

The Cost of Climate Change: From Coasts to Heartland, Health to Security

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

I am David Titley and currently serve as an Affiliate Professor of Meteorology at the Pennsylvania State University. Prior to my retirement from Penn State, I founded Penn State's Center for Solutions to Weather and Climate Risk. I also hold appointments as an Affiliate 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. I am currently retired and receive no funding from any organizations with an interest in climate policy and am testifying today in my personal capacity. 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, 2019 and again in 2020. Although not directly under this committee's jurisdiction, I encourage both chambers and both parties to support the climate-related amendments in the FY 2020 National Defense Authorization Act (NDAA) to further strengthen Department of Defense's ability to become more resilient and to manage the risk posed by climate change. Such pro-active management, in addition to maintaining the core readiness mission of the Department, will save taxpayers money over time by minimizing the reconstruction efforts brought on by extreme weather.

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 Executive Branch to think in a proactive manner when managing climate risks. These are bi-partisan actions the congress can take today that are interest of every State, Congressional District, and citizen.

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. Its changes impact not only the Department of Defense but also the Department of Homeland Security and many other federal agencies.
- **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. In addition to impacting readiness, the continual destruction and reconstruction of critical infrastructure is a significant drain on precious taxpayer resources that could be funding a variety of other, high-priority programs.
- 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 are risks that 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.

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.

In today's hearing I will highlight several of these risks.

Security Issues in the Arctic

Over the past few years in the Arctic, we have seen an almost 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 should 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; meanwhile the Russians planted a flag on the sea bottom near the North Pole. 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 Arctic, 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”. 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.

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 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 (we would call this 'readiness' in the military) 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 ice-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 breaches 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 physically 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 distractions and impact on morale if you are forward-deployed and see your family 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 understand 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

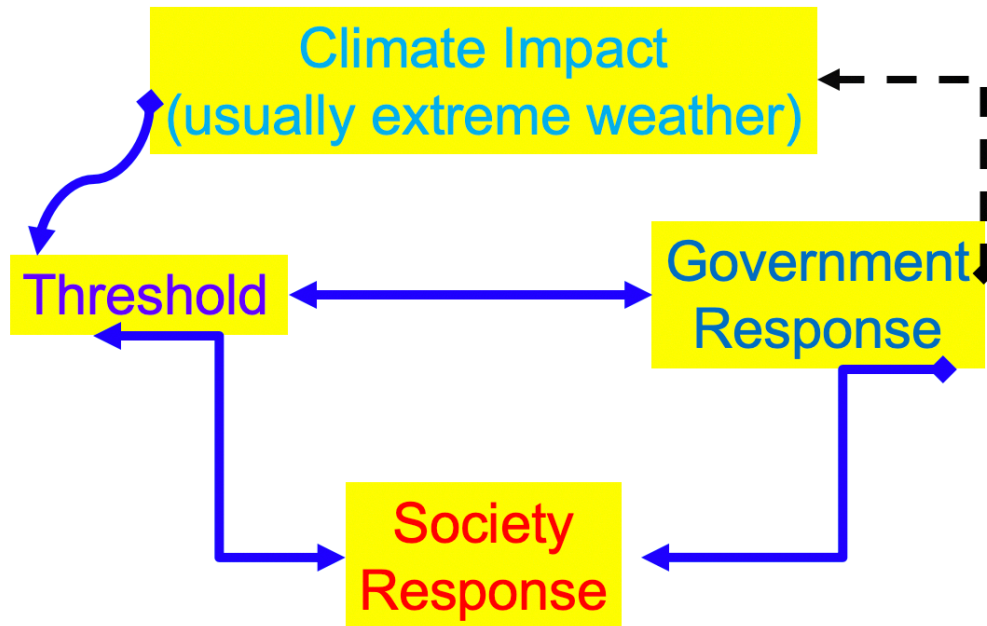
We should remember that the risks posed by rapid climate change do not exist in a vacuum. They affect, and are affected by, other large-scale 21st century trends: population growth, urbanization, expanding demand for food, energy and water resources, and globalization. The 2014 CNA Military Advisory Board (MAB) report on the “Accelerating Risks of Climate Change² expands on this theme. Half a billion people have been added since 2007 and another

² “National Security and the Accelerating Risks of Climate Change.”, CNA Corporation, May 2014. https://www.cna.org/cna_files/pdf/MAB_5-8-14.pdf

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 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 percent, 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.

These are the 'big picture' statistics – but we also know that not every extreme weather event leads to a security crisis. Much work has been accomplished and continues to be done in this area. The graphic (below) of my conceptual model accounts for extreme weather, a threshold for a specific type of weather disaster (e.g., level of storm surge or fresh water flooding, sufficient drought and heat to cause near total crop failure, etc.), and finally the national and international response to the crisis. These factors interact with each other and can explain some of the very different results we see around the world for a given extreme weather or climate situation.

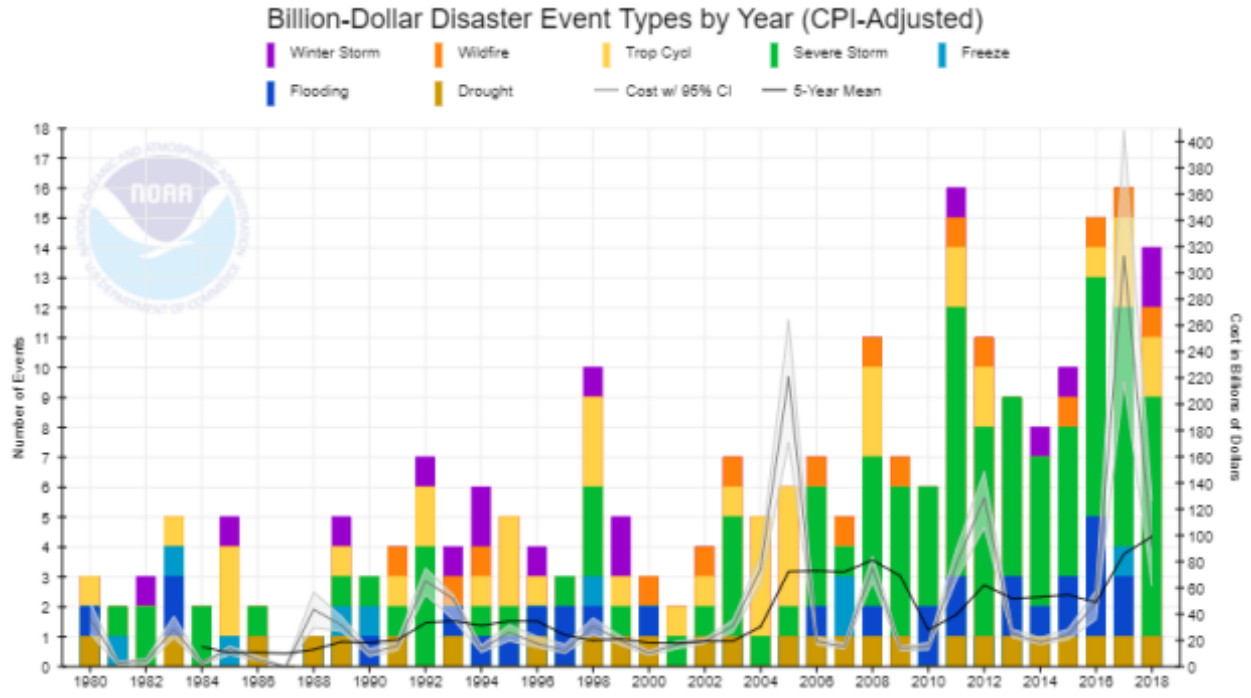
Complex links between climate, weather, and response



Risks to our Taxpayers

In addition to the mission and readiness issues raised above, the cumulative impact of the ever-increasing frequency and severity of extreme weather raises serious financial questions. Data from the National Oceanic and Atmospheric Administration (NOAA)³ show that both the absolute number of billion-dollar disasters and their annual cost (CPI-adjusted) are increasing.

³ <https://www.climate.gov/news-features/blogs/beyond-data/2018s-billion-dollar-disasters-context>

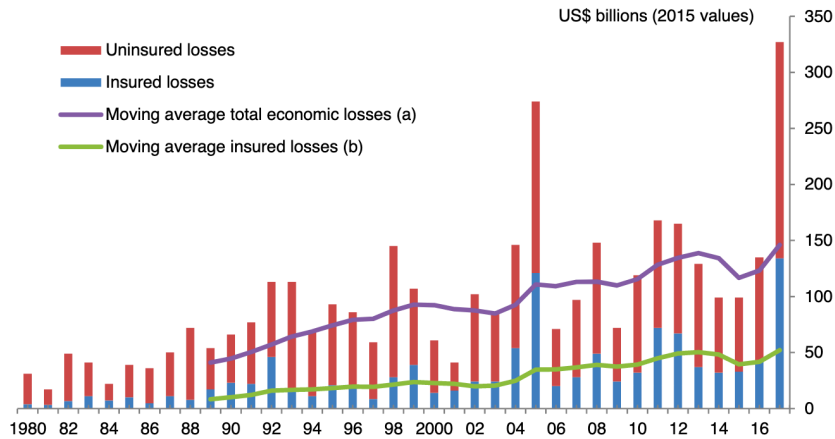


The number (bars, left axis), type (colors), and annual cost (right vertical axis) of U.S. billion-dollar disasters from 1980-2018. Running annual cost (grey line), along with the 95% confidence interval, and 5-year average costs (black line). The number and costs of disasters are increasing. Inland flooding (blue bars) and severe storms (green bars) are making an increasingly large contribution to the number of U.S. billion-dollar disasters.

Likewise, in a speech given last year by Mark Carney, Governor of the Bank of England⁴, weather and climate-related losses, adjusted for inflation, are following a similar trend:

⁴ <https://www.bankofengland.co.uk/-/media/boe/files/speech/2018/a-transition-in-thinking-and-action-speech-by-mark-carney.pdf>

Chart 1: Weather-related losses worldwide (1980-2017)



(a) Total Economic Losses = Insured + Uninsured losses. (b) 10-year moving average
Source: Munich Reinsurance Company, Geo Risks Research, NatCatSERVICE

Assessing what portion of these vast sums of money should be apportioned to climate change has not, to my knowledge, been accomplished. The science of attributing the impacts of specific weather events to climate change is still young, although rapidly gaining in maturity⁵. A separate challenge is devising a consistent method of accounting for these funds within the executive branch. In addition to its technical complexity, there is currently no incentive to explicitly spending as “climate-related”. However, there has been, and is, fear either the White House (in the Trump Administration) or the Congress (in the Obama Administration) would identify that money and zero out the funds. Peter Drucker’s saying of “if you can’t measure it, you can’t improve it” certainly applies here. If the Office of Management and Budget will not provide and enforce consistent guidance on how to track climate-related spending, perhaps this committee could assist in that challenge.

A financial risk that has not been widely discussed with respect to climate change, and especially the risk from sea-level rise, is that for all practical purposes, the need for dozens and even hundreds of coastal communities to adapt to rising seas will occur simultaneously. It will be very difficult to space out the expenditures over multiple decades, or said another way, to tell one portion of the country to wait while we attempt to fix a different section of coastline.

How much will all this cost? No one knows for sure, but the estimates are sobering. In a recent report, the Center for Climate Integrity states the cost of adapting to sea level rise will be at least

⁵ <https://www.nap.edu/catalog/21852/attribution-of-extreme-weather-events-in-the-context-of-climate-change>

\$400B over the next 20 years⁶. I expect this is a conservative estimate. As a reference point, the Dutch, who already possess arguably the most sophisticated coastal flood defenses in the world, expect to spend at least an additional \$100B by 2100 to account for a 3-foot rise in sea level. As a point of reference, the coastline of the Netherlands is roughly equivalent to our combined coastlines of Massachusetts and Connecticut.

Another recent example: The Department of Defense spent over \$1B (2005 dollars) rebuilding Keesler Air Force Base post-Katrina and has suffered and estimated \$8B in damage in the past eight months at Camp Lejeune (Hurricane Florence), Tyndall Air Force Base (Hurricane Michael) and Offutt Air Force Base (Nebraska flooding). In addition, in 2017 the U.S. Army Corps of Engineers requested nearly \$2B to enhance flood protection to the Norfolk Virginia area. This does not include the hundreds of millions of dollars the Navy will require to raise piers and harden critical infrastructure such as shipyard drydocks where our nuclear-powered submarines and aircraft carriers undergo required maintenance.

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.

One action that could be taken today is to ensure no future installation or infrastructure appropriation is obligated before some common-sense review of climate impacts for the projected lifespan of that infrastructure. The degree of hardening for climate and extreme weather impacts should be commensurate with the criticality of that specific infrastructure.

Climate risks and security risks share another trait in common: “The worst matters much more than the bad”⁷. 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 recommendations⁸ for the national security enterprise to consider. Consistent with that document, here are **five specific recommendations for**

⁶ https://www.climatecosts2040.org/files/ClimateCosts2040_Report-v5.pdf

⁷ Burroughs, William “Climate Change in Prehistory: The End of the Reign of Chaos”, Cambridge University Press, 2005

⁸ https://climateandsecurity.files.wordpress.com/2018/02/climate-and-security-advisory-group_a-responsibility-to-prepare_2018_02.pdf

managing climate risks on military installations. These recommendations, if they prove to be effective, could be leveraged more broadly by the executive branch

- Develop Department of Defense authorized and authoritative standards for use in projections out to 50 years. While the 4th National Climate Assessment⁹ 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 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.
- 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)¹⁰. The Directive is thoughtful and comprehensive – the only thing lacking is its execution by

⁹ <https://www.globalchange.gov/nca4>

¹⁰ <https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/471521p.pdf>

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 January 2017 a thorough 193-page ‘Climate Adaptation and Resilience’ handbook¹¹. Much of the foundational work on how to adapt defense installations to climate changes has been done. 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?

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. 50 years ago the public had higher trust in our government, we had a unity of effort between the Executive and Legislative branches, and our leadership successfully explained to the public both why this was hard but the effort was worthwhile. The challenge of successfully decarbonizing our global society, while maintaining and improving the standard of living and freedoms we expect, is every bit as daunting as going to the moon and returning safely. 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.

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