively affects port facilities and harbors, and causes closures of roads, airports, and bridges.<sup>4</sup>

Coastal flooding, erosion and contamination of freshwater supplies are major concerns throughout PACOM's AOR. Based on OECD statistics, of the current 10 coastal cities most at risk of being affected by sea level rise, six lie in PACOM's

### U.S. Pacific Command Quick Facts (PACOM)

- Headquarters in Honolulu, Hawaii.
- 36 countries in AOR (including all of Antarctica).
- AOR Includes two of the three largest world economies (Japan and China).
- AOR includes five of the six world's largest militaries.

AOR: Guangzhou and Shanghai in China; Calcutta and Mumbai in India; Osaka-Kobe in Japan; and Ho Chi Minh City in Vietnam. Mumbai is ranked most at risk, with nearly 2.8 million people (or 15.3 percent of the population) living within potential flood zones. Based on demographic, economic and environmental projections, within the next 60 years, eight of the 10 coastal cities with the most assets vulnerable to sea level rise will be in PACOM's AOR, amounting to more than 13.4 trillion dollars in assets that could be inundated by sea level rise. These projections also indicate that nine of the 10 coastal cities most at risk to sea level rise, ranked by population, will also be within the PACOM AOR.

Agriculture is also vulnerable to climate change, with potentially significant effects for developing economies in the region. Indeed, nine countries in PACOM's AOR depend on agriculture for more than 25 percent of their gross domestic product (GDP), while another four depend on agriculture for at least 20 percent of their GDP.<sup>6</sup> Given that the global average is approximately

## PACOM HQ'S DUEL ENERGY AND CLIMATE CHALLENGES

Hawaii, where the Pacific Command is headquartered, possesses unique vulnerabilities related to its energy dependencies and susceptibility to the effects of climate change. It uniquely showcases how energy consumption and the consequences of that consumption are linked.

Hawaii (and therefore PACOM) depends heavily on petroleum to meet its energy needs – and not only for transportation. About 90 percent of its energy needs, including the production of three fourths of its electricity, are met by petroleum. The state accounts for only about one-third of one percent of total U.S. electricity generation, but accounts for almost half of the country's electricity generation that is produced by petroleum. As this petroleum is often shipped through vulnerable shipping routes and the state lacks energy pipeline infrastructure, most energy imports to the state come through a single point: Honolulu. Adding to the vulnerabilities, the state's electric grids are notoriously weak. Luckily, the state does enjoy high potential capacity for wind, solar, geothermal and wave power, and DOD officials are contributing to Hawaii's ability to tap into these resources.<sup>9</sup> The military installations in Hawaii have made strong advances in energy efficiency, alternative energy and environmental considerations, and have tested everything from hydrogen fuel cell, electric and hybrid vehicles to various types of solar roofs.

Several institutions are facilitating PACOM's partnership with local actors and other federal departments to address Hawaii's energy and climate vulnerabilities. One coordinating body, the Hawaii Clean Energy Initiative (HCEI), a state partnership with Department of Energy (DOE) established in 2008, is intended to reduce this high dependence on petroleum, both to reduce vulnerability to price spikes and supply disruptions, and to reduce resulting greenhouse gas emissions.<sup>10</sup> Several national labs also contribute actively to Hawaii's and PACOM's energy and climate goals. The labs provide assessments and model options for mitigating grid and other vulnerabilities, and are creating a master plan on how to meet energy security goals. In January 2009, PACOM established its Energy Partnership and Strategy Council (PEPSC), a council that convenes relevant stakeholders from the military services and other federal departments along with state and local officials to coordinate on energy issues. As with any endeavor, opinions regarding its utility vary and the parties involved still struggle with differing visions of energy security; but PEPSC seems to be useful for uniting the services in their attempts to conserve energy – a vital first step.

Indeed, as a result of its work, PACOM released an energy strategy in October 2009 outlining steps that

will contribute to meeting Hawaii's goals of supplying 70 percent of state energy demands through clean energy by 2030 or sooner, and reducing overall demand for energy through conservation and efficiency. This strategy also acknowledges that addressing energy and climate concerns effectively at home can provide the experience it needs to lead similar efforts elsewhere in its AOR: "Today's energy landscape offers a once-in-a-generation chance to set a positive path for the entire Asia Pacific region."<sup>11</sup> These lessons are also applicable elsewhere in DOD, and through these efforts and others, PACOM can provide an abundance of information on the effects of climate change and clean energy options for mitigating emissions that are relevant to other combatant commands.

Interagency activities at PACOM show that working-level partnerships are critical and provide useful lessons about how to coordinate with DOE and other agencies to fund initiatives, and what knowledge and technical capabilities others can contribute to assist PACOM in meeting its needs. PACOM and the military services seem advanced in coordinating amongst themselves and with universities, private companies, and state and local government offices. Across our interviews, nearly every individual mentioned partnerships like the HCEI, PEPSC and others.

6 percent, this outsized dependence on agriculture for economic stability could represent a significant vulnerability if projected climate changes impede agricultural productivity. Meanwhile, water scarcity could impact agricultural development for other Southeast Asian states, such as Thailand, where water resources are already being strained by regional upstream dam building.<sup>7</sup>

Climate change carries the potential to affect political stability within the region as well. While the Asia-Pacific is not characterized by state weakness to the degrees seen in parts of U.S. Central Command's (CENTCOM) and Africa Command's (AFRICOM) AORs, according to the Failed States Index three states in this AOR are ranked among the top 20 "critical" states at risk of failure, including Burma, North Korea and Bangladesh. Meanwhile, three others – Nepal, Solomon Islands and Sri Lanka – are ranked as "in danger" of state failure. Even with relative stability in this region, primary drivers such as group grievance, demographic pressure, uneven economic development and state legitimacy are key concerns that could pair with changing climatic conditions to create new challenges for PACOM.<sup>8</sup>

Effectively assessing and managing these effects of climate change will require PACOM to coordinate with other U.S. agencies. The work that PACOM has already done addressing climate change and energy security at its Honolulu headquarters will serve as a strong foundation and offer useful lessons in how it may further partner with agencies such as the Department of Energy (DOE), U.S. Agency for International Development (USAID) and the U.S. Department of Agriculture (USDA) in order to better address the climate change challenges in its AOR.

**Recommendations for PACOM:** Despite the helpful experience and institutions PACOM

has developed to handle climate change-related challenges, with the largest AOR in terms of geographic area and population, PACOM will need to prioritize its efforts. As it develops long-term plans for its AOR, particularly the coastal nations along the Bay of Bengal and the western Pacific Ocean, it should identify those areas where changing demographics and work force migrations may lead to even greater risk to populations in coastal areas as the effects of sea level rise impact those areas. Early identification may allow planners to find ways to mitigate potential instability which could be exacerbated by these climate change effects.

### U.S. Central Command

Current climate observations suggest that countries within CENTCOM's AOR are likely to feel heavy effects of climate change. Indeed, environmental conditions and climatic dynamics are likely to shape this region for the next several decades. Though climate projections to date often lack detailed timelines and state-level analyses, scientists do largely agree on several key trends:

- A pattern of drought, which is by far the most dominant climate hazard in the region, especially in Central Asia.
- Reduced precipitation in Central Asia, and increased precipitation over the Arabian Peninsula.
- Extreme heat waves that have the potential to disrupt agricultural development.
- Increased melting of regional glaciers that are a significant source of water for rivers, lakes, reservoirs and subsurface aquifers.
- Increase in tropical cyclones in the Karachi region of Pakistan.
- Sea level rise coupled with more frequent storms are projected to increase the damage to coastal communities.



## U.S. Central Command Quick Facts (CENTCOM)

- Headquarters in Tampa and Qatar, with several subordinate and service component headquarters located across the AOR.
- 20 countries within the AOR.
- Oversees combat operations in Afghanistan and Iraq.
- Commands more than 210,000 U.S. service personnel in the region.

While coastal communities in CENTCOM's AOR will be vulnerable to the effects of rising sea levels, the changes are not likely to be as acute as in other regions in the world, such as Southeast Asia and the Caribbean. Two notable exceptions are already at risk of flooding: Alexandria, Egypt and the city of Dubai. In Alexandria approximately 1.3 million people are already at risk of flooding due to rising sea level. Current observations along with projected population trends suggest that nearly 4.4 million people will be vulnerable to sea level rise by 2070. By comparison, in Dubai, 260,000 people are currently at risk of flooding due to sea level rise, increasing to approximately 793,000 by 2070.<sup>12</sup> While these communities are generally well-developed and have better governance structures than many others in CENTCOM's AOR, unanticipated challenges (such as severe and potentially more frequent storms and coastal inundation) have the potential to corrode economic development

and political establishments while exacerbating existing social grievances.

Several CENTCOM countries critical to U.S. interests in this AOR suffer from ongoing conflict, weak governance and instability – factors that could be made worse by climate change or that may complicate efforts to adapt to the effects of climate change. In the Failed States Index, Iraq, Afghanistan and Pakistan are characterized as “critically” close to state failure and ranked sixth, seventh and tenth, respectively. Of the drivers undermining Iraqi and Afghan stability, top concerns are external intervention from state or non-state actors affecting the internal balance of power, group grievance (i.e., marginalized communities) and the legitimacy of the state. Meanwhile, Yemen, which is plagued by uneven development and factionalized politics that undermine state legitimacy, is ranked nineteenth on the Failed States Index, with four other states in the AOR ranked as “in danger” of state failure due to human rights and state legitimacy concerns.<sup>13</sup>

To ensure long-term stability in this AOR, military, development and diplomacy professionals will need to understand what a changing climate could mean for agricultural productivity and related water supply issues. In a surprise visit to Afghanistan on March 28, 2010, President Obama spoke to the role that the strength of agricultural production is likely to play in Afghanistan and Pakistan, which depend on agriculture for 31 percent and 21 percent of their GDPs, respectively. As Obama conveyed to U.S. troops, investing in civilian areas such as agricultural production will increase Afghanistan's prosperity, security and independence from extremists in the region.<sup>14</sup> Yet, as projected drought and heat waves set in, agricultural sectors in Afghanistan, Pakistan and other countries in the AOR could be affected.

## CLIMATE CHANGE AND SECURITY IN AFGHANISTAN, IRAQ AND YEMEN

The priorities established by CENTCOM in its 2010 Posture Statement offer a guide to where officials see the most immediate need for the command's attention.

### Afghanistan

General Petraeus reiterated Afghanistan's importance to U.S. national interests in his testimony in March 2010. In Afghanistan, U.S. goals "are to disrupt, dismantle, and defeat al-Qaeda and its extremist allies and to set conditions in Afghanistan to prevent reestablishment of trans-national extremist sanctuaries like one al-Qaeda enjoyed there prior to 9/11."<sup>20</sup> Central to this effort is building civilian capacity to support sustainable livelihoods – and it is well worth thinking through how the effects of climate change may interact with these goals.

While it is not yet clear how climate change will directly affect Afghanistan, observations suggest that climate change could potentially disrupt agricultural development by exacerbating drought (i.e., a decline in surface or sub-surface water resources, such as rivers, lakes, reservoirs and ground water) and increasing the severity and frequency of heat waves. According to the U.S. Geological Survey (USGS), Afghanistan's hydrology is largely dependent on runoff from ice caps and glaciers that supply many of its rivers with fresh water. However, the USGS reports that "[c] hanging climate is resulting in increased melting of these glaciers and increasing discharge while reducing the volume of water remaining in glacier storage. Most glaciers in this region are retreating and/or down-wasting rapidly."<sup>21</sup> Meanwhile, unsustainable irrigation practices and poor water governance will increasingly constrain storage and access to fresh water necessary for Afghan farmers to grow their crops. Heat waves are also expected to be particularly severe in Central Asia.<sup>22</sup> Extreme variations in heat can potentially disrupt crop development, especially with species sensitive to strong variations in temperature. While it is still unclear how climate change will affect Afghanistan's agricultural productivity, given that agricultural development and related water supply issues will be a cornerstone to long-term stability, military, development and diplomacy professionals operating in Afghanistan will need to understand these effects.



A California Army National Guardsman gathers a soil sample near Marawara, Afghanistan to learn how crop production can be improved in the area. (TECH. SGT. BRIAN BOISVERT/Army National Guard)

### Iraq

While security in Iraq has improved significantly, General Petraeus has noted that "the progress in Iraq is still fragile." In addition to the many social, cultural and political challenges likely to shape Iraq in the coming years, access to water and agricultural development are likely to affect the security environment – especially if climate change exacerbates drought and increases temperatures throughout the region. Like many of its neighbors, Iraq depends a great deal on water sources primarily from the Tigris and Euphrates rivers that flow from its northern neighbors Syria and Turkey. In the last year, Iraq suffered the most acute drought in recent history, leaving 2 million Iraqis vulnerable to electricity outages due to declines in hydroelectric power generation, and nearly as many parched without adequate access to fresh water.<sup>23</sup> Dr. Abdul Latif Rashid, Iraq's water minister, reported that 300,000 marshland residents had been displaced by drought in recent years.<sup>24</sup> Meanwhile, the UN Educational, Scientific and Cultural Organization (UNESCO) reported that more than 100,000 Iraqis had been internally displaced by drought since 2005.<sup>25</sup> Furthermore, 70 percent of the historic subterranean aqueducts, or karez, which had historically supplied hundreds of communities with access to fresh water, have been depleted due to drought and unsustainable pumping.<sup>26</sup>

Whether it is for power generation, consumption or agricultural production, access to water is likely to play a crucial role in shaping Iraq's future. As in Afghanistan and Pakistan, climate-induced drought and heat waves could affect water availability. While it is projected that annual precipitation will increase over the Arabian Peninsula, it is not clear whether Iraq's existing irrigation infrastructure and water management practices will allow the Iraqi people to harness increases in annual rainfall. Furthermore, existing projections are unclear as to where increased precipitation may occur (i.e., if the northern provinces will benefit over the southern provinces, or vice versa). Finally, in examining the region as a whole, Iraq could be vulnerable to its northern neighbors' adaptation practices; specifically, Turkey and Syria may choose to reduce the flow of the Tigris and Euphrates into Iraq in order to adapt to changes in the climate. Regardless, as U.S. military planners look at contingencies in Iraq for the near future they should factor in water trends and how climate change may engage these trends.

## Yemen

Yemen is an important country for CENTCOM to monitor. "In Yemen, we have seen an increase in the prominence of al-Qaeda as it exploits the country's security, economic, and social challenges," said General Petraeus. Indeed, Yemen's security, economic and social challenges are rooted in the state's natural resource management, and climate change could make managing these resources a nearly impossible task.

Today, Yemen – one of the most water impoverished states in the world – is experiencing an acute drought that is increasingly undermining the country's already fragile government. As The New York Times reported in November 2009, Yemen's water crisis is one that "threatens the very survival of this arid, overpopulated country, and one that could prove deadlier than the better known resurgence of Al Qaeda [there]."<sup>27</sup> Yet there are ways in which Yemen's declining water availability and the resurgence of al Qaeda show overlap. To date, the Yemeni government has been able to stave off a political and social meltdown by using its oil wealth, which accounts for approximately 85 percent of the

government's revenue, to subsidize expensive – but necessary – diesel pumps to extract water from deep aquifers. But the country is running out of oil. In fact, experts predict that by 2017, the government will run out of exportable oil, leaving it without the means to continue subsidizing its expensive, unsustainable water practices. Meanwhile, as water prices increase in Yemen – having quadrupled since 2005 – many of the country's farmers are turning to plant qat, a profitable narcotics plant popular in Yemen.<sup>28</sup> This water intensive plant is drying up the country, with more than 50 percent of the country's available water being used to irrigate qat farms.<sup>29</sup> At the same time that water becomes scarcer, the government is increasingly unable to maintain control and legitimacy over all of its governorates, leaving pockets of ungoverned spaces for al Qaeda to exploit.

As drought is projected to become worse with changes in the global climate, Yemen could experience a situation of absolute scarcity where the Yemeni government is unable to provide access to water. The potential for al Qaeda and other transnational actors to exploit this vulnerability could be more prominent. In order for officials at CENTCOM to adapt to the effects of climate change in Yemen, they will need access to better scientific projections that give them insight into the conditions and dynamics that are likely to shape the future security environment.

According to the Environmental Protection Agency (EPA), “An increase in average temperature can 1) lengthen the growing season in regions with a relatively cool spring and fall; 2) adversely affect crops in regions where summer heat already limits production; 3) increase soil evaporation rates, and 4) increase the chances of severe droughts.”<sup>15</sup>

Effects on agriculture have the potential to worsen food scarcity in states that are already having difficulty meeting demand. For example, concerns surrounding access to food have already sparked several Middle Eastern countries to lease large tracts of land throughout Africa and Southeast Asia, in part to grow food to meet their own sustenance needs. These include Bahrain, Jordan, Kuwait, Qatar, Saudi Arabia and United Arab Emirates.<sup>16</sup>

**Recommendations for CENTCOM:** CENTCOM should examine the local and regional projected climate change on water for its AOR, as it will affect all other environmental change in the region. Combined with other dynamics – instability, domestic tensions and broad environmental change – water pressures are likely to carry important implications for CENTCOM. CENTCOM’s focus on population-centric efforts to achieve security objectives necessitates many of the quality of life initiatives already underway, but it is important to look at how challenges such as water scarcity will further develop over time and to plan for those future capacity requirements now.

Today, military units in Afghanistan are drilling for potable water, in some cases more than 1,200 feet below the surface,<sup>17</sup> in order to reduce the military’s demand for bottled water in the field. The U.S. military’s outsized dependence on water to sustain combat operations is a significant operational challenge, accounting for 51 percent of the logistical burden in Afghanistan.<sup>18</sup>

Glacier melting, drought and acute water scarcity could further challenge the military’s ability to find sufficient sources in this AOR, and CENTCOM’s long-term planning must account for this contingency. Indeed, drought is likely to be the most pronounced climate hazard to countries within CENTCOM’s AOR.<sup>19</sup>

### U.S. European Command

Changes to the European climate have been observed in every corner of the continent. Because EUCOM forces are stationed across all parts of Europe and because climate change effects are notably different across the continent, EUCOM installations will likely experience a spectrum of effects from climate change. Some of these are already well documented and include:

- General warming across Europe at a slightly higher rate than the global average.
- Slightly higher warming in mountainous areas and the southwestern part of Europe as compared to the rest of Europe as a whole.
- Precipitation increase of 20 percent during the twentieth century in the already wet northern areas of Europe.
- Precipitation decrease of as much as 20 percent in some areas of southern Europe.
- Increased river flows in the north.
- Decreased river flows in the south.
- Increased risk of desertification in the southern areas of Europe, particularly Spain and Greece.
- Loss of two-thirds of the volume of Alpine glaciers since 1850.
- Steady decrease in Alpine snow cover in each of the past four decades.
- Decreased permafrost in the northern regions, which may lead to the damage of high-mountain infrastructure.<sup>30</sup>

### U.S. European Command Quick Facts (EUCOM)

- Headquarters in Stuttgart, Germany.
- AOR includes Greenland, all of Europe (including all of Russia) and Israel for a total of 51 countries, 21 million square miles.
- AOR includes one-eighth of the world's population and about one-fourth of the world's gross domestic product.
- Approximately 80,000 U.S. military personnel are stationed in Europe today.
- The EUCOM commander also serves as the Supreme Allied Commander Europe (SACEUR) and maintains his headquarters in Mons, Belgium.

The most strategically meaningful manifestation of climate change is decreased ice levels in the Arctic Ocean. The prospect of easier access opens the Arctic for large-scale economic activity, including access to shipping routes previously blocked by ice and access to what could possibly be vast natural resources underneath the sea. Much of these natural resources are likely to be found in the Exclusive Economic Zones (EEZs) of the bordering states – Canada, Denmark, Greenland, Norway, Russia and the United States. Under the United Nations Convention on the Law of the Sea (UNCLOS), nations are entitled to an EEZ reaching 200 nautical miles from the coastline. Countries may

also exercise sovereign rights over the physical continental shelf in areas beyond the EEZ under Article 76. The UN Commission on the Limits of the Continental Shelf has authority to make the final recommendation based on the evidence presented.

This increased activity will likely lead to an increased military presence both to ensure access to the sea lines of communication and to protect the sovereignty of each nation's EEZ. Because of the tremendous economic potential in the Arctic region, there is potential for cooperation, competition and conflict simultaneously. In the near term, the Arctic Council may be the logical forum to adjudicate grievances associated with an opening Arctic. The Arctic Council is an intergovernmental forum of all the Arctic states (Canada, Denmark, Finland, Iceland, Norway, Russian, Sweden, and the United States) that promotes cooperation, coordination and interaction on issues related to sustainable development and environmental protection.<sup>31</sup> Because the council executes decisions on the principle of consensus, giving each of the eight Arctic states veto power, decisions generally represent the national interests of individual states. This helps the council and member states navigate issues of enforcement, and it is an example of a formal, legitimate governing body in the Arctic.

America's European partners are working to improve capabilities for monitoring the pace and physical effects of the melting sea ice, which will afford EUCOM better information for planning purposes. Indeed, precisely measuring the warning signs of a changing climate is critical to accurately determining the current impacts and creating useful models for future predictions. To measure the effects of melting sea ice, for example, the European Space Agency recently launched CryoSat 2, which will measure ice thickness to within one centimeter. The data from CryoSat 2 can then be used to gain a more

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*The prospect of easier access opens the Arctic for large-scale economic activity, including access to shipping routes previously blocked by ice and access to what could possibly be vast natural resources underneath the sea.*

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accurate understanding of the prospect of future sea level rise and other effects.<sup>32</sup>

Resulting from melting Arctic ice and other effects of the changing climate, sea level rise is projected to affect populations and infrastructure in EUCOM's AOR. In particular, the Netherlands – a low-lying state with more than 25 percent of the country below sea level – will be affected. Today, 73 percent of Amsterdam's population (839,000 people) is currently at risk of flooding, in addition to 128 billion dollars in assets. Rotterdam fares similarly, with 68.3 percent of the population (752,000 people) and 114.8 billion dollars in assets at risk from sea level rise.<sup>33</sup> Future projections suggest that as sea level rises, Amsterdam and Rotterdam will see dramatic increases in vulnerability to the population and assets. While the Netherlands government and many other cities in EUCOM's AOR are planning to adapt to sea level rise with investments in coastal walls, dikes and levees, according to a QDR background report “the most significant impact of sea level on coastal regions is likely not the gradual erosion accompanying an increase in sea level, but the episodic sometimes dramatic

erosion and other damage accompanying coastal storms and storm surge.”<sup>34</sup>

The effects of climate change will also alter European agriculture in various ways. In EUCOM's AOR, agriculture will likely represent less of a vulnerability to economic sustainability as climate change comes to pass, due, in part, to the diverse economies within the command's AOR. Notable outliers include Moldova and Albania, which depend on agriculture for 20 percent of their GDP.<sup>35</sup> Indeed, as projected drought and heat waves set in throughout Europe, these countries' agricultural sectors may be particularly vulnerable. In general, changes in the climate have the potential to undermine domestic agricultural output, which could drive up food prices as well.

As the world's second largest consumer of energy, the European Union (EU) considers energy security essential to sustaining peace and security. In 2007, the EU imported 53 percent of its total energy requirements, including 83 percent of its crude oil requirements, and 60 percent of its natural gas needs. The EU is largely dependent on Russia for these imports, with 34 percent of imported crude oil and 40 percent of imported natural gas coming from Russia. By comparison, Persian Gulf states provided the EU with 19 percent of its crude oil imports in 2007.<sup>36</sup> This reliance on Russia for European energy consumption is perhaps the biggest security challenge on the European continent, as Russia can generate political troubles and constrain policy. Thus, understanding the centrality of European energy security is critical to properly formulating and framing U.S. climate policies and EUCOM plans related to climate change.

Russia holds many of the cards with regard to energy security in Europe. The Russian Federation enjoys a massive reserve of oil and natural gas. The lowest estimates assume that Russia has at

least 60 billion barrels of crude oil in reserve and some 1,700 trillion cubic feet of natural gas. Russia has used energy exports to begin to fund military modernization, develop infrastructure and build partnerships around the periphery of Russia. This abundance creates vulnerabilities for the many European countries that rely on Russian energy. Tumbling prices in the global natural gas market have put pressure on Russian companies and the greater Russian economy in recent years. A need for cash has also led to politico-economic disputes between natural gas companies in the Ukraine and Russia over contracts, prices, non-payment and debt. These disputes, which have persisted in one form or another for nearly two decades, have resulted in several interruptions of natural gas supply to Europe.

**Recommendation for EUCOM:** NATO Secretary General Anders Fogh Rasmussen recently identified the protection of energy supplies and the security implications of climate change as areas requiring further cooperation among NATO members, noting that “we can only cope with these challenges if we work together.”<sup>37</sup> EUCOM, with a staff directorate tailored for interagency cooperation and a commander that is dual-hatted as Supreme Allied Commander Europe (SACEUR), is well positioned to collaborate on the challenges of energy security and climate change with Europeans.

We recommend that EUCOM focus on leveraging its capacities for U.S. interagency collaboration in order to help facilitate technology sharing and international cooperation aimed at the dual energy and climate change challenge. An important step in strengthening cooperation between the United States and Europe was the U.S. creation of the EUCOM Interagency Partnering Directorate as part of the recent EUCOM staff reorganization. This directorate hosts representatives from U.S. agencies such as USAID, the Department of State

(DOS), the Department of the Treasury, and the Immigration and Customs Enforcement Agency (ICE). The Interagency Partnering Directorate intends to add other agency representatives later this year, including representatives from the DOE.<sup>38</sup> For addressing challenges resulting from the effects of climate change, this kind of interagency structure will be critical for accessing the best scientific projections and leveraging existing U.S. capabilities to mitigate emissions and adapt to change.

### U.S. Africa Command

President Obama, speaking before the Ghanaian Parliament in July 2009, declared that Africa “is the most threatened by climate change.” According to the president, “[a] warming planet will spread disease, shrink water resources, and deplete crops, creating conditions that produce more famine and more conflict.” Indeed, scientists have built consensus on several key trends that are likely to shape AFRICOM’s AOR:

- Drought hazard could be widespread across the AOR and “of greatest intensity in the Sahel, along the Somalia-Kenya border, and in an areas [sic] surrounding the Okavango and Kalahari Desert: southern Angola, northern Botswana, and southern Namibia.”<sup>40</sup>
- Increased incidence of wildfires could occur, especially in areas where drought and heat waves are most acute.
- The frequency and intensity of tropical cyclones may increase, and in particular, “[t]he island of Madagascar and the coast of Mozambique [which] experience tropical cyclones that develop over the Indian Ocean,” could be increasingly vulnerable.<sup>41</sup>
- More frequent severe droughts and heat waves could increase the incidence of water scarcity by affecting precipitation patterns and hydrological resources such as lakes, rivers and underground aquifers, though patterns of

increased precipitation may occur within the AOR as well.

- An increase in the incidence of vector-borne disease, particularly malaria, may occur in a warming climate, especially in high-elevation regions such as East Africa.<sup>42</sup>

Sea level rise may be an important effect of climate change for AFRICOM's AOR, especially along the coast where urbanization is expected to continue to accelerate. Today, along the coast of Benin, sea level rise has led to the destruction of roads, crops and hundreds of homes, and it now threatens the capital city of Cotonou.<sup>43</sup> Projections indicate that sea level rise could affect economic growth and exacerbate existing social grievances in already afflicted cities. For example, according to OECD statistics, in Mogadishu, the number of Somalis vulnerable to rising sea level is projected to increase 12 times by 2070, from 9,000 people at risk to 115,000. Meanwhile, in Lagos, Nigeria, the number of residents vulnerable to sea level rise will increase 9 times over the same period, from 357,000 to 3.2 million.<sup>44</sup> Conflict, instability and piracy in Somalia are fueled, in part, by a threatened fishing industry that could be more afflicted changing ocean conditions. Nigeria's oil industry, which provides for 80 percent of the government's revenue,<sup>45</sup> may be affected by rising sea level and more frequent and more severe storms. These storms have the potential to damage or destroy offshore oil platforms near Lagos, which are expected to provide significant oil production in the near future. The decline in oil revenue could become a destabilizing factor that could promote the spread of violent extremism in Nigeria.

Linked to this AOR's water issues, agricultural productivity (and its relationship to achieving sustainable economic development goals) is of high concern. One report by the Africa

### U.S. Africa Command Quick Facts (AFRICOM)

- **Headquarters in Stuttgart, Germany.**
- **53 countries in its AOR, including every African country except Egypt.**
- **AOR spans an area three and half times the continental United States and includes more than 1 billion people.**
- **Became fully operational as a combatant command on October 1, 2008.**
- **Responsibility for U.S. military and U.S government missions in Africa and is unique in its makeup.**
- **Required to be half staffed by civilian billets, including professionals from non-military organizations.**

Partnership Forum (led by the OECD) reported that "Africa is particularly vulnerable to climate change because of its overdependence on rain-fed agriculture, compounded by factors such as widespread poverty and weak capacity."<sup>46</sup> Indeed, as mentioned before, current climate observations suggest that drought, heat waves and wildfires will plague states within AFRICOM's AOR.<sup>47</sup>

These conditions stand to potentially degrade agricultural development, including by further straining water resources, which could have dramatic consequences for populations of agriculture-dependent economies within this AOR. Of the 53 states in AFRICOM's AOR, 23



## UNDERSTANDING CLIMATE CHANGE AND CONFLICT IN AFRICA

The DOD and key elements of the U.S. national security community recognize that understanding the security implications of climate change will be necessary for promoting U.S. interests in Africa. In North Africa, where AFRICOM supports operations to counter violent extremism through Operation Enduring Freedom-Trans Sahara (OEF-TS), Combined Joint Task Force Horn of Africa and other partner capacity building missions, analysts with the NIC collected and analyzed data to assess how climate change could impact North Africa in a follow up report to the 2008 National Intelligence Assessment on the National Security Implications of Global Climate Change to 2030. Security analysts understand that the effects of climate change have the potential to weaken already fragile governments and to create the conditions that can be exploited by transnational actors such as al Qaeda, and other regional terrorist groups, such as al-Shabaab in Somalia.

In an effort to better understand how climate change will affect African states, the DOD's Minerva Initiative – a DOD-sponsored, university-based social science research program – awarded a 7.6 million dollar grant to the University of Texas, Austin to conduct a multiyear effort to study the security consequences of climate change in Africa. The program, Climate Change and African Political Stability, “will identify whether climate change could trigger disasters that undermine state stability, define strategies for building African state capacity and assess global development aid response efforts.”<sup>61</sup> Such partnerships between government and academia have the potential to fill in the holes in much-needed national security research and provide AFRICOM officials with the data they need to plan for future contingencies in the security environment.

states depend on agriculture to support at least 25 percent of their GDP, with six states dependent on agriculture to support 55 percent or more of their GDP. Of those countries, Guinea-Bissau, Somalia and Liberia tip the scale, with agriculture contributing to 62 percent, 65 percent and 77 percent of their GDPs, respectively.<sup>48</sup> Meanwhile, extreme population growth coupled with unsustainable water management practices will likely strain existing freshwater resources, given that 34 of the 40 states with the highest population growth in the world are located within AFRICOM's AOR.<sup>49</sup> As the U.S. National Intelligence Council (NIC) describes, the effects on agriculture will likely be severe unless African communities develop “[a] daptation strategies, including modifications in sowing dates to match climate changes and development of heat-tolerant crop varieties.”<sup>50</sup> Given all of these factors, AFRICOM officials will also need to assess how climate change could affect pandemic disease trends, and how this could challenge military readiness for the state militaries that AFRICOM is engaged with in building security capacity.

Shrinking crop production will not only undermine economic development, but also sustainable livelihoods, which could weaken government legitimacy and exacerbate existing grievances that have the potential to lead to conflict. According to the 2009 Global Hunger Index, seven states in AFRICOM's AOR are ranked “extremely alarming” on the hunger severity index, with another 16 states ranked in the “alarming” category.<sup>51</sup> Indeed, food riots are already prevalent in many African states. Further complicating the situation, the political sensitivities associated with access to food and arable land have led to the recent deposing of at least one government in Africa and could shape political environments in the future.<sup>52</sup>

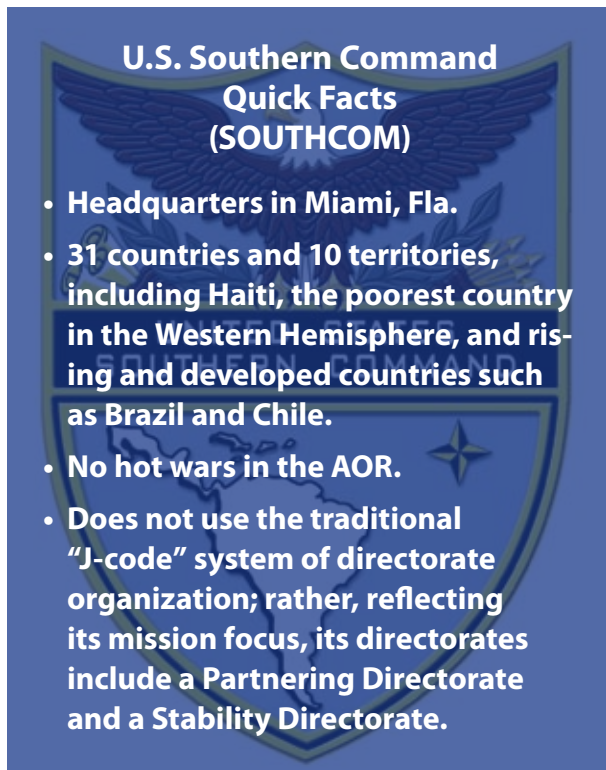
DOD officials, since before AFRICOM's inception, have defined the core responsibility in this

region as to “prevent problems from becoming crises, and crises from becoming conflicts.”<sup>53</sup> This is extremely challenging. To illustrate the sheer scale of the African continent, Cape Town, South Africa at Africa’s southern tip is as distant from AFRICOM’s headquarters in Stuttgart, Germany as Stuttgart is from Hong Kong. Africa is politically, culturally and socially diverse, with 800 ethnic groups and 1,000 different languages.<sup>54</sup> Given the complexity and dynamic nature of Africa’s strategic environment, officials recognized that AFRICOM would have to be a distinct unified combatant command, designed to directly support an interagency effort that supports development and diplomacy missions in addition to military operations. While AFRICOM is in the command chain of the DOD, it coordinates closely with its State Department and USAID partners. This is exemplified in the command structure, which includes a civilian deputy for civilian-military affairs and an unprecedented number of billets – half – for civilian employees, including non-military agencies of the U.S. government.<sup>55</sup> According to the 2010 Posture Statement, “Africa’s challenges require a holistic view of security that includes defense, law enforcement, and customs and border security. Addressing defense-related challenges must be pursued in concert with other U.S. government and partner security-related endeavors to sustain unity of effort.”<sup>56</sup>

Africa’s strategic environment is shaped by complex and dynamic challenges, including transnational threats such as violent extremism; ethnic tensions; illicit trafficking in drugs, weapons and humans; piracy; pandemic disease; extreme poverty; resource scarcity; and the lack of rule of law and democracy. Of the top 10 ranked states in the Failed States Index, seven states lie in AFRICOM’s AOR: Somalia, Zimbabwe, Sudan, Chad, Democratic Republic

of the Congo, Central African Republic and Guinea.<sup>57</sup> These challenges contribute to the drivers of instability associated with these states, including uneven economic development, group grievances (in particular, ethnic tensions), human rights abuses, a general lack of public services, and the illegitimacy of state authority. Today, AFRICOM officials are focused on addressing these challenges through sustained military-military, civilian-military, and civilian-civilian partnerships with African countries that: promote capacity building of conventional military forces through combined training and exercises; foster strong strategic relationships that sustain the benefits of capacity building efforts; promote regional cooperation and interoperability; counter violent extremism; contribute to stability in current conflict zones; and prevent the conditions that contribute to conflict.<sup>58</sup> According to the 2010 AFRICOM Posture Statement, “[t]hreats to stability do not necessarily manifest themselves in conflict, but can nevertheless have a corrosive influence on the development of good governance, viable market economies, and effective security sectors.”<sup>59</sup>

**Recommendation for AFRICOM:** Given the potential for climate change to exacerbate existing challenges to improving security and stability within AFRICOM’s AOR, of all the unified combatant commands, AFRICOM and its partner agencies should focus attention first on how to assist African counties to adapt to the effects of climate change. AFRICOM’s interagency structure will likely lend itself to support DOD’s climate change efforts, as envisioned by the QDR, which stated that “[m]anaging the national security effects of climate change will require DOD to work collaboratively, through a whole-of-government approach, with both traditional allies and new partners.”<sup>60</sup>



AFRICOM, in its role of supporting African efforts to provide for Africa’s security and development, should learn how climate change affects the continent today and in the future and include that knowledge in planning assistance efforts. AFRICOM can help Embassy Country Teams and African governments develop and prioritize initiatives that can help adapt to and mitigate the effects of climate change on Africa’s security environment through its Offices of Defense Cooperation. A thorough understanding of climate change can help AFRICOM help its African partners to proactively address climate change impacts that will threaten stability and development.

### **U.S. Southern Command**

According to one U.S. Southern Command (SOUTHCOM) official, climate change will be a “huge consideration” in this AOR, but difficulties in projecting likely effects of climate change

remain. Though climate projections to date still often lack detailed timelines and geographically specific effects, scientists agree that several general trends are likely to affect Central and South America, including:

- A general increase in wildfires, particularly in and around Brazil.
- A general wetting along the tropical Pacific and Atlantic coasts and in southern Chile.
- Increased drought and risk of desertification in Central America.
- Increased precipitation along the equatorial Pacific coast and southern Brazil, Uruguay, and northern Argentina on the Atlantic coast.
- Erosion, salt water intrusion, flooding and damage from storm surges.
- Observed sea level rise, which to date outpaces most projections.<sup>62</sup>

Indeed, one SOUTHCOM representative noted in a recent speech that several of its AOR’s top challenges include “climate, energy, water, and food.”<sup>63</sup> And as described in SOUTHCOM’s most recent Posture Statement, its challenges “include a broad and growing spectrum of public security threats, the possibility of natural and man-made disasters, and an emerging class of issues, such as those relating to the environment.”<sup>64</sup>

The effects of climate change are likely to manifest in several ways for SOUTHCOM. Since climate change is likely to increase the severity and frequency of major weather events, several SOUTHCOM officials noted that these issues can also drive missions such as Humanitarian Assistance/Disaster Relief (HA/DR). Natural disasters in already unstable regions, combined with broader environmental and resource pressures, may combine with more traditional national security threats. For instance, they may

increasingly trigger population displacement and migration, which could further complicate efforts to control cross-border illicit activities such as smuggling. Many gangs and illicit networks involved in narcotics trade and other criminal activities are also involved with oil theft and sabotage of infrastructure related to resources trade within SOUTHCOM's AOR.

Moreover, since SOUTHCOM presently has no interstate wars within its AOR, in recent years, SOUTHCOM has focused on soft power and engagement in order to enable stability the region and contribute to positive relationships with the United States. Addressing the effects of climate change in its AOR could provide SOUTHCOM with opportunities to strengthen this focus, given that SOUTHCOM's engagement with countries in its AOR already centers often on issues related to natural resources and science and technology collaboration. To address the negative consequences of climate change, SOUTHCOM and its partner countries can plan jointly for environmental change. Joint research and data collection can provide good opportunities for positive international cooperation, and U.S., Central American and South American militaries can learn from one another's scientific and information gathering capabilities in order to better advance the abilities of all countries to plan for potential effects of climate change. The USNS Henson, for example, recently engaged with a team of Brazilian Navy sailors to share oceanographic and bathymetric survey methods.<sup>65</sup> Finally, they can collect data on which areas are prone to different types of natural disasters, mudslides and flooding. In addition, SOUTHCOM has begun to invest in renewable energy production near its headquarters and within its AOR, including solar and biodiesel projects in Honduras and the Dominican Republic.

**Recommendations for SOUTHCOM:** In addition to continuing this kind of science and

technology engagement, SOUTHCOM should also identify which climate change effects could influence the challenges already identified in its unclassified strategy document, United States Southern Command Strategy 2018, and apply that analysis to its Theater Campaign Plan (TCP). In addition to identifying climate change effects that might lead to HA/DR missions, planners could identify areas in Central America that may require improved irrigation in the event of drought and work with partners in the development community to minimize negative repercussions of drought before they transpire. They might also identify port facilities in the AOR that require upgrading or reinforcement before damage from flooding or storm surges occurs. Such planning could then be used to develop the Prioritized Required Capabilities List in the TCP. Doing so will enhance SOUTHCOM's ability to develop solutions to the very real challenges of this region.

### U.S. Northern Command

Climate projections for the NORTHCOM AOR seem particularly complicated, with different models and projection scenarios showing wide variation. This could be a result of having better data for North America, as descriptions of how various climate dynamics will interact (e.g., how precipitation, evaporation, temperature change and El Niño effects will combine) seem to contain greater detail than for many other regions. Whatever its cause, climate projections for the NORTHCOM AOR seem to spark greater debate within the science community than other regions. For example:

- “Projections of El Niño-La Niña frequency and intensity remain a challenge for even the best climate models, and projecting how changes in either might influence fires in Southern California or climate hazards linked to El Niño-La Niña is highly uncertain.”

### U.S. Northern Command Quick Facts (NORTHCOM)

- **Headquarters in Colorado Springs, Colo.**
- **Co-located with the North American Aerospace Defense Command (NORAD), which monitors and controls the airspace over the United States and Canada.**
- **AOR includes the continental United States, Alaska, Canada, Mexico and the surrounding water out to approximately 500 nautical miles. It also includes the Gulf of Mexico, the Straits of Florida and portions of the Caribbean region to include The Bahamas, Puerto Rico, and the U.S. Virgin Islands.**
- **The commander of USNORTHCOM is responsible for theater security cooperation with Canada, Mexico and The Bahamas.**

- “Amid much discussion and controversy, there is a growing consensus that future hurricanes will be more intense with higher peak wind speeds and more heavy precipitation. There is little or no consensus on whether the frequency of hurricanes will increase.”<sup>66</sup>

NORTHCOM’s role in responding to these challenges is still taking shape. NORTHCOM operations have continued to evolve since its founding a little more than one year after the September 11, 2001 attacks. NORTHCOM provides “assistance in support of civil authorities

during natural and man-made disasters and pandemic events” when directed by either the secretary of defense or the president. NORTHCOM is unique among the regional combatant commands in that its operations within its AOR are constrained by the provisions of the Posse Comitatus Act in Title 18, U.S. Code. Given its atypical *raison d’être* and the current state of climate projections for its AOR, it is reasonable that NORTHCOM is focusing much attention on observed climatic changes as much as future projections. These are most prominent in the Arctic, where current observed changes in weather patterns are providing a sufficient level of information against which to plan.

Many NORTHCOM officials expect to see more areas with ice-free summers along a 20- to 40-year timeframe, based on the average of projections publicly available. This has important implications for NORTHCOM’s planning for its homeland defense roles. NORTHCOM must be prepared for the possibility that an opening Arctic may create a new route to enter U.S. territory for illicit transport interdiction and nonproliferation. Improving domain awareness and Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) will be important tasks given that these capabilities can be ineffective at high latitudes, and their command and control structure will need to comply with a range of treaties and constraints.

The effects of environmental change are also raising tough questions. Specifically, pollution and oil spills that could affect the territories of multiple countries will be a heightened concern as new areas are accessed for energy and minerals exploration. Migrating resources are also a growing concern, specifically the fish stocks that account for around 2 billion dollars in exports for Alaska.<sup>67</sup> Changing ocean conditions are altering where fish are breeding and moving, which in

turn can lead fishers from various countries into the EEZs of other countries, creating new concerns for managing U.S. territory. For example, according to a report by the USGCRP, “As air and water temperatures rise, marine species are moving northward, affecting fisheries, ecosystems, and coastal communities that depend on the food source.”<sup>68</sup> According to the report, observed fish stocks near Alaska moved, on average, 19 miles north of their original habitat between 1982 and 2006, sometimes moving outside America’s EEZ. “We think, depending on the year and conditions, that roughly 10 to 20% of the [Alaskan fish] stock goes over to the Russian side,” one National Marine Fisheries Service scientist told *The Los Angeles Times*.<sup>69</sup>

In the United States, coastal port communities could be particularly affected by sea level rise. In fact, if observed trends continue unabated, more than 12.5 million people and 9 trillion dollars in assets could be at risk of sea level rise by 2070. Of the most at risk areas, major port cities such as Baltimore; Boston; Los Angeles; Miami; New Orleans; New York-Newark; Providence, R.I.; Tampa Bay-St. Petersburg, Fla.; and Virginia Beach, Va. are likely to be affected the worst. Today’s observations suggest that approximately 6.1 million people in these communities are at risk from sea level rise. That number is projected to nearly double to 11.8 million at risk from sea level rise. Meanwhile, Canada will experience similar effects, with 6.5 million people and 337.8 million dollars in assets that could be vulnerable to rising sea level by 2070.<sup>70</sup>

Several effects of climate change are likely in NORTHCOM’s AOR. Mexico’s most vulnerable area is the center of the country, with major increases in population growth and decreasing water supplies already affecting Mexico City and surrounding areas. Its Tabasco coast is highly vulnerable to sea level rise with the prospect of dramatic inland sea penetration.<sup>71</sup> While states

within NORTHCOM’s AOR are considered “stable” on the Failed States Index, Mexico is categorized as “borderline.” According to the index, “[c]orruption and lack of transparency continue within the government. Drug cartels and organized crime are also on the rise and hundreds of police, soldiers and prosecutors have been killed.”<sup>72</sup> These trends appear to exacerbate the government’s illegitimacy, including its inability to provide security and social services. And given the recent spate of incidents associated with Mexico’s endemic drug cartels and the declining oil production, which accounts for 40 percent of the government’s revenue, it is possible that the next iteration of the Failed States Index could rank Mexico as “in danger” of state failure.

**Recommendation for NORTHCOM:**

NORTHCOM possesses a well-developed understanding of how climate change directly affects interests in the Arctic. It should place the same emphasis on understanding the potential impacts of climate change in Mexico and its interests in the Caribbean. The Caribbean and several areas of Mexico have witnessed decreasing rainfall in recent decades, a trend that projections indicate will continue. Water scarcity and a rapidly increasing population can present many security challenges that will affect Mexico’s ability to deal with an increasingly difficult security situation in the country and along the border with the United States. This and other changes in the climate have the potential to alter agricultural output by geographical region, which could drive up food prices, among other effects. The Caribbean islands are vulnerable to sea level rise and extreme weather events, and coral reefs in the region that drive an estimated 3.1 billion dollars to 4.6 billion dollars in tourism could suffer.<sup>73</sup> NORTHCOM’s success in managing future climate change effects will require a stronger recognition of changes in its AOR beyond just the Arctic.

## Recommendations

Several observations emerged through the course of our research and meetings with representatives of the unified combatant commands.

**Improve Stewardship of the Arctic.** The United States must clearly define its own roles and responsibilities in governance, diplomacy and security. We make the following three recommendations for that purpose.

**Ratify the UN Convention on the Law of the Sea.** Ratifying UNCLOS is perhaps the most important next policy step in ensuring that the United States and DOD are prepared to adapt to a changing climate and realize the opportunities that climate change may enable. As the participants in the 2008 Arctic Oceans Conference in Ilulissat, Greenland declared, UNCLOS is the international “legal framework to the orderly settlement of any possible overlapping claims” in the Arctic Ocean.<sup>74</sup> UNCLOS provides effective processes for delineation of the limits of the extended continental shelf, and delineates the freedom of navigation rules that the United States abides to today. Without ratification of UNCLOS, the United States will not have a seat at the table as recommendations are made regarding continental shelf claims in the Arctic.

**Participate in the Arctic Council.** At the national level, the United States must continue to use the Arctic Council as a forum for adjudicating grievances and conflicts, given that the Arctic Council is the only formal body outside of UNCLOS charged with facilitating cooperation, coordination and engagement between Arctic member states over development and environmental issues in the region. What is more, even with the ratification of UNCLOS, the United States would be able to use the Arctic Council to

sustain engagement with its Arctic neighbors and to adjudicate immediate issues, such as coordinating short-term crises that may develop and require an immediate response (e.g., search and rescue operations).

**Establish NORTHCOM as the supported commander in the Arctic region.** United States territorial waters and the resources within its EEZ already lie within NORTHCOM’s AOR. Also, given that NORTHCOM already coordinates closely with Canada over a number of combined operations such as theatre security cooperation, countering weapons of mass destruction and narcotics trafficking, aerospace control and maritime warning, the command has a unique and well-developed working relationship with Canada that would help navigate issues over Arctic cooperation while insulating it from political conflicts with other states (e.g., Russia) that fall outside its AOR. NORTHCOM’s unique role in governance of its AOR (versus roles that are primarily offensive in nature) could indicate that its expertise is better suited for command and control in the Arctic than EUCOM or PACOM. While it is unclear how the process of creating a comprehensive framework for the Arctic will play out, it is clear that it will take time to explore policy options, and require unity of effort from DOD. Finally, a civilian-led command akin to NORTHCOM would help to unify diplomatic, development and public engagement efforts with other Arctic states’ civilian agencies.<sup>75</sup>

Beyond the Arctic, the effects of climate change require further adjustments from all of the combatant commands as well. While each combatant commander’s AOR and missions are unique, there are likely to be common challenges to better incorporating climate science into their work. The following recommendations may facilitate the integration of climate change analysis into the commander’s decision making processes.

***Develop Climate Expertise in the COCOMs:***

Respecting the combatant commanders' roles in organizing their staffs, we recommend that combatant commanders each designate an action officer for addressing climate change impacts in planning and operations. Upon studying each combatant command, we feel the best location for this expertise is within the Strategy and Plans (J5) directorate, but most planning scenarios will require assistance and coordination from most, if not all, of the other directorates and command level staff.

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*No single source of information will ever suffice to cover what any given combatant commander needs to know about climate change. It is a global challenge that touches upon almost all aspects of security in some way.*

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In the course of our research, we observed that, across the combatant commands, there is no single point of contact within each staff for issues related to climate change, and that in some cases there is no person dedicated to look at these issues. Because climate change affects each combatant commander's AOR differently and because staff organizations are tailored to each commander's needs, there is no well-defined directorate in which to place

staff knowledgeable about climate change.

Directorates from logistics to resources to strategy and plans to the interagency may all have a need to address the secondary and tertiary impacts of climate change in the course of their work. During the staffing process for developing and reviewing the QDR, the points of contact for climate change issues could be found in any one or more of the directorates, most likely at the discretion of the staff's secretariat, who decides which directorate to assign formal tasks. When not well-defined, the decision of where in the staff to assign such formal staff tasking, or even whether this expertise is necessary, depends on the combatant commander's mission and operational environment.

***Access the Best Climate Science.*** We recommend that as often as possible, combatant command staff officers who need specific climate projections or information should seek answers from the climate science community. These relationships are important to accurately assess risks and avoid wrong information. And even where single sources of information provide the best data available, representatives from the climate science community can identify these best sources rather than leaving that responsibility up to DOD personnel.

In our conversations with field-grade staff officers, we observed that staff officers most often received their initial information about climate change for planning purposes from the U.S. Joint Forces Command's Joint Operating Environment (JOE) document series. The JOE serves to sketch the future strategic environment and anticipate possible threats and challenges that unified combatant commanders may face. Some of the more enterprising staff officers we spoke with used the JOE as a starting point for discussion and research and additionally looked to a myriad of other sources for scientific data and regional observations on climate change.



Their drive to seek out better data, however, did not stem from the need to understand climate change in and of itself, but rather to use the data for informing a specific theater-level mission planning initiative, scenario or decision.<sup>76</sup>

No single source of information will ever suffice to cover what any given combatant commander needs to know about climate change. It is a global challenge that touches upon almost all aspects of security in some way. Furthermore, it involves the full range of strategic, operational and tactical issues. No matter how good their content – or their critical importance in setting priorities for the DOD – documents like the QDR and the JOE should never be treated as primary sources for all climate change information. Global assessments such as the Intergovernmental Panel on Climate Change’s assessment reports and information provided by the USGCRP provide decent basic climate understanding. Depending on the region in question, sources from the World Bank, USAID, nongovernmental organizations or other groups can often provide useful local-level observations on how climatic changes are affecting specific communities. Science journals and reports from the National Academies of Science and Engineering are often useful as well. Finally, a forthcoming Naval Studies Board assessment will offer detailed assessments of how the DOD is prepared to accommodate a range of likely climate change effects.

In addition to the challenges involved with finding the best information for the types of decisions the combatant commanders need to make, we observed that in almost all cases, understanding, addressing and adapting to climate change impacts and energy security challenges requires an interagency approach. Analysts often point to PACOM as a test bed for examining hurdles to operational energy challenges and for systems-level alternative energy

integration, due to its unique energy and environmental challenges and its location so far away from the mainland.<sup>77</sup> While we concur with that assessment, the most important lessons from PACOM with regard to DOD addressing climate change could involve its structured and well-coordinated efforts to work with other federal agencies and state and local groups to meet energy and climate goals. Indeed, the QDR states that the kind of interagency cooperation exhibited at PACOM will be vital for addressing climate and energy issues for the department.

However, while these all serve as good information sources, they are still static. Collaboration between security officials and climate scientists offers one of the most helpful methods of researching this problem, as scientists can then work to provide the most helpful information and generate new observations that can be more tailored.

***Share Best Practices and Measure Success.*** We recommend that the combatant commanders leverage already-established ad hoc, casual or formal organizations that examine energy or environmental challenges, such as the Hawaii Clean Energy Initiative in Hawaii, as a forum for sharing best practices on meeting energy and climate requirements and goals. The Department of Defense (and potentially DOE or the White House Office of Energy and Climate Change Policy) should also aggregate these best practices at the federal level.

Many installations we visited while meeting with combatant command representatives are also beginning to experience some of the challenges and opportunities that the DOD faces regarding quantifying greenhouse gas emissions reductions. While touring a new Army base housing development in Hawaii, for example, we witnessed electricity metering equipment that calculated and stated the greenhouse gas emissions commensurate with the electricity

being used at that home. Aggregating this kind of information consistently across the country and across the military services is an important key to system-level planning, and the combatant commands offer a way for cross-service coordination to occur organically, particularly if the proper structures are in place for doing so. As the military components of several combatant commands are making progress on energy and climate measures, they are overcoming hurdles and developing best practices that would likely be useful information for other military installations. Maximizing effective use of contracting authorities and combining funding streams in order to invest in new energy technologies can take detailed knowledge and great effort. And even with the installation of clean energy technology, system-level questions can remain. For example, the hydrogen and E85 vehicles at Hickam Air Force Base in Hawaii would require more fueling infrastructure and fuel in order to increase their use. Steep challenges can also remain in integrating transport, residential and other energy use into a single, functioning system – especially in locations that suffer from fragile electric grids.

### Conclusion

The combatant commands have a unique role in analyzing how climate change will affect the DOD and responding to these challenges. While much of the expertise on climate change resides within civilian agencies of government, understanding how climate change can combine with other factors to influence trends or ignite conflicts within each AOR will be important to the combatant commander's success in achieving assigned objectives. Addressing climate change challenges can also be leveraged for building confidence and partnerships among countries that share common interests in any AOR. For example, one PACOM official noted that many Navy and PACOM successes in furthering

cooperation with Southeast Asian countries have stemmed from partnering with them on science and technology development, such as tsunami early warning systems.

Given the likely effects of climate change in each of their AORs, better assessing and planning for projected effects will also bolster their long-term abilities to meet their responsibilities around the world. A thorough analysis of climate change effects in each AOR and how these effects impact the populations within the AOR can help the combatant commander develop better long-term theater level plans. This is not, however, simply a question of deciding to include climate change analysis in planning. It is a matter of educating planners to see the links between climate science and current and future threats. As we see in several locations around the globe, climate change already distinctly impacts the operating environment and affects the security environment. Their positions on the front lines of promoting and defending U.S. interests globally likewise puts each combatant command on the front line of confronting the challenges of climate change.

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77. A forthcoming (Autumn 2010) CNAS report will more directly focus on DOD and national energy challenges.



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A P R I L 2 0 1 0

**Broadening Horizons:**  
*Climate Change and the U.S. Armed Forces*





## APPENDIX A: CLIMATE CHANGE AND THE QDR

By Christine Parthemore and Will Rogers

*CNAS formally launched this project in June 2009, with an off-the-record roundtable discussion on the implications of global climate change for national security. The focus of the discussion was how the Department of Defense planned to consider the effects of climate change in the 2010 Quadrennial Defense Review, as required by the 2008 National Defense Authorization Act. The working paper CNAS published following that discussion (contained in this appendix) served as an analytical starting point for this entire volume.*

When the Quadrennial Defense Review (QDR) is sent to Congress on February 1st, it will offer an unusual opportunity to shift how the national security community views climate change. Congress required in the 2008 National Defense Authorization Act (NDAA) that the Department of Defense (DOD) consider the effects of climate change on all of its “facilities, capabilities and missions,” and, perhaps most notably, it called for the Department to incorporate such concerns into the next QDR.

The QDR is an important analytical tool for the Department, intended to shape programs, plans and budgets for the nation’s defense. Adding such a specific requirement was a potentially significant step in advancing understanding of how climate change could affect the U.S. military’s operating and strategic environments, and, more broadly, the future security environment. However, given the relative paucity of research about the security implications of climate change, it was by no means obvious how the Department of Defense would meet this legislative requirement or what the implications would be for DOD priorities, budgets, policies and practices.

In June 2009, the Center for a New American Security (CNAS) launched its this project with an off-the-record event to discuss climate change and its effects on U.S. security and the QDR process. Throughout this project, CNAS researchers sought to examine how the Department of Defense has been meeting the challenge of integrating climate change into the QDR, as well as to engage in subject matter exchanges with the national security community. This overview working paper and forthcoming CNAS working papers on the implications for maritime, ground and air missions and for the Combatant Commands reflect extensive staff research and dozens of personal interviews with DOD officials.

In the following pages, we provide observations about how the QDR process addressed the 2008 NDAA requirement and some potential outcomes of that process. We hope that this background contributes to what Deputy Under Secretary of Defense for Strategy, Plans and Forces Kathleen Hicks described to the Senate as “a sea change in the understanding of the interrelationship between climate change and energy and their impact on national security.”<sup>1</sup>

### The Process

How the security implications of climate change are treated in the 2010 QDR is likely to represent a significant step forward, and it is therefore important to understand the precedents set by previous strategy documents and reviews, and the backdrop of various attitudes about climate change within the national security community. Based on DOD leadership statements and such efforts as the U.S. Navy’s Task Force Climate Change and wargaming conducted by the Office of the Secretary of Defense, it is fair to say that the Department of Defense now considers climate change to be a legitimate national security concern. Secretary Gates and numerous other defense leaders (including the commander in chief) have explicitly mentioned that climate change will be a factor to consider in the future security environment.<sup>2</sup>

**It is worth noting, however, that the military services were uneven in their input to the QDR process on climate change and vary in their level of attention to this issue.** The ground forces (U.S. Army and U.S. Marine Corps) do not appear to have devoted extensive analysis to climate change, which is indeed understandable and not unexpected given their need to fight and succeed in two ongoing ground wars and to navigate major shifts in their understanding of the likely nature of future warfare. The U.S. Navy, on the other hand, has thoroughly integrated climate change into its QDR considerations and contributed important

### ABOUT THE QDR

The Quadrennial Defense Review (QDR), a strategic planning exercise required by Congress, is intended to close the gap between vision and reality for the Department of Defense, delineating the “policies, capabilities and initiatives”<sup>7</sup> needed for the nation’s defense over a 20-year time horizon. The QDR was first established to provide a more systematic review of defense priorities immediately after the end of the Cold War; Congress later formalized in law the requirement to conduct the process.<sup>8</sup> The Office of the Secretary of Defense leads the QDR process and the drafting of the report, but the Joint Staff is largely responsible for collecting data and inputs from the various military services, Combatant Commands and defense agencies.<sup>9</sup> Generally, the Department of Defense is highly dependent on Congress to resource and execute the recommendations of the QDR, particularly when there are budget allocations involved. In the past, the QDR has proven to be a useful tool, and is in fact being replicated this year by the Departments of State and Homeland Security.<sup>10</sup>

analysis to the process. And although the U.S. Air Force has long focused on questions of energy security, it does not appear to have engaged extensively yet on climate change as a security issue given its larger-level strategic reevaluations of the past year.<sup>3</sup>

Consideration of climate change in most strategy documents preceding the 2010 QDR process is logical, albeit perfunctory and not always well integrated. The National Defense Strategy (July 2008) delineated a future in which U.S. interests will be shaped by *threats* and *trends*. Generally speaking, “threats” tend to be characterized as challenges with agency (i.e., an actor behind them with intent to harm the United States, our interests or our allies). The latter “trends” category is a catch-all for factors that will shape or drive global security, from pandemic flu to demographic change to climate change. In a way, the National

Defense Strategy identifies complexity and uncertainty as key characteristics of the global security environment. Most service-level assessments are consistent with this characterization, although the actual language differs. The U.S. Army, for example, describes the future security environment as “an era of persistent conflict.”<sup>4</sup> A notable outlier is the November 2008 Joint Operating Environment (JOE), which outlined a similar construct but stated incorrectly that the science about the causes of climate change is “contradictory.”<sup>5</sup> (While this is often true with regard to future *effects*, the science on the *causes* of climate change enjoys a widespread global consensus, including as the official U.S. government position, with relatively few outliers.<sup>6</sup>)

Questions about whether there is strong enough scientific evidence of anthropogenic climate change to warrant DOD attention— and whether those changes will truly constitute a threat to the nation’s security even if there is sufficient scientific evidence — are not unique to the 2008 JOE. In fact, it reflects a lingering skepticism that CNAS researchers encountered in numerous meetings with and information from military and civilian defense professionals. For example, a defense contractor involved in drafting DOD strategy documents, writing on a listserv in December 2008, noted that “those who are actually interested in the facts and real science stopped worrying about this problem some time ago.” In response, a DOD official wrote: “Facts do not bear out the redundant claims that global warming is happening. This is increasingly shrill and pedantic. Moreover, it’s becoming boring.”<sup>11</sup>

This skepticism may be rooted in the fact that climate science is complicated and technological advancements have a dynamic effect on scientific understanding. Wading through the shifting narrative of what scientists actually observe and can credibly project can be a challenge. As our own experiences have shown and as our conversations

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*It is fair to say that the Department of Defense now considers climate change to be a legitimate national security concern.*

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with DOD, intelligence community, State Department and other officials have affirmed, there is a serious problem of “translation” between the science and policy communities (as a forthcoming CNAS report will discuss<sup>12</sup>).

One practical consequence of this lack of good communication is that the national security community has a deficit of “actionable” data, or data that can be used for planning purposes or to guide policy responses. There is insufficient credible research tying together observations and projections about climate change with other social science trends (such as demographics and poor governance) and delineating how this will affect U.S. and global security. Officials working to increase the depth of understanding of the implications of climate change for the global security environment have been conducting original research and constructing cutting-edge studies of the climate and security nexus for the QDR process (as well as for further strategic planning) using the best data that is available today, with an understanding that projections continue to progress. And even while the U.S. military may lack enough specific information to understand exactly where and when climate change is likely to mean more missions or affect military operations and installations, there is sufficient information to develop a realistic understanding of the risks.

## IMPLICATIONS OF CLIMATE CHANGE FOR DOD

Climate change effects will range from drier conditions in some parts of the world, wetter conditions in other parts, warmer temperatures, sea level rise, melting ice on land and at sea and perhaps more frequent and more intense storms. Given that the U.S. military is a globally deployed force, it will have to adjust to new operating conditions for its ships, aircraft, vehicles and personnel.

Some of these changes could severely affect military installations. According to a groundbreaking 2007 CNA report, even modest increases in sea level rise and extreme weather are likely to flood military installations on low-lying islands and atolls such as Diego Garcia and Guam, and even U.S. bases such as those located around Norfolk, Virginia.<sup>13</sup> There are other potential effects on installations as well. For example, Camp Pendleton, a large Marine Corps base near San Diego, has been taking measures to adapt to more frequent wildfires in the area, which scientists attribute in part to climate change.<sup>14</sup> The U.S. military is likely to be able to adjust to all of these climate-related changes in the operating environment, but at some expense – and most likely at greater expense if the changes are not anticipated (i.e., it is generally more cost effective to invest in flood control measures than to mount rescue and clean up operations in response to more frequent flooding).

Also, as a major consumer of fossil fuels and generator of greenhouse gas emissions, the Department of Defense has a role in reducing national energy consumption and emissions, and in some cases (in many facilities, for example)



U.S. Navy SEALs assist flood victims in Manila after Tropical Storm Ketsana in September 2009.  
(MASS COMMUNICATION SPECIALIST 2ND CLASS WILLIAM RAMSEY/ U.S. Navy)

is required to do so by law and/or regulation. For example, Executive Order 13514, signed by President Obama on October 5, 2009, requires the Department of Defense and other federal agencies to set ambitious greenhouse gas emissions reduction targets and measure their progress. Such changes have the potential to affect military operations, including in ways that may be positive. Fuel convoys, for example, are vulnerable to attack and require combat troops for protection in current conflicts; reducing the number of convoys could reduce casualties and allow forces to be deployed for other missions.<sup>15</sup>

Most climate change projections suggest that there will be an increase in demand for humanitarian and disaster contingencies in the United States and abroad, and the United States is likely to continue to be the nation with the most robust capacity to respond

to complex or multiple disasters. The increase in demand for these types of military missions is likely to extend to more traditional “hard security” missions, as well. To describe how these missions might come about, DOD officials involved in the QDR have been using the term “instability accelerant.” In this definition, climate change is a factor that interacts with other trends, principally weak governance, poor economies and population growth, to drive states toward instability – which can, in turn, spawn a range of security challenges. In her October 2009 Senate testimony, Deputy Under Secretary of Defense Kathleen Hicks stated that climate change is “a stress that has the potential to accelerate state failure in some cases, and may also lead to the spread of insurgency as weak governments fail to cope with its effects.”<sup>16</sup>

## The Outcome

**The 2010 QDR will reflect the priorities of the current administration – and most likely preview the National Security Strategy.** Ideally, all DOD strategy documents rest on a foundation set by the president, perhaps most importantly as expressed in the National Security Strategy. The 2010 QDR (along with several other defense, foreign policy and homeland security strategy documents) will come out in advance of a public iteration of President Obama’s vision of national security.

The broad outlines of those priorities, and what is likely to be in the next National Security Strategy, can be inferred from President Obama’s public remarks to date. In a December 1, 2009 speech at West Point, President Obama described the global security environment as one “unlike the great power conflicts and clear lines of division that defined the 20<sup>th</sup> century” and characterized by “disorderly regions, failed states, diffuse enemies.”<sup>17</sup> In past speeches, he has described U.S. security in this more chaotic world as resting on “four pillars”: nonproliferation and disarmament; the promotion of peace and security; the preservation of the planet; and global economic prosperity.<sup>18</sup> President Obama has also emphasized the need for greater international cooperation, and in his December 2009 speech, he focused on the application of American power through non-military instruments (such as diplomacy, development and values). In the same speech, the President highlighted the need to restore “balance,” especially between domestic and foreign policy priorities. Given these statements, it is very likely that President Obama’s National Security Strategy will describe a more complicated national security environment, characterized by non-traditional threats and responses, with climate change explicitly identified in that context. The QDR’s treatment of climate change can therefore be considered akin to a statement of intent for the National Security Strategy.

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*It is very likely that President Obama’s National Security Strategy will describe a more complicated national security environment, characterized by non-traditional threats and responses, with climate change explicitly identified in that context.*

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**The 2010 QDR is very likely to have the effect of building upon and strengthening previous efforts to integrate climate change into security considerations.** Though many researchers (both inside and outside of government) have considered a wide range of the security consequences of climate change and conducted several good in-depth studies,<sup>19</sup> the U.S. government has not yet produced a single, definitive public assessment that is widely accepted as a factual baseline. However, based on our interactions with the primary drafters of the climate change language for the QDR in the Office of the Secretary of Defense, it is clear that they were ambitious and thorough in culling input from a wide range of experts and stakeholders, including through a lengthy questionnaire, and were rigorous in comparing and combining previous research on climate change and security. Reviewers of early drafts of the QDR report indicate that it includes robust language from that research effort.

**The research effort behind the QDR has been signaling a strong demand for more of the kind of data the security community needs for planning purposes. This in itself is a significant advancement.** By meeting the requirement to include climate change in its strategic planning documents, the Department has signaled that it needs better climate change-related data for planning purposes. If the QDR process indeed marks a shift to more regular and in-depth consideration of climate change in planning and strategy, the Department of Defense's sustained demand signal for actionable data could drive useful advances in our understanding of this global challenge.

**The 2010 QDR is likely to mark another shift from the past by explicitly linking energy and climate change as related security concerns.** The Department of Defense has generally considered energy security and climate change as separate issues (when the latter is considered at all). In general, the Department has focused more on energy security, given that there are more pressing concerns in this area related to current missions and escalating fuel costs. In some cases, such as in the U.S. Air Force's investment in coal-to-liquid fuels during the Bush administration, assuring affordable energy supplies took precedence over contributions of climate-changing emissions.

**The QDR process, as a concerted effort to understand what climate change could mean for the Department of Defense, has clarified that responding to climate change is not primarily a DOD mission.** Although the Department has a legitimate and important role to play in cutting greenhouse gas emissions, promoting global resilience to assist other nations in adapting to projected climate changes and responding to climate change-related contingencies at home and abroad, DOD should not be considered the lead agency, by any means. Civilian agencies, including the Departments of State, Homeland Security and Energy should take the lead role. (For an overview

of how climate change could affect the Department of Defense, see the text box "Implications of Climate Change for DOD.")

**Finally, the legislative requirement for the QDR has had a positive, unintended consequence.**

In order to comply with the law, the Office of the Secretary of Defense, the Joint Staff and the military services have all had to designate officials to study climate change, which has effectively created a new, nascent intellectual infrastructure of military and civilian officials who are well informed about the security consequences of climate change. In many cases, these are seasoned professionals with broad responsibilities for strategy, programs and budget planning. This intellectual infrastructure may well ensure that the study of the implications of climate change is institutionalized, keeping climate change fresh in the minds of DOD senior leadership. It is part of the "sea change" described by Deputy Under Secretary Hicks, and it will help to solidify this QDR's place in marking a turning point in the study of the national security implications of climate change.

### Conclusion

The 2010 Quadrennial Defense Review will be an important bellwether for how the Defense Department views the present and future security environment – and how climate change considerations fit into that assessment. Having a solid analysis of the security implications of climate change will be useful in itself, but it will also point to a need for further action. One of the most consistent critiques of the QDR process since its inception has been the mismatch between the analysis of the security threats and opportunities and the programmatic follow through, specifically through funding in subsequent defense authorizations and appropriations.<sup>20</sup>

However, we are confident that the rigor of DOD's process in meeting the 2008 NDAA requirement for considering this issue, and early indications of

the outcomes of that process, show that the QDR is only the beginning. As forthcoming CNAS working papers on climate change and maritime, ground and air missions will show, the verbiage of the QDR and the networks created by its process are growing more meaningful as climate change is more often incorporated into defense planning scenarios, wargaming, programming, planning and budgeting, particularly in the military services and the Combatant Commands.

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2. See for example: "I don't think I have to emphasize that climate change is one of the defining challenges of our time. The science is clear and conclusive, and the impacts can no longer be ignored. Ice sheets are melting. Sea levels are rising. Our oceans are becoming more acidic. And we've already seen its effects on weather patterns, our food and water sources, our health and our habitats. Every nation on this planet is at risk, and just as no one nation is responsible for climate change, no one nation can address it alone." President Barack Obama, "Remarks by the President on Major Economies Forum Declaration" (9 July 2009); and "As was the case at that time, the country is again trying to come to terms with new threats to national security. Rather than one, single entity – the Soviet Union – and one, single animating ideology – communism – we are instead facing challenges from multiple sources: a new, more malignant form of terrorism inspired by jihadist extremism, ethnic strife, disease, poverty, climate change, failed and failing states, resurgent powers, and so on. The contours of the international arena are much more complex than at any time during the Cold War. This stark reality – driven home in the years since September 11th – has led to a renewed focus on the overall structure and readiness of our government to deal with the threats of the 21st century." Secretary of Defense Robert Gates, "Speech to the Association of American Universities" (18 April 2008).
3. Forthcoming (Spring 2010) policy briefs on climate change and maritime, air and ground missions will provide more depth on this observation.
4. Submitted by Honorable Pete Geren and General George W. Casey, Jr., "A Statement on the Posture of the United States Army 2009" (May 2009): 1-2.
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17. President Barack Obama, "Address to the Nation on the Way Forward in Afghanistan and Pakistan" (1 December 2009).
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19. For example, see the National Intelligence Council's series, "The Impact of Climate Change to 2030: Commissioned Research and Conference Reports," (2009); and Sharon Burke, Jay Gullledge, Michael Horowitz, Christine Parthemore and Nirav Patel, "Uncharted Waters: The U.S. Navy and Navigating Climate Change" (Washington, DC: Center for a New American Security, 30 March 2009).
20. Jeffrey D. Brake, "Quadrennial Defense Review (QDR): Background, Process, and Issues," Congressional Research Service (21 June 2001): 6.



## APPENDIX B THAWING ARCTIC ASSETS

By Daniel Saraceno

The Arctic region features the sovereign claims of eight countries: Canada; Denmark (Greenland); Finland; Iceland; Norway; Russia; Sweden and the United States. If trends of melting Arctic ice continue, it will open up access to an array of resources. Estimates indicate that these resources include:

- 412.16 billion barrels of undiscovered oil and gas resources, representing 22 percent of the world's undiscovered oil and gas reserves.<sup>1</sup>
- Mineral deposits, potentially worth over 1 trillion dollars<sup>2</sup> (including, zinc, nickel, palladium, precious stones and other various minerals).
- The largest fish stock for human consumption in the world (Alaskan Pollack).
- Arctic Sea provides 50 percent of wild fish for human consumption in the United States.<sup>3</sup>

It is worth noting how these resources are distributed by region:

- Russia stands to obtain one-third of the planet's undiscovered natural gas resources, serving to reinforce, and potentially expand, its role as a global energy superpower.<sup>4</sup>
- North American territories account for an estimated 65 percent of undiscovered oil in the Arctic.
- However, only about 26 percent of undiscovered natural gas deposits are in estimated to be in North American territory.
- The Eurasian region holds a majority of potential natural gas reserves and only minimal oil deposits.

The Arctic has 33 different sedimentary provinces capable of resource recovery as determined by the U.S. Geological Survey. According to the U.S. Energy Information Administration:

“The three largest Arctic provinces account for 65 percent of the total Arctic oil and natural gas

Figure 1. Regional Concentration of Arctic Oil and Natural Gas Resources

Region	Crude Oil (billion barrels)	Natural Gas (trillion ft <sup>3</sup> )	Natural Gas Liquids (billion barrels)	Total Resources Oil Equivalent (billion barrels)
Eurasia	30.70 (34.1 percent)	1219.39 (73.1 percent)	27.55 (62.5 percent)	261.49 (63.4 percent)
North America	58.09 (64.6 percent)	435.40 (26.1 percent)	16.20 (36.8 percent)	146.85 (35.6 percent)
Indeterminate	1.20 (1.3 percent)	13.87 (0.8 percent)	0.31 (0.7 percent)	3.82 (0.9 percent)
Total	89.98 billion barrels	1668.66 trillion ft <sup>3</sup>	44.06 billion barrels	412.16 billion barrels

Source: U.S. Energy Information Administration, *Arctic Oil and Natural Gas Potential* (16 October 2009): 7.

resources, and the largest ten oil and natural gas provinces account for 93 percent of the total. The remaining 15 provinces (out of 25 qualitatively evaluated provinces) are estimated to hold only seven percent of the Arctic resource base.”<sup>5</sup>

Further complicating this picture, of the eight Arctic nations, five (Denmark, Canada, Norway, Russia and the United States) have overlapping economic sovereignty claims, including several unresolved territorial disputes. These disputes include those raised over Russia’s placing of a titanium flag on the Arctic floor,<sup>6</sup> a 40-year-old dispute between Norway and Russia<sup>7</sup> and another between the United States and Canada in the

Beaufort Sea.<sup>8</sup> These indicators point to why the U.S. military considers better governance of the Arctic region an important security question and, according to our recommendations, the importance of establishing a single supported combatant command for the Arctic.

## ENDNOTES

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