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14. ABSTRACT

Climatology in the Arctic, especially melting ice and resultant greater accessibility throughout the world, can show us how a connection exists between changes in the weather—due to evolution, science, or human existence—and regional instabilities—due to drought, flooding, fires, and other climate-related events; creating an environment where violent extremists can exploit weakened or fragile states. Regardless of what inputs are leading to the outputs of increasing global temperatures, rising sea level, and more frequent, more severe storm systems, mitigation efforts to address these effects are necessary to prevent devastation to readiness and destruction of civil societies.

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MASTER OF MILITARY STUDIES

TITLE:
The Climate is Changing: The Arctic and Everything from Accessibility to Nation-State Instability and Global Conflict

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

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Executive Summary

Title: The Climate is Changing: The Arctic and Everything from Accessibility to Nation-State Instability and Global Conflict

Author: Lieutenant Commander Christopher Culpepper, United States Coast Guard

Thesis: Close management of a high seas traffic scheme across the Arctic, in addition to its ecological changes, may serve as a harbinger of global conflict and instability due to climate change and its second- and third-order effects on US national security.

Discussion: The Arctic has not been a place of high concern or activity compared to the planet's temperate and tropical zones. As the polar ice melts and shorter maritime transit routes spark global interest as cost-savings opportunities for trans-Arctic Ocean commerce, an increase in ship traffic along these great circle routes brings with it all of the existing elements of maintaining freedom of navigation: environmental protection and response, search and rescue, protection of living marine resources, pollution prevention and response, domestic and maritime security, and other concerns related to the United Nations Convention on the Law of the Seas.

Maritime Domain Awareness (MDA) is critical in knowing what is moving through these regions, so expanding the scope of sensors and regional assets will improve visibility, but existing infrastructure is presently at risk throughout the world due to climate change. International cooperation and agreements will be crucial to operate in the frigid waters and desolation of these maritime passages. Movement of armed forces and war-time effort lines of communication affect those agreements as the maritime traffic scheme will undoubtedly skirt national sovereignty issues along its path until sea ice further recedes and sea lanes freely widen.

While all of these elements possess great concern and merit, the benefits of increasing MDA are threefold: power projection has served the US well as a longstanding reinforcement of national security; ecological and meteorological changes can serve to forecast global implications and used in conjunction with other forecasting models can help focus training and preparation efforts for humanitarian assistance and disaster relief; vessel tracking and intelligence gathering of ship movements through the polar region builds strategic awareness of economics and helps forecast ship and port activity.

Conclusion: Arctic response and prevention capability gaps leave mariners, the environment, and commerce quite vulnerable. The UN and specifically the US needs to bridge those gaps through cooperative strategy to reduce the amount of risk to national security. Establishing a physical presence in the Arctic is paramount to maintaining our national security interests; additionally, preparing for the likelihood that sea level will continue to rise and natural disasters will worsen requires deliberate planning to mitigate impacts and increase resilience to the effects of climate change.

Disclaimer

Preface

My interest in learning about transoceanic shipping started at a young age when I first developed an understanding of early trade routes and the inception of a resultant global economy. As I studied more, I became further interested in the impacts vessel traffic has had on the environment, and the impacts the environment has had on the vessels and their crews. As I began researching the long-term viability of an Arctic trade route and its proximity to US national security interests, the topic created additional intrigue. This research topic originated as a massively broad umbrella, and with the keen assistance of my mentor, Dr. J. W. Gordon, and my faculty advisor, LtCol O. Nucci, they provided me with some critical guidance in shifting my focus closer towards climate change and its effects on national security. Intensive research into the changing climate and the remarkable progress the Arctic Council and other groups have made over the previous decades has enriched my appreciation for, and awareness of, the economic and ecological impacts melting polar ice has on nations farthest from the poles, as well as the intertwining relationships with US national security interests.

Thank you to my mentor and instructors for the guidance, encouragement, and support not only in this endeavor, but certainly also throughout the entire course of study! I am grateful for the ongoing and endless support from my family and their sacrifices that allow us, collectively, to continue our personal pursuit of ongoing adventure built upon a solid foundation in professional career investment.

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Everything from the Arctic and Accessibility to Nation-State Instability and Global Conflict

The Future of Global Cargo Shipping

WEDNESDAY, JANUARY 5, 2180. Thank you for joining us today on Good Morning World! Today is the fifth of January, twenty-one-eighty, and a special thanks to those of you joining us via our new GalaxyFeed broadcast on Earth News Network. Our Breaking News segment today starts with a maiden voyage of a remarkable new ocean cargo transport. The newest 1,800-foot-long cargo super-ship DOMINUS ORBIS, laden with half-a-billion gallons of crude oil below the waterline and twenty-thousand shipping containers topside, navigates its way through the highest latitudes and across the North Pole at maximum speed through wide-open and sunny seas that were once bound by ice. Decades ago, the Panama Canal, even after massive construction projects twice widened it, still limited the size of ships making trans-global deliveries, while the Suez Canal was still too shallow for the massive evolution of shipping traffic. Since nearly all of the restrictive ice pack and glaciers in the Arctic melted years ago that previously confined navigable waters, the world's shipbuilding corporations focused efforts on manufacturing the biggest, fastest, heftiest vessels to make the trip over the top of the planet, avoiding canals and thousands of miles of transit distance. The world's largest tankers continue to grow and stretch the bounds of known physics and naval architecture while testing the mechanical limits of time, speed, and distance equations. Still reliant primarily upon fossil fuels, these vessels are more efficient than before, but with greater loading and higher speeds, their fuel consumption rates are reasonable in comparison to the supertankers at the turn of the 21st century. Thanks to ongoing interest in offshore oil exploration and the Arctic Council's strength

in partnerships, the Organization of Petroleum Exporting Countries (OPEC) grew from 13 member countries to 20 over the course of the last few decades. Successful drilling and collection operations throughout the Arctic Ocean facilitates oil supply to keep pace with demand, and oilrig platforms populate the nighttime seascape like a sprawling city's lights visible from miles overhead. Exciting times abound as the 22nd century shows increased promise for continuing tropical weather across most of the planet, and new urban areas develop on higher elevations to replace the former coastal metropolitan areas that flooded and washed away in the massive tides and storm surges as the sea levels continued to rise in the early 2100's. Tune in next time for our latest update on health-related issues with cloned fish stocks in the last decade since traditional sea-life went extinct. We hope you enjoyed this segment on Earth News Network.

The Ecology of National Security

FLASHBACK TO PRESENT DAY, January 5, 2017. The future landscape of our planet and climate is currently under construction as the world's waterways continue to carve their paths through terra firma and open up new concerns for international cooperation and partnerships while all concerned countries strive to manage, control, and respond to the waterways and their effects. The establishment and protection of a viable high seas traffic scheme through the arctic region is widely recognized as a safe and sustainable multi-national endeavor; however, close management of that waterway and its ecological changes may serve as a crucial harbinger of conflict and instability with a strong focus toward climate change and its second- and third-order effects on US national security. As Arctic ice melts, existing support infrastructure in the region suffers, and congenial international diplomacy serves as the roadbed this lucrative transit lane rests upon from one end to the other. The impacts of climate change

will have a dramatic effect on the Northwest Passage, and under extreme climate change circumstances, it will indiscriminately melt away, providing even greater freedom of movement across the North Pole, unconfined by glaciers or ice floes. The development and improvement of multi-national strategy in the Arctic region as it pertains to conserving its natural resources and preserving its landscape while encouraging freedom of navigation through various territorial seas claims is an on-going effort.

Arctic Region Maneuver Space

As "one of our planet's last great frontiers,"[1] the Arctic has not been a place of comparable concern or activity relative to the planet's temperate and tropical zones nearer the equator and highest concentrations of global economy. Proactive awareness and comprehensive action must supersede this complacency as the polar ice melts and shorter maritime transit routes spark global interest in cost-savings opportunities for trans-Arctic Ocean commerce. An increase in ship traffic along these great circle routes going over the North Pole brings with it all of the existing elements of maintaining "an absolute freedom of navigation upon the seas:"[2] environmental protection and response, search and rescue, protection of living marine resources, pollution prevention and response, domestic and maritime security, and other concerns subject to the United Nations Convention on the Law of the Seas. All UN Member-States, and non-signatory states with maritime or global economy interests alike, must invest in and take action to address issues relating not only to Freedom of the Seas in a challenging, new, and complicated geography across the North Pole, but also the dramatic effects ongoing climate change will have upon all countries around the globe.

Figure 1: Image depicting possible Arctic Shipping Routes. Source: The Economist[3]

US Arctic Strategy and Diplomacy

President Barack Obama signed the National Strategy for the Arctic Region in May 2013, outlining the United States' priorities for how the country will proceed in planning for the eventuality of major maritime movement through the Polar Regions, most notably the northern arctic and subarctic zones. These priorities are not new, nor are they apparent revelations directly attributed to global warming; they are rooted in more than 20 years' worth of consistent and deliberate administration dating back to President William Clinton's 1994 executive order on US policy in the Arctic. Even deeper roots tie back to President Harry Truman and post-World-War-II policy as it pertains to the conservation zone, seabed, and continental shelf. Specific focus on Arctic policy echoed through the administrations during the Cold War, but President Clinton placed renewed effort and energy into it that President George W. Bush and President Obama carried forward in his administration.

In the 2013 National Strategy for the Arctic Region, President Obama's first line of effort focused on advancing the United States' security interests. Maritime Domain Awareness is critical in knowing what is moving through these regions, so expanding the scope of sensors and regional assets will improve visibility. International cooperation and agreements will be crucial to operate in the frigid waters and desolation of these maritime passages. Most important is the strategic awareness the US must possess regarding indirect consequences of Arctic accessibility brought on by melting ice and the contributing factors to why the ice is melting, the global climate is changing, and how it affects the planet's biology in terms of food sources, energy, and ultimately civil unrest.[4]

Inhabitability and Safety

The climate itself is a deterrent for massing any sizable population on the existing lands surrounding the Arctic Ocean. The National Snow and Ice Data Center estimates roughly four million people worldwide, or 0.0005% of the world's 7.5 billion people, live around the Arctic Ocean, with scientific belief that indigenous peoples have inhabited those northernmost climes for 20,000 years.[5] In the future, perhaps it will be less harsh and deep-water ports will begin to materialize. This is potentially a highly lucrative transit route, and could serve to dramatically alter the global business scheme much like the early transoceanic routes did. As has been stated many times elsewhere, the future potential is high for a place like Iceland to become comparable to, or even outpace, Singapore as a regional shipping hub. That perhaps exists in a distant future and may be difficult to imagine right now as Arctic response and prevention capability gaps currently leave mariners, the environment, and commerce quite vulnerable, particularly as sea levels rise, devastating storms become more frequent and severe, and agrarian societies suffer from droughts. The UN, and specifically the US, needs to bridge those gaps through cooperative

strategy to reduce the amount of risk to national security. Establishing a physical presence in the Arctic is paramount to maintaining our national security interests much in the same way show of force is necessary in the rest of the world's seas and oceans and why, arguably, President Theodore Roosevelt's Great White Fleet first set sail to circumnavigate the globe. Additionally, this passage could serve as an ideal route for projecting power and influence across the globe more efficiently and effectively.

Severe Climate Alert

The changing climate is so significant a concern; President Obama delivered in his remarks to the graduating class of 2015 at the US Coast Guard Academy a message central to addressing the effects and mitigating the impacts of climate change. He specifically highlighted the following national security nexus:

> Climate change constitutes a serious threat to global security, an immediate risk to our national security…it will impact how our military defends our country…we need to act now. …Denying it, or refusing to deal with it endangers our national security. It undermines the readiness of our forces. …It will shape how every one of our services plan, operate, train, equip, and protect their infrastructure, their capabilities, today and for the long term…climate change increases the risk of instability and conflict. Rising seas are already swallowing low-lying lands, from Bangladesh to Pacific islands, forcing people from their homes. Caribbean islands and Central American coasts are vulnerable, as well. Globally, we could see a rise in climate change refugees. Elsewhere, more intense droughts will exacerbate shortages of water and food, increase competition for resources, and create the potential for mass migrations and new tensions. All of which is why the Pentagon calls climate change a "threat multiplier."[6]

The Arctic region continues to be a prominent topic for the Department of Defense, and especially for the US Coast Guard as it retains a statutory mission of breaking ice and tracking glacier movements throughout vast, world-wide navigable waterways. In a July 12, 2016 hearing in the Congressional House Subcommittee on Coast Guard and Maritime Transportation, Admiral Zukunft, Commandant of the US Coast Guard, Ms. Allison Stiller from the Navy Research, Development, and Acquisition office, and other senior executives including the

President of the Shipbuilders Council of America, testified before Congress that procurement, construction, and employment of a modern icebreaking fleet, particularly a heavy icebreaker, remains a current and significant affair with which all sea-going services should have concern, and the threats this lack of resource capacity poses to implementation of cooperative Arctic strategic capability is detrimental to filling a defense readiness gap in the Arctic. Chairman Duncan Hunter (R-CA) stated, "My concerns continue to lie with current mission gaps in the Arctic, particularly defense readiness, due to the inability of assets to support year-round missions in the region. And I believe this is the responsibility the Coast Guard and Navy should share."[7] Interoperability among parties in the Arctic Council is critical to ensure open, passable, and safely navigable waterways are available to mariners year-round given the herculean efforts involved in only seasonal passages to date. No single country can maintain the arctic with existing resources, nor does it benefit any single country to do so economically or diplomatically.

Full Steam Ahead

As ice recedes and glaciers melt, shrinking iceberg obstructions in the waterways will facilitate safer transits through lower risk of vessels impacting ice that would cause significant damage to their hulls. More ice may be prevalent in the coming years, to an extent, in the waters as glaciers melt and crumble, but those floating ice chunks pale in comparison to the ice floes, icebergs, and coastal shelf ice that is mostly static and poses massive threats to transiting vessel traffic today.

Increasing vessel traffic through the region will cause added stress to the environment through increased wave action due to ships' wakes. The cliff-like faces of many miles of glaciers adjacent to the water's edge do not dampen wave motion like gradual beach and other land surfaces. As the amplitude of waves compound without a dampening effect, the wave

motion continues to grow and its impact beating against glaciers will also weaken their structures to further exacerbate their disintegration. Increased combustion emissions from higher numbers of vessels transiting the area will continue to add to greenhouse gases being trapped in Earth's atmosphere. The Environmental Protection Agency outlines various impacts of greenhouse gas accumulation including all of the following effects that directly threaten the global food supply, regional clean water sources, physical infrastructure, and the planet's entire ecosystem consisting of human, animal, and plant health. Accumulation of Greenhouse Gas can:

- Increase Earth's average temperature
- Influence the patterns and amounts of precipitation
- Reduce ice and snow cover, as well as permafrost
- Raise sea level
- Increase the acidity of the oceans
- Increase the frequency, intensity, and/or duration of extreme events
- Shift ecosystem characteristics
- Increase threats to human health[8]

The rate at which the arctic ice recedes is directly related to the increase in temperatures of the oceans and the atmosphere due to global warming from human activities and other causative factors such as the greenhouse effect, the sun's energy effect, and how much energy enters Earth's system, according to the Environmental Protection Agency.[9]

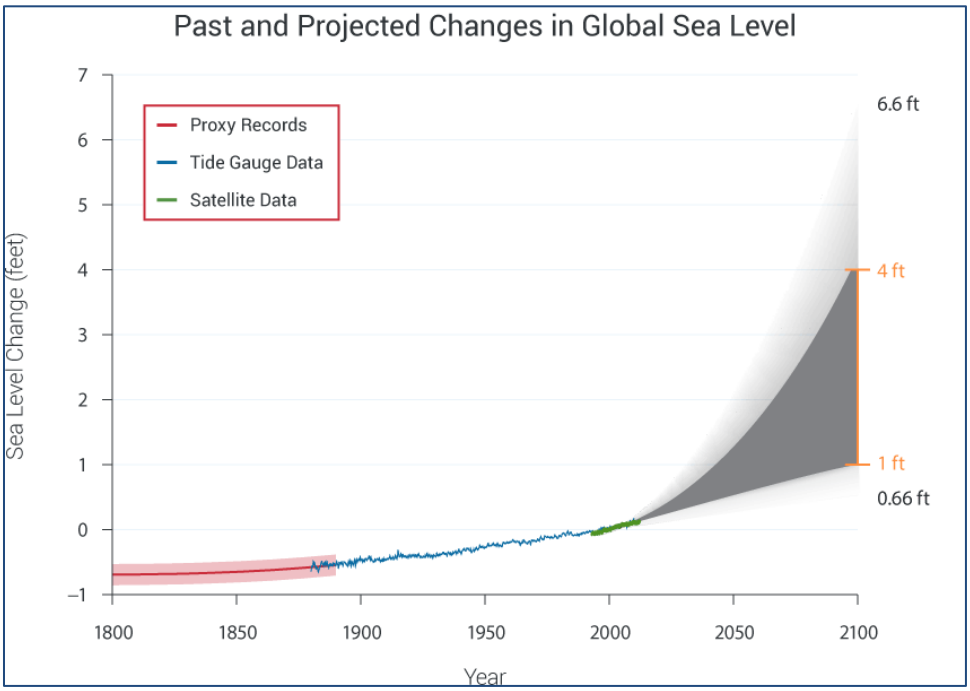

Figure 2: Past and Projected Changes in Global Sea Level. Source: 2014 US National Climate Assessment, http://nca2014.globalchange.gov/report/our-changing-climate/sea-level-rise

"Past and projected sea level rise from 1800 to 2100. The orange line at right shows the currently projected range of sea level rise of 1 to 4 feet by 2100; the wider range (0.66 feet to 6.6 feet) reflects uncertainty about how glaciers and ice sheets will react to climate change. Source: 2014 National Climate Assessment, http://nca2014.globalchange.gov/report/our-changing-climate/sea-level-rise."[10]

Ice Impacts Ships and Crews

Having less ice in the arctic region bodes well in favor of greater high-seas traffic scheme sustainability, comparable to other existing trans-oceanic routes. Similar in fashion to how massive cargo ships presently voyage from one side of the Pacific Ocean to the other, lacking any intermediate layover options due to draft, beam, and length limitations, these vessels and their crews must prepare for and adequately train for self-sustainment and preservation without expectation of at-sea assistance or immediate recovery in times of emergency or peril due to weather, mechanical failure, hull breach, medical issue, or any other potential dilemma. An additional planning factor while transiting the Arctic Ocean must certainly include freezing air and water temperatures as they pertain both to crew survivability and ship's systems

functionality. These factors are already integrated into the routines for vessels transiting the Bering Sea, the Southern Ocean, and the seas surrounding Antarctica, so information sharing between experienced mariners in those climes and inexperienced mariners embarking on journeys through polar and near-polar zones will be imperative toward educating and preserving the lives of new crews venturing well beyond the tropics and into the Arctic Circle.

The International Maritime Organization has made great strides towards "protecting ships and people aboard them, both seafarers and passengers, in the harsh environment of the waters surrounding the two poles by adopting the International Code for Ships Operating in Polar Waters (Polar Code) and amendments to make it mandatory under both the International Convention for the Safety of Life at Sea (SOLAS) and the International Conventions for the Prevention of Pollution from Ships (MARPOL)."[11]

With the Polar Code going into force January 1, 2017, ship survivability now requires tremendous planning and readiness given the dramatic effects sea ice can have on the topsides of vessels as sea spray freezes to every exposed surface, compounding and drastically changing a vessel's center of gravity, righting moment that keeps the vessel upright, and the likelihood of a capsize or loss of ship control. Without built-in mitigation techniques such as heated radar domes, heated windows, and other de-icing technologies, a vessel in freezing climates is susceptible to reduced visibility, loss of electronic navigation systems, radar, communications, ventilation, mechanical liquid cooling inefficiencies, and any other life support system that relies on freedom of air movement or mechanical rotation, for example. Crewmembers are sometimes required to use wooden baseball bats, batons, and other striking tools to remove accumulating ice from the ship's rails, decks, and gear, such as machinery, rigging, fittings, and in the armed services' case—weapons systems, gun mounts, and cannon barrels. Prolonged exposure by the

crew leads to increased risk of hypothermia, fatigue, falling overboard, and in the event of extremely reduced visibility, personnel posted as lookouts about the weather decks and high in the ship's mast are susceptible to reduced functionality and effectiveness. These concerns are imperative to consider in future shipbuilding designs to ensure sustainability even as the arctic becomes more accessible.[12]

Climate Change is Real: *Weather* or Not

Polar storms and sub-zero temperatures may never completely vanish from the arctic, and as storms are already becoming more violent and more frequent, perhaps due to global warming and melting arctic ice, the likelihood exists that the polar vortex will weaken, allowing freezing cold air and frozen precipitation to escape its confines, becoming even more extreme during the winter months and cause greater impacts to larger areas including both sea and land areas. As explained by The Weather Channel, "The polar vortex is an area of low pressure in the upper atmosphere, primarily in the stratosphere, a layer of the atmosphere above which most of our sensible weather occurs (known as the troposphere)."[13]

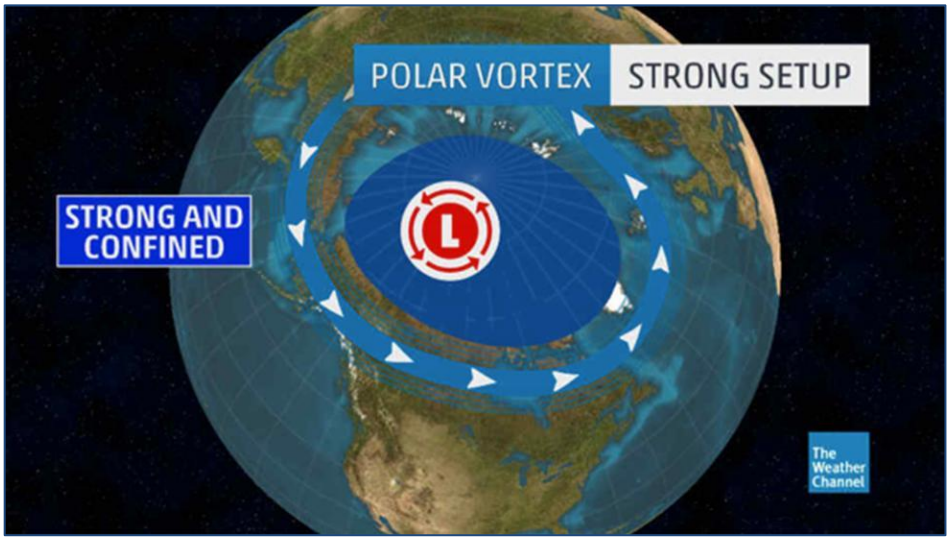

Figure 3: The Polar Vortex. Source: The Weather Channel

In a world where seasonal weather changes have drastic, sweeping impacts on farming, livestock, transportation, and general livelihood of society, the weather will inevitably be an impetus to increased social disorder and eventual chaos. Using the crisis in Nigeria as an example, whereby the terrorist organization Boko Haram exploited the regional instability left behind in the wake of severe drought and associated plight, it is relatively clear and present how climate change directly affects economies even more so in developing agrarian societies. Vacuums of power and popular control materialize when the existing modicum of social balance and governance becomes upended in the battle between providing for Maslow's hierarchy of needs to a community seeking safety, sustenance, and shelter and opposing the overpowering vice squads using violence and psychological manipulation. As Boko Haram played on the grievances of the population and held hundreds of citizens hostage to seek fulfillment of their own needs and wants, the entire country suffered without feasible means to help itself out of the situation.

Countering Violent Extremism with Crops

When something seemingly as simple as successful, sustainable crop growth can maintain equilibrium in a society, and the demise of those crops is tied directly to droughts caused by a shift in the global weather patterns, it is evident this instability creates opportunity for violent extremists to sweep in and exert their power while preying on weak, feeble nations. If stable nations are unable or unwilling to quell that kind of insurrection and wrongdoing, the opportunity widens and allows for greater instability and regional unrest to pose much larger national security threats.

Where there is opportunity to exploit weak populations due to poor agricultural ability, ample opportunity also exists to provide for those gaps in crop production, in essence, warding off the

opportunistic terrorist. Moving consumables and edible commodities around the world to satisfy the needs of a suffering society is an option, albeit a costly one currently due to transportation costs. Another option is to address the direct effect of drought, and seek to provide systems that create water, irrigate farmlands, and filter drinking water for human and animal consumption to build sustainable and repeatable colonies not confined by the geography of rivers, lakes, and oceans, and not bound by reliance upon industrial fuels to function or flourish.

Married to Fossil Fuels: 'Til Death do Us Part

Energy dependence is, at its heart, a blessing and a curse. Dependence upon energy provides for compounding technological advances evident in the revolution known as the Industrial Age. This rapid growth of machinery and technology opened the doors to an entirely new universe of productivity, manufacturing, distribution, exploration, and opportunity. Meanwhile, all of those blessings, or benefits, further separated the haves and have-nots. While those who have the industry dump toxins into the atmosphere at catastrophic rates without regard for future consequences, those who have no comparable industry suffer perilous consequences such as drought and famine even sooner than those with industrious mitigation strategies, ironically, consisting of more production, exploration, manufacturing, and pollution. "In the 2014 US National Climate Assessment, study results on atmospheric greenhouse gas concentrations over the course of two millennia show startling increases since 1750 and the associated human activity in the industrial era." The following chart (Figure 4) shows a graphical representation of three specific gas concentrations consisting of carbon dioxide, methane, and nitrous oxide.[14]

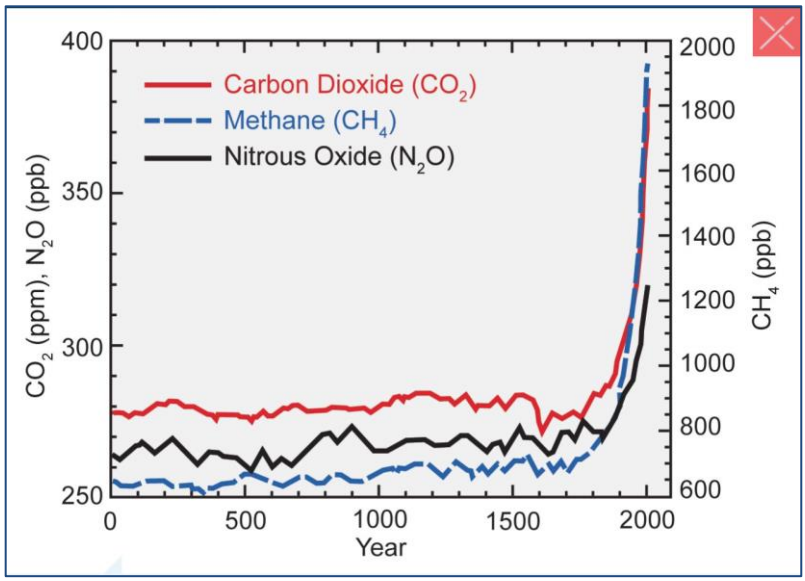

Figure 4: Gas concentration in the environment. Source: 2014 US National Climate Assessment

Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion molecules of air.

During the same speech President Obama delivered to the Coast Guard Academy in May 2015, he specifically referenced the importance of readiness and preparation prudent to military planners as new climate effects wreak havoc and generate pockets of instability around the globe:

> It's now believed that drought and crop failures and high food prices helped fuel the early unrest in Syria, which descended into civil war in the heart of the Middle East. So, increasingly, our military…will need to factor climate change into plans and operations, because you need to be ready. …Typhoon Haiyan in the Philippines gave us a possible glimpse of things to come – one of the worst cyclones ever recorded; thousands killed, many more displaced, billions of dollars in damage, and a massive international relief effort that included the United States military and its Coast Guard. So more extreme storms will mean more humanitarian missions to deliver lifesaving help.[15]

Military Core Competencies and National Power

While humanitarian assistance and disaster response are already substantial competencies of the Department of Defense and the US Coast Guard, among other government agencies, these missions are rapidly becoming more common and inevitable priorities for military service branch commanders to funnel more time, money, and resources into training, preparedness, and

readiness for these actions. While these important decisions to focus more towards helping foreign nationals recover from weather-related disasters, drought-induced famine, or any other factors leading to "human suffering, disease, hunger, or privation," these critical decisions could lead to erosion of combat readiness and unit effectiveness.[16]

A finite number of training hours exist in any given basic recruit training program, pre-deployment work-up period, and even in any specialized or advanced training school. Ideally, casting a wide net to train maximum available personnel in cultural relations, scalable response operations management, and international relations would much better position the Department of Defense as humanitarian workers and disaster response professionals. This should not become the intended objective or end-state of the world's largest, most professional, and most capable fighting force.

While the climate rapidly evolves and the future brings about relatively drastic change as compared to the previously documented centuries, the government faces countless challenges across the entire spectrum of national power employment using the Diplomatic, Informational, Military, Economic (DIME) model.[17]

Diplomatically, the US government has taken remarkable responsibility and ownership of the process to ensure freedom of navigation in the Arctic, and has actively participated in the recurring regional training and readiness exercises, planning meetings among the Arctic Council, the Northern Chiefs of Defense Conference, and the Arctic Security Forces Roundtable, and even hosted on occasion, the North Pacific Heads of Coast Guards Forum.[18]

Even though the US has not acceded to the UN Convention on the Law of the Seas (UNCLOS), the US has ensured its national sovereignty and exclusive economic rights through bilateral and multilateral agreements and continuous projection of sea power and presence.

Signing onto the UNCLOS does not yet provide a sound return on investment, given the relative concerns in the Arctic Ocean compared to any other ocean, UNCLOS does not amplify anything for the US already addressed through customary international law of the sea and codified through the International Maritime Organization.[19]

Knowing Root Causes Strengthens Infrastructure

While the foreign engagements and productivity toward collective strength and mutual assurance in the Arctic Ocean is strong and progressive, domestic interests and infrastructure are vulnerable. Where the Armed Forces need to focus and budget toward future safety, security, and long-term viability is on shore infrastructure vis-à-vis proximity to coastlines, flood zones, and fault lines. With polar ice melting and ocean temperatures increasing, the sea levels will rise and the wave surges associated with severe storms will become more devastating while reaching farther inland. Hurricane Sandy demonstrated this throughout the northeastern United States in late 2012, dumping storm surge waters up to eight feet above ground level in many of the worst inundated locations.[20]

Intoxicating Oceans

Furthermore, with increasing concentrations of carbon dioxide in the atmosphere, the ocean is straining to filter and absorb what it can, and the higher levels of CO_2 increase the acidity in the ocean water creating something called ocean acidification. Higher acidity affects biodiversity; marine life—such as small, shelled creatures—relies upon calcification from the water's chemistry to create, form, and harden their shells. Calcification—the accumulation of calcium salts—is hampered by the absence of the necessary carbonate ions due to too many carbon dioxide molecules in relation to water molecules and available carbonate ions. Shellfish essentially compete with the attacking carbon dioxide for the usage of carbonate ions to survive.

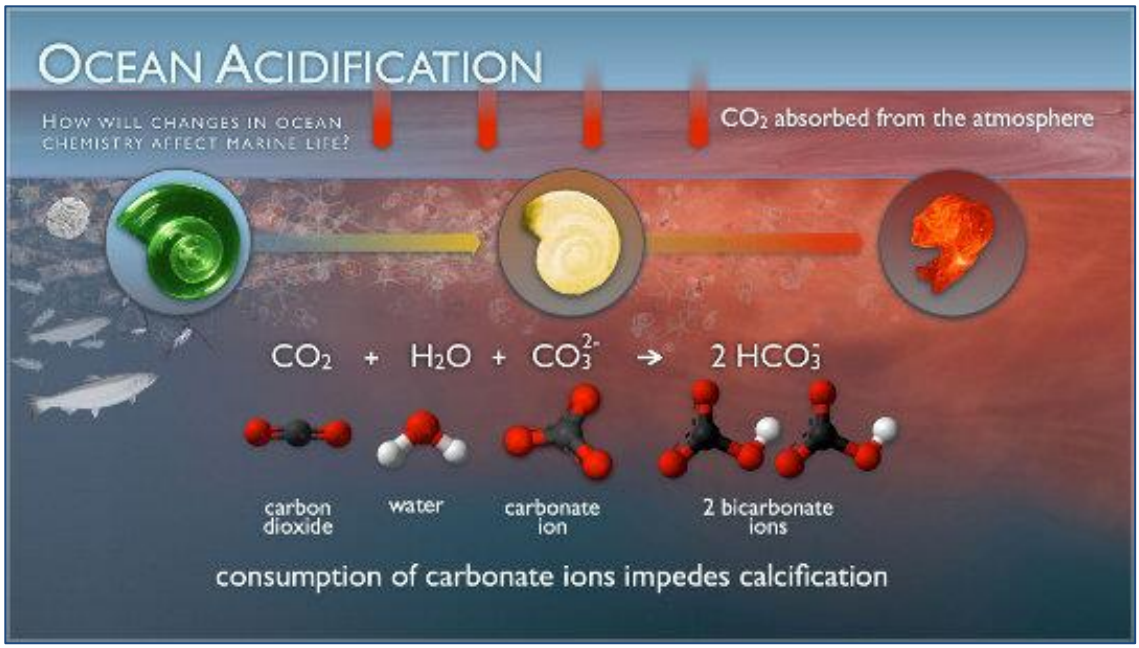

Figure 5: Ocean Acidification. Source: Pacific Marine Environment Laboratory, NOAA, http://www.pmel.noaa.gov/co2/story/Ocean+Acidification

Layering and Smothering Biodiversity

Additionally, ocean acidification leads to ocean stratification, a temperature layering effect with warmer surface water sitting on top of colder water, suppressing sunlight- and carbon-dioxide-hungry organisms to greater depths. The increases in carbon dioxide concentration in the ocean's surface via acidification or by organic consumption, such as by phytoplankton, creates an environment absent of the requisite microalgae to sustain a healthy ecosystem—due to too much warmth, too few nutrients, or both—threatening the entire food chain. Phytoplankton are the tiny organisms that "are a critical part of our planetary life support system…they produce half of the oxygen we breathe, draw down surface CO2, and ultimately support all of our fisheries," according to Boris Worm, a leading expert on global oceans, from Canada's Dalhousie University, in a 2010 article from Inter Press Service.[21]

As phytoplankton dive for cooler, more nutrient-rich waters, they leave the surface waters to further concentrate in acidity, and as the water becomes toxic to marine biology, it eventually

dissolves the fisheries for which, in 2013, "3.1 billion people relied upon to fulfill almost 20% of their average per capita intake of animal proteins," according to the latest report from the United Nations Food and Agriculture Organization.[22]

In developing countries, the reliance upon fisheries is much greater, and in many cases the population survives solely off of the local fishing industry. If climate change threatens marine life in the form of oceans becoming too warm or toxic, fish stock supply could reach a point where the regions become unstable from inability to harvest fish. This would rapidly lead to economic downturn with a lack of subsistence or sustainability through accessible alternative food stocks, and unrest would take hold; eventually conflict may occur. Enforcement of laws and treaties, and protection of living marine resources is of paramount interest for all mankind not only to preserve the existing resources, but also to ensure long-term viability of those resources. These protection measures should go hand-in-hand with environmental awareness and emissions regulations as they pertain to preservation of all food stocks reliant upon optimal environmental conditions—air, water, and sunlight—for growth and reproduction.

Recommendations for Readiness, Resilience, and Prevention

Renewable Energy Everywhere

As the US government looks to bolster or rebuild their near-shore infrastructure and renovate or build new inland construction due to climate-related concerns and sea level rise that will directly impact force readiness, it must do so with ever-more vigilant focus toward emissions reduction and renewable energy consumption. Opportunities exist in equipment design for incorporating solar, wind, wave, water, and geothermal technologies to offset or supplement conventional powertrains. The Navy's newest destroyer, USS ZUMWALT (DDG 1000), is rich with square footage surface area for solar panels. Ships could also take advantage of wind energy, both real and relative winds, as they are fully exposed to the elements while at sea.

Water turbines can generate electricity as vessels move through the water. Employing advanced hydrodynamic technologies, incorporating a series of water turbines would make their drag coefficient relative to the hull design insignificant if factored into the initial naval architecture. These same concepts could seamlessly develop in the commercial sector as well, with application aboard all maritime vessels.[23]

Figure 6: USS ZUMWALT (DDG 1000). Source: Power Electronics, http://powerelectronics.com/power-electronics-systems/us-navy-s-ddg-1000-incorporating-integrated-power-system-will-make-waves

Undoubtedly, adaptations to office buildings, housing areas, shopping complexes, and barracks for wind turbines, solar panels, and water, wave, and geothermal capture devices would all return significant reductions in conventional power consumption. In fitness centers, both aboard ships and in gyms ashore, rotational energy capture devices similar to presently-known automotive alternators, or power converters, should become regular attachments to workout equipment such as treadmills, stationary bicycles, stair-climbers, and all other electric equipment to not only recharge a battery cell storage system that could become self-sustaining for all attached equipment, but given the volume of exercise taking place in many of the nation's fitness

centers around the clock, these locations could stand to power the entire facility and perhaps more nearby. This technology has been employed in Hong Kong since 2007, and some US major cities have adopted the technology since 2010, all as a direct byproduct of increased exercise and physical personnel readiness.[24]

Modular, Transportable, Multi-Use Pier Systems

To help adapt to rising tides and storm surges, the government should further explore possibilities for new installation and retrofitting of double-deck floating pier structures such as the one researched and developed by BergerABAM in conjunction with US Naval Facilities Engineering Command (NAVFAC) as advertised in 2013 as their "Floating Double-Deck Pier (FDDP)…a new generation of berthing pier that offers a cost effective and sustainable alternative to traditional pile supported piers…easily reconfigurable and re-locatable…ideal for all legacy and envisioned classes of U.S. Navy ships except [nuclear powered aircraft carriers] and submarines."[25]

Figure 7A: Floating Double-Deck Pier. Source NAVFAC, https://www.navfac.navy.mil/content/dam/navfac/Specialty%20Centers/Engineering%20and%20Expeditionary%20Warfare%20Center/PDFs/ci_tech_data_sheets/TDS-NAVFAC-EXWC-CI-1410.pdf

Figure 7B: Floating Double-Deck Pier. Source NAVFAC, https://www.navfac.navy.mil/content/dam/navfac/Specialty%20Centers/Engineering%20and%20Expeditionary%20Warfare%20Center/PDFs/ci_tech_data_sheets/TDS-NAVFAC-EXWC-CI-1410.pdf

As Naval Station Norfolk, Virginia, has already demonstrated, outfitting the most susceptible and highest priority ports with these responsive pier systems could not only ensure ongoing normal operations in post-storm scenarios, but also guard against unplanned repair construction costs and downtime from training due to high-water mitigation efforts including isolating electrical and steam power to affected piers. Current and future projects to adjust piers to accommodate higher sea levels may limit the ability to maintain fleet readiness as dry-dock and dockside maintenance availabilities become limited due to dwindling usable pier space. Also, vessels moored in port rely upon mechanical and life-support systems attached to, and provided by, the piers. When waters rise and saltwater intrusion threatens those systems, engineers must shut them down to prevent significant damage, thus isolating any vessel moored to that pier, further impacting its in-port training, repairs, and readiness plans. Planning ahead for new construction now, installing floating piers with ample foresight and upland development

consideration, would afford port managers the ability to adjust these piers inland as the oceans consume more coastline. Ports with man-made sea walls and fixed quay walls will require further reinforcement or they will be susceptible to over-topping and consumption by the seas. Loss of pier space due to moorage maintenance, reconstruction, redevelopment, or condemnation due to weather or other impacts has a direct correlation to loss of vessel readiness. This is specifically concerning at piers where joint forces conduct rolling vehicle load-in or load-out operations between ships and shores.[26]

Conclusion

The US government must plan now for future significant tidal ranges, more harmful storm surges, devastating tsunamis, and other natural disasters by strengthening infrastructure with innovative technologies and flexible solutions. Such comprehensive planning will provide for required early relocation and prevention of costly devastation, resulting in much greater returns on capital investments; dividends will carry over into defense readiness and improved national security. Max Boot, a renowned military historian and foreign policy analyst, regularly argues in favor of recapitalizing the military force, especially during transition periods between major conflicts, and continuing to remain focused on quantity over quality when decision-makers are faced with reducing forces and replacing them with "fewer, more capable systems." Additionally, Boot states, "less money results in less capability," further engendering the paramount necessity of protecting sizeable defense budgets and investing in sustaining a super-power-sized military.[27]

If an entire naval station must evacuate due to forecasted seawater inundation, they could do so with a well-crafted logistics plan and operate in similar fashion as a Marine Corps Air-Ground Task Force: expeditionary, readily reconstituted according to a thorough plan ranging from

disassembly to reassembly, and additionally factoring in sustainable, renewable energy solutions. Continuity of Operations plans are not entirely cutting edge, and many likely lack vision and creativity. Their drafters base their assumptions on being able to return to the primary location within some given time after the threat or disaster has dissipated. New plans need to include the likelihood of never returning to the previous establishment and incorporate being able to reconstitute all operations from the ground up in a new and different location, using a systems approach to ensure energy, life support, force protection, and mission readiness, among all other dimensions of responsibility and sustainment, can rapidly materialize. Leveraging ongoing research and studies for projecting national military power in "places without bases" will easily propel domestic readiness in times where nature or other factors marginalize or eliminate existing bases.[28]

While greenhouse gases continue to pile up in the atmosphere, the planet gets warmer and more toxic, the polar ice melts and permits greater activity in the Arctic Ocean, and the US faces new and ongoing threats around the world, budgets still drive acquisition and strategy implementation success. Government leadership must appreciate and acknowledge results from studies such as the "Risk Quantification for Sustaining Coastal Military Installation Asset and Mission Capabilities," and always address the reality of soaring human populations, a reasonable expectation the planet can only support and filter so much pollution, and reactive approaches to fix what gets broken is not as fruitful as preventing it from getting broken in the first place. Achieving energy independence through full-scale support and budgeting of renewable energy projects will help guide the nation, and likely lead the world, towards preventing further climate damage and its associated second- and third order effects that lead to intra- and interstate conflicts that stand to threaten US national security.[29]

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