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ENSURING RESILIENCY OF MILITARY INSTALLATIONS AND OPERATIONS IN RESPONSE TO CLIMATE CHANGES

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[There were no Questions submitted post hearing.]

ENSURING RESILIENCY OF MILITARY INSTALLATIONS AND OPERATIONS IN RESPONSE TO CLIMATE CHANGES

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE ON READINESS,
Washington, DC, Wednesday, March 13, 2019.

The subcommittee met, pursuant to call, at 2:07 p.m., in room 2118, Rayburn House Office Building, Hon. John Garamendi (chairman of the subcommittee) presiding.

OPENING STATEMENT OF HON. JOHN GARAMENDI, A REPRESENTATIVE FROM CALIFORNIA, CHAIRMAN, SUBCOMMITTEE ON READINESS

Mr. GARAMENDI. Good afternoon, ladies and gentlemen, now that we are in order in the Readiness Subcommittee of the House Armed Services Committee, we are good to go. I want to welcome our committee members.

And the question before us: Is the U.S. military ready for climate change? Recent events indicate considerable doubt. Just this last year, Hurricanes Florence and Michael caused billions of dollars of damage to Camp Lejeune and leveled much of Tyndall Air Force Base in Florida. California wildfires led to the evacuation of family housing at Camp Pendleton, Naval Air Station Mugu, and the Marine Corps Mountain Warfare Training Center in the Sierras.

In addition, our coastal installations and the surrounding communities are already experiencing significant flooding due to sea-level rise. The Army's Ronald Reagan Ballistic Missile Defense Test Site at the Kwajalein Atoll in the South Pacific is threatened by sea-level rise and may not last 20 years. The Navy's principal Atlantic base, Norfolk-Hampton Roads, and the Naval Academy are already experiencing flooding.

Melting polar ice in the Arctic regions has already opened new sea routes and competition for resources. Yet it appears that the Department of Defense has not yet developed a systemic strategy for ensuring U.S. national interests in the Arctic.

The United States military is one of the largest employers in the world. It is also one of the largest energy consumers. The DOD [Department of Defense] owns millions of acres of global real property, including over 550,000 facilities valued at over a trillion dollars, and the Department is uniquely situated to enhance its readiness and resiliency through effective energy policy and programs. Installations are where we generate the force, train and sustain them, and, in many cases, house critical operational missions.

One way to enhance readiness is to consume less. In fiscal year 2017, the Department of Defense consumed over 85 million barrels

of fuel to power ships, aircraft, combat vehicles, and bases. And it cost nearly $8.2 billion. In many cases, though, contract vehicles and energy-saving performance contracts—these energy savings and resiliency-enhancement improvements can be made at no up-front cost to the Department.

In contested environments, better fuel consumption rates extend the range and mitigate the risk related to resupply convoys. Naval vessels are vulnerable during at-sea replenishment. For austere land-based sites in remote locations supporting contingency operations, lower fuel and water consumption rates are an essential readiness enabler, helping the facility to maintain a lower profile.

It is essential that our bases and facilities recover quickly from extreme weather events and energy disruptions that impact mission capabilities.

Section 335 of the fiscal year 2018 National Defense Authorization Act required the Department of Defense to report on the effects of climate change on the Department and proposed mitigation plans. The required report was delivered to Congress in January 2019 and indicated that two-thirds of the 79 installations that were reviewed are vulnerable to flooding, more than half are vulnerable to drought, and about half are vulnerable to wildfires.

Unfortunately, the report did not meet the congressional reporting requirement to describe future-focused mitigation necessary to ensure military resiliency.

To ensure that it can perform its national defense mandate, the Department of Defense must plan for a variety of exigencies. In the 2014 Climate Change Adaptation Roadmap, the Department noted that rising global temperatures, changing precipitation patterns, climbing sea levels, and more extreme weather events will intensify the challenges of global instability and hunger and poverty and conflict. They will likely lead to food and water shortages, pandemic diseases, disputes over refugees and resources, and destruction by natural disasters in regions around the globe.

Not only are these climate-related events impacting installation readiness, they are also creating more frequent requests for the military's support for disaster relief and humanitarian assistance. Both Active Duty service members and National Guard personnel are increasingly responding to assist communities impacted by these events. Think Puerto Rico.

Climate change represents a myriad of readiness challenges both at home and abroad. It is not only a future threat; it is impacting resiliency of our installations and operations today. The Department must act now to address these challenges.

From our witnesses today we hope to learn from their perspective on readiness the impact of climate change and what actions the Department should be taking to address these challenges.

Now, with that, I would like to turn it over to our ranking member, our Rocky Mountain member, Congressman Doug Lamborn, for your remarks.

[The prepared statement of Mr. Garamendi can be found in the Appendix on page 41.]

STATEMENT OF HON. DOUG LAMBORN, A REPRESENTATIVE FROM COLORADO, RANKING MEMBER, SUBCOMMITTEE ON READINESS

Mr. LAMBORN. Thank you, Mr. Chairman.

I applaud the ongoing efforts of the Department of Defense to make installations more resilient and both installations and operations more efficient. But I wish to note from the outset that the Committee on Armed Services is not among the committees of jurisdiction for climate change matters.

I understand that the House majority has directed each of the committee and subcommittee chairmen to have a hearing focused on climate change. However, when national energy policy is debated, this committee's role is to ensure that any emerging policy does not adversely affect military operations—an important but much more narrow issue.

As each of our witnesses have noted and will note in their testimony that we will hear in a minute, many of the Department's 500 installations have experienced the effects of severe weather. The United States Armed Forces must be prepared to operate in adverse conditions.

Further, it behooves us all to conserve resources wherever possible. In the case of military operations, fuel and water are critical commodities that are needed continuously and are difficult to transport.

We depend on our military forces and installations for national security and cannot afford lapses in either. Our forces and our bases must be able to operate in all conditions of conflict and weather. We must take responsible action to make military installations more resilient and responsible action to lighten the logistical burdens on our operational forces.

I emphasize "responsible." By that, I mean measures that enhance resiliency and national security, not arbitrary goals established for other reasons. I raise this concern because, in the past, environmentally based mandates have squandered too much money and effort on greening the military.

Given the small percentage of the Nation's total power usage that DOD represents, placing arbitrary and costly mandates upon the military does not meaningfully affect global climate change, but it does reduce the Department's readiness.

As we seek to enhance the resiliency of bases and reduce the vulnerability of our resource supply chains, I look forward to hearing about potential solutions. But if we diverge from our subcommittee's readiness jurisdiction in order to blame climate change for such things as the negative actions of international terrorist organizations or intergenerational tribal conflicts, I believe it will be a distraction from rebuilding our military's readiness at best or an excuse to pursue boondoggles at worst

Thank you, Mr. Chairman. I look forward to our witnesses' testimony.

[The prepared statement of Mr. Lamborn can be found in the Appendix on page 43.]

Mr. GARAMENDI. Thank you very much, Mr. Lamborn. We will clearly have a discussion in the days ahead, and we will sort all of this out, which is our task.

I want now to introduce our witnesses. I will introduce all of you, and then I think, Mr. Titley, if you will start.

Our first witness is David W. Titley, Rear Admiral, U.S. Navy, retired, professor of practice in meteorology at The Pennsylvania State University, and he is also the director of the Center for Solutions to Weather and Climate Risk.

Joining him on the panel is Sharon Burke, senior advisor, International Security Program and Resource Security Program; and Nicolas Loris, Herbert and Joyce Morgan fellow in energy and environmental policy, Center for Free Markets and Regulatory Reform.

Welcome. Thank you so very much for joining us. Thank you for the written testimony, which I think most of the members have in their file.

And if you will begin, Professor Titley.

STATEMENT OF RADM DAVID W. TITLEY, USN (RET.), PROFESSOR OF PRACTICE IN METEOROLOGY AND DIRECTOR, CENTER FOR SOLUTIONS TO WEATHER AND CLIMATE RISK, THE PENNSYLVANIA STATE UNIVERSITY

Admiral TITLEY. Thank you very much, Chairman Garamendi and Ranking Member Lamborn, distinguished members of the subcommittee, and other members of the Armed Services Committee, for the opportunity to present today.

I am David Titley and currently serve as a founding director for the Center for Solutions to Weather and Climate Risk at The Pennsylvania State University. I retired from the United States Navy in 2012 as the Oceanographer and Navigator of the Navy and Director of U.S. Navy Task Force Climate Change. I serve as an unpaid advisor for several organizations, including the National Academy of Science and the Center for Climate and Security. I am testifying today in my personal capacity.

Let me open with a personal note of thanks to the Congress and especially to the House Armed Services Committee for the addition of forward-thinking climate-related amendments in the markup language for the National Defense Authorization Act in 2018 and again in 2019.

Speaking as one with nearly 35 years' experience in the executive branch, I will tell you it is hugely helpful to have congressional language and intent that encourages the Department of Defense to think in a proactive manner when managing climate risks. These bipartisan actions would not have been possible without significant Republican support, so thank you.

In the Navy, we have a saying: Just give me the bottom line up front, or the BLUF. So here is my BLUF for today's hearing. Adapting for climate change is a readiness issue. It is not a partisan or political issue or a desire to appear green. The Department needs to manage the risks of climate change to ensure its readiness in the years and decades to come.

Two, the extremes of yesterday do not foretell the extremes of tomorrow. We have an excellent understanding of how our climate system operates based on 150 years of science. Science works. If we choose to heed its lessons, it will help us strengthen our security.

While we plan for climate, we live in weather, its day-to-day variations and, more importantly, its extremes. The challenge for

readiness and resilience is to ensure our military bases and infrastructure are designed for and can withstand the extremes of tomorrow.

The rapid-changing climate has significant impacts on our national security. The days of climate stability we have experienced for most of human civilization are over. Changing climate impacts national security in three major ways.

First, changing the battlespace or the physical environment in which our soldiers, sailors, airmen, and Marines will operate. The Arctic is a prime example of an operational environment today that is undergoing rapid change.

Two, posing increasing risks to the Department of Defense's installations. Without fully operational bases and training ranges in the United States in addition to key overseas bases, U.S. forces cannot maintain the required levels of readiness. In addition to sea-level rise threatening our coastal installations, other bases and training ranges are at risk from increased frequency and severity of wildfires, droughts, and floods.

And although not the focus of today's hearing, it is important to also note that a changing climate can make already unstable situations worse and sometimes catastrophically so. Climate change can be a powerful link in a chain of events that, if not broken, can lead to runaway instability.

Our rivals have been paying close attention to the changing Arctic even while we were not. The Russians are rebuilding their Arctic military capabilities, albeit from very low post-Cold War levels. China declares itself to be a near-Arctic state and hopes to build a Polar Silk Road as a northern flank in its Belt and Road Initiative. China continues to aggressively court the Nordic states and Greenland.

Climate change and its manifestations is a risk that we will need to manage for decades to come. It is not an issue that will be solved with any one single policy or program. So what to do? I have my full recommendations in the written statement, but here are some highlights.

Develop a Department of Defense-authorized standards for use and projections out to 50 years. I recommend the DOD produce and aggregate authoritative climate information that can inform risk management decisions on time and space scales and parameters that matter to the Department.

Develop a climate impacts handbook for each installation. While each installation is different, standardize the handbook to the degree practical. The U.S. Navy's Typhoon Havens Handbook could be one model.

Build on and expand existing authorities, programs, and resources to ensure the Department of Defense, working in collaboration with other Federal agencies and State, local, and Tribal authorities, has both the resources and the authorities needed to adapt to climate issues that directly impact the installation, whether they are inside or beyond the fence line.

Look for each service's top one or two near-term issues that should be supported and addressed today without further extensive analysis. For example, ensure our nuclear-capable shipyards are

protected adequately from rising sea levels, storm surge, and freshwater flooding over the coming decades.

Update our Nation's Arctic Strategy in response to changes in our National Security Strategy and Defense Strategy.

In closing, 50 years ago, we went to the moon and returned safely, not knowing everything we needed to know at the start of that journey. America can still do amazing things when focused. In the future, when we look back, I hope we will be rightfully proud of what we accomplished starting in 2019 to buy down these climate risks.

Thank you very much, sir, for your time and attention. I look forward to taking your questions.

[The prepared statement of Admiral Titley can be found in the Appendix on page 44.]

Mr. GARAMENDI. Thank you very much. I appreciate your timeliness as well as your testimony, both written and oral.

Ms. Burke, if you would care to share your thoughts with us.

STATEMENT OF SHARON E. BURKE, SENIOR ADVISOR, INTERNATIONAL SECURITY PROGRAM AND RESOURCE SECURITY PROGRAM, NEW AMERICA

Ms. BURKE. Thank you, Mr. Chairman, Ranking Member Lamborn. I really appreciate the opportunity to be here today to appear in front of this subcommittee.

And I would be remiss if I didn't mention that the opportunity to testify in front of a former colleague who is now serving the American people in a new capacity is truly inspiring.

I should clarify that I do not speak for my organization today. I am here in a personal capacity because they do not take corporate positions. I also have been asked to clarify that I do not speak for the Department of Defense, nor can they necessarily vouch for what I am about to say.

Now, of course, I did speak for the Department of Defense once upon a time, most recently as the Assistant Secretary of Defense for Operational Energy. And in that capacity, I got to do many great things, and one of them was to travel to Afghanistan with the logisticians and to see what these problems look like in situ.

On one of those trips, our protocol officer knew that I wanted to see what real housing looks like forward, so she showed me her own CHU [Containerized Housing Unit] in Kabul. And, now, this was a full-bird colonel, mind you, and she was sharing, like, a dingy, rattling compartment that was so small I could touch both walls. Down the hall, there was this faded poster, this Uncle Sam poster that said, "Don't waste energy. Turn off the lights."

So I tell you that not to suggest that this subcommittee needs to rush out and build McMansions on forward operating bases. I never met anyone in uniform who really wanted a flat-screen TV in every tent. They know they are at war. I tell you that story because, when it comes to energy and climate change, it has to be more than a poster on the wall.

Our troops should know, instead, the opportunity costs for the force's immense energy footprint. There was a strategic cost, for example, as we trucked Russian fuel—Russian fuel—through all of

Central Asia, which helped destabilize the Government of Kyrgyzstan, according to an investigation by this body.

There was a tactical and operational cost as combat patrols, convoys, helicopters, and C–130s delivered or protected fuel instead of conducting other missions.

There was a human cost in lives.

And these sorts of missions require far less fuel than would, say, maneuver warfare on the Korean Peninsula or any contingency in the Asia-Pacific, with its vast distances. And there are potential adversaries there who are capable of far more lethal, precise, and far-ranging attacks than an IED [improvised explosive device] or a weaponized human body.

Moreover, the United States increasingly has an electrified force, which introduces an entirely new attack surface, one that the Department of Homeland Security and the FBI [Federal Bureau of Investigation] have publicly warned us that the Russians are seeking to exploit even now.

The Department of Defense should increasingly take energy resilience into account as a planning factor and a capability enabler. When it comes to fixed installations, as the members of this subcommittee know and as you said, Mr. Chairman, in the digital age, the bases are increasingly platforms that directly support military operations. They shouldn't be seen as dispensable overhead or some kind of slush fund. They are critical to readiness and to operations.

The subcommittee should certainly ask the Pentagon to do a better job of assessing the vulnerability of these bases, not just to changing weather conditions but also to the changing threat profile to critical infrastructure. And there is tremendous civilian expertise outside the Department, including at universities around every base in this country.

Now, the Pentagon should also be looking at climate change in light of our strategic priorities. While the National Defense Strategy did not explicitly acknowledge climate change as a shaping factor in great power competition, no country is immune to its effects, and that includes China and Russia.

Our Phase Zero Project has forthcoming research on this, which we have done together with Pacific Northwest National Laboratory. And our early findings suggest that climate change will affect China's resource security and shape its strategic choices. It already does. We see resource security already figuring into the Belt and Road Initiative but also in some of China's relationships with key U.S. allies, including Australia and Canada.

Another top Chinese resource partner today is Russia, where the trade in energy, minerals, and agriculture undergirds a growing strategic partnership which, needless to say, is unlikely to benefit the United States, including in the Arctic.

The subcommittee should certainly ask that the Department of Defense report on how climate change and resource security will affect great power competition. You should ask, for example, how it is affecting our relationships, how we are bringing our relationships and alliances and trade into the equation. For example, how are we making sure that there will continue to be a free market for key minerals, which are so crucial to the information economy, to clean energy, and to a modern military?

Climate change is highly likely to affect other military missions, such as humanitarian and disaster relief and defense support to civil authorities for disaster relief here at home. It already has.

There are also indirect mission implications, as these conditions, as Dr. Titley said, may destabilize countries with poor or corrupt governance, weak economies, or a history of civil unrest and conflict. That, in particular, is not well understood, at least in terms of actionable information, and that is another role that the committee could play, in asking for that kind of information, which would not only help build military capabilities but also the broader national security priorities for development, trade, and diplomacy.

So, ultimately, climate change is certainly a security concern, but it is not necessarily one with a military solution. No soldier, sailor, airman, or Marine can defeat climate change by shooting at it or blowing it up, or even phishing it with a virus. Climate change is ultimately a governance and economic development challenge and fundamentally a civilian and a civil society responsibility.

On the other hand, while the Department of Defense has good reasons to account for energy and climate security now, if the Nation does not have the adequate civilian capacity, if we do not innovate, if we do not get ahead of the changes that are underway and coming, they might also want to prepare for a worst-case scenario where it is entirely their mission to deal with the consequences.

Thank you.

[The prepared statement of Ms. Burke can be found in the Appendix on page 63.]

Mr. GARAMENDI. Thank you very much.

Mr. Loris.

STATEMENT OF NICOLAS LORIS, HERBERT AND JOYCE MORGAN FELLOW IN ENERGY AND ENVIRONMENTAL POLICY, CENTER FOR FREE MARKETS AND REGULATORY REFORM, THE HERITAGE FOUNDATION

Mr. LORIS. Chairman Garamendi, Ranking Member Lamborn, and distinguished members of the subcommittee, thank you for this opportunity to testify this afternoon.

My name is Nick Loris, and I am the Herbert and Joyce Morgan fellow at The Heritage Foundation. The views I express in this testimony are my own and should not be construed as representing any official position of The Heritage Foundation.

Keeping America safe is a nonpartisan issue. For the Defense Department to carry out its missions, ensuring military resilience and readiness is critical. Without question, extreme weather and long-term climate changes can harm DOD installations, training, and operations. Solutions to protect against such threats should achieve cost-effective, meaningful results.

In this regard, I would like to make several observations.

First, preparing for natural disasters and adapting to land and water changes over time is pragmatic, commonsense policy. Safeguarding against current and future vulnerabilities with more durable infrastructure and innovative designs will mitigate risks and save lives. Employing local knowledge and specialized expertise will help tackle site- and situation-specific challenges. The accumu-

lation of scientific and technical data will assist in detecting the level of threat that extreme weather poses to the military.

Productively, DOD has taken necessary steps to reduce risks facing DOD installations and operations. For example, Langley Air Force Base used flood visualization tools to understand flooding impacts on their base. Accordingly, they installed door dams, which are far more efficient and less labor-intensive than using sandbags. They have also implemented a shore stabilization plan and installed pumps to remove floodwater from their base. New construction at the base is occurring at higher levels of elevation.

Moreover, Air Force bases in Florida are working with local experts to address coastal erosion and routinely conduct hurricane preparation exercises. And Navy Region Mid-Atlantic is working with a number of stakeholders in the area to protect against coastal storms, flooding, sea-level rise, and land subsidence.

This is just a small sample size of what the military is doing and should be doing to protect against climate-related risks. Congress should ensure that DOD has the necessary funding to carry out these activities that ensure military resilience and preparedness.

My second observation is that Congress should refrain from implementing costly, ineffective energy policies intended to reduce DOD's climate footprint but which instead divert resources away from protecting America's vital national security interests.

Although DOD is a large institutional energy consumer, it makes up only 1 percent of America's total energy use. Expensive, politically driven plans intended to shrink DOD's climate impact would have no meaningful impact on climate, producing a change in the Earth's temperature that is practically too small to even measure.

Above all else, capabilities should drive DOD's energy choices. Policy makers should not force the military to buy pricier energy if no national-security justification exists. In the past, DOD has spent money on renewable projects or costly biofuels where the national and energy security benefits were spurious. These policies leave fewer resources for training, modernization, and safeguarding DOD infrastructure, resulting in a less capable military.

My third observation is that DOD research and development in alternative energy sources can, in fact, produce significant economic benefits through spin-off technologies, but that spending must prioritize national security needs first.

Undoubtedly, renewable and alternative energy sources can offer unique advantages. For instance, lighter, more efficient batteries can lengthen the duration of a foot soldier's mission and reduce the weight of his or her backpack; or the use of solar photovoltaics can extend the travel distances of drones. Furthermore, more fuel-efficient engines reduce the need for refueling, which we all know is a risk to our soldiers. And developing microgrids and utilizing very small modular reactor technologies can safely provide reliable power to isolated bases for long stretches of time.

All of these initiatives can have broader economic value. To capture that value, Congress should ensure that the proper channels exist for the private sector to commercialize that research while protecting classified and sensitive information. Doing so will keep America safe while spurring clean-energy innovation.

In conclusion, whether carbon dioxide levels are rising, falling, or staying the same, the U.S. and the rest of the world will continue to experience extreme weather events. The climate will continue to change over time, and DOD must adapt to those changes no matter what the cause.

DOD should continue to identify vulnerabilities and make targeted investments to strengthen military installations. Moreover, DOD should use the best available science and information to prepare for extreme weather and apply lessons learned to minimize future infrastructure and personnel risks.

America's military should respond in kind to longer-term climate changes as well. However, wasteful energy mandates and spending will have a negligible impact on climate and make DOD worse off by allocating defense dollars away from more productive uses. Military spending on alternative energy technologies can have substantial geopolitical and economic benefits, but that spending should be mission- and capabilities-driven first.

Thank you, and I look forward to your questions.

[The prepared statement of Mr. Loris can be found in the Appendix on page 83.]

Mr. GARAMENDI. Well, thank you very much, Mr. Loris and Ms. Burke as well as Professor Titley.

Before we launch into questions, just a little housekeeping note. This committee is open to all members of the Armed Services Committee. So if you have other members of the committee that are interested in joining us, please do. And I note that one is here.

Mrs. Luria, thank you so much for joining us from the Seapower Subcommittee as well as the full committee. And so, pass the information on. So we want as many members of the committee that are interested to join us.

I would draw the attention of the members of the committee and the witnesses to the last two pages of the briefing memo that Jeanine put together here. Actually, it is the last three pages. There are two pages of Code that we have discovered in the last two NDAAs that speak directly to the issues before us. That is page 7 and 8 of the briefing memo.

There is plenty of law out there. There are more than enough opportunities for the military to deal with the issues that have been raised by the witnesses. And our task is to address the impacts of climate change on the military. We could get into a long, long discussion between Mr. Lamborn and I as to exactly how that might be done, but the laws that are on the books pretty much tell us which direction we can and should go.

I think really our task is to make sure that the Department of Defense is able to carry out these goals that are already in the law. And if we see along the way that there should be changes, then we will have the opportunity in the next 3 months going forward.

There is agreement among all the witnesses and, actually, between Mr. Lamborn and myself and perhaps the other members of the committee that it is in the interest of the military to be resilient. It is in the interest of the military to address the challenges, whether they are weather or cyber, and to make sure that they are able to carry out their mission in those exi—areas.

I am having trouble with that word, so please excuse me. I will get it by tomorrow.

In the meantime, just a couple of questions for the witnesses.

Without getting into the cause of climate change, without getting into the issue of reducing greenhouse gasses, the question for all of you is very direct: Is it in the interest of the military to reduce its energy consumption in the movement of vehicles, whether they are a ship or a tank or a truck or a car, and in the base itself?

So this is energy consumption. Is it in the interest? And what would you say are the first two methods you would recommend?

So let's start with Mr. Loris, and then we will go reverse down the——

Mr. LORIS. I would argue, yes, absolutely, as long as that reduced energy use doesn't compromise the mission.

And so I think if there are more investments in fuel-efficient technologies that reduce the need for refueling, that is a common-sense approach. And these investments in battery technologies, I think that is offering a number of wide range of mission capabilities that we didn't even know existed, let alone a decade ago.

And so I think the potential in the future for those technologies, both in the near term and the long term, are very valuable from a strategic sense and also just from a broader economic sense.

Mr. GARAMENDI. Thank you.

Ms. Burke.

Ms. BURKE. Thank you, Mr. Chairman.

Yes, I think it is in the interest of the Department to get more military output for less energy input.

So, for operations, you are talking about a future where the supply lines can be targeted, you know, with precision weapons, with hypersonic missiles. The supply chain is a soft target, and our adversaries are well aware of that, as are—any potential adversary has seen how well it has worked in Afghanistan and Iraq. So it is in our interest to shrink that footprint and to protect it better.

On bases, the same, that the less we use, the more resilient we are.

As far as setting targets, again, I would always put effectiveness in the lead, so not so much just set a flat consumption target. Because if the force has to go do something, they may have to blow that target. So it is better to look in terms of the return you get for the energy you use and making that balance better and making sure that the energy you use serves the mission. Whether it is, as Nick said, whether it is a solar hybrid generator or, you know, a diesel generator, it has to serve the mission better.

Mr. GARAMENDI. Thank you.

Mr. Titley.

Admiral TITLEY. Thank you, sir, for the question.

I would say it is in the interest of the Department if one or both of the following conditions are met: when energy savings enhances warfighting effectiveness or/and when such efficiencies save money and resources that can then be applied to other aspects of readiness. So there has to be something in it there.

As far as what to do, I could pontificate on that, and I am not going to. But what I would think about is a process very similar to what U.S. Navy Task Force Energy used and I was part of when

I was on Active Duty. We really looked at both how long it would take to return, what was the upfront cost, what was the return on that investment. There were a number of things that were, like, 2, 3, 4 years. Do them.

I would also be aware of former Deputy Secretary of Defense Bob Work's phrase of "watch the fuss to fun factor." If you are going to do it, make sure there is a sufficient return.

Mr. GARAMENDI. Thank you very much.

I will note, Mr. Loris, in your answer to my question, that the United States Navy has a hybrid electric destroyer, utilizing some of the technology that perhaps you had in mind.

I am going to now turn to my colleague Mr. Lamborn for questions, and then we will go down through the gavel order.

Mr. LAMBORN. Thank you, Mr. Chairman, and thank you for having this hearing.

And I think we have broad agreement, wherever we can save energy, let's do so. Wherever we can buy a cheaper source of energy that gets the job done and saves the taxpayers money, let's do so.

If it is a more efficient type of energy that is easier to transport, has a smaller footprint, as you said, Ms. Burke, that is good for the warfighter, as well, for getting those energy resources out into the field where they are needed.

There was an incident in 2011 that I think went in the opposite direction, and it still bothers me. The President directed the Departments of Navy, Energy, and Agriculture to really experiment with biofuels, committed half-a-billion dollars on that.

And among other spending, we had the Navy spending $12 million on biofuels at $26 a gallon. And that is when jet fuel was available at about one-eighth of that cost, 3-something a gallon. So, out of that $12 million, my rough estimate is that was a $10 million overpayment if you had just bought, you know, stuck to jet fuel.

And biofuels are less dense. You don't get as many BTU [British thermal units] per—you know, as much bang for the buck, you might say.

So I view that as going in the wrong direction. Mr. Loris, would you agree that that was an ill-advised use of $10 million?

Mr. LORIS. I would. You know, it is not that I have anything against biofuels; it is that I have something against biofuel mandates and using biofuels when I don't see any national security justification for buying pricier fuel.

And, again, that is a huge opportunity cost. That is potentially hundreds of thousands of dollars that could have been spent on conventional fuels that cannot otherwise be spent on military resilience and——

Mr. LAMBORN. Yeah, $10 million. And if the day comes when biofuels are less expensive, sure, let's experiment with them then and see how effective they are, how cheap they are, and how available they are. I am a believer in all of the above.

And, Mr. Titley, Admiral Titley, I am going to ask you a question about the Arctic. That is a huge interest of mine. I know it is for the chairman also. What are some of the opportunities and challenges that we have in the Arctic these days?

Admiral TITLEY. Well, thank you, sir, for the question. And, you know, we could have, as the chair cosponsored when he was ranking member, a whole hearing on the Arctic. And maybe in a component of a jurisdiction of the Armed Services Committee, that would be a really interesting topic.

What I talk about in my written testimony——

Mr. GARAMENDI. Actually, if I might interrupt, we are thinking about a wintertime CODEL [congressional delegation].

Admiral TITLEY. I am all for it. Watch out for the polar bears on the runways, because you don't see them in the winter.

So the Arctic, as I think everybody knows, is changing incredibly quickly. And our great power rivals as defined in our National Defense Strategy, both Russia and China, are, frankly, taking advantage of this.

Russia is monetizing their Northern Sea Route. They have just, I read in the open press this past week, passed restrictions that are trying to basically, frankly, keep U.S. and NATO [North Atlantic Treaty Organization] ships—make it harder for us to operate in what I think the United States would term international waters or waters in which we should be able to navigate.

China is looking at a Polar Silk Road.

So how are we going to really look at this? It is very possible that trade routes could be changing significantly in the next, let's say, couple of decades. While that may sound a long ways away, you all on this committee know better than me that, by the time you appropriate funds for a ship, build that ship, and that service life of a ship, that is 30 to 50 years. We need to be thinking that far ahead in the Arctic there.

There will be ice-free summers. There will be ice-free falls. Shippers will push the limits of the season. People are both going to get in trouble and there will be opportunity.

We need familiarity in working up there. We need presence. Presence can be Coast Guard, can be NOAA [National Oceanic and Atmospheric Administration], can be Navy. But we need sovereign presence to build on our scientific capabilities.

There are tremendous opportunities for us in the Arctic. We need to pay attention.

Mr. LAMBORN. Thank you. And I would like to highlight for anyone who hasn't looked at the briefing memo for this hearing, on pages 7 and 8 there are a list of about 25 different measures that, in the last two fiscal years—well, the last two NDAAs, we put in on a bipartisan basis for the saving of energy and the increasing of resilience. So that is something that we will continue to work on.

And, once again, thank you for having the hearing, and I yield back.

Mr. GARAMENDI. Thank you, Mr. Lamborn.

Now we are going to go by the gavel order, and that would bring next Mr. Crow.

Mr. CROW. Thank you, Mr. Chairman.

And thank you to all of you for joining us today. We appreciate your time and insights.

I am particularly interested, I guess, starting with Ms. Burke, in your former role, and I obviously would love to hear from the others, about the energy resilience and conservation program and

other similar programs and their capacity and impact on cybersecurity.

Our installations draw a tremendous amount of their power from the civilian grid, and that is a very vulnerable grid if we were to come under cyber attack. And if our installations lost power, we would immediately lose substantial capacity for our national defense.

So, in your experience and background, you know, these microgrid projects at Fort Hunter Liggett and Fort Hood and other places, do they have the capability to make us more secure by removing us from the grid?

Ms. BURKE. Thank you, Congressman, for the question.

I did not actually oversee that program in my time in office, but we were certainly very concerned about electricity as an operational input.

And I agree with the content of your question, which is the Department has not really grappled with just how much their electricity demand has escalated in the last few years, in the last decade; how much it is mission-critical, even here at domestic bases; and the relative vulnerabilities of that supply, because, of course, we are reliant for almost all of our electricity on the civilian grid. And it gets even more interesting when you go overseas, because we are often relying on host-nation infrastructure. So their vulnerabilities are our vulnerabilities.

I think the Department needs to do a much better job of understanding what those vulnerabilities are but also what the risk is. So the vulnerability plus the threat adds up to a level of risk, and you add in the mission criticalities on those bases. So they need to characterize that much better than they do.

And I think, in a lot of places, there is more than one right answer to how you improve resilience, but microgrids have proven to be one very good answer, especially in a tactical environment, as I think you know. But I think they have already proven to be a very useful answer in a number of places where they have been deployed, including the bases that you talked about.

And just to add one last thought on that, continuity of operations is everything. Making sure that the critical loads can be served no matter what is essential. But it is also not realistic to isolate completely from the civilian community around you, because bases are part of that community. And it is not just their electricity they get; they also get their water. Sometimes people live off post. So they need to also be able to work with the community around them and not completely isolate from the community.

Mr. CROW. Okay.

Admiral Titley and Mr. Loris, I would welcome your thoughts.

Admiral TITLEY. Just very briefly, sir. Thank you. I would absolutely agree with everything that Ms. Burke said there.

I would only add that the CNA Military Advisory Board, of which I am a member, did quite a comprehensive report about 2 years ago on the vulnerabilities of U.S. military to our civilian electric and power grid, and I would be happy to provide the committee with that report.

And just to emphasize Ms. Burke's comment that bases are part of the community. We see this in flooding. We see this in climate

and extreme weather. And this makes it—as hard as it is within the fence line, we have to think beyond the fence line.

Thank you, sir.

Mr. CROW. Thank you.

Mr. LORIS. Yeah, I would just simply echo what Ms. Burke and Rear Admiral Titley said. You know, this can provide increased resiliency, improved tactical operations, both in the United States and abroad.

And I think there is a number of different maturations of what these microgrids can look like, which, again, can have broader economic benefits. I think one thing that is compelling to me is these investments and research into some of the very small modular reactor technologies that DOD is currently looking at.

I don't know if that is ultimately the way DOD will go, and they are the ones who should make those determinations, but, again, I think that is something that could provide tremendous value to our operational readiness all around the world.

Mr. CROW. Thank you.

And one last question for Ms. Burke.

I would love your thoughts on just the cost-savings element. And we have already alluded to that. But, very briefly, with some of these energy-efficient programs, are we seeing some cost savings already at some of these facilities?

Ms. BURKE. Yes, Congressman. We are seeing cost savings. And, also, we have financing tools—they have financing tools in the Department of Defense that allow them to take advantage of private-sector financing so that there is no upfront cost to taxpayers.

And, again, the private sector wouldn't come in and do this if there weren't cost savings involved. So those tools, such as I think you mentioned energy savings performance contracts, have proven successful ways to achieve those goals, those cost savings.

Mr. CROW. Thank you.

I yield back.

Mr. GARAMENDI. Thank you. We might call those public-private partnerships.

Mr. Scott.

Mr. SCOTT. Thank you, Mr. Chairman.

Ms. Burke, I apologize for stepping out during your testimony. I was listening in there as I talked to a Senator literally about disaster relief for the southeastern United States, which, apparently, is not coming this week or next week but perhaps the following week. And I appreciate my colleagues in the House for working with us in the Southeast to resolve this issue.

I want to talk briefly about the Marine Corps Logistics Base in Albany, Georgia. As I understand it, this is one of the few net-zero installations in the country that we have. They use a combination of solar as well as methane gas from the landfill that is adjacent to them in a combination of a public-private partnership to provide energy for the Marine Corps Logistics Base in Albany, Georgia.

When I have been on that base the last few times during a couple storms, the issue is the solar panels are destroyed. And, in many cases, I will tell you that it—I would just say it has reiterated the need to me for redundancy of power supply at our military installations, whether that is redundancy with traditional sources

of power or redundancy with alternative sources of power. I very much believe that our bases need to be able to function regardless of the environment, the weather environment, that we are in.

I have questions about how do we take the model that worked—because what worked in Albany is not going to necessarily be the same thing that is going to work in other bases. Other bases aren't going to be in close proximity to a landfill.

Where do you see the areas specifically where we have the most opportunity with bases to move the fastest with proven technology to reduce the amount of emissions that we have in the operation of our bases?

Admiral Titley, is there a base that you have in mind and a solution?

Admiral TITLEY. What I would look for, sir, is really match up what are the resources available. So, you know, in places like the Southwest, of course, we have a lot of potential for solar energy. In the Midwest is really our greatest potential—and up to the Front Range is our greatest potential for wind energy. There could be some——

Mr. SCOTT. If I may, Admiral, would you agree that we need redundancy with the wind and the solar and that——

Admiral TITLEY. Absolutely. This is——

Mr. SCOTT [continuing]. It will almost always be traditional sources, what we consider to be——

Admiral TITLEY. This is a kill chain. So you have to look at generation, you have to look at transmission, and then you have to look at how it is used. And it doesn't do you any good to get electricity to the building if the buildings got blown away.

Mr. SCOTT. That is right.

Admiral TITLEY. But you have to have all parts of that. And just like a kill chain, if not all of it works, nothing works.

Mr. SCOTT. That is right.

Admiral TITLEY. So you really have to put all of these things together. And it is going to be different in different places.

Mr. SCOTT. Ma'am.

Ms. BURKE. I agree with that, Congressman. And, you know, I think the Marine Corps has been very forward-leaning on both the resiliency of fixed installations and how some of these technologies can help them build resiliency but also for operating positions. So it is great to hear that it has been successful in your district.

You said to reduce emissions. I would say that the number one driver there is continuity of operations, and particularly of critical missions, and let that be the driver. Emissions reductions would be an outcome, not the reason. So they do what they do so that the mission is protected, but if they are doing it right, that is often going to be an outcome.

Mr. SCOTT. But we do pursue alternative sources for energy in an effort to reduce pollution. Correct? I mean, we are not——

Ms. BURKE. For domestic bases, there is law, there is statute, and there have been Executive orders—I think they have been withdrawn though—to that effect. And, certainly, U.S. military bases that are in the United States comply with all laws, and they are certainly mindful of the relationships with the communities

around them, and they want to do the best for the communities around them.

But what I am saying is, the primary driver for them is always going to be the mission. And I think that is a good way of looking at it.

Mr. SCOTT. Mr. Loris.

Mr. LORIS. Yeah, agree. I think it needs to be mission- and capabilities-driven first. And it also needs to be site- and situation-specific too, because what works in certain regions of the country doesn't work in others. And if you are factoring in lengthy transmission lines to take the power from where it is produced to where it needs to be consumed, you could create a whole new set of vulnerabilities.

So I think it is up to the officials within those bases to identify what makes most operational sense for those bases. And again, that could include an abundance of natural gas, as well, because we have a lot of that in this country.

Mr. SCOTT. Sure. Mr. Chairman, my time has expired.

Mr. GARAMENDI. Thank you, Mr. Scott.

I will now turn to Ms. Slotkin so that she can question her former boss.

Ms. SLOTKIN. It is great to be here. Thank you.

And we did work together when I was Acting Assistant Secretary of Defense, with a few of the folks in the room here, when we published the Climate Change Roadmap. And it was clear back in 2014, just as it is now, that climate change is a national security issue that has implications for our military, for our installations, for our ranges, and, overall, the safety and security of the country.

And in our report we talked about doing prudent planning and risk mitigation to reverse—or reduce, I should say, the adverse impacts of climate change. Even at that time, we saw some of our bases were dealing with flooding, some of our ranges were unable to be used because it was getting too hot, and our soldiers were having to conduct exercises differently because of the change in climate.

In the January 2019 report, "The Effects of a Changing Climate to the Department of Defense," which was mandated, I think, by this committee, which DOD submitted to Congress, the Department reported that 53 installations are vulnerable to recurrent flooding, 42 installations are vulnerable to drought, 36 installations are vulnerable to wildfire.

And then we all know the changing landscape in the Arctic and what it is allowing the Russians and the Chinese to do up there. We all should have, like, a blinking light in terms of what that is going to do for our future threat perspective.

So I want to make sure—I feel very confident that the Department itself and senior ranking officials within the Department understand this as an issue, but, obviously, I am concerned the administration is not taking it as seriously as we would like by the appointment of a man to look at climate change who at least is on record at some point saying that he is not convinced climate change is manmade.

So can you help me—and I would just say, I think the aspect that we need to keep in mind—I think maybe, Mr. Loris, you men-

tioned it—is that soldiers do die because we transport such a huge amount of fuel. The reports that I have seen is that 3,000 casualties between 2003 and 2007 in Iraq were because of the transport of fuel.

So, even if we didn't believe it was a national security problem, that climate change wasn't a national security problem, just wanting to reduce the casualties to our force would be a reason to mitigate our dependency on fossil fuels.

So can you help me understand, any of you, based on your conversations with the Department, what kind of real, prudent planning is going on to mitigate the impacts both to our facilities and then, separately, on our dependence on fossil fuels?

Ms. BURKE. Congresswoman, I am going to take the liberty of responding first since you directed it to all of us. Not enough. There is not enough going on, and I think that is a big problem. And in fact, there has never been a ton of institutional capacity to work on these issues. There is maybe one person in the Office of the Secretary of Defense who really works on this issue full time. And the Department is rolling back support for a lot of the assistant secretariats in the services that can actually work on these issues—on the full range of issues that we have been talking about, including cyber resilience of the critical infrastructure.

So I think that is the first thing, is the institutional capacity to actually plan deliberately in a way, whether it is for bases or for operations or for understanding the future threat, is not good and needs to be better.

You do see, at a leadership level, recognition, consistently now, at least since I know, since 2007, that this is a security issue, that climate change is a security issue, that energy operations and improving our energy operations is a security issue. But the actual follow-through on what that looks like and the commitment to it has not been consistent. So I think we need to see better capacity, more institutional capacity, and more deliberate effort to understand how these issues are incorporated into strategy, plans, requirements, acquisitions, and bases.

Admiral TITLEY. Thank you, ma'am. There are, I think, two things here, and sometimes they get conflated. One is, how do you provide energy to—especially to forward units? That is not a climate issue. That is a safety issue. That is a readiness issue. That is an operational capability issue. And it is an extremely important one, because people die if you don't get it right.

There is, also, an issue of how do you make sure that our installations, where we generate readiness, are ready for a changing climate. As Ms. Burke said, there is at least some recognition, but there is very little action on this, and what action is taken is usually talked around. As you know better than probably most people, I tell folks the Pentagon is a hierarchical institution. So that means if your boss is interested, you are fascinated. But the reverse is also true, and right now, the boss is not interested. And I would say, at the National Security Council, they have given very definite signals: Do not bring this issue up. That makes it much, much harder.

The Pentagon is between a rock and a hard place. They understand their board of directors is interested. They know they should

be. Their boss is not there. And so anything we can do to—by law, by money, by appropriations, by language, to help them basically overcome the institutional opposition to this in the White House will be most useful. Thank you, ma'am.

Mr. LORIS. Can I quickly add one thing? Sorry. I don't have to. I just wanted to add the DOD Strategic Environmental Research and Development Program I think is a great program that helps identify these risks. It enhances our scientific ability to minimize risks in the future, and as Ms. Burke said, we need more of it because of these installations that are currently under threat and potentially under threat in the future.

Mr. GARAMENDI. This conversation has laid out the task this committee has. We know there is a problem. We know that bases have a problem. And we also know that there is resistance to this issue of climate change, and so we will have to find a way of maneuvering through that, at least for the near term, and we will do so.

Mr. Brooks, it is your turn.

Mr. BROOKS. Thank you, Mr. Chairman.

As a quick overview, I hope that you all will do your part in making sure that the military understands that, over the past century, sea levels have risen approximately 8 to 9 inches, which is one-third of the average century rise over the last 20,000 years. Over the last 20,000 years, the average rise per century has been 2 feet, versus that one-third over the past century, which is about 8 or 9 inches. So hopefully our military facilities will anticipate, based on history, that there will be future sea-level rises that they need to anticipate, and we can get into why it is only one-third now versus what it was over the entire 20,000-year period. But I think one thing is pretty sure is that sea levels are likely to rise, perhaps for a variety of reasons.

Now, to my comment and question on a different matter. Over the past decade, many domestic military bases have been ordered to install very costly energy projects on their property, including solar fields, wind farms, and biomass facilities. In theory, the ability to produce energy on military bases should increase their resiliency by insulating them from the adverse impacts of electricity grids going down due to weather-related events or, in the event of a conflict, insulate them from cyber attacks targeting vulnerable local electricity grids.

Ensuring our mission-critical facilities have access to electricity power is a worthy goal. However, merely producing power on a military base does not necessarily achieve this goal. We must also have the physical mechanisms that permit transmission of the energy produced on military bases to the base's own mission-critical facilities. There are many instances where the energy produced on military bases is not well utilized due to energy or fuel-storage issues, or insufficient control systems.

In other words, in the event of an emergency, the military bases are unable to retain the energy produced on their property in a reliable and predictable way.

Admiral Titley, with that as a backdrop, in your opinion, is the Department of Defense investing enough in physical mechanisms

to direct that energy that is produced on military bases be available for base mission-critical facilities?

Admiral TITLEY. Thank you, sir, for the question. The details of energy management is not my area of expertise. I was not the facilities guy. I was the weather guy.

Mr. BROOKS. All right, then, Ms. Burke or Mr. Loris, do you have any insight on whether the military should have the ability to utilize, for its own bases, the electrical power that is produced on its own bases?

Ms. BURKE. Well, sir, the Department has 28 million acres under management and half a million structures. So there is not going to be a one-size-fits-all answer to that question, but if you have a specific place in mind where that is a problem, then, yes, I think that there are definitely risks and threats that require that kind of management. But I think it is very site-dependent.

Mr. LORIS. I think they do need that in many installations. Part of the problem is that the national security justifications for some of these projects are very nebulous, and you don't have to really describe in too much detail why you are making these investments. There was a Government Accountability Office report from, I think, 2016, that looked at a number of different installations that made renewable investments—I think it was 17. So kind of a relatively small sample size. Seven of them had said that they could supply power without the commercial grid, that, you know, if the grid went offline, that they would have the ability to supply that power. But only two of them actually had that ability. The others needed far more investments. Fort Benning was one where they needed $30 million of investment. Camp Lejeune was another where they needed $48 million in additional investment to actually provide power if the commercial grid went offline.

And so I think that speaks to kind of the broader challenge and problem here, is, one, you are talking about more costs—and maybe those benefits of national security and having power when the grid's offline justify those costs, but there needs to be, I think, more concrete definitions and justifications as to why these investments are being made for national security purposes.

Mr. BROOKS. Yeah, my reservation was the discovery that, while the military bases may produce the electricity, it goes to the general power grid in the surrounding areas and that the military doesn't have the ability in every instance to retain it for military use if an emergency should arise.

Mr. LORIS. Right. And that was the issue with Fort Benning, is that they needed $30 million more to invest in battery storage technology to keep that power on the base. So, even if the commercial grid went out, you know, that power that they are producing at the base is effectively useless without that battery storage or any type of energy storage system, as well as the distribution capabilities to get it to the rest of the base.

Admiral TITLEY. Storage is expensive.

Ms. BURKE. Congressman, now I understand better. Yes, you are absolutely right. There are places like Nellis Air Force Base, which had a large solar field that originally, when it was built, only returned electricity. They just used the land, and it returned electricity. Although, again, Nellis did not pay for the development of

that solar field. Ideally, you would use that kind of financing and return the power to the grid, but then in an outage, the power from the solar would be dedicated to the base. And that just reflects that—different priorities at the time that it was built, which were on cost savings and on ways to leverage the private sector for some of those cost savings. Now, I think—for some time now, we have been looking more at resilience as the driving concern, so——

Mr. BROOKS. Thank you, Mr. Chairman.

Mr. GARAMENDI. Thank you for your question. Mentioned earlier were microgrids, and that should be part of this discussion. As we go along, we will pick up the microgrid issue.

Our next questioner is Ms. Horn.

Ms. HORN. Thank you, Mr. Chairman.

And thank you all for being here. Glad to have this conversation on such an important topic. We talked about other—the impact of readiness on—on our bases based on the number of weather events. But being from Oklahoma, as you might imagine, tornadoes are a pretty serious challenge, and not just for us, as we have seen in the southeast part of our country, and with growing climate change, the severity and the length of tornado season, and the lack of predictability is something that I think is something important to address.

So, having said that, Oklahoma averages 56 tornadoes per year. Some of the most deadly tornadoes in the Nation have hit very close to some of our major bases. And taking this into consideration, I just wanted to ask—and I will let this be an open question, I think, at first—if you know of any specific studies that are being done, that the military is undertaking to assess the impacts of tornadoes, specifically in respect to the potential impacts on our bases and readiness.

Admiral TITLEY. I will start with that. Thank you for the question. I think as far as I know, the tornado studies are being rolled into larger resilience and severe weather studies. And as has been mentioned by all of the witnesses here several times, there are large differences between bases in geographic areas. So Guam is not worried about tornadoes, but it is a huge issue in the Midwest.

As far as how tornadoes are changing, as you probably know, ma'am, this is actually one of the cutting edges of climate. I chaired the attribution—National Academy of Science Attribution Study, and we found very low attribution on specific tornadoes. There have been studies done that shows the region of tornadoes is moving, and the time, as you mentioned. Oklahoma may be getting fewer, actually. But not to everybody.

So I think it needs to be rolled in. EF–3, EF–4, EF–5 tornadoes are very, very hard to survive unless you have a strong, reinforced building, and we saw the tragedy, of course, in the southeast just a weekend or two ago.

Ms. BURKE. Congresswoman, I have had the great fortune to go to Oklahoma City and to Tulsa to talk about tornado resilience, and including meeting with members of the National Guard there, who, of course, are heavily called on to respond. And I think one of the interesting questions, too, is that it is not a surprise that tornadoes are going to happen along the dry line in Oklahoma. And there are a lot of other weather events that happen there, too. It

is some of the most significant incidents of billion-dollar weather events and of nationally declared disasters are in your State.

It would be a really interesting question about whether we couldn't use the Guard more to also look at resilience so that they that don't have to always just respond. And I think we have seen some really interesting investments in Oklahoma, in particular, in Joplin, as well, as far as how do you rebuild in a way that makes you more resilient to those kinds of disasters, and the Guard may have a role in that.

Mr. LORIS. Yeah, I would just add that, you know, this seems like an ideal opportunity for the Strategic Environmental Research and Development Program at DOD to invest in this type of activity, and maybe they already do, so I am just not familiar with that. But I think better understanding the risks that are involved and trying to predict, as accurately as can, where tornadoes are going to hit, where they may inflict the most damage, again, is just common-sense policy that will help reduce casualties from these types of storms.

Ms. HORN. Thank you, and one additional question, just on the subject, as we talk about major weather events, whether it is flooding or—I know I am short, so I will try to look around—whether it is tornadoes, whether it is flooding, whether it is the impact of hurricanes, is the question of a need for redundancy, not only—we have talked about the grids and the power supply within bases—but of capability amongst bases in the event that we completely lose capacity in certain bases. So that is a question I wanted to ask is where you see that and the needs on that subject.

Admiral TITLEY. Yes, ma'am. I mean, it is kind of a truism in the military: you always have plan B. And that is not only in the military; it is also in the civilian side. So I ran the Navy's weather prediction—computer weather prediction capability. About 15 years ago, we had the opportunity to back up the National Weather Service. They had a big fire in their computer center, and the Navy backed up the Weather Service. Now, it could have gone the other way. So there has to be backups.

When I ran, again, whether we had—Norfolk could back up San Diego and vice versa. You always want to make sure you have that.

And just on the tornadoes, I did want to mention, the National Science Foundation does have a very robust tornado research program, and the military bonuses and can use that information. Thank you.

Ms. BURKE. And just quickly, Congresswoman, I think inherent in your question is a really important point, which is that bases play a really important role in defense support to civil authorities [DSCA] during disasters, both in terms of their own operations but the communities around them. And I think there has to be a very—an effort to deconflict. Where are the critical missions? Where are we supported? Where are the bases expected to support DSCA? And is the military making sure they can do all those things when there is a complex contingency and a complex emergency? I think it is a very important part of their planning effort that could be more robust than it is.

Mr. GARAMENDI. Before I turn to our next questioner, Ms. Escobar, I just want to put something on the table for the commit-

tee to consider as we go through these issues, and it is called resiliency. And so we have the job of looking at all of the military construction projects, all MILCON. Some of those will be new; some of those will be retrofits. In every case, we should, in my view, require that that project be resilient to the risks at that particular location. So if it is the depot outside Oklahoma City, and it is tornado country, will that building be built to withstand a tornado? Similarly, we are going to spend some $3 billion at Camp Lejeune. Will those buildings be able to withstand the next flood? Similarly at Tyndall Air Force Base, the next hurricane. So that will be part of the work that we will be doing going forward.

Ms. Escobar, it is your turn.

Ms. ESCOBAR. Thank you, Chairman, and I want to thank you for having this hearing and for having us focus on what is really just one of the most significant challenges that our generation faces, and that is climate change. And I know, for the military, it is viewed through the prism and the perspective of readiness and national security, but for many of us there is an additional perspective, and that is our moral obligation to preserve the planet.

I have two grown children. They are 20 and 22 years old, and I think about the planet that they will be inheriting, and my heart breaks. I cannot believe that we are facing this challenge and that we have been essentially sitting on our hands for so long, and even if we take absolute, urgent, and really kind of significant action today, we are still going to see a very different planet in 2040 than we see today.

But our role—obviously, the hat that I have on today is as a HASC [House Armed Services Committee] committee member. This morning, some of my colleagues and I met with the Secretary of the Army, and one of the things that we talked about was the upcoming budget. And what I really appreciated about that meeting was the idea of thinking about the budget today in terms of the impact it will have several years from now. And I think we need to position ourselves in that same way when it comes to climate change and making us ready to deal with that.

And I think that, while infrastructure is definitely an important component, natural resources are another component that, you know, an area that really frightens me. You know, in El Paso, we have, on Fort Bliss, a key asset for our country, an asset that I share with my colleague, Representative Torres Small. We had a partnership between Fort Bliss and our City of El Paso Public Service Board. And 15 years ago, we celebrated the opening of the world's largest inland desalinization plant, that takes brackish water and through reverse osmosis produces drinking water, because like many southwest cities, we were facing and we are facing droughts and limited runoff from smaller and smaller snowpacks to our north. And this was sort of our solution. And although we opened it 15 years ago, it took 15 years of design, plan, funding, building. I feel like we are already so far behind on these kinds of innovations going forward, especially with natural resources.

I really appreciated Mr. Scott's comments about what is happening in Georgia, about capturing the methane and using it along with solar as a way of generating energy.

I really appreciated Mr. Brooks' conversation about the grid and finding ways to capture and save electricity for the military installation.

Do we even have an assessment of best practices? Do we have an inventory of who is doing what? Do we have a list of opportunities for public-private partnerships or for public-public partnerships, like what took place in El Paso between the city and our Public Service Board and Fort Bliss? Are we even that ready in terms of assessing what we have got and where we have done well?

Admiral TITLEY. I will take a very quick stab at that. Thank you, ma'am, for the question. And I fully support your feeling that, you know, we are not where we need to be. In naval aviation, they say one of the things that is of no use to you is runway behind you. We have put a lot of runway behind us on this issue. In 2009, I told the Chief of Naval Operations this would be a challenge, not a crisis, but if we waited long enough, it will be a crisis.

In my recommendations, in my written recommendations, I recommend these so-called climate handbooks, but the types of information you mentioned, ma'am, could be in here. I think one of the things the Department frankly is kind of struggling with is, we don't have, as best I can tell from the outside now, an easily accessible sort of database, spreadsheet, whatever you want to call it, of information that you could see, that Congress could see. We could see where our resources are. We could then measure the effectiveness and learn from that and improve. And we need to do this and do this in a fast manner. So I think these are the kinds of assistance that this committee can help the Department with. Thank you.

Ms. ESCOBAR. Thank you.

Ms. BURKE. Thank you, Congresswoman, and I agree with you. I have an 18-year-old who—you know, most of our projections about when the damage is really going to set in are mid-century, and he will be my age. So I do think about that all the time, that it is very real for him.

Ms. ESCOBAR. And he may have children.

Ms. BURKE. I hope so. Not soon.

Ms. ESCOBAR. But the impact on his children.

Ms. BURKE. Absolutely. And we are behind where we need to be. And I would agree with Rear Admiral Titley, that we should have an inventory on best practices. I think it is a great idea. The one cautionary note I would throw is, remember, they don't have a lot of capacity to respond to that kind of request. So you either also need to help them build the capacity or be very specific that that inventory needs to be created by somebody outside the Department because otherwise you will see what you saw for the last report, which is, they will just put out a memo that says, "Tell me what you know," and then you will get what you get.

Ms. ESCOBAR. Got you. Thank you.

Mr. LORIS. I spent a lot of time looking at Department of Energy's National Laboratories and what type of innovations we could get from our National Labs at DOE, and I think there is a lot of carryover as to what research could look like and how we can transition it into the marketplace. And I think there are obstacles and bureaucracies in working with the Federal Government and our

National Labs and even DOD research labs that I think if we had better engagement with the private sector, you would get more of those spinoff technologies.

I mean, look at GPS [Global Positioning System]. We always credit the Federal Government for coming up with GPS, but it was a research mission that was geared for a national security objective, and an entrepreneur saw a commercial opportunity and spun that to what we have today. There are all sorts of opportunities that happen at the National Labs and research facilities that we could have more of those types of innovations. And they occur, and they occur now and today, and they occur on some incremental levels. And that is all well and good, but we still need to have better communication and better information available so we have the private sector, in my opinion, using private dollars to commercialize those technologies.

Mr. GARAMENDI. Thank you very much, Ms. Escobar.

I now turn to Ms. Torres Small.

Ms. TORRES SMALL. Thank you. Thank you so much to the witnesses, and thank you, Mr. Chair.

I want to pick up where my colleague, Representative Escobar, was speaking about water and about the real impact that climate change has on water, especially in the Southwest. I represent southern New Mexico, and Representative Slotkin also mentioned the 42 installations that are vulnerable to drought. So we see it, of course, here.

We also see it overseas. In fact, overseas, water ranks at the top list with fuel as the number one driver of resupply for our troops. So resupply operations are an essential aspect of military operations, as we have already discussed, but they also draw the attention to remote locations that require convoys to resupply.

So, to all of the witnesses, do you believe the Defense Department has incorporated water-resource vulnerability due to the increased impact of climate change into their resiliency plans for military installations?

Admiral TITLEY. I will just start very briefly. I think, ma'am, it is in its infancy if it is there. It is, as you mentioned on Fort Bliss, I think it is sort of looked at as a one of. What we need to do is collectively realize that the future will not be like the past. This is not some natural cycle that magically comes back. And, therefore, we need to be planning 10, 20, 30, for installations, 40 years, into the future. So, that whether it is desal [desalination] or other opportunities, that we do these in a deliberate manner, cost efficiently, effectively; we are not just throwing money and wasting money at this. So I think the glass is maybe one-tenth full if we are generous.

Ms. BURKE. Congresswoman, no is the short answer. No, I don't think so. Now, there are bases where they have been taking water into account for a long time, such as Fort Bliss but also Fort Irwin in California, which is the area where I am from out in the Mojave. So they are well aware that they have water constraints, and they have taken them seriously. And bases do tend to have very strong relationships with the communities around them. So if it is a community problem, the base is often going to be engaged.

However, it is not as systematic as it could be, and you alluded to the—or you said directly the problem with military operations. And I think that is where there are two interesting plays. One is, how does our water constraints going to play into geopolitics? How is that going to shape conflict? How is that going to shape great power relations? You know, China is a water-constrained country. No, I don't think we know that as well as we should. I don't believe it is incorporated into the way we are thinking about the future as a government, and it should be.

And then, at the operational and tactical level, it was certainly a challenge in Afghanistan. We were largely shipping plastic water bottles and dropping them to bases that were remote. That was not a great way to resupply, and also it left us with a hazardous-waste problem that also became a health issue for a lot of our forces.

So I think both at the tactical, operational, and the geopolitical level, there is a lot more to be done here.

Mr. LORIS. What she said.

Ms. TORRES SMALL. Oh, great, then I can ask a followup question.

Admiral TITLEY. So, ma'am, I would just submit that, just like the CNA Military Advisory Board did a report on electricity, we also did one on water, water scarcity, potential for water conflict. I would be happy to submit that to the committee.

Ms. TORRES SMALL. That would be great.

Admiral TITLEY. Thank you, ma'am.

Ms. TORRES SMALL. And just a quick followup, and Mr. Loris, if you want to take this one, to the extent that we are planning for water scarcity, do you also advise that we include potential impact, environmental impact that we are already seeing? So, for example, with PFAS [per- and polyfluoroalkyl substances] and other places where our limited supply for water in aquifers is also threatened by other means?

Mr. LORIS. Yeah. And, again, I think this gets back to hopefully what we were all saying earlier, is that if it is with regard to what the military is doing, it needs to be capabilities- and mission-driven first, and then if there are other environmental beneficial outcomes, that is certainly a welcome bonus.

Ms. BURKE. Again, I agree with that. Of course, I mean, that is what I did in office, and it was our guiding principle. But at the same time, the Department of Defense doesn't exist in isolation from the rest of the country, so national priorities and national security, writ large, what is good for our communities, and what is good for our people does drive the Department of Defense. Moral obligations, the future, that is part of their responsibility as a public good as well. So I just want to throw that in there.

Ms. TORRES SMALL. Thank you. I yield the rest of my time.

Mr. GARAMENDI. Ms. Haaland.

Ms. HAALAND. Thank you, Chairman.

And my apologies, I think there is pollen in the air or something like that, that I am not used to. In New Mexico, I would be fine, but here it is a different story. So please excuse me.

This question is for Rear Admiral Titley. The DOD provided testimony to the House Armed Services Committee last year that it had a maintenance backlog of over $116 billion. We have heard tes-

timony in both Chambers this year regarding the negative impacts that poor military housing conditions have had on the health and safety of our military members and their families, which, of course, is a readiness issue.

Rear Admiral, is it safe to say that older, poorly maintained infrastructure is also less resilient to extreme weather events such as hurricanes?

Admiral TITLEY. I think, ma'am—thank you for the question. I think in general we certainly have seen that. Building codes have evolved, structures have evolved. We see this in earthquakes. We see this in winds. We see this in flooding. In general, older buildings are less resilient.

Ms. HAALAND. Thank you for that answer.

In President Trump's press conference announcing he would divert funds from DOD programs, including military construction, for his border wall, he said that the original intended uses of those funds didn't sound too important to me, quote/unquote. Given the now well-documented substandard housing conditions existing at many bases, including in my district, like Kirtland Air Force Base, and the fact that the damage to both Tyndall Air Force Base from Hurricane Michael and Camp Lejeune from Hurricane Florence appears to exceed $3 billion for each installation, how important do you think it is that we prioritize rebuilding safe, resilient infrastructure at our military installations?

Admiral TITLEY. Again, thank you, ma'am. I can tell you, last week I was down at Fort Bragg talking to the troops in the 10th Airborne about climate issues. One of the things the troops reinforced to me was the importance of safe family housing and safe bases while they are forward deployed. There is nothing more distracting if you think that your family is not safe, for whatever reason, including extreme weather issues, but it can be other things as well. That is a huge distractor.

I lived through Hurricane Katrina and I dealt with a workforce that went through Ground Zero on Katrina. I can tell you firsthand, it is a massive distraction, unless we have adequate funding for adequate housing so that our families are taken care of because that is a critical readiness issue.

Ms. HAALAND. Thank you so much. I have a little bit of time left. I am going to move to training impacts. One of the functions of military installations is to train our force. And I think, Rear Admiral, you can take this first. Can you provide examples of how climate change impacts training?

Admiral TITLEY. There are many examples, ma'am. I will just give you two very quickly here, is, with the combination of drought and heat, and it is not just the drought by itself, but drought and heat, tend to make ranges, firing—live-fire ranges much more combustible. It turns out that neighbors don't really like it when you set fire to the range because they think their stuff is going to burn down, too. So that restricts your live fire, which we do, as you know, ma'am, very high-end training so that our troops are as ready as they can be.

The other part, and this is some research that is just going on. I have been talking to climate central on this, is, we are looking at how many and how much increase in so-called black flag days,

days where personal training is greatly restricted because of a combination of heat, humidity, and sunlight. And we believe we are seeing an increase in that. The research is very preliminary, but those are just two ways, of many, that training is being materially affected. Wildfire smoke, not just the wildfires, but the smoke can shut down low-level aviation. That is another one.

Ms. HAALAND. Yes, thank you. That is important.

Ms. Burke, would you care to——

Ms. BURKE. Yes, Congresswoman, I would agree with that and also point out that I think Fort Carson had a big fire not so long ago. So it definitely can have a direct—and that is predeployment training. So you don't want to lose any time on range.

Also, a lot of the Navy bases are littoral, of course, as you would expect, and flooding and sea-level rise can also affect both training and operations, and we certainly see that locally here down at Norfolk. They have a problem with even nuisance flooding, as they call it, meaning it is not raining and there is no particular storm surge, but they still have water on the base that is a problem. So it is definitely a problem.

Also permafrost in Alaska—which are unique training ranges, that we don't want to lose access to—as it melts, it causes all kinds of problems. So I think there is definitely a training impact.

Ms. HAALAND. Thank you so much.

Chairman, I yield.

Mr. GARAMENDI. Thank you very much.

I will now return to Mrs. Luria.

Mrs. LURIA. Well, thank you, Mr. Chairman, for letting me participate in this hearing, as I am not normally on the Readiness Committee, but I am on Seapower, and I do represent the Hampton Roads region, and so I will just quote from the recent report that was required by the 2018 NDAA and was delivered in January 2019. Navy Region Mid-Atlantic and the greater Hampton Roads area is one of the most vulnerable to flooding of military operational installations in the United States. Sea-level rise, land subsidence, and changing ocean currents have resulted in more frequent nuisance flooding and increased vulnerability to coastal storms. As a result and to better mitigate these issues, the region has engaged in several initiatives and partnerships to address the associated challenges.

So I will state that, at our local level, between Federal, State, and local government, there is a lot of coordination, there is a lot of communication. We are working to establish a center of excellence for sea-level rise and recurrent flooding through our local universities and local, State research activities.

Yet the main problem that we see is there really are not any resources currently allocated behind fixing these problems. And in the preparatory documents for today's hearing, when speaking of the same study, it says that it did not meet the congressional reporting requirements to describe future focused mitigations that would be required to ensure the resiliency that we are looking for. And reading through your testimony ahead of time, there were a couple of things that were mentioned.

So, Admiral Titley, you mentioned that simply, quote/unquote, walling off and protecting only the physical base will not be effec-

tive. I would like to comment in response to that, that, you know, throughout the local area and the three joint land use studies that are under way within the Hampton Roads area—the Norfolk one having recently been completed, Virginia Beach in progress but about to be released, and the one on the peninsula for Hampton—what I found with my coordination with the Army Corps of Engineers is that we are actually doing the opposite of that. We are not walling off the bases and only studying them. The joint land use studies within the community are not including Federal property. So it is quite a conundrum when the water doesn't care about city or municipal boundaries when our process doesn't allow us to take into account the Federal property and the impacts on that and we are only looking at it from the city level.

So, Admiral Titley, you mentioned a risk-management approach, and I think that a thorough risk-management approach and something similar to your climate-impacts handbook that would lay out the impacts and the cost to our military readiness and the cost to upgrade these facilities is really a critical thing that we need for decision making in the future. And you also said that each service should determine its top one or two. Well, we have eight major installations in the area, and in the documents, in your testimony here, the bases within our district and our Hampton Roads region are mentioned no less than half a dozen times between Norfolk and Joint Base Langley-Fort Eustis. And I, you know, laud your quoting of the part about the sandbags, but, you know, just finding a solution to cut sandbags by 70 percent is really just the tip of the iceberg on what we are going to need to do in our region to combat sea-level rise and recurrent flooding.

So, Mr. Loris, I will quote you. You said that DOD should identify current and near-term vulnerabilities and make the necessary and targeted spending to strengthen military installations. So I agree with that completely. But as you know, also, we have to deal with limited resources, and I think, one, we need to identify these issues, we need to study them, and we need to determine our priorities. But I also think that we can address these as well with some other things that don't necessarily immediately cost money. There is quite a bit of land in our region, for example, that doesn't directly benefit the military's mission, and I think that coordination between the localities and the adjacent military bases and installations, that land could be used to facilitate flooding mitigation, essentially at no cost to DOD but in a sharing partnership where the land could be provided to some degree for use by the municipalities and then also to mitigate the flooding on DOD installations and the access roads.

And I will finish by going back to the list of things that were authorized in the 2019 NDAA, which is the Defense Access Roads Program. That is an essential program, but we didn't put any money behind it last cycle. So, with the local municipalities in our area have identified numerous access road projects that will benefit the reliability of access to our military bases within the region, and I think that that is very important that we put resources behind that to provide for future resiliency.

And, lastly, the new-start designation by the Army Corps of Engineers, I think that we should look at in that process through the

Army Corps of Engineers, flooding and sea-level rise and the impact of flooding and sea-level rise on military readiness as additional factors in determining how we rank those limited number of new-start or even potentially add additional new-start designations on a yearly basis to take into account the impacts on DOD readiness since there is a limited number of those designations offered each year.

So thank you. And thank you for giving me the opportunity to speak. I know I didn't really ask a question, but because this is such a critical issue to our region and all of our services and Coast Guard located in the area, I just really appreciate the opportunity to speak and provide feedback on, you know, the good research that you have done here and how that can help, you know, us as armed services make——

Mr. GARAMENDI. The information you provided is very, very helpful to us. We know that we have to deal with the ports—or the military, naval institutions there. And your background will be very useful as we sort out how we are going to do that and allocate money and resources.

Mr. Carbajal, you are next, and then we are going to turn to the two members of the committee that have joined us. So——

Mr. CARBAJAL. Thank you, Mr. Chair, and I, too, am not part of this committee, so I appreciate the opportunity to participate with this subcommittee.

In light of some statements that have been made, I think it is important to recognize that we are not trying to use the military or national security as a tool to promote or advance a political argument that climate change is real. There is no question that climate factors are impacting military missions globally, whether it is in the Arctic or in Africa, such that the former Secretary of Defense Mattis once said that one of the most significant threats facing our national security is climate change.

And our jobs, along with the military's, is to ensure that the planning and resources are in place to address factors that may disrupt our missions and this includes climate factors. Unfortunately, until recently we have not provided the necessary resources for the Department of Defense to address the impacts of these climate factors, which is why we are here today.

I agree with Ms. Burke that the instability effect is the most important climate security concern. Climate change is and will continue to be a factor in a host of human security issues. And oftentimes these human security issues lead to regional conflict, which may or may not involve the intervention of the American military. Furthermore, unresolved human security issues leave a void that terrorists or extremist groups can take advantage of. When looking at long-term planning for the U.S. military and installations, climate factors must be considered.

I represent Vandenberg Air Force Base. Vandenberg suffered from a severe canyon fire in 2016, where several facilities on the base lost complete power, and a scheduled rocket launch was canceled. The facilities that lost power were operating off a generator until the power lines were repaired. If a base as big as Vandenberg lost all its power due to another disaster, I wonder if their genera-

tors would be able to provide them power, enough energy, to function for 14 days.

Ms. Burke, actually, I am very concerned about the risk that wildfires pose to our installations.

Ms. Burke and Admiral Titley, can you characterize the way that wildfires threats have changed, and, two, what kind of steps can installations take to improve the resilience to this threat?

Admiral TITLEY. Okay. I am told the science goes my way. We will try not to make this too much of a science thing, but basically, as you know, sir, certainly in California—but we see this in large parts of the country—the wildfire season is expanding. And when we see fires, they tend to be more intense. There are many reasons for this, but one of the reasons, not the only one, but one of the reasons is certainly the increased heat and what we have seen as drought in many places. So the risk from wildfires, regardless of the cause, is going up.

As far as the mitigation, I think places like CAL FIRE [California Department of Forestry and Fire Protection] and some of the Federal agencies have pretty good understanding of how do you deal with these fires, including setbacks, including the kinds of roofs, including the way you build basically barriers. But I think unless you have been in one of these fires, or near them, it is impossible to understand how fast they go, how hot they go, and how far they can throw embers, which then get the fires going.

So, again, as I have mentioned several times here, the future is not like the past, and we have to, as we build or rebuild places, we have to think about how do we manage, if we are going to be in an urban-wildfire interface, how do we manage that, and can we manage that, or do we need to move?

Ms. BURKE. Congressman, thank you for your question, and as a native Californian, I respond in particular to the fire risk. It is where my family is, so I am very concerned about it. I think for the military, you asked—you made some very cogent points. It is about resilience to the mission, and my former colleague—John Conger, is sitting behind us—did a lot of work on just how much generator capacity bases have on hand. And I don't think anybody has 14 days of backup power. So that is an excellent point that that would be a problem, and they would have to figure out what to do about it. This is one reason why microgrids are a potentially good solution to be looking at, as well as other kinds of resilience investments.

I also think it is worth talking about the mission impacts. So, if wildfires in a place like California, which I am pretty sure that the Department of Defense is the single largest employer and landholder in the State—so I don't think a lot of Californians know that, but it is the case. And there is a huge variety of kinds of missions, and then there is also the National Guard, the California National Guard, which is very actively responding to these kinds of incidents. So I think that the Department of Defense needs to do a better look at what is the future trend line for these kinds of disasters. You know, how much more frequently are we going to see disruption or are we going to see missions? I don't believe they have done that kind of deliberative, active planning for these kinds of disaster missions, and I think it is really important that they do.

Mr. CARBAJAL. Thank you, Ms. Burke.

And, Mr. Chair, if I could just finish with the 20 seconds that I have to conclude here, I just want to reiterate that in my district I also represent Camp Roberts, and they have expressed to me that they don't believe they could sustain 14 days if they lost power on a generator. This is a readiness issue, and I do hope that we address this important—these important issues in this year's NDAA.

Thank you, Mr. Chairman. I yield back.

Mr. GARAMENDI. Thank you, I will not get into the fire issue because that could go on for several hours.

However, I would like to call upon Mr. Kim for questions.

Mr. KIM. Thank you, Chairman.

Thank you so much for taking the time to come and brief us on this and take our questions.

This is an issue that I am trying to wrap my head around more, in terms of how DOD presence in my district connects with climate issues across the board. And the way I am thinking about it is in terms of three angles. One is about response. So I live in New Jersey, the Third District. This is where Joint Base McGuire-Dix-Lakehurst is, and that joint base served as the focal point for the coordinated response to Superstorm Sandy. So I see that as one angle in which DOD is connected with climate issues in my district, because we know that it is going to be a matter of when, not if, we get hit by another storm.

Two, it is about research, and research and assessment. Right now, we have the Army Corps of Engineers in the district doing an assessment on back bay flooding and sort of the issues there and what we can do to mitigate the constant threat that we have from rising sea levels and other issues.

And the third one is about resources. And I think a lot of what has been talked about here in terms of the footprint of the joint base, energy consumption, and different angles on what we can do to try to make the joint base to be stronger in terms of drawing upon alternative sources of energy.

I just want to start by, is that the right frame, or is that a helpful way for me to approach it? Are there things that I am missing, other angles in which I should be thinking about how to draw upon DOD and involve them on these issues of climate in my district? And, number two, more specifically, when it comes to energy issues, what are your thoughts, kind of seeing across the board? You know, I kind of focus and zoom in on McGuire-Dix-Lakehurst, but what are the other kind of ways that other bases, especially in the Northeast, are approaching trying to diversify their energy sources? So I will just open that up to the group.

Admiral TITLEY. Thank you, sir. I will take a shot at a very quick response to that. I think that is a pretty good way, in fact, it is a really good way of thinking through things. I might add a fourth R, and that is resilience. It is hard to be the center of response if your base itself is kind of beaten up there.

On research, I will just plug something that the Congress has supported now since fiscal year 2013. There is a program the Navy submitted called Earth System Prediction Capability, and basically this is a program spearheaded by the Navy, but with NOAA, NASA [National Aeronautics and Space Administration], and our National

Labs, and the U.S. Air Force, of course, to work what I call the zero hour, or very near-term weather, all the way out to about three decades. And they are really working on the seasonal and subseasonal part right now.

So how do we give planners an idea all the way from 90 days to a year, not only in the United States but also where potential contingencies may come? The Congress and both Armed Services Committees in the Senate and House have been very supportive of this program. The Weather Research Forecasting and Improvement Act directs NOAA to collaborate with the Department of Defense on this important program.

So, in addition to SERDP [Strategic Environmental Research and Development Program] that has already been mentioned today, I just wanted to mention that since you talked about research. I will defer to the other witnesses on your other parts of the question on the energy, sir.

Ms. BURKE. I think it is a good frame for looking, Congressman, at the issues and particularly the bases are—you know, it is definitely a hierarchical command as you know, but it is also very decentralized. And the bases have a lot of latitude to engage with the communities around them. And so not just to call on DOD for research and support, but also to work with local universities and municipal authorities to investigate risk in the same way that Congresswoman Luria mentioned.

I think also Congresswoman Haaland mentioned that as you are looking at spending for bases, these are the kinds of issues you should be considering upfront, not as a sort of after the fact, asking them to take it into account. Ask them to take it into account upfront as they are getting their money. And there are other research pots of money that can also support this kind of activity, this kind of research.

Mr. LORIS. Yeah, I would echo that. I think the cooperation is key when you are looking at cooperation with the local community, with local experts who have been in that region and have studied different land use changes over time. Pulling in the appropriate scientists and the specialized knowledge and expertise to better help DOD identify what that preparedness for resilience should ultimately look like.

I think, when I have seen DOD installations make the necessary adjustments to storms and learn lessons from previous storms, engaging those appropriate stakeholders has resulted in productive outcomes to minimize the risks for infrastructure and personnel in the future.

Mr. KIM. Great. Thank you. That shared foundation, shared language of how we approach these problems is something that we are trying to build with the community. As we know, we have different interests and perspectives coming at this from different angles, and hopefully that will help us in our own district. Thank you for your input. I yield back.

Mr. GARAMENDI. Thank you, Mr. Kim.

Ms. Houlahan.

Ms. HOULAHAN. Am I last but not least?

Mr. LAMBORN. Last but not least.

Ms. HOULAHAN. Okay. Thank you so much.

Mr. GARAMENDI. No, actually, Mr. Lamborn and I have the last word.

Ms. HOULAHAN. Wonderful, wonderful.

And thank you so much for the opportunity to ask questions of you all.

I have a similar line of questioning in the sense that I am using personal experience to try to make sure I can wrap my head around these really important issues.

I served in the military. I served in the Air Force. I did my field training at Tyndall Air Force Base, which is no longer really an operational base. And one of the things I read in the preparation materials was about black flag days. And back when I was doing my field training, we had a lot of them, and this was in the late 1980s. Those days when we weren't able to exercise, we weren't able to get ready, be ready, because the weather was just too awful.

And fast-forward another 30 years, and as you know, the climate has gotten increasingly more and more erratic down in that area to the point where, with that latest hurricane, it has obliterated much of Tyndall Air Force Base. So one of my questions has to do with, do we have a way to quantify and measure those black flag days and the consequences to our readiness and to our troop training? That is my first question, and I don't know which one of you all would be best able to answer that question.

Admiral TITLEY. I will start with that. I think as you look at putting together training—now, I have not run a training base, but I have been responsible for training in other—other components—you always build in a little bit for, you know, for weather, for other contingencies. Similar to humanitarian assistance, we can do some of it, and it really doesn't impact things that much, but at some point, you start impacting readiness, right? I mean, it is like a shutdown. You can do a shutdown over a weekend, but you do it for a month, and there is a big—there is a huge impact.

As I mentioned earlier, we are actually looking at trying to quantify the increase in black flag days, and that would be sort of the first step. Do we see how much has changed up until, let's say, 2019, and then using various models, how much is it going to keep changing. And then my recommendation, ma'am, is work with the training commands of the services to say: Hey, at, be it where, you know, the different services do their training, tell me the impacts.

So I would kind of go to the horse's mouth, if you will, of the people who are responsible and accountable for training, whether it is advanced or basic training or anything in between, and say: If you have these kind of days missing in, let's say, 10 years, 20 years, 30 years, what will you do? How will you manage that risk? And that is how I would look at it to try to really find out from the people accountable, how are they going to do this rather than——

Ms. HOULAHAN. Can I ask a more proactive question then, which is, I guess, that I would assume that we probably know the answer to that question in that in the last few decades, there has been more and more of these kinds of days. Should we be more proactive in the sense of not maybe placing training bases in the panhandle of Florida and maybe putting them somewhere where the weather may be more temperate and more realistic, more days available for training?

Admiral TITLEY. Well, I used to live in Mississippi, and now I live in Pennsylvania, so you can take that, maybe, as an answer. I think we are going to have to look at that. And I know this becomes incredibly contentious, right, because that sounds, you know, like a four-letter word starting with B, and I am not going to grab that 440-volt line right now. But we are—you know, one of the things I think the Department, from a readiness perspective, has to look at, is, where best can we do the missions? Lots of things go into that, but weather is one of those components.

Ms. HOULAHAN. So my last question, with my last minute, has to do with Tyndall as well, which as one of my colleagues from a former life has recognized, that—that construction and resilience is a big deal, you know, making sure that we are prepared for the climate of tomorrow. And so she is in the process of—literally the innovation is longer nails for roofing, you know, so that wind speeds won't necessarily tear roofs off the way that they have been. Is that something that in rebuilding a base like Tyndall that we are already thinking about, as sort of those resilience, and are we learning from the civilian sector in terms of how they are rebuilding things?

Admiral TITLEY. In my written statement, ma'am, I recommend we do that. So I will give you an example. After Andrew went through Homestead, Florida learned a lot of this and they had pretty good building codes. I then bought a house a decade after Andrew. It was a new house, north shore of New Orleans, Lake Pontchartrain. No building codes. Oh, hurricanes don't come here. Well, they do, and they have huge impacts. So it is not only learning the lessons—we know a lot of these lessons; they aren't rocket science; they aren't even that hard—we need to execute them. We need to do it on our bases but also in our communities where our people are living.

Ms. HOULAHAN. Thank you very much, for everyone, for sitting and waiting for me. I am sorry. I was at a different—different hearing——

Mr. GARAMENDI [continuing]. Stick around.

Ms. HOULAHAN. Of course.

Mr. GARAMENDI. The final words will be from Mr. Lamborn——

Ms. HOULAHAN. Of course, sir.

Mr. GARAMENDI [continuing]. And myself.

Mr. Lamborn.

Mr. LAMBORN. I want to thank the witnesses for being here. I appreciate the testimony of each one of you. And I do want to call attention to the fact, I mentioned this earlier, on pages 7 and 8 of our hearing memo, there are scores of provisions that, on a bipartisan basis, we put into the NDAA over the last 2 years, when Republicans were in the majority, and here are the kinds of provisions that we put in there: Section 2831(a) adds energy resilience as an element of readiness policy for the Department, directs the Department to ensure readiness of the Armed Forces through pursuing energy security and energy resilience. Section 2833 requires the Secretary to prioritize energy security and resilience in awarding energy and fuel contracts. Section 314 encourages development of operational energy policies that improve warfighting capabilities through energy resilience and energy security. Section 312 includes

energy resilience and energy security measures among the list of uses for energy cost savings resulting from energy savings contracts.

And I could go on and on. So this is something Congress has been diligently pursuing. I am glad that we will keep giving attention to it, and any time we can save the taxpayers money by finding cheaper sources of energy, to me that is a good in and of itself because we spend a large amount of money, but we can't afford to have any of them misspent or used inefficiently, whenever possible, for the sake of the taxpayers.

Plus, using less energy also has environmental benefits, and I would absolutely agree with that as well. So let's keep working on these things. I appreciate having the hearing, and, Mr. Chairman, I yield back.

Mr. GARAMENDI. Mr. Lamborn, thank you very much.

Just a couple of comments. First of all, a very big thank you to the witnesses. Your willingness to engage in the discussion with us has been extremely helpful to all of us.

I wanted to just briefly address the issue that Ms. Houlahan raised with regard to Tyndall Air Force Base. It is in harm's way now. It has been in the past and it will be in the future. And the question that this committee is asking—and we will expect an answer from the Air Force—does it make any sense to rebuild at that place? There are some very powerful reasons to be at that place, having your own experience with the exercise testing range offshore. All very important, but we are going to ask the very, very hard question about just how much is going to be done at that base. And similarly with Camp Lejeune, are there other places that certain parts of the mission or all of the mission should be conducted? And then, if it must be at those locations, the requirement will be that it be built to maximum resiliency given the threats that exist there. Similarly, on every other MILCON project, wherever it may be around the world, that the all new MILCON, all new reconstruction or improvements be built to maximum resiliency for the threat in that area. That is what I think this committee intends, listening to the witnesses, listening to the participation here. So we will be moving in that direction.

I will also note that I was really pleased to hear Mr. Scott talk about methane from a landfill next to Beale Air Force Base, as a very large landfill that has not been utilized for its methane but will be in the future, and I suspect there will be some sort of a pipe from that landfill to the microgrid at Beale. And any other place we have a landfill, we will use it. Enormous potential here and enormous need.

Thank you very much for the witnesses and for the participation of the members.

Mr. Lamborn, thank you.

Mr. LAMBORN. Thank you.

Mr. GARAMENDI. We are adjourned.

[Whereupon, at 4:02 p.m., the subcommittee was adjourned.]

A P P E N D I X

MARCH 13, 2019

PREPARED STATEMENTS SUBMITTED FOR THE RECORD

MARCH 13, 2019

Statement of the Honorable John Garamendi
Chairman, Readiness Subcommittee
"Ensuring Resiliency of Military Installations and Operations in Response to Climate Changes"

March 13, 2019

Good afternoon.

Ladies and gentlemen, I call to order this hearing of the Readiness Subcommittee of the House Armed Services Committee.

Is the US military ready for Climate Change? Recent events indicate considerable doubt. Just this last year Hurricanes Florence and Michael caused billions of dollars in damage to Camp Lejeune and leveled much of Tyndall Air Force Base. California wildfires led to the evacuation of family housing at Camp Pendleton, Naval Air Station Point Mugu, and the Marine Corps Mountain Warfare Training Center. In addition, our coastal installations and their surrounding communities are already experiencing significant flooding due to sea-level rise. The Army's Ronald Reagan Ballistic Missile Defense Test Site at the Kwajalein Atoll in the South Pacific is threatened by sea level rise and may not last 20 years. The Navy's principal Atlantic Base Norfolk/Hampton Rhodes and the Naval Academy are already experiencing flooding. Melting polar ice in Arctic regions has already opened new sea routes and competition for resources, yet it appears that DOD has not developed a systematic strategy for ensuring U.S. national interests in the Arctic.

The United States military is one of the largest employers in the world. It is also one of its largest consumers of energy. The DOD owns millions of acres of global real property, including over 550,000 facilities valued over a trillion dollars, and the Department is uniquely situated to enhance its readiness and resiliency through effective energy policy and programs. Installations are where we generate the force, train and sustain them, and in many cases house critical operational missions. One way to enhance readiness is to consume less. In FY 2017, the DOD consumed over 85 million barrels of fuel to power ships, aircraft, combat vehicles, and contingency bases at a cost of nearly $8.2 billion. In many cases, through contract vehicles such as energy savings performance contracts, these energy saving and resiliency enhancing improvements can be made at no up-front cost to the Department.

In contested environments, better fuel consumption rates extend range and mitigate risk related to resupply convoys. Naval vessels are vulnerable during at-sea replenishment. For austere land-based sites in remote locations supporting contingency operations, lowered fuel and water consumption rates are an essential readiness enabler, helping the facility to maintain a lower profile.

It is essential that our bases and facilities recover quickly from extreme weather events and energy disruptions that impact mission capabilities. Section

335 of the FY18 National Defense Authorization Act required the Department of Defense to report on the Effects of Climate Change on the Department and propose mitigation plans. The required report was delivered to Congress in January 2019 and indicated that two thirds of the 79 installations reviewed are vulnerable to flooding, more than half are vulnerable to drought, and about half are vulnerable to wildfires. Unfortunately, the report did not meet the congressional reporting requirement to describe future focused mitigations necessary to ensure mission resiliency.

To ensure it can perform its national defense mandate, the Department of Defense must plan for a variety of exigencies. In the 2014 Climate Change Adaptation Roadmap, the Department noted that "Rising global temperatures, changing precipitation patterns, climbing sea levels, and more extreme weather events will intensify the challenges of global instability, hunger, poverty, and conflict. They will likely lead to food and water shortages, pandemic disease, disputes over refugees and resources, and destruction by natural disasters in regions across the globe."[1]

Not only are these climate-related events impacting installation readiness, but they are also creating more frequent requests for military support for disaster relief and humanitarian assistance. Both active duty service members and national guard personnel are increasingly responding to assist communities impacted by these events.

Climate change presents a myriad of readiness challenges both at home and abroad. It is not only a future threat, but is impacting resiliency of our installations and operations today. The Department must act now to address these challenges.

From our witnesses today we hope to learn from their perspectives on readiness impacts from changing climates and what actions the Department should be taking to address these challenges.

With that, I would like to turn to our Ranking Member, Congressman Doug Lamborn of Colorado, for any remarks he may have.

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[1] Department of Defense 2014 Climate Change Adaptation Roadmap, forward, https://www.acq.osd.mil/eie/downloads/CCARprint_wForward_e.pdf

Opening Statement
Ranking Member Doug Lamborn
Subcommittee on Readiness
Ensuring Resiliency of Military Installations and Operations in Response to Climate Changes

March 13, 2019

Thank you, Mr. Chairman. I applaud the ongoing efforts of the Department of Defense to make installations more resilient and both installations and operations more efficient, but I wish to note from the outset that the Committee on Armed Services is not among the committees of jurisdiction for climate change matters. I understand the House Majority has directed each of the committee chairs to have a hearing focused on "climate change," however, when national energy policy is debated, this Committee's role is to ensure that any emerging policy does not adversely affect military operations—an important, but far narrower subset of the climate change debate.

As each of our witnesses have noted, many of the Department's 500 installations have experienced the effects of severe weather. The United States armed forces must be prepared to operate in adverse conditions; further, it behooves all of us to conserve resources wherever possible. In the case of military operations, fuel and water are critical commodities needed continuously, but are difficult to transport.

We depend on our military forces and installations for national security and cannot afford lapses in either. Our forces and our bases must be able to operate in all conditions of conflict and weather. We must take responsible action to make military installations more resilient and responsible action to lighten the logistical burdens on our operational forces. I emphasize responsible…by that I mean measures that enhance resiliency and national security, not arbitrary goals established for other reasons.

I raise this concern because, in the past, environmentally based mandates have squandered too much money on "greening" the military. Given the minute percentage of the nation's total power usage the DoD represents, placing arbitrary and costly mandates upon the military does not meaningfully affect global climate change, but it does reduce the Department's readiness.

As we seek to enhance the resiliency of bases and reduce the vulnerability of our resource supply chains, I look forward to hearing about potential solutions. But insofar as we diverge from our subcommittee's jurisdiction in order to blame climate change for the actions of international terrorist organizations and intergenerational tribal conflicts, I believe it will be a distraction from rebuilding our military's readiness at best and an excuse to pursue boondoggles at worst.

Thank you, Mr. Chairman. I look forward to our witnesses' testimony.

Ensuring Resiliency of Military Installations and Operations in Response to Climate Changes

David W Titley, Rear Admiral USN (Ret.), Ph.D.
Professor and Director, Center for Solutions to Weather and Climate Risk
The Pennsylvania State University

Statement to the United State House of Representatives
Committee on Armed Services
Readiness Subcommittee
13 March 2019

Thank you, Chairman Garamendi, Ranking Member Lamborn, and distinguished members of the Subcommittee, for the opportunity to testify today. This is a privilege to come before you at this hearing and discuss this very important topic.

I am David Titley and currently serve as the Founding Director of the Center for Solutions to Weather and Climate Risk at the Pennsylvania State University. I also hold appointments as a Professor of Practice in Meteorology and a Professor of International Affairs. I had the privilege of serving in the United States Navy for 32 years and retired in 2012 as a Rear Admiral and Assistant Deputy Chief of Naval Operations for Information Dominance. When I retired, I was also the Oceanographer and Navigator of the Navy, and Director of U.S. Navy Task Force Climate Change. Subsequent to my time in the Navy, I served as the Chief Operating Officer position of the National Oceanic and Atmospheric Administration (NOAA). I serve on the Board of Directors for the Council on Strategic Risks, the Advisory Board of the Center for Climate & Security. I am a member of the CNA Military Advisory Board and the National Academy of Science Board on Atmospheric Sciences and Climate. My Center at Penn State currently receives no government or private sector funding; my views today are my own. I am testifying this afternoon in my personal capacity and do not represent any of the organizations named above. I am here today because I believe it's important to discuss the challenges to our nation's security posed by a changing climate, and how we can best manage that risk. Thank you for holding this hearing.

First, **I wish to thank the House** – and the Senate – **for the addition of forward-thinking climate-related amendments in each Chamber's mark-up language for the National Defense Authorization Act** in 2018 and 2019**.** I encourage you to build on those actions with additional measures in the FY 2020 National Defense Authorization Act to further strengthen Department of Defense's ability to become more resilient and to manage the risk posed by climate change. Amendments such as Congressman Langevin's 2018 language directing the Department to identify their most vulnerable installations, and the 2019 language that includes directing the Defense Department to fully address climate-related risks in installation master planning, as well as legislatively defining the term "military installation resilience" are most constructive. Speaking as one with nearly 35 years' experience in the Executive Branch, I will

tell you it is hugely helpful to have Congressional language and intent that encourages the DoD to think in a proactive manner when managing climate risks. These bi-partisan actions would not have been possible without significant Republican support. Thank you!

In the Navy we have a saying, to just give me the 'Bottom Line Up Front' or BLUF. So here's my BLUF – or four major points -- for today's hearing:

- **The extremes of yesterday do not foretell the extremes of tomorrow:** The change in the climate, and therefore the change in the weather, is real. Multiple independent sources of data show a rise in temperatures and rise in the ratio of record high temperatures to record low temperatures; an increase in the intensity of precipitation events – that is, the hardest rains are getting harder; the continued collapse in the area and amount of summer-time sea ice in the Arctic Ocean; an acceleration of sea level rise; acidifying oceans; and ecosystems moving poleward and up in elevation where possible. We understand why the climate is changing, based on science extending back to the mid-19th century. The basic concept of greenhouse gasses trapping heat and keeping the atmosphere warmer than it would be in the absence of these gasses is extremely well understood. This idea explains not only the temperature of the Earth, but the same concept also applies to understanding the temperatures of Venus and Mars.[1]

  While we plan for climate, we live in weather – its day-to-day variations, and more importantly, its extremes. The challenge for readiness and resilience is to ensure our military bases and infrastructure are designed for and can withstand the extremes tomorrow – which we will not understand by simply looking back over the past 50 or 100 years.

- **The rapid and continual change in climate will have significant impacts on our national security:** The climate will continue to change, rapidly, for the remainder of the 21st Century and likely beyond. The days of climate stability that we have experienced for most of human civilization are over. All aspects of society, including the security enterprise, will no longer be able to assume that "the past is prologue" when considering the future physical environment. Specifically, the changing climate impacts National Security in three major ways. Climate change impacts our security by:

[1] MacCracken, M. "Climate Change in Six Well-Documented Findings". http://www.climate.org/topics/climate-change/science-in-six-findings.html

- **Changing the battlespace, or the physical environment in which our Soldiers, Sailors, Airmen and Marines will operate.** The Arctic is a prime example of an operational environment that is changing rapidly today.
- **Posing increasing risks to the Department of Defense's bases and training ranges.** Without fully operational bases and training ranges in the United States, in addition to key overseas bases, U.S. forces cannot maintain the levels of readiness required by our National Command Authorities and Combatant Commanders to execute our defense missions. In addition to sea level rise threatening our coastal installations, other bases and training ranges are at risk from increased frequency and severity of wildfires, droughts and floods not previously experienced. In addition, sustained smoke from wildfires and an increasing number of days with excessive heat and humidity can significantly degrade the training value of that base or range.
- While not the focus of today's hearing, it is important to also note that **a changing climate can make already unstable situations worse, sometimes catastrophically so.** Climate change is rarely the sole contribution to a nation-state failing, or conflict breaking out. However it can be a powerful link in a chain of events that, if not broken can lead to runaway instability. While large-scale human suffering often accompanies these situations, U.S. military forces are frequently directed to these areas and our troops are placed at risk. As we have seen with Syria, once the geopolitical situation deteriorates to a point where there are no good policy options, other opportunistic countries can move in and exploit the instability to their advantage – to the detriment of U.S. interests.

- **We know how to succeed even when the future is not perfectly known:** Traditional risk planning takes the chance or probability of an event and multiplies it by the impact. But even when it is difficult to assess the likelihood of a specific event, there are still available methods by which risk planning and mitigation can be accomplished. Our national security teams frequently have to account for these "deep uncertainties" and they have a variety of tools to assist them. Rich scenario planning, assumptions-based planning and similar methods can be used with the goal of identifying all plausible vulnerabilities and their subsequent impacts. National Security and strategic military planners have used these tools successfully for decades – we can apply these methods and adapt them to the climate change challenge.

- **There are actions we can and should take today**. The Department of Defense should resource and take actions today that will buy down some of the nearest-term risk, ensure that climate-sensible policies already in place are followed, and lay the groundwork for continued adaptation to a changing climate. For the Department of Defense, climate change and its manifestations is a risk that will need to be managed for

decades to come – it is not an issue that will be solved with a single policy or program. I provide six recommendations to enhance installation resilience and an additional four recommendations to improve our posture in the Arctic.

Risks to National Security from Rapid Climate Change

The security establishment does not view this issue as partisan. At its most fundamental level, this is simply about the ensuring current and readiness of our Armed Forces and managing externally imposed risks. The Department of Defense has taken the challenge of climate change and national security seriously for over a decade, spanning the George W. Bush, Obama and now Trump administrations. Our forces must be prepared to operate in a rapidly changing Arctic, with decreasing sea ice, increased human activity, an ascendant Russia and an opportunistic China. Our forces must be equipped to train and operate in areas of increasingly prolonged extreme temperatures and heat stress. Our bases and our training ranges must be resilient to the impacts and stresses of increasingly extreme weather, as we generate the readiness of our soldiers, sailors, airmen and marines from our infrastructure. Our overseas defense infrastructure is no less critical to ensuring readiness, and unfortunately no less vulnerable to a changing climate.

For today's hearing I will focus on operations in the Arctic and the resilience of our military installations.

Security Issues in the Arctic

Over the past few years in the Arctic, we have seen an exponential rise in the activity in the Arctic; more shipping, more resource extraction and more posturing for control over the resources. The Arctic is an example of where climate change could serve as a catalyst for international cooperation. The world is not yet prepared to respond to an accident or disaster that could occur with increasing shipping and energy exploration in this fragile region with limited infrastructure and extreme operating conditions. Some work has been done across the U.S. government in putting together plans for increased future operation in the Arctic, with the Navy's 2014 Arctic Roadmap as one example. The challenge is that the increase is happening now. 73 ships sailed through the Northwest Passage in 2013, up from 4 in 2007. Preparations for energy exploration are well underway and when oil prices rise, as they always do, the Arctic will be a tempting and economically viable area for exploitation. We assess that today we do not have the communications equipment, navigation aids, and sufficient ice hardened ships to respond to natural or manmade disasters in that fragile area or to protect our vital interests. In other words, we are not prepared in the short term for the rate of increase and we must invest today in increasing our capability and capacity.

This increase in Arctic human activity is playing out on a backdrop of increasingly assertive Russian activity in the Arctic. While the Russians maintain their military buildup in the High North is peaceful and for defensive purposes only, it is impossible for us, our NATO allies, and our partners to ignore the aggressive operations of Russian forces in that part of the world and their high-readiness, no-notice snap exercises. Regardless of intent, Russian forces have, over

the past few years, significantly upgraded the ability to operate and command and control forces in the Arctic. Their actions are disconcerting to our allies; we would be remiss to completely ignore this change in security dynamics.

The Arctic's physical environment is changing faster than any other place on Earth today: Today's Arctic climate continues to warm at a rate twice that of the rest of the world. Temperatures at the North Pole the past three years have reached the freezing point – in the middle of winter. Prior to 2016, this was virtually unheard of. While these days make headlines – especially when it's colder in Washington than at the North Pole – the real news is how much less cold there is in the Arctic relative to even 30 years ago. Over the past three winters, most of the central Arctic has been 5 to 7 degrees Fahrenheit warmer than normal. To put this into comparison: that much warming in Washington DC would make the winters here more like those in North Carolina.

One of the many effects of this tremendous warming has been to thin the ice. 30 years ago, there was nearly as much old hard thick ice (scientists call it 'multiyear ice') as there was first year ice. Now nearly 80% of the ice you see in any picture of the Arctic is softer, thinner first year ice, and only 20% of the ice has lasted for more than one year. So the Arctic sea-ice is changing in two ways: it's not only decreasing in extent, losing over 13% each decade each September, but it is also rapidly thinning. Combined, these changes lead to a much more variable, dynamic ice pack that will make maritime transportation more tempting, more feasible – and paradoxically more hazardous due to rapidly changing and less predictable conditions.

Our rivals are paying close attention to the changing Arctic, even if we were not: While the United States has shown, at best, sporadic and episodic interest in the Artic, our great power rivals, as defined in our National Security Strategy, have made deliberate investments in planning and resources. The Russians are actively monetizing their Northern Sea Route and rebuilding their Arctic military capabilities, albeit from a very low post-cold war level. After western sanctions were imposed following Russian actions in Crimea and the Ukraine, Russia has courted Chinese investment for their fossil fuel industry. China meanwhile released its Arctic Strategy in January of this year. China declares itself to be a "near Arctic State" and hopes to jointly build a "Polar Silk Road" – likely the Northern Sea Route -- as the northern flank in its "Belt and Road" initiative. China continues to court the Nordic states and Greenland, likely looking for a combination of natural resources and an Atlantic terminus to any future trans-polar shipping route.

I am happy to report that in recent weeks and months our senior military commanders have begun to speak out about U.S. interests in the Arctic. The Secretary of the Navy has publicly spoken about the need for surface Naval presence in the Arctic and recently Admiral Jamie Foggo, Commander of U.S. Naval European forces stated that the Arctic is "nobody's lake"[2].

[2] https://www.washingtonexaminer.com/policy/defense-national-security/its-nobodys-lake-us-admiral-warns-china-and-russia-over-arctic

Earlier this month, in response to questions from Senator Warren, General Curtis Scaparrotti, Commander of the U.S. European Command, described how Russia is taking advantage of warming Arctic conditions by moving additional weapons into the region, and how those actions required U.S. forces to modify their planning[3].

There is still time to execute a deliberate strategy that will assert our economic and security interests, assure our allies, and ensure we are ready for the future that will be very different than the past: In May 2009, at the direction of then Chief of Naval Operations Admiral Gary Roughead, I initiated and led the U.S. Navy Task Force on Climate Change. The U.S. Navy started this task force, not in response to any perceived political pressure, but as a reaction to the collapse of sea-ice in the Arctic in the summer of 2007. Admiral Roughead asked me to assess the conditions in the Arctic, and provide him with recommendations for the Navy's response. My conclusions were that the sea-ice collapse in the Arctic, which happened well ahead of most of the computer models of the time, was the leading edge of climate changes to come that would change the operating environment for the Navy. The goal of Task Force Climate Change was to prepare, in a deliberate manner, the U.S. Navy for this future environment, with an emphasis on getting ready for the Arctic, as it was the change that would likely impact the Navy first.

In 2009 I characterized the Arctic as "a challenge but not a crisis". However I said if we ignored changes in the Arctic or were slow to respond, we heighten the risk of the region becoming a crisis. We need to address the Arctic taking a "system of systems" approach. We need to address our security, economic, scientific and certainly social issues in the Arctic, while simultaneously understanding the motives and intentions of Russia and China and assuring our allies and friends.

Shipping Issues in the Arctic

It's important to outline the many challenges that arise for any arctic maritime transportation operations today or for the next couple of decades, at least. The old Facebook status said it best: "it's complicated".

- It's cold and austere. Yes, the temperatures are warming in the arctic and the ice is melting at unprecedented rates. However, it can still be very cold (-30 degrees) in the winter and very foggy in the summer. It's dark for many months in the wintertime. As the ice thins and breaks up it becomes even more difficult to predict. Thick ice can be like hurricanes: it only takes one to ruin your whole day. Shell found this out to their chagrin in 2012. While the Arctic as a whole experienced record-low sea ice that year, relatively small pieces of multi-year ice floated into the Chukchi Sea and disrupted their offshore operations.
- There is much work still to do charting safe passages and routes for arctic shipping. I'm pleased to note some of this work is underway, with NOAA ship surveys and the Bering

[3] https://climateandsecurity.org/2019/03/06/gen-scaparotti-and-gen-lyons-agree-with-intelligence-assessments-on-climate-change/

Sea Traffic Separation Scheme that will come into effect this December. However, much of the Arctic Ocean has yet to be surveyed to modern standards.

- If you get in trouble, you may be on your own. Although the Arctic Council has led the implementation of both a Search & Rescue and a Marine Oil Spill Agreements, it's one thing to have a signed agreement, and another to have the resources and training to be able to respond effectively when the call comes.
- The combined impacts of the above-listed bullets give shippers, and more importantly, insurers, pause when running shipping through the Arctic.
- The current routes available for navigating across the Arctic, that is the Northern Sea Route across Russia's coast and the Northwest Passage through the Canadian archipelago, have significant draft limitations for modern commercial shipping. The Northwest Passage is also a technically demanding navigation detail, particularly in waters subjected to high winds, poor visibility, and rapidly varying and unpredictable ice conditions.
- Both Canada and Russia claim parts of their respective sea routes through the Arctic as 'internal waters'. While the U.S. does not recognize these claims, the lack of agreement in governance of specific waters adds uncertainty to any risk equation.
- The current business model of the container fleets stresses both reliability of delivery date and shipping very large numbers of containers to reduce fixed costs. As of today, and likely for the next 10-20 years, those constraints will continue. Once a seasonally iee-free trans-arctic route opens up, most probably sometime in the 2030's, these conditions might change.
- We should always be aware of the potential for disruptive change. The liquefied natural gas (LNG) carrier *Christophe de Margerie* class of ships set a transit speed record for a commercial ship across the Northern Sea Route in August 2017. Another ship in the class transited the Northern Sea Route in February 2018 with no icebreaker assistance. While it's possible these are 'one off' events – many revolutions are not recognized until they are well underway.

Risks to our Military Installations

While the direct risks to our military installations from rising sea levels and associated storm surges receive most of the public attention, it's important to examine each installation in a systematic manner in a broader geographic, physical, and hydrological context and understand the range of potential climate and weather-related impacts that should prudently be planned for within a given range of years or decades. In addition to understanding the type, frequency, severity and likelihood of climate-related impacts, a complete analysis needs to account for how well an installation deals with such impacts today; stated another way, what is the threshold, when the impact transitions from manageable, to critically impacting life or mission accomplishment. An example would be what magnitude of storm surge breeches a levy, or how many black flag days delay training to the point where a unit would be delayed in achieving its certification to deploy.

Second-order impacts from the direct climate or weather event need to be considered. Examples would be for the potential of sea level rise to contaminate fresh-water drinking aquifers before the water physically floods an installation, or the smoke from significant wildfires disrupting

training even if the flames are not on the installation and the troops are not re-directed to firefighting efforts.

We must remember that virtually all of our installations are imbedded in, and are part of, larger communities and of resilience-relevant systems and actions well beyond those installations and communities. Simply 'walling off' or protecting only the physical base will not be effective. Many of our military and civilians who are stationed on, and work at the installation, live off base. Many of the essential services, such as power, water, fuel, sewer and communications come from beyond the fence line. So even if the base itself is OK, if key access roads start to flood routinely with high tides, such as is becoming the case in Norfolk Virginia, there can be an impact to mission effectiveness. Likewise, if the property values become impacted in neighborhoods where our troops or civilians are living, that can be a large distraction and negatively impact the Department's competition for top talent.

Extreme weather events affecting an installation can have impacts even for our forces deployed downrange. If that home base is providing critical reach-back support to the forward deployed forces, that support may need to shift to another concept of operations. More substantively, it is a huge distraction and impact on morale if you are forward-deployed and know your family is dealing with the aftermath of a natural disaster without your presence. Senior leaders have known for decades that military personnel have the highest readiness when they believe their families' basic needs and safety have been met. A weather event such as Hurricane Florence impacting Fort Bragg and Camp Lejeune or Hurricane Michael's destruction of the Florida panhandle, particularly Tyndall Air Force Base, can significantly impact the mission effectiveness of our troops already deployed in harm's way.

Additionally, we need to address climate-related risks to not only to our installations as such, but also to the key military and civilian air and seaports critical to the deployment and sustainment of our forces, equipment, and supplies.

Finally, we need to account for climate-related risks when assessing our critical installations beyond the Continental U.S. Bases in regions such as Japan, Singapore and Diego Garcia should all be examined in the same way we consider our installations in Texas, California, Florida or Virginia.

Climate Risk Interacts with other large 21st Century Trends

We should remember that the risks posed by rapid climate change do not exist in a vacuum. They affect, and are affected by, other large-scale 21st century trends: population growth, urbanization, expanding demand for food, energy and water resources, and globalization. The 2014 CNA Military Advisory Board (MAB) report on the "Accelerating Risks of Climate Change[4] expands on this theme. Half a billion people have been added since 2007 and another half billion will be added by 2025. Most of this growth is in Africa and Asia, two of the areas likely to be most impacted by climate change. Nearly half of the world now lives in urban areas

[4] "National Seeurity and the Accelerating Risks of Climate Change.", CNA Corporation, May 2014. https://www.cna.org/cna_files/pdf/MAB_5-8-14.pdf

with 16 out of 20 of the largest urban areas being near coastlines. The result is more of the world's population is at risk from extreme weather events and sea level rise. There is a global increase in the middle class with an accompanying growth in demand for food, water, and energy. The National Intelligence Community predicts that by 2030 demand for food would increase by 35 pereent, fresh water by 40 percent, and energy 50 percent. Even without the climate changing, it will be a challenge to meet these growth targets. Climate change will further stress the world's ability to produce food and drinkable water at levels necessary to meet demand. A 2012 National Intelligence Council assessment found that water challenges will likely increase the risk of instability and state failure, exacerbate regional tensions, and divert attention from working with the United States and other key allies on important policy objectives. Finally, the world is becoming more politically complex and economically and financially interdependent. As such, it is no longer adequate to think of the projected climate impacts to any one region of the world in isolation. Climate change impacts, combined with globalization, transcend international borders and geographic areas of responsibility.

Recommendations

So, what should we do? **Overall, I recommend a risk management approach**. The Defense Department will be managing (as opposed to solving) these climate-related risks for the foreseeable future. A risk management approach requires knowledge of the number, type, and severity of impacts, where and how widespread they are expected to be, what are the effects on mission readiness if unabated, and the cost to 'buy down' these risks, compared to the value of maintaining mission readiness. There is of course some degree of inherent uncertainty in all these values – and that uncertainty needs to be accounted for as well.

Climate risks and security risks share another trait in common: "The worst matters much more than the bad"[5]. In other words: What are the near-term and future risks to our way of life – and what policies and structures should we put in place to manage and mitigate those risks? How might we meet this challenge?

In 2018, the Climate and Security Advisory Group of the Center for Climate and Security released a comprehensive list of recommendations[6] for the national security enterprise to consider. Consistent with that document, here are my **six specific recommendations for managing climate risks on installations:**

- Develop Department of Defense authorized and authoritative standards for use in projections out to 50 years. While the 4th National Climate Assessment[7] provides much useful climate information for U.S. regions, it is not designed as the authoritative handbook for climate impacts on a given base or installation. I recommend the Department of Defense, specifically Naval Oceanography and the U.S. Air Force Weather Service, in collaboration

[5] Burroughs, William "Climate Change in Prehistory: The End of the Reign of Chaos", Cambridge University Press, 2005

[6] https://climateandsecurity.files.wordpress.com/2018/02/climate-and-security-advisory-group_a-responsibility-to-prepare_2018_02.pdf

[7] https://www.globalchange.gov/nca4

with the National Oceanic and Atmospheric Administration and the U.S. Global Climate Research Program administered by the Office of Science and Technology Policy, produce climate information, recognized as authoritative by the Department of Defense, that can inform risk management decisions on time and space scales and parameters that matter.

- Using a deliberate process, develop over the next 5 to 10 years, a 'climate impacts' handbook for each installation and critical node in the deployment system. While each installation is different, standardize the handbook to the degree practical. The U.S. Navy's "Typhoon Havens Handbook" could be one model. Each climate handbook should be updated about once every decade to account for new climate information and/or significant changes to the installation's infrastructure, vulnerabilities and resilience. The climate impacts handbook should consider impacts outside of the fence line that have a direct impact on the installation's readiness and its ability to perform its mission.

    - It seems reasonable to examine risks in 5, 30, and 50-year timeframes. Five years is within the Department of Defense Planning and Programming Budget System and is a time of strategic interest for Combatant Commanders. 30 years aligns with major procurement strategies, such as the Naval 30 year shipbuilding program. Finally, 50 years is a reasonable outlook for the life expectancy of major installation infrastructure.

- Build on and expand existing authorities, programs, and resources to ensure the Department of Defense, working in collaboration with other federal agencies, and State, local and tribal authorities, has both the resources and the authorities needed to adapt to climate issues that directly impact the installation, whether they are inside or beyond the immediate fence line. Those authorities, programs, and resources should include developing and sustaining a comprehensive system to provide the Department of Defense with current and detailed information about the relevant resilience and risk mitigation projects and plans of non-DoD entities throughout the broader geographic area within which installations are located.

- Look for each service's top one or two near-term issues that should be supported and addressed today without further extensive analysis. For example, ensure our nuclear-capable shipyards are protected adequately from rising sea levels, storm surge and fresh water flooding over the coming decades.

- In January 2016 then Deputy Secretary of Defense Bob Work signed out a Department of Defense Directive titled 'Climate Change Adaptation and Resilience' (DODD 4715.21)[8]. The Directive is thoughtful and comprehensive – the only thing lacking is its execution by the Department of Defense. The Congress should obtain periodic external or internal assessments of how the Department is adhering to its own directive with respect to managing climate risk. The U.S. Naval Facilities Engineering Command (NAVFAC) produced in

[8] https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/471521p.pdf

January 2017 a thorough 193-page 'Climate Adaptation and Resilience' handbook[9]. Much of the foundational work on how to adapt defense installations to climate changes has been done. But there needs to be follow-through on the execution.

- Over the past several years, we have witnessed billions of dollars of damage sustained on Defense installations as a result of extreme weather, much of which has arguably been intensified by our changing climate. No one wished for these damages to happen, but the fact that they occurred now provides the opportunity to collect and share lessons learned and best practices across the services and department. Especially for bases that had already undertaken some resilience preparations, what worked and what did not. What additional tools, capacities, authorities or resources would have been most useful to maximize resilience? How did natural and built protective infrastructure perform? Are there lessons learned that would help the department make better decisions with respect to installation energy resilience? Such lessons could be incorporated into a redo of the original January 2019 Climate report[10] sent to the Congress as required by the 2018 National Defense Authorization Act.

Here are four specific recommendations to address the security challenges in the Arctic:

It's important we step back and consider the obvious: we have never been in a position in the modern world where access to an entire ocean opened up within a matter of decades. While we tend to think that the days of geographic exploration ended in the 18th and 19th Centuries, in many aspects, the changes in the Arctic will likely create a wave of human exploration and activity. Now is the time to think carefully about how to manage that very different world and what we want that world to look like. We must think of this in terms of our security, our economy, the likely actions of our friends and rivals, and critically, engage in a meaningful and sustained way with the indigenous people who have lived in the arctic for thousands of years. While many of these recommendations are similar to what I published with Elizabeth Rosenberg at the Center for New American Security in 2014[11], they are still relevant today:

- **Update our Nation's Arctic Strategy in response to the changes in our National Security Strategy and National Defense Strategy**
    - Use all our sovereign assets (DOD, DHS, Navy, Coast Guard, NOAA) to develop a coherent and sustainable presence in the Arctic that will demonstrate long-term

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[9] https://www.fedcenter.gov/_kd/Items/actions.cfm?action=Show&item_id=31041&destination=ShowItem

[10] https://climateandsecurity.files.wordpress.com/2019/01/sec_335_ndaa-report_effects_of_a_changing_climate_to_dod.pdf

[11] E. Rosenberg, D. W. Titley and A. Wicker. Arctic 2015 and Beyond: A Strategy for U.S. Leadership in the High North. *Center for New American Security*, December 2014 https://s3.amazonaws.com/files.cnas.org/documents/CNAS_ArcticHighNorth_policybrief_RosenbergTitleyWiker.pdf?mtime=20160906080459

commitment to our sovereign interests in the Arctic, reassure our Allies, and send an unmistakable message to our great power rivals that as an Arctic Nation, we will neither ignore nor neglect this strategic region.

- Direct and resource the National Science Foundation to set up a permanent research presence on Svalbard. Both the Russians and Chinese have a presence on the island, but the U.S. does not. I am very confident our Norwegian friends would welcome a permanent U.S. research presence on Svalbard, under the auspices of the 1920 Treaty of Svalbard.
- Adequately resource the U.S. Coast Guard to construct and operate a new class of heavy icebreakers that will be the foundation of U.S. maritime presence in the Arctic. The 2019 Department of Homeland Security budget recently signed into law by President Trump is a good first step.
- Reengage with our allies on Arctic exercises. The U.S. Navy sent a guided missile destroyer to the Canadian Exercise NANOOK in 2010, but has not done so since, primarily for budget reasons and the lack of available surface assets. There are valuable lessons learned and experience gained by operating with our partners in the Arctic and High North. We should not let the urgent crowd out the strategically important when allocating assets.
- Commit to 'Arctic Domain Awareness' to ensure we understand who and what is operating in the Arctic, what the trends are, and to keep our borders safe and protected.
- Seek clarity from the Department of Defense and the U.S. Navy as to its strategy, and required resources to execute that strategy, in the Arctic. Ensure they are planning for a seasonally ice-free future, and not looking backwards at historical data.

- **Develop – and resource – a plan that in conjunction with state, Native Alaskan corporations, allied, and private sector interests, builds out the foundations of an infrastructure that can support U.S. objectives for a seasonally ice-free Arctic.**
  - Ice predictions need to be improved on all time scales from daily to seasonal to multi-year outlooks. The Department of the Navy is funding today the 'Earth System Prediction Capability' or ESPC – an interagency program designed to provide our country the next-generation of integrated air-ocean-ice-land prediction system[12]. Navy is working with other components of the DoD, as well as NOAA, NASA and the Department of Energy to ensure our nation has the world's best operational weather and climate prediction tools at our disposal. This national imperative must be a national priority. I want to thank the Congress for including language in the 'Weather Research and Forecasting Innovation Act of 2017' that directs NOAA to cooperate with the DoD on further developing ESPC, and to thank the Armed Services Committees in both chambers for their consistent support of ESPC.
  - Weather forecasts in the Arctic are still significantly less accurate than those we produce for the lower 48. For both safety and economic reasons, this needs to change.

[12] http://espc.oar.noaa.gov/

  - We need to continue to map the U.S. Arctic Exclusive Economic Zone (EEZ) waters to support safe maritime navigation and operations as well as gathering data and knowledge for optimal and sustainable ecosystem management.
  - We must address the lack of ports north of the Bering Strait and lack of permanent infrastructure for safety assets, such as Search and Rescue or Oil Spill response ships and aircraft. This should be done in conjunction with partnerships of state and indigenous stakeholders, as well as in close coordination with our Canadian allies.
- **Commit to ratification of the UN Convention of the Law of the Sea (UNCLOS).** UNCLOS was written primarily by the U.S. to encode maritime advantages inherent to our economic and security well-being. UNCLOS is the governance structure for the world's oceans, including the Arctic Ocean. Accession to UNCLOS, among many other advantages, would allow the U.S. to file a claim for seabed resources north of Alaska in an area that is nearly the size of California.
- **Continually adjust policies today based on what we learn** – and for what we might reasonably expect in the coming decades. Ensure we do not simply plan for the best case or even the most likely, hut also consider seriously less likely scenarios that pose either great challenges – or great opportunities – to the U.S. We learned in the military a long time ago that hope by itself is rarely a good strategy.

In closing, our country is dealing with a significant change in the world's climate; it is a very serious challenge and if we do not manage this risk climate change, unchecked, will make many of our existing threats worse. But our country has met challenges of this magnitude before and succeeded – and we will do so again. While we don't know everything – and we never will – we do know more than enough to act now. By focusing our efforts in a risk-based framework on meeting the climate challenge, we can prepare for the short-term while shaping our longer-term future. We can provide the policies, stability and guidance our country needs to unleash our country's energy, creativity and initiative.

50 years ago, we went to the moon and returned safely, not knowing everything we needed to know at the start of that journey. I am convinced that America still can do amazing things when focused – and when we look back in the decades ahead I hope we can be rightfully proud of what we accomplished to manage these climate risks.

Thank you very much for your time and attention; I look forward to taking your questions.

David Titley

David Titley is a Professor of Practice in Meteorology and a Professor of International Affairs at the Pennsylvania State University. He is the founding director of Penn State's Center for Solutions to Weather and Climate Risk. After graduating from Penn State, Titley served as a naval officer for 32 years and rose to the rank of Rear Admiral. Dr. Titley's career included duties as commander of the Naval Meteorology and Oceanography Command, and Oceanographer and Navigator of the Navy. While serving in the Pentagon, Dr. Titley initiated and led the U.S. Navy's Task Force on Climate Change. After retiring from the Navy, Dr. Titley served as the Deputy Undersecretary of Commerce for Operations, the chief operating officer position at the National Oceanic and Atmospheric Administration.

In 2017 Dr. Titley gave a TED talk on Climate Change and National Security that has been viewed over 1 million times. He serves on numerous climate and security related advisory boards and National Academy of Science (NAS) committees; he currently chairs the National Academies of Science, Engineering and Medicine Climate Communication Initiative advisory committee, and is a member of the NAS Board on Atmospheric Sciences and Climate. He received an honorary Doctorate degree from the University of Alaska Fairbanks and is a Fellow of the American Meteorological Society.

DISCLOSURE FORM FOR WITNESSES
COMMITTEE ON ARMED SERVICES
U.S. HOUSE OF REPRESENTATIVES

INSTRUCTION TO WITNESSES: Rule 11, clause 2(g)(5), of the Rules of the U.S. House of Representatives for the 116th Congress requires nongovernmental witnesses appearing before House committees to include in their written statements a curriculum vitae and a disclosure of the amount and source of any federal contracts or grants (including subcontracts and subgrants), or contracts or payments originating with a foreign government, received during the current and two previous calendar years either by the witness or by an entity represented by the witness and related to the subject matter of the hearing. As a matter of committee policy, the House Committee on Armed Services further requires nongovernmental witnesses to disclose whether they are a fiduciary (including, but not limited to, directors, officers, advisors, or resident agents) of any organization or entity that may have an interest in the subject matter of the hearing. Committee policy also requires nongovernmental witnesses to disclose the amount and source of any contracts or grants (including subcontracts and subgrants), or payments originating with any organization or entity, whether public or private, that has a material interest in the subject matter of the hearing, received during the current and two previous calendar years either by the witness or by an entity represented by the witness.

Please note that a copy of these statements, with appropriate redactions to protect the witness's personal privacy (including home address and phone number), will be made publicly available in electronic form not later than one day after the witness's appearance before the committee. Witnesses may list additional grants, contracts, or payments on additional sheets, if necessary. Please complete this form electronically.

Hearing Date: Wednesday, March 13, 2019

Hearing Subject:

"Ensuring Resiliency of Military Installations and Operations in Response to Climate Changes"

Witness name: RADM David W Titley, USN (ret.) Ph.D.

Position/Title: Professor, Penn State University

Capacity in which appearing: (check one)

● Individual ○ Representative

If appearing in a representative capacity, name of the organization or entity represented:

Federal Contract or Grant Information: If you or the entity you represent before the Committee on Armed Services has contracts (including subcontracts) or grants (including subgrants) with the federal government, received during the current and two previous calendar years and related to the subject matter of the hearing, please provide the following information:

2019

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
none			

2018

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
none			

2017

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
none			

Foreign Government Contract or Payment Information: If you or the entity you represent before the Committee on Armed Services has contracts (including subcontracts or subgrants) or payments originating from a foreign government, received during the current and two previous calendar years and related to the subject matter of the hearing, please provide the following information:

2019

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
none			

2018

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
none			

2017

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
none			

Fiduciary Relationships: If you are a fiduciary of any organization or entity that may have an interest in the subject matter of the hearing, please provide the following information:

Organization or entity	Brief description of the fiduciary relationship
Council on Strategic Risks	Member, Board of Directors
Center for Climate & Security	Member, Advisory Board
Penn State University	Employee (Professor)
Citizens' Climate Lobby	Member, Advisory Board
CNA Military Advisory Board	Member

Organization or Entity Contract, Grant or Payment Information: If you or the entity you represent before the Committee on Armed Services has contracts or grants (including subcontracts or subgrants) or payments originating from an organization or entity, whether public or private, that has a material interest in the subject matter of the hearing, reeeived during the current and two previous calendar years, please provide the following information:

2019

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
none			

2018

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
none			

2017

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
none			

Ensuring Resiliency of Military Installations and Operations in Response to Climate Changes
U.S. House of Representatives
Armed Services Committee
Subcommittee on Readiness
March 13, 2019

Statement of Sharon E. Burke
Senior Advisor and Director of the Resource Security Program
New America

Thank you, Chairman Garamendi, Ranking Member Lamborn, and Members of the Committee, for the opportunity to appear before you today.

My name is Sharon Burke, and I direct the Resource Security program at New America, a nationally networked civic organization headquartered in Washington, DC. One of my research efforts, the Phase Zero Project, examines how to shape the strategic landscape, to prevent conflict or to give the United States an advantage. We are looking to bring to this task some of the analytical tools the Department of Defense uses to forecast threats and the private sector uses to anticipate opportunities, such as modeling, big data, machine learning, and scenario analysis, as well as the narrative approach New America is known for. Climate change is one of the shaping trends we consider in our work. Previously, as the Assistant Secretary of Defense for Operational Energy, I was responsible for improving the energy security of military operations. In that capacity, I focused on a range of efforts, from improving forward operating bases to incorporating energy considerations in the requirements process to conducting geopolitical wargames. My office also helped draft Directive 4715.21, which focuses on climate change adaptation and resilience. I first joined the Pentagon in 1994 as a civil servant through the Presidential Management Fellows program, and my service has included a stint as the Country Director for South Asia.

Today, I am here to discuss climate change as a security issue, the challenges it presents for readiness, and the opportunities we have today to enhance the resilience of missions and capabilities to such changes. This is not a new topic for the Department of Defense. In October 2007, the Department of Defense (DoD) released "A Cooperative Strategy for 21st Century Seapower," the first ever collective maritime strategy for the Navy, Marine Corps, and the Coast Guard. It was also the first U.S. military strategy document to explicitly refer to climate change as a national security concern. In the years since, a number of documents from the Defense Department and Intelligence Community have followed that basic template, defining climate change as a national security issue and citing civilian scientific judgments. Most recently, in January 2019, the Department of Defense released "Report on the Effects of a Changing Climate to the Department of Defense" and the Director of National Intelligence acknowledged the threat of climate change in the Worldwide Threat Assessment.

The scientific judgment the Department now relies on includes the Trump Administration's National Climate Assessment, released in November 2018. The Assessment, the concerted judgment of 13 Federal agencies, painted a grim picture of projected climate change effects by the middle of the century, such as increases in high heat days, heavy precipitation, droughts, and sea level rise, as well as more volatile weather patterns. According to an October 2018 Intergovernmental Panel on Climate Change report, the potential impacts of these changes worldwide include species extinctions, loss of ecosystems and habitat, decline or destruction of fisheries and coral reefs, and drops in agricultural productivity and availability of freshwater.

These climate-accelerated natural phenomena will interact with human societies in ways that are not yet clear but are increasingly under examination.

Climate change will affect U.S. national interests and the safety and wellbeing of all Americans where they live, from impacts as relatively benign as shifting growing zones and as serious as the sorts of more destructive coastal storms we saw in Puerto Rico, Texas, and Florida in 2017 and 2018. It will shape our trade and strategic partners and allies, as well, and our adversaries, too. In 2016, the Department of Defense issued Directive 4715.21, which assigned roles for implementing climate change adaptation and resilience at bases and in operations. While the Department has not made much progress in implementing the Directive, incorporating climate change into strategy and military force development is prudent and will cost relatively little, in dollar terms. A small investment now, however, may pay significant dividends in better resilience and readiness for great power competition, military missions, and defense infrastructure in the future

Great Power Competition

The 2018 National Defense Strategy realigned the national security priorities of the United States, proclaiming great power competition to be the defining context and singling out China and Russia. While the strategy did not explicitly acknowledge climate change as a shaping factor in great power competition, no country is immune to its effects and impacts, and that includes China and Russia.

China is about the size of the United States, with a long coastline, the two largest megacities in the world, and a landscape that varies from desert to rainforest. Climate change is likely to have a range of effects on the country, including shifts in precipitation, the number of high heat days, and more volatile weather patterns, especially along the coasts. The impacts on China will be diverse, affecting everything from agricultural productivity to the availability of fresh water. New America has forthcoming research on these impacts, based on analysis from the Pacific Northwest National Laboratory's Global Change Assessment Model (GCAM). Our early findings suggest that taken together with the country's growing import dependency for energy, China's resource security will help shape its strategic choices. China already is investing extensively in key resource relationships, in ways that are not always separable from regional and global strategic priorities. This has been the case with many of the countries in China's Belt and Road Initiative, but New America's analysis across 25 indicators, including China's bilateral trade, investments, and mineral dependencies, suggests that some of its most important resource relationships are with key U.S. allies, including Australia and Canada.

Another top Chinese resource partner is Russia, where the trade in energy, minerals, and agriculture undergird a growing strategic partnership. Needless to say, an enhanced Russia-China relationship is unlikely to benefit the United States. According to our forthcoming analysis from GCAM, Russia may also have a comparative advantage when it comes to climate change, at least toward the middle of the century. This may unlock more productive land and milder temperatures for the country, making Russia a more attractive agricultural trade partner. On the other hand, there are always uncertainties when it comes to climate change: parts of Russia where permafrost is already thawing, for example, have experienced releases of deadly bacteria and methane gas, as well as the emergence of giant sinkholes.

Indeed, the Arctic has the potential to be another front in the global competitive space. Satellite imagery of the Arctic – which is tracked by the Naval Ice Center, as well as civilian agencies – shows dramatic evidence of the formation of an entirely new ocean, where there was only solid ice before. This means new oil, gas, and other mineral resources are becoming recoverable and new global trade routes are opening for the first time in recorded human history.

To date, international interests in the region have focused on scientific research and enjoyed good cooperation. Indeed, most Arctic littoral nations are partners or treatied allies for the United States, but Russia enjoys a relative advantage in the region and has been increasingly aggressive about its military and commercial presence in "the Far North." The country has a very long Arctic coastline with relatively warmer waters, making the Northern Sea Route off their coast more navigable than alternate routes through the thawing ice. Russia also currently has around 40 icebreakers, including seven that are nuclear-powered. China, which has no Arctic coastline but a keen interest in a polar sea rote, has two heavy icebreakers and a third in construction, as well as land acquisitions in the area.

The United States has increased regional surveillance and likely dusted off our missile defense sites in the region, but has not significantly changed our presence, given the difficulty and expense of operating in the harsh Arctic climate and the view that most area missions belong to the Coast Guard. The United States currently has only one functioning heavy icebreaker and one medium icebreaker, though U.S. forces can and do transit the region in submarines and aircraft, including for Freedom of Navigation operations. The United States also relies on cooperation with Canada for Arctic missions, despite the fact that the United States does not recognize Canada's claim to the Northwest Passage as an internal Canadian waterway.

Military Missions

Climate change is highly likely to affect military missions, both directly and indirectly. The most direct effect is on disaster relief missions, at home and abroad, and the indirect effects concern the way that changing conditions may destabilize countries with poor or corrupt governance, weak economies, and a history of civil unrest and conflict.

The risk of devastating violence in this era of mobility is the potential energy gathering behind every internal or interstate friction, ragged political change and corrupt governance, and the human misery and migration that follow disasters and shortages of food, water, energy, and other basic necessities. A recent World Bank repot found, for example, that by 2050, the impacts of climate change in S-Saharan Africa, South Asia, and Latin America could force 143 million people to move. That is why the 2010 Quadrennial Defense Review labeled climate change an "accelerant of instability or conflict," a factor that can push that potential energy into a perfect storm of instability and conflict.

The Sahel region of Africa is illustrative. A semi-arid region with a history of political instability and weak governance, violence, and poverty, the Sahel is nonetheless seeing significant population growth. The region is home to 135 million people today, which is forecasted to rise to 330 million by 2050 and around 670 million by the century's end. This region is already experiencing a rise in droughts and a fall in agricultural productivity and access to freshwater, and is expected to be one of the most climate-change affected regions of the world in the coming decades. There is already internal displacement and out migration, given these conditions. While the remedies to the looming regional crisis are largely civilian in nature -- such as the empowerment of women and improvement in governance -- there are clear military implications, including a correlating increase in regional violent extremist organizations, such as the Islamic State in the Greater Sahara, Al Qaeda in the Islamic Maghreb, and Boko Haram.

This instability effect is the most important climate security concern, but unfortunately, it is also one of the least well understood. There is no comprehensive, credible risk portfolio, for example, delineating which regions and countries are most likely to be destabilized, with what consequences. The deficit in available climate risk projections reflects, in part, a gap between the scientific study of climate change and practical applications of that information. So, for example, the kind of information and data a military strategist or planner needs in order to incorporate climate change into an operational or campaign plan, global force management

decisions, or a Theater Cooperation Plan is not yet available. One way to help close this gap is to incorporate climate change into military threat assessments, strategies, and plans, calling on civilian agencies or nongovernmental institutions to provide the relevant data or even to develop a climate risk portfolio. A military demand signal for the kinds of actionable information they need would greatly help in building not only relevant future defense capabilities and plans, but also broader national security priorities for development, trade, and diplomacy.

There are also more direct impacts to military missions. According to the National Climate Assessment and the United Nations, climate change increases the frequency and/or severity of extreme weather events, which in turn connotes a rising demand for humanitarian and disaster relief. Active duty forces generally are not the lead for such missions, but rather support civilian authorities, such as the State Department, the Federal Emergency Management Agency (FEMA), or in the case of the National Guard, governors and other state authorities.

Military forces, however, have unique capabilities for such incidents, particularly when it comes to logistics, and have been frequently called on in recent years to support disaster relief missions. More than 10,000 active duty and National Guard personnel responded to Sandy in 2012, for example, and around 9,000 to Typhoon Haiyan in the Philippines the following year. Around 14,000 defense personnel joined 27,000 FEMA employees in Houston to deal with Hurricane Harvey in 2017, as well as 17,000 active duty, reserve, and National Guard personnel, aircraft, and combat support hospitals to Puerto Rico in the aftermath of Hurricane Maria. In 2018, the National Guard, Army engineers, and Air Force assets assisted with response to the California wildfires. Across these disasters, defense personnel engaged in everything from search and rescue to emergency food distribution to electricity restoration.

Indeed, most military strategy documents identify humanitarian and disaster relief (HADR) or Defense Support to Civil Authorities (DSCA), as it is generally called in the domestic context, as part of the defense mission, though often as a limited or associated concern. This reflects internal DoD ambivalence about these responsibilities, which are relatively lower priority than combat missions in training, organizing, equipping, and posturing of armed forces. Civilian disaster relief capacity largely consists of the Office of Foreign Disaster Assistance at the State Department, with only about 500 staff worldwide, FEMA for domestic relief only, state and local assets, and non-governmental organizations. In addition, no other nation has the capacity the United States does to conduct such missions, particularly the logistics support. HADR operations, in addition to their humanitarian importance, generate good will in partner and allied nations, which has reputational and material advantages for the United States. At the same time, China is improving rapidly in this area; indeed, HADR operations could well become another driver for either cooperation or competition between the two nations.

Military Installations and Readiness

As this Subcommittee knows very well, militaries need bases of operations for administrative activities, training, and to support a range of missions. For the United States, that translates to 28 million acres under Pentagon management worldwide, with nearly 600,000 structures. The replacement value for this infrastructure has been estimated at more than a trillion dollars. Many of these bases are more than housing or training sites; in the digital age, they are increasingly "platforms" that directly support military operations. Although the Department has taken some action to protect these bases from climate change, such as updating building codes and conducting some vulnerability assessments, bases are a relatively low priority policy concern. In 2012, the Government Accountability Office observed that DoD lacked sufficient official scientific information and coordination to effectively and consistently anticipate and adapt to the effects of climate change at bases. Based on DoD's January 2019 "Report on the Effects of a Changing Climate to the Department of Defense," which this subcommittee and others in Congress requested, that situation does not appear to have changed.

For that report, Congress asked the Department to identify bases most vulnerable to climate change, given that such vulnerability assessments can help prioritize and inform investments and protect the continuity of operations. Ideally, such assessments should look at changing hazards, vulnerabilities in military and civilian infrastructure, which most bases rely on, and the criticality of missions and capabilities on the bases, to get a comprehensive picture of risk. While the increasing hazards of severe weather should certainly be a chief concern, there is also a changing threat profile. Several nations -- Russia and Iran among them -- have shown both the capability and intent to attack U.S. electricity grids and other critical infrastructure using remote cyber means. A comprehensive vulnerability assessment can be a win-win tool, helping identify both natural and manmade vulnerabilities, hazards, threats, and risks for bases.

These assessments may well identify a need for expensive retrofits or relocations, but they may also just identify a need for updated codes, regulations, policies, and other low-cost changes. As the Department considers how to improve this process, it may want to give special consideration to fixed military infrastructure overseas, which often depends on host nation infrastructure. If the Department lacks sufficient scientific and technical capability to design an adequate assessment tool and carry out the examinations, there is considerable expertise in civilian agencies and at the local level around the country, including at universities.

Congress and the Department of Defense have been careful to make a distinction between fixed bases and contingency and other operational bases, platforms, equipment, and missions, when it comes to energy and climate change. There are several reasons for this distinction, including that there are entirely different requirements, budgeting, and procurement processes and personnel involved (the force development process vs. the facilities sustainment, restoration, and modernization process). The main reason to make a distinction, however, is that environmental limits, no matter how intrinsically good, are unlikely to serve the country well at forward deployed bases. At best, the armed forces would have to violate those limits when elected leaders deploy them for combat, rescue, or humanitarian missions. Indeed, it is the nature of war to consume and destroy resources; arguably, the best military environmental policy is not to go to war in the first place. As the saying goes, however, the enemy gets a vote -- nations don't always get to choose when a threat will emerge or conflict or disaster will strike.

There is, however, a role for energy and environmental considerations when it comes to operational equipment and activities; indeed, the gravity of military needs can provide a natural pull for environmental improvements and innovation. There are good reasons to go "green" for military operations, after all. A lower requirement for resources, particularly fuel and water, for example, means a more logistically sustainable operation with fewer soft, supply targets for adversaries to strike. The Taliban, armed chiefly with cheap improvised explosive devices, weaponized human bodies, small arms, and rudimentary rocket propelled grenades, has been able to successfully target U.S. supply convoys, which disproportionately carry fuel and water. This lesson is not lost on other potential U.S. adversaries. Those potential adversaries may be far better equipped than our current foes, including with GPS-guided maritime mines, precision strike, and hypersonic missiles. Moreover, the United States increasingly has an electrified force, which introduces an entirely new attack surface, one that the Department of Homeland Security and the FBI have publicly warned the Russians are seeking to exploit with remote cyber weapons. The Department of Defense should increasingly take energy resilience into account as a planning factor and a capability enabler. These considerations are not as explicitly incorporated into strategy, plans, and any modeling and simulations as they could be.

In this regard, the Pentagon itself is a barrier, given today's focus on "lethality." Climate change and other resource challenges are generally not seen as "real" security issues. In addition, the Department has its hands full with active combat operations, pressing modernization needs, unfolding cyber and high tech wars, and overall budget uncertainties. Moreover, our apolitical

military may consider climate security a political fight best avoided. And to be fair, climate change is a security concern, but not necessarily one with a military solution.

It follows, then, that the lack of civilian operational capacity for climate security, at home and abroad, is also a barrier to stronger national security. With the exception of discrete offices, such as the Office of Foreign Disaster Assistance, the State Department lacks operational equipment, training, and organization, a situation exacerbated by the current depletion of staffing. This is not to say that diplomacy and development missions are unimportant; they are just not sufficient to build climate security and respond to contingencies in a tangible way. Moreover, in extreme circumstances, civilian agencies and NGOs will continue to require the assistance of National Guard, reserve, and active duty forces, especially for logistics support. The American people are historically generous in responding to crises ad hoc, but have shown little enthusiasm for increasing the standing resources for security building, such as foreign aid or disaster risk mitigation. This is problematic, given that climate change is a security issue, but it is not truly a military matter: no soldier, sailor, airman, or Marine can defeat climate change by shooting at it, blowing it up, or even by phishing it with a virus. Climate change is ultimately a governance and economic development challenge and fundamentally a civilian and civil society responsibility, but if the nation does not get ahead of the changes that are underway and coming, there may well be a growing need for military missions to deal with the consequences.

Sharon Burke
Senior Advisor, International Security Program and Resource Security Program, New America

The Honorable Sharon E. Burke is a senior advisor to New America, where she focuses on international security and Resource Security, a program that examines the intersection of security, prosperity, and natural resources.

Before joining New America, Burke served in the Obama Administration as the assistant secretary of defense for operational energy, a new office that worked to improve the energy security of U.S. military operations. Prior to her service at DoD, Burke held a number of senior U.S. government positions, including at the Department of State in the George W. Bush Administration, and was a vice president and senior fellow at the Center for a New American Security. She attended Williams College and Columbia University, where she was a Zuckerman and International fellow at the School of International and Public Affairs.

Honorable Sharon E. Burke

EXPERIENCE

Senior Advisor and Program Director
New America, Washington, DC
May 2014-present
Directs a research program to look at security building in the 21st century, with a focus on the intersection of natural resources and national security. Major projects include:

- Phase Zero: new data tools and partnerships to examine root causes of conflict, including water, energy, and climate change.
- Weather Eye: data visualization and research of community impacts of severe weather in the United States, including best practices and resilience gaps.
- Electric Shock: a research initiative looking at changing threats and risks to the electric grid.
- Things of the Internet: a research project on the geopolitics of information age critical minerals.
- The Energy of War: a research project examining how America's relentless need for energy has influenced both the causes and the conduct of modern warfare.
- Civic Resilience to Terrorism: a project looking at the potential consequences for civic resilience of a terrorist attack.
- Future of War: advisor to partnership with Arizona State University bringing together thinkers and practitioners from the worlds of technology, the academy, policy, the military, and the media to address the changing nature of war.

Assistant Secretary of Defense for Operational Energy Plans and Programs
U.S. Department of Defense, Washington, DC
May 2010-May 2014
Top U.S. government official for improving energy security at the Department of Defense (DoD), focusing on the $15 billion in fuel consumed annually in military operations. Extensive speaking, press, and social media experience.

- Created and managed a new office, including organizational design, recruitment of staff of technical and military experts, and business plan for $30 million annual budget.
- Provided strategic energy vision for DoD, including Army, Navy, Marine Corps, Air Force, Office of the Secretary of Defense, Joint Staff, and Combatant Commands. Pioneered approach focused on energy performance, reducing risks, and saving money.
- Served as Senate-confirmed, principal energy advisor to the Secretary of Defense.
- Provided advice and oversight on energy in strategic planning, acquisition, and procurement as an advisor to the Defense Acquisition Board, the Joint Requirements Oversight Council, and the Senior Sustainability Council.

- Instigated partnerships with military organizations, other Federal agencies, national laboratories, and industry to promote DoD's adoption of energy efficiency and renewable energy technologies. Focused on rapid fielding of energy improvements to military forces in Afghanistan and other locations.
- Exercised oversight of approximately $17 billion in DoD annual programming and budgeting for energy as one of only two DoD officials with budget certification authority.
- Directed inter-agency energy security futures games focused on the Persian Gulf, Africa, South America, and South China Seas.

Vice President and Senior Fellow
Center for a New American Security, Washington, DC
2007- 2010
Principal officer and researcher for non-partisan national security think tank.

- Created the Natural Security Program, a novel effort to examine the national security dimensions of natural resources challenges. The project looked at the strategic implications of new demands for resources, such as critical minerals and energy, as well as consequences, such as biodiversity loss and climate change.
- Managed and raised funds for energy security and climate change projects.
- Directed an international climate change war game, designing complex futures scenarios that incorporated unique climate model runs, in partnership with Oak Ridge National Laboratory. The game was featured in *Earth 2100*, a documentary that aired on ABC on June 2, 2009.
- Published numerous reports and articles on natural security topics.

Director, National Security Project
Third Way, Washington, DC
2006-2007
Manager of program supporting public office holders and candidates for office with policy positions and communications strategies on national security issues.

- Facilitated and designed national security trainings for candidates and for Members of Congress.
- Co-authored numerous reports and position papers on military transformation, Iran, Iraq, China, weapons of mass destruction, terrorism and Latin America.

Independent Consultant, Washington, DC
2005-2010

- Advised high-level clients on strategic communications, including a Governor, a former Cabinet Secretary, and a U.S. Senator.

Member, Policy Planning Staff, U.S. Department of State, Washington, DC
2002-2005
Advisor and chief speechwriter to Hon. Richard Armitage, Deputy Secretary of State.

- Authored more than 150 speeches and articles, including major policy addresses and testimony on U.S. foreign policy, Asia, the Middle East, and leadership.

Advocacy Director for the Middle East and North Africa
Amnesty International, Washington, DC
2001-2002
Lead on crisis response, lobbying, and communications on human rights in Middle East.

- Served as spokesperson on Middle East issues and authored reports on Middle East and U.S. military.

Country Director for South Asia; Speechwriter to the Secretary of Defense
U.S. Department of Defense, Washington, DC
1994-2001
Served as career civil servant in the Office of the Secretary of Defense and political appointee for the Secretary of Defense.

- Authored major speeches for two Secretaries of Defense on a range of defense policy subjects, including military operations in the Balkans.
- Served as chief policy advisor for Office of the Secretary of Defense on South Asia and North Africa and managed bilateral defense relations with the regions.
- Led DoD response to 1998 South Asian nuclear tests.
- Selected for prestigious management training program (Office of the Secretary of Defense Presidential Management Intern Program).

Research Analyst
U.S. Congress, Office of Technology Assessment, Washington, DC
1989-1992

- Conducted research and supported events for the Energy and Transportation Programs.
- Authored and edited chapters in reports on energy in developing countries and U.S. domestic public works for agency of U.S. Congress.

EDUCATION

Master of International Affairs and Certificate of Middle Eastern Studies
Columbia University, New York City, NY
1992-1994

- Concentration in International Energy Policy.
- Selected for small, elite program with full tuition and stipend.

Bachelor of Arts, Williams College, Williamstown, MA
1984-1988

- Majors in English and History.
- Concentration in Middle Eastern and African Studies.
- Semester abroad in Kenya through St. Lawrence University

RECOGNITION

- Member, Advisory Committee for Environmental Research and Education, National Science Foundation (2018-2019)
- Technical Review Panel, Energy Systems Integration, National Renewable Energy Laboratory (2018-2019)
- Sasakawa USA Alumni Fellow (2018)
- Member, Scientific Advisory Committee, Energy and Environmental Sciences Directorate, Oak Ridge National Laboratory (2016-2017)
- World Economic Forum, Decarbonizing Energy Global Agenda Council (2015-2016)
- Department of Defense Distinguished Civilian Service Award (2014)
- Aspen Atlantic Group Participant (2008-2009)
- Leadership Team, Next Generation Project, American Assembly (2006-2007)
- Department of State Superior Honor Award (2004)
- Department of Defense Exceptional Public Service Award (2001)
- Department of Defense Meritorious Service Group Award (1995)
- Presidential Management Intern, Office of the Secretary of Defense, U.S. Department of Defense (1994-96)
- Foreign Language and Areas Studies Fellow for Arabic (1993)
- International Fellow, Columbia University (1993)
- Zuckerman Fellow, Columbia University (1992-1994)
- Dean's List, Williams College and St. Lawrence University

PUBLICATIONS

Books & Reports

Strategic Distraction: America, China, and Japan in the 21st Century Competitive Space, New America, Washington, DC, October 2018.

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With Alyssa Sims and David Sterman, *War and Tweets: Terrorism in America in the Digital Age*, New America, Washington, DC, October 2016.

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With Jay Gulledge et al., *Uncharted Waters: The U.S. Navy and Navigating Climate Change*, Center for a New American Security, December 2008.

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DISCLOSURE FORM FOR WITNESSES
COMMITTEE ON ARMED SERVICES
U.S. HOUSE OF REPRESENTATIVES

INSTRUCTION TO WITNESSES: Rule 11, clause 2(g)(5), of the Rules of the U.S. House of Representatives for the 116th Congress requires nongovernmental witnesses appearing before House committees to include in their written statements a curriculum vitae and a disclosure of the amount and source of any federal contracts or grants (including subcontracts and subgrants), or contracts or payments originating with a foreign government, received during the current and two previous calendar years either by the witness or by an entity represented by the witness and related to the subject matter of the hearing. As a matter of committee policy, the House Committee on Armed Services further requires nongovernmental witnesses to disclose whether they are a fiduciary (including, but not limited to, directors, officers, advisors, or resident agents) of any organization or entity that may have an interest in the subject matter of the hearing. Committee policy also requires nongovernmental witnesses to disclose the amount and source of any contracts or grants (including subcontracts and subgrants), or payments originating with any organization or entity, whether public or private, that has a material interest in the subject matter of the hearing, received during the current and two previous calendar years either by the witness or by an entity represented by the witness.

Please note that a copy of these statements, with appropriate redactions to protect the witness's personal privacy (including home address and phone number), will be made publicly available in electronic form not later than one day after the witness's appearance before the committee. Witnesses may list additional grants, contracts, or payments on additional sheets, if necessary. Please complete this form electronically.

Hearing Date: Wednesday, March 13, 2019

Hearing Subject:

Ensuring Resiliency of Military Installations and Operations to Climate Change

Witness name: Sharon Burke

Position/Title: Senior Advisor, New America

Capacity in which appearing: (check one)

(●) Individual ( ) Representative

If appearing in a representative capacity, name of the organization or entity represented:

I am not representing my employer, New America, but do have a fiduciary relationship. New America is a 501(c)(3) organization that publicly discloses all of its funding sources at https://www.newamerica.org/our-funding/

Federal Contract or Grant Information: If you or the entity you represent before the Committee on Armed Services has contracts (including subcontracts) or grants (including subgrants) with the federal government, received during the current and two previous calendar years and related to the subject matter of the hearing, please provide the following information:

2019

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
None			

2018

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
None			

2017

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
None			

Foreign Government Contract or Payment Information: If you or the entity you represent before the Committee on Armed Services has contracts (including subcontracts or subgrants) or payments originating from a foreign government, received during the current and two previous calendar years and related to the subject matter of the hearing, please provide the following information:

2019

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
None			

2018

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
None			

2017

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
None			

Fiduciary Relationships: If you are a fiduciary of any organization or entity that may have an interest in the subject matter of the hearing, please provide the following information:

Organization or entity	Brief description of the fiduciary relationship
New America	Full time employee/run a research program

Organization or Entity Contract, Grant or Payment Information: If you or the entity you represent before the Committee on Armed Services has contracts or grants (including subcontracts or subgrants) or payments originating from an organization or entity, whether public or private, that has a material interest in the subject matter of the hearing, received during the current and two previous calendar years, please provide the following information:

2019

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
Grant	Skoll Foundation	$1,000,000	Phase Zero Project

2018

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
Grant	Skoll Foundation	$1,000,000	Phase Zero Project

2017

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
grant	Skoll Foundation	$50,000	Phase Zero Project

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CONGRESSIONAL TESTIMONY

Ensuring Resiliency of Military Installations and Operations in Response to Climate Changes

Subcommittee on Readiness

Committee on Armed Services

U.S. House of Representatives

March 13, 2019

Nicolas Loris

Herbert & Joyce Morgan Research Fellow

The Heritage Foundation

My name is Nick Loris and I am the Herbert & Joyce Morgan Fellow in the Roe Institute for Economic Freedom at The Heritage Foundation. The views I express in this testimony are my own and should not be construed as representing any official position of The Heritage Foundation. Thank for this opportunity to appear before the subcommittee to discuss the resiliency of military installations and operations in response to climate changes.

For the Department of Defense (DOD) to successfully carry out its missions, military resilience and readiness is critical. Without question, extreme weather and long-term climate changes can adversely affect DOD infrastructure, training, and operations. Solutions to protect against such threats should achieve cost-effective, meaningful results. The DOD should address climate-related infrastructure vulnerabilities through site- and situation-specific analysis and spending. Furthermore, the DOD should continue to collaborate with the scientific community, states and local governments, the private sector, and other stakeholders to maximize resiliency and preparedness.

While the DOD is a large institutional energy consumer, its overall carbon-dioxide footprint is quite small. Congress should remove any costly, unnecessary mandates and spending on activities intended to reduce the DOD's climate footprint but divert resources away from DOD's core mission of protecting America's vital national interests. They have practically no effect on impacting the climate and do nothing to current and future climate-related vulnerabilities the DOD recognizes.

Instead, spending on alternative technologies must be mission- and proficiencies-driven first. Any positive commercial innovation and broad economic benefits resulting from DOD research and development must come second. Policymakers should open channels to government research, so that innovators can spin off research into economically viable products. Government R&D for national security objectives can have tremendous economic value. Pathways for innovation can co-exist with protecting classified and sensitive information.

Policymakers should also refrain from jumping to conclusions with regard to anthropogenic emissions' influence on regional conflict. Too often, advocates of climate action label man-made warming as a threat multiplier when historical research, empirical evidence, and micro-level data on specific regions suggest that the connection is weak. Overstating climate factors and understating more deterministic political, social, and economic factors severely misrepresents the true reasons for violence, conflict, and migration in different regions in the world.

Mitigating Risk to DOD Infrastructure

With more than 500 installations,[1] the DOD has an extensive setup of infrastructure in the United States and around the world.[2] Including all bases, installations, and other associated buildings, there are over 7,000 facilities under the DOD's purview.[3] Some installations are currently vulnerable to extreme weather. Because of their geographic location, certain DOD infrastructure is more susceptible to natural disaster and long-term changes in climate than others.

No matter the cause of extreme weather and climate change, these events have the potential to significantly damage military installations and reduce operational readiness. A January 2019 DOD report identified 79 military installations impacted by climate-related events. The report also described where climate-related events could adversely affect installations and facilities over the next 20 years. The report determines that recurrent flooding, drought, and wildfires are the primary concerns and also includes the impacts of thawing permafrost and desertification.

Several examples in the report illustrate the challenges DOD installations face. The Navy Base Coronado incurs flash flooding, especially in El Nino years, and Naval Air Station Key West grappled with droughts in 2011 and 2015.[4] A 2017 wildfire burned 380 acres on Vandenberg Air Force Base in California.[5] Furthermore, "Navy Region Mid-Atlantic and the greater Hampton Roads area is one of the most vulnerable to flooding military operational installation areas in the United States. Sea level rise, land subsidence, and changing ocean currents have resulted in more frequent nuisance flooding and increased vulnerability to coastal storms."[6]

Other DOD installations and facilities suffer or have suffered from weather-related challenges as well. An Initial Vulnerability Assessment Survey report published in 2018 took a broader approach and qualitatively assessed how climate change impacts over 3,500 individual sites maintained by the Army, Navy, and Air Force. Nearly 1,700 sites reported no effects in the survey.[7] However, 22 percent of sites reported effects from drought and wind. Non-storm-surge

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[1]According to a January report on climate change and the DOD, "An installation is defined as a base, camp, post, station, yard, center, homeport facility for any ship, or including any leased facility, which is located within any of the States, the District of Columbia, the Commonwealth of Puerto Rico, American Samoa, the Virgin Islands, the Commonwealth of the Northern Mariana Islands, or Guam." U.S. Department of Defense, "Department of Defense Climate-Related Risk to DoD Infrastructure Initial Vulnerability Assessment Survey (SLVAS) Report," January 2018, https://climateandsecurity.files.wordpress.com/2018/01/tab-b-slvas-report-1-24-2018.pdf (accessed March 8, 2019).

[2]Dorothy Robyn and Jeffrey Marqusee, "The Clean Energy Dividend: Military Investment in Energy Technology and What It Means for Civilian Energy Innovation," Information Technology and Innovation Foundation, March 2018, http://www2.itif.org/2019-clean-energy-dividend.pdf?_ga=2.133613257.674204463.1551967655-1212308.1551734962 (accessed March 8, 2019).

[3]Jane A. Leggett, "Climate Change Adaptation by Federal Agencies: An Analysis of Plans and Issues for Congress," Congressional Research Service, February 23, 2015, https://fas.org/sgp/crs/misc/R43915.pdf (accessed March 8, 2019).

[4]U.S. Department of Defense, "Report on Effects of a Changing Climate to the Department of Defense," January 2019, https://partner-mco-archive.s3.amazonaws.com/client_files/1547826612.pdf (accessed March 8, 2019).

[5]Ibid., p. 7.

[6]Ibid., p. 6.

[7]U.S. Department of Defense, "Department of Defense Climate-Related Risk to DoD Infrastructure Initial Vulnerability Assessment Survey (SLVAS) Report," January 2018, https://climateandsecurity.files.wordpress.com/2018/01/tab-b-slvas-report-1-24-2018.pdf (accessed March 8, 2019).

related-flooding affected 20 percent.[8] Extreme temperatures affected 10 percent of the sites and storm surge and wildfires impacted 6 percent of the sites responding to the survey.[9]

Regardless of what causes climate events, it is practical for the DOD to safeguard against current and future risks and vulnerabilities. Whether a challenge occurs slowly over time like sea-level rise or occurs without much warning like a hurricane, adaptation to extreme weather is critical to increasing resilience for both the DOD and civilian infrastructure. The DOD has an incentive to reduce outages, minimize time offline, and promote efficient coordination and communication to successfully carry out its missions and continue for daily operations. Spending on durable infrastructure will enhance resiliency and protect human lives. Learning lessons from previous storms and using the best scientific and technical information available improve the DOD's ability to reduce dangers from future climate-related challenges. Establishing thorough readiness plans in coordination with the private sector, local communities, and first responders and identifying future vulnerabilities is simply commonsense policy. However, the military's mission must guide these decisions. They should not be overtaken by some other political agenda.

Productively, the DOD has taken and continues to take the necessary steps to adapt to a changing climate to reduce risks facing DOD operations and missions. For instance, JBLE-Langley Air Force Base "is using a flood visualization tool to understand flooding impacts across the base. By modeling different storm flooding elevations, they were able to determine where to install door dams, which require less time and less labor than sandbags. The base reduced the number of required sandbags by 70 percent."[10] Air Force Bases in Florida are working with local groups in Florida to address coastal erosion and Navy Region Mid-Atlantic is working with relevant stakeholders including state and local governments, communities, nonprofits, and academia to protect against flooding, sea-level rise, and land subsidence.[11]

Preparing for natural disasters and adapting land and water changes over time is a cost-effective, pragmatic solution. Specialized knowledge and unique expertise will help address site- and situation-specific challenges. The accumulation of scientific and technological knowledge will help understand the probability and level of threat that extreme weather and climate change poses to military installations. Congress should provide the required funding for the DOD to carry out these activities.

The DOD as an Energy Consumer and its Negligible Impact on Climate

Compared to other government agencies, the DOD uses a significant amount of energy. In fact, in fiscal year (FY) 2017, the DOD accounted for 75 percent of the federal government's energy use.[12] As a percentage of America's overall energy use, however, the DOD constitutes only 1

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[8]Ibid., p. 16.
[9]Ibid., p. 16.
[10]Ibid., p. 11.
[11]Ibid., p. 12.
[12]Robyn and Marqusee, "The Clean Energy Dividend: Military Investment in Energy Technology and What It Means for Civilian Energy Innovation."

percent of America's total energy consumption and only 1.2 percent of America's total oil consumption.[13]

Consequently, the DOD's domestic and global carbon-dioxide footprint is minuscule. From Standard operations and Non-Standard operations,[14] the DOD produced 58.4 million metric tons of greenhouse gases in FY 2017 as carbon-dioxide equivalent.[15] Total U.S. greenhouse gas emissions were 6,472.3 million metric tons of carbon-dioxide equivalent for 2017.[16] The DOD is exempt from reporting greenhouse gas emissions for a number of installations and operations to protect classified information and national security interests so that figure underestimates the DOD's greenhouse gas emissions. Nevertheless, even if the exempted emissions quadrupled the DOD's total carbon-dioxide footprint, the agency would account for 3.6 percent of the America's emissions. In the context of global greenhouse gas emissions, the DOD's carbon-dioxide contribution is a tiny fraction of one percent.

No matter where one stands on the urgency to combat climate change, policies that significantly restrict the use of conventional resources would be ineffective in slowing global warming. In fact, the U.S. could cut its carbon-dioxide emissions 100 percent and it would not make a difference in abating temperature increases or sea-level rise. Using the same climate sensitivity (the warming effect of a doubling of carbon-dioxide emissions) as the U.N.'s Intergovernmental Panel on Climate Change assumes in its modeling, and assuming the climate models are accurate, the world would only be less than 0.2 degree Celsius cooler by 2100 if the U.S. reduced its emissions 100 percent.[17] Eliminating the DOD's carbon-dioxide footprint would produce a change that is practically too small to measure and certainly indistinguishable from natural climate variation.[18]

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[13]Ibid., p. 6.

[14]Non-Standard operations "are vehicles, vessels, aircraft and other equipment used by Federal Government agencies in combat support, combat service support, tactical or relief operations, training for such operations, law enforcement, emergency response, or spaceflight (including associated ground-support equipment). Non-Standard operations also includes generation of electric power produced and sold commercially to other parties." See "Energy Savings Performance Contracts (ESPCs) and Utility Energy Service Contracts (UESCs)," Congressional Research Service, November 23, 2018, https://fas.org/sgp/crs/misc/R45411.pdf (accessed March 8, 2019).

[15]The Intergovernmental Panel on Climate Change developed Global Warming Potential (GWP) metrics to weigh the warming potential of different greenhouse gas emissions. To provide a more uniform measure, greenhouse gas reporting converts all emissions to carbon-dioxide equivalent. See U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, "Comprehensive Annual Energy Data and Sustainability Performance," https://ctsedwweb.ee.doe.gov/Annual/Report/ComprehensiveGreenhouseGasGHGInventoriesByAgencyAndFiscalYear.aspx (accessed March 8, 2019).

[16]U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017," February 2019, https://www.epa.gov/sites/production/files/2019-02/documents/us-ghg-inventory-2019-main-text.pdf (accessed March 8, 2019).

[17]Kevin D. Dayaratna, "Methods and Parameters Used to Establish the Social Cost of Carbon," testimony before the Subcommittee on Environment and Oversight, Committee on Science and Technology, U.S. House of Representatives, February 24, 2017, https://docs.house.gov/meetings/SY/SY18/20170228/105632/HHRG-115-SY18-Wstate-DayaratnaK-20170228.pdf (accessed March 7, 2019).

[18]These climate estimates come from the Model for Assessment of Greenhouse-gas Induced Climate Change (MAGICC), produced by scientists at the National Center for Atmospheric Research with funding from the Environmental Protection Agency. MAGICC: Model for the Assessment of Greenhouse-gas Induced Climate

Remove Costly, Ineffective Mandates and Requirements

Above all else, the DOD's energy consumption should be driven by capabilities, not politics. That is not always the case. For instance, under Section 2911(e) of Title 10 of the U.S. Code, the Defense Department has a goal to "to produce or procure not less than 25 percent of the total quantity of facility energy it consumes within its facilities during fiscal year 2025 and each fiscal year thereafter from renewable energy sources."[19] The DOD can meet its obligation through the purchase of renewable energy certificates (RECs), which divert money to meeting the renewable mandate and away from more productive uses. Policymakers should not force pricier electricity on the DOD through mandates. DOD officials should make the determination to use more expensive alternative energy if they believe national security benefits justify the higher costs. If renewable power is cheaper and the DOD can save money, no mandate is necessary.

Another example is the DOD's spending on biofuels. In 2011, President Obama directed the Departments of the Navy, Energy, and Agriculture to "work with private industry to create advanced drop-in biofuels that [would] power both the Department of Defense and private sector transportation throughout America."[20] Collectively, the agencies committed to spending $510 million in taxpayer money on advancing biofuel production.[21] The Navy paid $26 per gallon for biofuels ($12 million total) when the price for a gallon of diesel was $3.60 per gallon.[22] The Air Force bought 11,000 gallons of alcohol-to-jet fuel at $59 per gallon for a total of $649,000.[23] The equivalent cost for 11,000 gallons in diesel costs at $3.60 per gallon would be $39,600. This cost comparison assumes a one-to-one energy-density ratio, which is not the case. The lower energy density of biofuels makes the comparison even more costly. There is no strategic advantage to biofuels since the Department of Energy (DOE) fuels vehicles and transports biofuels the same way they would petroleum-based fuel.

Forcing the military to purchase more expensive alternatives would leave fewer resources for training, modernization, and recapitalization, resulting is a less capable military. Congress should specify that energy programs for defense applications prioritize national security objectives over political interests.

Technology Innovation Should Enhance Mission First

Change, The National Center for Atmospheric Research, 2007, http://www.cgd.ucar.edu/cas/wigley/magicc/ (accessed March 8, 2019).

[19]Energy Policy of the Department of Defense 10 U.S. Code § 2911.

[20]U.S. Department of Energy, "Memorandum of Understanding Between the Department of the Navy and the Department of Energy and the Department of Agriculture," June 2011, http://energy.gov/sites/prod/files/2014/04/f14/DPASignedMOUEnergyNavyUSDA.pdf (accessed March 6, 2019).

[21]Todd Woody, "Don't Scuttle The U.S. Navy's Biofuels Program," *Forbes*, June 12, 2012, https://www.forbes.com/sites/toddwoody/2012/06/12/dont-scuttle-the-u-s-navys-biofuels-program/#212c67c4a31c (accessed March 8, 2019).

[22]Brian Slattery and Michaela Dodge, "Biofuel Blunder: Navy Should Prioritize Fleet Modernization over Political Initiatives," Heritage Foundation *Issue Brief* No. 4054, September 24, 2013, http://thf_media.s3.amazonaws.com/2013/pdf/ib4054.pdf.

[23]David Alexander, "U.S. Air Force Tests Biofuel at $59 per Gallon," Reuters, July, 15, 2012, https://www.reuters.com/article/us-usa-military-biofuels-idUSBRE86E01N20120715 (accessed March 8, 2019).

The DOD must weigh the trade-offs when making choices among various energy sources and technologies. Undoubtedly, there are risks and vulnerabilities with refueling vehicles where soldiers have lost their lives in refueling missions.[24] However, using alternative technologies like batteries is subject to risks as well. Lithium-ion batteries are explosive, though newer batteries are more efficient and significantly reduce or eliminate the risk of explosion.[25]

Whether it is conventional fuels, renewable technologies, or nuclear power, spending on energy use should be mission-driven first. Certainly, alternative technologies provide advantages that enhance mission capabilities. Lighter, more efficient batteries lengthen the duration of a foot soldier's mission and reduce the weight of a soldier's backpack. Solar photovoltaics can also lighten a soldier's load and extend the travel distance of a drone. More fuel-efficient engines reduce the need for refueling. Developing micro grids and utilizing very small modular nuclear reactors can safely provide reliable power to isolated bases for long periods of time. As highlighted by a recent Information Technology and Innovation Foundation (ITIF) report, DOD research and development in energy can pay huge dividends for the agency to more effectively carry out its mission.[26] The ITIF's report demonstrates how energy research and development improves the competences of the DOD's soldier power, base power, platform power, autonomous systems power, and weapon power.[27]

The DOD should continue to use America's system of national laboratories and scientific research facilities to meet national security objectives that the private sector cannot fulfill. Congress should enable opportunities that allow the private sector, using private funds, to commercialize that research while protecting classified information and national security interests. Too often, advocates of government spending on specific energy technologies tout the federal government's involvement in commercial successes that originated from government research, such as the Internet or the Global Positioning System (GPS). Yet, the initial intention for these government projects was not any private commercial need. Entrepreneurs saw a commercial opportunity in these defense technologies and created commercially viable products. The DOD and other agencies should continue this model that improves America's defense competencies while creating pathways for commercial innovation.

In other circumstances, there may be instances where relying on hundreds of diesel generators makes the most economic and strategic sense. The DOD should make those determinations, not policymakers and outside interests who have different political or financial motivations.

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[24]Army Environmental Policy Institute, "Sustain the Mission Project: Casualty Factors for Fuel and Water Resupply Convoys," September 2009, https://www.aepi.army.mil/docs/whatsnew/SMP_Casualty_Cost_Factors_Final1-09.pdf (accessed March 8, 2019).
[25]Katherine Owens, "New li-ion Battery Will Make Soldiers' Electronics More Efficient and Less Explosive," Defense Systems, September 15, 2017, https://defensesystems.com/articles/2017/09/15/army-lithium-ion-batteries.aspx (accessed March 8, 2019).
[26]Robyn and Marqusee, "The Clean Energy Dividend: Military Investment in Energy Technology and What It Means for Civilian Energy Innovation."
[27]Ibid., pp. 9–18.

Climate Change as a Threat Multiplier

Many national security experts and social scientists perceive climate change as a threat multiplier that causes and exacerbates conflict. The 2014 *Quadrennial Defense Review* argued that the "pressures caused by climate change will influence resource competition while placing additional burdens on economies, societies, and governance institutions around the world. These effects are threat multipliers that will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions—conditions that can enable terrorist activity and other forms of violence."[28]

The evidence for climate change as a threat multiplier is far from conclusive and in many circumstances diminishes the complexity of regional conflicts. Conflict occurs because of a number of political, economic and societal factors. While climate-related events can play a role in conflict and migration patterns, correlations also exist between extreme weather events and cooperation in communities around the world. For instance, Malawi's massive flooding did not enter into stages of conflict and violence but instead cooperated to safely relocate its people. That is not to suggest Malawi's relocation efforts were costless, but rather it did not cause conflict and violence.

Importantly, climate change is by no means as deterministic for armed conflict and migration as some policymakers and journalists purport it to be, and the evidence for causality is weak. For example, a May 2017 article in *Political Geography* examined climate change's impact on the Syrian civil war. The authors conclude "that there is no clear and reliable evidence that anthropogenic climate change was a factor in Syria's pre-civil war drought; that this drought did not cause anywhere near the scale of migration that is often alleged; and that there exists no solid evidence that drought migration pressures in Syria contributed to civil war onset. The Syria case, the article finds, does not support 'threat multiplier' views of the impacts of climate change; to the contrary, we conclude, policymakers, commentators and scholars alike should exercise far greater caution when drawing such linkages or when securitising climate change."[29]

More broadly, a March 2018 article in *Nature Climate Change* argues that sampling biases likely overstate the link between climate and conflict.[30] Even beyond sampling biases, scholars specializing in conflict analyses argue that the connection between climate change and violence

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[28]U.S. Department of Defense, *Quadrennial Defense Review*, 2014, http://archive.defense.gov/pubs/2014_Quadrennial_Defense_Review.pdf (accessed March 8, 2019).

[29]Jan Selby et al., "Climate Change and the Syrian Civil War Revisited," *Political Geography*, September 2017, Vol. 60, pp., 232–244, https://reader.elsevier.com/reader/sd/pii/S0962629816301822?token=03451BCF3F6F5F3B6F2B0DA26FF071DE5439CF56CED82330FA69DFF359A02526647BD9D8113BF8A6859D5391BA19D1CA (accessed March 8, 2019).

[30]Courtland Adams et al., "Sampling Bias in Climate–Conflict Research," *Nature Climate Change*, March 2018, Vol. 8, pp. 200–203, https://www.nature.com/articles/s41558-018-0068-2.epdf?referrer_access_token=x-9d-nk9b7S_Yvl0Y7UfB9RgN0jAjWel9jnR3ZoTv0MBGf-XKFhPtGRiSnQjsZ3DfJlsaZMld88NEE7BXfZ7o6Om3LtJxH_IQkN7N09wi08BgW6O72T2RcPMMo2U-_pWOz2bbt0p_6IhwagzHL5pFTsct2nSSXnVJuVGW30nx4sa9olWh8Ywpai0PTWzXjQverWrursGcnaSODJgLJT_MJKCqk9-7btEq7TtNKXiYzLHgvQvihq_9tOufjOro9-3ZXAdHFW9hFJNpAjppm2bsJ10MMJX3csWFtR8K_PZtQ4%3D&tracking_referrer=www.theatlantic.com (accessed March 8, 2019).

and climate change and migration patterns is quite tenuous.[31] Overstating climate factors and understating more deterministic political, social, and economic factors severely misrepresents the true context of conflict and violence in those regions.

Long-term Trends in Natural Disasters and Extreme Weather

Practically speaking, the DOD should protect its installations in the U.S. and around the world from extreme weather events. However, given the lack of trends of more frequent and intense natural disasters, policymakers should refrain from assuming man-made emissions are to blame for specific vulnerabilities to military installations. The Intergovernmental Panel on Climate Changes 5th Assessment (IPCC AR5) report and other mainstream science confirms the lack of trends for extreme weather events.

Tropical cyclone activity is not becoming more frequent. The IPCC notes in its most recent scientific assessment that "[n]o robust trends in annual numbers of tropical storms, hurricanes and major hurricanes counts have been identified over the past 100 years in the North Atlantic basin," and that there are "no significant observed trends in global tropical cyclone frequency." Further, "confidence in large scale changes in the intensity of extreme extratropical cyclones [such as "Superstorm" Sandy] since 1900 is low."[32] A recently published article in the *American Meteorological Society* further shows that there has been no increase in trends for frequency or intensity of land-falling hurricanes in the continental U.S. since 1900.[33]

The IPCC found evidence for increases, decreases, and no trend at all in flood activity or severity.[34] As the U.S. National Climate Assessment (NCA) summarized, "The IPCC AR5 did not attribute changes in flooding to anthropogenic influence nor report detectable changes in flooding magnitude, duration, or frequency. Trends in extreme high values of streamflow are mixed across the United States. Analysis of 200 U.S. stream gauges indicates areas of both increasing and decreasing flooding magnitude but does not provide robust evidence that these trends are attributable to human influences."[35]

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[31]Jan Selby and Clemens Hoffmann, "Rethinking Climate Change, Conflict and Security," *Geopolitics* (2014); Clionadh Raleigh et al., "Assessing the Impact of Climate Change on Migration and Conflict," The World Bank Group, http://siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/SDCCWorkingPaper_MigrationandConflict.pdf (accessed March 8, 2019); and Clionad Raleig and Henrik Urdal, "Climate Change, Environmental Degradation and Armed Conflict," *Political Geography*, Vol. 26 (August 2007), pp., 674–694, https://www.sciencedirect.com/science/article/pii/S096262980700087X (accessed March 8, 2019).

[32]D. L. Hartmann et al., "Observations: Atmosphere and Surface," in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, p. 216, http://www.climatechange2013.org/images/report/WG1AR5_Chapter02_FINAL.pdf (accessed March 11, 2019).

[33]Philip J. Klotzbach et al., "Continental U.S. Hurricane Landfall Frequency and Associated Damage: Observations and Future Risks," American Meteorological Society, July 2018, https://science2017.globalchange.gov/chapter/8/ (accessed March 8, 2019).

[34]Hartmann et al., "Observations: Atmosphere and Surface," p. 216.

[35]M. F. Wehner, J. R. Arnold, T. Knutson, K. E. Kunkel, and A. N. LeGrande, "2017: Droughts, Floods, and Wildfires," in D. J. Wuebbles, D. W. Fahey, K. A. Hibbard, D. J. Dokken, B. C. Stewart, and T. K. Maycock, eds., *Climate Science Special Report: Fourth National Climate Assessment*, Vol.1 (U.S. Global Change Research

Trends in local events like hail and thunderstorms were also inconclusive.[36] Data for tornado activity in the U.S. shows tornadoes occur no more frequently now than in the past and that the number of strong tornadoes (F3 and above) has actually decreased.[37]

As for droughts, the IPCC overstated previous conclusions about increasing trends and that "the compelling arguments both for and against a significant increase in the land area experiencing drought has hampered global assessment."[38] The NCA reports that

> there has not yet been a formal identification of a human influence on past changes in United States meteorological drought through the analysis of precipitation trends. Some, but not all, U.S. meteorological drought event attribution studies, largely in the "without detection" class, exhibit a human influence. Attribution of a human influence on past changes in U.S. agricultural drought are limited both by availability of soil moisture observations and a lack of subsurface modeling studies. While a human influence on surface soil moisture trends has been identified with medium confidence, its relevance to agriculture may be exaggerated.[39]

Cherry-picking endpoints can produce trends that increase or decrease frequency of natural disasters to justify a politically determined need. Furthermore, it is always important to remember that correlation is not causality. Dismissing the complexity of factors that contribute to a changing climate and how they affect certain areas of the country is irresponsible.

Conclusion

Whether carbon-dioxide levels rise, fall, or stay the same, the United States and the rest of the world will experience extreme weather events. The climate and land will continue to change over time for a wide variety of reasons. The DOD should identify current and near-term vulnerabilities and make the necessary and targeted spending to strengthen military installations. The DOD should use the best available science to better prepare before storms inflict any damage. Furthermore, the DOD should continue to learn lessons after extreme weather events and make any necessary adjustments to mitigate damages from future natural disasters.

Ineffective, costly energy mandates and requirements will do little to impact climate change and make the DOD worse off by allocating defense dollars away from more valuable uses. The DOD's research and development in alternative energy technologies can have a lot of geopolitical and economic value, but it should be mission- and capabilities-driven first.

Program, Washington, DC), pp. 231–256, https://science2017.globalchange.gov/chapter/8/ (accessed March 8, 2019).

[36]Hartmann et al., "Observations: Atmosphere and Surface," p. 216.

[37]After accounting for the apparent increase in tornado counts due to improved identifying technology. National Oceanic and Atmospheric Administration, "Historical Records and Trends," U.S. Department of Commerce, http://www.ncdc.noaa.gov/climate-information/extreme-events/us-tornado-climatology/trends (accessed March 11, 2019).

[38]Ibid., pp. 214–215.

[39]Wehner et al., "2017: Droughts, Floods, and Wildfires," pp. 231–256.

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Nicolas (Nick) Loris, an economist, focuses on energy, environmental, and regulatory issues as the Herbert and Joyce Morgan fellow at The Heritage Foundation.

A research fellow in Heritage's Roe Institute for Economic Policy Studies, Loris studies and writes about energy supplies, energy prices, and other economic effects of environmental policies and regulations, including climate change legislation, energy efficiency mandates, and energy subsidies.

He also covers coal, oil, natural gas, nuclear gas, and renewable energy policy and articulates the benefits of free market environmentalism.

Loris has testified before House and Senate committees. He has been published and quoted in major newspapers such as The Wall Street Journal and The New York Times. His radio and television appearances include CNN, Fox News Channel, MSNBC, and National Public Radio. He is a prolific contributor to the energy and environment section of The Daily Signal, Heritage's multimedia news organization.

Loris was promoted to research fellow in March 2016. He had been a senior policy analyst since 2013, and was named Morgan fellow the year before. The fellowship was endowed by retired real estate developer Herbert Morgan and his late wife, Joyce, of Arlington, Va., longtime proponents of free enterprise and limited government.

Before joining Heritage in 2007, Loris was an associate at the Charles G. Koch Charitable Foundation, immersing himself for a year in a market-based management program. He received his master's degree in economics from George Mason University in Fairfax, Va. He holds a bachelor's degree in economics, finance, and political science from Albright College in Reading, Pa.

Loris, who was born and grew up in Quakertown, Pa., currently resides in Washington, D.C.

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Hearing Date: Wednesday, March 13, 2019

Hearing Subject:

Ensuring Resiliency of Military Installations and Operations in Response to Climate Changes

Witness name: Nicolas Loris

Position/Title: Research Fellow, The Heritage Foundation

Capacity in which appearing: (check one)

● Individual ○ Representative

If appearing in a representative capacity, name of the organization or entity represented:

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2019

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment

2018

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment

2017

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment

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Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment

2018

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment

2017

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment

○